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AUTHOR	Weissman, Kenneth
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ABSTRACT

This booklet was designed for the use of junior high school or high school students. Detailed, step-by-step instructions are given for using the computer, for writing programs in BASIC, and for using the various commands in the BASIC language. A list of 75 computer programing ideas in varying degrees of difficulty is presented in the index. (MP)

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School BASIC

by

Kenneth Weissman
Benjamin Franklin High School

SECONDARY SCHOOL PUBLICATION

KIEWIT COMPUTATION CENTER
DARTMOUTH COLLEGE
HANOVER, NEW HAMPSHIRE 03755

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TABLE OF CONTENTS

FOREWARD TO TEACHERS

This booklet was designed for the use of Junior High School and High School students. A student who shows an interest in computers or has completed more than a semester of High School Algebra should be given the opportunity to use the regular BASIC Manual (latest edition).

While a limited number of exercises and program examples are given in this booklet, sets of TOPIC OUTLINES are available from:

NSF SECONDARY SCHOOL PROJECT
Kiewit Computation Center
Dartmouth College
Hanover, New Hampshire 03755

NOT ALL OF THE BASIC LANGUAGE IS EXPLAINED IN THIS BOOKLET.

Explanations of BASIC and other mathematical concepts contained herein have been adjusted to meet the needs and understanding of the "average" teenager.

A table of contents and index is provided for easier reference.

The specific individual ability, imagination, and creativity of the student determines to a large extent the meaningful and productive use of a time-sharing teletype in school. A high degree of teacher interest also leads to motivated students.

Ken Weissman

Preface

"A program is a set of directions that is used to tell a a computer how to provide an answer to some problem."

This booklet will explain many of these directions, so that you will be able to operate the computer. The directions are called a language.

The language that this booklet explains is called BASIC. It is a lot of fun to learn. However, not everything about the BASIC language is explained in this booklet. When you finish the booklet you might like to learn more. If you do, then ask your teacher for more information.

The computer you are using is a GE-635 located in the Kiewit Computation Center at Dartmouth College, Hanover, New Hampshire. You will be able to operate the Dartmouth Time-Sharing System (DTSS) computer from a teletype terminal at your school that uses regular telephone lines for communication.

CHAPTER ONE

USER NUMBER

Everybody needs a user number.

Get your user number from your teacher, or the person in charge. Write it below so you won't forget.

My user number:______________________ __________

TURNING ON THE TELETYPE

Directions are posted near most teletypes telling how to operate them.

There are several different models of teletype machines.

Usually you just push the originate button, marked ORIG. Some teletypes are marked LINE 1 or LINE 2, instead of ORIG. In a few seconds, you will hear a beep, and you are ready to start.

On some hook-ups, you may hear a dial-tone after pushing the ORIG button. If this happens, then dial anyone of these special phone numbers (don't pick up the phone):

7 6511 2091 2101

Then in a few seconds, you will hear a beep, and you are ready to start.

If you have any trouble, please let your teacher know about it, so that you can be helped.

NEW

After turning on the teletype, hearing the beep, and giving your user number, the computer will ask NEW OR OLD--.

If you are starting a NEW program, type NEW, and push the return key on the teletype.

(You must push the return key every time you have finished typing a line.)

The computer will then ask for the NEW FILE NAME--.

Make up a name. (You can name your program with any word up to 8 letters.)

Given below are some sample program names.

JOE FAT-2 X JACK BASEBALL

NOW YOU'RE READY TO WRITE A PROGRAM IN BASIC

The computer isn't very smart. You have to tell it everything it has to do, in a specific order.

The line numbers tell the computer in which order to do the program, usually lowest number first. Line numbers also make it easy for us to locate parts of the program so that we can make changes.

If you didn't already know that the computer could:

Add	(+)	
Multiply	(*)	
Divide	(/)	
Subtract	(-)	then you have just been informed.

Let's write a program that will multiply 15 by 3.

O.K.!! Here goes the program!

```
DARTMOUTH TIME-SHARING
TERMINAL 124 ON AT 10:49  12 AUG 69, 058 USERS   Heading typed by
DTSS TILL 2400.  LIST CCNEWS*** 6 AUG 69          teletype.

USER NUMBER--(Type your user number)
NEW OR OLD--NEW TIMES
READY
                        (remember to push the return key at
                        the end of every line)
10 PRINT 15*3
20 END
RUN

TIMES    08/12/69  10:50

 45

TIME: 0.038 SEC.
READY
```

That's all there is to it! After a second or so, the teletype will print your answer....45.

With this little bit of information, you can probably do most of the arithmetic you will ever need!

It's a simple job to change line 10 to either add (+), subtract (-), or divide (/). It is just as easy to change the numbers you want to work with.

NOW YOU'RE READY TO WRITE A PROGRAM IN BASIC (Continued)

Here is another program that adds three numbers 8,3, and 7:

(remember you must push the return key at the end of each line.)

```
NEW ADD
READY

10 PRINT 8+3+7
20 END
RUN

ADD      08/12/69  10:51

 18

TIME:  0.040 SEC.
READY
```

LINE NUMBERS

All programs have line numbers.

The line number identifies the line and tells the computer which lines to do in order. (Usually, lowest number first.)

We try to leave space between line numbers, so that we can place other lines between. (10,20,30 instead of 11,12,13, etc.)

A set of line numbers is shown below:

```
10
20
30      you can choose any set of line numbers you want.
35
59
80
etc.
```

When you have finished typing a line, you must push the return key on the teletype keyboard.

Line numbers may be typed in any order.

```
 8                                                 8
32  the computer will sort them from lowest to    15
15  highest---------------------------------->    19
19                                                32
```

You may eliminate any line simply by retyping the line number with nothing after it. (This is useful when making corrections.)

You may choose any set of line numbers you wish. Most people pick line numbers in the ten times table. (10,20,30,40,etc.)

MAKING CORRECTIONS

There are 5 major ways to make corrections when you are working on the teletype that is hooked into the DTSS (Dartmouth Time-Sharing System):

1. To eliminate the line you are working on, you can just retype the line number and start all over again.

2. To delete the line that you are working on, push the <u>control key</u> and the <u>X</u> key at the same time.

3. To delete one or two, or just a few letters, push the <u>shift key</u>and the O key at the same time. This produces a backwords arrow ← for each letter eliminated. An example is shown below:

SATRUDAY←←←←←URDAY

The computer will continue as if RUDAY was never typed.

4. You can type NEW at any time and eliminate or erase your entire current program.

5. You can type IGNORE at any time and everything since your last <u>command</u> will be ignored. <u>Some commands are</u>: RUN, LIST, SAVE, UNSAVE, REPLACE, NEW, OLD.

END

The last line of a program must contain the END statement. It looks like this:

```
999 END
```

Only one END is allowed in a program.

(The computer isn't too smart, and you have to tell it where the end of the program is.)

PRINT - Calculations

Calculations involving addition (+), subtraction (-), multiplication (*), or division (/) can be done with a PRINT statement.

Other calculations which will be explained later can also be done using the PRINT statement in the same manner. The names of some of these are:

Exponents (↑), Square root SQR(x), Sine SIN(x), Cosine COS(x), Tangent TAN(x), absolute value ABS(x), exponents to base e EXP(x), and complicated formulas that you can make up.

In the example below, the number 10 is divided by 2.

```
NEW JOE
READY
            (remember you must always push the return key at the
            end of every line.)
15 PRINT 10/2
20 END
RUN

JOE         08/12/69  10:53

 5

TIME:  0.039 SEC.
READY
```

The program will print the answer...5 after the RUN command is typed. The calculation of 10/2 is done by the computer.

Can you write a program that adds two numbers together?

Can you write a program that multiplies three numbers together?

PARENTHESES

The computer isn't able to determine what you really wanted to do if you make a mistake. It can only do what you tell it to do.

Suppose you wanted to find the average of two test grades 70 and 90. If you wrote this program like someone I know did, you would get the wrong answer.

WRONG

```
NEW AVERAGEW
READY

10 PRINT 70+90/2
20 END
RUN

AVERAGEW  08/12/69  10:54

 115

TIME:  0.041 SEC.
READY
```

The computer printed out 115 and we know this is wrong.

What we really wanted to do was to add 70+90 first, and then divide by 2. This can be done by using parentheses.

CORRECT

```
NEW AVERAGEC
READY

10 PRINT (70+90)/2
20 END
RUN

AVERAGEC  08/12/69  10:54

 80

TIME:  0.041 SEC.
READY
```

The computer will print out 80, the correct answer.

What happened here was that the computer first added 70+90 and got 160, then divided the 160 by 2 to get 80.

The computer is scheduled to do multiplication and division before addition and subtraction and then to proceed from left → to right in calculating answers.

Suppose we wanted to add 2+2 and then multiply the result by 3. If we simply wrote: 2+2*3 or 3*2+2, we would get the same <u>wrong</u> answer in both cases:

```
NEW TRY1
READY

10 PRINT 2+2*3
20 END
RUN

TRY1  08/12/69  10:55

 8

TIME:  0.041 SEC.
READY
```

or

```
NEW TRY2
READY

10 PRINT 3*2+2
20 END
RUN

TRY2  08/12/69  10:55

 8

TIME:  0.041 SEC.
READY
```

Of course, this isn't what we wanted to do. To correct this, we use parentheses:

```
NEW TRY
READY

10 PRINT (2+2)*3
20 END
RUN

TRY  08/12/69 10:56

 12

TIME:  0.039 SEC.
READY
```

A good rule to follow is that if you aren't sure what the computer will do, group your calculations with parentheses the way you want the problem solved.

A more complicated problem is shown below:

Suppose you wanted to add 3+5 and 2+7, then take both of these answers and multiply them together, after doing that you want to divide by the number 4. What expression would do that?

PARENTHESES (Continued)

```
NEW PARENTHE
READY

10 PRINT ((3+5)*(2+7))/4
20 END
RUN

PARENTHE  08/12/69  10:57

 18

TIME:  0.040 SEC.
READY
```

The answer that the computer will calculate is....18.

PRINT - Numbers

Suppose you just want to print a number. The PRINT statement can be used for this purpose.

```
NEW NUMBER
READY

10 PRINT8
20 END
RUN

NUMBER  08/12/69  10:58

 8

TIME:  0.039 SEC.
READY
```

The program will print the number 8 after you type the word RUN.

Write a program that will print the number 143.

```
NEW NUMBER1
READY

10 PRINT 143
20 END
RUN

NUMBER1  08/12/69  10:58

 143

TIME:  0.040 SEC.
READY
```

When the computer asks NEW OR OLD and you are calling-up a program that you have already worked on and saved, type the word OLD, and push the return key.

The computer will then ask for the OLD FILE NAME--.

Type the old program name exactly as you did the first time you used it.

Some OLD programs that have already been worked on and saved are given below (try them):

BANDIT*** BINGO*** (***indicates placed in the computer library)

CHANGING THE PROGRAM YOU ARE WORKING ON

At any time you may type NEW or OLD. This will allow you to start a new program or call-up an old program from a computer library called catalog.

Once you have a little experience, you can take a shortcut and call a program directly.

Two examples of this are shown below:

OLD BANDIT*** (return key)

The computer will answer READY *or*

NEW JOE (return key)

The computer will answer READY.

S KEY (STOP)

At any time, even when the teletype is printing, you may stop the program simply by pushing the letter S key on the keyboard, or typing the word STOP.

Certain other commands you will find useful are given below:

'RUN Command'

When you type RUN, your program will do the job (be executed), if properly written.

If not written correctly, the computer will tell you some of the errors, and where to look for them.

'LIST Command'

When you type LIST, your program (as written and corrected) will be listed on the teletype.

'SAVE Command'

If you wish to SAVE your program for some later time, type the word SAVE. The program is placed in an area in the computer called storage, or library, or catalog.

'UNSAVE Command'

If you wish to remove your program from storage (library or catalog) and UNSAVE it, type the word UNSAVE. This is almost the same as DESTRUCT in the TV program "Mission Impossible."

'REPLACE Command'

If you have already saved a program and wish to correct or modify it, type the word REPLACE or REP after making the latest correction.

'HELLO Command'

By typing HELLO or HEL you can change the user number without turning off (disconnecting) the telephone line.

'BYE or GOODBYE Command'

When typing BYE or GOODBYE, this is a signal to the computer that you wish to discontinue your work. The computer will then disconnect the teletype and erase everything you have done. You can avoid erasure by typing SAVE OR REP before typing BYE.

Now that you are an Official BASIC Programmer, Level One, you are ready to start on Level Two.

If you tried either:

OLD BANDIT*** or

OLD BINGO*** described earlier, you realize that there is more to programming than just adding or multiplying numbers together.

First, these programs used words and whole sentences, while you have used only numbers.

Second, these programs skipped or jumped lines and asked you questions.

This chapter will explain how some of this was done, so you can do it too.

MORE ON PRINT

A message to be printed must have quotes (" ") around it. Also, everything inside the quote symbols will be printed as typed.

A program to print the message SNOOPY SLEEPS is given below:

```
NEW SLEEPS
READY

30 PRINT "SNOOPY SLEEPS"
40 END
RUN

SLEEPS  08/12/69  10:59

SNOOPY SLEEPS

TIME:  0.040 SEC.
READY
```

Notice the quote symbols <u>before</u> and <u>after</u> the message

Write a program that will print your name.

Write a program that will print the name of your school.

You can have more than one PRINT statement in a program.

Shown below are two programs that print a message about Snoopy. The first program has a semi-colon, the second program doesn't.

The semi-colon (;) at the end of line 32 causes the next line to print right after it. Try the program both ways, with and without the semi-colon (;).

```
NEW SNOOP-1
READY

32 PRINT "SNOOPY SLEEPS";
34 PRINT "UNDER THE TREE."
39 END
RUN

SNOOP-1  08/12/69  11:02

SNOOPY SLEEPS UNDER THE TREE.

TIME:  0.049 SEC.
READY
```

```
NEW SNOOP-2
READY

32 PRINT "SNOOPY SLEEPS"
34 PRINT "UNDER THE TREE."
39 END
RUN

SNOOP-2  08/12/69  11:03

SNOOPY SLEEPS
UNDER THE TREE.

TIME:  0.049 SEC.
READY
```

It is very important to realize that the semi-colon(;) causes information to be squeezed or placed on the same line.

The comma (,) not shown on the preceding page places information fifteen spaces apart in 5 columns. The comma will be explained in greater detail later.

LINE JUMPING USING PRINT

We just learned that the PRINT statement permits the computer, by means of the teletype, to print or write a message.

We can use the PRINT statement in other ways.

The PRINT statement with nothing after it (without a message) is an order to make the paper on the teletype move-up one line.

An example of this program is given below:

20 PRINT 30 END	Paper moves up one line on the command RUN.

Can you write a program to jump the paper five lines?

Don't look at the answer!!! Try it first.

Most probably you chose the following program or something like it to make the paper jump five lines:

```
NEW JUMP-1
READY

21 PRINT
22 PRINT
23 PRINT
24 PRINT
25 PRINT
30 END
```

However, an easier method is available using the line-feed key.

Here it is:

```
21 PRINT "
                 Notice the line-feed key was used
                 between the quote symbols.

         "       Try it.
30 END
```

WHAT IS A VARIABLE?

A variable in the BASIC language is any one of the 26 letters of the alphabet.

Each letter (or variable) may be given a different number value at various points in our program.

However, we try to avoid using the letter 'O' (oh), because we can easily mix this letter up with the number zero.

Some examples of variables are given below:

A B C R S T W X Y Z

Can you name any three other variables not already shown?

SOME ADDITIONAL VARIABLES

If we use up all of the letters in the alphabet, the BASIC language has additional variables we can use.

Every letter followed by a number from 0 to 9 is also considered a variable. This combination of letter and number is treated just as if it were a single letter.

Some examples are given below:

A1 A6 H9 I7 Z5 B1 K3 L8

Is K25 a variable?	NO, because the letter is followed by a 2 digit number.
Is N6 a variable?	YES.
Is O3 a variable?	YES, but we try to avoid using the letter 'O' (oh), because we easily mix it up with the number zero.

THE LET STATEMENT USES VARIABLES (or letters)

So far, we have not assigned any number value to a letter.

The LET statement permits you to assign a value (some number) to a letter (variable).

A program using the LET statement is shown below:

```
NEW LET1
READY

10 LET X=5                          ' X IS ASSIGNED THE VALUE OF 5.
20 PRINT X                          ' THE 5 IS PRINTED.
30 END                              ' THE PROGRAM STOPS.
RUN

LET1  08/12/69  11:08

 5

TIME:  0.041 SEC.
READY
```

We didn't put a quote (" ") around X because we want the value of the variable X printed, not the letter X. Another way of saying this is: we want the number value assigned to X printed; in this case it was 5.

Here is another program:

```
NEW LET2
READY

10 LET X=5                          ' X IS ASSIGNED THE VALUE 5.
20 PRINT "X="X                      ' THE 5 IS PRINTED, SO IS X=.
30 END                              ' THE PROGRAM STOPS.
RUN

LET2  08/12/69  11:09

X= 5

TIME:  0.045 SEC.
READY
```

Here the program will print out: X=5

Another program using the LET statement and a different variable is shown below:

```
NEW LET3
READY

10 LET R3=5                          ' R3 IS ASSIGNED THE VALUE 5.
20 PRINT R3                          ' THE 5 IS PRINTED.
30 END                               ' THE PROGRAM STOPS.
RUN

LET3  08/12/69  11:10

 5

TIME:  0.044 SEC.
READY
```

Given below is a more complicated program that multiplies TWO letters (variables) together:

```
NEW LET4
READY

NEW LET4
READY

10 LET A=15
20 LET B=3
30 LET C=A*B
40 PRINT C
50 END
RUN

LET4  08/12/69  11:11

 45

TIME:  0.042 SEC.
READY
```

<u>or</u>

```
NEW LET5
READY

10 LET A=15
20 LET B=3
30 PRINT A*B
40 END
RUN

LET5  08/12/69  11:12

 45

TIME:  0.044 SEC.
READY
```

The answer 45 is printed by the teletype.

STRINGS ($)

We can let a variable be equal to an entire word or sentence, just by putting a dollar sign ($) after the letter.

This is an example of a string:

```
NEW STRING
READY

10 LET A$="SNOOPY SLEEPS"
20 LET B$="UNDER THE TREE."
30 PRINT A$;B$
40 END
RUN
```

Remember the semi-colon keeps the message on the same line. Close-up or tightly packed on the line.

```
STRING 08/12/69 11:13

SNOOPY SLEEPSUNDER THE TREE.

TIME: 0.054 SEC.
READY
```

The teletype will print:

SNOOPY SLEEPSUNDER THE TREE

We goofed! We didn't leave a space after SLEEPS, so the lines came together.

Let's fix it up. Just type line 10 correctly.

```
10 LET A$="SNOOPY SLEEPS "
RUN

STRING 08/12/69 11:13

SNOOPY SLEEPS UNDER THE TREE.

TIME: 0.052 SEC.
READY
```

Now the teletype printed:

SNOOPY SLEEPS UNDER THE TREE

I'm certain that you will want to try out strings for a little while before we go on to the next part of being a Computer Programmer Level Two.

Try printing your name using a string, or perhaps write a whole paragraph.

ASKING QUESTIONS (INPUT STATEMENT)

We can make a program ask a question, perhaps even ask your name and age. Below is a sample program that does just this:

```
NEW RED
10 PRINT "HI, MY NAME IS GE-635"
20 PRINT "WHAT IS YOUR NAME";
30 INPUT A$
40 PRINT "HOW OLD ARE YOU"
50 INPUT A
60 END
RUN
```

The computer will print:

```
HI, MY NAME IS GE-635
WHAT IS YOUR NAME?          and stop.
```

Notice the semi-colon causes the question mark (?) to be placed right after WHAT IS YOUR NAME. But, no question mark was in the program!!! Where did the question mark come from?

The INPUT statement causes a question mark (?) to be printed.

Notice we used a variable A$, because we expect to receive a word message (or string) back after the computer stops. The computer stops after the ? is printed on the teletype paper.

You answer: (Your own name or RED BARON, or whatever)

```
RED BARON (return key)
HOW OLD ARE YOU
?                 and stop.
```

Notice the semi-colon is missing on line 40, so the INPUT question mark (?) appears on the next line, and the teletype stops. Also, the variable this time was A, because we expect a number and not a word message.

You answer: (Your age, or 99, or some number) and (return key)

Can you write a program using INPUT statements?

Given below are two more useful statements that we will use shortly.

STOP

The STOP statement acts like the END statement, by ending or stopping the program.

STOP statements can be located anywhere, except the last line.

Examples of a STOP statement look like this:

```
10
20 STOP
30                        The program has 2 STOP statements.
37 STOP
40
45
90
110 END                   The END statement is always the last line.
```

GO TO

The GO TO statement permits the computer to jump around in a program and not follow the order of line numbers from lowest to highest.

An example of this is given below:

```
30 GOTO 47      When the computer reaches line 30, it is told to
41 STOP         go to line 47, jumping over the STOP on line 41.
47
53 GO TO 30     At line 53, it is told to go back to line 30,
99 END          starting the process all over again.
```

<u>This is called loop</u>.

Will this program ever end?

How can you break (get out of) the loop?

CHAPTER THREE

CONGRATULATIONS!!!!!!!!!!!!!!!!!

You are now an Official BASIC Programmer, Level Two. Of course, to be a Level Three Programmer requires more work on your part, and a lot more math.

This chapter deals with something called exponents, which is nothing more than a shorthand way of multiplying the same number together.

Also, this chapter works with fractions and explains what happens to them.

I'm certain that you would want to know more about loops which make things easier to program, and how to display your answers in a neater fashion.

EXPONENTS

In arithmetic, we have a shorthand way of saying 4 times 4. It is written 4^2. The little ^{2} is called an exponent. Of course, the answer is 16.

Also,

7X7	is	7^2	or	49
8X8	is	8^2	or	64
10X10X10	is	10^3	or	1000
2X2X2X2X2	is	2^5	or	32

What is 3^2? 5^2? 4^3?

In the BASIC language, we use the upward arrow (↑) to denote the exponent.

Suppose we wanted to find the area of a square whose side was 6, we could then write a program to do this:

```
NEW SQUARE
READY

10 PRINT 6↑2
20 END
RUN

SQUARE  08/12/69  11:16

 36

TIME:  0.040 SEC.
READY
```

Since the area of a square is its length times width, and in this case both were six, we could have written 10 PRINT 6*6 and have gotten the same answer.

SIGNS (+ and -)

Before every number in the BASIC language is a space for the sign. If it's positive, the sign is NOT printed and the space is left blank or empty. However, if it is negative or minus (-), the sign is put in by the computer.

All numbers must be either positive (+) or negative (-) in BASIC. Zero, of course, doesn't have a sign, but it does have the space.

FRACTIONS AND SCIENTIFIC NOTATION

Fractions

The computer understands the symbol (/) meaning division, as a fraction. However, all answers to problems are given as either:

(a)	Integers	0,1,2,3,-5,etc.
(b)	Decimals	0.1, .325, -.4,etc. or as an
(c)	Exponent	1.4E+9 (meaning 1400000000) or 1.2E-3 (meaning .0012)

Scientific Notation

Numbers larger than 8 digits are converted into the E notation, as well as decimals smaller than one-tenth (0.1). Some examples of this are given below:

(a) The number 45,176,325,416 has 11 digits. The computer will then change the number to: 4.51763E+10

(b) The number 39,165,216 will be printed as: 39165216

(c) The number 0.34561273215 will be printed as: 3.45612E-1

From the above, it can easily be shown that E+2 means 'times 100' or 10^2 and E+3 means 'times 1000' or 10^3. E-2 means 'divide by 100' or divide by 10^2.

This topic is usually called SCIENTIFIC NOTATION and additional questions about it should be asked of your teacher. It was presented here so that in the event you did get a number with E, you would be somewhat familiar with this strange type of answer and could find out more about it at that time.

FOR...NEXT LOOP

Loops make counting easier, as well as some other types of problems.

Suppose we wanted to print a series of numbers 1,2,3,4,5, etc. to 100. (Usually, this is written as 1,2,3,.. 100).

We could type out each number after a print statement something like this:

```
5 PRINT 1
10 PRINT 2
15 PRINT 3
etc.
```

This is very time consuming, but it would work!

There is a shorter way of doing this using a loop. In this case, the loop is called a FOR...NEXT loop because we use the words FOR and NEXT.

For every FOR there must be a NEXT in the program.

Here's how to use the FOR...NEXT statements:

Choose any letter (a dummy variable). I like the letter J. You can choose any letter you want.

```
NEW LOOP
READY

10 FOR J=1 TO 100
20 PRINT J;
30 NEXT J
40 END
RUN

LOOP   08/12/69   11:17

 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19  20
 21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38
 39  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56
 57  58  59  60  61  62  63  64  65  66  67  68  69  70  71  72  73  74
 75  76  77  78  79  80  81  82  83  84  85  86  87  88  89  90  91  92
 93  94  95  96  97  98  99  100

TIME:  0.257 SEC.
READY
```

I put the semi-colom (;) after J in line 20 because I wanted the numbers close-packed. A comma (,) would put 5 numbers on a line. Nothing after J would put the numbers underneath each other.

What happens here is that the J takes the value of 1, is printed by line 20, and sent back to line 10. The word NEXT <u>acts like</u> 'GOTO line 10'.

However, we already used 1, so it takes the next number 2, prints 2 and is sent back to line 10 by the NEXT. This continues, round and round (loop), until all the J's are used up.

When all the J's are used up, and we come to the NEXT, there is no NEXT J so the program goes onto line 40 which in this case is the end.

Suppose I wanted to write a program that would print out all of the whole numbers between 8 and 17. It's a simple matter using a FOR...NEXT loop to do this!

```
NEW LOOP-1
READY

10 FOR J=8 TO 17
20 PRINT J,
30 NEXT J
40 END
RUN

LOOP-1   08/12/69   11:19

 8               9               10               11               12
 13              14              15               16               17

TIME:  0.090 SEC.
READY
```

In this case, the numbers will be printed 5 to a line, 15 spaces apart because a comma (,) after J on line 20 was used.

Shown below are a number of other examples that can be done simply by retyping line 10.

(a) 10 FOR J=0 TO 4
(b) 10 FOR J=-5 TO 5
(c) 10 FOR J=-10 TO 0
(d) 10 FOR J=-100 TO 0
(e) 10 FOR J=100 TO 0 STEP -1

FOR...NEXT LOOP AND STEP

By retyping (e) in program LOOP-1 and LISTing we get:

```
LIST

LOOP-1  08/12/69  11:21

10 FOR J=100 TO 0 STEP -1
20 PRINT J,
30 NEXT J
40 END
READY                  (Line 20 is retyped to closely pack the numbers)

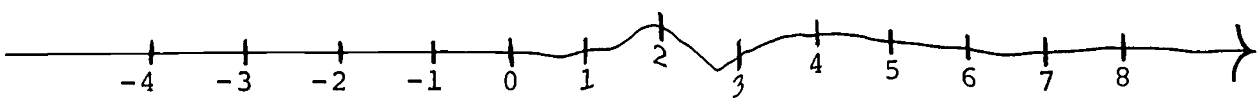
20 PRINT J;
RUN

LOOP-1  08/12/69  11:22

 100  99  98  97  96  95  94  93  92  91  90  89  88  87  86  85  84  8
 82   81  80  79  78  77  76  75  74  73  72  71  70  69  68  67  66  65
 64   63  62  61  60  59  58  57  56  55  54  53  52  51  50  49  48  47
 46   45  44  43  42  41  40  39  38  37  36  35  34  33  32  31  30  29
 28   27  26  25  24  23  22  21  20  19  18  17  16  15  14  13  12  11
 10   9   8   7   6   5   4   3   2   1   0

TIME:  0.259 SEC.
READY
```

The last example uses STEP -1, since the computer counts in a positive direction on the number line,...



and we wanted to count backwards, we instructed the program to do this with STEP -1.

We could write a number of things such as times tables and, odd and even numbers using STEP.

Below is a program that writes the 5 times table:

```
NEW FIVEX
READY

10 FOR X=5 TO 100 STEP 5
20 PRINT X;
30 NEXT X
40 END
RUN

FIVEX  08/12/69  11:24

 5  10  15  20  25  30  35  40  45  50  55  60  65  70  75  80  85  90
 95  100

TIME:  0.085 SEC.
READY
```

Retyping line 20 with a comma (,) after X spreads the numbers into five columns.

```
20 PRINT X,
RUN

FIVEX  08/12/69  11:24

 5                10                15                20                2
 30               35                40                45                5
 55               60                65                70                7
 80               85                90                95                1

TIME:  0.141 SEC.
READY
```

Write a program that prints the (a) 3 times table, (b) odd numbers, and (c) even numbers.

STEPs may be variables, decimals, fractions, integers, complicated formulas and negative or positive numbers.

MORE ON FOR...NEXT

Of course, we could have more than one FOR...NEXT loop in a program, but they cannot cross each other.

INCORRECT

```
FOR J
FOR R
NEXT J
NEXT R
```

CORRECT

```
FOR J
FOR R
NEXT R
NEXT J
```

We could have many FOR...NEXT loops, these being nested inside each other:

CORRECT

```
FOR J
FOR K
FOR R
NEXT R
FOR T
NEXT T
NEXT K
NEXT J
```

PREPARING A TABLE OF VALUES

Often it is necessary to prepare a table of values, so that you can see the relationship between variables in an equation. In the case below, the table of values can be used to graph the line y=3X+5.

```
NEW TABLE
READY

10 PRINT "TABLE OF VALUES FOR ";
20 PRINT "Y=3X+5"
30 PRINT
40 PRINT "X","Y"
50 PRINT
60 FOR X=-10 TO 10
70 LET Y=(3*X)+5
80 PRINT X,Y
90 NEXT X
100 END
RUN

TABLE  08/12/69  11:30

TABLE OF VALUES FOR Y=3X+5

X              Y

-10            -25
-9             -22
-8             -19
-7             -16
-6             -13
-5             -10
-4             -7
-3             -4
-2             -1
-1              2
 0              5
 1              8
 2              11
 3              14
 4              17
 5              20
 6              23
 7              26
 8              29
 9              32
 10             35

TIME:  0.243 SEC.
READY
```

Write a program to print a table of values from -5 to 5 of Y=4X-2.

Write a program to print a table of values from -5 to 5 of $Y=\frac{2X}{3}+4$.

HINT: LET Y=(((2*X)/3)+4)

THE LINE and TAB

Each line on the teletype has exactly 75 spaces numbered from 0 - 74. By using the TABulator, we can cause information to be printed at any specific location on a line.

Suppose we want the number seven (7) to be printed in the 13th space on the line. A program that will do this si shown below:

```
NEW TAB
READY

10 PRINT TAB(12);"7"
20 END

TAB 08/12/69  11:32

          7

TIME:   0.044 SEC.
READY
```

This program brings the line pointer to space 13 (remember 0 is the first" space, and 1 the second, etc.) and prints out 7. Since we used number no plus (+) or minus (-) sign or space was taken before the number.

```
NEW TAB1
READY

10 PRINT TAB(12);7
20 END
RUN

TAB1  08/12/69  11:33

           7

TIME:  0.045 SEC.
READY
```

This program will print the 7 in space 14 since space 13 has an invisible (+) sign. The quotes were removed from around 7.

You, of course, could have many TABs on a line, each separated by a semi-colon (;).

THE LINE AND TAB (Continued)

Instead of TAB, we might find it useful to use a comma (,) after a PRINT. The comma brings the line pointer to the next 15th space from where it is. Commas cause the line pointer to skip across from 0 - 14, 15 - 29, 30 to 44, 45 to 59, and 60 to 74. The pointer points to either 0, 15, 30, 45, or 60 and returns to 0 on the next line.

THE LINE and COMMA

The program shown below causes the number "7" to print at the space numbered 44. (This, of course, is the 45th space on the line 0 - 74.)

```
NEW COMMA
READY

10 PRINT ,,,"7"
20 END
RUN

COMMA  08/12/69  11:33

                                             7

TIME:  0.056 SEC.
READY
```

CHAPTER FOUR

You're really getting up there!!

Now that you have become a Level Three BASIC Programmer, you probably want to know more about BASIC.

This chapter deals with the mathematical concepts of inequalities and conditional statements called IF...THEN and ON... GO TO and GOSUB...RETURN.

In addition, a method for putting in large amounts of information either numbers or strings, is explained by the use of READ...DATA.

INEQUALITIES

In the BASIC language, as in mathematics, we have a great deal of use for inequalities. Shown below are the inequalities used in BASIC:

A<B	means A is less than B
A>B	means A is more than B
A=B	means A has the value of B
A<>B or A><B	means A does not have the value of B
A<=B or A=<B	means A is less than or has the value of B
A>=B or A=>B	means A is more than or has the value of B

IF...THEN

The IF...THEN statement is a method for making a decision or branching. In English, it is called a conditional statement "if something happens, then something will be sure to follow."

Some examples using IF...THEN statements are shown below: (The number after THEN refers to a line number in the program)

```
NEW RAIN
READY

10 PRINT "IS IT RAINING OUTSIDE";
20 INPUT A$
30 IF A$="YES" THEN 100
40 IF A$="NO" THEN 200
50 GO TO 10
100 PRINT "READ A BOOK OR PLAY CHECKERS."
110 STOP
200 PRINT "PLAY BALL!!!   GOOD WEATHER."
999 END
RUN
```

The program asks the question IS IT RAINING OUTSIDE?

If you answer YES, then you are sent to line 100 which gives indoor activities to do. If you answer NO, then you are told to play ball because of good weather. If you type in some other word like 'DON'T KNOW' neither the IF on line 30 or line 40 is done (executed) and you drop through to line 50 which sends you back to line 10 and asks the question all over again. The stop is placed on line 110 so that you won't print the statement on line 200. There is no stop on any line after 200 since the next line is END.

```
RAIN  08/12/69  11:38

IS IT RAINING OUTSIDE? YES
READ A BOOK OR PLAY CHECKERS.

TIME:  0.076 SEC.
READY

RUN

RAIN  08/12/69  11:38

IS IT RAINING OUTSIDE? NO
PLAY BALL!!!   GOOD WEATHER.

TIME:  0.078 SEC.
READY
```

Another sample is given below:

```
NEW TEMP
READY

10 PRINT "WHAT IS THE TEMPERATURE OUTSIDE";
20 INPUT A
30 IF A<32 THEN 300
40 IF A=32 THEN 200
50 IF A>32 THEN 100
100 PRINT "THE TEMPERATURE IS NOT YET FREEZING, GET YOUR ANTIFREEZE NOW."
101 STOP
200 PRINT "IT'S FREEZING NOW, ALMOST TOO LATE FOR ANTIFREEZE."
201 STOP
300 PRINT "IF YOU DIDN'T GET ANTIFREEZE YOUR CAR IS ZAPPED!!!!"
999 END
RUN
```

This program shows the use of inequalities on line 30, 40 and 50. We really didn't need line 50 since no other case could exist if line 30 or line 40 weren't done (executed). The THEN statements were so constructed that if line 50 wasn't there, the program would still work for temperature above 32 since it would print the correct statement when it reached line 100, and then stop.

```
TEMP   08/12/69   11:42

WHAT IS THE TEMPERATURE OUTSIDE? 25
IF YOU DIDN'T GET ANTIFREEZE YOUR CAR IS ZAPPED!!!!

TIME:  0.092 SEC.
READY

RUN

TEMP   08/12/69   11:42

WHAT IS THE TEMPERATURE OUTSIDE? 32
IT'S FREEZING NOW, ALMOST TOO LATE FOR ANTIFREEZE.

TIME:  0.094 SEC.
READY

RUN

TEMP   08/12/69   11:43

WHAT IS THE TEMPERATURE OUTSIDE? 101
THE TEMPERATURE IS NOT YET FREEZING, GET YOUR ANTIFREEZE NOW.

TIME:  0.098 SEC.
READY
```

ON...GO TO

Is similiar to the IF...THEN statement, but allows a many branched switch.

ON X GOTO 100,200,300,350 means:

If X = 1 GOTO 100

If X = 2 GOTO 200

If X = 3 GOTO 300

If X = 4 GOTO 350

The X may be a complicated formula

GOSUB and RETURN

As you become more experienced in BASIC your programs will probably become longer and more complicated.

Often you may have to do a certain routine a number of times. Suppose you would have to compute a complicated set of instructions a number of times in the same program. Instead of retyping out the set of instructions, you could place them at a suitable location, say line 850, and refer to them whenever you needed this set of procedures. This is accomplished by using the GOSUB and RETURN.

15 GOSUB 850 sends your program to line 850 and does the routine,in this case 2 lines,and then returns your program one line later when the word RETURN at the end of the routine is reached.

```
14 FOR X=1 to 10
15 GOSUB 850
16 NEXT X

     .
     .
     .
     .
840 STOP
850 LET A = (3.14) * (R↑2)
860 PRINT A, R, R 2
870 RETURN
```

Often you prepare a program, but do not know the exact information you are working with. This information is called DATA. It could be sales of teckets to the school basketball game, or election results or test grades. Anything that can be represented as either a number or word can be considered DATA.

DATA can be placed anywhere in your program, but is usually at the beginning or the end. It is suggested that DATA be placed, depending upon the size of your program, at lines 80 or 800 or 8000, etc.

READ statements use letters (variables) and can also be placed anywhere in your program. If you do not have enough DATA, or if you want the program to continue until all of the DATA is used up, the computer will print OUT OF DATA ON LINE ________, and end the program. This is a signal to you.

A program using READ and DATA is given below:

```
NEW LUNCHRM
READY

10 PRINT "SALES OF MILK AND SODA"
20 PRINT,"SEPT. 1969"
30 PRINT
40 READ A$,A
50 PRINT A$,A
60 GOTO 40
80 DATA MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY
90 DATA 32.40,23,5,76.45,27.40
99 END
RUN

LUNCHRM  08/12/69  11:46

SALES OF MILK AND SODA
              SEPT. 1969

MONDAY         32.4
TUESDAY        23
WEDNESDAY      5
THURSDAY       76.45
FRIDAY         27.4
OUT OF DATA IN 40

TIME:  0.122 SEC.
READY
```

READ and DATA, RESTORE

If the program has the word RESTORE, <u>all</u> the DATA can again be used from the beginning. RESTORE$ only restores the string DATA and RESTORE* only restores the numerical DATA.

In the program LUNCHRM, the RESTORE statement <u>was not</u> used.

If the words or strings are too complicated, it is sometimes necessary to put a pair of quote symbols around each particular piece of data. Examples of complicated strings are shown below:

```
800 DATA "SMITH, MR. JOHN", "SMITH, MRS. MARY"
810 DATA "SMITH, DR. & MRS. THOMAS", "336 PLEASANT AVE."
```

CHAPTER FIVE

Congratulations again!!!

We are certainly pleased that you have come this far in BASIC.

This chapter will discuss in greater detail exponents that are fractions (or decimals), something called functions and procedure of making your own functions.

Some special commands not given before will be described, plus the REMark statement. A whole group of things called the EDIT package will be explained, and of course, more math.

J = J+1,etc.

In arithmetic or algebra the statement J equals J + 1 is impossible! But in BASIC the equals sign does not have exactly the same meaning. Equals in BASIC means whatever is on the left side of the equals sign takes on the value of the right side.

A program using the idea of J = J + 1 is shown below:

```
NEW COUNTING
READY

10 LET J=J+1
20 PRINT J;
30 IF J= 100 THEN 50
40 GO TO 10
50 END
RUN

COUNTING  08/12/69  11:47

 1  2  3  4  5  6  7  8  9  10  11  12  13  14  15  16  17  18  19  20
 21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38
 39  40  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56
 57  58  59  60  61  62  63  64  65  66  67  68  69  70  71  72  73  74
 75  76  77  78  79  80  81  82  83  84  85  86  87  88  89  90  91  92
 93  94  95  96  97  98  99  100

TIME:  0.261 SEC.
READY
```

Line 10 says LET J be replaced by J+1. Since the first time through the J in J+1 was not assigned a value the computer said to itself that it was zero. Therefore line 10 LET J=J+1 gave the J on the left of the equals sign the value of 0+1.

Line 20 prints J or in this case the number 1, close packed because of the semi-colon(;).

Line 30 is checking statement if J is 100 then the program would go to line 50 or END. The J was not 100.

Line 40 sends the program to line 10 with J now equal to 1 not zero as before.

Line 10 says J=J+1 but now the J on the right is a 1, so 1+1 is 2. J on the left now has the value of 2.

Line 20 prints J...in this case the number 2.

Line 30 checks if J is 100! J is 2 not 100.

J=J+1 (Continued)

Line 40 sends program back to 10.

Line 10 now says Let J=J+1, but the J on the right side is a 2. Therefore 2+1 is 3.

Line 20 prints J...in this case the number 3.

Line 30 checks if J is 100. J is 3 not 100.

Line 40 sends program back to 10.

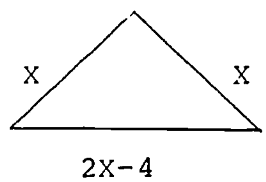
This continues until J = 100 and the check on line 30 sends the computer to line 50 or END.

MORE ON J=J+1

An excellent use for the idea of (concept) J=J+1 is problem solving. Below are a number of problems and solutions using the idea of J=J+1 in BASIC.

PROBLEM 1

The base of an isosceles triangle is 4 feet less than the sum of the two equal sides. The perimeter of the triangle is 76 feet. Find the length of each side. (X is a whole number.)




```
NEW
NEW FILE NAME--NEW PBLM1
READY

10 LET X=X+1
20 LET P=X+X+2*X-4
30 IF P=76 THEN 50
40 GO TO 10
50 PRINT X,X,2*X-4
60 END
RUN

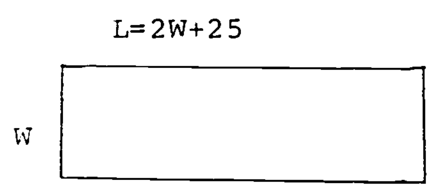
NEW  08/12/69  11:49

 20            20            36

TIME:  0.064 SEC.
READY
```

PROBLEM 2

The length of a yard exceeds twice its width by 25 feet, and 950 feet of fencing are needed to enclose it. Find its dimensions. (W is a whole number.)




```
NEW PBLM2
READY

10 LET W=W+1
20 LET L=2*W+25
30 LET P=2*L+2*W
40 IF P=950 THEN 60
50 GO TO 10
60 PRINT W,L,P
70 END
RUN

PBLM2  08/12/69  11:52

 150           325           950

TIME:  0.074 SEC.
READY
```

MORE ON J=J+1 (Continued)

PROBLEM 3

John and Otto picked 33 quarts of cherries. The number picked by John exceeded half the number picked by Otto by 3. How many did each pick?

```
NEW PBLM3
READY

10 LET O=O+1
20 LET J=(.5*O)+3
30 LET N=J+O
40 IF N=33 THEN 60
50 GO TO 10
60 PRINT "JOHN= "J,"OTTO= "O, "TOGETHER= "N
70 END
RUN

PBLM3  08/12/69  11:54

JOHN= 13                OTTO= 20                TOGETHER= 33

TIME: 0.071 SEC.
READY
```

An exit check should be inserted in programs PBLM1, PBLM2 and PBLM3 in the event that the answer is not a whole number, a sample exit check for PBLM3 is shown below:

```
45 IF N>33 THEN 65
64 STOP
65 PRINT "N>33, ANSWER NOT A WHOLE NUMBER"
```

Write an exit check for PBLM1 and PBLM2.

RADIAN MEASURE, ANGLES and π(Pi)

Of course you are aware that you <u>could</u> measure angles with something called a protractor.

The BASIC language does not use angles, but does use something called a radian. Before we discuss this function further you have been introduced to the symbol Pi (π) back in 6th, 7th, and 8th grades.

Do you remember what π stood for?

Sure you do: π was almost equal to 3 1/7 or 22/7 or 3.14.

The teletype does not have the symbol π on the keyboard so we are going to have to use a decimal. We use the following decimal for greater accuracy: 3.14159265

π = 3.14159265...for some purposes we need π to more decimal places

The area of a circle is π times the radius times the radius or:

$$A = \pi R^2$$

In BASIC this would be:

```
LET A = (3.14159265)*R↑2
```

The circumference of a circle was either:

$C = \pi D$ or $C = 2\pi R$

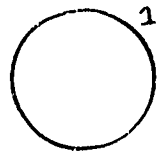
In BASIC you would write:

```
LET C = (3.14159265)*D
```

or

```
LET C = 2*(3.14159265)*R
```

A circle, of course has 360°, so if we start at point 1 and go all around the circle and return to point 1, we have then made a complete tour around the circle.



We could say we went 360° or better still 2π. Since 2π would seem to mean 360° or the circumference of the circle.

From this we could easily form the following table:

$$2\pi = 360°$$

$$\pi = 180°$$

$$\pi/2 = 90°$$

$$\pi/4 = 45°$$

$$\pi/6 = 30°$$

$$\pi/18 = 10°$$

I'm certain you could figure $\pi/3$ is 60° or 4π is 720°.

We now have a new meaning for π.

$$\pi = 180° = 3.14159265 \text{ (radian)}$$

By careful calculation we can find that a specific angle smaller than 60° has the value 1. This is called a radian.

$$\text{One radian} > 57°$$

$$< 58°$$

$$57° < (\text{one radian}) < 58°$$

All of the angles in the BASIC language are written in radian measure. Therefore it is necessary to convert radians to angles and angles to radians.

We use the following proportion to do these calculations:

$$\frac{180°}{\text{angle}} = \frac{3.14159265}{X}$$

If we have an angle of 90° and want to find its value in radians, we would do the following:

$$\frac{180°}{90°} = \frac{3.14159265}{X}$$

or

$$180°*X = 3.14159265 * 90°$$

or

$$X = \frac{3.14159265 \text{ X } 90°}{180°}$$

A BASIC program that does this (FOR 57.296°) is:

```
NEW X
READY

10 PRINT "WHAT ANGLE DO YOU WISH CONVERTED (LEAVE OFF DEGREE MARKS)"
20 INPUT A
30 LET X=(3.14159265)*A/180
40 PRINT X
50 END
RUN

X   08/12/69  17:05

WHAT ANGLE DO YOU WISH CONVERTED (LEAVE OFF DEGREE MARKS)
? 57.296
 1.

TIME:  0.079 SEC.
READY
```

We could make the answer a little fancier by replacing line 40 with:

```
40 PRINT A"  DEGREES = "X" RADIANS."
RUN

X  08/12/69  17:09

WHAT ANGLE DO YOU WISH CONVERTED (LEAVE OFF DEGREE MARKS)
? 57.296
 57.296 degrees = 1. RADIANS

TIME: 0.092 SEC.
READY
```

SINE, COSINE and TANGENT

In 9th year math or algebra we use functions called Sine, Cosine and Tangent. We must know how to convert angles to radians to use the computer in these problems.

SIN (X)	
COS (X)	All refer to X as radian measure.
TAN (X)	

The sine of 45° is written:

Sine $(\frac{\pi}{4})$ or Sine $(\frac{3.14159265}{4})$ or Sine (.785381625)

You can construct your own Sine, Cosine and Tangent tables using the following program:

```
NEW SOHCAHTOA
READY

SOHCAHTO  08/12/69  17:13

5 PRINT "ANGLE","RADIAN,"SINE,"COSINE","TANGENT"
10 FOR A=0 TO 90 STEP 10
20 LET X=(3.14159265)*A/180
30 PRINT A,X,SIN(X),COS(X),TAN(X)
40 NEXT A
99 END
READY

RUN

SOHCAHTO  08/12/69  17:13

ANGLE       RADIAN      SINE        COSINE       TANGENT
 0           0           0           1            0
 10          0.174533    0.173648    0.984808     0.176327
 20          0.349066    0.34202     0.939693     0.36397
 30          0.523599    0.5         0.866025     0.57735
 40          0.698132    0.642788    0.766044     0.8391
 50          0.872665    0.766044    0.642788     1.19175
 60          1.0472      0.866025    0.5          1.73205
 70          1.22173     0.939693    0.34202      2.74748
 80          1.39626     0.984808    0.173648     5.67128
 90          1.5708      1.          1.58933 E-8  6.29198 E+7

TIME:  0.360 SEC.
READY
```

REMARK also (APOSTROPHE ')

The REMark or REM statement has no effect upon the running of the program. It appears only on a listing as an aid to the programmer.

On long or complicated programs, the REM statement is used to explain to the programmer what is happening.

An apostrophe (') does the same thing as a REM statement and is quicker to type.

An incomplete program using the REM and (') is shown below:

```
10 LET X=(A*3.14)/180   ' CONVERTS DEGREES TO RADIANS
20 REM                    PRINTS OUT A TABLE OF SINES
30 FOR A =1 to 90       ' START OF LOOP IN A
40 PRINT A, SIN(X)      ' OUTPUT A, SIN(X)
   .
   .
   .
   ETC.
```

(Special Note: REM's can only be used immediately after a line number. In all other places, use the apostrophe (').)

FUNCTIONS

The BASIC language provides many other useful tools called functions. As you learn more Mathematics it will become easier for you to understand the use of these functions.

(The definitions below are not strictly defined nor listed completely-see full edition of BASIC Manual for a complete description.)

FUNCTIONS	INTERPRETATION	
SIN(X)	Find the sine of X	X interpreted as a number, or as an angle measured in radians
COS(X)	Find the cosine of X	
TAN(X)	Find the tangent of X	
COT(X)	Find the cotangent of X	
ATN(X)	Find the arctangent of X	
EXP(X)	Find e^x	
LOG(X)	Find the natural logarithm of X (ln x)	
ABS(X)	Find the absolute value of x; $\lvert x \rvert$	
SQR(X)	Find the square root of x ($\sqrt{x}$ or $x^{1/2}$)	
INT(X)	Gives the greatest integer not greater than X INT (1.38)=1 INT (12.99)=12 INT (-2.65)=-3	
RND	Produces random numbers	
SGN(X)	Produces 1,0 or -1 SGN (6.25)=1 SGN (0)=0 SGN (-3.15)=-1	
NUM	Counts the number of numbers after a MAT input (LET N = NUM)	
TIM	Gives running time of program in seconds	
CLK$	Has the value of the time (16:26:46)	
DAT$	Has the value of the date (06/23/69)	
USR$	Has the value of the user number	
VAL(S$)	Converts the string (S$) to a number	
LEN (S$)	Counts the letters in a string	
ASC (CHAR) or ASC (ASCII abbreviation)	Converts the letters in ASCII value	

FUNCTIONS, use of

An example of how to use one of these functions (SQR(X)) is shown below:

```
NEW SQROOT
READY

10 PRINT "THIS PROGRAM PREPARES A TABLE OF NUMBERS,SQUARES AND  ";
20 PRINT "SQUARE ROOTS."
30 PRINT "

         "
40 PRINT "NUMBER","SQUARE","SQUARE ROOT"
50 PRINT "------","------","-----------"
60 PRINT "
         "
70 FOR J=1 TO 25
80 PRINT J,J↑2,SQR(J)
90 NEXT J
99 END
RUN

SQROOT      08/12/69  17:18

THIS PROGRAM PREPARES A TABLE OF NUMBERS,SQUARES AND  SQUARE ROOTS.


NUMBER          SQUARE          SQUARE ROOT
------          ------          -----------


 1              1               1
 2              4               1.41421
 3              9               1.73205
 4              16              2
 5              25              2.23607
 6              36              2.44949
 7              49              2.64575
 8              64              2.82843
 9              81              3
 10             100             3.16228
 11             121             3.31662
 12             144             3.4641
 13             169             3.60555
 14             196             3.74166
 15             225             3.87298
 16             256             4
 17             289             4.12311
 18             324             4.24264
 19             361             4.3589
 20             400             4.47214
 21             441             4.58258
 22             484             4.69042
```

23	529	4.79583
24	576	4.89898
25	625	5

ROUNDING OFF (DECIMAL PLACES)

Using the INTeger function we are able to round-off numbers to the nearest tenth (one decimal place) or nearest hundredth (two decimal places) or to whatever number of decimal places wanted.

```
10 LET X= (some number)
20 PRINT INT(10*X+.5)/10↑2
30 END
```

Will round-off a number to two decimal places.

The following program will round-off a number to any number of decimal places needed:

```
10 LET X= (some number)
20 LET D= (number of decimal places)
30 PRINT INT(X*10↑D+.5)/10↑D
```

DEF

Often it is necessary for you to create your own functions. You can do this in each program using a DEFine statement.

Of course as an alternate to this procedure you could always use a GOSUB and RETURN as previously discussed.

THE DEF STATEMENT is always followed by a space and the letters FNA or FNB or FNC, etc. All the way to FNZ.

Therefore you can create up to 26 DEF FN'S in your program for numbers. The two programs below print out a table of sines.

```
NEW SINETAB1
READY

10 DEF FNA(X)=(X*3.14159265)/180
20 DEF FNB(X)=SIN(FNA(X))
30 PRINT "ANGLE","SINE"
40 FOR X=0 TO 180 STEP 10
50 PRINT X,FNB(X)
60 NEXT X
70 END
RUN

SINETAB1   08/12/69   17:23

ANGLE          SINE
 0              0
 10             0.173648
 20             0.34202
 30             0.5
 40             0.642788
 50             0.766044
 60             0.866025
 70             0.939693
 80             0.984808
 90             1.
 100            0.984808
 110            0.939693
 120            0.866025
 130            0.766044
 140            0.642788
 150            0.5
 160            0.34202
 170            0.173648
 180            3.614 E-9

TIME:  0.277 SEC.
READY
```

or

```
NEW SINETAB2
READY

10 DEF FNC(Y)=SIN (Y*3.14159265/1
30 PRINT "ANGLE","SINE"
40 FOR Z=0 TO 180 STEP 10
50 PRINT Z,FNC(Z)
60 NEXT Z
70 END
RUN

SINETAB2   08/12/69   17:26

ANGLE          SINE
 0              0
 10             0.173648
 20             0.34202
 30             0.5
 40             0.642788
 50             0.766044
 60             0.866025
 70             0.939693
 80             0.984808
 90             1.
 100            0.984808
 110            0.939693
 120            0.866025
 130            0.766044
 140            0.642788
 150            0.5
 160            0.34202
 170            0.173648
 180            3.614 E-9

TIME:  0.267 SEC.
READY
```

Please consult the regular BASIC Manual for more information about the use of DEF.

The square root of 25 is 5.
The square root of 36 is 6.
The square root of 1 is 1.

We can define the square root as "what number times itself makes" 81? the answer is 9.

The square root of 100 is 10.

The square root of 50 is ... a decimal larger than 7, but smaller than 8. Why?

No number times itself exactly equals 50. You can say 5 times 10 is 50, but this isn't a number times itself. Seven times seven is 49, eight times eight is 64. Then of course the square root of 50 must be more than seven and less than eight.

What is the square root of 50?

We can use the SQR(X) function to find square root. A program to do this is given below:

This program finds the square root of 50:

```
NEW ROOTS
READY

10 PRINT SQR(50)
20 END
RUN

ROOTS  08/12/69  17:27

 7.07107

TIME:  0.042 SEC.
READY
```

We could expand the idea of square root!!!

In fact, we could think of square root as the inverse of the exponent ^{2}. Below is a table of squares and square roots.

N Number	N^2 Square	$\sqrt{N}$ or N↑(1/2) Square Root
1	1	1
2	4	1.414
3	9	1.732
4	16	2
.	.	.
.	.	.
.	.	.

We can easily write a program to prepare this table:

```
NEW ROOT1
READY

10 PRINT "N","N↑2","N↑(1/2)"
20 PRINT"
        "
30 FOR N=1 TO 10
40 PRINT N,N↑2,N↑(1/2)
50 NEXT N
60 END
RUN

ROOT1     08/12/69  17:29

N              N↑2            N↑(1/2)


 1              1              1
 2              4              1.41421
 3              9              1.73205
 4              16             2.
 5              25             2.23607
 6              36             2.44949
 7              49             2.64575
 8              64             2.82843
 9              81             3.
10              100            3.16228

TIME:  0.226 SEC.
READY
```

Since we defined square root as N↑(1/2) or N raised to the 1/2 power (exponent). We can think of cube root as N↑(1/3)

ROOT	BASIC EXPRESSION	INTERPRETATION
SQUARE ROOT	N↑(1/2)	SQUARE ROOT OF N
CUBE ROOT	N↑(1/3)	CUBE ROOT OF N
FOURTH ROOT	N↑(1/4)	FOURTH ROOT OF N
FIFTH ROOT	N↑(1/5)	FIFTH ROOT OF N
.	.	.
.	.	.
.	.	.

CUBE ROOT DEFINITION

"What number times itself, three times" makes 8:

N * N * N = 8   The cube root is 2.

"What number times itself, three times" makes 27?

N * N * N = 27 The cube root is 3.

Can <u>you</u> write a simple definition for the 4th root or N↑(1/4)?

Listed below are some other commands that you might find useful:

'LIST (space) (line number)'

allows you to list a part of your program starting at a specific line number. (i.e. LIS 320)

'SYS'

allows you to change the system from the BASIC language. (i.e. FORTRAN, ALGOL, LAFFF)

'CAT'

allows you to get a list of all of your program names (or files) that you have saved.

'RENAME'

allows you to rename a program without destroying it.

'SCRATCH'

allows you to destroy your current program and let its name remain.

'(RETURN KEY)'

allows you to find out how long your program has been running after you type RUN.

'OLD DARTCAT***'

You can only LIST this file. LISTs all subjects filed in Dartmouth College Computer Library. From this you then LIST the subject to get specific programs.

'(CONTROL SHIFT P)'

Stops your program when nothing else works, also called break.

'TTY'

Supplies information about your teletype. (i.e. teletype number, programmer, language, status).

'CATALOG'

May also be called with special option codes these are:

LEN (length)
DLU (date last used)
DLM (date last modified)

ALL (all options)
SEL (starts a request for specific file names)

CHAPTER SIX

ADVANCED BASIC

This chapter contains information on the more advanced concepts and ideas in the BASIC language. Details on how to use these concepts are obtainable by calling the specific information from the computer. (i.e. EDIT) or by consulting the regular edition of the BASIC manual.

This chapter includes such topics as secret passwords, debugging programs, the EDIT package, MATRIX and determinants, files, random numbers and flags.

PASSWORDS

Certain user numbers have passwords. Passwords for user numbers are available from your teacher.

Programs (or files) can have passwords, too!

(Caution: Since only you know what the password is, and if you use too many passwords, and forget what password belongs to what program the programs are lost to you and everybody else.)

Therefore, please use the same password on all your programs. Most programs don't need passwords at all. To place a password on your program do the following:

```
NEW JOE
READY
SAVE JOE,PASSWORD:
```

The 'password' is assigned to the program JOE.

Your teacher has a special book in which passwords are recorded for each student. Students may get and use as many passwords as necessary.

DEBUGGING

If your program seems to have errors (or bugs), then it needs correction (debugging.)

First, retype RUN for error messages.

Second, correct error messages. Type LIST.

Third, retype RUN for additional error messages.

Fourth, correct error messages again. Type LIST.

Fifth, continue until no error messages appear on RUN.

Sixth, if program still doesn't work, recheck for missing PRINT statements and incomplete DATA.

Seventh, ask for help!

Your teacher has a special TRACE program available

The EDIT (or EDI) functions available are listed below:

EDIT	APPEND	DELETE	DESEQUENCE	LIST	GMD
EXPLAIN	INSERT	EXTRACT	RESEQUENCE	LOCATE	LIFE
HELP	JOIN	MOVE	SEQUENCE	PAGE	JGK
				STRING	SID

To find out how to use any of these functions type:

EDIT EXPLAIN (name of function)

or

EDI EXP (name of function)

For more information about EDIT in general type:

EDIT EXPLAIN EDIT

(Mathematicians and computer programmers enjoy themselves and like a little bit of entertainment. Four of the functions listed above are for this purpose. Can you find them?)

MATRIX and DETERMINANTS

A set of instructions for the use of the many MATRIX statements are available from your teacher, or from the regular BASIC Manual (latest edition.)

If you are interested in finding out about this topic, please ask your teacher.

FILES

A set of instructions for the use of the many FILE statements are available from your teacher, or from the regular BASIC Manual (latest edition.)

If you are interested in finding out more about this topic, please ask your teacher.

ERROR MESSAGES

See the regular BASIC Manual for an explanation or description of the many error messages that DTSS provides. Listings of the error messages and their explanations are posted near the teletype.

FLAGS

'Flags' are used by programmers to signal certain changes in routine. Often the numbers -1 or 0 are used as a flag.

The program below would eventually produce an OUT OF DATA message when RUN.

```
NEW FLAG
READY

10 READ A
20 PRINT A;
30 GO TO 10
80 DATA 1,3,4,5,6,7,2,5,6,7
99 END
RUN

FLAG       08/2/69   11:46

 1   3   4   5   6   7   2   5   6   7
OUT OF DATA IN 10

TIME:  0.071 SEC.
READY
```

By inserting the two lines below, the program is given a FLAG to finish the program without printing the OUT OF DATA message.

```
15 IF A=-1 THEN 99              'CHECKING FOR FLAG -1
90 DATA -1                      'LAST PIECE OF DATA IS SET TO -1
LIST


FLAG      08/20/69

10 READ A
15 IF A=-1 THEN 99              'CHECKING FOR FLAG -1
20 PRINT A:
30 GO TO 10
80 DATA 1,3,4,5,6,7,2,5,6,7
90 DATA -1                      'LAST PIECE OF DATA IS SET TO -1
99 END
READY

RUN

FLAG       08/20/69   11:48

 1   3   4   5   6   7   2   5   6   7

TIME:  0.071 SEC.
READY
```

RND and RANDOMIZE

RND produces a sequence of numbers between .000000 and .999999 from a table of random numbers. Each time you run RND the same sequence of numbers will be prepared.

Shown below is a program using RND:

```
NEW RND
READY

10 PRINT RND,
15 GO TO 10
99 END
RUN

RND        08/20/69  09:53

 0.406533       0.927599       0.264283       0.789368       0.976272
 0.948228       0.165784       0.328597       0.552183       0.615669
 0.912571       0.512762       0.53556        0.825354       0.777282
 0.907836       0.884522       9.99165 E-2    0.883958       0.109132
 0.742572       0.362751       0.216531       0.858972       0.133681
0.420067        0.786135

STOP

TIME:  0.999 SEC.
READY
```

RANDOMIZE when used with RND produces a random sequence of numbers between .000000 and .999999. A different sequence of numbers will be prepared each time.

Shown below is a program using RANDOMIZE with RND:

```
NEW RANDOMIZ
READY

5 RANDOMIZE
10 PRINT RND,
15 GO TO 10
99 END
RUN

RANDOMIZ  08/20/69   09:54

 0.867272       0.131017       0.246894       0.578099       0.527731
 0.659141       0.905874       0.781341       0.856027       0.182354
 0.14529        0.126799       0.428908       0.584435       0.935397
 0.43124        0.330366       0.425612       0.618403       0.217188
 0.929499       0.296386       0.624037       0.735241

STOP
```

By using the round-off procedure and INT function a sequence of numbers to the nearest tenth, hundredth, or whole number could be produced.

The following program will produce a sequence of numbers from the random number table between 0 and 99.

```
NEW RNDINT
READY

10 PRINT INT (RND*100);
20 GO TO 10
99 END
RUN

RNDINT    08/20/69  11:33

 40  92  26  78  97  94  16  32  55  61  91  51  53  82  77  90  88  9
 88  10  74  36  21  85  13  42  78  31
```

Can you write a program to produce a sequence of numbers between 0 and 999?

Can you write a program to produce a different sequence of numbers between 0 and 999 each time?

<u>APPENDIX A</u>

SOME SUGGESTIONS FOR STUDENT PROGRAMS

The following is taken from a list of computer programming ideas in varying degrees of difficulty prepared by Jean H. Danver under the NSF-Dartmouth Secondary School Project (NSF Grant GW-2246). For a full copy of this TOPIC OUTLINE, please contact:

KIEWIT COMPUTATION CENTER
Dartmouth College
Hanover, New Hampshire 03755

1. Write a program that will print out your name.

2. Write a program to find the product of two numbers.

3. Write a program that will read successive pairs of numbers and, on each pass, will print the numbers and their sum.

4. Write a program to read and compute the sum of the first 12 even integers.

5. Write a program to compare two numbers. If the first is larger than the second print, "NOT LESS THAN OR EQUAL". Otherwise print. "LESS THAN OR EQUAL TO".

6. Write a program to generate and compute the first ten integers and their cubes.

7. Write a program to find the sum of pairs of numbers. Print out each number and the sum in appropriate headed columns.

8. Write a program to divide any two numbers.

9. Read a list of numbers and print them out in as few rows as possible.

10. Read a list of numbers and print out every other number.

11. Read a list of numbers and print them out in two columns:

    a) As close together as possible
    b) As far as possible
    c) Somewhere in between

12. Write a program that will generate the first ten integers, c[illegible] squares and print out in columns headed:

    "[illegible]", "[illegible]e", "Sum of Squares'.

13. [illegible] generate the first 10 integers, compute

their square roots, print out the number and its square root in appropriately labeled columns.

14. Print out the numbers 1-30 in a) 5 columns, b) 7 columns, c) like this:

```
12345       678910

1112131415  1617181920

2122232425  2627282930
```

15. Add up the squares of odd numbers for 101 to 201.

16. Write a program to find the sum and products of pairs of numbers. Print out each number, the smaller first in appropriate headed columns. Arrange the printout so that the results of the last pair are printed first and the first pair printed last.

17. Consider the numbers .5 thru 5 in steps of .5 inclusive. Write a program that will center a three column table on the paper where the first column contains the numbers, the second column contains the fifth powers of the numbers, and the third column contains the fifth roots. Also, have headings for each column.

18. Write a program that will have the computer center a three column table on the page. The three columns should have headings and should contain the entries X, X to the fourth power, and the fourth root of X, where X takes on the values .5, 1.5, 2, .. 4.5, and 5.

19. Write a program to compute absolute value without using the command.

20. Write a program to round off numbers to the nearest 10, 100, 1000, 1/10, 1/100.

21. Write a program to round off numbers to any place desired.

22. Read any three numbers and print them out in descending (ascending) order.

23. Determine if one number is divisible by another.

24. Print out all integers between 1 and 100 which are:

    1. Divisible by 3 and 5
    2. " " 13
    3. " " 31

Also, find the sums of the numbers in each group.

SOME SUGGESTIONS FOR STUDENT PROGRAMS (Continued)

25. Compose a program which will find the largest factor of any number.

26. Determine the common factors of any two given numbers.

27. Write a program to determine the greatest common divisor (GCD) and lowest common multiple (LCM) of any two numbers.

28. Factor integer using the Method of Fermat.

29. Compute the greatest common divisor (GCD) of 2 given numbers through the use of the Euclidean Algorithm.

30. List the prime numbers up to a given number, N.

31. List the prime numbers between any two given numbers, N and M.

32. Express any number as a product of its prime factors.

33. Find the prime factors of a given number.

34. List all primes which are the sum of squares.

35. Program the Sieve of Eratosthenes.

36. Find all the pairs of twin primes between any two numbers.

37. Test numbers for primeness by the use of Wilson's Theorem ...n is prime if the only if (n-1) ! = -1 mod(n).

38. List N, N! and 1/N in 3 columns.

39. Find the sum of the first N odd numbered even numbers.

40. Locate the largest number in a sequence of numbers and its position in the sequence.

41. Find the smallest, the largest, and the difference between the smallest and the largest of a list of numbers.

42. Order a list of numbers.

43. Construct a table of squares and cubes of the multiples of 3 from 12 to 42.

44. Write a program to compute N↑E where N = any number and E = any integer without using the operator↑.

45. Write a program to compute $(X*Y)^2$ without using the command↑ or *.

46. Write a program using the random number generator to

generate 25 random integers between 1 and 100. Then print out the list hese integers from the smallest to the largest.

47. Change fractions t imals.

48. Write a program which will convert linear measures in the metric system (meters and centimeters only) to quivalent measures in the English system (feet and inches ly). INT(X) may be useful here.

49. Write a program to play the following game: The computer tries to guess a number you have in mind from one to 100. First, it guesses a number and you tell it if the number is too high or too low or correct. On the basis of the information you give, the computer guesses again. This continues until the computer guesses right!

50. Compose a program which will supply the decimal equivalents to the rational numbers 1/11, 2/11,..., 10/11. On the first pass through the program the equivalents should be rounded off to the nearest hundredth, on the second pass to the nearest thousandth, and on the third pass to the nearest ten-thousandth.

51. Program a general conversion between arbitrary bases.

52. List Pythagorean triplets.

53. List numbers which are the sums of two squares up to any given number.

54. Write a program to compute N mod M.

55. Write a program to determine if two numbers are congruent in mod M.

56. Print out modular arithmetic tables.

57. Program an algorithm to convert numbers from decimal to octal to binary.

58. Write a program to determine the solutions of a quadratic equation.

59. Write a program to solve 1st degree equations in one unknown.

60. Determine the slope of a line given any two points.

61. Find the square root of a number without using the operator SQR.

62. Program Newton's Method for approximating square roots. This is a guess and then averaging the divisor and quotient for a new guess.

63. Modify Newton's Method and approximate cube roots.

64. Write a program to calculate the sum of the first N terms of a geometric progression.

65. Write a program to generate a list of numbers which is the sum of corresponding elements of two other lists of equal number of elements.

66. Find the perimeter and area of various geometric figures.

67. Find the volume of various geometric figures.

68. Write a program to solve percentage word problems.

69. Change integers to Roman Numerals.

70. Read a four digit number. Print out the number and the number of times the digit 7 appears in the number.

71. Find sets of 5 numbers greater than zero which have a sum of 1000.

72. Given the coordinates of 4 points, determine whether they form the vertices of a square, a rhombus, a rectangle or a quad.

73. Given two sets A,B, compute A∪B and A∩B.

74. Write a program which tells if two sets are equal.

75. Write a program to solve the triangle problem--i.e., to find the sum of the perimeters of triangles inscribed in a 4 inch equilateral triangle if you continuously counted the mid-points of previous triangles.

INDEX

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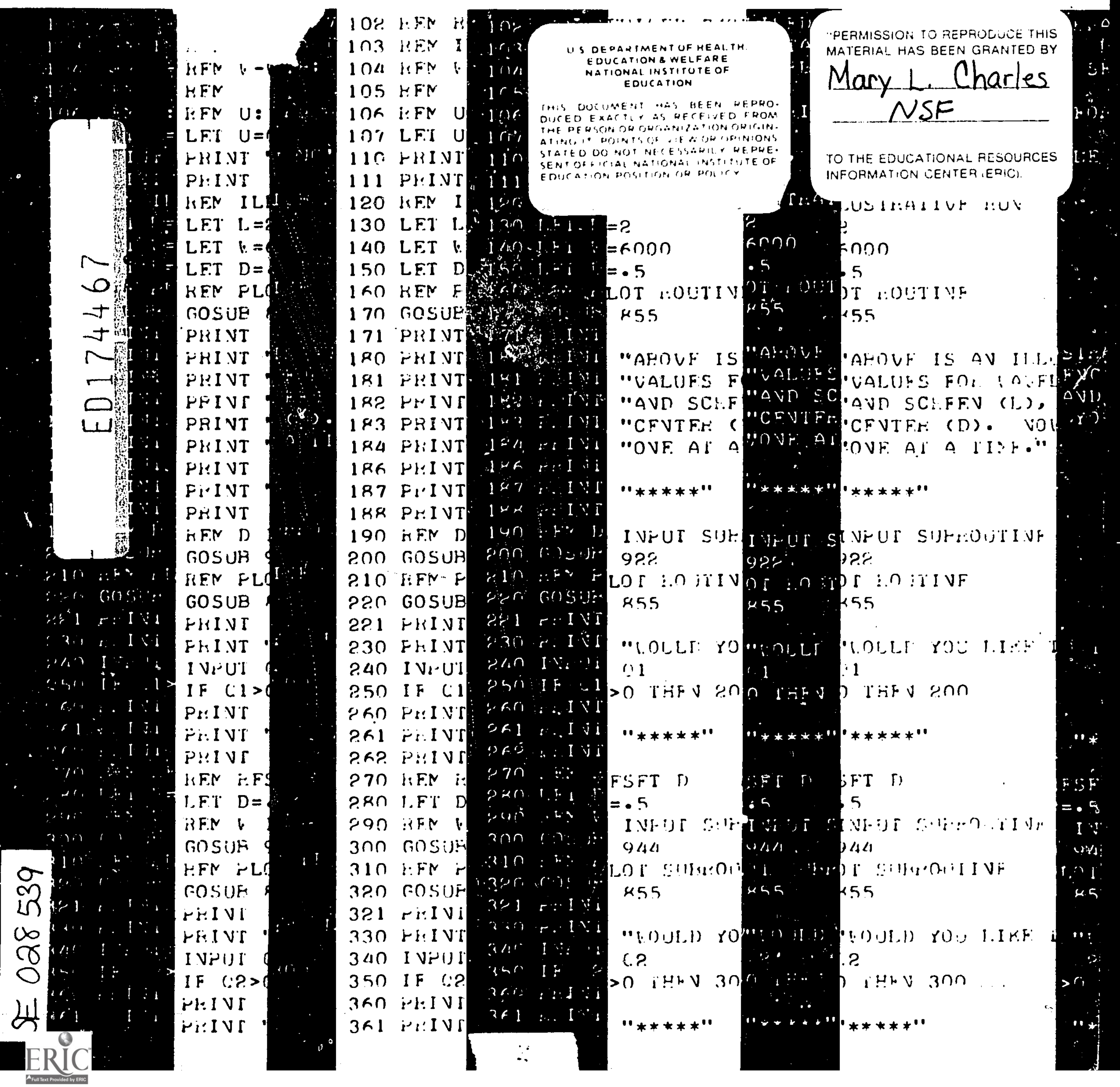
PTORS Biology; Chemistry; *Computer Programs; *Computers; Curriculum; Earth Science; *Instruction; *Learning Activities; Mathematics; *Mathematics Education; Physics; *Science Education; Secondary Education; Social Studies

T

A compilation of BASIC computer programs developed by s and students involved in the Huntington Computer Project is ed. The programs are grouped by subject area. The six subject re biology, earth science, chemistry mathematics, physics, studies, and teacher assistance. For each program, the ng information is given: (1) description; (2) objectives; (3) nary preparation for the student and for materials needed; (4) icn; (5) sample output; and (6) the BASIC program. (MP)

HUNTINGTON COMPUTER PROJECT

...TEACHERS MANUAL...



HUNTINGTON COMPUTER PROJECT

A TEACHER'S MANUAL

(COMPUTER - RELATED MATERIALS)

Second Edition

January 31, 1971

Director: Dr. Ludwig Braun
Assistant Director: Dr. Marian Visich, Jr.

Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

Developed by the Huntington Computer Project during the period May, 1968 and September, 1970. This effort was supported by the National Science Foundation under Grant No. J000079.

The enclosed material is a compilation of computer programs developed during the period May, 1968 to September, 1970. These programs were developed by teachers and students in the high schools which participated with us, and by the Project staff.

All of the enclosed programs have been tested on a Digital Equipment Corporation TSS-8 time-shared computer during the summer of 1970. To the best of our ability, we have assured ourselves that the programs actually run. It should be pointed out, however, that we were not able to make an exhaustive exploration of the programs. There may be undiscovered bugs (if there aren't, it may be the first time in the history of computing). We would appreciate hearing of any which emerge in the future.

These programs run in the version of BASIC which existed on the TSS-8 in August, 1970, and should run on most other versions of BASIC. The major potential problem on other machines is the output format (DEC uses 14 columns per print zone, while some other manufacturers use 15; we used the TAB function, which doesn't exist in all BASIC compiles). It may be necessary to make some minor changes in programs to adjust this format. Another possible problem is in the use of the RANDOMIZE command in some programs to start the random-number generator at a random point. If this command is not available, some other means should be devised for randomizing the start.

It is our sincere hope that these programs and their supporting documentation will be helpful to educators who are exploring the uses of computers in education.

We are anxious to hear of any bugs, errors, or improvements in these programs, and are especially anxious to hear of any novel ways of using them.

Ludwig Braun
Marian Visich, Jr.

TABLE OF CONTENTS

Volume I

Volume II

CHEMISTRY

Volume III

MATHEMATICS

MATHEMATICS (con't)

Volume IV

PHYSICS

PHYSICS (con't)

Volume V

SOCIAL STUDIES

Volume VI

TEACHER ASSISTANCE

DISCIPLINE BIOLOGY

SUBJECT GENETICS

PROGRAM NAME DROS

DESCRIPTION:

This program determines the genetic characteristics of the offspring of a pair of Drosophila flies with specified traits. A game approach is used involving the entire class, in which the students can select different genotypes.

OBJECTIVES:

To show the student:

A. The result of MEIOSIS and the effect of random assortment.

B. That various genetic recombinations occur in sex cells and in genotypes of offspring.

C. That if enough trials are run, Mendelian ratios are verified.

D. That he can simulate different genotypic conditions and determine the probability of the phenotypic outcome.

PRELIMINARY PREPARATION:

A. Student - An understanding of the concepts in the computer program GAMGN. It is best to use DROS as soon as possible after GAMGN.

B. Materials - Eight containers grouped in two sets of four and labeled A, B, C, D. Designate one of the group of four as male chromosomes, and the other as female. Into each container, place two slips of paper, one marked 1 and the other, 2.

Before beginning the program have a student:

1. Take out one slip of paper from each of the containers of the male group and mark the designation on the chalk board. For instance: A1, B2, C2, D1:
2. Take out one slip from each container of the female group and do the same as with the male group.

Decide what the phenotype would be by discussing it in class.

You will run the program using the information you have on the chalk board. It will give you the correct phenotype. See how the class' answer compares with the computer's.

DISCUSSION:

A. Operational Suggestions

1. Student level - average
2. This program can be used on a classroom basis.
3. Pitfalls to avoid - See that the students run the program several times and keep a record of each run. This is necessary to show the various possible combinations that can occur, and their frequencies.

B. Follow-up

After the program has been run:

1. Get as many runs as possible so that percentages can be determined for each phenotype of the offspring.
2. a) Determine the total number of offspring. Each run represents 1 offspring. Count them.
   b) Determine the total number of offspring which lived.
   c) Determine each phenotype and show that a ratio exists between dominant and recessive traits. (This should follow typical Mendelian ratios)
3. Elicit from the students:
   a) What was their role in the game? (The students conduct meiosis by randomly selecting the genotype of each gamete.)
   b) (When using a small number of runs) Why did the Mendelian ratios not hold true?

```
THIS PROGRAM IS DESIGNED TO GIVE THE GENETIC RESULTANT TRAITS
OF OFFSPRING WHOSE PARENTAGE WAS DISCUSSED IN PROGRAM 'GAMGN'

ARE YOU READY? HERE WE GO.

FOR THE SPERM CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 2
                    WHAT IS 'B'? 1
                    WHAT IS 'C'? 2
                    WHAT IS 'D'? 2
FOR THE EGG CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 2
                  WHAT IS 'B'? 1
                  WHAT IS 'C'? 1
                  WHAT IS 'D'? 1
OFFSPRING HAS NORMAL WINGS
AND IS RED EYED.

     LET'S TRY THIS SEVERAL TIMES AND SEE THE RESULTS WE GET
OVER SEVERAL TRIALS. KEEP A RECORD.
SHALL WE TRY AGAIN? IF YES TYPE 1, IF NO TYPE 0.
? 1
FOR THE SPERM CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                    WHAT IS 'B'? 2
                    WHAT IS 'C'? 2
                    WHAT IS 'D'? 2
FOR THE EGG CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                  WHAT IS 'B'? 2
                  WHAT IS 'C'? 1
                  WHAT IS 'D'? 1
OFFSPRING HAS VESTIGIAL WINGS
AND IS WHITE EYED

SHALL WE TRY AGAIN? IF YES TYPE 1, IF NO TYPE 0.
? 1
FOR THE SPERM CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                    WHAT IS 'B'? 1
                    WHAT IS 'C'? 2
                    WHAT IS 'D'? 2
FOR THE EGG CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                  WHAT IS 'B'? 2
                  WHAT IS 'C'? 1
                  WHAT IS 'D'? 2
OFFSPRING HAS VESTIGIAL WINGS
AND IS RED EYED.

SHALL WE TRY AGAIN? IF YES TYPE 1, IF NO TYPE 0.
? 1
FOR THE SPERM CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                    WHAT IS 'B'? 2
                    WHAT IS 'C'? 2
                    WHAT IS 'D'? 2
FOR THE EGG CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                  WHAT IS 'B'? 2
                  WHAT IS 'C'? 2
                  WHAT IS 'D'? 2
OFFSPRING HAS VESTIGIAL WINGS
AND IS WHITE EYED
```

```
SHALL WE TRY AGAIN? IF YES TYPE 1, IF NO TYPE 0.
? 1
FOR THE SPERM CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 2
                    WHAT IS 'B'? 1
                    WHAT IS 'C'? 1
                    WHAT IS 'D'? 1
FOR THE EGG CELL, WHAT IS 'A'? (TYPE 1 OR 2)? 1
                  WHAT IS 'B'? 1
                  WHAT IS 'C'? 1
                  WHAT IS 'D'? 1
DEVELOPING EMBRYO HAS DIED DUE TO LETHAL GENE ACTION.
SHALL WE TRY AGAIN? IF YES TYPE 1, IF NO TYPE 0.
? 0
     I HOPE THAT I HAVE BEEN OF SOME HELP TO YOU,
AND THAT 5 RUNS PROVIDE ENOUGH INFORMATION.

READY
```

```
100REM THIS PROGRAM DEVELOPED BY R. COOPERMAN--JOHN GLENN HIGH SCHOOL
110 REM  REVISED BY C.LOSIK  7-9-70
119 REM  C IS THE RUN COUNTER, ALL INPUTS ARE TEMPORARY
120 LET C=0
125 REM WE ASSIGN EACH GENE A "WEIGHT",
126 REM AND COMBINE THE WEIGHTS TO GIVE RESULTS !
130PRINT"THIS PROGRAM IS DESIGNED TO GIVE THE GENETIC RESULTANT TRAITS"
140PRINT"OF OFFSPRING WHOSE PARENTAGE WAS DISCUSSED IN PROGRAM 'GAMGN'"
150PRINT
440PRINT"ARE YOU READY? HERE WE GO."
450PRINT
540PRINT"FOR THE SPERM CELL, WHAT IS 'A'? (TYPE 1 OR 2)";
550 INPUT X
551 IF X=1 THEN 559
552 LET X=5
553 GO TO 560
559 LET X=10
560PRINT"                        WHAT IS 'B'";
570 INPUT Y
571 IF Y=1 THEN 579
572 LET Y=100
573 GO TO 580
579 LET Y=50
580PRINT"                        WHAT IS 'C'";
590 INPUT W
591 IF W=1 THEN 599
592 LET W=0
593 GO TO 600
599 LET W=500
600PRINT"                        WHAT IS 'D'";
610 INPUT Z
620PRINT"FOR THE EGG CELL, WHAT IS 'A'? (TYPE 1 OR 2)";
630 INPUT L
631 IF L=1 THEN 639
632 LET L=5
633 GO TO 640
639 LET L=10
640PRINT"                        WHAT IS 'B'";
650 INPUT M
651 IF M=1 THEN 659
652 LET M=100
653 GO TO 660
659 LET M=50
660PRINT"                        WHAT IS 'C'";
670 INPUT N
671 IF N=1 THEN 679
672 LET N=0
673 GO TO 680
679 LET N=500
680PRINT"                        WHAT IS 'D'";
690 INPUT O
```

```
700 LET T=W+N
710 LET S=Y+M
720 LET R=X+L
725 LET C=C+1
730 IF T<999 THEN 750
740PRINT"DEVELOPING EMBRYO HAS DIED DUE TO LETHAL GENE ACTION."
745 GO TO 910
750 IF R<19 THEN 770
760PRINT"OFFSPRING HAS VESTIGIAL WINGS"
765 GO TO 780
770PRINT"OFFSPRING HAS NORMAL WINGS"
780 IF S<199 THEN 800
790PRINT "AND IS WHITE EYED"
795 GO TO 910
800PRINT"AND IS RED EYED."
910 PRINT
915 IF C>1 THEN 940
920PRINT"      LET'S TRY THIS SEVERAL TIMES AND SEE THE RESULTS WE GET"
930PRINT"OVER SEVERAL TRIALS. KEEP A RECORD."
940 PRINT "SHALL WE TRY AGAIN? IF YES TYPE 1, IF NO TYPE 0."
950 INPUT I
960 IF I=1 THEN 540
963 IF I=0 THEN 970
966 GO TO 940
970PRINT"      I HOPE THAT I HAVE BEEN OF SOME HELP TO YOU,"
980 PRINT "AND THAT"C"RUNS PROVIDE ENOUGH INFORMATION."
990 END
```

DISCIPLINE BIOLOGY

SUBJECT EVOLUTION

PROGRAM NAME EVOLU

DESCRIPTION:

A population of dark and light pepper moths are studied over a period of 30 years. The student selects the year and direction of environmental changes which favors one or the other. The concept of natural selection in evolution is developed.

OBJECTIVES:

To show the student that:

A. The mutation rate within a population for a specific trait can be stable for a period of time, or can change. The success of the progeny exhibiting this variation is dependent upon environmental conditions.

B. Progeny exhibiting an hereditary trait do not necessarily reach maturity, because of the influence of environment.

C. Evolution depends upon mutation, heredity, and environmental pressures.

PRELIMINARY PREPARATION:

A. Student - An understanding of the following terms: 1) mutation rate, 2) species, 3) environmental change, 4) population.

B. Materials - 1) Specimens showing color variations within any species (optional); and 2) Ditto of the list of assumptions presented in this program (optional). Assumptions are listed below.

DISCUSSION:

A. Operational Suggestions

1. Student level - average
2. Group size - Work in small groups of five or less. Remaining students may be engaged in a related activity.
3. Assumptions - Prior to running the program, the students should be told to assume the following:

   a) The environment initially favors the light moths.
   b) At first, brown moths are produced, but because of environmental pressures they do not reach maturity.
   c) The total population in the area cannot exceed the initial number of moths, because this is the maximum number of moths the environment can support.

DISCUSSION: (con't)

4. Each group of students should run the program at least two times, varying the environmental pressure; once favoring the dark moths and once favoring the light.
5. You might have the runs of different groups of students reflect different mutation rates.
6. Supervision of the number of program runs per group is necessary since they are not automatically cut off.

B. Suggested Follow-up

These questions may be used to initiate discussion:

1. Why does the mutation rate remain constant? Does it always remain constant under natural conditions? Explain your reasons.
2. Assuming constant environmental conditions, how does changing the mutation rate affect the population? Why?
3. How does changing the mutation rate affect the dark moth population when environmental pressures favor these moths? Why?
4. What environmental pressures could favor the dark moths? (industrial expansion, predators which favor the light or dark moths) (The classic case of the pepper moths and the industrial revolution in England could be discussed at this point.)
5. What possible role might pollutants play in altering a mutation rate? What other factors could affect a mutation rate?
6. Is evolution a slow or fast process? Explain your answer.
7. Why do a few white moths always remain in the population, even though the environment favors the dark moths?
8. What is natural selection? What is its role in evolution?
9. Make a list of all factors important to evolution.

EVOLUTION STUDY

WITHIN A LARGE POPULATION OF PEPPER MOTHS, THERE ARE A FEW INDIVIDUALS WHICH SHOW-UP DARKER IN COLOR THAN THE NORMAL LIGHT COLORED MOTHS BECAUSE OF MUTATIONS.

YOU ARE GOING TO STUDY THIS POPULATION OF PEPPER MOTHS FOR 30 YEARS AND SEE WHAT HAPPENS TO THE NUMBER OF DARK MOTHS WHEN YOU ALTER ENVIRONMENTAL CONDITIONS.

SELECT A MUTATION RATE VALUE BETWEEN 1 AND 10. THE HIGHER THE NUMBER, THE HIGHER THE MUTATION RATE IS, AND THUS THERE ARE MORE DARK MOTHS IN OUR POPULATION.
? 9

HOW MANY LIGHT COLORED MOTHS ARE THERE IN THE AREA?
SELECT A NUMBER BETWEEN 1000 AND 1000000 ? 65789

YOU HAVE THE POWER TO CHANGE THE ENVIRONMENT.
AT WHAT POINT IN OUR THIRTY YEAR PERIOD DO YOU WANT TO IMPLEMENT YOUR POWER? SELECT A YEAR FROM 3 THROUGH 10.
? 5

IS THE ENVIRONMENTAL CHANGE GOING TO FAVOR LIGHT MOTHS (TYPE 1) OR DARK MOTHS (TYPE 2)? 2

HOW DO YOU WISH TO SEE THE RESULTS?
1=TABLE ONLY, 2=GRAPH ONLY, 0=BOTH? 0

FOR A MUTATION RATE OF 9

YEAR	DARK MOTHS	LIGHT MOTHS
1	0	65789
2	0	65789
3	0	65789
4	0	65789
5	5921	59868
6	11309	54480
7	16212	49577
8	20674	45115
9	24734	41055
10	28429	37360
11	31791	33998
12	34851	30938
13	37635	28154
14	40169	25620
15	42475	23314
16	44573	21216
17	46482	19307
18	48220	17569
19	49801	15988
20	51240	14549
21	52549	13240
22	53741	12048
23	54825	10964
24	55812	9977
25	56710	9079
26	57527	8262
27	58271	7518
28	58948	6841
29	59564	6225
30	60124	5665

```
                L=LIGHT MOTHS,    D=DARK MOTHS
                VALUES GRAPHED AS PERCENTAGE OF POPULATION.

     0                                               100
     I---------I---------I---------I---------I---------I
  1  D                                                 L
  2  D                                                 L
  3  D                                                 L
  4  D                                                 L
  5  I   D                                        L
  6  I       D                                L
  7  I           D                        L
  8  I              D                  L
  9  I                 D            L
 10  I                    D      L
 11  I                       DL
 12  I                      L  D
 13  I                    L      D
 14  I                  L          D
 15  I                L              D
 16  I               L                D
 17  I             L                    D
 18  I            L                      D
 19  I           L                        D
 20  I          L                          D
 21  I         L                            D
 22  I        L                              D
 23  I       L                                D
 24  I      L                                  D
 25  I     L                                    D
 26  I     L                                    D
 27  I    L                                      D
 28  I    L                                      D
 29  I   L                                        D
 30  I   L                                        D

DO YOU WANT TO RUN THIS PROGRAM AGAIN (1=YES,0=NO)? 1

SELECT A MUTATION RATE VALUE BETWEEN 1 AND 10.  THE
HIGHER THE NUMBER, THE HIGHER THE MUTATION RATE IS, AND THUS
THERE ARE MORE DARK MOTHS IN OUR POPULATION.
? 9

HOW MANY LIGHT COLORED MOTHS ARE THERE IN THE AREA?
SELECT A NUMBER BETWEEN 1000 AND 1000000 ? 65789

YOU HAVE THE POWER TO CHANGE THE ENVIRONMENT.
AT WHAT POINT IN OUR THIRTY YEAR PERIOD DO YOU WANT
TO IMPLEMENT YOUR POWER? SELECT A YEAR FROM 3 THROUGH 10.
? 5

IS THE ENVIRONMENTAL CHANGE GOING TO FAVOR
LIGHT MOTHS (TYPE 1) OR DARK MOTHS (TYPE 2)? 1

HOW DO YOU WISH TO SEE THE RESULTS?
1=TABLE ONLY, 2=GRAPH ONLY, 0=BOTH? 1
```

FOR A MUTATION RATE OF 9

YEAR	DARK MOTHS	LIGHT MOTHS
1	0	65789
2	0	65789
3	0	65789
4	0	65789
5	0	65789
6	0	65789
7	0	65789
8	0	65789
9	0	65789
10	0	65789
11	0	65789
12	0	65789
13	0	65789
14	0	65789
15	0	65789
16	0	65789
17	0	65789
18	0	65789
19	0	65789
20	0	65789
21	0	65789
22	0	65789
23	0	65789
24	0	65789
25	0	65789
26	0	65789
27	0	65789
28	0	65789
29	0	65789
30	0	65789

DO YOU WANT TO RUN THIS PROGRAM AGAIN (1=YES,0=NO)? 0

READY

```
100REM PROGRAM DEVELOPED BY DR. A. FRISHMAN, S.U.N.Y. FARMINGDALE
110REM AND R. COOPERMAN, JOHN GLENN HIGH SCHOOL.
112 REM  REVISED BY C.LOSIK  7-6-70
115 REM D=DARK MOTH ARRAY, L=LIGHT MOTH ARRAY, Z=MAX. POPUL.
116 DIM D(31), L(31)
117 PRINT " ","EVOLUTION STUDY"
118 PRINT
120PRINT"WITHIN A LARGE POPULATION OF PEPPER MOTHS, THERE ARE A FEW"
130PRINT"INDIVIDUALS WHICH SHOW UP DARKER IN COLOR THAN THE NORMAL"
140 PRINT "LIGHT COLORED MOTHS BECAUSE OF MUTATIONS."
150PRINT
160PRINT"YOU ARE GOING TO STUDY THIS POPULATION OF PEPPER MOTHS FOR 30"
170PRINT"YEARS AND SEE WHAT HAPPENS TO THE NUMBER OF DARK MOTHS WHEN"
180PRINT"YOU ALTER ENVIRONMENTAL CONDITIONS."
200 PRINT
210 PRINT "SELECT A MUTATION RATE VALUE BETWEEN 1 AND 10.  THE"
220PRINT"HIGHER THE NUMBER, THE HIGHER THE MUTATION RATE IS, AND THUS"
230 PRINT "THERE ARE MORE DARK MOTHS IN OUR POPULATION."
240INPUTM
250IFM<1THEN280
260 IF M<=10 THEN 310
280PRINT"THE MUTATION RATE YOU HAVE CHOSEN DOES NOT FALL WITHIN THE"
290PRINT"PRESCRIBED RANGE 1-10. TRY AGAIN."
300GOTO240
310 PRINT
330 PRINT "HOW MANY LIGHT COLORED MOTHS ARE THERE IN THE AREA?"
340 PRINT "SELECT A NUMBER BETWEEN 1000 AND 1000000 ";
350INPUTPO
360 IF PO<1E3 THEN 390
370 IF PO<=1E6 THEN 420
390PRINT"THE NUMBER OF MOTHS YOU HAVE CHOSEN DOES NOT FALL WITHIN THE"
400PRINT"PRESCRIBED RANGE 1000-1000000. TRY AGAIN."
410GOTO350
420LET Z=PO
430PRINT
440PRINT"YOU HAVE THE POWER TO CHANGE THE ENVIRONMENT."
450PRINT"AT WHAT POINT IN OUR THIRTY YEAR PERIOD DO YOU WANT"
460PRINT"TO IMPLEMENT YOUR POWER? SELECT A YEAR FROM 3 THROUGH 10."
470 INPUT X
480 IF X<3 THEN 492
490 IF X<=10 THEN 500
492 PRINT "THE YEAR CHOSEN DOES NOT FALL WITHIN THE RANGE 3-10."
494 PRINT "TRY AGAIN."
496 GO TO 470
500PRINT
510PRINT"IS THE ENVIRONMENTAL CHANGE GOING TO FAVOR"
520PRINT"LIGHT MOTHS (TYPE 1) OR DARK MOTHS (TYPE 2)";
530INPUT E
532 IF E=1 THEN 540
534 IF E=2 THEN 540
536 PRINT "PLEASE TYPE 1 OR 2 NOT";E
538 GO TO 530
540PRINT
600 REM ONE LOOP FOR CALCULATION
610 FOR T=1 TO 30
615 REM  CHECK IF ENVIRONMENT HAS CHANGED
620 IF T>=X THEN 650
625 REM  NOT YET (FAVORS LIGHT MOTHS)
630 LET P1=0
640 GO TO 710
649 REM  ENVIRONMENT HAS CHANGED
650 IF E<>2 THEN 630
660 LET P1=INT(P1+.01*M*PO+.5)
670 LET PO=INT(Z-P1+.5)
```

```
680 IF P1<2 THEN 710
689 REM  COMPLETE REVERSAL OF POPULATION HAS OCCURED
690 LET P1=2
700 LET P0=0
710 LET L(T)=P0
720 LET D(T)=P1
730 NEXT T
740 REM OUTPUT OF RESULTS
750 PRINT "HOW DO YOU WISH TO SEE THE RESULTS?"
760 PRINT "1=TABLE ONLY, 2=GRAPH ONLY, 0=BOTH";
770 INPUT E
780 FOR T=0TO2
790 IF E=T THEN 825
800 NEXT T
810 PRINT "AW C'MON. I'M NOT DUMB. TRY AGAIN."
820 GO TO 760
823 PRINT
825 PRINT
826 PRINT "FOR A MUTATION RATE OF";M
830 IF E>1 THEN 910
840 PRINT
850 PRINT
860 PRINT "YEAR", "DARK MOTHS", "LIGHT MOTHS"
870 PRINT "----", "---- -----", "----- -----"
875 REM  OUTPUT TABLE
880 FOR T=1 TO 30
890 PRINT T, D(T), L(T)
900 NEXT T
910 IF E=1 THEN 1080
915 PRINT
920 PRINT
925 PRINT " ","L=LIGHT MOTHS,    D=DARK MOTHS"
930 PRINT " ","VALUES GRAPHED AS PERCENTAGE OF POPULATION."
935 PRINT
940 REM SCALE OF GRAPH IS ZERO TO ONE
990 PRINT TAB(5);"0";TAB(54);"100"
1000 PRINT TAB(5);"I---------I---------I---------I---------I---------I"
1010 FOR T=1 TO 30
1020 PRINT T;TAB(5);"I";
1023 LET L(T)=50*L(T)/2
1026 LET D(T)=50*D(T)/2
1030 IF L(T)>D(T) THEN 1060
1040 IF D(T)> L(T) THEN 1070
1050 PRINT TAB(5+L(T));"*"
1055 GO TO 1075
1060 PRINT TAB (5+D(T));"D"; TAB(5+L(T));"L"
1065 GO TO 1075
1070 PRINT TAB(5+L(T));"L";TAB(5+D(T));"D"
1075 NEXT T
1080 PRINT
1090 PRINT
1100 PRINT "DO YOU WANT TO RUN THIS PROGRAM AGAIN (1=YES,0=NO)";
1110 INPUT E
1120 IF E=1 THEN 200
1130 IF E<>0 THEN 1100
1140 END
```

26

DISCIPLINE BIOLOGY

SUBJECT GAMETOGENESIS + INHERITANCE

PROGRAM NAME GAMGN

DESCRIPTION:

A review of the process of gametogenesis, applying it to the concept of dominant recessive traits.

OBJECTIVES:

A. To reinforce the meaning of the terms random assortment, meiotic divisions, monoploid, and diploid.

B. To allow the student to make decisions based upon knowledge gained in the program, thus causing the students to think.

C. To review and reinforce both spermatogenesis and oogenesis.

PRELIMINARY PREPARATION:

A. Student

1. Students should be familiar with all phases of meiosis.
2. Genetics should have been introduced so that the student understands the implications of gene action, dominance and recessiveness, homologous and non-homologous chromosomes.
3. Programming and machine knowledge. Keep in mind that for this program the students should be given time to try to determine what genetic traits are represented by the chromosome designation shown in the program.

normal wing - red eye	=	A1A2,	B1B2,	C1C2,	D1D2
normal wing - white eye	=	A1A2,	B2B2,	C1C2,	D1D2
vestigial wing	=	A1A1,	B1B2,	C1C2,	D1D2
lethal gene	=	A1A2,	B1B2,	C1C1,	D1D2

red eye	=	B1B2 or B1B1
white eye	=	B2B2 (recessive)
normal wing	=	A1A2 or A2A2
vestigial wing	=	A1A1 (recessive)
non lethal gene	=	C2C2
lethal gene carrier	=	C1C2
lethal (dies)	=	C1C1 (recessive)

B. Materials - none necessary

DISCUSSION:

A. Operational Suggestions

1. Student level - Average to above average ability
2. If the student is confused alert him to the fact that chromosomes are letters and the number following the letter represent genes. Similar letters indicate homologous chromosomes. (see program)
3. Read the program ahead of time to make sure your students are familiar with the terms used in the program.
4. If the students are thrown off the machine see that they review with the teacher the concept of gametogenesis before continuing with the program.
5. Ideally, students should work individually. If this is not possible, then work in groups of 5 or less. Allow one group at a time at the computer while the remaining groups are engaged in a related activity.

B. Suggested Follow-up

To maximize the value of this program, it is strongly suggested that the teacher:

1. Elicit from the students:

   What are the gene locations for the various genetic traits (eye color, wing normalcy, lethality)? Which is recessive? Which is dominant? Why is there no chance that the offspring will have the exact chromosomal composition of the father?

2. Ask the following questions, based on the information given, as lead-ins to discussion or as a homework assignment.

   (a) What is a polar body? How does the formation of polar bodies increase the survival chance of the egg cell?
   (b) How is random assortment responsible for genetic trait variations?
   (c) Why is it possible for all offspring to have the same traits without variations?

ARTICULATION INTO NEXT AREA TO BE COVERED:

This program can lead directly into the topic of genetics. A second program, DROS , appearing in the manual, should follow. It demonstrates, with a game, the random recombinations of the chromosomes in offspring, showing all possible combinations and, if repeated often enough, Mendelian ratios.

RUN

THE FOLLOWING DIAGRAMS ARE REPRESENTATIONS OF PRIMARY SEX CELLS. CHROMOSOMES ARE REPRESENTED BY LETTERS.

```
PRIMARY SPERMATOCYTE          PRIMARY OOCYTE
     ----------                    ----------
     ( A1 A2   )                   ( A3 A4   )
     (         )                   (         )
     ( B1 B2   )                   ( B3 B4   )
     ----------                    ----------
```

BY TYPING IN A NUMBER, WHAT IS THE DIPLOID NUMBER OF CHROMOSOMES FOR THIS ORGANISM? 4

SO YOU SEE THAT A1 + A2, FOR EXAMPLE, ARE PAIRS OF HOMOLOGOUS CHROMOSOMES. IT IS ESSENTIAL THAT AFTER FERTILIZATION, IF THE DIPLOID CONDITION IS TO BE RETAINED THAT WE HAVE SOME MEANS OF PLACING ONLY ONE A AND ONE B CHROMOSOME IN THE SPERM AND ONLY ONE A AND ONE B CHROMOSOME IN THE EGG. THIS INVOLVES MEIOSIS.

LOOK AT THE PRIMARY SPERMATOCYTE ABOVE.
DURING THE FIRST STAGE OF MEIOSIS, THE MALE SEX CELL SHOULD APPEAR AS IT IS IN ONE OF THE FOLLOWING DIAGRAMS.

```
     1             2             3             4             5
----------    ----------    ----------    ----------    ----------
( A1A1    )   ( A1   A2 )   (    A    )   (  A1 A2  )   (         )
(    A2A2 )   (         )   (         )   (         )   (         )
( B1B1    )   (         )   (         )   (         )   (         )
(    B2B2 )   ( B1   B2 )   (    B    )   (         )   (  B1 B2  )
----------    ----------    ----------    ----------    ----------
```

WHICH DIAGRAM MOST CLOSELY REPRESENTS THIS MEIOTIC STAGE ? 1

O.K., NOW WE CAN MOVE ALONG. MEIOTIC DIVISION OCCURS AND WE GET TWO SECONDARY SPERMATOCYTES FROM EACH PRIMARY SPERMATOCYTE AND ONE SECONDARY OOCYTE FROM EACH PRIMARY OOCYTE. EACH SPERMATOCYTE CONTAINS THE FOLLOWING CHROMOSOMES: A1 A2, B1 B2.   EACH OOCYTE HAS A3 A4, B3 B4.

THE REASON WHY ONLY ONE OOCYTE IS PRODUCED IS:

1)THE OOCYTE DOES NOT UNDERGO DIVISION.
2)THE OOCYTE DIVIDES AFTER FERTILIZATION.
3)A POLAR BODY IS FORMED.
4)THERE IS AN ERROR IN THE COMPUTER.

WHICH NUMBER WOULD REPRESENT THE CORRECT ANSWER? 3

CORRECT.   NOW LET'S MOVE TO THE FINAL STAGE IN WHICH WE WILL END UP WITH 4 MONOPLOID(HAPLOID) SPERM--1)A1B1 2)A2B2 3)A1B2 4)A2B1 AND ONE OVUM--1)A3B3 OR 2)A4B4 OR 3)A3B4 OR 4)A4B3

WHAT IS THE POSSIBILITY THAT THE OFFSPRING WILL HAVE THE SAME CHROMOSOMAL COMPOSITION AS THE FATHER?
PRINT ONE OF THE FOLLOWING NUMBERS.
1)50 CHANCE   2)NO CHANCE   3)100 CHANCE
4)YOU CAN'T TELL FROM THE INFORMATION GIVEN
? 2
GOOD THINKING.
I HOPE YOU HAVE A FAIRLY GOOD IDEA OF SEVERAL PRINCIPLES INVOLVED, PARTICULARLY RANDOM ASSORTMENT.

NOW LET'S SEE IF WE CAN USE THESE IDEAS TO DETERMINE WHAT OCCURS IN A POPULATION. WE WILL USE AS OUR ORGANISM THE FRUIT FLY, DROSOPHILA, WHICH HAS 8 AS THE DIPLOID NUMBER OF CHROMOSOMES. THE FOLLOWING WILL REPRESENT CERTAIN CONDITIONS IN FRUIT FLIES :

NORMAL WING-RED EYE=A1A2, B1B2, C1C2, D1D2
NORMAL WING-WHITE EYE=A1A2, B2B2, C1C2, D1D2
VESTIGIAL WING=A1A1, B1B2, C1C2, D1D2
LETHAL GENE=A1A2, B1B2, C1C1, D1D2

SUPPOSE WE CROSS THE NORMAL RED EYED WITH THE NORMAL WHITE EYED FRUIT FLY. WHAT COULD THE OFFSPRING LOOK LIKE? LOOK AT THE GENOTYPES CAREFULLY AND SEE IF YOU CAN PICK OUT THE DIFFERENT GENE COMBINATIONS. THEN MAKE ALL POSSIBLE CROSSES. AT A LATER DATE, WE WILL SEE HOW I, THE COMPUTER, CAN SOLVE THIS PROBLEM FOR YOU.
BUT FIRST, TAKE THIS SHEET BACK TO YOUR SEATS AND WORK ON IT.

READY

```
100REM THIS PROGRAM DEVELOPED BY R. COOPERMAN--JOHN GLENN HIGH SCHOOL
105 REM  REVISED BY C.LOSIK  7-9-70
107 REM  ALL INPUTS ARE TEMPORARY
110PRINT"THE FOLLOWING DIAGRAMS ARE REPRESENTATIONS OF PRIMARY SEX"
120PRINT"CELLS. CHROMOSOMES ARE REPRESENTED BY LETTERS."
130PRINT
140PRINT"PRIMARY SPERMATOCYTE          PRIMARY OOCYTE"
150PRINT"    ----------                ----------"
160PRINT"    ( A1 A2  )                ( A3 A4  )"
170PRINT"    (        )                (        )"
180PRINT"    ( B1 B2  )                ( B3 B4  )"
190PRINT"    ----------                ----------"
200PRINT
210LET Y=0
220PRINT"BY TYPING IN A NUMBER,WHAT IS THE DIPLOID NUMBER OF"
230PRINT"CHROMOSOMES FOR THIS ORGANISM";
240INPUT C
250IF C=4 THEN 320
260PRINT
270PRINT" ARE YOU SURE THAT YOU UNDERSTAND WHAT IS MEANT BY DIPLOID"
280PRINT"AND HAPLOID?"
290IF Y=1 THEN 1160
300LET Y=Y+1
310GO TO 220
320PRINT
330PRINT"SO YOU SEE THAT A1 + A2, FOR EXAMPLE, ARE PAIRS OF HOMOLOGOUS"
340PRINT"CHROMOSOMES. IT IS ESSENTIAL THAT AFTER FERTILIZATION, IF THE"
350PRINT"DIPLOID CONDITION IS TO BE RETAINED THAT WE HAVE SOME MEANS OF"
360PRINT"PLACING ONLY ONE A AND ONE B CHROMOSOME IN THE SPERM AND ONLY"
370PRINT"ONE A AND ONE B CHROMOSOME IN THE EGG. THIS INVOLVES MEIOSIS."
380PRINT
390PRINT"LOOK AT THE PRIMARY SPERMATOCYTE ABOVE."
400PRINT"DURING THE FIRST STAGE OF MEIOSIS, THE MALE SEX CELL"
410PRINT"SHOULD APPEAR AS IT IS IN ONE OF THE FOLLOWING DIAGRAMS."
420PRINT
430PRINT"    1           2           3           4           5"
440PRINT"----------  ----------  ----------  ----------  ----------"
450PRINT"( A1A1    )  ( A1  A2 )  (    A    )  ( A1 A2 )  (         )"
460PRINT"(    A2A2 )  (        )  (         )  (       )  (         )"
470PRINT"( B1B1    )  (        )  (         )  (       )  (         )"
480PRINT"(    B2B2 )  ( B1  B2 )  (    B    )  (       )  ( B1 B2 )"
490PRINT"----------  ----------  ----------  ----------  ----------"
500LET X=0
510PRINT
520PRINT"WHICH DIAGRAM MOST CLOSELY REPRESENTS THIS MEIOTIC STAGE ";
530INPUT D
540IF D=1 THEN 600
550PRINT
560PRINT"YOUR REASONING IS FAULTY."
565 PRINT "DO YOU RECALL THAT A TETRAD IS FORMED?"
570IFX=2THEN 1180
580LET X=X+1
590GO TO 520
600PRINT
610PRINT"O.K., NOW WE CAN MOVE ALONG. MEIOTIC DIVISION OCCURS AND"
620PRINT"WE GET TWO SECONDARY SPERMATOCYTES FROM EACH PRIMARY"
630PRINT"SPERMATOCYTE AND ONE SECONDARY OOCYTE FROM EACH PRIMARY "
640PRINT"OOCYTE. EACH SPERMATOCYTE CONTAINS THE FOLLOWING CHROMOSOMES:"
650PRINT"A1 A2, B1 B2.    EACH OOCYTE HAS  A3 A4, B3 B4."
660PRINT
670PRINT"THE REASON WHY ONLY ONE OOCYTE IS PRODUCED IS:"
680PRINT
690PRINT"      1)THE OOCYTE DOES NOT UNDERGO DIVISION."
700PRINT"      2)THE OOCYTE DIVIDES AFTER FERTILIZATION."
```

```
710PRINT"      3)A POLAR BODY IS FORMED."
720PRINT"      4)THERE IS AN ERROR IN THE COMPUTER."
730PRINT
740PRINT"WHICH NUMBER WOULD REPRESENT THE CORRECT ANSWER";
750INPUT E
760PRINT
770IF E=3 THEN 810
780PRINT"STOP GUESSING. THERE IS A PERFECTLY GOOD EXPLANATION WHICH"
790PRINT"HAS A VITAL FUNCTION."
800GO TO 730
810PRINT"CORRECT.      NOW LET'S MOVE TO THE FINAL STAGE IN WHICH"
820PRINT"WE WILL END UP WITH 4 MONOPLOID(HAPLOID) SPERM--1)A1B1"
830PRINT"2)A2B2  3)A1B2  4)A2B1  AND ONE OVUM--1)A3B3 OR  2)A4B4"
840PRINT"OR  3)A3B4  OR  4)A4B3"
850PRINT
860PRINT"WHAT IS THE POSSIBILITY THAT THE OFFSPRING WILL HAVE"
870PRINT"THE SAME CHROMOSOMAL COMPOSITION AS THE FATHER?"
880PRINT"PRINT ONE OF THE FOLLOWING NUMBERS."
890PRINT"      1)50 CHANCE   2)NO CHANCE   3)100 CHANCE"
900PRINT"      4)YOU CAN'T TELL FROM THE INFORMATION GIVEN"
910INPUT F
920IF F=2 THEN 960
930PRINT"YOU COULDN'T BE MORE WRONG. LOOK AT ALL THE CELLS AGAIN AND"
940PRINT"COMPARE ALL POSSIBILITIES."
950GO TO 910
960PRINT"GOOD THINKING."
970PRINT"I HOPE YOU HAVE A FAIRLY GOOD IDEA OF SEVERAL PRINCIPLES"
980PRINT"INVOLVED, PARTICULARLY RANDOM ASSORTMENT."
990PRINT
1000PRINT"NOW LET'S SEE IF WE CAN USE THESE IDEAS TO DETERMINE WHAT"
1010PRINT"OCCURS IN A POPULATION. WE WILL USE AS OUR ORGANISM THE FRUIT"
1020PRINT"FLY, DROSOPHILA, WHICH HAS 8 AS THE DIPLOID NUMBER OF"
1030PRINT"CHROMOSOMES.  THE FOLLOWING WILL REPRESENT CERTAIN CONDITIONS"
1035 PRINT "IN FRUIT FLIES :"
1040PRINT
1050PRINT"NORMAL WING-RED EYE=A1A2, B1B2, C1C2, D1D2"
1060PRINT"NORMAL WING-WHITE EYE=A1A2, B2B2, C1C2, D1D2"
1070PRINT"VESTIGIAL WING=A1A1, B1B2, C1C2, D1D2"
1080PRINT"LETHAL GENE=A1A2, B1B2, C1C1, D1D2"
1090PRINT
1100PRINT"SUPPOSE WE CROSS THE NORMAL RED EYED WITH THE NORMAL WHITE"
1110PRINT"EYED FRUIT FLY. WHAT COULD THE OFFSPRING LOOK LIKE? LOOK AT"
1120PRINT"THE GENOTYPES CAREFULLY AND SEE IF YOU CAN PICK OUT THE"
1130PRINT"DIFFERENT GENE COMBINATIONS. THEN MAKE ALL POSSIBLE CROSSES."
1140PRINT"AT A LATER DATE, WE WILL SEE HOW I, THE COMPUTER, CAN"
1150PRINT"SOLVE THIS PROBLEM FOR YOU."
1160PRINT"BUT FIRST, TAKE THIS SHEET BACK TO YOUR SEATS AND WORK ON IT."
1170 STOP
1180PRINT"      YOU'RE JUST GUESSING. I DON'T HAVE TIME TO FOOL"
1190PRINT"AROUND. TAKE THIS SHEET OUT AND STUDY IT; THEN SEE YOUR"
1200PRINT"TEACHER BEFORE YOU COME BACK TO ME."
1210REM NEXT PROGRAM NAME IS DROS**
1220END

READY
```

DISCIPLINE BIOLOGY

SUBJECT CELL MEMBRANES

PROGRAM NAME MEMBR

DESCRIPTION:

This program simulates an experiment on diffusion. Membrane characteristics are "observed" by the student, and means of transport across membranes identified.

OBJECTIVES:

A. To provide background for understanding of transport of materials across living membranes;

B. To evaluate and reinforce an understanding of conditions under which diffusion, osmosis, and active transport take place;

C. To help in the understanding of solution concentrations.

PRELIMINARY PREPARATION:

A. Student - exposed to the meaning of diffusion, osmosis, active transport, and semipermeable; should understand the need for energy expenditure in active transport; and have observed or performed the iodine test for starch.

B. Materials - a prepared ditto of questions to be answered by students as a homework assignment or for classroom discussion.

DISCUSSION:

A. Operational Suggestions

1. Student level - this program has been effective with average and above average students.
2. An incorrect answer results in the students being instructed to return to their seats, correct their answer, and give a reason for its correctness. A correct answer is immediately reinforced.
3. The class is grouped. A maximum of 5 per group is recommended. The groups sequentially run the program until completion, or they are sent away from the machine by an incorrect answer. The other groups may be engaged in performance of the same experiment being "done" by the computer, or in a related activity. Interruption of an actual experiment, as a group goes to the computer, should not affect the results.
4. When the program is to be used with more than one class, it is suggested that the data line in the program (see list) be changed. Since this is a

simple change to make, it can be made between groups within a class. This prevents their memorization and/or transmission to other groups and classes. Examples follow:

```
      140 DATA10, 11, 12, 13, 14  may be changed to:

      140 DATA1,2, 3, 4, 5
or    140 DATA4, 2, 6, 9, 1
or    140 DATA20, 30, 40, 50, 60
```

Any combination of numbers may be inserted. There must be a total of of five, however, since the student is asked to respond to five questions.

It has been found that extensive discussion preceeds the answering of each question on the computer, and in the writing of the rationalizations. This is certainly desirable.

Suggested Follow-up

Questions which may be used for discussion, or given as a homework assignment:

1. What happens to the concentration of water within the membrane as the glucose diffuses out? Why?
2. What observations indicated that the iodine had moved into the "cell"?
3. Why couldn't the same observations be made outside of the membrane?
4. What changes in observations would you expect if the cellophane had not been permeable?
5. Can materials diffuse through a semipermeable membrane in both directions at the same time?
6. What is meant by equilibrium?
7. Under what conditions is a cell in complete equilibrium with its environment? (When it is dead.)

CELL MEMBRANES

AN IMPORTANT FUNCTION OF CELL MEMBRANES IS TO CONTROL THE PASSAGE OF MATERIAL INTO AND OUT OF CELLS. THIS PROGRAM GOES INTO THE MEANS BY WHICH THIS PROCESS TAKES PLACE.

IN THIS EXPERIMENT A STARCH AND GLUCOSE SOLUTION WAS PLACED WITHIN A PIECE OF CELLOPHANE TUBING. CELLOPHANE IS POROUS ENOUGH TO PERMIT THE PASSAGE OF SOME SMALLER MOLECULES THROUGH IT. THEREFORE, A CLOSED OFF PIECE OF TUBING CAN REPRESENT A CELL.

AFTER THE STARCH AND GLUCOSE SOLUTION WAS PLACED INTO THE TUBING, THE END WAS TIED OFF AND THE 'CELL' PLACED IN A BEAKER OF WATER TO WHICH A FEW DROPS OF IODINE HAD BEEN ADDED.

LET 10 REPRESENT THE OUTSIDE OF THE MEMBRANE
LET 11 REPRESENT THE INSIDE OF THE MEMBRANE

WHERE IS THE CONCENTRATION OF GLUCOSE THE GREATEST? 11

THAT IS CORRECT. WHERE IS THE CONCENTRATION OF STARCH THE GREATEST? 11

RIGHT. WHERE IS THE CONCENTRATION OF IODINE THE GREATEST? 10

WOW! WHAT A SUPERIOR MIND YOU HAVE, OR IS IT JUST LUCKY GUESSING? WHERE IS THE CONCENTRATION OF WATER THE GREATEST? 10

YES. IF THE MEMBRANE WERE THE OUTER LIMITS OF A LIVING CELL, WHICH OF THE PROCESSES BELOW WOULD ACCOUNT FOR THE MOVEMENT OF GLUCOSE OUT OF THE CELL?

LET OSMOSIS = 12
LET ACTIVE TRANSPORT = 13
LET DIFFUSION = 14

? 14

CORRECT. THE GLUCOSE DIFFUSED FROM AN AREA OF HIGHER CONCENTRATION TO ONE OF LOWER CONCENTRATION. WHICH PROCESS WOULD ACCOUNT FOR THE MOVEMENT OF THE WATER OUT OF THE CELL? 13

RIGHT. THE CONCENTRATION OF WATER IS GREATER OUTSIDE OF THE CELL THAN INSIDE. ACTIVE TRANSPORT WOULD ACCOUNT FOR MOVEMENT AGAINST DIFFUSION. WHICH PROCESS WOULD EXPLAIN THE TRANSPORT OF WATER INTO THE CELL? 12

YES, OSMOSIS IS DIFFUSION OF WATER THROUGH A SEMIPERMEABLE MEMBRANE. IF THE IODINE OUTSIDE OF THE CELL HAD TURNED BLACK, WHAT PROCESS WOULD HAVE CAUSED IT? 13

YES. SINCE STARCH MOLECULES ARE RELATIVELY LARGE, THE CELL WOULD HAVE TO EXPEND ENERGY TO MOVE THEM ACROSS THE MEMBRANE, EVEN WHEN THE STARCH CONCENTRATION IS GREATER INSIDE THE CELL.

CONGRATULATIONS. YOU HAVE SCORED 100. KEEP UP THE GOOD WORK.

*** END OF PROGRAM ***

READY

```
100REM COURT, G., BIOLOGY, 7/9/69
105 REM  REVISED BY C.LOSIK  7-9-70
107 REM  ALL INPUTS ARE TEMPORARY
110PRINT"                                CELL MEMBRANES"
120PRINT
130READL,M,N,O,P
140DATA10,11,12,13,14
150PRINT
160PRINT"      AN IMPORTANT FUNCTION OF CELL MEMBRANES IS TO CONTROL"
170PRINT"THE PASSAGE OF MATERIAL INTO AND OUT OF CELLS. THIS PROGRAM"
180PRINT"GOES INTO THE MEANS BY WHICH THIS PROCESS TAKES PLACE."
190PRINT
200PRINT"      IN THIS EXPERIMENT A STARCH AND GLUCOSE SOLUTION WAS"
210PRINT"PLACED WITHIN A PIECE OF CELLOPHANE TUBING. CELLOPHANE IS"
220PRINT"POROUS ENOUGH TO PERMIT THE PASSAGE OF SOME SMALLER MOLECULES"
230PRINT"THROUGH IT. THEREFORE, A CLOSED OFF PIECE OF TUBING CAN"
240PRINT"REPRESENT A CELL."
250PRINT
260PRINT"      AFTER THE STARCH AND GLUCOSE SOLUTION WAS PLACED INTO THE"
270PRINT"TUBING, THE END WAS TIED OFF AND THE 'CELL' PLACED IN A BEAKER"
280PRINT"OF WATER TO WHICH A FEW DROPS OF IODINE HAD BEEN ADDED."
290PRINT
300PRINT"      LET "L" REPRESENT THE OUTSIDE OF THE MEMBRANE"
310PRINT"      LET "M" REPRESENT THE INSIDE OF THE MEMBRANE"
320PRINT
330PRINT"WHERE IS THE CONCENTRATION OF GLUCOSE THE GREATEST";
340INPUTA
350PRINT
360IFA=MTHEN410
370PRINT"SORRY. THAT IS NOT THE CORRECT ANSWER. WHY NOT? WRITE YOUR"
380PRINT"REASONS ON A PIECE OF PAPER AND HAVE THEM VERIFIED BY YOUR"
390PRINT"TEACHER BEFORE CALLING THIS PROGRAM AGAIN."
400 STOP
410PRINT"THAT IS CORRECT. WHERE IS THE CONCENTRATION OF STARCH THE"
420PRINT"GREATEST";
430INPUTB
440PRINT
450IFB<>MTHEN370
460PRINT"RIGHT.  WHERE IS THE CONCENTRATION OF IODINE THE GREATEST";
470INPUTC
480PRINT
490IFC<>LTHEN370
500PRINT"WOW!  WHAT A SUPERIOR MIND YOU HAVE, OR IS IT JUST LUCKY"
510PRINT"GUESSING? WHERE IS THE CONCENTRATION OF WATER THE GREATEST";
520INPUTD
530PRINT
540IFD<>LTHEN370
550PRINT"YES.  IF THE MEMBRANE WERE THE OUTER LIMITS OF A LIVING"
560PRINT"CELL, WHICH OF THE PROCESSES BELOW WOULD ACCOUNT FOR THE MOVE-"
570PRINT"MENT OF GLUCOSE OUT OF THE CELL?"
580PRINT
590PRINT"      LET OSMOSIS = "N
600PRINT"      LET ACTIVE TRANSPORT = "O
610PRINT"      LET DIFFUSION = "P
620INPUT E
630PRINT
640IFE<>PTHEN370
650PRINT"CORRECT.  THE GLUCOSE DIFFUSED FROM AN AREA OF HIGHER"
660PRINT"CONCENTRATION TO ONE OF LOWER CONCENTRATION. WHICH PROCESS"
670PRINT"WOULD ACCOUNT FOR THE MOVEMENT OF THE WATER OUT OF THE CELL";
680INPUTF
690PRINT
700IFF<>OTHEN370
```

```
710PRINT"RIGHT.  THE CONCENTRATION OF WATER IS GREATER OUTSIDE OF THE"
720PRINT"CELL THAN INSIDE. ACTIVE TRANSPORT WOULD ACCOUNT FOR MOVE-"
730PRINT"MENT AGAINST DIFFUSION. WHICH PROCESS WOULD EXPLAIN THE"
740PRINT"TRANSPORT OF WATER INTO THE CELL";
750INPUTG
760PRINT
770IFG<>NTHEN370
780PRINT"YES, OSMOSIS IS DIFFUSION OF WATER THROUGH A SEMIPERMEABLE"
790PRINT"MEMBRANE. IF THE IODINE OUTSIDE OF THE CELL HAD TURNED BLACK,"
800PRINT"WHAT PROCESS WOULD HAVE CAUSED IT";
810INPUTH
820PRINT
830IFH=0THEN860
840PRINT"NO.  ";
850GOTO870
860PRINT"YES.  ";
870PRINT"SINCE STARCH MOLECULES ARE RELATIVELY LARGE, THE CELL"
880PRINT"WOULD HAVE TO EXPEND ENERGY TO MOVE THEM ACROSS THE "
890PRINT"MEMBRANE, EVEN WHEN THE STARCH CONCENTRATION IS GREATER"
900PRINT"INSIDE THE CELL."
910PRINT
920IFH<>0THEN960
930PRINT"CONGRATULATIONS.  YOU HAVE SCORED 100. KEEP UP THE GOOD WORK."
950GOTO970
960PRINT"WELL, YOU HAVE DONE WELL IN SPITE OF SOME ERROR."
970PRINT
980PRINT"          ***          END OF PROGRAM          ***"
990END
```

DISCIPLINE BIOLOGY

SUBJECT ENZYMES

PROGRAM NAME NZYMC

DESCRIPTION:

This program covers enzymatic reaction rates, and conveys the idea that enzyme reactions are dependent upon environmental factors such as pH, temperature, and the concentration of the enzymes. A simulated experimental situation is created, whereby the student works with one parameter at a time and can vary the degree of the enzyme reactivity.

OBJECTIVES:

The program presents the students with the following concepts:

A. Enzymatic reaction rates are dependent upon environmental factors: (these include pH, temperature, concentration of enzymes, and substrate)

B. The value of graphing to help in the interpretation of data;

C. The meaning of the term "limiting factor";

D. Different enzymes may vary in degree of reactivity and thereby affect reaction rates;

E. Enzymes are not used up, but can take part in additional reactions.

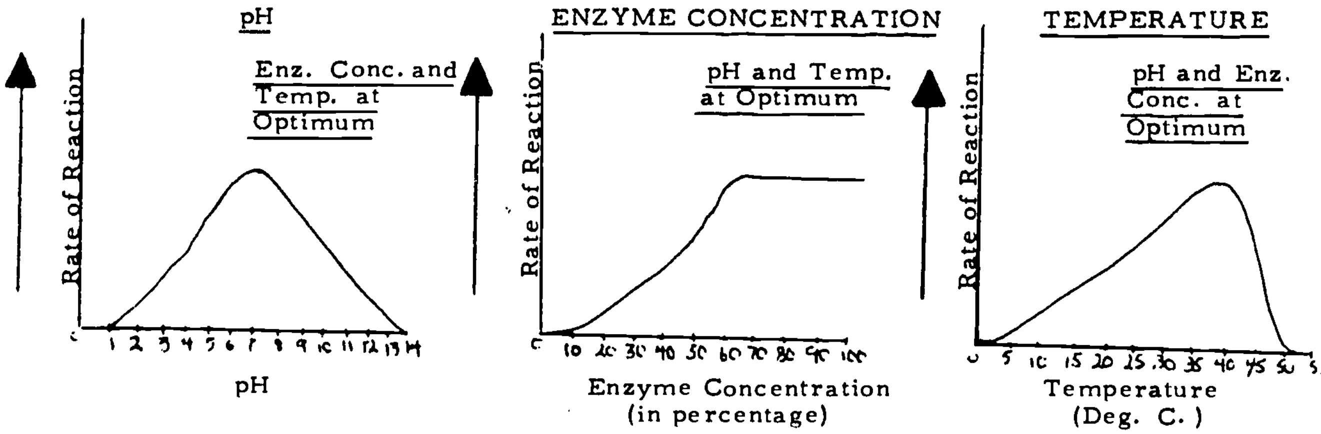
PRELIMINARY PREPARATION:

A. Student - The student should have some understanding of these terms: pH, substrate, enzyme, and chemical reaction. He should know that there is a substrate-enzyme interaction, and that enzymes act as catalytic agents, therefore, more than one reaction can take place with one molecule of the enzyme over a period of time.

B. Materials - graph paper, transparencies of the following plots, and one of the three together for simultaneous viewing. (optional)

Biology
NZYMC

RATES OF ACTIVITY WHEN VARYING



DISCUSSION:

A. Operational Suggestions

1. Student level - Average to above average ability
2. The student should use all three limiting factors presented in the computer program.
3. Students' graphs should be checked before proceeding with the follow-up question.
4. Students work in groups of 5 or less. Allow one group at a time at the computer while the remaining groups are engaged in a related activity. For Example: Food testing with hydrogen peroxide for catalase activity.

B. Suggested Follow-up

To maximize the value of this program, it is strongly suggested that the teacher:

1. Elicit from the students:

   What represents maximum and minimum reaction rate for pH, temperature, and enzyme concentration? (Use appropriate transparencies or chalkboard)

2. Ask the following questions, based on the plotted graphs, as lead-ins to discussion or as a homework assignment.

   (a) At what point do most reactions take place with regard to pH, enzyme concentration, and temperature? (This and subsequent questions are intended to bring up the ideas of optimal pH, temperature, and enzyme concentration.)

   (b) Why is death caused when pH rises or falls beyond a certain point in a system?

(c) Why does the concentration of enzymes reach a point and then no increase in reactions take place?
(d) What is normal body temperature? What relationship is there between reaction rate and body temperature? High fever? Freezing temperature? (Note: 40 deg. C. is 104 deg. F., which is higher than normal.)
(e) Suppose the pH of a system is 7, enzyme concentration is 90, and temperature is 0 degrees. What is the reaction rate? Why? *
(f) Supppose the temperature is 37 deg. C., enzyme concentration is 30, and pH is 14. What is the reaction rate? Why? *
(g) What is meant by limiting factors?

* Student must examine all three graphs before reaching a conclusion.

```
THIS PROGRAM IS DESIGNED TO SHOW THAT ENZYME ACTION IS
RELATED TO CERTAIN LIMITING FACTORS. THESE FACTORS INCLUDE PH,
THE CONCENTRATION OF ENZYMES, AND TEMPERATURE. IN THIS PROGRAM
WE ASSUME THAT TWO OF THE THREE FACTORS ARE CONSTANTS AND
WILL CHANGE ONLY ONE AT A TIME. WE ALSO ASSUME THAT EACH
FACTOR WORKS INDEPENDENTLY, ALTHOUGH THIS IS NOT TRUE IN
NATURE.

     YOU HAVE A CHOICE OF THE FOLLOWING LIMITING FACTORS:

1)PH            2)CONCENTRATION OF ENZYMES          3)TEMPERATURE

WHICH NUMBER DO YOU WISH ? 1

*** PH ***

HOW REACTIVE AN ENZYME ARE YOU WORKING WITH? USE A VALUE OF
FROM 1 (NOT VERY REACTIVE) TO 10 (VERY REACTIVE). ? 7.5

PH VALUE        REACTION RATE 0         50        100       150       200
--------        ------------- I---------I---------I---------I---------I
1               0             *
2               11.25         I *
3               30            I     *
4               56.25         I          *
5               90            I                 *
6               138.75        I                         *
7               157.5         I                             *
8               138.75        I                         *
9               90            I                 *
10              56.25         I          *
11              30            I     *
12              11.25         I *
13              3.75          *
14              0             *

DO YOU WISH ANOTHER RUN? IF YES, PRINT 1; IF NO, PRINT 0. ? 1

     YOU HAVE A CHOICE OF THE FOLLOWING LIMITING FACTORS:

1)PH            2)CONCENTRATION OF ENZYMES          3)TEMPERATURE

WHICH NUMBER DO YOU WISH ? 2

*** CONCENTRATION OF ENZYMES ***
HERE WE MUST ASSUME THAT THE SUBSTRATE IS ALWAYS SUFFICIENT.

HOW REACTIVE AN ENZYME ARE YOU WORKING WITH? USE A VALUE OF
FROM 1 (NOT VERY REACTIVE) TO 10 (VERY REACTIVE). ? 7.5

ENZYME CONC.    REACTION RATE 0         50        100       150       200
------------    ------------- I---------I---------I---------I---------I
10              0             *
20              33.75         I     *
30              67.5          I            *
40              101.25        I                   *
50              135           I                          *
60              157.5         I                             *
70              157.5         I                             *
80              157.5         I                             *
90              157.5         I                             *
100             157.5         I                             *
```

```
     YOU HAVE A CHOICE OF THE FOLLOWING LIMITING FACTORS:

1)PH          2)CONCENTRATION OF ENZYMES          3)TEMPERATURE

WHICH NUMBER DO YOU WISH ? 3

*** TEMPERATURE ***

HOW REACTIVE AN ENZYME ARE YOU WORKING WITH? USE A VALUE OF
FROM 1 (NOT VERY REACTIVE) TO 10 (VERY REACTIVE). ? 7.5

DEGREES C.     REACTION RATE 0         50        100       150       200
----------     ------------- I---------I---------I---------I---------I
 0              0            *
 5              11.25        I *
 10             22.5         I   *
 15             41.25        I       *
 20             63.75        I           *
 25             86.25        I                *
 30             112.5        I                     *
 35             146.25       I                            *
 40             127.5        I                        *
 45             37.5         I      *
 50             0            *

DO YOU WISH ANOTHER RUN? IF YES, PRINT 1; IF NO, PRINT 0. ? 0

STUDY THE GRAPHS AND TABLES, AND TRY TO FIGURE
OUT WHAT'S HAPPENING HERE.

READY
```

```
100DIMA(15),J(11),H(12)
110REM PROGRAM DEVELOPED BY R. COOPERMAN - JOHN GLENN HIGH SCHOOL
120REM ELWOOD, NEW YORK
121 REM  REVISED BY C.LUSIK  7-6-70
122 REM ALSO SEE NZYM2
123 REM A(I)=PH VALUES, J(I)=CONC. OF ENZYME VALUES, H(I)=TEMP VALUES
124 REM Y=REACTIVITY
125 REM  ALL RESULTS ARE TABULATED AND GRAPHED (NO OPTIONS)
130PRINT"      THIS PROGRAM IS DESIGNED TO SHOW THAT ENZYME ACTION IS"
140FORN=1TO14
150READA(N)
160NEXTN
170PRINT"RELATED TO CERTAIN LIMITING FACTORS. THESE FACTORS INCLUDE PH,"
180FORN=1TO10
190READJ(N)
200NEXTN
210PRINT"THE CONCENTRATION OF ENZYMES, AND TEMPERATURE. IN THIS PROGRAM"
220FORN=1TO11
230READH(N)
240NEXTN
250PRINT"WE ASSUME THAT TWO OF THE THREE FACTORS ARE CONSTANTS AND"
260PRINT"WILL CHANGE ONLY ONE AT A TIME. WE ALSO ASSUME THAT EACH"
270PRINT"FACTOR WORKS INDEPENDENTLY, ALTHOUGH THIS IS NOT TRUE IN"
280PRINT"NATURE."
290PRINT
300PRINT"      YOU HAVE A CHOICE OF THE FOLLOWING LIMITING FACTORS:"
310PRINT
320PRINT"1)PH          2)CONCENTRATION OF ENZYMES          3)TEMPERATURE"
330PRINT
340PRINT"WHICH NUMBER DO YOU WISH ";
350INPUTA
360PRINT
370IFA=1THEN420
380IFA=2THEN680
390IFA=3THEN810
400PRINT"THAT IS NOT A PERMISSIBLE ANSWER."
410GOTO340
420 PRINT "*** PH ***"
430GOSUB520
440PRINT
450 PRINT "PH VALUE","REACTION RATE","0          50          100";
451PRINT "       150       200 "
460 PRINT "--------","-------------","I---------I---------I";
461 PRINT "---------I---------I"
470 DATA 0,1.5,4.0,7.5,12.0,18.5,21.0,18.5,12.0,7.5,4.0,1.5,0.5,0
480FORN=1TO14
490 PRINT N,A(N)*Y, "I"; TAB(INT((A(N)*Y+.5)/5)+28);"*"
500NEXTN
510GOTO920
520PRINT
530 LET A=0
540PRINT"HOW REACTIVE AN ENZYME ARE YOU WORKING WITH? USE A VALUE OF"
550PRINT"FROM 1 (NOT VERY REACTIVE) TO 10 (VERY REACTIVE). ";
560INPUTY
570IFY<1THEN600
580 IF Y<=10 THEN 670
600 IF A>=2 THEN 650
610PRINT"THE NUMBER YOU HAVE CHOSEN DOES NOT FALL WITHIN THE RANGE "
620PRINT"GIVEN.  TRY AGAIN."
630 LET A=A+1
640GOTO560
650 PRINT "NEXT TIME, PLEASE FOLLOW INSTRUCTIONS."
660STOP
670RETURN
680 PRINT "*** CONCENTRATION OF ENZYMES ***"
```

```
690PRINT"HERE WE MUST ASSUME THAT THE SUBSTRATE IS ALWAYS SUFFICIENT."
700GOSUB520
710PRINT
730 PRINT "ENZYME CONC.","REACTION RATE","0          50          100";
731 PRINT "          150          200"
740 PRINT"------------","-------------","I---------I---------I";
741 PRINT "---------I---------I"
750DATA0
760DATA 4.5,9.0,13.5,18.0,21.0,21.0,21.0,21.0,21.0
770 FOR N=1 TO 10
780 PRINT 10*N, U(N)*Y, "I"; TAB(INT((U(N)*Y+.5)/5)+26);"*"
790 NEXT N
800GOTO920
810 PRINT "*** TEMPERATURE ***"
820GOSUB520
830PRINT
840 PRINT "DEGREES C.","REACTION RATE","0          50          100";
841 PRINT "          150          200"
850 PRINT "----------","-------------","I---------I---------I";
851 PRINT "---------I---------I"
860 DATA 0,1.5,3.0,5.5,8.5,11.5,15.0,19.5,17.0,5.0,0
870LETT=0
880FORN=1TO11
890 PRINT T,R(N)*Y,"I"; TAB(INT((R(N)*Y+.5)/5)+26); "*"
900LETT=T+5
910NEXT N
920PRINT
930PRINT"DO YOU WISH ANOTHER RUN? IF YES, PRINT 1; IF NO, PRINT 0. ";
940 INPUT A
950PRINT
960 IF A=1 THEN 300
970 IF A<>0 THEN 930
980 PRINT "STUDY THE GRAPHS AND TABLES, AND TRY TO FIGURE"
981 PRINT "OUT WHAT'S HAPPENING HERE."
990END
```

DISCIPLINE BIOLOGY

SUBJECT ENZYME REACTION RATE

PROGRAM NAME NZYM2

DESCRIPTION:

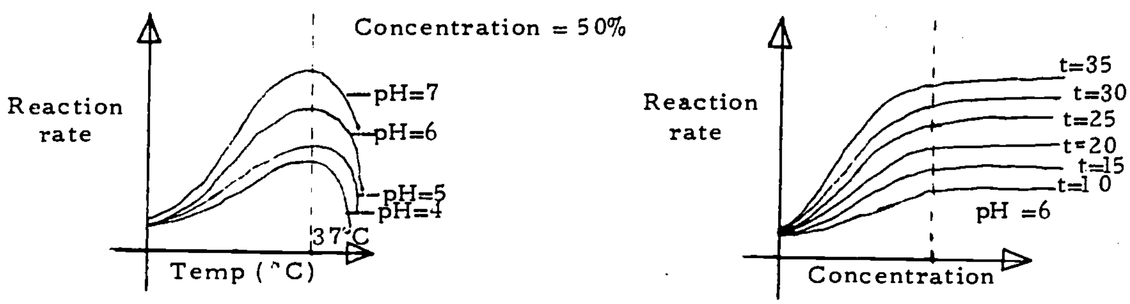
An extension of NZYMC which permits the student to examine the effect on reaction rate with continuous changes in environmental factors.

OBJECTIVES:

In addition to reinforcing the concept that reaction rate is governed by pH, temperature, and enzyme concentration; the program can be used to:

A. Introduce the idea of controlled experimentation where two factors are kept constant and a third is permitted to vary.

B. Develop the idea of plotting experimental data to generate a family of curves as illustrated below.



PRELIMINARY PREPARATION:

A. Student - Same as NZYMC . It might also be helpful if the student has been exposed previously to an actual experimental demonstration in which the change of reaction rate with one or more factors is visually displayed. The rate of bubble formation when one of the reactant products is a gas for example, might serve as one practical illustration of variation of reaction rate with temperature.

B. Materials - none

DISCUSSION:

A. Operational Suggestions

1. This program has not yet been tested in the classroom.
2. Average students should work as part of a group; above-average students could be permitted to work alone.
3. For group effort activity, it would be instructive to use three different groups, each of which holds a different factor constant while the other two factors are allowed to vary.

B. Suggested Follow-up

1. Each group should be required to plot their data, on a board, if possible, so the whole class can see the results. Families of curves should be discussed.
2. Equivalent points on each data set should be compared; e. g. is reaction rate the same when pH is 4, temperature is 25°C and concentration is 50%, regardless of which factor is held constant and the others allowed to vary?
3. Introduce the concepts of interpolation between curves and again check comparable points on each set.
4. Indicate that the maximum reaction rate obtained is the same regardless of the technique used to reach maximum.

```
THIS PROGRAM WILL ENABLE YOU TO SEE THE EFFECTS ON THE RATE OF
REACTION WITHIN A SYSTEM CONTROLLED BY ENZYMES.  THE
REACTION RATE WILL VARY AS THE ENVIRONMENTAL CONDITIONS
VARY.  THESE CONDITIONS, PH, CONCENTRATION OF ENZYMES,
AND TEMPERATURE, IN A NATURAL SITUATION ARE NEVER CONSTANT.
LET'S SEE WHAT CONTROLS THIS RATE IN THESE SYSTEMS.

THE FOLLOWING ARE THE LIMITS WITHIN WHICH EACH OF OUR
ENVIRONMENTAL CONDITIONS CAN VARY.
                1)PH----------BETWEEN 4 AND 10
                2)ENZ. CONC.--BETWEEN 10 AND 100 PERCENT
                3)TEMP.-------BETWEEN 5 AND 47 DEGREES C.

I AM GOING TO PRINT A '?'. YOU MUST THEN TYPE A NUMBER FOR PH,
CONC., AND TEMP. (IN THAT ORDER), WHICH FALLS WITHIN EACH
LIMIT STATED (SEE ABOVE.)
? 4,10,5
PH              CONC.           TEMP.           REACTION RATE
--              -----           -----           -------- ----
 4               10              5               .05

NOTE THE REACTION RATE WITH THE THREE VALUES WHICH YOU
SELECTED TO PROVIDE A BASIS FOR JUDGEMENT OF REACTION
RATE, CHOOSE ANOTHER SET OF VALUES FOR PH, CONC., AND
TEMP.  (SEE LIMITS ABOVE).

? 7,10,5
PH              CONC.           TEMP.           REACTION RATE
--              -----           -----           -------- ----
 7               10              5              4.5
IS THE RESULT A HIGHER OR LOWER REACTION RATE?  IS THE HIGHEST
VALUE OBTAINED A MAXIMUM VALUE?  DO YOU WANT TO TRY ANOTHER
SET OF VALUES (TYPE '1') OR WOULD YOU PREFER A MORE ORGANIZED
APPROACH TO DETERMINE MAXIMUM REACTION RATE (TYPE '2')
? 2

WE ARE NOW GOING TO PERFORM AN EXPERIMENT IN WHICH YOU ARE
TO TYPE IN THE VALUES FOR PH, CONC. AND TEMP. AS YOU DID
BEFORE. HOWEVER,NOW YOU ARE GOING TO BE ABLE TO CHOOSE THE
FACTOR WHICH WILL VARY. THE OTHER TWO FACTORS WILL REMAIN
CONSTANT. (USE DIFFERENT NUMERICAL VALUES FOR EACH FACTOR.)
TO OBTAIN THE MOST SIGNIFICANT DATA, START THE EXPERIMENT
USING LOW NUMERICAL VALUES FOR EACH FACTOR.

I AM GOING TO PRINT A '?'. YOU MUST THEN TYPE A NUMBER FOR PH,
CONC., AND TEMP. (IN THAT ORDER), WHICH FALLS WITHIN EACH
LIMIT STATED (SEE ABOVE.)
? 4,20,5
TYPE THE NUMBER WHICH IS TO BE VARIED.
? 20
PH              CONC.           TEMP.           REACTION RATE
--              -----           -----           -------- ----
 4               20              5               .1
 4               30              5               .13
 4               40              5               .16
 4               50              5               .17
 4               60              5               .19
 4               70              5               .19
 4               80              5               .2
 4               90              5               .2
 4               100             5               .2
```

```
YOU NOW HAVE A SET OF VALUES FOR REACTION RATE AS ONE OF
THE GOVERNING FACTORS IS VARIED AND THE OTHER TWO ARE HELD
CONSTANT. DOES THE REACTION RATE HAVE A MAXIMUM VALUE?
IS THIS THE MAXIMUM POSSIBLE REACTION RATE? TO DETERMINE THIS,
USE THE SAME INITIAL VALUE FOR THE VARYING FACTOR, BUT THIS
TIME TYPE IN DIFFERENT VALUES FOR THE CONSTANT FACTORS.

IF YOU WANT ANOTHER SET OF VALUES FOR REACTION RATE,TYPE '1'
IF YOU ARE SATISFIED THAT YOU KNOW THE VALUES FOR EACH FACTOR'S
MAXIMUM REACTION RATE THEN TYPE '2'.
? 1

I AM GOING TO PRINT A '?'. YOU MUST THEN TYPE A NUMBER FOR PH,
CONC., AND TEMP. (IN THAT ORDER), WHICH FALLS WITHIN EACH
LIMIT STATED (SEE ABOVE.)
? 7,20,5
TYPE THE NUMBER WHICH IS TO BE VARIED.
? 20
PH            CONC.          TEMP.          REACTION RATE
--            -----          -----          -------- ----
 7             20             5              8.86
 7             30             5              12.28
 7             40             5              14.67
 7             50             5              16.28
 7             60             5              17.31
 7             70             5              17.97
 7             80             5              18.39
 7             90             5              18.65
 7             100            5              18.8
IF YOU WANT ANOTHER SET OF VALUES FOR REACTION RATE,TYPE '1'
IF YOU ARE SATISFIED THAT YOU KNOW THE VALUES FOR EACH FACTOR'S
MAXIMUM REACTION RATE THEN TYPE '2'.
? 2

READY
```

```
100REM R. BLESSER, POLYTECH. INST. OF BKLYN.
103 REM  REVISED BY C.LOSIK  7-16-70
105 REM  A=PH, K=ENZ. CONC., T=TEMP
107 REM  FOR EFFICIENCY, ALL CALCULATIONS DONE VIA GOSUB CALLS
110PRINT"THIS PROGRAM WILL ENABLE YOU TO SEE THE EFFECTS ON THE RATE OF"
120PRINT"REACTION WITHIN A SYSTEM CONTROLLED BY ENZYMES.  THE"
130PRINT"REACTION RATE WILL VARY AS THE ENVIRONMENTAL CONDITIONS"
140PRINT"VARY.  THESE CONDITIONS, PH, CONCENTRATION OF ENZYMES,"
150PRINT"AND TEMPERATURE, IN A NATURAL SITUATION ARE NEVER CONSTANT."
160PRINT"LET'S SEE WHAT CONTROLS THIS RATE IN THESE SYSTEMS."
170PRINT
180PRINT"THE FOLLOWING ARE THE LIMITS WITHIN WHICH EACH OF OUR"
190PRINT"ENVIRONMENTAL CONDITIONS CAN VARY."
200PRINT " ","1)PH-----------BETWEEN 4 AND 10"
210PRINT " ","2)ENZ. CONC.--BETWEEN 10 AND 100 PERCENT"
220PRINT " ","3)TEMP.-------BETWEEN 5 AND 47 DEGREES C."
240GOSUB1320
310GOSUB1020
320PRINT
330PRINT"NOTE THE REACTION RATE WITH THE THREE VALUES WHICH YOU"
340PRINT"SELECTED TO PROVIDE A BASIS FOR JUDGEMENT OF REACTION"
350PRINT"RATE, CHOOSE ANOTHER SET OF VALUES FOR PH, CONC.,,AND"
360PRINT"TEMP.  (SEE LIMITS ABOVE)."
370PRINT
380GOSUB1020
390PRINT"IS THE RESULT A HIGHER OR LOWER REACTION RATE?  IS THE HIGHEST"
400PRINT"VALUE OBTAINED A MAXIMUM VALUE?  DO YOU WANT TO TRY ANOTHER"
410PRINT"SET OF VALUES (TYPE '1') OR WOULD YOU PREFER A MORE ORGANIZED"
420PRINT"APPROACH TO DETERMINE MAXIMUM REACTION RATE (TYPE '2')"
430INPUTX
440IFX=2THEN 480
442IF X=1 THEN 450
444 PRINT "PLEASE TYPE 1 OR 2"
446 GO TO 430
450 PRINT "WHAT ARE YOUR NEW VALUES FOR PH, CONC., AND TEMP.";
460GOSUB1020
470GOTO390
480PRINT
490PRINT"WE ARE NOW GOING TO PERFORM AN EXPERIMENT IN WHICH YOU ARE"
500PRINT"TO TYPE IN THE VALUES FOR PH, CONC. AND TEMP. AS YOU DID"
510PRINT"BEFORE. HOWEVER,NOW YOU ARE GOING TO BE ABLE TO CHOOSE THE"
520PRINT"FACTOR WHICH WILL VARY. THE OTHER TWO FACTORS WILL REMAIN"
530PRINT"CONSTANT. (USE DIFFERENT NUMERICAL VALUES FOR EACH FACTOR.)"
540PRINT"TO OBTAIN THE MOST SIGNIFICANT DATA, START THE EXPERIMENT"
550PRINT"USING LOW NUMERICAL VALUES FOR EACH FACTOR."
560LETM=0
570GO SUB 1320
580GOSUB1100
590PRINT"TYPE THE NUMBER WHICH IS TO BE VARIED."
600INPUTX
630IF X=A THEN 725
640IF X=K THEN 795
650 IF X=T THEN 655
652PRINT "PLEASE TYPE THE VALUE FOR PH, CONC., OR TEMP.";
653GO TO 600
655GOSUB 1370
660GOSUB1220
670GOSUB1240
680GOSUB1260
690GOSUB1280
700LETT=T+5
710IFT>=47THEN870
```

```
720GOTO680
725GOSUB 1370
730GOSUB1240
740GOSUB1260
750GOSUB1220
760GOSUB1280
770IFA>10THEN870
780LETA=A+.5
790GOTO750
795GOSUB 1370
800GOSUB1220
810GOSUB1260
820GOSUB1240
830GOSUB1280
840LETK=K+10
850IFK>100THEN870
860GOTO820
870LET M=M+1
880IFM>=2THEN960
890PRINT"YOU NOW HAVE A SET OF VALUES FOR REACTION RATE AS ONE OF"
900PRINT"THE GOVERNING FACTORS IS VARIED AND THE OTHER TWO ARE HELD"
910PRINT"CONSTANT. DOES THE REACTION RATE HAVE A MAXIMUM VALUE?"
920PRINT"IS THIS THE MAXIMUM POSSIBLE REACTION RATE? TO DETERMINE THIS,"
930PRINT"USE THE SAME INITIAL VALUE FOR THE VARYING FACTOR, BUT THIS"
940PRINT"TIME TYPE IN DIFFERENT VALUES FOR THE CONSTANT FACTORS."
950PRINT
960PRINT"IF YOU WANT ANOTHER SET OF VALUES FOR REACTION RATE,TYPE '1'"
970PRINT"IF YOU ARE SATISFIED THAT YOU KNOW THE VALUES FOR EACH FACTOR'S
980PRINT"MAXIMUM REACTION RATE THEN TYPE '2'."
990INPUTB
1000IFB=1THEN 570
1005IF B=2 THEN 1010
1007PRINT "PLEASE TYPE 1 OR 2"
1008GO TO 990
1010STOP
1020GOSUB1100
1030GOSUB1220
1040GOSUB1240
1050GOSUB1260
1060GOSUB 1370
1080GOSUB1280
1090RETURN
1100INPUTA,K,T
1105 REM  INPUT AND CHECK BOUNDS
1110IFA<4THEN1180
1120IFA>10THEN1180
1130IFK<10THEN1180
1140IFK>100THEN1180
1150IFT<5THEN1180
1160IFT>47THEN1180
1170GOTO1210
1180PRINT"AT LEAST ONE OF THE VARIABLES DOES NOT LIE WITHIN THE"
1190PRINT"PRESCRIBED LIMITS. SEE LIMITS ABOVE AND TRY AGAIN."
1200GOTO1100
1210RETURN
1220LETV1=EXP(-((.71*A-4.97)↑2))
1230RETURN
1240LETV2=EXP(-.08*K)-2*EXP(-.05*K)+1
1250RETURN
1260LETV3=16.3*EXP(.074*T)-EXP(.133*T)
1270RETURN
1280LETV=.88*V1*V2*V3
1290LETV=INT(V*100+0.5)/100
1300PRINTA,K,T,V
1305 REM  PRINT REACTION RATE
1310RETURN
1320 PRINT
1330PRINT"I AM GOING TO PRINT A '?'. YOU MUST THEN TYPE A NUMBER FOR PH,
1340PRINT "CONC., AND TEMP. (IN THAT ORDER), WHICH FALLS WITHIN EACH"
1350 PRINT "LIMIT STATED (SEE ABOVE.)"
1360 RETURN
1370PRINT "PH","CONC.","TEMP.","REACTION RATE"
1380PRINT "--","-----","-----","-------- ----"
1390RETURN
1400END
```

DISCIPLINE BIOLOGY

SUBJECT PHOTOSYNTHESIS

PROGRAM NAME PHOSYN

DESCRIPTION:

This program investigates changes in the rate of photosynthesis when carbon dioxide concentration and light intensity are varied.

OBJECTIVES:

A. To permit the student to see the effects of varying two of the factors of the photosynthetic reaction.

B. To reinforce the concept of the fundamental importance of the process of photosynthesis.

C. To lead the student to develop ideas for increasing a plant's food output by manipulating factors involved in photosynthesis.

D. To learn or practice graphing.

E. To learn the concept of controlled experimentation.

F. Analysis and interpretation of data.

PRELIMINARY PREPARATION:

A. Student - An understanding of the photosynthetic process.

B. Materials - graph paper

DISCUSSION:

A. Operational Suggestions
   1. Student level - average
   2. Pitfalls to avoid -
      a. If the student is not familiar with decimals, allow him to use integers for graphing
      b. The computer levels off at a light intensity of 12. If a student selects all of his light intensity values above 11, a straight line of asterisks will appear on the graph.
      c. Remind students that the computer plotted graph is to be viewed sideways. (see run)
   3. Students work in groups of 5 or less. Allow one group at a time at the computer while the remaining groups are engaged in a related activity.

B. Suggested Follow-up

The students, after running the program, are expected to graph the results obtained from varying the carbon dioxide concentration.

Elicit from the student:

1. What happens to the rate of photosynthesis as:
   a. The carbon dioxide concentration increases?
   b. The intensity of the light increases?
2. How might you increase the size of tomatoes grown in a greenhouse? What, if any, limitations are there to this type of increase?
3. What is apt to happen to the world's food supply if the amount of carbon dioxide or the light intensity was reduced by one-half?
4. Compare your graph with the graph made on the computer. Point out similarities and differences. Explain them.

```
HELLO. BY NOW YOU SHOULD KNOW FROM YOUR LECTURES WHAT
PHOTOSYNTHESIS IS. THIS LABORATORY WILL ENABLE YOU TO
CONDUCT EXPERIMENTS ON THE COMPUTER WHICH WOULD NOT BE
PRACTICAL DURING CLASS TIME.

SINCE ALL OF OUR FOOD COMES FROM PLANTS, LET'S FIND OUT
HOW CHANGING THE AMOUNT OF CARBON DIOXIDE OR THE INTENSITY
OF LIGHT WILL AFFECT THE PLANT'S RATE OF PHOTOSYNTHESIS,
MEASURED IN MICROGRAMS OF GLUCOSE PRODUCED PER DAY.

LET'S BEGIN WITH CHANGING THE LIGHT INTENSITY. YOU WILL
VARY THIS BY SELECTING INTEGER VALUES IN THE RANGE OF
0 TO 30 (THE UNITS FOR LIGHT INTENSITY ARE IN ERGS/SEC/SQ.CM)
BY VARYING ONLY ONE FACTOR AT A TIME, WE ARE CONDUCTING
A CONTROLLED EXPERIMENT. WE WILL ASSUME THAT OUR PLANT
HAS ALL OF THE CARBON DIOXIDE, WATER AND CHLOROPHYLL
THAT IT NEEDS.

YOU SHOULD CHOOSE BETWEEN FIVE AND TEN LIGHT INTENSITY
VALUES. TYPE IN ONLY ONE VALUE AFTER EACH QUESTION MARK.
BY TYPING IN 100, NO MORE QUESTION MARKS WILL APPEAR AND
THE PROGRAM WILL CONTINUE.
(NOTE: 'RP' MEANS RATE OF PHOTHSYNTHESIS)

LIGHT INTENSITY(LI)? 2
RP= 45
(LI)? 15
RP= 121
(LI)? 7
RP= 99
(LI)? 29
RP= 125
(LI)? 20
RP= 124
(LI)? 5
RP= 84
(LI)? 6
RP= 92
(LI)? 11
RP= 114
(LI)? 12
RP= 116
(LI)? 10
RP= 111

1 = TABLE ONLY, 2 = PLOT ONLY, 3 = BOTH? 3

 LIGHT          RATE OF
INTENSITY     PHOTOSYNTHESIS
---------     --------------
 2              44.81
 5              83.8
 6              92
 7              98.57
 10             111.42
 11             114.12
 12             116.29
 15             120.52
 20             123.52
 29             124.8
```

```
 LIGHT
INTENSITY
              RATE OF PHOTOSYNTHESIS
              0    25   50   75   100  125
              I----I----I----I----I----I
              I
              I
2             I        *
              I
              I
5             I                *
6             I                 *
7             I                   *
              I
              I
10            I                     *
11            I                      *
12            I                      *
              I
              I
15            I                       *
              I
              I
              I
              I
20            I                        *
              I
              I
              I
              I
              I
              I
              I
              I
29            I                        *
              I
```

O.K. LET'S NOW VARY THE AMOUNT OF CARBON DIOXIDE IN THE ATMOSPHERE SURROUNDING OUR PLANT.

THIS TIME ASSUME OUR PLANT HAS ALL THE LIGHT, WATER AND CHLOROPHYLL THAT IT NEEDS.

LET THE VALUES YOU SELECT FOR THE CARBON DIOXIDE CONCENTRATION BE FOR TWO DECIMAL PLACES ONLY, AND IN THE RANGE OF 0 TO .30
UNITS FOR CO2 CONC. ARE CUBIC CENTIMETERS PER LITER OF AIR.

AS BEFORE, I WILL TYPE IN A '?' AND THEN YOU TYPE IN THE CARBON DIOXIDE CONC. AVAILABLE TO THE PLANT.
THIS TIME YOU MUST CHOOSE TEN DIFFERENT VALUES.
REMEMBER RP = RATE OF PHOTOSYNTHESIS.

```
CARBON DIOXIDE CONC.(CO2)? .10
RP= 118
(CO2)? .20
RP= 125
(CO2)? .30
RP= 125
(CO2)? .15
RP= 124
(CO2)? .05
RP= 94
(CO2)? .25
RP= 125
(CO2)? .02
RP= 54
(CO2)? 0
RP= 0
(CO2)? .11
RP= 119
(CO2)? .09
RP= 115
```

```
1 = TABLE ONLY, 2 = PLOT ONLY, 3 = BOTH? 3

CO2 CONC.          RATE OF PHOTOSYNTHESIS
--- -----          ---- -- --------------
 0                  0
 .02                53.87931
 .05                94.1092
 .09                114.9425
 .1                 117.8161
 .11                119.2529
 .15                123.5632
 .2                 125
 .25                125
 .3                 125

CO2 CONC.
                   RATE OF PHOTOSYNTHESIS
                   0    25   50   75   100  125
                   I----I----I----I----I----I
 0                 *
                   I
 .02               I          *
                   I
                   I
 .05               I                *
                   I
                   I
                   I
 .09               I                    *
 .1                I                     *
 .11               I                     *
                   I
                   I
                   I
 .15               I                      *
                   I
                   I
                   I
                   I
 .2                I                      *
                   I
                   I
                   I
                   I
 .25               I                      *
                   I
                   I
                   I
                   I
 .3                I                      *

DO YOU KNOW WHAT IS HAPPENING IN BOTH THESE INSTANCES?

READY
```

```
100 REM F. H. COOPER, WYANDANCH H.S., REVISED 7/69
105 REM  REVISED BY C.LOSIK  7-9-70
106 REM V(I)=INPUT VALUES (LIGHT INTENSITY, CO2 CONC.)
107 REM R(I)=RATE OF PHOTOSYNTHESIS
110 DIM V(31),R(31)
120 PRINT "HELLO. BY NOW YOU SHOULD KNOW FROM YOUR LECTURES WHAT"
130 PRINT "PHOTOSYNTHESIS IS. THIS LABORATORY WILL ENABLE YOU TO"
140 PRINT "CONDUCT EXPERIMENTS ON THE COMPUTER WHICH WOULD NOT BE"
150 PRINT "PRACTICAL DURING CLASS TIME."
160 PRINT
200 PRINT "SINCE ALL OF OUR FOOD COMES FROM PLANTS, LET'S FIND OUT"
210 PRINT "HOW CHANGING THE AMOUNT OF CARBON DIOXIDE OR THE INTENSITY"
220 PRINT "OF LIGHT WILL AFFECT THE PLANT'S RATE OF PHOTOSYNTHESIS,"
230 PRINT "MEASURED IN MICROGRAMS OF GLUCOSE PRODUCED PER DAY."
240 PRINT
290 PRINT "LET'S BEGIN WITH CHANGING THE LIGHT INTENSITY. YOU WILL"
300 PRINT "VARY THIS BY SELECTING INTEGER VALUES IN THE RANGE OF"
310PRINT"0 TO 30 (THE UNITS FOR LIGHT INTENSITY ARE IN ERGS/SEC/SQ.CM)"
315 PRINT "BY VARYING ONLY ONE FACTOR AT A TIME, WE ARE CONDUCTING"
320 PRINT "A CONTROLLED EXPERIMENT. WE WILL ASSUME THAT OUR PLANT"
330 PRINT "HAS ALL OF THE CARBON DIOXIDE, WATER AND CHLOROPHYLL"
335 PRINT "THAT IT NEEDS."
340 PRINT
350 PRINT "YOU SHOULD CHOOSE BETWEEN FIVE AND TEN LIGHT INTENSITY"
360 PRINT "VALUES. TYPE IN ONLY ONE VALUE AFTER EACH QUESTION MARK."
380 PRINT "BY TYPING IN 100, NO MORE QUESTION MARKS WILL APPEAR AND"
390PRINT"THE PROGRAM WILL CONTINUE."
395 PRINT "(NOTE: 'RP' MEANS RATE OF PHOTHSYNTHESIS)"
400 PRINT
410 PRINT "LIGHT INTENSITY";
412 REM  INITIALIZE
413 FOR I=0 TO 30
415 LET V(I)=-1
417 NEXT I
419 FOR I=1 TO 10
420 PRINT "(LI)";
430 INPUT W
435 IF W=100 THEN 560
440 IF W>30 THEN 510
450 IF W<0 THEN 510
460 IF W<>INT(W) THEN 510
470 LET V(W)=W
480 LET R(W)=INT(12500*(1-EXP(-.222*V(W)))+.05)/100
490 PRINT "RP=";INT(R(W)+.5)
500 GO TO 550
510 PRINT "WRONG!  USE ONLY INTEGER VALUES BETWEEN 0 AND 30."
520 PRINT "TRY AGAIN."
530 GO TO 430
550 NEXT I
560 PRINT
565 REM  CHOICE OF OUTPUT
570 PRINT "1 = TABLE ONLY, 2 = PLOT ONLY, 3 = BOTH";
580 INPUT W
590 IF W=1 THEN 600
593 IF W=2 THEN 650
595 IF W=3 THEN 600
596 GO TO 570
600 PRINT
605 PRINT "  LIGHT","   RATE OF"
610 PRINT "INTENSITY","PHOTOSYNTHESIS"
615 PRINT "---------","--------------"
620 GOSUB 1500
630 IF W<>3 THEN 760
650 PRINT
660 PRINT "  LIGHT"
670 PRINT "INTENSITY"
680 GOSUB 1600
760 PRINT
770 PRINT
780 PRINT "O.K. LET'S NOW VARY THE AMOUNT OF CARBON DIOXIDE IN THE"
790 PRINT "ATMOSPHERE SURROUNDING OUR PLANT."
```

```
800 PRINT
810 PRINT "THIS TIME ASSUME OUR PLANT HAS ALL THE LIGHT, WATER AND"
820 PRINT "CHLOROPHYLL THAT IT NEEDS."
830 PRINT
840PRINT"LET THE VALUES YOU SELECT FOR THE CARBON DIOXIDE CONCENTRATION"
850 PRINT"BE FOR TWO DECIMAL PLACES ONLY, AND IN THE RANGE OF 0 TO .30"
880 PRINT "UNITS FOR CO2 CONC. ARE CUBIC CENTIMETERS PER LITER OF AIR."
890 PRINT
900 PRINT "AS BEFORE, I WILL TYPE IN A '?' AND THEN YOU TYPE IN THE"
910 PRINT "CARBON DIOXIDE CONC. AVAILABLE TO THE PLANT."
920 PRINT "THIS TIME YOU MUST CHOOSE TEN DIFFERENT VALUES."
925 PRINT "REMEMBER RP = RATE OF PHOTOSYNTHESIS."
930 PRINT
940 PRINT "CARBON DIOXIDE CONC.";
941 REM  INITIALIZE
942 FOR I=0 TO 30
944 LET V(I)=-1
946 NEXT I
948 FOR I=1 TO 10
950 PRINT "(CO2)";
960 INPUT W
970 IF W=100 THEN 1050
980 IF W<0 THEN 1040
990 IF W>.3 THEN 1040
995 LET Q=100*W
1000 IF ABS(Q-INT(Q+.5))>.00001 THEN 1040
1003 REM  FUDGE 1005 CAUSE INTEGER MESSES UP
1005 LET Q=INT(100*W+.5)
1010 LET V(Q)=W
1020 LET R(Q)=INT(175*(1-EXP(-28*V(Q)))+.005)/174*125
1025 PRINT "RP=";INT(R(Q)+.5)
1030 GO TO 1050
1040 PRINT "INPUT VALUES BETWEEN 0 AND .3 TO TWO PLACES ONLY"
1041 PRINT "TRY AGAIN"
1045 GO TO 960
1050 NEXT I
1060 PRINT
1070 PRINT "1 = TABLE ONLY, 2 = PLOT ONLY, 3 = BOTH";
1080 INPUT W
1090 IF W=1 THEN 1100
1093 IF W=2 THEN 1150
1095 IF W=3 THEN 1100
1096 GO TO 1070
1100 PRINT
1105 PRINT "CO2 CONC.","RATE OF PHOTOSYNTHESIS"
1110 PRINT "--- -----","---- -- --------------"
1120 GOSUB 1500
1130 IF W<>3 THEN 1200
1150 PRINT
1160 PRINT "CO2 CONC."
1180 GOSUB 1600
1200 PRINT
1210 PRINT
1220 PRINT "DO YOU KNOW WHAT IS HAPPENING IN BOTH THESE INSTANCES?"
1230 STOP
1499 REM  TABLE PRINTER
1500 FOR I=0 TO 30
1510 IF V(I)<0 THEN 1530
1520 PRINT V(I),R(I)
1530 NEXT I
1540 RETURN
1599 REM  PLOT ROUTINE
1600 PRINT " ","RATE OF PHOTOSYNTHESIS"
1610 PRINT " ","0    25    50    75    100  125"
1620 PRINT " ","I----I----I----I----I----I"
1630 FOR I=0 TO 30
1633 IF V(I)>=0 THEN 1645
1636 PRINT " ","I"
1640 GO TO 1670
1645 PRINT V(I),"I";TAB(14+INT(R(I)/5+.5));"*"
1670 NEXT I
1680 RETURN
1700 END
```

DISCIPLINE EARTH SCIENCE

SUBJECT CLIMATES

PROGRAM NAME CLIMAT

DESCRIPTION:

This program is designed to give students practice in identifying climates and climatic patterns. As the program runs, students are asked questions regarding precipitation and potential evapotranspiration on the basis of P and P. E. curves randomly selected and matched by the computer. At the conclusion of the program they are asked to specifically identify the climate of the region, (i. e. Tropical rain forest, Humid continental) on the basis of these curves, his answers, and the computer's corrections.

OBJECTIVES:

The program presents the student with the following concepts:

A. The value of graphing to help in the interpretation of data;

B. There are a limited number of characteristic annual precipitation patterns which affect the earth;

C. The P. E. characteristics of a region are primarily related to 1) latitude and 2) proximity to large bodies of water;

D. Combinations of P and P. E. patterns yield a relatively small, distinct number of climates;

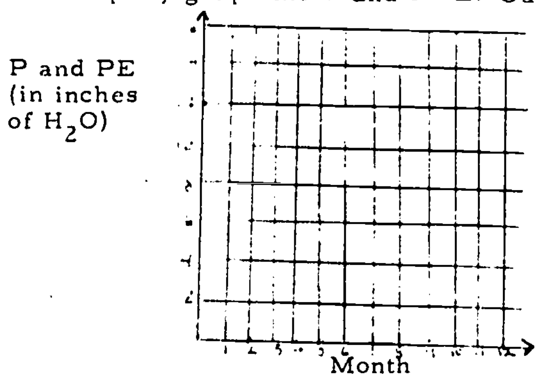
E. The precipitation patterns are modified by the prevailing wind pattern, regional geography and altitude.

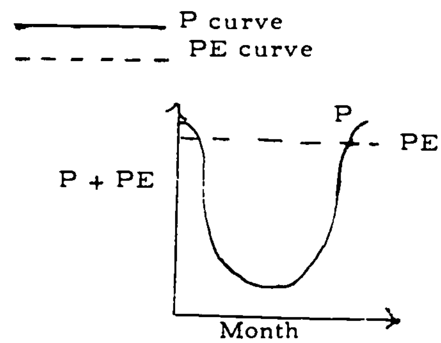
PRELIMINARY PREPARATION:

A. Student - The student should have been introduced to the general climatic regions and their characteristics. He should also have some understanding of the earth's wind belts and how they affect precipitation on the windward and lee side of mountains and continents.

PRELIMINARY PREPARATION: (con't)

B. Materials - 1) Dittos of graphs set up to permit students to rapidly graph the P and P. E. Curves:





2) Each student should be given a student progress code number. This activates the selection of P and P. E. curves for that student when typed into the computer. Each time a student uses the program he should be given a NEW progress code number.

DISCUSSION:

This program is for students of average ability. It should be used individually or in groups of 5 or less.

Student graphs are employed only to help the student rapidly assimilate the numberical data presented by the computer. They need not be checked beforehand by the teacher, but should be used during the follow-up discussion of the students' run.

The follow-up discussion on a class, group, or individual basis will greatly enhance the value of the lesson and the student comprehension of the entire topic of climates.

As proficiency increases (or with superior students), the student might be asked to complete the program by inspection of the data without actually plotting the P and P. E. curves.

In the program, the criteria used in evaluating P patterns are:

80" - wet climate
13-80" - moderate precipitation
<13" - arid or dry climate

Although these values may not agree exactly with values taught by individual teachers, they are close enough to accepted standards to make the use of the program extremely worthwhile.

DISCUSSION: (con't)

As with many of the other programs presented here, this program may be used in a demonstration lesson -- using the computer to provide data and questions; and the class to suggest and evaluate responses to be fed into the machine. Later, individuals or groups might be permitted to use the program as previously discussed. (If the program is used in this manner, the teacher might wish to prepare transparencies of the data and curves in advance for use during the computer run.)

O.K., HERE ARE SOME VALUES FOR THE PRECIPITATION (P) AND FOR THE POTENTIAL EVAPOTRANSPIRATION (PE) OF AN AREA:

MONTH	P	PE
1	14	0
2	10	3
3	9	7
4	16	10
5	9	13
6	14	14
7	13	13
8	8	10
9	12	7
10	8	3
11	13	1
12	11	0

TOTAL PRECIPITATION = 137 INCHES

O.K., PLOT YOUR GRAPH ON THE PAPER PROVIDED YOU
AND WHEN YOU ARE READY TO CONTINUE.... MERELY TYPE
ANY NUMBER AND THE RETURN KEY. ? 0

READY? GOOD, NOW TELL ME . . . DOES YOUR GRAPH SHOW THAT
THE CLIMATE HAS DEFINITE WET AND DRY SEASONS (1=YES, 0=NO) ? 0

TELL ME, IS THE CLIMATE [1] WET, [2] DRY, OR [3] MODERATE ALL
YEAR? 1

NICE GOING, SMARTY PANTS. KEEP UP THE GOOD WORK.
BY CHECKING THE PE CURVE ON YOUR GRAPH, WOULD YOU SAY THAT THE
SUMMERS ARE [1] HOT, [2] WARM, OR [3] COOL? 2

AW C'MON, YOU COULDN'T POSSIBLY MEAN THAT....
YOU SHOULD HAVE SAID 1

FROM THE SAME INFORMATION (PE GRAPH), WOULD YOU SAY THAT THE
WINTERS ARE [1] COLD, [2] MILD, OR [3] WARM? 1

IT WARMS MY HEART TO HEAR YOU SAY THAT. GOOD GOING.

WELL, BY NOW YOU MUST HAVE AN INKLING AS TO THE TYPE OF
CLIMATE WE HAVE HERE. BELOW IS A COMPLETE LISTING OF ALL THE
CLIMATES IN THE WORLD. REFER TO THEM BY THEIR NUMBER ONLY.

```
NUMBER          NAME OF CLIMATE
======          ===============
1               TROPICAL RAINFOREST
2               TROPICAL EAST COAST
3               TROPICAL MONSOON
4               TROPICAL SAVANNA
5               TROPICAL DESERT
6               MEDITERRANEAN
7               MARINE WEST COAST
8               HUMID CONTINENTAL
9               HUMID SUBTROPICAL
10              MIDDLE LATITUDE GRASSLANDS
11              MIDDLE LATITUDE DESERT
12              SUBARTIC CLIMATES
13 OR 14        HIGHLAND CLIMATES
                (TROPICAL OR MIDDLE LATITUDES)
15              POLAR TUNDRA
16              POLAR ICECAP

WHAT IS THE NUMBER OF THE CLIMATE WE HAVE (WE'LL ACCEPT THE
FACT THAT THEY MAY OVERLAP)? 1


MY SUGGESTION - STICK TO LANGUAGES OR SOCIAL STUDIES.
YOU SHOULD HAVE SAID 8 .  GOOD DAY TO YOU.

READY
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```
100REM--E.A.GALLETTA,PATCHOGUE-H.S.,4/22/69 EARTH SCIENCE (BIICAC)
105REM--PROGRAM ON CLIMATES
110REM--REWRITTEN--7/28/69--BASIC--<ROD>
112 REM  REVISED BY TONY PEREZ, WALT WHITMAN HS, 8-69
113 REM  RE-REVISED BY C.LOSIK  8-26-70
115DIML(56)
118 RANDOMIZE
120READN,L(N)
125IFN<>56THEN120
130LETT=0
155PRINT"O.K., HERE ARE SOME VALUES FOR THE PRECIPITATION (P) AND FOR"
160PRINT"THE POTENTIAL EVAPOTRANSPIRATION (PE) OF AN AREA:"
165PRINT
170PRINT" ","MONTH","  P","  PE"
175PRINT" ","=====","=====","======"
195LETP=INT(10*RND(1))
200IFP>6THEN195
205IFP<1THEN195
210LETE=INT(10*RND(1))
215IFE>4THEN210
220 IFE<1THEN210
225LETZ=5*E+6*P
230 IF (Z-21)*(Z-22)*(Z-17)*(Z-38)=0 THEN 195
235FORI=1TO12
240PRINT" ",I,
245IFP>1THEN255
250LETP1=12*COS(.261*I)↑2+2*RND(-1)
255IFP<>2THEN265
260LETP1=12*SIN(.261*I)+2*RND(-1)
265IFP<>3THEN275
270LETP1=2+3*RND(-1)
275IFP<>4THEN285
280LETP1=2*RND(-1)
285IFP<>5THEN295
290LETP1=7+10*RND(-1)
295IFP<>6THEN305
300LETP1=3*COS(.5+.15+I)↑2
305PRINTINT(P1),
310IFE>1THEN320
315LETE1=10*SIN(.261*I)↑2
320IFE<>2THEN330
325LETE1=12*SIN(.261*I)↑2
330IFE<>3THEN340
335LETE1=2*SIN(.5+.15*I)↑2
340IFE<>4THEN350
345LETE1=8+4*RND(-1)
350LETT=T+INT(P1)
```

```
355PRINTINT(E1+(E1/10)*2)
360NEXTI
365PRINT
370PRINT"TOTAL PRECIPITATION =";T;"INCHES"
375PRINT
380PRINT"O.K., PLOT YOUR GRAPH ON THE PAPER PROVIDED YOU"
385PRINT"AND WHEN YOU ARE READY TO CONTINUE.... MERELY TYPE"
390PRINT"ANY NUMBER AND THE RETURN KEY.          ";
395INPUTQ
400PRINT
405PRINT"READY?  GOOD, NOW TELL ME . . . DOES YOUR GRAPH SHOW THAT"
410PRINT"THE CLIMATE HAS DEFINITF WET AND DRY SEASONS (1=YES, 0=NO) ";
420 INPUT S
425PRINT
430IFS=0THEN505
433 IF S<>1 THEN 405
435IFP<3THEN560
437 LET B=0
440 GO SUB 1045
445PRINT"TELL ME, IS THE CLIMATE [1] WET, [2] DRY, OR [3] MODERATE ALL"
450PRINT"YEAR";
455 INPUT S
460PRINT
465IFS=1THEN525
470IFS=3THEN545
473 IF S<>2 THEN 445
475IFT<13THEN625
480IFT>80THEN495
485GOSUB1040
490GOTO630
495GOSUB1020
500GOTO630
505IFP>2THEN445
510IFP=2THEN475
515GOSUB1020
520GOTO560
525IFT>80THEN625
530IFT>=13THEN485
535GOSUB1030
540GOTO630
545IF(T-13)*(80-T)>=0THEN625
550IFT<13THEN535
555IFT>80THEN495
560PRINT"TELL ME, WHICH IS THE WET SEASON, [1] THE WINTER OR [2] THE"
565PRINT"SUMMER";
570PRINT
575 INPUT S
580PRINT
585IFS=1THEN605
587 IF S<>2 THEN 560
```

```
590 IFP=2THEN625
595 GOSUB1020
600 GOTO630
605 IFP=1THEN625
610 GOSUB1020
615 GOTO630
620 PRINT
625 PRINT"NICE GOING, SMARTY PANTS.  KEEP UP THE GOOD WORK."
630 PRINT"BY CHECKING THE PE CURVE ON YOUR GRAPH, WOULD YOU SAY THAT THE"
635 PRINT"SUMMERS ARE [1] HOT, [2] WARM, OR [3] COOL";
640 INPUT S
645 PRINT
650 IFS=2THEN695
655 IFS=3THEN715
657 IF S<>1 THEN 625
660 IFE=2THEN725
665 IFE=4THEN725
667 IF E=1 THEN 725
670 GOSUB1020
675 GOTO730
695 IFE=1THEN725
700 IFE<>3THEN670
705 GOSUB1040
710 GOTO730
715 IFE=3THEN725
720 IFE<>3THEN670
725 PRINT"YOU HAVE RESTORED MY FAITH IN TEENAGERS."
730 PRINT"FROM THE SAME INFORMATION (PE GRAPH), WOULD YOU SAY THAT THE"
735 PRINT"WINTERS ARE [1] COLD, [2] MILD, OR [3] WARM";
740 INPUT S
745 PRINT
750 IFS=2THEN790
755 IFS=3THEN810
760 IF S<>1 THEN 730
765 IFE<3THEN825
770 GOSUB1030
775 GOTO830
780 GOSUB1040
785 GOTO830
790 IFE=3THEN825
795 IFE=4THEN780
800 GOSUB1020
805 GOTO830
810 IFE=3THEN770
815 IFE=4THEN830
820 GOTO800
825 PRINT"IT WARMS MY HEART TO HEAR YOU SAY THAT.  GOOD GOING."
830 PRINT
835 PRINT"WELL, BY NOW YOU MUST HAVE AN INKLING AS TO THE TYPE OF"
840 PRINT"CLIMATE WE HAVE HERE.  BELOW IS A COMPLETE LISTING OF ALL THE"
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845PRINT"CLIMATES IN THE WORLD.  REFER TO THEM BY THEIR NUMBER ONLY."
850PRINT
855PRINT
860PRINT"NUMBER","NAME OF CLIMATE"
865PRINT"======","=============="
870PRINT"1","TROPICAL RAINFOREST"
875PRINT"2","TROPICAL EAST COAST"
880PRINT"3","TROPICAL MONSOON"
885PRINT"4","TROPICAL SAVANNA"
890PRINT"5","TROPICAL DESERT"
895PRINT"6","MEDITERRANEAN"
900PRINT"7","MARINE WEST COAST"
905PRINT"8","HUMID CONTINENTAL"
910PRINT"9","HUMID SUBTROPICAL"
915PRINT"10","MIDDLE LATITUDE GRASSLANDS"
920PRINT"11","MIDDLE LATITUDE DESERT"
925PRINT"12","SUBARTIC CLIMATES"
930PRINT"13 OR 14","HIGHLAND CLIMATES"
935PRINT" ","(TROPICAL OR MIDDLE LATITUDE)"
940PRINT"15","POLAR TUNDRA"
945PRINT"16","POLAR ICECAP"
950PRINT
955PRINT"WHAT IS THE NUMBER OF THE CLIMATE WE HAVE (WE'LL ACCEPT THE"
960 PRINT "FACT THAT THEY MAY OVERLAP)";
965INPUTS
970PRINT
975PRINT
980PRINT
985IFS=L(Z)THEN1005
990PRINT"MY SUGGESTION - STICK TO LANGUAGES OR SOCIAL STUDIES."
995PRINT"YOU SHOULD HAVE SAID";L(Z);".  GOOD DAY TO YOU."
1000STOP
1005PRINT"YOUR FORTUNE AS A METEOROLOGIST IS BUDDING.  IT WAS"
1010PRINT"VERY NICE TO WORK WITH YOU.  SO LONG."
1015STOP
1020LETB=1
1025GOTO1045
1030LETB=2
1035GOTO1045
1040LETB=3
1045PRINT"AW C'MON, YOU COULDN'T POSSIBLY MEAN THAT...."
1050PRINT"YOU SHOULD HAVE SAID";B
1055PRINT
1060RETURN
1085DATA11,6,16,7,23,10,26,3,27,15
1090DATA28,8,29,11,32,3,33,13,34,11
1095DA
TA35,9,39,16,40,8,41,13,44,5
1100DATA46,10,45,16,50,1,51,12,56,4
1105DATA39,4,44,5,35,9,40,8,45,1,41,15,46,12,51,5,56,16
1110DATA0,0
1115END
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DISCIPLINE EARTH SCIENCE

SUBJECT CLOUD FORMATION

PROGRAM NAME CLOUDS

DESCRIPTION:

This program tests student ability to solve problems related to the formation of cumuliform clouds (i. e. L. C. L., temperature at various altitudes). In Phase I of the program students enter the variables and unknowns of previously assigned problems. The computer checks the students' answers and supplies the correct answers if an error is detected.

When Phase I is completed the computer automatically presents a group of new problems for the student to solve and check at the machine.

OBJECTIVES:

The program attempts to reinforce and apply the following concepts:

A. There is a specific rate at which temperature drops in a rising parcel of unsaturated air.

B. Once air becomes saturated and condensation begins, the lapse rate decreases due to the release of latent heat of vaporization.

C. The base level of a cloud (LCL), and temperatures within it can be calculated from ground level data.

PRELIMINARY PREPARATION:

A. Student - Students should be familiar with the terms and values of the dry and wet adiabatic lapse rates, normal lapse rate, and the formula for calculating the Lifting-Condensation Level.

B. Materials - Printed sets of problems with the following variables and unknowns:
   1. Air temperature on the ground.
   2. Dew point on the ground
   3. Temperature at the base of the cloud.
   4. The elevation, in feet, of the base of the cloud (LCL).

DISCUSSION:

This program is designed for average students. Individuals should be permitted to go to the computer to check any problem or groups of problems whenever the machine is free. The teacher in the lesson acts solely as a resource person to help those students unable to arrive at correct responses because of conceptual errors - not mechanical errors.

To speed the lesson, Phase II of the program may be omitted entirely, by procedure 1, or from early runs by procedure 2.

Procedure 1

Erase Lines 561 - 699, 770 - 790 and change line 557 to read: If P> 1 then 2000.

Procedure 2

Change line 557 to read: If P> 1 then 2000.

When you are ready to use Phase II merely retype line 557 as originally listed.

Earth Science
CLOUDS

```
            CLOUD NINE
            ===== ====

   STRONG CONVECTION CURRENTS ARE CAUSING ADIABATIC
COOLING OF AIR WHERE YOU ARE AND ARE RESPONSIBLE FOR THE
FORMATION OF A CLOUD.  BOTH THE DRY AND THE MOIST ADIABATIC
(AS WELL AS THE NORMAL LAPSE RATES) ARE CONSIDERED IN THIS
PROGRAM.


            LEGEND
            ======
1=THE TEMPERATURE ON THE GROUND
2=THE DEW POINT TEMPERATURE ON THE GROUND
3=THE TEMPERATURE AT THE BASE OF THE CLOUD
4=THE ELEVATION, IN FEET, OF THE CLOUD BASE


CHOOSE ANY TWO OF THE ABOVE VARIABLES AND SELECT VALUES FOR
THEM.  TYPE THEM IN AS:
VARIABLE CODE ,VALUE, VARIABLE CODE ,VALUE...(E.G. 1,50,2,30)

? 1,50,2,41

OKAY, TYPE IN YOUR CALCULATED VALUE FOR
THE TEMPERATURE AT THE BASE OF THE CLOUD
FOLLOWED BY A COMMA, AND THEN TYPE IN YOUR VALUE FOR
THE ELEVATION, IN FEET, OF THE CLOUD BASE
? 39,2000

VERY GOOD.  VERY, VERY GOOD.

DO YOU HAVE ANY OTHER PROBLEMS YOU WOULD LIKE TO TRY?
(1=YES, 0=NO) : ? 1

USING THE SAME LEGEND AS BEFORE...
CHOOSE ANY TWO OF THE ABOVE VARIABLES AND SELECT VALUES FOR
THEM.  TYPE THEM IN AS:
VARIABLE CODE ,VALUE, VARIABLE CODE ,VALUE...(E.G. 1,50,2,30)

? 1,50,3,25

OKAY, TYPE IN YOUR CALCULATED VALUE FOR
THE DEW POINT TEMPERATURE ON THE GROUND
FOLLOWED BY A COMMA, AND THEN TYPE IN YOUR VALUE FOR
THE ELEVATION, IN FEET, OF THE CLOUD BASE
? 30,4000

IT LOOKS LIKE WE GOOFED SOME PLACE.
LET'S SEE WHAT THE CORRECT VALUES ARE.

 50 DEGREES - THE TEMPERATURE ON THE GROUND
 29.54545 DEGREES - THE DEW POINT TEMPERATURE ON THE GROUND
 25 DEGREES - THE TEMPERATURE AT THE BASE OF THE CLOUD
 4545.455 FEET - THE ELEVATION, IN FEET, OF THE CLOUD BASE

DO YOU HAVE ANY OTHER PROBLEMS YOU WOULD LIKE TO TRY?
(1=YES, 0=NO) : ? 0

WELL, BEFORE YOU LEAVE, I HAVE A FEW I'D LIKE YOU TO TRY...
BASED ON YOUR VALUES, THE HEIGHT OF THE CLOUD
(MEASURED FROM THE CLOUD BASE) IS  18181.82  FT.  CAN YOU TELL ME:

WHAT IS THE TEMPERATURE AT EACH OF THESE ALTITUDES:
              1  3182 FT
              2  31818 FT
              3  13636 FT

THE TEMPERATURE AT  3182  FT. IS ? 30

SORRY.  YOU WERE DOING GREAT THERE FOR A WHILE.
WELL, BACK TO THE BOOKS.  THE VALUES YOU SHOULD HAVE ARE:

 1 THE TEMPERATURE AT 3182 FEET IS  32.5 DEGREES
 2 THE TEMPERATURE AT 31818 FEET IS -61.36364 DEGREES
 3 THE TEMPERATURE AT 13636 FEET IS -2.272727 DEGREES

READY
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10REM--A.C.CAGGIANO+E.A.GALLETTA, PATCHOGUE H.S., 11-20-68
11REM--REVISED BY CHARLES LOSIK AND TONY PEREZ  7/18/69
12 REM  RE-REVISED BY C.LOSIK  8-26-70
20REM--THIS PROGRAM IS ASSOCIATED WITH CLOUD FORMATION
25REM PHASE I OF PROGRAM BEGINS HERE.  STUDENTS WILL BE GIVEN
26REM INTRODUCTORY INFORMATION AND BE ALLOWED TO ASK AND ANSWER
27REM ANY NUMBER OF PROBLEMS. WHEN THEY INPUT NO. 2 (LINES 554-556)
28REM PROGRAM SENDS THEM TO PHASE II (LINE 561 AND FOLLOWING).
30PRINT" ","CLOUD NINE"
40PRINT" ","===== ===="
45 DIM B(2), T(4), Q(3), A(3), C(3)
50PRINT
60PRINT"   STRONG CONVECTION CURRENTS ARE CAUSING ADIABATIC"
70PRINT"COOLING OF AIR WHERE YOU ARE AND ARE RESPONSIBLE FOR THE"
80PRINT"FORMATION OF A CLOUD.  BOTH THE DRY AND THE MOIST ADIABATIC"
90PRINT"(AS WELL AS THE NORMAL LAPSE RATES) ARE CONSIDERED IN THIS"
91PRINT"PROGRAM."
100PRINT
105 PRINT
110PRINT" ","LEGEND"
120PRINT" ","======"
140PRINT"1=";
150GOSUB1000
160PRINT"2=";
170GOSUB1010
180PRINT"3=";
190GOSUB1020
200PRINT"4=";
210GOSUB1030
220PRINT
225 PRINT
230 PRINT"CHOOSE ANY TWO OF THE ABOVE VARIABLES AND SELECT VALUES FOR"
231 PRINT"THEM.  TYPE THEM IN AS:"
232PRINT"VARIABLE CODE ,VALUE, VARIABLE CODE ,VALUE...(E.G. 1,50,2,30)"
233 PRINT
240 LET X=0
242 LET Y=0
245 LET A=0
246 LET B=0
247 LET B(1)=0
248 LET B(2)=0
250INPUTB(1),A,B(2),B
290PRINT
300FORI=1TO4
310IFB(1)=ITHEN330
320NEXTI
330LETT(I)=A
340FORJ=1TO4
350IFB(2)=JTHEN370
360NEXTJ
370LETT(J)=B
380IFI<>JTHEN405
390PRINT"YOU CAN'T USE THE SAME VALUES TWICE."
395GOTO250
405PRINT"OKAY, TYPE IN YOUR CALCULATED VALUE FOR";
406PRINT
410IFJ*I<>2THEN425
411LETT=(T(1)-T(2))/4.5
412LETT(4)=1000*T
413LETT(3)=T(2)-T
414GOSUB1020
415GOSUB1050
416GOSUB1030
417INPUTX,Y
418IFABS(X-T(3))>=.6THEN500
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```
419IFABS(Y-T(4))>=.6THEN500
420GOTO550
425IFJ*I<>3THEN440
426LETT=(T(1)-T(3))/5.5
427LETT(4)=1000*T
428LETT(2)=T+T(3)
429GOSUB1010
430GOSUB1050
431GOSUB1030
432INPUTX,Y
433IFABS(X-T(2))>=.6THEN500
434IFABS(Y-T(4))>=.6THEN500
435GOTO550
440IFJ*I<>4THEN455
441LETT=T(4)/1000
442LETT(2)=T(1)-4.5*T
443LETT(3)=T(2)-T
444GOSUB1010
445GOSUB1050
446GOSUB1020
447INPUTX,Y
448IFABS(X-T(2))>=.6THEN500
449IFABS(Y-T(3))>=.6THEN500
450PRINT"OKAY, TYPE IN YOUR CALCULATED VALUE FOR"
455IFJ*I<>6THEN470
456LETT=T(2)-T(3)
457LETT(4)=1000*T
458LETT(1)=T(3)+5.5*T
459GOSUB1000
460GOSUB1050
461GOSUB1030
462INPUTX,Y
463IFABS(X-T(1))>=.6THEN500
464IFABS(Y-T(4))>=.6THEN500
465GOTO550
470IFJ*I<>8THEN485
471LETT=T(4)/1000
472LETT(3)=T(2)+T
473LETT(1)=T(2)+6.5*T
474GOSUB1010
475GOSUB1050
476GOSUB1020
477INPUTX,Y
478IFABS(X-T(1))>=.6THEN500
479IFABS(Y-T(3))>=.6THEN500
480GOTO550
481IFABS(X-T(3))>=.6THEN500
485IFJ*I<>12THEN390
486LETT=T(4)/1000
487LETT(1)=T(3)+5.5*T
488LETT(2)=T(3)+T
489GOSUB1000
490GOSUB1050
491GOSUB1010
492INPUTX,Y
493IFABS(X-T(1))>=.6THEN500
494IFABS(Y-T(2))>=.6THEN500
495GOTO550
500PRINT
502PRINT"IT LOOKS LIKE WE GOOFED SOME PLACE."
505PRINT"LET'S SEE WHAT THE CORRECT VALUES ARE."
507PRINT
510 PRINT T(1)"DEGREES - ";
512 GO SUB 1000
515 PRINT T(2)"DEGREES - ";
517 GO SUB 1010
520 PRINT T(3)"DEGREES - ";
522 GO SUB 1020
525 PRINT T(4)"FEET - ";
527 GO SUB 1030
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530 PRINT
535GOTO554
550PRINT
552PRINT"VERY GOOD.  VERY, VERY GOOD."
553PRINT
554PRINT"DO YOU HAVE ANY OTHER PROBLEMS YOU WOULD LIKE TO TRY?"
555 PRINT "(1=YES, 0=NO) : ";
556 INPUT P
557IFP<1THEN561
558PRINT
559PRINT"USING THE SAME LEGEND AS BEFORE..."
560GOTO230
561LETH=(T(1)-T(3))*2000-7*T(4)
562REM LINE 561 CALCULATES ALTITUDE FOR TOP OF CLOUD AND BEGINS
563REM  PHASE II OF PROGRAM.  PROBLEM NO.2 IN THIS PART (CALCULATION
564REM  OF TEMP. ABOVE CLOUD TOP) INVOLVES USE OF THE NORMAL LAPSE RATE.
565PRINT
567PRINT"WELL, BEFORE YOU LEAVE, I HAVE A FEW I'D LIKE YOU TO TRY..."
570PRINT"BASED ON YOUR VALUES, THE HEIGHT OF THE CLOUD"
580PRINT"(MEASURED FROM THE CLOUD BASE) IS ";H;" FT.  CAN YOU TELL ME:"
600LETQ(1)=.7*T(4)
601LETQ(2)=T(4)+1.5*H
602LETQ(3)=T(4)+.5*H
610LETA(1)=T(1)-T(4)*3.85E-3
611LETA(2)=T(1)-(T(4)+1.5*H)*3.5E-3
612LETA(3)=T(3)-1.5E-3*H
614PRINT
615PRINT"WHAT IS THE TEMPERATURE AT EACH OF THESE ALTITUDES:"
620FORN=1TO3
625PRINT" ",N;INT(Q(N)+.5);"FT"
627NEXT N
628PRINT
629FORN=1TO3
630PRINT"THE TEMPERATURE AT ";INT(Q(N)+.5);" FT. IS ";
631INPUTC(N)
635IFABS(C(N)-A(N))>1.1THEN750
640NEXTN
699PRINT
700PRINT"WOW, YOU MUST BE A BRAIN.  AND YOU PROBALLY KNOW"
710PRINT"A LOT ABOUT CLOUDS AND THINGS LIKE THAT.  IT WAS VERY"
720PRINT"NICE TO WORK WITH SOMEONE WHO UNDERSTANDS ME."
730PRINT" ","THANK YOU AND . . . . PEACE AND LONG LIFE"
740STOP
750PRINT
755PRINT"SORRY.  YOU WERE DOING GREAT THERE FOR A WHILE."
760PRINT"WELL, BACK TO THE BOOKS.  THE VALUES YOU SHOULD HAVE ARE:"
765PRINT
770FORN=1TO3
774PRINTN;
780PRINT"THE TEMPERATURE AT";INT(Q(N)+.5);"FEET IS ";A(N);"DEGREES"
790NEXTN
830STOP
1000PRIN
T"THE TEMPERATURE ON THE GROUND"
1005RETURN
1010PRINT"THE DEW POINT TEMPERATURE ON THE GROUND"
1015RETURN
1020PRINT"THE TEMPERATURE AT THE BASE OF THE CLOUD"
1025RETURN
1030PRINT"THE ELEVATION, IN FEET, OF THE CLOUD BASE"
1035RETURN
1050PRINT"FOLLOWED BY A COMMA, AND THEN TYPE IN YOUR VALUE FOR "
1055RETURN
2000END
```

DISCIPLINE EARTH SCIENCE

SUBJECT WATER BUDGET

PROGRAM NAME WATER1

DESCRIPTION:

This is a tutorial program which takes a student through the step-by-step calculations of a water budget, checks the correctness of his responses, and indicates the location of his errors. In difficult parts of the budget instructions, clues are given before the student is asked to re-calculate his work.

OBJECTIVES:

This program is designed to:

A. Enable students to "visualize" an areas' climate in terms of its moisture patterns of usage, storage, recharge, and deficit.

B. Illustrate the relationship of deficit and surplus in light of growing seasons for crops, watering of lawns, the need for irrigation, and the occurrence of floods.

C. Develop the skills necessary for the successful completion of a water budget.

PRELIMINARY PREPARATION:

A. Student - Students should understand the following terms: potential evapotranspiration, actual evapotranspiration, deficit, and surplus. The concept of a change in value of a number (Δ-ST or 'delta' -ST) should also have been covered.

B. Materials - Ditto sheets containing water budget tables should be available for each class member. A sample table follows:

WATER BUDGET

FOR:______________

Progress code no.		J	F	M	A	M	J	J	A	S	O	N	D
	P												
	PE												
	P-PE												
	ST												
	ΔST												
	AE												
	D												
	S												

A set of water budget graphs should also be available if the teacher wishes to have his classes complete the graph in addition to the water budget. See: Investigating the Earth, Teacher's Guide, Part I. P. 402 of the Earth Science Curriculum Project.

DISCUSSION:

This program is applicable to individual or small group (5 or less) instruction, and is designed for average students.

The progress code number assigned to the student indicates to the program the extent to which the student has progressed through the program. These numbers should be chosen according to the following table:

Progress Code #	Stage of Calculation of Water Budget
0-10	Introductory information
11-20	Student is ready for "P-PE" section of program
21-30	ready for "ST" section of program
31-40	ready for " -ST" section of program
41-50	ready for "A.E." section of program
51-60	ready for "D" section of program
61-70	ready for "S" section of program

Each student may work on a different water budget by entering a unique set of data in lines 43 and 44. Line 42 also may be changed to indicate the region whose water budget is under study.

This program should be used in conjunction with program WATER2.

```
WHAT IS YOUR PROGRESS CODE NUMBER? 5

WATER BUDGET FOR RUTLAND,VT.:
==============================================
P:
 57   48   63   74   80   90   86   86   92   94   88   56
PE:
 0    0    0    28   75   114  133  114  78   41   8    0
NOW, RETURN TO YOUR SEATS AND SEPARATELY WORK OUT YOUR VALUES
    FOR:  'P-PE'    AND 'STORAGE'.
RETURN ONLY AFTER YOUR TEACHER HAS CHECKED YOUR WORK AND GIVEN
     YOU A NEW PROGRESS CODE NUMBER!


READY

RUN

WHAT IS YOUR PROGRESS CODE NUMBER? 15


PRINT YOUR 12 VALUES FOR P-PE WHEN YOU SEE THE QUESTION
   MARK.  AFTER EACH OF THE VALUES PRINT A COMMA (,)--BUT
   DO NOT PRINT A COMMA AFTER YOUR LAST VALUE; SIMPLY HIT
   'RETURN'.
? 55,48,63,46,5,-24,-47,-28,14,53,80,56,
TOO MUCH INPUT, EXCESS IGNORED
OUCH!! THERE'S AN ERROR AT MONTH  1 .  RETYPE THIS LINE.
? 57,48,63,46,5,-24,-47,-28,14,53,80,56
GOOD WORK!
NOW LET'S SEE HOW WELL YOUR VALUES FOR 'ST' CAME OUT.  PRINT
   THEM AFTER THE QUESTION MARK.
? 100,100,100,100,100,76,29,1,15,68,100,100
YOUR VALUES FOR 'STORAGE' ARE CORRECT.
  HAVE YOU FINISHED THE REST OF THE WATER BUDGET?
(1=YES, 0=NO) : ? 0
OK! GO BACK TO YOUR SEATS AND WORK OUT 'DELTA-ST' AND 'A.E.'


READY
```

```
1 REM  CLASS ROOM EDITION OF WB -- PEREZ 5/1/69
2 DIM P(12),Z(12),X(12),T(12),A(12),V(12),S(12),D(12),E(12)
3 DIM Q(12)
4 REM  REVISED BY C.LOSIK  8-26-70
10 PRINT"WHAT IS YOUR PROGRESS CODE NUMBER";
13 INPUT B
14PRINT
30 FOR I = 1 TO 12
32READP(I)
34LETZ(I)=P(I)
36IFB>10THEN48
40IFI>1THEN47
42PRINT"WATER BUDGET FOR RUTLAND,VT.:"
43DATA57,48,63,74,80,90,86,86,92,94,86,56
44DATA0,0,0,26,75,114,133,114,78,41,8,0
45PRINT"================================================="
46 PRINT "P:"
47 GOSUB 500
48 NEXT I
49 PRINT
50 FOR I = 1 TO 12
51 READ T(I)
52  LET Z(I)=T(I)
53 IF B>10 THEN 58
55 IF I>1 THEN 57
56  PRINT "PE:"
57 GOSUB 500
58 NEXT I
70 IF B > 10 THEN 90
80 PRINT"NOW, RETURN TO YOUR SEATS AND SEPARATELY WORK OUT YOUR VALUES"
81 PRINT"    FOR:  'P-PE'    AND 'STORAGE'."
83 PRINT"RETURN ONLY AFTER YOUR TEACHER HAS CHECKED YOUR WORK AND GIVEN"
84 PRINT"       YOU A NEW PROGRESS CODE NUMBER!"
85 GOTO 999
90 IF B > 20 THEN 110
100 PRINT"PRINT YOUR 12 VALUES FOR P-PE WHEN YOU SEE THE QUESTION"
101 PRINT"   MARK.  AFTER EACH OF THE VALUES PRINT A COMMA (,)--BUT"
[illegible] PRINT"   DO NOT PRINT A COMMA AFTER YOUR LAST VALUE; SIMPLY HIT"
[illegible]PRINT"   'RETURN'."
10[illegible] GOSUB 530
110FORI=1TO12
115LETX(I)=P(I)-T(I)
117IFB>20THEN130
120 IF X(I)=Q(I) THEN 130
121PRINT"OUCH!! THERE'S AN ERROR AT MONTH ";I".  RETYPE THIS LINE."
122 GOTO0105
130 NEXT I
137 IF B > 30 THEN 200
138 IF B > 20 THEN 142
140 PRINT "GOOD WORK!"
142 PRINT"NOW LET'S SEE HOW WELL YOUR VALUES FOR 'ST' CAME OUT.  PRINT "
143 PRINT"   THEM AFTER THE QUESTION MARK."
150 GOSUB 530
200 FOR I = 1 TO 12
201IFX(I)>=0THEN208
202  LET G = 0
203 LET S(I) = T + X(I)
204  LET T = S(I)
205IFS(I)<=0THEN275
206 LET G = 0
207 NEXT I
208 LET T = 100
209 LET S(I) = X(I)+G
210 LET G = S(I)
```

```
211 LET T = 100
212 LET S(I) = X(I)+G
213IFS(I)>=100THEN280
215 GOTO 207
275 LET S(I) = 0
276 GOTO 281
280LETS(I)=100
281LETN1=I+1
282LETG=I
290FORI=N1TO12
310LETM=I-1
311LETN=I+1
320GOSUB352
321NEXTI
324 FOR I = 1 TO G
325  LET M = I-1
327  IF I>1 THEN 332
328  LET M=12
332 GOSUB 352
333 NEXT I
334 GOTO 400
352 LET S(I)=S(M)+X(I)
355 IF S(I)>=100 THEN 363
357 IF S(I)<I THEN 380
360 GOTO 368
363 LET E(I)=S(I)-100
364 LET S(I)=100
368 LET V(I)=S(I)-S(M)
369 LET A(I)=T(I)
371 GOTO 389
380 LET S(I)=0
382  LET D(I)=ABS(P(I)+S(M)-T(I))
383  LET A(I)=S(M)+P(I)
384   LET V(I)=S(I)-S(M)
389 RETURN
400 IF B > 30 THEN 440
401  FOR I = 1 TO 12
402 IF Q(I) = S(I) THEN 420
404PRINT"SORRY ABOUT THAT!! MONTH";I;"IS IN ERROR. RECALCULATE PLEASE."
410 GOTO 999
420 NEXT I
425 PRINT"YOUR VALUES FOR 'STORAGE' ARE CORRECT."
426 PRINT"  HAVE YOU FINISHED THE REST OF THE WATER BUDGET?"
427 PRINT "(1=YES, 0=NO) : ";
428 INPUT L
430IFL=1THEN441
433 IF L<>0 THEN 426
435PRINT"OK! GO BACK TO YOUR SEATS AND WORK OUT 'DELTA-ST' AND 'A.E.'"
439 GOTO 999
440 IF B > 40 THEN 455
441 PRINT"LET'S SEE YOUR VALUES FOR 'DELTA-ST'."
443 GOSUB 530
444 FOR I = 1 TO 12
446IFQ(I)=V(I)THEN451
447PRINT"THERE SEEMS TO BE AN ERROR IN MONTH "I".  BETTER TAKE A LOOK"
448 PRINT"  AT YOUR VALUES. REMEMBER DELTA-ST = ST FOR LAST MONTH MINU
449PRINT"  ST FOR THIS MONTH.  PLEASE LEAVE AND RECHECK YOUR WORK."
450GOTO999
451NEXTI
453 PRINT"THESE VALUES ARE FINE."
455 IF B>50 THEN 470
456PRINT"HOW DID YOUR A.E. VALUES COME OUT?  JUST LIST THEM AS BEFORE.
457 GOSUB 530
458FORI=1TO12
459IFQ(I)=A(I)THEN465
460PRINT"OOPS!  YOU DID IT! MONTH"I"IS INCORRECT...RECALCULATE!!!"
```

```
461 GO TO 999
465 NEXT I
466 PRINT"GOOD WORK!  THEY'RE ALL CORRECT."
470 IF B>60 THEN 485
471 PRINT"PLEASE LIST YOUR 'D' VALUES."
473 GOSUB 530
474 FOR I = 1 TO 12
475    IF Q(I)=D(I) THEN 480
476PRINT"YOU HAVE A DEFICIT WHENEVER P.E.>A.E.---AND---ST=0.  THE"
477PRINT"  DEFICIT = THE AMT.OF H2O YOU'R SHORT TO MEET THE P.E. FOR"
478PRINT"  MONTH";I".  THAT IS: D=PE-AE.  HAVE ANOTHER TRY....."
479 GOTO 999
480 NEXT I
485PRINT"NOW FOR THE FINAL ROW.  PLEASE PRINT YOUR 'SURPLUS' FIGURES."
486 GOSUB 530
487  FOR I = 1 TO 12
488     IF Q (I)= E (I) THEN 495
489PRINT"A SURPLUS OCCURS ONLY WHEN 'ST'=>100. DID THIS CONDITION EXIST"
490PRINT"FOR MONTH"I"? IF SO THEN 'S'=EXCESS 'P' NOT NEEDED FOR P.E."
491PRINT"  SEE YOU AFTER YOU HAVE RECALCULATED!!!!"
492GOTO999
495  NEXT I
497 PRINT"WELL, IT LOOKS LIKE YOU DID IT.  FINE!!"
499 GO TO 999
500PRINTZ(I);
502IFZ(I)>99THEN525
503IFZ(I)>9THEN520
504IFZ(I)>-1THEN515
505IFZ(I)>-10THEN520
506IFZ(I)>-1000THEN525
515PRINT" ";
520PRINT" ";
525RETURN
530INPUTQ(1),Q(2),Q(3),Q(4),Q(5),Q(6),Q(7),Q(8),Q(9),Q(10),Q(11),Q(12)
533RETURN
999END
```

DISCIPLINE EARTH SCIENCE

SUBJECT WATER BUDGET

PROGRAM NAME WATER2

DESCRIPTION:

This program prints out a completed water budget. It may be used by a teacher to quickly calculate a series of water budgets he plans to use or it may be employed with more advanced students to check out an entire budget in one run.

OBJECTIVES:

A. To free teachers from the time-consuming task of calculating a number of practice water budgets.

B. To allow students a rapid means of verifying budgets they have been assigned for practice and drill.

PRELIMINARY PREPARATION:

A. Student - Students should be completely familiar with the concepts of evapotranspiration, water surplus, water storage, and water deficit.

B. Materials - A ditto of water budget tables as shown below:

WATER BUDGET
FOR:__________

	J	F	M	A	M	J	J	A	S	O	N	D
P												
PE												
P-PE												
ST												
ΔST												
AE												
D												
S												

DISCUSSION:

To place a particular water budget in the program:

1. Call up the program by name.

2. Type the precipitation data on line 5; the P. E. data on line 6 and the title of the budget on line 4.

   example:

   ```
   4PRINT " Water Budget for N. Y., N. Y.:"
   5DATA 89, 86, 98, 86, 84, 85, 106, 113, 88, 88, 82, 85
   6DATA 0, 0, 12, 40, 86, 125, 149, 132, 94, 55, 22, 2
   ```

3. Type " RUN"

The complete water budget will print out. (Check the value for P and PE to make sure you have typed them in correctly.)

To add other budgets repeat steps 2 and 3 until all budgets have been completed.

Additional P and PE data for other regions can be found in Investigating the Earth, Teacher's Guide, Part I, pages 392-397.

```
WATER BUDGET FOR ANCHORAGE, ALASKA:
==========================================================

P:
 22    18    13    10    12    22    48    68    66    47    25    23
PE:
 0     0     0     18    71    104   115   105   65    21    0     0
P-PE:
 22    18    13    -8    -59   -82   -67   -37   1     26    25    23
DELTA-ST:
 22    3     0     -8    -59   -33   0     0     1     26    25    23
STORAGE-(ST):
 97    100   100   92    33    0     0     0     1     27    52    75
AE:
 0     0     0     18    71    55    48    68    65    21    0     0
D:
 0     0     0     0     0     49    67    37    0     0     0     0
SURPLUS:
 0     15    13    0     0     0     0     0     0     0     0     0

TOTAL P =       374
TOTAL PE =      499
P/PE = .749499

READY
```

```
1 REM   CALCULATES WATER BUDGET -- PEREZ 20MAR69
2DIM P(12),Z(12),X(12),I(12)
3 REM   LINES 4,5,6 ARE FOR "TITLE LINE", "P DATA", & "P.E. DATA"
4 PRINT"WATER BUDGET FOR ANCHORAGE, ALASKA:"
5DATA22,18,13,10,12,22,48,68,66,47,25,23
6DATA0,0,0,18,71,104,115,105,65,21,0,0
7PRINT"================================================================="
8 PRINT
9 PRINT "P:"
10 FOR I = 1 TO 12
11  READ P(I)
12 LET Z(I)=P(I)
13 GOSUB 499
15 NEXT I
16 PRINT
29 DIM T(12)
39 PRINT"PE:"
40 FOR I = 1 TO 12
41   READ T(I)
42 LET Z(I)=T(I)
44 GOSUB 499
45  NEXT I
46 PRINT
59 PRINT "P-PE:"
61 FOR I = 1 TO 12
62 LET X(I)=P(I)-T(I)
65 LET Z(I)=X(I)
66 GOSUB 499
67 NEXT I
68 PRINT
69 GOTO 99
97 LET G = 0
98 DIM A(12),V(12)
99 DIM S(13),D(13),X(12)
100 FOR I = 1 TO 12
101 IF X(I)>=0 THEN 108
102 LET G = 0
103 LET S(I) = T + X(I)
104  LET T = S(I)
105  IF S(I)<=0 THEN 175
106 LET G = 0
107 NEXT I
108  LET T = 100
109  LET S(I) = X(I)+G
110  LET G = S(I)
111 LET T = 100
112 LET S(I) = X(I)+G
113 IF S(I)>=100 THEN 180
115 GOTO 107
175 LET S(I) =0
176 GOTO 181
180 LET S(I)=100
181 LET N1 = I + 1
182 LET G = I
190 FOR I = N1 TO 12
210 LET M=I-1
211 LET N = I+1
220 GOSUB 252
221 NEXT I
224 FOR I=1 TO G
225 LET M=I-1
227IFI>1THEN238
226 LET M=12
```

```
232 GOSUB 252
233 NEXT I
234 GOTO 391
252 LET S(I)=S(M)+X(I)
255 IF S(I)>=100 THEN 263
257 IF S(I)<1 THEN 280
260 GOTO 268
261 GOTO 268
263 LET E(I)=S(I)-100
264 LET S(I)=100
268 LET V(I)=S(I)-S(M)
269 [illegible](I)=T(I)
271 [illegible] 289
280 [illegible])=0
282   [illegible] D(I)=ABS(P(I)+S(M)-T(I))
283   LET A(I)=S(M)+P(I)
284   LET V(I)=S(I)-S(M)
289 RETURN
391 PRINT "DELTA-ST:"
392 FOR I = 1 TO 12
393 LET Z(I)=V(I)
394 GOSUB 499
395 NEXT I
396 PRINT
399 PRINT"STORAGE-(ST):"
400 FOR I=1 TO 12
405 LET Z(I)=S(I)
406 GOSUB 499
410 NEXT I
415 PRINT
419 PRINT"AE:"
420 FOR I = 1 TO 12
425 LET Z(I)=A(I)
426 GOSUB 499
427 NEXT I
428 PRINT
439 PRINT "D:"
440 FOR I = 1 TO 12
445 LET Z(I)=D(I)
446 GOSUB 499
450 NEXT I
451 PRINT
459 PRINT "SURPLUS:"
460 FOR I = 1 TO 12
465 LET Z(I)=E(I)
466 GOSUB 499
468 NEXT I
470 PRINT
475 FOR I = 1 TO 12
477  LET O=P(I)+O
479  LET H=T(I)+H
480  NEXT I
481 PRINT
482 PRINT "TOTAL P =",O
483 PRINT "TOTAL PE =",H
484 PRINT "P/PE ="O/H
485 GOTO 999
499 PRINT Z(I);
500 IF Z(I)>99 THEN 525
501 IF Z(I)>9 THEN 520
502 IF Z(I)>-1 THEN 515
503 IF Z(I)>-10 THEN 515
504 IF Z(I)>-1000 THEN 520
505 REM 504 READS >1000 TO PREVENT SPACING AFTER NUMBERS  BETWEEN
506 REM              -100 AND -1000
515 PRINT " ";
520 PRINT " ";
525 RETURN
999END
```

84

HUNTINGTON COMPUTER PROJECT

A TEACHER'S MANUAL

(COMPUTER - RELATED MATERIALS)

Second Edition

January 31, 1971

Director: Dr. Ludwig Braun
Assistant Director: Dr. Marian Visich, Jr.

Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

Developed by the Huntington Computer Project during the period May, 1968 and September, 1970. This effort was supported by the National Science Foundation under Grant No. J000079.

The enclosed material is a compilation of computer programs developed during the period May, 1968 to September, 1970. These programs were developed by teachers and students in the high schools which participated with us, and by the Project staff.

All of the enclosed programs have been tested on a Digital Equipment Corporation TSS-8 time-shared computer during the summer of 1970. To the best of our ability, we have assured ourselves that the programs actually run. It should be pointed out, however, that we were not able to make an exhaustive exploration of the programs. There may be undiscovered bugs (if there aren't, it may be the first time in the history of computing). We would appreciate hearing of any which emerge in the future.

These programs run in the version of BASIC which existed on the TSS-8 in August, 1970, and should run on most other versions of BASIC. The major potential problem on other machines is the output format (DEC uses 14 columns per print zone, while some other manufacturers use 15; we used the TAB function, which doesn't exist in all BASIC compiles). It may be necessary to make some minor changes in programs to adjust this format. Another possible problem is in the use of the RANDOMIZE command in some programs to start the random-number generator at a random point. If this command is not available, some other means should be devised for randomizing the start.

It is our sincere hope that these programs and their supporting documentation will be helpful to educators who are exploring the uses of computers in education.

We are anxious to hear of any bugs, errors, or improvements in these programs, and are especially anxious to hear of any novel ways of using them.

Ludwig Braun
Marian Visich, Jr.

TABLE OF CONTENTS

Volume I

CHEMISTRY

MATHEMATICS

PHYSICS

PHYSICS (con't)

SOCIAL STUDIES

TEACHER ASSISTANCE

DISCIPLINE CHEMISTRY

SUBJECT ATOMIC WEIGHT (ATOMIC MASS)

PROGRAM NAME ATWT

DESCRIPTION:

This program will calculate the atomic weight (atomic mass) of an element from the % abundance of each isotope of the element. The % abundance may be found in the chemistry handbook.

OBJECTIVES:

To show that the atomic weight is an average weight and not the weight of any particular atom.

PRELIMINARY PREPARATION:

A. Student - The student should have an introductory understanding of atomic weight, mass number, and isotopes.

B. Materials - A chemistry handbook from which mass numbers and % abundances may be obtained is necessary.

DISCUSSION:

It is usually difficult to get the point across that the atomic weight is an average weight and not the weight of any particular atom. This point can be made rather easily if the calculations for atomic weight are examined. This program will enable the teacher, in a few minutes during his discussion, to do a large number of calculations. This is particularly impressive when the teacher uses % data that is significant to 5-6 figures, and thus produces an atomic weight as accurate as those given in most tables.

If the teacher is interested in discussing programming with his students, this program is a good one to use. It has the advantage of being short, but still containing a number of interesting programming techniques.

```
THIS PROGRAM WILL CALCULATE THE ATOMIC WEIGHT (ATOMIC MASS)
FROM THE PERCENT ABUNDANCE OF EACH ISOTOPE.  PERCENT
ABUNDANCES MAY BE FOUND IN THE CHEMISTRY HANDBOOK.

HOW M   ' ISOTOPES DOES THE ELEMENT HAVE ? 7

IN        MASS NUMBER AND THE PERCENT ABUNDANCE FOR
EAC       HE 7 ISOTOPES.

ISOTOPE NO. 1  ? 196,.15
ISOTOPE NO. 2  ? 198,10
ISOTOPE NO. 3  ? 199,16.9
ISOTOPE NO. 4  ? 200,23.1
ISOTOPE NO. 5  ? 201,13.2
ISOTOPE NO. 6  ? 202,29.8
ISOTOPE NO. 7  ? 204,6.8


ATOMIC WEIGHT (ATOMIC MASS) IS 200.525

ANOTHER RUN (1=YES, 0=NO) ? 0


READY
```

```
100 REM  HARRY DORFMAN  7-15-69
105 REM  REVISED BY C.LOSIK  8-12-70
106 REM  B(I) ARE THE MASS NOS., C(I) ARE THE PERCENTS
110 PRINT " THIS PROGRAM WILL CALCULATE THE ATOMIC WEIGHT (ATOMIC MASS)"
120 PRINT " FROM THE PERCENT ABUNDANCE OF EACH ISOTOPE.  PERCENT"
130 PRINT " ABUNDANCES MAY BE FOUND IN THE CHEMISTRY HANDBOOK."
140 PRINT
150 PRINT " HOW MANY ISOTOPES DOES THE ELEMENT HAVE ";
160 INPUT A
163 IF ABS(A-INT(A))>.0001 THEN 150
166 PRINT
170 PRINT " INPUT THE MASS NUMBER AND THE PERCENT ABUNDANCE FOR"
180 PRINT " EACH OF THE"A"ISOTOPES."
185 PRINT
190 DIM B(20),C(20)
193 LET D=0
196 LET E=0
200 FOR I=1 TO A
205 PRINT " ISOTOPE NO."I" ";
210 INPUT B(I),C(I)
213 LET D=D+B(I)*C(I)
216 LET E=E+C(I)
220 NEXT I
235 PRINT
245 PRINT
300 IF ABS(E-100)<.2 THEN 309
302 PRINT
304 PRINT " THE PERCENT ABUNDANCE DOES NOT TOTAL 100."
305 PRINT " CHECK PERCENTAGES AND REENTER DATA."
306 GO TO 185
309 LET D=D/100
310 PRINT " ATOMIC WEIGHT (ATOMIC MASS) IS";D
315 PRINT
320 PRINT " ANOTHER RUN (1=YES, 0=NO) ";
330 INPUT A
335 PRINT
340 IF A=1 THEN 140
350 IF A<>0 THEN 320
360 END
```

DISCIPLINE CHEMISTRY

SUBJECT AVOGADRO' S NUMBER

PROGRAM NAME AVOGA

DESCRIPTION:

A class presentation designed to calculate Avogadro' s number, by using the molecular weight of a compound and dividing by the combined actual weight of the total numbers of neutrons and protons in a single molecule.

OBJECTIVES:

To show by calculation, the value of Avogadro' s Number, and to reinforce the concept of Avogadro' s hypothesis.

PRELIMINARY PREPARATION:

A. Student - The student must be familiar with atomic structure, atomic mass, nuclear particles, and isotopes.

B. Materials - none

DISCUSSION:

A. Operational Suggestions

The presentation of this program can be utilized to occupy one forty-five minute teaching period, even though the actual running time is approximately 10 minutes.

B. Suggested Follow-up

The occurrence of built-in error, due to the use of average atomic weights, generally provokes discussion as to the reasons for the error.

```
IF INSTRUCTIONS DESIRED, TYPE 1, IF NOT, TYPE 0? 1

THIS PROGRAM WILL CALCULATE AVOGADRO'S NUMBER BY USING
ANY PURE GASEOUS ELEMENT OR BINARY COMPOUND.

THIS VALUE WILL BE CALCULATED BY USING THE MASS IN GRAMS
OF THE NEUTRON, WHICH IS : 1.674383E-24
AND THE MASS OF THE PROTON, WHICH IS : 1.672059E-24

YOU MUST SUPPLY THE ATOMIC NUMBER AND THE ATOMIC WEIGHT OF
EACH ELEMENT USED. CARRY DIGITS UP TO 6 PLACES IF YOU
WISH. WHEN THE MACHINE ASKS (?) INPUT THE ATOMIC NUMBER
AND THE ATOMIC WEIGHT OF THE FIRST ELEMENT, THEN THE
ATOMIC NUMBER AND THE ATOMIC WEIGHT OF THE SECOND IN THE
FORM A,B,C,D. IF USING SINGLE ELEMENTS, BE SURE TO
PUT IN 0 FOR VALUES C AND D.

               ***************

NOW INPUT THE VALUES FOR YOUR COMPOUND
? 6,12.0012,8,15.9994
INPUT THE NUMBER OF ATOMS FOR EACH ELEMENT.
(CO2 WOULD BE 1,2)  :? 1,2

*** THE NUMBER OF PARTICLES PER MOLE OF THIS GAS IS 5.976496E+23

WOULD YOU LIKE TO TRY ANOTHER PROBLEM ?
TYPE 1 IF YES, TYPE 0 IF NO  ? 1

               ***************

NOW INPUT THE VALUES FOR YOUR COMPOUND
? 8,15.994,0,0
INPUT THE NUMBER OF ATOMS FOR EACH ELEMENT.
(CO2 WOULD BE 1,2)  :? 2,0

*** THE NUMBER OF PARTICLES PER MOLE OF THIS GAS IS 5.976497E+23

WOULD YOU LIKE TO TRY ANOTHER PROBLEM ?
TYPE 1 IF YES, TYPE 0 IF NO  ? 0

READY
```

```
100 REM   JOHN MARCHISOTTO  PIB SUMMER '69   7/2/69
103 REM   REVISED BY C.LOSIK   7-27-70
105 REM   A,B=AT NO, AT WT OF FIRST,  C,D=AT NO, AT WT OF SECOND
106 REM   E,F=# ATOMS FIRST, # ATOMS SECOND
110 PRINT "IF INSTRUCTIONS DESIRED, TYPE 1,  IF NOT, TYPE 0";
112 REM   G=PHOTON MASS, H=NEUTRON MASS
113 LET G=1.602E-19/9.581E4
116 LET H=1.0086*G/1.0072
120 INPUT N
130 IF N=0 THEN 220
131 IF N<>1 THEN 110
135 PRINT
140 PRINT "THIS PROGRAM WILL CALCULATE AVOGADRO'S NUMBER BY USING"
150 PRINT "ANY PURE GASEOUS ELEMENT OR BINARY COMPOUND."
151 PRINT
152 PRINT "THIS VALUE WILL BE CALCULATED BY USING THE MASS IN GRAMS"
153 PRINT "OF THE NEUTRON, WHICH IS :";H
154 PRINT "AND THE MASS OF THE PROTON, WHICH IS :";G
155 PRINT
156 PRINT "YOU MUST SUPPLY THE ATOMIC NUMBER AND THE ATOMIC WEIGHT OF"
157 PRINT "EACH ELEMENT USED.  CARRY DIGITS UP TO 6 PLACES IF YOU"
158 PRINT "WISH.  WHEN THE MACHINE ASKS (?) INPUT THE ATOMIC NUMBER"
159 PRINT "AND THE ATOMIC WEIGHT OF THE FIRST ELEMENT, THEN THE"
160 PRINT "ATOMIC NUMBER AND THE ATOMIC WEIGHT OF THE SECOND IN THE"
161 PRINT "FORM A,B,C,D.  IF USING SINGLE ELEMENTS, BE SURE TO"
162 PRINT "PUT IN 0 FOR VALUES C AND D."
220 PRINT
222 PRINT " ","***************"
224 PRINT
230 PRINT "NOW INPUT THE VALUES FOR YOUR COMPOUND"
240 INPUT A,B,C,D
250 PRINT "INPUT THE NUMBER OF ATOMS FOR EACH ELEMENT."
260 PRINT "(CO2 WOULD BE 1,2)  :";
270 INPUT E,F
339 PRINT
340 PRINT "*** THE NUMBER OF PARTICLES PER MOLE OF THIS GAS IS";
350 PRINT ((E*B)+(F*D))/((((E*A)+(F*C))*G)+((E*(B-A))+(F*(D-C)))*H)
355 PRINT
360 PRINT "WOULD YOU LIKE TO TRY ANOTHER PROBLEM ?"
370 PRINT "TYPE 1 IF YES, TYPE 0 IF NO  ";
380 INPUT N
390 IF N=1 THEN 220
395 IF N<>0 THEN 370
400 END
```

DISCIPLINE CHEMISTRY

SUBJECT RADIOACTIVE DECAY

PROGRAM NAME DECAY1

DESCRIPTION:

Radioactive decay is treated pseudo-quantitatively, by permitting the student to determine the approximate number of radioactive particles remaining after various times.

OBJECTIVES:

To induce a "feel" for exponential decay, by repeated exercises.

PRELIMINARY PREPARATION:

A. Student-Awareness of terms: Half-life, exponential, and radioactivity

B. Materials-none

DISCUSSION:

The concept of radioactive decay is presented in a game format, allowing the student to challenge his own ability in determining (with 5, 10, or 20% error), the number of radioactive "chips" remaining after various times. The number of chips successively decreases with each trial, increasing the level of difficulty as the program runs. In each case, the exact number remaining is given, following the students' entered value.

Individuals or small groups find this program exciting. They enjoy the game approach, at least the first time through it, and seem to be motivated by the opportunity to "break the bank."

This program can be used as an integral part of a class lesson to introduce the concept, or to motivate group discussion and participation concerning the phenomenon.

```
---THE NEW CLEA CASINO---

     MR. A. TOM MICK, GENERAL MANAGER OF THE NEW CLEA CASINO,
HAS, AT TIME  T=0,  DISCOVERED  100,000 RADIOACTIVE PLAYING
CHIPS AT HIS TABLE. THEIR HALF-LIFE IS 10 MINUTES. EACH CHIP
TRANSMUTES SPONTANEOUSLY AND COMPLETELY IN A RANDOM FASHION.

     AT VARIOUS TIMES T, AFTER T=0, YOU MUST DETERMINE WITHIN
A CERTAIN PERCENTAGE, HOW MANY CHIPS ARE LEFT.

     TO FURTHER THE INTEREST OF THE GAME, YOU WILL START WITH
$1,000 AND THE HOUSE WITH AN UNSPECIFIED AMOUNT.  HALF THE
MONEY YOU HAVE WILL RIDE ON EACH GUESS YOU TAKE.  LET'S SEE
IF YOU CAN BREAK THE HOUSE BEFORE THE CHIPS RUN OUT.

THE HOUSE OFFERS THE FOLLOWING ODDS:
     2) 2 TO 1 ODDS FOR GUESSING WITHIN 20 PERCENT
     4) 4 TO 1 ODDS FOR GUESSING WITHIN 10 PERCENT
     8) 8 TO 1 ODDS FOR GUESSING WITHIN  5 PERCENT.

ENTER THE NUMBER 2, 4, OR 8 FOR THE ODDS YOU WANT AFTER THE
QUESTION MARK IN THE COLUMN LABELLED ODDS.

YOUR $         HOUSE $         TIME (MIN)     ODDS

 1000           1.000000E+6     7.2           ? 8
HOW MANY CHIPS LEFT ? 60700
ACTUAL NUMBER LEFT IS  60716
YOU WON. TRY AGAIN.

 5000           996000         13.9           ? 8
HOW MANY CHIPS LEFT ? 38150
ACTUAL NUMBER LEFT IS  38164
YOU WON. TRY AGAIN.

 25000          976000         26.9           ? 8
HOW MANY CHIPS LEFT ? 15500
ACTUAL NUMBER LEFT IS  15502
YOU WON. TRY AGAIN.

 125000         876000         30.7           ? 8
HOW MANY CHIPS LEFT ? 11900
ACTUAL NUMBER LEFT IS  11913
YOU CAN BREAK THE HOUSE IF YOU TRY A LONG SHOT.

 625000         376000         46.4           ? 8
HOW MANY CHIPS LEFT ? 3500
ACTUAL NUMBER LEFT IS  3494
YOU BROKE THE HOUSE. YOU NEEDED ONLY THE MINIMUM NUMBER OF GUESSES.
CONGRATULATIONS.
YOU MUST KNOW A LOT ABOUT RADIOACTIVITY AND THINGS.
THANKS FOR PLAYING..

-------------------------------------------------------------

                                        CHECK NO. 3499

                                     DATE: -------------19--

 PAY TO THE ORDER OF--------CASH------$ 1.001000E+6

 THE NEW CLEA CASINO                     A. TOM MICK
                                         GENERAL MANAGER

-------------------------------------------------------------

DONT SPEND IT ALL IN ONE PLACE.

READY
```

```
100 REM  RICHARD F. PAV, PATCHOGUE H.S., (PHYSICS)  REVISED NOV. 26,1968
105 RANDOMIZE
110 REM  THIS IS A GAME BASED ON RADIOACTIVE DECAY.
120 PRINT "                   ---THE NEW CLEA CASINO---"
130 PRINT
140 PRINT "     MR. A. TOM MICK, GENERAL MANAGER OF THE NEW CLEA CASINO"
150 PRINT "HAS, AT TIME  T=0,  DISCOVERED  100,000 RADIOACTIVE PLAYING"
160 PRINT "CHIPS AT HIS TABLE. THEIR HALF-LIFE IS 10 MINUTES. EACH CHIP"
170 PRINT "TRANSMUTES SPONTANEOUSLY AND COMPLETELY IN A RANDOM FASHION."
180 PRINT
190 PRINT "     AT VARIOUS TIMES T, AFTER T=0, YOU MUST DETERMINE WITHIN"
200 PRINT "A CERTAIN PERCENTAGE, HOW MANY CHIPS ARE LEFT."
210 PRINT
220 PRINT "     TO FURTHER THE INTEREST OF THE GAME, YOU WILL START WITH
230 PRINT "$1,000 AND THE HOUSE WITH AN UNSPECIFIED AMOUNT.  HALF THE"
240 PRINT "MONEY YOU HAVE WILL RIDE ON EACH GUESS YOU TAKE.  LET'S SEE"
250 PRINT "IF YOU CAN BREAK THE HOUSE BEFORE THE CHIPS RUN OUT."
260 PRINT
270 PRINT "THE HOUSE OFFERS THE FOLLOWING ODDS:"
280 PRINT "     2) 2 TO 1 ODDS FOR GUESSING WITHIN 20 PERCENT"
290 PRINT "     4) 4 TO 1 ODDS FOR GUESSING WITHIN 10 PERCENT"
300 PRINT "     8) 8 TO 1 ODDS FOR GUESSING WITHIN  5 PERCENT."
310 PRINT
320 PRINT "ENTER THE NUMBER 2, 4, OR 8 FOR THE ODDS YOU WANT AFTER THE"
330 PRINT "QUESTION MARK IN THE COLUMN LABELLED ODDS."
340 PRINT
350 PRINT "YOUR $",  "HOUSE $",  "TIME (MIN)",  "ODDS"
360 LET A=0
370 LET B=0
380 LET T=0
390 LET Y=1000
400 LET [illegible]0
410 PRI[illegible]
420 IF ABS(G-D)<1500 THEN 450
430 LET G=5
440 LET D=2
450 LET B=B+1
450 FOR I=1 TO 3+A+ABS(G-D)
470 LET T3=INT(100*RND(-Y))/10
430 NEXT I
490 LET T=T+T3
500 LET D=INT(1E5*EXP(-.0693*T))
510 IF D=0 THEN 860
520 PRINT Y,1001000-Y,T,
530 INPUT A
540 IF A=2 THEN 610
550 IF A=4 THEN 610
560 IF A=8 THEN 610
570 PRINT "SORRY PAL, WE DONT OFFER THOSE ODDS."
580 IF C=1 THEN 820
590 LET C=1
600 GOTO 580
610 PRINT "HOW MANY CHIPS LEFT ";
620 INPUT G
630 PRINT "ACTUAL NUMBER LEFT IS ";D
640 IF A=2 THEN 700
650 IF A=4 THEN 680
660 LET P=.05
670 GOTO 710
680 LET P=.1
690 GOTO 710
700 LET P=.2
```

```
710 LET T=10*B
720 IF ABS(D-G)<=P*D THEN 770
730 LET Y=INT(Y-Y/8)
740 IF Y<=50 THEN 820
750 PRINT "TOO BAD, YOU LOST. TRY AGAIN."
760 GOTO 400
770 LET Y=INT(Y+A*Y/2)
780 IF 1000000-Y<1 THEN 890
790 IF Y>2E5 THEN 840
800 PRINT "YOU WON. TRY AGAIN."
810 GOTO 400
820 PRINT "IT SEEMS YOU JUST CANT GET THE HANG OF IT. SAVE YOUR BREAD."
830 GOTO 960
840 PRINT "YOU CAN BREAK THE HOUSE IF YOU TRY A LONG SHOT."
850 GOTO 400
860 PRINT "OOOOPS... SORRY PAL, THE LAST CHIP JUST DISINTEGRATED."
870 PRINT "THE HOUSE IS CLOSED."
880 GOTO 960
890 PRINT "YOU BROKE THE HOUSE. YOU NEEDED ONLY ";
895 LET Y=1001000
900 IF B>5 THEN 930
910 PRINT "THE MINIMUM NUMBER OF GUESSES."
920 GOTO 940
930 PRINT B;"GUESSES."
940 PRINT "CONGRATULATIONS."
950 PRINT "YOU MUST KNOW A LOT ABOUT RADIOACTIVITY AND THINGS."
960 PRINT "THANKS FOR PLAYING.."
970 PRINT
980 PRINT "------------------------------------------------------------"
990 PRINT
1000 PRINT "                                        CHECK NO.";B+D
1010 PRINT
1020 PRINT "                                   DATE: ";
1030 PRINT "-------------19--"
1040 PRINT
1050 PRINT
1060 PRINT " PAY TO THE ORDER OF--";
1070 PRINT "------CASH------";
1080 PRINT "$";Y
1090 PRINT
1100 PRINT
1110 PRINT " THE NEW CLEA CASINO                    A. TOM MICK"
1120 PRINT "                                        GENERAL MANAGER"
1130 PRINT
1140 PRINT "------------------------------------------------------------"
1150 PRINT
1160 PRINT "DONT SPEND IT ALL IN ONE PLACE."
1170END
```

DISCIPLINE CHEMISTRY-PHYSICS

SUBJECT NUCLEAR DECAY

PROGRAM NAME DECAY2

DESCRIPTION:

This program will do the following:

A. Calculate half-life from 2 readings on a geiger counter, and the time between them.

B. Calculate mass of a radioactive sample remaining after some given amount of time.

C. Prints out a table showing mass or number of particles of a radioactive sample remaining vs. some range of time.

OBJECTIVES:

A. To provide tables and graphs for a better understanding of the exponential decay of a radioactive substance.

B. To provide a calculator for determining the amount of mass of a radioactive sample remaining after some given amount of time.

C. To provide a calculator for half-life experiments.

PRELIMINARY PREPARATION:

A. Student - The student should have a general introduction to half-life before the use of the program.

B. Materials - none

DISCUSSION:

It is difficult to teach about the exponential (logarithmic) manner by which radioactive elements decay without meaningful illustrations and simulations.

DISCUSSION: (con't)

With this program, a number of interesting possibilities are available. For example, if the initial mass is 100 g and the time is equal to 10 half-lives with an increment equal to the half-life, the student will see the mass decrease to 0.1 g during that time. More important, the example may be generalized to show that for any radioactive sample:

after 1 half-life 50% of the substance remains
after 2 half-life 25% of the substance remains
after 3 half-life 12.5% of the substance remains
after 10 half-life 0.1% of the substance remains

You may also illustrate nuclear decay by using particles instead of mass. Use Avogadro's number of particles with students who feel comfortable with scientific notation. For the others, you may use a number up to 1,000,000 without having exponential numbers print out in the table.

The fact that the teletype unit takes about 8 seconds to type out a line provides you with cute little gimmicks. Set up a run with 8 seconds (or any multiple of 8) and the print-out of the table will keep time with the decay of the sample substance.

Please note that the half-life calculations are not accurate for a small number of particles, thus it is misleading to make runs go to zero mass or zero particles.

```
DO YOU WANT INSTRUCTIONS (1=YES, 0=NO) : ? 1
  THIS PROGRAM WILL DO THE FOLLOWING:
        CHOICE 1 - CALCULATES HALF-LIFE FROM TWO READINGS
                   ON A GEIGER COUNTER.
        CHOICE 2 - CALCULATES HOW MUCH OF A RADIOACTIVE SAMPLE
                   WILL REMAIN AFTER SOME GIVEN AMOUNT OF TIME
        CHOICE 3 - PRINTS OUT A TABLE SHOWING MASS OF SAMPLE
                    VS. TIME OR NO. OF PARTICLES VS. TIME.
                    (GRAPH OPTIONAL) NOTE: FOR THE TABLE YOU
                    MUST INPUT TOTAL TIME AND TIME INCREMENT.
                     EXAMPLE: IF TOTAL TIME=100 AND TIME
                    INCREMENT=10, THEN TIME IN THE TABLE WILL
                    BE 10,20,30,.............,100.
         CHOICE 4 - END OF PROGRAM

                    NOTE: IN ANY ONE PROBLEM,TIME MUST
                    ALWAYS BE INPUTED IN THE SAME UNITS
                    OF MEASURE (IE: SECS.,MINS.,ETC.)

**********

WHAT IS YOUR CHOICE? 1

 WHAT IS THE INITIAL READING ON THE GEIGER COUNTER,
 THE SECOND READING, AND THE TIME BETWEEN READINGS.
? 1500,3000,36

INITIAL READING= 3000 SECOND READING= 1500 TIME= 36
HALF-LIFE= 35.99755

**********

WHAT IS YOUR CHOICE? 1

 WHAT IS THE INITIAL READING ON THE GEIGER COUNTER,
 THE SECOND READING, AND THE TIME BETWEEN READINGS.
? 775,1256,212
INITIAL READING= 1256 SECOND READING= 775 TIME= 212
HALF-LIFE= 304.3265

**********

WHAT IS YOUR CHOICE? 2

WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE, AND
TOTAL TIME OF DECAY? 18,56,76

HALF-LIFE= 18 INITIAL MASS= 56 TOTAL TIME= 76
MASS OF SAMPLE REMAINING= 3.000952

**********

WHAT IS YOUR CHOICE? 3

DO YOU WANT TO WORK WITH PARTICLES OR MASS? (ANSWER 1 FOR
 PARTICLES OR 2 FOR MASS) ? 1

 WHAT IS THE HALF-LIFE, INITIAL NUMBER OF PARTICLES IN THE
 SAMPLE, TOTAL ELAPSED TIME FOR DECAY, AND THE
 INCREMENT OF ELAPSED TIME? 10,6.02E23,100,10

HALF-LIFE= 10 INITIAL NO. OF PARTICLES= 6.020000E+23
TOTAL TIME= 100 INCREMENT= 10
```

Chem
DECAY2

TIME	PARTICLES	PART. LOSS	TOTAL PART. LOSS
0	6.020000E+23	0	0
10	3.010142E+23	3.009858E+23	3.009858E+23
20	1.505142E+23	1.505000E+23	4.514858E+23
30	7.526065E+22	7.525355E+22	5.267393E+23
40	3.763210E+22	3.762855E+22	5.643679E+23
50	1.881694E+22	1.881516E+22	5.831831E+23
60	9.408913E+21	9.408026E+21	5.925911E+23
70	4.704679E+21	4.704235E+21	5.972953E+23
80	2.352450E+21	2.352228E+21	5.996475E+23
90	1.176261E+21	1.176170E+21	6.008237E+23
100	5.881661E+20	5.881126E+20	6.014118E+23

DO YOU WANT THE ABOVE DATA GRAPHED? (1-YES, 0-NO)? 1

```
                                  MASS (OR PARTICLES) REMAINING
                0
 6.020000E+23
TIME            I---------I---------I---------I---------I---------I
 0              I                                                 *
 10             I                        *
 20             I            *
 30             I     *
 40             I  *
 50             I *
 60             I*
 70             *
 80             *
 90             *
 100            *
```

****

WHAT IS YOUR CHOICE? 3

DO YOU WANT TO WORK WITH PARTICLES OR MASS? (ANSWER 1 FOR PARTICLES OR 2 FOR MASS) ? 2

WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE, TOTAL ELAPSED TIME FOR DECAY, AND THE INCREMENT OF ELAPSED TIME? 15,100,150,15

HALF-LIFE= 15 INITIAL MASS= 100 TOTAL TIME= 150 INCREMENT= 15

TIME	MASS	MASS LOSS	TOTAL MASS LOSS
0	100	0	0
15	50.00236	49.99764	49.99764
30	25.00236	25	74.99764
45	12.50177	12.50059	87.49823
60	6.25118	6.25059	93.74882
75	3.125737	3.125443	96.87426
90	1.562942	1.562795	98.43706
105	.7815361	.7814344	99.21849
120	.3907725	.3907356	99.60923
135	.1953955	.195377	99.8046
150	.09770234	.09769313	99.90229

```
DO YOU WANT THE ABOVE DATA GRAPHED? (1-YES, 0-NO)? 1

                                 MASS (OR PARTICLES) REMAINING
              0                                                 100
TIME          I---------I---------I---------I---------I---------I
 0            I                                                 *
 15           I                        *
 30           I            *
 45           I     *
 60           I  *
 75           I *
 90           I*
 105          *
 120          *
 135          *
 150          *

**********

WHAT IS YOUR CHOICE? 4

READY
```

```
100 REM R. BOFFMAN+ J. MARCHISOTTO PIB 7/24/69
105 REM  REVISED BY C.LOSIK  6-12-70
110 REM CALCULATION OF HALF-LIFE AND REMAINING MASS INCLUDING
120 REM TABLES AND GRAPHS.
122 PRINT "DO YOU WANT INSTRUCTIONS (1=YES, 0=NO) : ";
124 INPUT A
126 IF A=0 THEN 300
128 IF A<>1 THEN 122
130 PRINT "  THIS PROGRAM WILL DO THE FOLLOWING:"
140 PRINT "        CHOICE 1 - CALCULATES HALF-LIFE FROM TWO READINGS"
150 PRINT "                   ON A GEIGER COUNTER."
160PRINT"        CHOICE 2 - CALCULATES HOW MUCH OF A RADIOACTIVE SAMPLE"
170PRINT"                   WILL REMAIN AFTER SOME GIVEN AMOUNT OF TIME"
180 PRINT "       CHOICE 3 - PRINTS OUT A TABLE SHOWING MASS OF SAMPLE"
190 PRINT"                  VS. TIME OR NO. OF PARTICLES VS. TIME."
200 PRINT"                  (GRAPH OPTIONAL) NOTE: FOR THE TABLE YOU"
210 PRINT"                  MUST INPUT TOTAL TIME AND TIME INCREMENT."
220PRINT"                   EXAMPLE: IF TOTAL TIME=100 AND TIME"
230 PRINT"                  INCREMENT=10, THEN TIME IN THE TABLE WILL"
240 PRINT"                  BE 10,20,30,.............,100."
250 PRINT"       CHOICE 4 - END OF PROGRAM"
260 PRINT
270 PRINT"                  NOTE: IN ANY ONE PROBLEM,TIME MUST"
280 PRINT"                  ALWAYS BE INPUTED IN THE SAME UNITS"
290 PRINT"                  OF MEASURE (IE: SECS.,MINS.,ETC.)"
300 PRINT
310 PRINT "**********"
320 PRINT
330 PRINT "WHAT IS YOUR CHOICE";
340 INPUT A
350PRINT
360 IF A=1 THEN 410
370 IF A=2 THEN 490
380 IF A=3 THEN 570
390 IF A<>4 THEN 320
400 STOP
410PRINT" WHAT IS THE INITIAL READING ON THE GEIGER COUNTER,"
420 PRINT" THE SECOND READING, AND THE TIME BETWEEN READINGS."
430 INPUT B,A,C
433 IF A>B THEN 440
435 PRINT "INITIAL READING IS ALWAYS LESS THAN FINAL READING."
437  GO TO 430
440 LET D=(.6931*C)/LOG(A/B)
450 PRINT
460 PRINT "INITIAL READING="A;"SECOND READING="B;"TIME="C
470 PRINT "HALF-LIFE="D
480 GO TO 300
490 PRINT "WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE, AND"
500 PRINT "TOTAL TIME OF DECAY";
510 INPUT E,F,G
520 LET H=F*EXP(-.6931*G/E)
530 PRINT
540PRINT"HALF-LIFE="E;"INITIAL MASS="F;"TOTAL TIME="G
550 PRINT "MASS OF SAMPLE REMAINING="H
560 GO TO 300
570 PRINT "DO YOU WANT TO WORK WITH PARTICLES OR MASS? (ANSWER 1 FOR"
580 PRINT" PARTICLES OR 2 FOR MASS) ";
590 INPUT J
600 PRINT
610 IF J=1 THEN 760
615 IF J<>2 THEN 570
620 PRINT" WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE,TOTAL"
630 PRINT"ELAPSED TIME FOR DECAY, AND THE INCREMENT OF "
640 PRINT"ELAPSED TIME";
[illegible]
[illegible]
[illegible]
```


110

```
680 LET Z=F
690 PRINT
700 IF J=1 THEN 800
710 PRINT"HALF-LIFE="E;"INITIAL MASS="F;"TOTAL TIME="K;"INCREMENT="M
720 PRINT
730 PRINT "TIME", "MASS", "MASS LOSS", "TOTAL MASS LOSS"
740 PRINT "----", "----", "---- ----", "----- ---- ----"
750 GO TO 850
760 PRINT" WHAT IS THE HALF-LIFE, INITIAL NUMBER OF PARTICLES IN THE"
770 PRINT" SAMPLE, TOTAL ELAPSED TIME FOR DECAY, AND THE "
780 PRINT" INCREMENT OF ELAPSED TIME";
790GO TO 650
795 PRINT
800 PRINT"HALF-LIFE="E;"INITIAL NO. OF PARTICLES="F
810 PRINT"TOTAL TIME="K;"INCREMENT="M
820 PRINT
830 PRINT" TIME", " PARTICLES", "PART. LOSS", "TOTAL PART. LOSS"
840 PRINT" ----", " ---------", "----- ----", "----- ----- ----"
850 PRINT
860 FOR G = 0 TO K STEP M
870 LET H=F*EXP(-.6931*G/E)
880 LET W=ABS(H-Z)
890 LET U=U+W
900 IF F >1E6 THEN 920
910 IF J=1 THEN 940
920 PRINT G,H,W,U
930 GO TO 950
940 PRINT INT(G+.5),INT(H+.5),INT(W+.5),INT(U+.5)
950 LET Z=H
960 NEXT G
970 PRINT
980 PRINT
990 PRINT
1000 PRINT" DO YOU WANT THE ABOVE DATA GRAPHED? (1=YES, 0=NO)";
1010 INPUT R
1020 IF R=0 THEN 300
1023 IF R<>1 THEN 1000
1030 PRINT
1040 PRINT
1050 PRINT
1060 PRINT TAB(30);"MASS (OR PARTICLES) REMAINING"
1070 PRINT
1080 PRINT " ","0";TAB(62);F
1100PRINT"TIME","I---------I---------I---------I---------I---------I"
1120 FOR G = 0 TO K STEP M
1130 LET H=F*EXP(-.6931*G/E)
1140 LET H1=INT(H/F*50+.5)
1150 IF H1<=50 THEN 1170
1160 LET H1=50
1170 PRINT G,"I";TAB(H1+14.5);"*"
1250 NEXT G
1260 GO TO 300
1280 END
```

DISCIPLINE CHEMISTRY

SUBJECT EMPIRICAL FORMULAE

PROGRAM NAME EMPIR

DESCRIPTION:

A classroom demonstration designed to calculate the empirical formulae from atomic mass (atomic weight) and percent composition.

OBJECTIVES:

A. To distinguish between molecular and empirical formulae

B. To illustrate the law of multiple proportions.

C. To emphasize the unity of the atom when writing chemical formulae

D. To demonstrate the importance of accurate calculation with empirical formulae problems

PRELIMINARY PREPARATION:

A. Student - The student should have some experience in writing chemical formulae and calculating percent composition from chemical formulae. An understanding of significant figures would also add to the value of the lesson.

B. Materials - none

DISCUSSION:

In this program the atomic number is used for identification only and has no part in the actual calculations.

The student generally has difficulty understanding the function of the ratio in calculating empirical formulae. This program is designed to emphasize that function.

The importance of significant figures could also be illustrated. The students' tendency to approximate generally results in numbers of questionable value. In this program, by using a series of calculations for the same compound with figures of progressively greater accuracy, an empirical formula closer to whole numbers will be obtained.

```
THIS PROGRAM WILL FIND THE EMPIRICAL FORMULA FOR
ANY COMPOUND CONTAINING UP TO FIVE DIFFERENT ELEMENTS

 WHEN INFORMATION IS REQUESTED, TYPE IN THE ATOMIC
 NUMBER, THE ATOMIC WEIGHT, AND THE PCT COMPOSITION BY
 WEIGHT IN THAT ORDER; FOR EXAMPLE, IN THE COMPOUND SO2,
 THE DATA WOULD BE ENTERED AS FOLLOWS:  16,32,50 FOR
 SULFUR AND 8,16,50 FOR OXYGEN.

HOW MANY ELEMENTS DOES YOUR UNKNOWN COMPOUND CONTAIN? 2
ENTER THE ATOMIC NUMBER, THE ATOMIC WEIGHT, AND THE
PCT COMPOSITION FOR EACH OF THE ELEMENTS IN YOUR COMPOUND.
BE SURE TO ENTER ONE SET OF NUMBERS FOR EACH QUESTION MARK.

      1 .  ? 26,55.9,69.96
      2 .  ? 8,16,30.04
```

ATOMIC NUMBER	PCT. COMP.	INITIAL RATIO	RATIO*2	RATIO*3
26	69.96	1	2	3
8	30.04	1.5	3	4.5

```
TO FIND THE EMPIRICAL FORMULA LOCATE THE FIRST RATIO
COLUMN IN WHICH ALL OF THE NUMBERS MOST CLOSELY APPROXIMATE
A WHOLE NUMBER.
IF YOU WOULD LIKE TO TRY AGAIN TYPE 1, IF NOT TYPE 0.? 1

HOW MANY ELEMENTS DOES YOUR UNKNOWN COMPOUND CONTAIN? 3
ENTER THE ATOMIC NUMBER, THE ATOMIC WEIGHT, AND THE
PCT COMPOSITION FOR EACH OF THE ELEMENTS IN YOUR COMPOUND.
BE SURE TO ENTER ONE SET OF NUMBERS FOR EACH QUESTION MARK.

      1 .  ? 1,1,2
      2 .  ? 16,32,32.7
      3 .  ? 8,16,65.3
```

ATOMIC NUMBER	PCT. COMP.	INITIAL RATIO	RATIO*2	RATIO*3
1	2	2	3.9	5.9
16	32.7	1	2	3
8	65.3	4	8	12

```
IF YOU WOULD LIKE TO TRY AGAIN TYPE 1, IF NOT TYPE 0.? 1

HOW MANY ELEMENTS DOES YOUR UNKNOWN COMPOUND CONTAIN? 1
THE EMPIRICAL FORMULA FOR A COMPOUND THAT CONTAINS ONLY
A SINGLE ELEMENT IS STRAIGHTFORWARD.

IF YOU WOULD LIKE TO TRY AGAIN TYPE 1, IF NOT TYPE 0.? 0


READY
```

```
100  REM  JOHN MARCHISOTTO  BASIC  7/14/69  PBI  EMPIR*
105 REM  REVISED BY C.LOSIK  7-31-70
106 REM A(I)=ATOMIC NOS, B(I)=AT WTS AND THEN C(I)/B(I), C(I)=PCT COMP
130 PRINT " THIS PROGRAM WILL FIND THE EMPIRICAL FORMULA FOR "
140 PRINT "ANY COMPOUND CONTAINING UP TO FIVE DIFFERENT ELEMENTS"
150 PRINT
160 PRINT "  WHEN INFORMATION IS REQUESTED, TYPE IN THE ATOMIC"
170 PRINT " NUMBER, THE ATOMIC WEIGHT, AND THE PCT COMPOSITION BY"
180 PRINT " WEIGHT IN THAT ORDER; FOR EXAMPLE, IN THE COMPOUND SO2,"
190 PRINT " THE DATA WOULD BE ENTERED AS FOLLOWS:  16,32,50 FOR"
200 PRINT " SULFUR AND 8,16,50 FOR OXYGEN."
210 PRINT
220 DIM A(5),B(5),C(5)
230 LET W=0
240 PRINT " HOW MANY ELEMENTS DOES YOUR UNKNOWN COMPOUND CONTAIN";
280 INPUT Z
285 IF Z=1 THEN 930
290 FOR I=2 TO 5
295 IF I=Z THEN 320
300 NEXT I
305 PRINT "ENTER AN INTEGER FROM 1 TO 5."
310 GO TO 240
320 PRINT " ENTER THE ATOMIC NUMBER, THE ATOMIC WEIGHT, AND THE"
330 PRINT " PCT COMPOSITION FOR EACH OF THE ELEMENTS IN YOUR COMPOUND."
340 PRINT " BE SURE TO ENTER ONE SET OF NUMBERS FOR EACH QUESTION MARK."
350 LET S=0
355 LET F=1E25
357 PRINT
360 FOR I=1 TO Z
370 PRINT TAB(5);I;".  ";
380 INPUT A(I), B(I), C(I)
383 LET B(I)=C(I)/B(I)
385 IF B(I)>F THEN 390
387 LET F=B(I)
389 REM  MAKE SURE SUM OF PCT COMPS = 100
390 LET S=S+C(I)
400 NEXT I
410 IF ABS(S-100)<.1 THEN 760
420 PRINT "THE PCT COMPOSITION DOES NOT TOTAL 100 PERCENT."
430 PRINT "ADJUST DATA AND REENTER."
440 GO TO 320
700 REM  PRINT RATIOS
760 PRINT
770 PRINT " ATOMIC"," PCT. ","INITIAL","RATIO*2","RATIO*3"
780 PRINT "NUMBER","COMP.","RATIO"
800 FOR I=1 TO Z
810 PRINT A(I),C(I),INT(10*B(I)/F+.5)/10,
820 PRINT INT(20*B(I)/F+.5)/10,
830 PRINT INT(30*B(I)/F+.5)/10
840 NEXT I
845 PRINT
850 IF W = 1 THEN 950
870 PRINT " TO FIND THE EMPIRICAL FORMULA LOCATE THE FIRST RATIO"
880PRINT" COLUMN IN WHICH ALL OF THE NUMBERS MOST CLOSELY APPROXIMATE"
890 PRINT " A WHOLE NUMBER."
900 GO TO 950
930 PRINT " THE EMPIRICAL FORMULA FOR A COMPOUND THAT CONTAINS ONLY"
940 PRINT " A SINGLE ELEMENT IS STRAIGHTFORWARD." ,
945 PRINT
950 PRINT "IF YOU WOULD LIKE TO TRY AGAIN TYPE 1, IF NOT TYPE 0.";
980 INPUT W
985 PRINT
990 IF W = 1 THEN 240
1000 IF W<>0 THEN 950
1070 END
```

DISCIPLINE CHEMISTRY

SUBJECT EQUILIBRIUM

PROGRAM NAME EQUIL1 and EQUIL2

DESCRIPTION:

This program calculates the effects of concentration changes in the equilibrium systems $2HI \rightleftharpoons H_2 + I_2$ and $PCl_5 \rightleftharpoons PCl_3 + Cl_2$.

OBJECTIVES:

A. To show that an equilibrium system is a dynamic one.

B. To illustrate and reinforce Le Chateliers principle.

C. An exercise in the interpretation of experimental data.

D. The significance of the Equilibrium constants.

PRELIMINARY PREPARATION:

A. Student - The student should have been made aware of "reversible" reactions, equilibrium systems and Le Chateliers principle.

B. Materials - none

DISCUSSION:

These two programs can be used as classroom demonstrations to illustrate the effect of varying the concentration of one of the products of a system at Equilibrium. The results are given not only as a table, but also graphically, since it was found that students have less trouble recognizing trends when they can be illustrated.

The equilibrium constant can also be changed to show its effect on the equilibrium system.

As always, the teacher should have run the program he wishes to use prior to its classroom presentation since the choice of constants will determine the slope of the curves.

NOTE:

The vertical axis (horizontal on the output) is labeled in percent of maximum y value.

```
THIS PROGRAM WILL INVESTIGATE THE EQUILIBRIUM SYSTEM

             2HI = H2 + I2

WHAT IS THE EQUILIBRIUM CONSTANT? .5
WHAT IS THE INITIAL CONCENTRATION OF HI? 2

WOULD YOU LIKE THE RESULTS PLOTTED (1), TABULATED (2)
OR BOTH (3) (TYPE THE APPROPRIATE NUMBER)? 3

INIT. I2        EQUIL. H2      EQUIL. I2      EQUIL. HI
--------        ---------      ---------      ---------
INIT. HI        INIT. HI       INIT. HI       INIT. HI

 0              .2928932       .2928932       .4142136
 1              .1771243       1.177124       .6457513
 2              .1291713       2.129171       .7416574
 3              .1020842       3.102084       .7958316
 4              .08452404      4.084524       .8309519
 5              .0781727       5.078173       .8556546
 6              .06299609      6.062996       .8740078
 7              .05590278      7.055903       .8881944
 8              .0502525       8.050252       .899495
 9              .04564393      9.045644       .9087121
 10             .04181236      10.04181       .9163753
 11             .03857601      11.03858       .922848
 12             .03580582      12.03581       .9283884
 13             .03340775      13.03341       .9331845
 14             .03131127      14.03131       .9373775
 15             .02946627      15.02946       .9410746

A: (EQUIL. H2)/(INIT. HI)        MAXIMUM IS  .2928932
B: (EQUIL. I2)/(INIT. HI)        MAXIMUM IS  15.02946
C: (EQUIL. HI)/(INIT. HI)        MAXIMUM IS  .9410746

INIT. I2                  A - B - C
--------  0        25        50        75       100   % OF MAXIMUM
INIT. HI  I---------I---------I---------I---------I
       0  IB                C                     A
       1  I  B                    A  C
       2  I     B           A             C
       3  I       B     A                   C
       4  I          BA                      C
       5  I         A  B                      C
       6  I        A      B                    C
       7  I       A          B                  C
       8  I      A             B                C
       9  I     A                 B              C
      10  I     A                    B           C
      11  I    A                       B         C
      12  I    A                          B      C
      13  I    A                             B    C
      14  I   A                                B  C
      15  I   A                                   B

*****

WOULD YOU LIKE ANOTHER RUN (1-YES, 0-NO)? 0

READY
```

116

```
100 REM EQUILIBRIUM SYSTEM, JOHN MARCHISOTTO
101 REM REVISED 8/20/70 (D. PESSEL)
105 DIM D(20),E(20),F(20),W(3)
106 LET D1=0
107 LET E1=0
108 LET F1=0
120 PRINT "THIS PROGRAM WILL INVESTIGATE THE EQUILIBRIUM SYSTEM"
121 PRINT
122 PRINT "              2HI = H2 + I2"
130 PRINT
140 PRINT "WHAT IS THE EQUILIBRIUM CONSTANT";
141 INPUT K
142 IF K>=0 THEN 150
143 PRINT "THE EQUILIBRIUM CONSTANT MUST BE NON-NEGATIVE."
144 GO TO 140
150 PRINT "WHAT IS THE INITIAL CONCENTRATION OF HI";
151 INPUT C
152 IF C>=0 THEN 159
153 PRINT "THE INITIAL CONCENTRATION OF HI MUST BE NON-NEGATIVE."
154 GO TO 150
159 PRINT
160 PRINT "WOULD YOU LIKE THE RESULTS PLOTTED (1), TABULATED (2)"
161 PRINT "OR BOTH (3) (TYPE THE APPROPRIATE NUMBER)";
162 INPUT Q1
180 IF Q1<2 THEN 195
183 PRINT
184 PRINT
185 PRINT "INIT. I2"," EQUIL. H2"," EQUIL. I2"," EQUIL. HI"
186 PRINT "--------"," ---------"," ---------"," ---------"
187 PRINT "INIT. HI"," INIT. HI"," INIT. HI"," INIT. HI"
188 PRINT
195 LET A=4*K
196 LET B=1-A
200 FOR X=1 TO 16
201 LET X1=X-1
210 LET D(X)=(-(A+X1)+SQR((A+X1)↑2+A*B))/(2*B)
220 LET E(X)=X1+D(X)
230 LET F(X)=1-2*D(X)
240 IF Q1<2 THEN 260
250 PRINT X1,D(X),E(X),F(X)
260 IF D(X)<D1 THEN 270
265 LET D1=D(X)
270 IF E(X)<E1 THEN 280
275 LET E1=E(X)
280 IF F(X)<F1 THEN 290
285 LET F1=F(X)
290 NEXT X
295 IF Q1<>2 THEN 395
300 PRINT
330 PRINT "*****"
331 PRINT
340 PRINT "WOULD YOU LIKE ANOTHER RUN (1-YES, 0-NO)";
350 INPUT Q2
360 IF Q2>0 THEN 140
370 STOP
390 REM PLOTTING ROUTINE FOR THREE CURVES
395 PRINT
396 PRINT
400 PRINT "A: (EQUIL. H2)/(INIT. HI)      MAXIMUM IS "D1
401 PRINT "B: (EQUIL. I2)/(INIT. HI)      MAXIMUM IS "E1
402 PRINT "C: (EQUIL. HI)/(INIT. HI)      MAXIMUM IS "F1
403 PRINT
404 PRINT "INIT. I2";TAB(26);"A - B - C"
405 PRINT "--------  0         25         50         75         100";
```

117

```
406 PRINT "   % OF MAXIMUM"
408 PRINT "INIT. HI  I---------I---------I---------I---------I"
410 FOR X=1 TO 16
420 PRINT TAB(5);X-1;TAB(10);"I";
430 LET W(1)=INT(40*D(X)/D1+.5)
431 LET W(2)=INT(40*E(X)/E1+.5)
432 LET W(3)=INT(40*F(X)/F1+.5)
580 REM  FIND WHICH IS SMALLEST, THEN PRINT IT AND MAXIMIZE IT
600 FOR Q=1 TO 3
605 LET K1=1E20
610 FOR I=1 TO 3
620 IF W(I)>K1 THEN 640
630 LET K1=W(I)
640 NEXT I
650 PRINT TAB(K1+10);
660 FOR I=1 TO 3
670 IF ABS(W(I)-K1)<.0001 THEN 700
680 NEXT I
690 STOP
700 IF I<>1 THEN 730
710 PRINT "A";
720 GO TO 780
730 IF I<>2 THEN 760
740 PRINT "B";
750 GO TO 780
760 IF I<>3 THEN 690
770 PRINT "C";
780 LET W(I)=1E25
790 NEXT Q
795 PRINT " "
800 NEXT X
810 PRINT
815 PRINT
820 GO TO 330
999 END
```


118

```
THIS PROGRAM WILL INVESTIGA'E THE EQUILIBRIUM SYSTEM

            PCL5 = PCL3 + CL2

WHAT IS THE EQUILIBRIUM CONSTANT? .75
WHAT IS THE INITIAL CONCENTRATION OF PCL5? 10

WOULD YOU LIKE THE RESULTS PLOTTED (1), TABULATED (2)
OR BOTH (3) (TYPE THE APPROPRIATE NUMBER)? 3

INIT. CL2       EQUIL. PCL3    EQUIL. CL2     EQUIL. PCL5
----------      -----------    ----------     -----------
INIT. PCL5      INIT. PCL5     INIT. PCL5     INIT. PCL5

 0              .2389168       .2389168       .7610832
 1              .06574643      1.065746       .9342536
 2              .03553601      2.035536       .964464
 3              .0241998       3.0242         .9758002
 4              .01832259      4.018323       .9816774
 5              .01473555      5.014736       .9852645
 6              .0123207       6.012321       .9876793
 7              .01058486      7.010585       .9894151
 8              9.277403E-3    8.009277       .9907226
 9              8.256972E-3    9.008257       .991743
 10             7.438660E-3    10.00744       .9925613
 11             6.767869E-3    11.00677       .9932321
 12             6.208003E-3    12.00621       .993792
 13             5.733609E-3    13.00573       .9942664
 14             5.326569E-3    14.00533       .9946734
 15             4.973471E-3    15.00497       .9950265

A: (EQUIL. PCL3)/(INIT. PCL5)      MAXIMUM IS  .2389168
B: (EQUIL. CL2)/(INIT. PCL5)       MAXIMUM IS  15.00497
C: (EQUIL. PCL5)/(INIT. PCL5)      MAXIMUM IS  .9950265

INIT. CL2                   A - B - C
----------   0        25        50        75       100   % OF MAXIMUM
INIT. PCL5   I---------I---------I---------I---------I
     0       IB                             C        A
     1       I  B       A                          C
     2       I    BA                                C
     3       I   A   B                              C
     4       I  A       B                           C
     5       I A          B                          C
     6       I A             B                       C
     7       I A                B                    C
     8       I A                  B                  C
     9       IA                      B               C
     10      IA                         B            C
     11      IA                           B          C
     12      IA                              B       C
     13      IA                                 B    C
     14      IA                                   B  C
     15      IA                                      B


*****

WOULD YOU LIKE ANOTHER RUN (1-YES, 0-NO)? 0


READY
```

110

```
100 REM EQUILIBRIUM SYSTEM, JOHN MARCHISCTTO
101 REM REVISED 8/20/70 (D. PESSEL)
105 DIM D(20),E(20),F(20),W(3)
106 LET D1=0
107 LET E1=0
108 LET F1=0
120 PRINT "THIS PROGRAM WILL INVESTIGATE THE EQUILIBRIUM SYSTEM"
121 PRINT
122 PRINT "              PCL5 = PCL3 + CL2"
130 PRINT
140 PRINT "WHAT IS THE EQUILIBRIUM CONSTANT";
141 INPUT K
142 IF K>=0 THEN 150
143 PRINT "THE EQUILIBRIUM CONSTANT MUST BE NON-NEGATIVE."
144 GO TO 140
150 PRINT "WHAT IS THE INITIAL CONCENTRATION OF PCL5";
151 INPUT A
152 IF A>=0 THEN 159
153 PRINT "THE INITIAL CONCENTRATION OF PCL5 MUST BE NON-NEGATIVE."
154 GO TO 150
159 PRINT
160 PRINT "WOULD YOU LIKE THE RESULTS PLOTTED (1), TABULATED (2)"
161 PRINT "OR BOTH (3) (TYPE THE APPROPRIATE NUMBER)";
162 INPUT Q1
180 IF Q1<2 THEN 195
183 PRINT
184 PRINT
185 PRINT "INIT. CL2"," EQUIL. PCL3"," EQUIL. CL2"," EQUIL. PCL5"
186 PRINT "----------"," ----------"," ----------"," ----------"
187 PRINT "INIT. PCL5"," INIT. PCL5"," INIT. PCL5"," INIT. PCL5"
188 PRINT
195 LET B=K/A
200 FOR X=1 TO 16
201 LET X1=X-1
210 LET D(X)=(-(B+X1)+SQR((B+X1)*(B+X1)+4*B))/2
220 LET E(X)=X1+D(X)
230 LET F(X)=1-D(X)
240 IF Q1<2 THEN 260
250 PRINT X1,D(X),E(X),F(X)
260 IF D(X)<D1 THEN 270
265 LET D1=D(X)
270 IF E(X)<E1 THEN 280
275 LET E1=E(X)
280 IF F(X)<F1 THEN 290
285 LET F1=F(X)
290 NEXT X
295 IF Q1<>2 THEN 395
300 PRINT
330 PRINT "*****"
331 PRINT
340 PRINT "WOULD YOU LIKE ANOTHER RUN (1-YES, 0-NO)";
350 INPUT Q2
360 IF Q2>0 THEN 140
370 STOP
390 REM PLOTTING ROUTINE FOR THREE CURVES
395 PRINT
396 PRINT
400 PRINT "A: (EQUIL. PCL3)/(INIT. PCL5)      MAXIMUM IS "D1
401 PRINT "B: (EQUIL. CL2)/(INIT. PCL5)       MAXIMUM IS "E1
402 PRINT "C: (EQUIL. PCL5)/(INIT. PCL5)      MAXIMUM IS "F1
403 PRINT
404 PRINT "INIT. CL2";TAB(29);"A - B - C"
405 PRINT "----------    0       25         50         75         100";
406 PRINT "   % OF MAXIMUM"
```


120

```
408 PRINT "INIT. PCL5    I---------I---------I---------I---------I"
410 FOR X=1 TO 16
420 PRINT TAB(5);X-1;TAB(13);"I";
430 LET W(1)=INT(40*D(X)/D1+.5)
431 LET W(2)=INT(40*E(X)/E1+.5)
432 LET W(3)=INT(40*F(X)/F1+.5)
580 REM  FIND WHICH IS SMALLEST, THEN PRINT IT AND MAXIMIZE IT
600 FOR Q=1 TO 3
605 LET K1=1E20
610 FOR I=1 TO 3
620 IF W(I)>K1 THEN 640
630 LET K1=W(I)
640 NEXT I
650 PRINT TAB(K1+13);
660 FOR I=1 TO 3
670 IF ABS(W(I)-K1)<.0001 THEN 700
680 NEXT I
690 STOP
700 IF I<>1 THEN 730
710 PRINT "A";
720 GO TO 780
730 IF I<>2 THEN 760
740 PRINT "B";
750 GO TO 780
760 IF I<>3 THEN 690
770 PRINT "C";
780 LET W(I)=1E25
790 NEXT Q
795 PRINT " "
800 NEXT X
810 PRINT
815 PRINT
820 GO TO 330
999 END
```

DISCIPLINE CHEMISTRY

SUBJECT KINETICS

PROGRAM NAME KINET

DESCRIPTION:

A class room presentation designed to calculate equilibrium concentrations and graph the progress (concentration vs. time) from initiation to equilibrium for the general reaction $A \rightleftharpoons P$.

OBJECTIVES:

A) An understanding of Equilibrium

B) The significance of the magnitude of the Equilibrum constant.

C) The relationship of the rate constant to the point of equilibrium.

PRELIMINARY PREPARATION:

A. Student (1) The distinction between initial and equilibrium concentration should be made very clear.

(2) The meaning of the terms "Rate constant" and "Equilibrium constant."

B. Materials - None

DISCUSSION:

To insure the success of this program in a teaching situation, the teacher should run the program prior to its use in the classroom. This is necessary to insure that the choice of constants illustrates the point to be made and the amount of classroom time be kept to a minimum.

By varying the equilibrium constant it is possible to move the point of equilibrium on the concentration axis, and show the relative concentrations of product and reactant as a function of the value of the equilibrium constant.

The effect of different rate constants on the time it takes to attain equilibrium can also be shown. The point at which the two curves approach a straight line is the point of equilibrium (if the two curves intersect a dot is used as the point).

In this program, time is plotted in ten equal steps from initiation of the reaction to equilibrium. The time to attain equilibrium is different depending on the constant used. It should be pointed out that while the point of equilibrium on the graph may appear to be at the same spot, the units of time are changing, thus the point on the graph is different.

Chemistry
KINET

FOR THE EQUILIBRIUM PROBLEMS YOU ARE ABOUT TO DO, THE
DATA MAY BE PRESENTED IN THE FOLLOWING MANNER:
(INDICATE YOUR CHOICE BY NUMBER)

CHOICE 1 = TABLE OF DATA
CHOICE 2 = GRAPH OF DATA
CHOICE 3 = TABLE AND GRAPH OF DATA
CHOICE 4 = END PROGRAM

WHAT IS YOUR CHOICE? 3

LET F = THE FORWARD RATE CONSTANT
LET K = THE EQUILIBRIUM CONSTANT FOR THE REACTION A =P
TYPE IN THE CONSTANTS F AND K IN THAT ORDER.
? 5,1

****

LET A1 = ORIGINAL CONCENTRATION OF A
LET A = PERCENT CONCENTRATION OF A (A/A1*100)
LET P = PERCENT CONCENTRATION OF P (P/A1*100)

TIME	A	P
0	100	0
.069	75.0788	24.9212
.138	62.57893	37.42107
.207	56.30929	43.69071
.276	53.16459	46.83541
.345	51.58728	48.41272
.414	50.79614	49.20386
.483	50.39933	49.60067
.552	50.20029	49.79971
.621	50.10046	49.89954
.69	50.05039	49.94961

PERCENT CONCENTRATION OF A(*) AND P(+)

```
           0        25        50        75       100
TIME       I---------I---------I---------I---------I
0          +                                       *
.069       I         +                   *
.138       I              +         *
.207       I                +     *
.276       I                  + *
.345       I                  + *
.414       I                   .
.483       I                   .
.552       I                   .
.621       I                   .
.69        I                   .
```

```
WHAT IS YOUR CHOICE? 2

LET F = THE FORWARD RATE CONSTANT
LET K = THE EQUILIBRIUM CONSTANT FOR THE REACTION A =P
TYPE IN THE CONSTANTS F AND K IN THAT ORDER.
? 5,0.1


              ******************************


                PERCENT CONCENTRATION OF A(*) AND P(+)

               0         25        50        75        100
 TIME          I---------I---------I---------I---------I
0              +                                       *
.01254545      I +                                   *
.02509091      I  +                                 *
.03763636      I  +                                 *
.05018182      I  +                                 *
.06272727      I   +                               *
.07527273      I   +                               *
.08781818      I   +                               *
.1003636       I   +                               *
.1129091       I   +                               *
.1254545       I   +                               *

WHAT IS YOUR CHOICE? 2

LET F = THE FORWARD RATE CONSTANT
LET K = THE EQUILIBRIUM CONSTANT FOR THE REACTION A =P
TYPE IN THE CONSTANTS F AND K IN THAT ORDER.
? 10,0.1


              ******************************


                PERCENT CONCENTRATION OF A(*) AND P(+)

               0         25        50        75        100
 TIME          I---------I---------I---------I---------I
0              +                                       *
6.272727E-3    I +                                   *
.01254545      I  +                                 *
.01881818      I  +                                 *
.02509091      I  +                                 *
.03136364      I                                   *
.03763636      I                                   *
.04390909      I   +                               *
.05018182      I   +                               *
.05645455      I   +                               *
.06272727      I   +                               *
```

```
WHAT IS YOUR CHOICE? 2

LET F = THE FORWARD RATE CONSTANT
LET K = THE EQUILIBRIUM CONSTANT FOR THE REACTION A =P
TYPE IN THE CONSTANTS F AND K IN THAT ORDER.
? 5,.5


             ******************************


               PERCENT CONCENTRATION OF A(*) AND P(+)

             0        25        50        75       100
 TIME        I---------I---------I---------I---------I
0            +                                       *
.046         I      +                         *
.092         I         +                   *
.138         I           +               *
.184         I           +               *
.23          I            +             *
.276         I            +             *
.322         I            +             *
.368         I            +             *
.414         I            +             *
.46          I            +             *

WHAT IS YOUR CHOICE? 2

LET F = THE FORWARD RATE CONSTANT
LET K = THE EQUILIBRIUM CONSTANT FOR THE REACTION A =P
TYPE IN THE CONSTANTS F AND K IN THAT ORDER.
? 5,.2


             ******************************


               PERCENT CONCENTRATION OF A(*) AND P(+)

             0        25        50        75       100
 TIME        I---------I---------I---------I---------I
0            +                                       *
.023         I  +                                 *
.046         I    +                             *
.069         I     +                           *
.092         I     +                           *
.115         I     +                           *
.138         I      +                         *
.161         I      +                         *
.184         I      +                         *
.207         I      +                         *
.23          I      +                         *

WHAT IS YOUR CHOICE? 4

READY
```

```
100 REM  KINET  HOWARD SHANNON  HARBORFIELDS HS  8/15/68
110 REM      REVISED 7/28/69  PIB J. MARCHISOTTO
115 REM  REVISED BY C.LOSIK  7-28-70
116 REM  F,K ARE DEFINED BELOW; L IS THE TIME INCREMENT;
117 REM  G IS THE DECAY CONSTANT; D IS THE FRACTION OF 'P'
120 REM     THIS PROGRAM STUDIES THE KINETICS OF A SINGLE SPECIES
130 REM (A) GOING TO A SINGLE SPECIES (P),AND APPROACHES EQUILIBRIUM
140 REM WITH (P).
150 REM          IE. ISOMER EQUILIBRIUM
160 REM      IF THE EQUILIBRIUM CONSTANT IS VERY LARGE (K>10,000),
170 REM IT CAN BE ASSUMED THAT ALL OF THE REACTANT GOES TO PRODUCT.
180 REM THIS PROGRAM CAN THEN BE USED FOR RADIOACTIVE DECAY.
190 REM      AN INPUT OF THE FORWARD RATE CONSTANT AND THE EQUILIBRIUM
200 REM CONSTANT WILL GIVE A PRINTOUT OF THE CONCENTRATION OF (A)
210 REM AND (P) COMPARED TO THE INITIAL CONCENTRATION OF (A) AT 10
220 REM EQUAL TIME INTERVALS AS IT APPROACHES 99.9PERCENT TO EQUILIBRIUM
230 PRINT "  FOR THE EQUILIBRIUM PROBLEMS YOU ARE ABOUT TO DO, THE "
240 PRINT "  DATA MAY BE PRESENTED IN THE FOLLOWING MANNER:  "
250 PRINT "     (INDICATE YOUR CHOICE BY NUMBER)"
260 PRINT
270 PRINT "            CHOICE 1 = TABLE OF DATA"
280 PRINT "            CHOICE 2 = GRAPH OF DATA"
290 PRINT "            CHOICE 3 = TABLE AND GRAPH OF DATA"
300 PRINT "            CHOICE 4 = END PROGRAM"
310 PRINT
320 PRINT " WHAT IS YOUR CHOICE";
330 INPUT Q
340 IF Q> 4 THEN 1120
350 IF Q<1 THEN 1120
360 IF Q = 4 THEN 1140
370 PRINT
380 PRINT " LET F = THE FORWARD RATE CONSTANT"
390 PRINT " LET K = THE EQUILIBRIUM CONSTANT FOR THE REACTION A =P"
400 PRINT " TYPE IN THE CONSTANTS F AND K IN THAT ORDER."
410 INPUT F,K
420 PRINT
460 PRINT
470 PRINT "               ******************************"
480 PRINT
500 LET H = K/(K+1)
520 LET G = F/H
530 LET L=.69/G
550 LET T = -L
552 IF Q=2 THEN 690
560 PRINT " LET A1 = ORIGINAL CONCENTRATION OF A"
570 PRINT " LET A = PERCENT CONCENTRATION OF A  (A/A1*100)"
580 PRINT " LET P = PERCENT CONCENTRATION OF P  (P/A1*100)"
590 PRINT
```

```
600 PRINT " TIME "," A "," P "
610 PRINT " ---- "," --- "," --- "
620 FOR I = 0 TO 10
630 LET T = T +L
640 LET D = H* (1-EXP(-G*T))
650 PRINT T,(1-D)*100,D*100
660 NEXT I
670 LET T =-L
680 IF Q = 1 THEN 310
690 PRINT
700 PRINT"                    PERCENT CONCENTRATION OF A(*) AND P(+)"
710 PRINT
720 PRINT " ",     "0         25         50         75         100"
730 PRINT "  TIME","I---------I---------I---------I---------I"
740 FOR I = 0 TO 10
750 LET T = T+L
760 LET D = H*(1-EXP(-G*T))
770 LET X = 1-D
775 PRINT I*L,"I";
780 IF INT(40*D+.5) = INT(40*X+.5) THEN 930
790IF INT(40*D+.5)> INT(40*X+.5) THEN 1000
800 PRINT TAB(40*D+14.5);"+";TAB(40*X+14.5);"*"
850 GO TO 1100
930 PRINT TAB(40*D+14.5);"."
950 GO TO 1100
1000 PRINT TAB(40*X+14.5);"*";TAB(40*D+14.5);"+"
1100 NEXT I
1110 GO TO 310
1120 PRINT " YOUR CHOICE MUST BE A NUMBER BETWEEN 1 AND 4, TRY AGAIN."
1130 GO TO 310
1140 END
```

DISCIPLINE CHEMISTRY

SUBJECT MASS DEFECT

PROGRAM NAME MASSD

DESCRIPTION:

A classroom presentation that could be used to calculate mass defect, and give the answer in terms of usable energy (kw-hr. of electricity).

OBJECTIVES:

A. To calculate and explain mass defect.

B. To introduce the concept of binding energy.

C. Conversion of mass to energy. (atomic power)

PRELIMINARY PREPARATION:

A. Student - The student should have an understanding of nuclear particles, and the law of conservation of mass and energy.

B. Materials - The teacher should make available a table of isotopes that lists the actual mass. (Handbook of Chemistry and Physics, Chemical Rubber Company)

DISCUSSION:

It should be noted that the masses used here include the electrons. The very small difference which would be obtained if the bare nuclear mass were known is negligible for the purpose of this calculation.

Time permitting, it would be beneficial to have the student investigate the conversion of atomic mass units (AMU) to calories and kilowatt-hours in order to recognize the significance of the units and the magnitude of the numbers involved.

```
THIS PROGRAM IS DESIGNED TO INVESTIGATE MASS DEFECT

WHICH OF THE ELEMENTS WOULD YOU LIKE TO CONSIDER?
REMEMBER WE ARE DEALING WITH A SINGLE ATOM, THEREFORE
IN ADDITION TO THE ATOMIC NUMBER WE ARE GOING TO NEED THE
ACTUAL MASS (IN AMU) AND THE MASS NUMBER OF THE ISOTOPE
YOU WANT TO WORK WITH.

WHEN THE MACHINE TYPES A QUESTION MARK (?) TYPE IN
YOUR ANSWER THEN HIT RETURN KEY. USE NUMBERS OF UP TO
SIX SIGNIFICANT FIGURES. ROUND IF NECESSARY TO 6 DIGITS.
IN THE VALUES FOR MASS DEFECT.


THE ATOMIC NUMBER IS ? 8
THE ACTUAL MASS IS ? 15.9949
THE MASS NUMBER IS ? 16

THE SUM OF THE MASS OF THE 8 PROTONS AND THE 8 NEUTRONS
PLUS THE WEIGHT OF THE 8 ELECTRONS IS THE CALCULATED
MASS.

CALCULATED MASS  -  ACTUAL MASS  =  MASS DEFECT
     16.13199    -    15.9949     =    .1371

THE MASS DEFECT IN TERMS OF ENERGY IS THE EQUIVALENT OF
2936 X 10↑9 CAL. PER MOLE OF THIS SUBSTANCE,
OR 184 X 10↑9 CAL. PER GRAM.

IF WE DIVIDE THIS BINDING ENERGY BY THE NUMBER OF
PARTICLES IN THE NUCLEUS, WE GET A RATIO KNOWN AS THE
BINDING ENERGY PER NUCLEON, WHICH IS A MEASURE OF THE
STABILITY OF THE NUCLEUS.  THE MORE 'BINDING'
PER NUCLEON, THE MORE STABLE IS THE NUCLEUS.
THE BINDING ENERGY PER NUCLEON IS : 1.276744E-5 ERGS. PER NUCLEON, OR
3.047121E-13 CAL. PER NUC.,
WHICH IS MORE COMMONLY EXPRESSED AS 800 MEV.

THE AMOUNT OF ENERGY (BINDING ENERGY) CONTAINED IN ONE
GRAM OF THIS SUBSTANCE WOULD BE SUFFICIENT TO SUPPLY ALL
THE ELECTRICAL NEEDS IN AN AVERAGE ONE FAMILY HOUSE USING
15 KW-HRS. PER DAY FOR A PERIOD OF 14245 DAYS OR
39 YEARS.

IF YOU WOULD LIKE TO RUN ANOTHER PROBLEM TYPE IN 1,
IF NOT TYPE IN 0.
? 0

               ***************

READY
```

```
100 REM JOHN MARCHISOTTO  PIB SUMMER 69   BASIC
105 REM  REVISED BY C.LOSIK  7-22-70
106 REM  AT NO=A, MASS=B, MASS NO=C
107 REM  MASS DEFECT IS F
130 PRINT"   THIS PROGRAM IS DESIGNED TO INVESTIGATE MASS DEFECT"
140 PRINT
150 PRINT"   WHICH OF THE ELEMENTS WOULD YOU LIKE TO CONSIDER? "
160 PRINT" REMEMBER WE ARE DEALING WITH A SINGLE ATOM, THEREFORE"
170 PRINT" IN ADDITION TO THE ATOMIC NUMBER WE ARE GOING TO NEED THE"
180 PRINT" ACTUAL MASS (IN AMU) AND THE MASS NUMBER OF THE ISOTOPE"
190 PRINT" YOU WANT TO WORK WITH."
200 PRINT
210 PRINT " WHEN THE MACHINE TYPES A QUESTION MARK (?) TYPE IN"
220 PRINT " YOUR ANSWER THEN HIT RETURN KEY. USE NUMBERS OF UP TO"
230 PRINT " SIX SIGNIFICANT FIGURES. ROUND IF NECESSARY TO 6 DIGITS."
237 PRINT "IN THE VALUES FOR MASS DEFECT."
238 PRINT
240 PRINT
250 PRINT " THE ATOMIC NUMBER IS ";
260 INPUT A
270 PRINT " THE ACTUAL MASS IS ";
280 INPUT C
290 PRINT " THE MASS NUMBER IS ";
300 INPUT B
310 PRINT
320 REM  G IS AVOGADRO'S NUMBER
330 LET G=6.023E23
340 LET D = B - A
350 LET E=(1.00728*A)+(1.00867*D)+(5.48597E-4*A)
360 LET F=INT(1E4*(E-C)+.5)/1E4
370 PRINT " THE SUM OF THE MASS OF THE"A"PROTONS AND THE"D"NEUTRONS"
380 PRINT " PLUS THE WEIGHT OF THE"A"ELECTRONS IS THE CALCULATED"
390 PRINT " MASS."
400 PRINT
410 PRINT"  CALCULATED MASS  -  ACTUAL MASS  =  MASS DEFECT"
420 PRINT"      "E,"     -  "C;"     =    "F
430 PRINT
440 REM   CONVERSION FACTORS:
450 REM         1.49 X 10-3 ERGS PER AMU
460 REM         4.19 X 10 7 ERGS PER CAL.
470 REM         3.6  X 10 13 ERGS PER KW-H
475 REM          931.0 MEV PER AMU
480 LET H=(1.49E-3*F*G)/4.19E7
490 PRINT " THE MASS DEFECT IN TERMS OF ENERGY IS THE EQUIVALENT OF"
500 PRINT INT(H/1E9+.5)"X 10↑9 CAL. PER MOLE OF THIS SUBSTANCE,"
510 PRINT "OR"INT((H/C)/1E9+.5)"X 10↑9 CAL. PER GRAM."
511 PRINT
512 PRINT " IF WE DIVIDE THIS BINDING ENERGY BY THE NUMBER OF"
```

```
513 PRINT " PARTICLES IN THE NUCLEUS, WE GET A RATIO KNOWN AS THE"
514 PRINT " BINDING ENERGY PER NUCLEON, WHICH IS A MEASURE OF THE"
515 PRINT " STABILITY OF THE NUCLEUS.  THE MORE 'BINDING'"
516 PRINT " PER NUCLEON, THE MORE STABLE IS THE NUCLEUS."
517 PRINT " THE BINDING ENERGY PER NUCLEON IS :";
518 PRINT 1.49E-3*F/B"ERGS. PER NUCLEON, OR";
519 PRINT 1.49E-3*F/(B*4.19E7)"CAL. PER NUC.,"
520PRINT" WHICH IS MORE COMMONLY EXPRESSED AS"100*INT(931*F/B+.5)"MEV."
522 LET J = ((H/C)*4.19E7/3.6E13)/15
525 PRINT
530 PRINT " THE AMOUNT OF ENERGY (BINDING ENERGY) CONTAINED IN ONE"
540 PRINT " GRAM OF THIS SUBSTANCE WOULD BE SUFFICIENT TO SUPPLY ALL"
550 PRINT " THE ELECTRICAL NEEDS IN AN AVERAGE ONE FAMILY HOUSE USING"
560 PRINT " 15 KW-HRS. PER DAY FOR A PERIOD OF"INT(J+.5)"DAYS OR"
565 PRINT INT((J/365)+.5)"YEARS."
570 PRINT
580 PRINT " IF YOU WOULD LIKE TO RUN ANOTHER PROBLEM TYPE IN 1,"
590 PRINT " IF NOT TYPE IN 0."
600 INPUT M
610 PRINT
620 PRINT " ","***************"
630 IF M=1 THEN 240
640 IF M<>0 THEN 580
650 END

READY
```

DISCIPLINE CHEMISTRY

SUBJECT ACID - BASE TITRATION

PROGRAM NAME MOLAR

DESCRIPTION:

This program will calculate molarity by using data obtained from an acid-base titration.

OBJECTIVES:

To provide the teacher and the student with a molarity calculator to be used where either finds it applicable.

PRELIMINARY PREPARATION:

A. Student - This program can be used with students who have had no preliminary preparation or those with extensive preparation.

B. Materials - none

DISCUSSION:

It should be noted that normality is no longer in the New York State syllabus. It thus becomes necessary to teach titration calculations in the molarity systems by way of moles of H^+ reacted vs. moles of OH^- reacted, a much preferred method. This program does just that.

This program may be used in lab, as check on homework problems, and for tutorial work.

The teacher may also wish to show the logic of programs in general by using this very elementary program. The teacher need only take the list and explain it line by line to enhance the students' understanding. The equation used to solve the problems is:

$$\text{Moles } H^+ = \text{Moles } OH^-$$

$$(M_A)(V_A)(n) = (M)(V_B)(n)$$

V = volume in liters
n = subscript of the H^+ or OH^-

132

```
THIS PROGRAM IS DESIGNED TO CALCULATE THE UNKNOWN MOLARITY
IN AN ACID-BASE TITRATION.

WHAT IS THE SUBSCRIPT OF THE H+ IN THE ACID FORMULA,
AND THE SUBSCRIPT OF THE OH- IN THE BASE FORMULA? 2,1

HOW MANY ML OF ACID, AND HOW MANY ML OF BASE
WERE USED? 19.7,10.0

IS THE KNOWN MOLARITY FOR THE ACID OR THE BASE?
ANSWER 1 FOR ACID OR 2 FOR BASE? 1

WHAT IS THE MOLARITY OF THE ACID? 5.5

ANSWER: THE BASE IS  21.67 M.

DO YOU WANT TO WORK ANOTHER PROBLEM?  ANSWER 1 FOR YES
OR 0 FOR NO? 1

***************

WHAT IS THE SUBSCRIPT OF THE H+ IN THE ACID FORMULA,
AND THE SUBSCRIPT OF THE OH- IN THE BASE FORMULA? 3,1

HOW MANY ML OF ACID, AND HOW MANY ML OF BASE
WERE USED? 0,29.3

IS THE KNOWN MOLARITY FOR THE ACID OR THE BASE?
ANSWER 1 FOR ACID OR 2 FOR BASE? 1

WHAT IS THE MOLARITY OF THE ACID? 2.0

ANSWER: THE BASE IS  0 M.

DO YOU WANT TO WORK ANOTHER PROBLEM?  ANSWER 1 FOR YES
OR 0 FOR NO? 1

***************

WHAT IS THE SUBSCRIPT OF THE H+ IN THE ACID FORMULA,
AND THE SUBSCRIPT OF THE OH- IN THE BASE FORMULA? 2,1

HOW MANY ML OF ACID, AND HOW MANY ML OF BASE
WERE USED? 15.0,24.7

IS THE KNOWN MOLARITY FOR THE ACID OR THE BASE?
ANSWER 1 FOR ACID OR 2 FOR BASE? 2

WHAT IS THE MOLARITY OF THE BASE? 1.5

ANSWER: THE ACID IS  1.23 M.

DO YOU WANT TO WORK ANOTHER PROBLEM?  ANSWER 1 FOR YES
OR 0 FOR NO? 0

***************

READY
```

```
100 REM HARRY DORFMAN 7/16/68 JOHN GLENN H.S. ( REV. 7/10/69 )
105 REM  REVISED BY C.LOSIK  7-23-70
110 PRINT "THIS PROGRAM IS DESIGNED TO CALCULATE THE UNKNOWN MOLARITY"
120 PRINT "IN AN ACID-BASE TITRATION."
130 PRINT
140 PRINT
150 PRINT " WHAT IS THE SUBSCRIPT OF THE H+ IN THE ACID FORMULA,"
160 PRINT " AND THE SUBSCRIPT OF THE OH- IN THE BASE FORMULA";
165 REM  D,C= # OF H+,  # OF OH-
170 INPUT D,C
180 PRINT
190 PRINT " HOW MANY ML OF ACID, AND HOW MANY ML OF BASE"
200 PRINT " WERE USED";
205 REM  E,F= ML ACID, ML BASE
210 INPUT E,F
220 PRINT
230 PRINT " IS THE KNOWN MOLARITY FOR THE ACID OR THE BASE?"
240 PRINT " ANSWER 1 FOR ACID OR 2 FOR BASE";
250 INPUT Z
260 PRINT
270 IF Z = 2 THEN 360
280 IF Z<>1 THEN 240
290 PRINT " WHAT IS THE MOLARITY OF THE ACID";
300 INPUT A
310 LETB= (E*A*D)/(C*F)
320 PRINT
330 PRINT
340 PRINT " ANSWER: THE BASE IS "INT(100*B+.5)/100"M."
350 GO TO 420
360 PRINT " WHAT IS THE MOLARITY OF THE BASE";
370 INPUT B
380 LET A=(C*F*B)/(D*E)
390 PRINT
400 PRINT
410 PRINT " ANSWER: THE ACID IS "INT(100*A+.5)/100"M."
420 PRINT
430 PRINT
440 PRINT " DO YOU WANT TO WORK ANOTHER PROBLEM?  ANSWER 1 FOR YES"
450 PRINT " OR 0 FOR NO";
460 INPUT X
462 PRINT
464 PRINT " ***************"
470 IF X=1 THEN 130
480 IF X<>0 THEN 430
490 END
```

DISCIPLINE CHEMISTRY

SUBJECT pH, pOH, PCT. DISSOCIATION

PROGRAM NAME PHPOH

DESCRIPTION:

A class presentation designed to calculate pH, pOH, and percent dissociation of weak monoprotic acids, using the quadratic equations for rigorous solutions.

OBJECTIVES:

A. To illustrate the relationships between the magnitude of the K_a value, and the strength of the acid.

B. To show the relationship between pOH and pH.

PRELIMINARY PREPARATION:

Student - The distinction between weak and strong acids should have been covered. The student should also be aware of the role hydrogen ion concentration plays in acid-base calculations, and the effect it has on hydroxide ion concentration.

DISCUSSION:

This program can be used in different ways, depending upon the ability level of the group.

1. With groups of average abilities, it is used primarily as a calculator, to solve large numbers of problems in a minimum amount of time.
2. In above average groups, the program listing was used as a device to illustrate theory. The entire lesson consists of an extensive step-wise explanation of the program list. In these classes all students were familiar with the Basic programming language. Some calculations built into the program (lines 41-43) are not part of the normal curriculum, but are necessary to solve the problem as the product of the K_a value and the concentration approaches 1×10^{-14}.

```
THIS PROGRAM WILL FIND THE PH, POH, AND PCT DISSOCIATION
FOR ANY WEAK MONOPROTIC ACID.

KA OF ACID =? 1E-5
 MOLAR CONCENTRATION OF ACID =? 1

PH= 2.5          POH= 11.5      PCT. DISSOCIATION= .3157262

 ANY MORE PROBLEMS (1=YES, 0=NO)? 1

KA OF ACID =? 1E-3
 MOLAR CONCENTRATION OF ACID =? 2

PH= 1.35         POH= 12.65     PCT. DISSOCIATION= 2.211206

 ANY MORE PROBLEMS (1=YES, 0=NO)? 1

KA OF ACID =? 1E-10
 MOLAR CONCENTRATION OF ACID =? 1

PH= 5            POH= 9         PCT. DISSOCIATION= 9.998950E-4

 ANY MORE PROBLEMS (1=YES, 0=NO)? 1

KA OF ACID =? 1E-15
 MOLAR CONCENTRATION OF ACID =? 2

PH= 6.96         POH= 7.04      PCT. DISSOCIATION= 9.128709E-7

 ANY MORE PROBLEMS (1=YES, 0=NO)? 0

READY
```

```
100 REM PHPOH*  JOHN MARCHISOTTO 7/10/69  CHEMISTRY BASIC
101 REM  REVISED BY C.LOSIK  7-22-70
103 REM A IS THE KA, B IS THE MOLAR CONC.
110 REM  PROGRAM DOES ONE CALCULATION AT A TIME.!
140 PRINT "THIS PROGRAM WILL FIND THE PH, POH, AND PCT DISSOCIATION"
150 PRINT "FOR ANY WEAK MONOPROTIC ACID."
170 PRINT
180 PRINT "KA OF ACID =";
190 INPUT A
200 IF A<=0.5 THEN 210
202 PRINT "ANSWER INVALID FOR WEAK ACID.  TRY AGAIN."
204 GO TO 190
210 PRINT " MOLAR CONCENTRATION OF ACID =";
220 INPUT B
230 PRINT
240 LET S = A*B
250 IF S>=1E-12 THEN 280
260 LET H = SQR(S+1E-14)
270 GO TO 290
280 LET H =-A/2+(SQR(A↑2+(4*A*B)))/2
290 LET T = 1E-14/H
300 LET R = H-T
310 LET C = -LOG (H)/2.303
320 LET D = 14 - C
330 IF B<1E-5 THEN 360
340 LET E = R/B*100
350 GO TO 370
360 LET E = 100
370 PRINT "PH="INT(100*C+.5)/100,"POH="INT(100*D+.5)/100,
380 PRINT "PCT. DISSOCIATION="E
390 PRINT
410 PRINT " ANY MORE PROBLEMS (1=YES, 0=NO)";
430 INPUT N
440 IF N=1 THEN 170
445 IF N<>0 THEN 410
450 END
```

DISCIPLINE CHEMISTRY

SUBJECT PERCENT COMPOSITION

PROGRAM NAME PRCNT

DESCRIPTION:

This program is designed to calculate the percent composition (by weight) of a compound that may contain up to 5 elements. The program also contains a detailed sample calculation which is optional.

OBJECTIVES:

A. For the students who are familiar with percentage, this program may be used as a self-teaching device to show how this concept applies to a chemical situation.

B. The program may be used as a calculator to:

1) Illustrate the Law of Multiple Proportions
2) Illustrate the Law of Definite Proportions
3) Work out percent water of hydration, percent sulfate, nitrate, etc. (see discussion)
4) Check homework problems, class problems, lab problems, etc.

C. The program may be used as a tutorial device for students having difficulty.

PRELIMINARY PREPARATION:

A. Student - The student should at least have an understanding of the concept of percentage. The teacher may also wish to discuss how this concept applies to chemical compounds.

B. Materials - none

DISCUSSION:

This program makes it possible for the teacher to spend very little time in class on percent composition and still have the student receive ample instruction and drill on the topic. This is possible since the program may be used in a number of situations such as teaching, self-teaching, and tutorial.

It should be brought to the students' attention that % water of hydration, % sulfate, % nitrate, etc., may be calculated by treating the groups of atoms as a single element when entering data.

```
     THIS PROGRAM IS DESIGNED TO CALCULATE THE PERCENT
COMPOSITION BY WEIGHT OF A COMPOUND THAT MAY CONTAIN
FROM 2 TO 5 ELEMENTS.

 DO YOU WANT TO SEE A SAMPLE CALCULATION?
ANSWER 1 FOR YES OR 0 (ZERO) FOR NO? 1

EXAMPLE :    THE PERCENT COMPOSITION OF SULFURIC ACID

LET W1 = ATOMIC WEIGHT OF HYDROGEN
 LET A1 = THE NO. OF HYDROGEN ATOMS IN THE FORMULA
LET W2 = THE ATOMIC WEIGHT OF SULFUR
 LET A2 = THE NO. OF SULFUR ATOMS IN THE FORMULA
LET W3 = THE ATOMIC WEIGHT OF OXYGEN
 LET A3 = THE NO. OF OXYGEN ATOMS IN THE FORMULA

 Y= FORMULA WEIGHT OF SULFURIC ACID
 Y= (W1*A1) + (W2*A2) + (W3*A3)
 Y= (1.008*2) + (32.064*1) + (15.999*4)
 Y= 98.076

PERCENT H = (W1*A1/Y)*100
PERCENT H = (1.008*2/98.076)*100
PERCENT H = 2.005

PERCENT S = (W2*A2/Y)*100
PERCENT S = (32.064*1/98.076)*100
PERCENT S = 32.693

PERCENT O = (W3*A3/Y)*100
PERCENT O = (15.999*4/98.076)*100
PERCENT O = 65.2514

 DO YOU WANT TO DO A PROBLEM ?
ANSWER 1 FOR YES OR 0 (ZERO) FOR NO? 1

 WHAT IS THE NUMBER OF ELEMENTS IN THE FORMULA? 3
 TYPE (THE ATOMIC WEIGHT,NO. OF ATOMS) FOR EACH ELEMENT,
 ONE ELEMENT TO A LINE.
? 12.011,12
? 1.008,22
? 15.999,11
                  ******************************

FORMULA WEIGHT = 342.297

ATOMIC WEIGHT   NO. OF ATOMS   PERCENT COMPOSITION
 12.011         12             42.10729
 1.008          22             6.478584
 15.999         11             51.41412

                  ******************************

 DO YOU WANT TO DO ANOTHER PROBLEM?
ANSWER 1 FOR YES OR 0 (ZERO) FOR NO? 0

READY
```

```
100 REM R. SHANNON, HARBORFIELDS H.S. 7/23/68  (REV 7/18/69)
105 REM  REVISED BY C.LOSIK  7-23-70
106 REM  THE SAMPLE CALCULATION EXPLAINS HOW THIS PROGRAM WORKS
110 REM CALCULATES PERCENTAGE COMPOSITION BY WEIGHT OF A COMPOUND
120 PRINT "      THIS PROGRAM IS DESIGNED TO CALCULATE THE PERCENT"
130 PRINT "COMPOSITION BY WEIGHT OF A COMPOUND THAT MAY CONTAIN"
140 PRINT "FROM 2 TO 5 ELEMENTS."
150 PRINT
160 PRINT " DO YOU WANT TO SEE A SAMPLE CALCULATION?"
170 PRINT "ANSWER 1 FOR YES OR 0 (ZERO) FOR NO";
180 INPUT  X
190 IF X = 0 THEN 460
193 IF X<>1 THEN 170
199 PRINT
200 PRINT  "EXAMPLE :   THE PERCENT COMPOSITION OF SULFURIC ACID "
210 PRINT
220 PRINT "LET W1 = ATOMIC WEIGHT OF HYDROGEN"
230 PRINT " LET A1 = THE NO. OF HYDROGEN ATOMS IN THE FORMULA"
240 PRINT "LET W2 = THE ATOMIC WEIGHT OF SULFUR"
250 PRINT " LET A2 = THE NO. OF SULFUR ATOMS IN THE FORMULA"
260 PRINT "LET W3 = THE ATOMIC WEIGHT OF OXYGEN"
270 PRINT " LET A3 = THE NO. OF OXYGEN ATOMS IN THE FORMULA "
280 PRINT
290 PRINT " Y= FORMULA WEIGHT OF SULFURIC ACID"
300 PRINT " Y= (W1*A1) + (W2*A2) + (W3*A3)"
310 PRINT " Y= (1.008*2) + (32.064*1) + (15.999*4)"
320 PRINT " Y= 98.076"
330 PRINT
340 PRINT "PERCENT H = (W1*A1/Y)*100"
350 PRINT "PERCENT H = (1.008*2/98.076)*100"
360 PRINT "PERCENT H = 2.005"
370 PRINT
380 PRINT "PERCENT S = (W2*A2/Y)*100"
390 PRINT "PERCENT S = (32.064*1/98.076)*100"
400 PRINT "PERCENT S = 32.693"
410 PRINT
420 PRINT "PERCENT O = (W3*A3/Y)*100"
430 PRINT "PERCENT O = (15.999*4/98.076)*100"
440 PRINT "PERCENT O = 65.2514"
450 PRINT
460 PRINT " DO YOU WANT TO DO A PROBLEM ?"
470 PRINT "ANSWER 1 FOR YES OR 0 (ZERO) FOR NO";
480 INPUT X
490 IF X = 0 THEN 770
493 IF X<>1 THEN 470
500  DIM W(5), A(5)
505 PRINT
510 PRINT " WHAT IS THE NUMBER OF ELEMENTS IN THE FORMULA";
520 REM J = NO. OF ELEMENTS IN THE FORMULA
530 INPUT J
533 REM THIS LOOP CHECKS FOR VALID ANSWER
535 FOR I=2 TO 5
540 IF I=J THEN 560
545 NEXT I
550 PRINT "THIS PROGRAM CONSIDERS COMPOUNDS WITH 2 TO 5 ELEMENTS."
552 GO TO 510
560 LET Y = 0
570 PRINT " TYPE (THE ATOMIC WEIGHT,NO. OF ATOMS) FOR EACH ELEMENT,"
580 PRINT " ONE ELEMENT TO A LINE."
590 FOR I = 0 TO J-1
```

```
600 INPUT W(I),A(I)
610 REM Y = FORMULA WEIGHT
620     LET Y= Y+W(I)*A(I)
630 NEXT I
640 PRINT "                    ******************************"
645 PRINT
650 PRINT "FORMULA WEIGHT ="; Y
660 PRINT
670 PRINT "ATOMIC WEIGHT  NO. OF ATOMS   PERCENT COMPOSITION"
680 REM J = NO. OF ELEMENTS IN THE FORMULA
690 FOR I = 0 TO J-1
700 PRINT W(I),A(I),W(I)*A(I)/Y*100
710 NEXT I
720 PRINT
730 PRINT "                    ******************************"
740 PRINT
750 PRINT" DO YOU WANT TO DO ANOTHER PROBLEM?"
760 GO TO 470
770 END
```

141

DISCIPLINE CHEMISTRY

SUBJECT STOICHIOMETRY

PROGRAM NAME STOICH

DESCRIPTION:

This program solves mass-mass, mass-volume, and volume-volume problems. The input may be in grams and/or moles and the output will be in grams, moles and/or liters

OBJECTIVES:

To provide the teacher and the student with a stoichiometry calculator to be used where either finds it applicable.

PRELIMINARY PREPARATION:

A. Student - The student must have an introduction to stoichiometry.

B. Materials - none

DISCUSSION:

Some of the situations where this program is useful:

A. In Class

1. Enables teacher to cover a large number of problems without using time to do calculations.
2. Can be used in conjunction with a problem exercise in class so teacher can go around and give individual help.

B. Outside of Class

1. Tutorial Work
2. Students can check homework problems during study periods or after school.

```
DO YOU WISH TO SKIP THE INSTRUCTIONS? 1 FOR YES ,0 FOR NO? 0
THIS PROGRAM IS DESIGNED TO SOLVE:
        1. MASS-MASS PROBLEMS
        2. MASS-VOLUME PROBLEMS
        3. VOLUME-VOLUME PROBLEMS

SOME GENERAL INSTRUCTIONS FOR USING THE PROGRAM WILL
BE HELPFUL AT THIS TIME.
     1. IF TWO PIECES OF DATA ARE REQUESTED, BE SURE TO
        GIVE THEM IN THE ORDER REQUESTED AND SEPARATE
        THEM WITH A COMMA.
     2. THE BALANCED EQUATION IS THE FIRST THING
        NEEDED WITH EACH TYPE OF PROBLEM SO HAVE IT PREPARED.
     3. THE FORMULA WEIGHTS ARE NEEDED NEXT SO HAVE THEM
        PREPARED.


PICK THE TYPE OF CALCULATION YOU DESIRE BY ANSWERING THE
FOLLOWING QUESTION WITH A 1,2, OR 3:
             1 FOR MASS-MASS CALCULATIONS
             2 FOR MASS-VOLUME CALCULATIONS
             3 FOR VOLUME-VOLUME CALCULATIONS

WHAT IS THE NUMBER OF YOUR CHOICE? 1
              ***************

 PROVIDE THE FOLLOWING DATA FOR THIS MASS-MASS PROBLEM:

HOW MANY MOLES OF KNOWN COMPOUND AND UNKNOWN COMPOUND
ARE SHOWN IN THE BALANCED CHEMICAL EQUATION? 1,1
WHAT IS THE FORMULA WEIGHT OF THE KNOWN COMPOUND
 AND THE UNKNOWN COMPOUND ? 100,56
 WHAT MASS, IN GRAMS, OF THE KNOWN COMPOUND IS INVOLVED
 IN THE CHEMICAL REACTION?  IF THIS INFORMATION IS AVAILABLE
 IN MOLES ANSWER ZERO (0) AND WAIT FOR THE NEXT QUESTION? 50.0
 ANSWERS: ................. .5  MOLES OF UNKN. CPD.
          ................. 28  GRAMS OF UNKN. CPD.

              ***************

DO YOU WISH TO SOLVE ANOTHER PROBLEM?  ANSWER 1 FOR M-M,
 2 FOR M-V, 3 FOR V-V, AND ZERO (0) TO END THE PROGRAM.? 2

              ***************

 PROVIDE THE FOLLOWING DATA FOR THIS MASS-VOLUME PROBLEM:

 HOW MANY MOLES OF KNOWN COMPOUND AND UNKNOWN COMPOUND
 ARE SHOWN IN THE BALANCED EQUATION? 2,2
WHAT IS THE FORMULA WEIGHT OF THE KNOWN COMPOUND AND THE
 UNKNOWN COMPOUND? 18,2
 WHAT MASS, IN GRAMS, OF THE KNOWN COMPOUND IS INVOLVED
 IN THE CHEMICAL REACTION? IF ONLY VOLUME IS KNOWN
 ANSWER ZERO (0) AND WAIT FOR THE NEXT QUESTION? 20.0
ANSWERS: ......................... 1.111111 MOLES OF UNKN. GAS
         ......................... 24.88889  LITERS OF UNKN. GAS

              ***************

DO YOU WISH TO SOLVE ANOTHER PROBLEM?  ANSWER 1 FOR M-M,
 2 FOR M-V, 3 FOR V-V, AND ZERO (0) TO END THE PROGRAM.? 3

              ***************
```

143

```
PROVIDE THE FOLLOWING DATA FOR THIS VOLUME-VOLUME PROBLEM:

HOW MANY MOLES KNOWN GAS AND UNKNOWN GAS ARE SHOWN
 IN THE BALANCED EQUATION? 1.3,3
 WHAT IS THE VOLUME IN LITERS OF THE KNOWN GAS INVOLVED
 IN THE CHEMICAL REACTION? (VOLUME MUST BE AT STP.)? 146
ANSWER: ............................ 336.9231 LITERS OF UNKN. GAS

               ***************

DO YOU WISH TO SOLVE ANOTHER PROBLEM?  ANSWER 1 FOR M-M,
 2 FOR M-V, 3 FOR V-V, AND ZERO (0) TO END THE PROGRAM.? 1

               ***************

 PROVIDE THE FOLLOWING DATA FOR THIS MASS-MASS PROBLEM:

HOW MANY MOLES OF KNOWN COMPOUND AND UNKNOWN COMPOUND
ARE SHOWN IN THE BALANCED CHEMICAL EQUATION? 1,1
WHAT IS THE FORMULA WEIGHT OF THE KNOWN COMPOUND
 AND THE UNKNOWN COMPOUND ? 56,74
 WHAT MASS, IN GRAMS, OF THE KNOWN COMPOUND IS INVOLVED
 IN THE CHEMICAL REACTION?  IF THIS INFORMATION IS AVAILABLE
 IN MOLES ANSWER ZERO (0) AND WAIT FOR THE NEXT QUESTION? 0
 HOW MANY MOLES OF KNOWN COMPOUND WERE INVOLVED IN
 THE CHEMICAL REACTION? 2.9
 ANSWERS: .................. 2.9  MOLES OF UNKN. CPD.
          .................. 214.6  GRAMS OF UNKN. CPD.

               ***************

DO YOU WISH TO SOLVE ANOTHER PROBLEM?  ANSWER 1 FOR M-M,
 2 FOR M-V, 3 FOR V-V, AND ZERO (0) TO END THE PROGRAM.? 2

               ***************

 PROVIDE THE FOLLOWING DATA FOR THIS MASS-VOLUME PROBLEM:

 HOW MANY MOLES OF KNOWN COMPOUND AND UNKNOWN COMPOUND
 ARE SHOWN IN THE BALANCED EQUATION? 1,2
WHAT IS THE FORMULA WEIGHT OF THE KNOWN COMPOUND AND THE
 UNKNOWN COMPOUND? 2,23
 WHAT MASS, IN GRAMS, OF THE KNOWN COMPOUND IS INVOLVED
 IN THE CHEMICAL REACTION? IF ONLY VOLUME IS KNOWN
 ANSWER ZERO (0) AND WAIT FOR THE NEXT QUESTION? 0
 WHAT IS THE VOLUME, IN LITERS, OF THE KNOWN GAS
INVOLVED IN THE CHEMICAL REACTION? (VOLUME MUST BE AT STP)? 212
 ANSWERS:.................... 18.92857  MOLES OF UNKN. CPD.
         .................... 435.3571  GRAMS OF UNKN. CPD.

               ***************

DO YOU WISH TO SOLVE ANOTHER PROBLEM?  ANSWER 1 FOR M-M,
 2 FOR M-V, 3 FOR V-V, AND ZERO (0) TO END THE PROGRAM.? 0

               ***************


READY
```

```
100 REM HARRY DORFMAN, JOHN GLENN H.S.7/23/68  ( REV.7/9/69 )
105 REM  REVISED BY C.LOSIK    7-22-70
106 REM  DIFFERENT VARIABLES ARE USED IN EACH PROBLEM
107 REM  THEIR MEANING MAY BE DETERMINED BY LOOKING AT EACH SECTION
108 REM  OF THE PROGRAM (VARS. CORRESPOND WITH INPUTS AND PRINTS)
110 REM THIS PROGRAM IS DESIGNED TO SOLVE MASS-MASS,MASS-VOLUME,
120 REM AND VOLUME-VOLUME PROBLEMS.
123 REM
125 REM  EACH INPUT HAS A DIFFERENT LETTER CORRESPONDING TO
126 REM  THE INFORMATION IN THE PRINTED QUESTION.
130 REM
140 PRINT " DO YOU WISH TO SKIP THE INSTRUCTIONS? 1 FOR YES ,0 FOR NO";
150 INPUT Z
160 IF Z=1 THEN 320
162 IF Z<>0 THEN 130
170 PRINT "THIS PROGRAM IS DESIGNED TO SOLVE:"
180 PRINT "         1. MASS-MASS PROBLEMS"
190 PRINT "         2. MASS-VOLUME PROBLEMS"
200 PRINT "         3. VOLUME-VOLUME PROBLEMS"
210 PRINT
220 PRINT "SOME GENERAL INSTRUCTIONS FOR USING THE PROGRAM WILL"
230 PRINT "BE HELPFUL AT THIS TIME."
240 PRINT "      1. IF TWO PIECES OF DATA ARE REQUESTED, BE SURE TO"
250 PRINT "         GIVE THEM IN THE ORDER REQUESTED AND SEPARATE"
260 PRINT "         THEM WITH A COMMA."
270 PRINT "      2. THE BALANCED EQUATION IS THE FIRST THING"
280 PRINT"          NEEDED WITH EACH TYPE OF PROBLEM SO HAVE IT PREPARED."
290 PRINT "      3. THE FORMULA WEIGHTS ARE NEEDED NEXT SO HAVE THEM"
300 PRINT "         PREPARED."
310 PRINT
320 PRINT
330 PRINT "PICK THE TYPE OF CALCULATION YOU DESIRE BY ANSWERING THE"
340 PRINT"FOLLOWING QUESTION WITH A 1,2, OR 3:"
350 PRINT"               1 FOR MASS-MASS CALCULATIONS"
360 PRINT"               2 FOR MASS-VOLUME CALCULATIONS"
370 PRINT"               3 FOR VOLUME-VOLUME CALCULATIONS"
380 PRINT
390 PRINT "WHAT IS THE NUMBER OF YOUR CHOICE";
400 INPUT A
410 PRINT " ","***************"
420 PRINT
430 IF A=1 THEN 470
440 IF A=2 THEN 830
450 IF A=3 THEN1150
455 PRINT "USE 1, 2, OR 3.  TRY AGAIN."
460 GO TO 390
470 PRINT" PROVIDE THE FOLLOWING DATA FOR THIS MASS-MASS PROBLEM:"
480 PRINT
490 PRINT"HOW MANY MOLES OF KNOWN COMPOUND AND UNKNOWN COMPOUND"
500 PRINT "ARE SHOWN IN THE BALANCED CHEMICAL EQUATION";
510 INPUT B,C
520 PRINT"WHAT IS THE FORMULA WEIGHT OF THE KNOWN COMPOUND"
530 PRINT " AND THE UNKNOWN COMPOUND ";
540 INPUT D,E
550 PRINT" WHAT MASS, IN GRAMS, OF THE KNOWN COMPOUND IS INVOLVED"
560PRINT" IN THE CHEMICAL REACTION?  IF THIS INFORMATION IS AVAILABLE"
570 PRINT " IN MOLES ANSWER ZERO (0) AND WAIT FOR THE NEXT QUESTION";
580 INPUT F
590 IF F=0 THEN620
600 LET G=F/D
610 GO TO 650
620 PRINT" HOW MANY MOLES OF KNOWN COMPOUND WERE INVOLVED IN"
630 PRINT " THE CHEMICAL REACTION";
640 INPUT G
```

```
650 LET H=(C/B)*G
660 PRINT" ANSWERS: ..................."H" MOLES OF UNKN. CPD."
670 LET J=H*E
680 PRINT "             ..................."J" GRAMS OF UNKN. CPD."
690 PRINT
700 PRINT " ","***************"
710 PRINT
720 PRINT"DO YOU WISH TO SOLVE ANOTHER PROBLEM?  ANSWER 1 FOR M-M,"
730 PRINT " 2 FOR M-V, 3 FOR V-V, AND ZERO (0) TO END THE PROGRAM.";
740 INPUT Y
745 PRINT
750 PRINT " ","***************"
760 PRINT
770 IF Y=1 THEN 470
780 IF Y=2 THEN 830
790 IF Y=3 THEN 1150
800 IF Y<>0 THEN 810
805 STOP
810 PRINT " YOU MUST USE 0,1,2, OR 3.  TRY AGAIN."
820 GO TO 720
830 PRINT " PROVIDE THE FOLLOWING DATA FOR THIS MASS-VOLUME PROBLEM:"
840 PRINT
850 PRINT " HOW MANY MOLES OF KNOWN COMPOUND AND UNKNOWN COMPOUND"
860 PRINT " ARE SHOWN IN THE BALANCED EQUATION";
870 INPUT K,L
880 PRINT "WHAT IS THE FORMULA WEIGHT OF THE KNOWN COMPOUND AND THE"
890 PRINT " UNKNOWN COMPOUND";
900 INPUT M,N
910 PRINT" WHAT MASS, IN GRAMS, OF THE KNOWN COMPOUND IS INVOLVED"
920 PRINT" IN THE CHEMICAL REACTION? IF ONLY VOLUME IS KNOWN"
930 PRINT " ANSWER ZERO (0) AND WAIT FOR THE NEXT QUESTION";
940 INPUT P
950 IF P=0 THEN 1040
960 LET R=(L/K)*(P/M)
970 PRINT"ANSWERS: ............................"R"MOLES OF UNKN. GAS"
980 LET S=R*22.4
990 PRINT"             ............................"S" LITERS OF UNKN. GAS"
1030 GO TO 690
1040 PRINT" WHAT IS THE VOLUME, IN LITERS, OF THE KNOWN GAS"
1050 PRINT"INVOLVED IN THE CHEMICAL REACTION? (VOLUME MUST BE AT STP)";
1060 INPUT Q
1070 LET T=(Q/22.4)*(L/K)
1080 PRINT" ANSWERS:...................."T" MOLES OF UNKN. CPD."
1090 LET U=T*N
1100 PRINT"             ...................."U" GRAMS OF UNKN. CPD."
1140 GO TO 690
1150 PRINT "PROVIDE THE FOLLOWING DATA FOR THIS VOLUME-VOLUME PROBLEM:"
1160 PRINT
1170 PRINT "HOW MANY MOLES KNOWN GAS AND UNKNOWN GAS ARE SHOWN"
1180 PRINT " IN THE BALANCED EQUATION";
1190 INPUT U,V
1200 PRINT" WHAT IS THE VOLUME IN LITERS OF THE KNOWN GAS INVOLVED"
1210 PRINT " IN THE CHEMICAL REACTION? (VOLUME MUST BE AT STP.)";
1220 INPUT W
1230 LET X=(V/U)*W
1240 PRINT"ANSWER: ............................"X"LITERS OF UNKN. GAS"
1280 GO TO 690
1300 END

READY
```

HUNTINGTON COMPUTER PROJECT

A TEACHER'S MANUAL

(COMPUTER - RELATED MATERIALS)

Second Edition

January 31, 1971

Director: Dr. Ludwig Braun
Assistant Director: Dr. Marian Visich, Jr.

Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

Developed by the Huntington Computer Project during the period May, 1968 and September, 1970. This effort was supported by the National Science Foundation under Grant No. J000079.

The enclosed material is a compilation of computer programs developed during the period May, 1968 to September, 1970. These programs were developed by teachers and students in the high schools which participated with us, and by the Project staff.

All of the enclosed programs have been tested on a Digital Equipment Corporation TSS-8 time-shared computer during the summer of 1970. To the best of our ability, we have assured ourselves that the programs actually run. It should be pointed out, however, that we were not able to make an exhaustive exploration of the programs. There may be undiscovered bugs (if there aren't, it may be the first time in the history of computing). We would appreciate hearing of any which emerge in the future.

These programs run in the version of BASIC which existed on the TSS-8 in August, 1970, and should run on most other versions of BASIC. The major potential problem on other machines is the output format (DEC uses 14 columns per print zone, while some other manufacturers use 15; we used the TAB function, which doesn't exist in all BASIC compiles). It may be necessary to make some minor changes in programs to adjust this format. Another possible problem is in the use of the RANDOMIZE command in some programs to start the random-number generator at a random point. If this command is not available, some other means should be devised for randomizing the start.

It is our sincere hope that these programs and their supporting documentation will be helpful to educators who are exploring the uses of computers in education.

We are anxious to hear of any bugs, errors, or improvements in these programs, and are especially anxious to hear of any novel ways of using them.

Ludwig Braun
Marian Visich, Jr.

TABLE OF CONTENTS

Volume I

Volume II

CHEMISTRY

Volume III

MATHEMATICS

Volume IV

PHYSICS

Volume V

SOCIAL STUDIES

TEACHER ASSISTANCE

DISCIPLINE MATHEMATICS 9th YEAR

SUBJECT MULTIPLICATION INVOLVING ONE AND TWO DIGIT MULTIPLIERS

PROGRAM NAME ARITH

DESCRIPTION:

This program calls upon students, in a random fashion, to perform multiplication problems. Each student calculates five separate problems, and is allotted three chances to respond with the correct answer. At the conclusion of three incorrect responses, the computer will report to the student the correct answer. At the conclusion of five problems, the student will be given a score, and a new student will be called. Each factor will not exceed 100.

OBJECTIVES:

To review and reinforce students' ability to multiply by one and two digit multipliers.

PRELIMINARY PREPARATION:

None

DISCUSSION:

A. Operational Suggestions - This particular program is designed for group study, and may be used for an entire period. A portable TV was originally used to display computer output.

B. Follow-up - By modifying line numbers 520 and 560 to

```
520 LET X = A + B
560 PRINT A "+" B "=";
```

this program becomes practice in addition. Modifications may also be made for division, subtraction and individual remedial work.

C. MODIFICATION-If your computer has string capability, student names may be used rather than student numbers, by making a few minor programming changes. This change (having the computer type out the student's name) increases the student interest.

```
HELLO CLASS.....TODAY I WANT TO REVIEW  MULTIPLICATION
WITH YOU.   WHEN I CALL ON YOU PLEASE COME UP AND TYPE IN
YOUR ANSWERS.  IF YOU ARE WRONG YOU GET TWO MORE CHANCES.
HOW MANY STUDENTS ARE THERE IN THE CLASS TODAY? 30
TEACHER!...GIVE EVERYONE A NUMBER FROM 1 TO 30


OK, STUDENT NO.  27  IT'S YOUR TURN!

GIVE ME YOUR LUCKY NUMBER
? 5


 81  X  54  = ? 4374
YOU'RE RIGHT STUDENT NO. 27


 63  X  97  = ? 6111
YOU'RE RIGHT STUDENT NO. 27


 62  X  17  = ? 1054
YOU'RE RIGHT STUDENT NO. 27


 50  X  78  = ? 3900
YOU'RE RIGHT STUDENT NO. 27


 93  X  81  = ? 7533
YOU'RE RIGHT STUDENT NO. 27
YOU GOT  5  RIGHT OUT OF 5 PROBLEMS.
GOODBYE...STUDENT NO. 27

OK, STUDENT NO.  25  IT'S YOUR TURN!

GIVE ME YOUR LUCKY NUMBER
?
↑C

READY
```



```
100 REM W. TEPPER, WYANDANCH HS, 4/21/69
105 REM  REVISED BY C.LOSIK  8-5-70
106 REM  WE DO A RANDOM PROBLEM FOR EACH STUDENT,  A -OP- B
110 REM THIS PROGRAM CALLS STUDENTS IN A RANDOM FASHION TO DO INDIVIDUAL
120 REM PROBLEMS.  BY MODIFYING A FEW STATEMENTS I CAN CHANGE THE
130 REM TYPE OF PROBLEMS.
140 REM REVISED 5/7/69
150 PRINT "HELLO CLASS.....TODAY I WANT TO REVIEW ";
151 REM  CHANGE BELOW FOR YOUR OPERATION
152 PRINT " MULTIPLICATION"
160 PRINT
170 PRINT "WITH YOU.   WHEN I CALL ON YOU PLEASE COME UP AND TYPE IN"
180 PRINT
190 PRINT "YOUR ANSWERS.  IF YOU ARE WRONG YOU GET TWO MORE CHANCES."
200 PRINT
210 PRINT "HOW MANY STUDENTS ARE THERE IN THE CLASS TODAY";
220 INPUT S
230 PRINT
240 PRINT "TEACHER!...GIVE EVERYONE A NUMBER FROM 1 TO"S
250 PRINT
260 PRINT
270 PRINT
272 REM  YOU MUST RANDOMIZE THE PROCESS FOR BEST RESULTS
275 RANDOMIZE
280 LET Q=INT(RND(-2)*S)
290 PRINT "OK, STUDENT NO. "Q" IT'S YOUR TURN!"
300 LET J=0
310 LET L =0
320 PRINT
330 PRINT
340 PRINT "GIVE ME YOUR LUCKY NUMBER"
350 INPUT Z
360 FOR T=1 TO Z
370 LET A=INT(RND(-2)*100)
380 LET B=INT(RND(-5)*100)
390 NEXT T
400 LET N=0
410 LET J=J+1
415 REM  X IS THE ANSWER TO A -OP- B
420 LET X=A*B
430 PRINT
440 PRINT
450 PRINT
455 REM  PRINT A -OP- B = ?
460 PRINT A" X "B" = ";
470 INPUT K
480 IF ABS(K-X)<.005 THEN 590
490 LET N=N+1
```

```
500 IF N=3 THEN 530
510 PRINT "YOU'RE WRONG...TRY AGAIN"
520 GO TO 460
530 PRINT "YOUR WRONG AGAIN"
540 PRINT "THE ANSWER IS "X
550 IF J<5 THEN360
560 PRINT "YOU GOT "L"  RIGHT OUT OF 20 PROBLEMS"
570 PRINT "GOOD BYE .... STUDENT NO."Q
580 GO TO 250
590 PRINT "YOU'RE RIGHT STUDENT NO."Q
600 LET L = L+1
610 IF J<5 THEN360
620 PRINT "YOU GOT "L" RIGHT OUT OF 5 PROBLEMS."
630 PRINT "GOODBYE...STUDENT NO."Q
640 GO TO 260
650 END
```

DISCIPLINE MATHEMATICS-SOCIAL SCIENCE

SUBJECT FINANCIAL PROBLEMS

PROGRAM NAME BANK

DESCRIPTION:

This program solves financial problems concerning installment buying, long-term loans, and savings accounts. The program gives you a choice of these three types of problems, and asks for the information needed to do said problem.

OBJECTIVES:

A. This program aids students in learning the terms used in certain financial problems.

B. Student will hopefully be motivated to learn the mathematical logic behind the solution of these problems.

PRELIMINARY PREPARATION :

A. Student - A review of decimals and fractions would be helpful.

B. Materials - A terminal, and a means by which to display the output to an entire class (e.g. overhead projector, closed circuit TV, etc.)

DISCUSSION:

A type of problem may be demonstrated through the use of the computer, then the mathematical logic behind the solution of the problem may be developed through the use of a flow chart similar to the one that follows.

Terminology may be taught when the computer asks for input (see sample run).

Since the execution time of one run is extremely short, many more problems may be demonstrated. Depending upon the ability of the class or student, a variety of relationships may be discovered.

FINANCIAL PROBLEMS

```
THIS PROGRAM SOLVES THREE TYPES OF PROBLEMS:

     (1) INTEREST ON INSTALLMENT BUYING
     (2) PAYMENTS ON LONG TERM LOAN
     (3) BALANCE OF A SAVINGS ACCOUNT

WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)? 1

*****

THIS SECTION WILL DETERMINE THE ACTUAL INTEREST YOU PAY
WHEN YOU PURCHASE SOMETHING ON CREDIT.

WHAT IS THE CASH PRICE OF THE ARTICLE ($)? 88.99
            DOWN PAYMENT ($)? 10
            NUMBER OF PAYMENTS EXCLUDING THE DOWN PAYMENT? 18
            NUMBER OF PAYMENTS PER MONTH? 1
            AMOUNT PER PAYMENT ($)? 4.85


THE RATE OF INTEREST CHARGED WAS 5.69  PERCENT.


*****

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)? 1
WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)? 2

*****

THIS SECTION WILL DETERMINE PAYMENTS FOR A LONG TERM LOAN.

WHAT IS THE AMOUNT BORROWED ($)? 3000
            INTEREST CHARGED (%)? 8
            INTERVAL BETWEEN PAYMENTS (MONTHS)? 1
            TERM OF THE LOAN (YEARS)? 2

DO YOU WISH TO SEE THE TOTALS ONLY - INSTEAD OF THE ENTIRE
TABLE - (1-YES, 0-NO)? 0
```

PERIOD	OUTSTANDING PRINCIPAL AT BEGINNING OF PERIOD	INTEREST DUE AT END OF PERIOD	PRINCIPAL REPAID AT END OF PERIOD
1	3000	20	115.68
2	2884.32	19.23	116.45
3	2767.87	18.45	117.23
4	2650.64	17.67	118.01
5	2532.63	16.88	118.8
6	2413.83	16.09	119.59
7	2294.24	15.29	120.39
8	2173.85	14.49	121.19
9	2052.66	13.68	122
10	1930.66	12.87	122.81
11	1807.85	12.05	123.63
12	1684.22	11.23	124.45
13	1559.77	10.4	125.28
14	1434.49	9.56	126.12
15	1308.37	8.72	126.96
16	1181.41	7.88	127.8
17	1053.61	7.02	128.66
18	924.95	6.17	129.51
19	795.44	5.3	130.38
20	665.06	4.43	131.25
21	533.81	3.56	132.12
22	401.69	2.68	133
23	268.69	1.79	133.89
24	134.8	.9	134.78
TOTALS		256.34	3000

```
YOUR MONTHLY PAYMENT IS $ 135.68  AND TOTALS $ 3256.34
```

```
*****

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)? 1
WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)? 3

*****

THIS SECTION CALCULATES THE BALANCE OF A SAVINGS ACCOUNT
IN WHICH DEPOSITS ARE MADE REGULARLY.

WHAT IS THE AMOUNT DEPOSITED PER INTEREST PERIOD ($)? 10000
HOW OFTEN IS THE INTEREST COMPOUNDED (MONTHS,? 3
WHAT IS THE RATE OF INTEREST PAID (%)? 5
FOR HOW LONG WILL YOU DEPOSIT MONEY (YEARS)? 5


THE BALANCE OF YOUR ACCOUNT AFTER  5 YEARS WILL BE $ 202500


*****

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)? 0

READY
```

```
100 REM FINANCIAL PROBLEMS   A. WEBB  12/67
101 REM REVISED 8/25/70 (D. PESSEL)
110 PRINT TAB(20);"FINANCIAL PROBLEMS"
115 REM REVISED BY W. TEPPER,  WYANDANCH H.S.   7/10/69
120 PRINT
130 PRINT"THIS PROGRAM SOLVES THREE TYPES OF PROBLEMS:"
132 PRINT
134 PRINT"     (1) INTEREST ON INSTALLMENT BUYING"
136 PRINT"     (2) PAYMENTS ON LONG TERM LOAN"
138 PRINT"     (3) BALANCE OF A SAVINGS ACCOUNT"
140 PRINT
142 PRINT"WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)";
144 INPUT Q1
146 PRINT
147 PRINT"*****"
148 PRINT
150 IF Q1>2 THEN 820
155 IF Q1>1 THEN 260
160 GO TO 590
260PRINT "THIS SECTION WILL DETERMINE PAYMENTS FOR A LONG TERM LOAN."
270 PRINT
280 PRINT"WHAT IS THE AMOUNT BORROWED ($)";
281 INPUT A
285 PRINT"            INTEREST CHARGED (%)";
286 INPUT I
290 PRINT"            INTERVAL BETWEEN PAYMENTS (MONTHS)";
291 INPUT P
295 PRINT"            TERM OF THE LOAN (YEARS)";
296 INPUT Y
300 PRINT
360 PRINT"DO YOU WISH TO SEE THE TOTALS ONLY - INSTEAD OF THE ENTIRE"
361 PRINT"TABLE - (1-YES, 0-NO)";
362 INPUT P5
370 PRINT
375 IF P5>0 THEN 430
380 PRINT"          OUTSTANDING"
390 PRINT"          PRINCIPAL AT                          PRINCIPAL"
400 PRINT"          BEGINNING       INTEREST DUE AT       REPAID AT"
410 PRINT"PERIOD    OF PERIOD       END OF PERIOD         END OF PERIOD"
420 PRINT
430 LET Z=(Y*12)/P
440 LET K=(I*(P/12))/100
445 LET E=A*K/(1-1/(1+K)^Z)
446 LET E=INT(E*100+.5)/100
450 LET C=A
460 LET F=0
461 LET D1=0
470 LET T1=0
480 LET T1=T1+1
490 IF T1>Z THEN 554
500 LET B=T1
510 LET C=C-F
520 LET D=C*K
522 LET F=E-D
525 LET C=INT(C*100+.5)/100
530 LET D=INT(D*100+.5)/100
535 LET F=INT(F*100+.5)/100
541 LET D1=D1+D
548 IF P5>0 THEN 480
550 PRINT B;TAB(11);C;TAB(29);D;TAB(48);F
```


161

```
552 GO TO 480
554 IF P5<1 THEN 561
555 PRINT
556 LET D1=INT(D1*100+.5)/100
558 PRINT"TOTAL INTEREST PAID - $"D1
559 PRINT"TOTAOL PRINCIPAL REPAID - $"A
560 GO TO 565
561 PRINT"                                        ---------------          -------------"
564 PRINT"TOTALS";TAB(29);D1;TAB(48);A
565 LET E5=INT((D1+A)*100+.5)/100
566 PRINT
567 LET E6=E5/((Y*12)/P)
568 LET E6=INT(100*E6+.5)/100
569 PRINT"YOUR MONTHLY PAYMENT IS $"E6" AND TOTALS $"E5
570 GO TO 1060
590 PRINT"THIS SECTION WILL DETERMINE THE ACTUAL INTEREST YOU PAY"
600 PRINT"WHEN YOU PURCHASE SOMETHING ON CREDIT."
610 PRINT
620 PRINT"WHAT IS THE CASH PRICE OF THE ARTICLE ($)";
621 INPUT C
630 PRINT"                DOWN PAYMENT ($)";
631 INPUT D
640 PRINT"                NUMBER OF PAYMENTS EXCLUDING THE DOWN PAYMENT";
641 INPUT N
650 PRINT"                NUMBER OF PAYMENTS PER MONTH";
651 INPUT S
660 PRINT"                AMOUNT PER PAYMENT ($)";
661 INPUT R
690 PRINT
720 LET B=R*N+D
730 LET I=B-C
740 LET M=N/(S*12)
750 LET T=I*100/(B*M)
760 PRINT
770 PRINT
775 LET T=INT(100*T+.5)/100
780PRINT "THE RATE OF INTEREST CHARGED WAS"T" PERCENT."
790 GO TO 1060
820 PRINT"THIS SECTION CALCULATES THE BALANCE OF A SAVINGS ACCOUNT"
830 PRINT"IN WHICH DEPOSITS ARE MADE REGULARLY."
840 PRINT
860 PRINT"WHAT IS THE AMOUNT DEPOSITED PER INTEREST PERIOD ($)";
861 INPUT A
870 PRINT"HOW OFTEN IS THE INTEREST COMPOUNDED (MONTHS)";
871 INPUT B
880 PRINT"WHAT IS THE RATE OF INTEREST PAID (%)";
881 INPUT C
890 PRINT"FOR HOW LONG WILL YOU DEPOSIT MONEY (YEARS)";
891 INPUT D
950 LET F=0
960 LET E=(C/100)/(12/B)
970 LET G=(12/B)*D
980 LET T1=0
990 LET T1=T1+1
1000 IF T1=G+1 THEN 1030
1010 LET F=(E*A)+(A+F)
1020 GO TO 990
1030 PRINT
1040 PRINT
1045 LET F=INT(100*F+.5)/100
1050 PRINT"THE BALANCE OF YOUR ACCOUNT AFTER "D"YEARS WILL BE $"F
1060 PRINT
1070 PRINT
1080 PRINT
1081 PRINT"*****"
1082 PRINT
1084 PRINT"WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)";
1086 INPUT Q4
1090 IF Q4>0 THEN 142
1100 END
```

DISCIPLINE CALCULUS-GRADE 13

SUBJECT LENGTH OF ANY CURVE

PROGRAM NAME CRVLEN

DESCRIPTION:

This program approximates the length of any curve between two fixed points on the curve, by taking an increasing number of subintervals and computing the sum of the secants involved.

OBJECTIVES:

A. Time saving factor for computations.

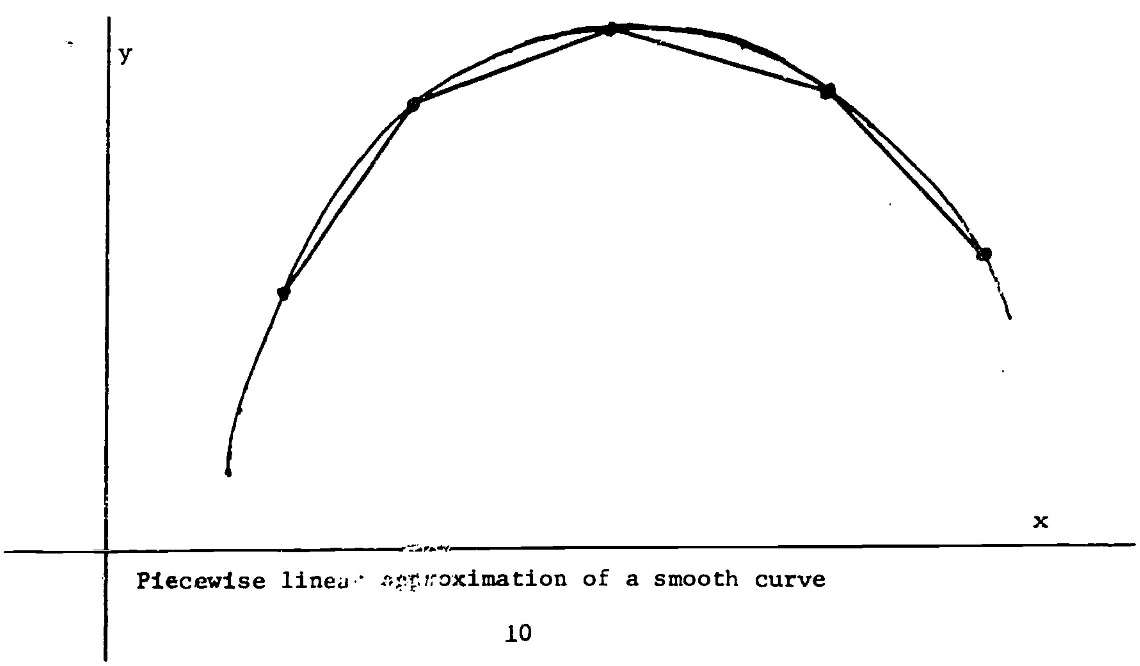
B. By typing out successive approximations, the machine displays the manner by which the limit is approached.

C. The attendant discussion focuses attention upon the techniques needed to build up the analytic method for finding the length of a curve.

PRELIMINARY PREPARATION: None

DISCUSSION:

The operator inserts any function, sets up his own limits, and the computer proceeds to print out several approximations to the actual length a diagram (such as below) should be displayed, indicating the geometric basis for the computations.



Piecewise linear approximation of a smooth curve

LENGTH OF A CURVE

THIS PROGRAM APPROXIMATES THE LENGTH OF ANY CURVE BETWEEN TWO POINTS HAVING P AND Q AS THEIR RESPECTIVE ABSCISSAS. THE PROGRAM DIVIDES THE CURVE INTO INCREASING NUMBERS OF SUBINTERVALS, JOINS THESE WITH SECANTS AND FINDS THE SUM OF THESE SECANTS.

TO INPUT THE FUNCTION WHICH YOUR CURVE REPRESENTS, TYPE AS FOLLOWS AFTER THE PROGRAM STOPS:
(TYPE THE 'RETURN' KEY AFTER EACH LINE INCLUDING 'RUN')

```
1 GO TO 200
300 DEF FNY(X)=....(YOUR FUNCTION OF X)....
RUN
```

FOR EXAMPLE, TO USE THE FUNCTION 2*X↑3+3*X↑2-2*X+3
YOU WOULD TYPE:

```
1 GO TO 200
300 DEF FNY(X)=2*X↑3+3*X↑2-2*X+3
RUN
```

YOU MIGHT TRY THAT AS YOUR FIRST RUN.

```
READY

1 GO TO 200
300 DEF FNY(X)=2*X↑3+3*X↑2-2*X+3
RUN
```

WHAT ARE THE ABSCISSAS OF THE END POINTS OF THE INTERVAL WHOSE LENGTH YOU WANT (SMALLER ONE FIRST:P,Q)? -1,6

NUMBER OF SUBINTERVALS	SUM OF SECANT LENGTHS	% CHANGE IN LENGTH
1	525.0467	NO PREVIOUS VALUE
2	525.1553	.02185142
4	529.6522	.8557383
8	531.0171	.2576957
16	531.9648	.1783583
32	532.0166	9.834262E-3
64	532.0416	4.713729E-3
128	532.0485	1.287718E-3
256	532.0501	3.068687E-4

*****

WOULD YOU LIKE TO TRY NEW END POINTS (1-YES, 0-NO)? 0

TO TRY ANOTHER FUNCTION, RETYPE LINE 300, AND 'RUN'. SEE INSTRUCTIONS FOR MORE DETAILS. IF YOU ARE FINISHED, TYPE '1' AND 'RETURN' KEY AFTER THE PROGRAM STOPS.

READY

1

```
100 REM LENGTH OF A CURVE-G.J. O'CONNOR 7-29-68
101 REM REVISED 8-7-70 (D. PESSEL) (COMBINATION OF LECUQ & LEFUQ)
103 REM IMPORTANT VARIABLES: S-SECANT LENGTH; S1-PREVIOUS SECANT
104 REM LENGTH; P-PERCENT CHANGE IN SECANT LENGTH
110 PRINT TAB(20); "LENGTH OF A CURVE"
111 PRINT
120 PRINT "THIS PROGRAM APPROXIMATES THE LENGTH OF ANY CURVE BETWEEN"
121 PRINT "TWO POINTS HAVING P AND Q AS THEIR RESPECTIVE ABSCISSAS."
122 PRINT "THE PROGRAM DIVIDES THE CURVE INTO INCREASING NUMBERS OF"
123 PRINT "SUBINTERVALS, JOINS THESE WITH SECANTS AND FINDS THE SUM"
124 PRINT "OF THESE SECANTS."
125 PRINT
126 PRINT "TO INPUT THE FUNCTION WHICH YOUR CURVE REPRESENTS, TYPE AS"
127 PRINT "FOLLOWS AFTER THE PROGRAM STOPS:"
128 PRINT "(TYPE THE 'RETURN' KEY AFTER EACH LINE INCLUDING 'RUN')"
129 PRINT
130 PRINT "           1 GO TO 200"
131 PRINT "           300 DEF FNY(X)=....(YOUR FUNCTION OF X)...."
132 PRINT "           RUN"
133 PRINT
134 PRINT "FOR EXAMPLE, TO USE THE FUNCTION 2*X↑3+3*X↑2-2*X+3"
135 PRINT "YOU WOULD TYPE:"
136 PRINT
137 PRINT "           1 GO TO 200"
138 PRINT "           300 DEF FNY(X)=2*X↑3+3*X↑2-2*X+3"
139 PRINT "           RUN"
140 PRINT
141 PRINT "YOU MIGHT TRY THAT AS YOUR FIRST RUN."
150 STOP
200 REM CALCULATION AND PRINTING IF RESULTS
205 PRINT "WHAT ARE THE ABSCISSAS OF THE END POINTS OF THE INTERVAL"
206 PRINT "WHOSE LENGTH YOU WANT (SMALLER ONE FIRST:P,Q)";
207 INPUT P,Q
208 IF P<Q THEN 213
209 PRINT "P MUST BE LESS THAN Q!"
210 GO TO 207
212 INPUT P,Q
213 PRINT
214 PRINT " NUMBER OF"," SUM OF"
215 PRINT "SUBINTERVALS","SECANT LENGTHS","  % CHANGE IN LENGTH"
216 PRINT "------------","--------------","  ------------------"
217 PRINT
230 LET S1=0
250 FOR N=1 TO 9
300 DEF FNY(X)=2*X↑3+3*X↑2-2*X+3
310 LET E=2↑(N-1)
320 LET H=(Q-P)/E
330 LET S=0
340 FOR I=0 TO E-1
350 LET L=SQR((FNY(P+I*H+H)-FNY(P+I*H))↑2+H*H)
360 LET S=S+L
370 NEXT I
372 IF S1#0 THEN 375
373 PRINT E,S,"  NO PREVIOUS VALUE"
374 GO TO 385
375 LET P5=((ABS(S1-S))/S1)*100
380 PRINT E,S,"  "P5
385 LET S1=S
390 NEXT N
400 PRINT
401 PRINT "*****"
402 PRINT
403 PRINT "WOULD YOU LIKE TO TRY NEW END POINTS (1-YES, 0-NO)";
404 INPUT Q1
405 IF Q1>0 THEN 210
410 PRINT
445 PRINT "TO TRY ANOTHER FUNCTION, RETYPE LINE 300, AND 'RUN'."
446 PRINT "SEE INSTRUCTIONS FOR MORE DETAILS.  IF YOU ARE FINISHED,"
447 PRINT "TYPE '1' AND 'RETURN' KEY AFTER THE PROGRAM STOPS."
500 END
```

DISCIPLINE CALCULUS - GRADE 13

SUBJECT AREA UNDER ANY CURVE, (ANALYTICALLY DEFINED)

PROGRAM NAME CVAREA

DESCRIPTION:

By numerical methods, this program evaluates the definite integral of f(x), from x = a to x = b, by four different methods of successive approximation:

I Rectangles (starting with f(a) as height)

II Rectangles (starting with f(a+h) as height)

III Trapezoids

IV Parabolas (Simpson's Rule)

OBJECTIVES:

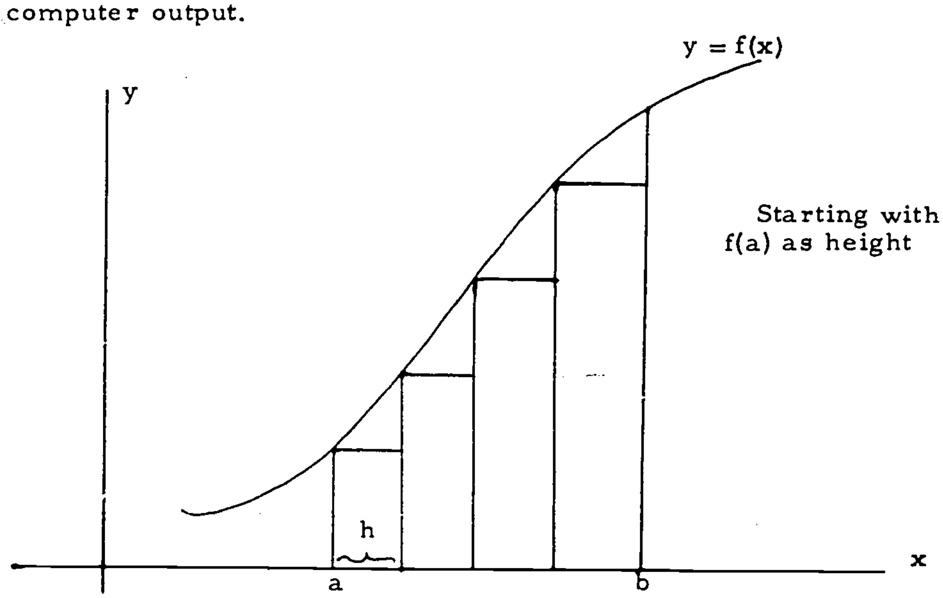
A. Enhances comprehension of the analytic procedures for finding the area under a curve.

B. Dramatizes the limiting processes involved.

C. Decreases the time needed for lengthy computations.

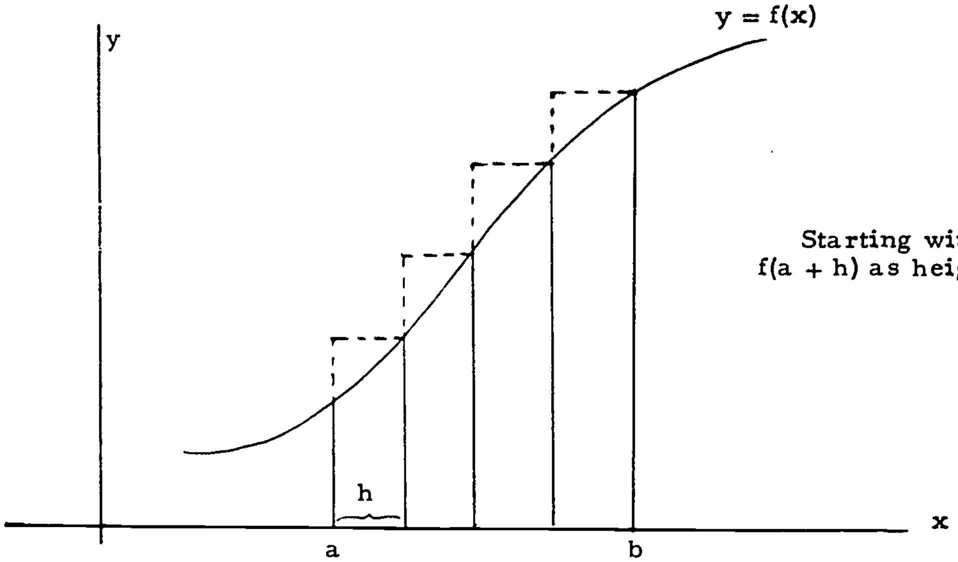
PRELIMINARY PREPARATION:

Prior to the computer run, diagrams should appear on the board, or on the overhead projector screen to demonstrate the geometric significance of the computer output.



Inscribed Rectangular Approximation

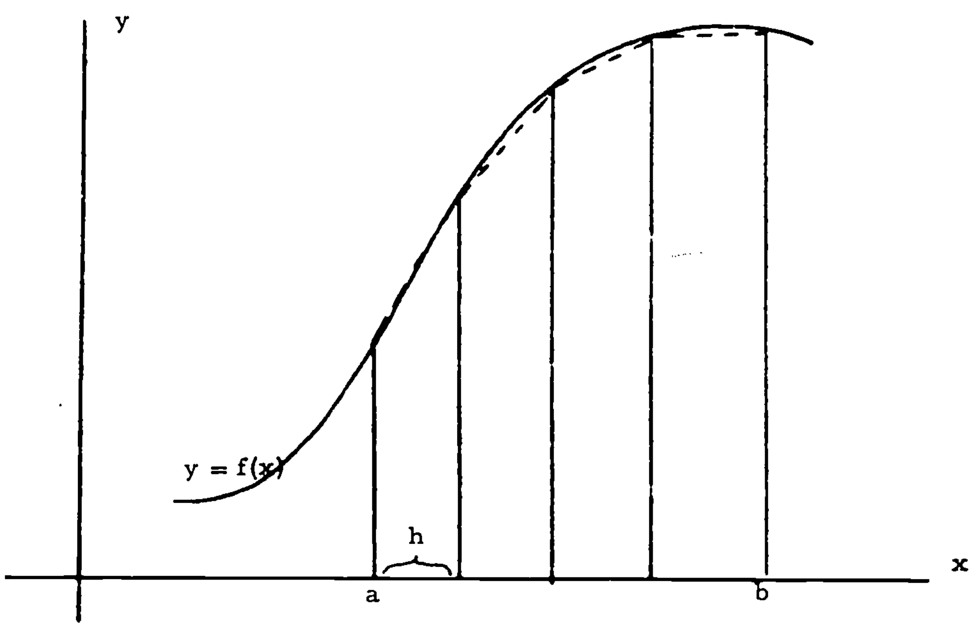
Mathematics
CVAREA



Circumscribed Rectangular Approximation

DISCUSSION:

This program may be run as an introduction to the problem of finding the area under a curve. In some classes, the consideration of Simpson's Rule may be omitted or briefly hinted at. With the more mathematically talented classes, an explanation of this parabolic approximation should precede the running of the program.



Trapezoid Approximation

AREA UNDER A CURVE - INTEGRATION

```
     THIS PROGRAM EVALUATES THE DEFINITE INTEGRAL OF F(X)
FROM X=A TO X=B BY FOUR METHODS OF NUMERICAL APPROXIMATION:

                     I RECTANGLES (INITIAL HEIGHT OF F(X))
                    II RECTANGLES (INITIAL HEIGHT OF F(X+H))
                   III TRAPEZOIDS
                    IV PARABOLAS (SIMPSON'S RULE)

AFTER THE PROGRAM STOPS, YOU MAY ENTER YOUR FUNCTION AS FOLLOWS:

             1 GO TO 200
             300 DEF FNY(X)=...(YOUR FUNCTION OF X)...
             RUN

FOR EXAMPLE, TO FIND THE AREA UNDER THE CURVE Y=X↑3 YOU
WOULD TYPE:

             1 GO TO 200
             300 DEF FNY(X)=X↑3
             RUN

YOU MIGHT TRY THAT AS YOUR FIRST RUN.
END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY.


READY

1 GO TO 200
300 DEF FNY(X)=X↑3
RUN

WHAT ARE YOUR VALUES FOR A AND B (SMALLER FIRST:A,B)? 1,10
```

NUMBER OF SUBINTERVALS	I. SUM OF RECTANGLES	II. SUM OF RECTANGLES	III. SUM OF TRAPEZOIDS	IV. SUM OF PARABOLAS
2	753.1875	5248.687	3000.937	2499.75
4	1501.172	3748.922	2625.047	2499.75
8	1969.137	3093.012	2531.074	2499.75
16	2226.612	2788.55	2507.581	2499.75
32	2361.223	2642.192	2501.708	2499.75
64	2429.997	2570.481	2500.239	2499.75

```
NOTE THAT SIMPSON'S RULE (IV) CONVERGES FASTEST.

WOULD YOU LIKE TO TRY NEW VALUES FOR A AND B (1-YES, 0-NO)? 0

*****

TO USE A NEW FUNCTION YOU NEED ONLY RETYPE LINE 300
AND 'RUN'.  SEE INSTRUCTIONS FOR MORE DETAILS.
IF YOU ARE FINISHED, TYPE '1' AND THE 'RETURN' KEY.


READY

1
```

```
100 REM AREA UNDER A CURVE-Q.J. O'CONNOR
101 REM REVISED 8/18/70 (D. PESSEL) (COMBINATION OF DEFIN AND ACCUQ)
102 REM IMPORTANT VARIABLES: D-# OF SUBINTERVALS; AREA BY
103 REM RECTANGLES (F(X))-P, BY RECTANGLES (F(X+H))-Q,
104 REM BY TRAPEZOIDS-T, BY PARABOLAS-S; C-STORES PREVIOUS
105 REM VALUE OF S.
110 PRINT TAB(15); "AREA UNDER A CURVE - INTEGRATION"
111 PRINT
112 PRINT "     THIS PROGRAM EVALUATES THE DEFINITE INTEGRAL OF F(X)"
113 PRINT "FROM X=A TO X=B BY FOUR METHODS OF NUMERICAL APPROXIMATION:"
114 PRINT
115 PRINT TAB(20); "I RECTANGLES (INITIAL HEIGHT OF F(X))"
116 PRINT TAB(19); "II RECTANGLES (INITIAL HEIGHT OF F(X+H))"
117 PRINT TAB(18); "III TRAPEZOIDS"
118 PRINT TAB(19); "IV PARABOLAS (SIMPSON'S RULE)"
119 PRINT
120 PRINT "AFTER THE PROGRAM STOPS, YOU MAY ENTER YOUR FUNCTION AS";
121 PRINT " FOLLOWS:"
122 PRINT
123 PRINT TAB(13); "1 GO TO 200"
124 PRINT TAB(13); "300 DEF FNY(X)=...(YOUR FUNCTION OF X)..."
125 PRINT TAB(13); "RUN"
126 PRINT
127 PRINT "FOR EXAMPLE, TO FIND THE AREA UNDER THE CURVE Y=X↑3 YOU"
128 PRINT "WOULD TYPE:"
129 PRINT
130 PRINT TAB(13);"1 GO TO 200"
131 PRINT TAB(13);"300 DEF FNY(X)=X↑3"
132 PRINT TAB(13);"RUN"
133 PRINT
134 PRINT "YOU MIGHT TRY THAT AS YOUR FIRST RUN."
135 PRINT "END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY."
150 STOP
200 PRINT "WHAT ARE YOUR VALUES FOR A AND B (SMALLER FIRST:A,B)";
201 INPUT A,B
203 IF B>=A THEN 210
204 PRINT "A MUST BE LESS THAN B!"
205 GO TO 200
210 PRINT
211 PRINT " NUMBER OF","I. SUM OF","II. SUM OF","III. SUM OF",
212 PRINT "IV. SUM OF"
213 PRINT "SUBINTERVALS","RECTANGLES","RECTANGLES","TRAPEZOIDS",
214 PRINT "PARABOLAS"
218 PRINT "------------","----------","----------","-----------",
219 PRINT "----------"
250 LET M=-2
260 LET S=0
300 DEF FNY(X)=X↑3
310 LET M=M+3
320 FOR N=M TO M+2
330 LET C=S
340 LET Q=0
350 LET P=0
360 LET D=2↑N
```

```
365 PRINT D,
370 LET H=(B-A)/D
380 FOR I=0 TO (D-1)
390 LET P=P+H*FNY(A+I*H)
400 LET Q=Q+H*FNY(A+I*H+H)
410 NEXT I
415 PRINT P,Q,
420 LET T=(P+Q)/2
425 PRINT T,
430 LET U=FNY(A)+FNY(B)
440 FOR J=2 TO (D-2) STEP 2
450 LET U=U+2*FNY(A+J*H)
460 NEXT J
470 LET V=0
480 FOR K=1 TO (D-1) STEP 2
490 LET V=V+4*FNY(A+K*H)
500 NEXT K
510 LET S=(U+V)*(H/3)
520 PRINT S
530 NEXT N
535 IF D<64 THEN 310
540 IF ABS((C-S)/((C+S)/2))>.0001 THEN 310
550 PRINT
560 PRINT "NOTE THAT SIMPSON'S RULE (IV) CONVERGES FASTEST."
600 PRINT
610 PRINT "WOULD YOU LIKE TO TRY NEW VALUES FOR A AND B (1-YES, 0-NO)";
611 INPUT Q5
612 PRINT
613 PRINT "*****"
614 PRINT
615 IF Q5>0 THEN 200
620 PRINT "TO USE A NEW FUNCTION YOU NEED ONLY RETYPE LINE 300"
621 PRINT "AND 'RUN'.  SEE INSTRUCTIONS FOR MORE DETAILS."
622 PRINT "IF YOU ARE FINISHED, TYPE '1' AND THE 'RETURN' KEY."
650 END
```

DISCIPLINE MATHEMATICS, JR. HIGH

GENERAL MATH

SUBJECT GREATEST COMMON DIVISOR

PROGRAM NAME GCD

DESCRIPTION:

This program finds the greatest common divisor for two or more numbers.

OBJECTIVES:

To aid the teacher in demonstrating a method of finding the greatest common divisor.

PRELIMINARY PREPARATION:

See discussion.

DISCUSSION:

It is suggested that the teacher explain the meaning of the greatest common divisor prior to using this program, and show a number of examples.

By using the flow chart which follows, the method and logic the computer uses, can be explained to students. It is suggested that a supplementary device be used to display output to class-size groups.

174

```
THIS PROGRAM WILL FIND THE GREATEST COMMON DIVISOR
FOR TWO OR MORE NUMBERS.
HOW MANY NUMBERS DO YOU WISH TO INVESTIGATE? 3
TYPE IN THE NUMBERS, ONE AFTER EACH QUESTION MARK.
? 12
? 36
? 96
THE NUMBERS 12  36  96 HAVE THE G.C.D.  12

ANOTHER SET OF NUMBERS (1=YES, 0=NO) ? 1
HOW MANY NUMBERS DO YOU WISH TO INVESTIGATE? 3
TYPE IN THE NUMBERS, ONE AFTER EACH QUESTION MARK.
? 20
? 36
? 96
THE NUMBERS 20  36  96 HAVE THE G.C.D.  4

ANOTHER SET OF NUMBERS (1=YES, 0=NO) ? 1
HOW MANY NUMBERS DO YOU WISH TO INVESTIGATE? 3
TYPE IN THE NUMBERS, ONE AFTER EACH QUESTION MARK.
? 20
? 36
? 97
THE NUMBERS 20  36  97 ARE RELATIVELY PRIME.

ANOTHER SET OF NUMBERS (1=YES, 0=NO) ? 0

READY
```

```
100 REM W. TEPPER  WYANDANCH H.S.   -   MATHEMATICS
110 REM  REVISED BY C.LOSIK  8-10-70
111 REM  X(I) ARE THE NUMBERS (UP TO 100)
120 PRINT "THIS PROGRAM WILL FIND THE GREATEST COMMON DIVISOR"
130 PRINT "FOR TWO OR MORE NUMBERS."
140 DIM X(100)
150 PRINT "HOW MANY NUMBERS DO YOU WISH TO INVESTIGATE";
160 INPUT N
165 IF ABS(N-INT(N))<.0001 THEN 170
166 PRINT "TRY AGAIN."
167 GO TO 150
170 PRINT "TYPE IN THE NUMBERS, ONE AFTER EACH QUESTION MARK."
175 LET S=1E25
180 FOR K=1 TO N
190 INPUT X(K)
193 IF X(K)>S THEN 210
200 LET S=X(K)
210 NEXT K
220 LET G=0
230 FOR M=2 TO S
240 FOR I=1 TO N
250 IF X(I)/M<>INT(X(I)/M) THEN 300
260 NEXT I
290 LET G=M
300 NEXT M
310 PRINT "THE NUMBERS";
320 FOR T=1 TO N
330 PRINT X(T);
340 NEXT T
350 IF G>0 THEN 380
360 PRINT "ARE RELATIVELY PRIME."
370 GO TO 390
380 PRINT "HAVE THE G.C.D. ";G
390 PRINT
400 PRINT
410 PRINT "ANOTHER SET OF NUMBERS (1=YES, 0=NO) ";
420 INPUT Z
430 IF Z=1 THEN 150
440 IF Z=0 THEN 470
450 PRINT "TYPE 1 OR 0 AS DIRECTED."
460 GO TO 420
470 END
```

DISCIPLINE CALCULUS - GRADE 13

SUBJECT LIMIT OF $\frac{\sin x}{x}$

PROGRAM NAME LIMSIN

DESCRIPTION:

This program demonstrates that the limit of $\frac{\sin x}{x}$, as x approaches 0, equals 1, provided x is measured in radians. If x is measured in degrees, the limit equals approximately .017.

OBJECTIVES:

A. To demonstrate the manner by which the limit of $\frac{\sin x}{x}$ is approached.

B. To show that degree measure does not yield the same solution as radian measure.

PRELIMINARY PREPARATION:

A. Student

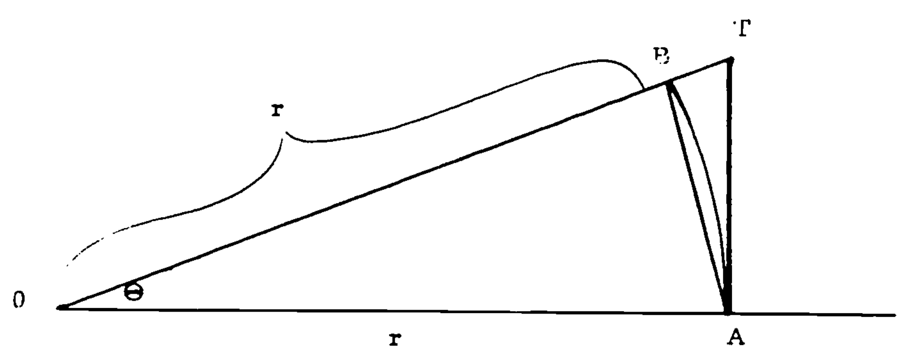
Knowledge of degree vs. radian measure.

B. Materials

None

DISCUSSION:

Following the computer type-out, the teacher will use the analytic method to evaluate the limit. Prior to this discussion, the student should be reminded of the area formulas for a triangle and for a sector in terms of the central angle measured in radians. A geometric diagram should be presented showing the sector lying between two triangles.



Here, $\frac{1}{2}r^2 \sin \Theta \leq \frac{1}{2}r^2\Theta \leq \frac{1}{2}r^2\tan \Theta$

Circular Sector with Circumscribed and Inscribed Triangles

The teacher can modify the type-out by inserting: 195 Go to 300. This decreases the number of lines typed out to the final eleven appearing on the program "run".

THIS PROGRAM DEMONSTRATES THAT THE LIMIT OF F(X) = (SIN X)/X, AS X APPROACHES 0, IS EQUAL TO 1, PROVIDED X IS MEASURED IN RADIANS.

```
          SIN(X)
LIMIT     ------   =   1
X-->0       X
```

WHEN X IS IN DEGREES,		WHEN X IS IN RADIANS,	
X IS	F(X) IS	X IS	F(X) IS
90	.01111111	1.570795	.6366203
85	.01171994	1.483529	.6715035
80	.01231009	1.396262	.705317
75	.01287901	1.308996	.7379134
70	.01342418	1.221729	.7691492
65	.01394319	1.134463	.7988866
60	.01443375	1.047197	.8269936
55	.01489367	.9599303	.8533449
50	.01532088	.8726639	.8778225
45	.01571347	.7853975	.9003165
40	.01606968	.6981311	.9207256
35	.01638789	.6108647	.9389575
30	.01666665	.5235983	.9549297
25	.01690472	.4363319	.9685698
20	.01710099	.3490656	.9798156
15	.01725459	.2617992	.988616
10	.0173648	.1745328	.9949308
5	.01743113	.08726639	.9987313
1	.01745239	.01745328	.9999492
.9	.01745256	.01570795	.9999589
.8	.01745271	.01396262	.9999675
.7	.01745284	.01221729	.9999751
.6	.01745296	.01047197	.9999817
.5	.01745306	8.726639E-3	.9999873
.4	.01745314	6.981312E-3	.9999919
.3	.0174532	5.235984E-3	.9999954
.2	.01745324	3.490656E-3	.999998
.1	.01745327	1.745328E-3	.9999995
.09	.01745327	1.570795E-3	.9999996
.08	.01745327	1.396262E-3	.9999997
.07	.01745327	1.221729E-3	.9999998
.06	.01745327	1.047197E-3	.9999998
.05	.01745328	8.726639E-4	.9999999
.04	.01745328	6.981311E-4	.9999999
.03	.01745328	5.235984E-4	1
.02	.01745328	3.490656E-4	1
.01	.01745328	1.745328E-4	1

READY

```
100 REM  BRUCE BRENT   HHHH   BKLYN POLY   7/11/69
105 REM  REVISED BY C.LOSIK   8-27-70
110 PRINT "     THIS PROGRAM DEMONSTRATES THAT THE LIMIT OF"
115 PRINT "F(X) = (SIN X)/X,  AS X APPROACHES O, IS EQUAL TO 1,"
117 PRINT "PROVIDED X IS MEASURED IN RADIANS."
120 PRINT
125 PRINT " ","        SIN(X)"
130 PRINT " ","LIMIT  ------  =  1"
135 PRINT " ","X-->0     X"
140 PRINT
150 PRINT
160 PRINT "WHEN X IS IN DEGREES,","WHEN X IS IN RADIANS,"
165 PRINT "--------------------","--------------------"
170 PRINT "X IS","F(X) IS","X IS","F(X) IS"
175 PRINT "----","-------","----","-------"
180 PRINT
200 FOR Y=90 TO 5 STEP -5
210 LET Z=Y
220 LET Z=3.14159*Z/180
230 LET X=SIN(Z)/Z
240 LET Q=SIN(Z)/Y
250 PRINT Y,Q,Z,X
260 NEXT Y
270 PRINT
300 FOR Y=1 TO .1 STEP -.1
310 LET Z=Y
320 LET Z=3.14159*Z/180
330 LET X=SIN(Z)/Z
340 LET Q=SIN(Z)/Y
350 PRINT Y,Q,Z,X
360 NEXT Y
370 PRINT
400 FOR Y=.09 TO .01 STEP -.01
410 LET Z=Y
420 LET Z=3.14159*Z/180
430 LET X=SIN(Z)/Z
440 LET Q=SIN(Z)/Y
450 PRINT Y,Q,Z,X
460 NEXT Y
500 END
```

DISCIPLINE MATHEMATICS 10th YEAR
GEOMETRY

SUBJECT AREA OF A CIRCLE

PROGRAM NAME PI2

DESCRIPTION:

This program computes the area of a circle and "pi" by using the areas of inscribed and circumscribed regular polygons.

OBJECTIVES:

As an introduction to the limit process and a method for approximating "pi".

PRELIMINARY PREPARATION:

A. Student - Students must know how to calculate the area of a circle and a triangle using the formulas: $A = \pi R^2$ and $A = \frac{1}{2}bh$.

B. Materials - chalkboard, board compass, and straight edge.

DISCUSSION:

Ask students to find the area of a circle without using the formula. The instructor may suggest to the class to inscribe and/or circumscribe an equilateral triangle. Have students compare the area of their figures to that of the circle. Some students will suggest to increase the number of sides and the instructor should suggest that a regular hexagon be used for convenience of drawing. This can be illustrated on the chalkboard for the class. Another comparison is made between the areas and then the students will observe that to obtain any satisfactory results, the number of sides must increase greatly. At this moment the instructor should introduce this program and explain to the class that the program will increase the number of sides of a regular polygon and compute the area of each new figure. A table is printed giving the areas of both inscribed and circumscribed regular polygons and also the number of sides for each area. The students can readily see that the machine has eliminated the tedious calculations. Now, have the students calculate the area of the circle using the formula and make a comparison of results; thus, the students can observe that the areas of the polygons approach the area of the circle.

DISCUSSION: (con't)

If students had taken a unit circle, they would have observed a method for approximating "pi".

Due to machine operation, the value of "pi" was used to convert degrees into radians. To avoid any circular reasoning, the instructor can use half-angle formulas to eliminate "pi" from this program.

AREA OF A CIRCLE USING INSCRIBED AND CIRCUMSCRIBED REGULAR POLYGONS

*****

WHAT IS THE RADIUS OF THE CIRCLE? 10

INSCRIBED AREA	CIRCUMSCRIBED AREA	NUMBER OF SIDES	INSCRIBED % ERROR	CIRCUMSCRIBED % ERROR
129.9039	519.6148	3	-58.65	65.4
259.8076	346.4098	6	-17.3	10.27
299.9[illegible]8	321.5387	12	-4.51	2.35

HOW MANY SIDES DO YOU THINK ARE NEEDED TO APPROXIMATE
THE AREA OF THIS CIRCLE? 100

313.9523	314.2624	100	-.07	.03

WOULD YOU LIKE TO TRY ANOTHER NUMBER OF SIDES (1-YES, 0-NO)? 1
HOW MANY SIDES DO YOU THINK ARE NEEDED TO APPROXIMATE
THE AREA OF THIS CIRCLE? 1E6
THAT MANY SIDES IS VALID, BUT NOT NECESSARY FOR A
GOOD APPROXIMATION. USE 10000 AS THE MAXIMUM NUMBER.
HOW MANY SIDES DO YOU THINK ARE NEEDED TO APPROXIMATE
THE AREA OF THIS CIRCLE? 10000

314.159	31[illegible]9	10000	0	0

WOULD YOU LIKE TO TRY ANOTHER NUMBER OF SIDES (1-YES, 0-NO)? 0
WOULD YOU LIKE TO TRY ANOTHER RADIUS (1-YES, 0-NO)? 1

*****

WHAT IS THE RADIUS OF THE CIRCLE? 1000000
ANY RADIUS WILL WORK, BUT USE A NUMBER LESS THAN 1000.
WHAT IS THE RADIUS OF THE CIRCLE? 999

INSCRIBED AREA	CIRCUMSCRIBED AREA	NUMBER OF SIDES	INSCRIBED % ERROR	CIRCUMSCRIBED % ERROR
1.296442E+6	5.185764E+6	3	-58.65	65.4
2.592881E+6	3.457173E+6	6	-17.3	10.27
2.994001E+6	3.208960E+6	12	-4.51	2.35

HOW MANY SIDES DO YOU THINK ARE NEEDED TO APPROXIMATE
THE AREA OF THIS CIRCLE? 10000

3.135310E+6	3.135310E+6	10000	0	0

WOULD YOU LIKE TO TRY ANOTHER NUMBER OF SIDES (1-YES, 0-NO)? 0
WOULD YOU LIKE TO TRY ANOTHER RADIUS (1-YES, 0-NO)? 0

*****

READY

```
100 REM ILLUSTRATION OF LIMITS USING CIRCLES AND POLYGONS
101 REM REVISED 8/3/70 (D. PESSEL)
105 REM IMPORTANT VARIABLES: A1-INSCRIBED AREA; A2-CIRCUMSCRIBED
106 REM AREA; A3-ACTUAL AREA; P1-% ERROR OF A1; P2-% ERROR OF A2
110 PRINT "AREA OF A CIRCLE USING INSCRIBED AND CIRCUMSCRIBED ";
111 PRINT "REGULAR POLYGONS"
112 PRINT
115 PRINT "*****"
116 PRINT
120 PRINT "WHAT IS THE RADIUS OF THE CIRCLE";
125 INPUT R
127 IF R<1000 THEN 131
128 PRINT "ANY RADIUS WILL WORK, BUT USE A NUMBER LESS THAN 1000."
129 GO TO 120
130 INPUT R
131 IF R>=.1 THEN 134
132 PRINT "RADIUS SHOULD BE AT LEAST .1!!"
133 GO TO 120
134 LET A3=3.1416*R*R
135 PRINT
136 PRINT
140 PRINT "INSCRIBED","CIRCUMSCRIBED","  NUMBER OF",
141 PRINT "INSCRIBED","CIRCUMSCRIBED"
150 PRINT "  AREA","      AREA","    SIDES"," % ERROR","   % ERROR"
155 PRINT
160 FOR K=0 TO 2
170 LET N=3*(2↑K)
175 GOSUB 180
177 NEXT K
178 GO TO 240
179 REM COMPUTATION SUBROUTINE (LINES 180-220)
180 LET L=2*R*SIN(3.14159/N)
190 LET A1=R*COS(3.14159/N)*N*L/2
200 LET A2=N*(R↑2)*TAN(3.14159/N)
205 LET P1=((A1-A3)/A3)*100
206 LET P2=((A2-A3)/A3)*100
210 PRINT A1,A2,"   ";N,INT(P1*100+.5)/100, INT(P2*100+.5)/100
220 RETURN
240 PRINT
250 PRINT
260 PRINT "HOW MANY SIDES DO YOU THINK ARE NEEDED TO APPROXIMATE"
261 PRINT "THE AREA OF THIS CIRCLE";
262 INPUT N
263 IF N>1E5 THEN 268
264 IF N<3 THEN 266
265 GO TO 273
266 PRINT "THE NUMBER OF SIDES SHOULD BE AT LEAST THREE!!"
267 GO TO 260
268 PRINT "THAT MANY SIDES IS VALID, BUT NOT NECESSARY FOR A"
269 PRINT "GOOD APPROXIMATION.  USE 10000 AS THE MAXIMUM NUMBER."
270 GO TO 262
273 PRINT
274 LET N=INT(N+.5)
275 GOSUB 180
280 PRINT
285 PRINT "WOULD YOU LIKE TO TRY ANOTHER NUMBER OF SIDES";
286 PRINT " (1-YES, 0-NO)";
287 INPUT Q1
288 IF Q1>0 THEN 260
290 PRINT "WOULD YOU LIKE TO TRY ANOTHER RADIUS (1-YES, 0-NO)";
291 INPUT Q2
293 PRINT
294 PRINT "*****"
295 PRINT
296 IF Q2>0 THEN 120
300 END
```

181

DISCIPLINE MATHEMATICS 9, 10, 11, 12, 13

SUBJECT PLOTTING A GRAPH

PROGRAM NAME PLOTTR

DESCRIPTION:

This program plots the graph of any function (analytically defined) which the operator inputs into the program.

OBJECTIVES:

A. To check a student's plotting procedures.

B. To obtain a quick plot of an involved function.

PRELIMINARY PREPARATION:

A. Student - Knowledge of coordinates, and plotting procedures.

B. Materials - graph paper for plotting

DISCUSSION:

The operator inputs any analytic function, along with the lower and the upper limits for x and the interval to appear on the x-axis.

The type-out positions x-values on the vertical axis, and y-values on the horizontal axis.

The points typed out may be connected by a smooth curve, and the graph may be rotated 90° to give the usual positioning of a function of x.

It should be noted that because the carriage spacing is discrete, many smooth curves may appear slightly jagged.

In the third sample run, a plot is made of a rather complex transcendental function. It is worth mentioning that this plot is obtained as easily, using this program as is that of the function Y=X.

The teacher should notice also, that, in this third sample run, we have found two of the roots of the function

Y=X+LOG(2*(SIN(X)) 2)-1.5xCOS(X)

(at X=1 and X=2.98). This program may be used for finding the roots of such difficult funcions.

```
    THIS PROGRAM WILL GRAPH A FUNCTION OF X BETWEEN ANY LIMITS
(A AND B) YOU CHOOSE, WITH AN INTERVAL OF YOUR CHOICE (I)
BETWEEN SUCCESSIVE VALUES OF X, IF YOU TYPE THE FOLLOWING:
        1 GO TO 220
        220 DEF FNY(X)=...(YOUR FUNCTION OF X)...
        230 LET A=...(YOUR SMALLER LIMIT OF X)...
        240 LET B=...(YOUR LARGER LIMIT OF X)...
        250 LET I=...(YOUR X-INCREMENT)...
        RUN

READY

1 GO TO 220
220 DEF FNY(X)=SIN(X)
230 LET A=0
240 LET B=7
250 LET I=.5
RUN

X
-
V
A
L
U
E
S
                      - - - - Y-VALUES - - - -
              -3             -1.5            0              1.5
               I---------I----+----I---------I---------I----+----I
 0                                           *
 .5                                          I    *
 1                                           I       *
 1.5                                         I         *
 2                                           I        *
 2.5                                         I     *
 3                                           I*
 3.5                                     *   I
 4                                   *       I
 4.5                               *         I
 5                                 *         I
 5.5                                  *      I
 6                                        *  I
 6.5                                         I *
 7                                           I      *

NOTE: THE SIX I'S ON THE HORIZONTAL Y-AXIS REPRESENT:
-3 ,-2 ,-1 , 0 , 1 , 2

READY

220 DEF FNY(X)=X
230 LET A=-1
240 LET B=9
250 LET I=1
RUN
```

```
X
-
V
A
L
U
E
S
                  - - - - Y-VALUES - - - -
        -1            2                5                  8
-1      I---------I----+----I---------I---------I----+----I
0       *    I
1            +
2            I    *
3            I         *
4            I              *
5            I                   *
6            I                        *
7            I                             *
8            I                                  *
9            I                                       *
             I                                            *
NOTE: THE SIX I'S ON THE HORIZONTAL Y-AXIS REPRESENT:
-1 , 1 , 3 , 5 , 7 , 9

READY
```

```
1 GO TO 220
220 DEF FNY(X)=X+LOG(2*(SIN(X))↑2)-1.5*COS(X/2)
230 LET A=0.5
240 LET B=3.1
250LET I=0.1
RUN

X
-
V
A
L
U
E
S                     - - - - Y-VALUES - - - -
              -3             -1.5            0              1.5
               I---------I----+----I---------I---------I----+----I
 .5                         *                I
 .6                             *            I
 .7                                 *        I
 .8                                    *     I
 .9                                        * I
1                                            *
1.1                                          I  *
1.2                                          I    *
1.3                                          I      *
1.4                                          I        *
1.5                                          I          *
1.6                                          I           *
1.7                                          I             *
1.8                                          I              *
1.9                                          I               *
2                                            I                *
2.1                                          I                 *
2.2                                          I                 *
2.3                                          I                 *
2.4                                          I                 *
2.5                                          I                *
2.6                                          I               *
2.7                                          I             *
2.8                                          I          *
2.9                                          I     *
3                                         *  I
3.1                *                         I

NOTE: THE SIX I'S ON THE HORIZONTAL Y-AXIS REPRESENT:
-3 ,-2 ,-1 , 0 , 1 , 2
```

```
READY

1 GO TO 220
220 DEF FNY(X)=LOG((SIN(X))↑2)
230 LET A=1
240 LET B=3
250 LET I=0.1
RUN

X
-
V
A
L
U
E
S                     - - - - Y-VALUES - - - -
              -5             -3.5           -2             -.5
               I---------I----+----I---------I---------I----+----I
 1                                                            *  I
 1.1                                                           * I
 1.2                                                            *I
 1.3                                                            *I
 1.4                                                             *
 1.5                                                             *
 1.6                                                             *
 1.7                                                             *
 1.8                                                            *I
 1.9                                                            *I
 2                                                             * I
 2.1                                                          *  I
 2.2                                                         *   I
 2.3                                                       *     I
 2.4                                                     *       I
 2.5                                                   *         I
 2.6                                                *            I
 2.7                                            *                I
 2.8                                       *                     I
 2.9                                *                            I
 3                        *                                      I

NOTE: THE SIX I'S ON THE HORIZONTAL Y-AXIS REPRESENT:
-5 ,-4 ,-3 ,-2 ,-1 , 0

READY
```

```
110 REM QUENTIN J. O'CONNOR, COMMACK H.S.NORTH, REVISED JULY,1969
115 REM  REVISED BY C.LOSIK  8-7-70
116 REM  A,B,I ARE SELF-EXPLANATORY
117 REM AUTOMATIC SCALING AND A FLOATING AXIS ARE USED.
120PRINT"     THIS PROGRAM WILL GRAPH A FUNCTION OF X BETWEEN ANY LIMITS"
130PRINT"(A AND B) YOU CHOOSE, WITH AN INTERVAL OF YOUR CHOICE (I)"
140PRINT"BETWEEN SUCCESSIVE VALUES OF X, IF YOU TYPE THE FOLLOWING:"
150 PRINT"           1 GO TO 220"
160 PRINT"           220 DEF FNY(X)=...(YOUR FUNCTION OF X)..."
170 PRINT"           230 LET A=...(YOUR SMALLER LIMIT OF X)..."
180 PRINT"           240 LET B=...(YOUR LARGER LIMIT OF X)..."
190 PRINT"           250 LET I=...(YOUR X-INCREMENT)..."
200 PRINT"           RUN"
210 STOP
220 DEF FNY(X)=X
230 LET A=-1
240 LET B=9
242 IF A<B THEN 250
244 PRINT "YOUR 'A' MUST BE LESS THAN YOUR 'B'."
246 STOP
250 LET I=1
260 LET L=FNY(A)
270 LET U=FNY(A)
280 FOR X=A TO B STEP I
290 LET Y=FNY(X)
300 IF Y-L<0 THEN 320
310GOTO 330
320 GOSUB380
330 IF Y-U>0 THEN 350
340 GO TO 360
350 GOSUB 400
360 NEXT X
370 GO TO 420
380 LET L=Y
390 RETURN
400 LET U=Y
410 RETURN
420 IF INT(U)-U=0 THEN 450
430 LET U1=INT(U)+1
440 GO TO 460
450 LET U1=U
460 LET L1=INT(L)
470 LET D=U1-L1
480 IF INT(D/5)-D/5=0 THEN 570
490 FOR K=1 TO2
500 LET L1=L1-1
510 LET D=U1-L1
520 IF INT(D/5)-D/5=0 THEN 570
530 LET U1=U1+1
540 LET D=U1-L1
550 IF INT(D/5)-D/5=0 THEN 570
560 NEXT K
570 LET E=D/5
580 PRINT "X"
590 PRINT "-"
600 PRINT "V"
610 PRINT "A"
620 PRINT "L"
630 PRINT "U"
640 PRINT "E"
650 PRINT "S                                   - - - - Y-VALUES - - - -"
660PRINT"                     "L1," ";L1+E*1.5," ";L1+E*3,"  ";L1+E*4.5
670PRINT"                     I---------I---------I---------I---------I";
```

```
671 PRINT "-----+-----I"
680 IF L1>0 THEN 1020
690  LET Q=INT((-L1)*(10/E)+.5)
700 DEF FNP(Y)=INT((Y-L1)*(10/E)+.5)
710FOR X=A TO B STEP I
720 PRINTX,
730 LET Y=FNY(X)
740 IF Y>=0 THEN 850
760 PRINT TAB(15+FNP(Y));"*";TAB(Q+15);"I"
840 GO TO 1000
850 IF Y>0 THEN 910
860 PRINT TAB(Q+15);"*"
900 GO TO 1000
910 PRINT TAB(15+Q);"I";TAB(15+FNP(Y));"*"
1000 NEXT X
1010 GO TO 1100
1020 FOR X=A TO B STEP I
1030 PRINTX,
1040 LET Y= FNY(X)
1050 PRINT TAB(INT((Y-L1)*(10/E)+.5)+14);"*"
1090 NEXT X
1100 PRINT
1110 PRINT "NOTE: THE SIX I'S ON THE HORIZONTAL Y-AXIS REPRESENT:"
1120 PRINT L1;",";L1+E;",";L1+E*2;",";L1+E*3;",";L1+E*4;",";L1+E*5
1240 END
```

DISCIPLINE MATHEMATICS, GEN. 9th YR.

SUBJECT PRIME FACTOR

PROGRAM NAME PRIFA

DESCRIPTION:

This program finds the prime factors of any given integer, or prints " is prime" if the integer has no proper divisors.

OBJECTIVES:

A. To display to the student the prime factors of a large number of integers, giving the students a chance to discover relationships.

B. To use the motivation of the computer to teach the method that the program uses to find the prime factors.

PRELIMINARY PREPARATION:

A. Student - Should understand the meaning of composite, prime, factor, and prime factor.

B. Materials - If you desire to use this program with a group, a means by which the output can be displayed is necessary.

DISCUSSION:

The speed with which the computer operates in this program gives the student an opportunity to make generalizations based upon many more observations then heretofore was possible. The question can be asked: " By what method does the computer find the prime factor?" A flow chart would be highly useful at this point, not only in developing the method for finding a prime factor, but also in understanding the mathematical logic behind this method.

```
THIS PROGRAM WILL GIVE YOU THE PRIME FACTORS OF ANY
WHOLE NUMBER.  IF YOU WISH TO STOP THE PROGRAM, ENTER A
ZERO FOR THE NUMBER.

WHAT IS THE NUMBER ? 105

 105            3   5   7

WHAT IS THE NUMBER ? 72

 72             2   2   2   3   3

WHAT IS THE NUMBER ? 89

 89            IS PRIME

WHAT IS THE NUMBER ? 47

 47            IS PRIME

WHAT IS THE NUMBER ? 155

 155            5   31

WHAT IS THE NUMBER ? 362

 362            2   181

WHAT IS THE NUMBER ? 0


READY
```


194

Mathematics
PRIFA

```
100 REM W. TEPPER WYANDANCH H.S.
105 REM  REVISED BY C.LOSIK  8-10-70
106 REM  M IS THE NUMBER, A(I) ARE ITS FACTORS
110 REM ADAPTATION OF TWO PROGRAMS
120 REM THIS PROGRAM FINDS THE PRIME FACTORS OF ANY GIVEN INTEGER
130 REM AND PRINTS PRIME IF IT HAS NO PROPER DIVISORS
140 DIM A(100)
150 LET C=0
160 PRINT "THIS PROGRAM WILL GIVE YOU THE PRIME FACTORS OF ANY"
170 PRINT "WHOLE NUMBER.  IF YOU WISH TO STOP THE PROGRAM, ENTER A"
172 PRINT "ZERO FOR THE NUMBER."
174 PRINT
180 PRINT "WHAT IS THE NUMBER ";
190 LET X=0
200 INPUT M
205 IF ABS(M-INT(M+.5))<.0001 THEN 210
206 PRINT "WHOLE NUMBERS ONLY, PLEASE."
207 GO TO 180
210 PRINT
215 IF M<=0 THEN 470
220 PRINT M,
230 LET I=1
240 LET I=I+1
245 IF I>M THEN 310
250 IF M/I<>INT(M/I) THEN 240
260 LET X=X+1
270 LET A(X)=I
280 LET M=M/I
300 GO TO 250
310 IF X=1 THEN 360
320 FOR L=1 TO X
330 PRINT A(L);
340 NEXT L
350 GO TO 370
360 PRINT "IS PRIME"
370 PRINT
380 PRINT
385 GO TO 180
400 INPUT B
410 IF B=1 THEN 180
420 IF B=0 THEN 470
430 PRINT " TYPE 1 OR 0 AS INSTRUCTED"
440 LET C=C+1
460 GO TO 400
470 END
```

DISCIPLINE MATHEMATICS 12, 13

SUBJECT ANALYTIC GEOMETRY

PROGRAM QUADRT

DESCRIPTION:

This program determines the nature of the graph of $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, after the operator inputs the six constants (A, B, C, D, E, F). Limiting cases, such as a point or a line, are separated from the general cases so that the computer type-out gives the exact nature of the graph.

OBJECTIVE:

To permit exploration of the properties of the second-degree equation.

PRELIMINARY PREPARATION:

A. Student - should have a reasonable knowledge of conic sections, second - degree equations in two unknowns, invariant functions of the coefficients under transformations, etc.

B. Materials - An overhead projector along with a transparency of the flow chart would be desirable,

DISCUSSION:

Before running the program, the teacher should discuss the general form of a second-degree equation in two variables, the functions of the coefficients used in the program, and the implications of the flow chart.

The discussion of the flow chart for this program enhances the understanding of the problem.

The type-out serves as a check on students' efforts in identifying second-degree equations.

```
    THIS PROGRAM DETERMINES THE NATURE OF THE GRAPH OF:
          A*X↑2+B*X*Y+C*Y↑2+D*X+E*Y+F=0
    ENTER YOUR CONSTANTS IN THE ORDER LISTED ABOVE.

? 5,8,5,0,0,0
THE GRAPH OF YOUR EQUATION IS A SINGLE POINT.

ANOTHER RUN (1=YES, 0=NO) : ? 1

    ENTER YOUR CONSTANTS IN THE ORDER LISTED ABOVE.

? 5,8,5,0,0,36
THERE IS NO REAL LOCUS FOR YOUR EQUATION.

ANOTHER RUN (1=YES, 0=NO) : ? 1

    ENTER YOUR CONSTANTS INTTHE ORDER LISTED ABOVE.

? 0,5,0,0,0,9
THE GRAPH /F YOUR EQUATION IS A HYPERBOLA.

ANOTHER RUN (1=YES, 0=NO) : ? 0


READY
```

```
100 REM QUENTIN J.O'CONNOR, COMMACK H.S.NORTH, JULY 16, 1969
103 REM  REVISED BY C.LOSIK  8-7-70
105 REM  A,B,C,D,E,F ARE AS IN EQUATION
110 PRINT "     THIS PROGRAM DETERMINES THE NATURE OF THE GRAPH OF:"
120 PRINT "              A*X↑2+B*X*Y+C*Y↑2+D*X+E*Y+F=0"
130 PRINT "     ENTER YOUR CONSTANTS IN THE ORDER LISTED ABOVE."
140 PRINT " "
150 INPUT A,B,C,D,E,F
160 IF A*A+B*B+C*C+D*D+E*E+F*F>0 THEN 210
170 PRINT"    WITH ALL YOUR CONSTANTS EQUAL TO ZERO, ANY VALUES OF X"
180 PRINT"AND Y WILL SATISFY YOUR EQUATION. IN OTHER WORDS, YOUR"
190 PRINT"GRAPH IS A COMPLETE PLANE."
200 GO TO 550
210 IF A*A+B*B+C*C+D*D+E*E=0 THEN 500
220 IF A*A+B*B+C*C>0 THEN 240
230 GO TO 400
240 LET I=A+C
250 LET K=4*A*C-B*B
260 LET J=4*A*C+4*C*F+4*A*F-E*E-D*D-B*B
270 LET P=4*A*C*F+B*D*E-A*E*E-C*D*D-F*B*B
280 IF P=0 THEN 360
290 IF K=0 THEN 540
300 IF K<0 THEN 520
310 IF I*P>0 THEN 500
320 IF A<>C THEN 340
330 IF B=0 THEN 480
340 PRINT "THE GRAPH OF YOUR EQUATION IS AN ELLIPSE."
350 GO TO 550
360 IF K>0 THEN 460
370 IF K<0 THEN 440
380 IF J<0 THEN 420
390 IF J>0 THEN500
400 PRINT "THE GRAPH OF YOUR EQUATION IS A SINGLE STRAIGHT LINE."
410 GO TO 550
420 PRINT "THE GRAPH OF YOUR EQUATION CONSISTS OF 2 PARALLEL LINES."
430 GO TO 550
440 PRINT "THE GRAPH OF YOUR EQUATION CONSISTS OF 2 INTERSECTING LINES."
450 GO TO 550
460 PRINT "THE GRAPH OF YOUR EQUATION IS A SINGLE POINT."
470 GO TO 550
480 PRINT "THE GRAPH OF YOUR EQUATION IS A CIRCLE."
490 GO TO 550
500 PRINT "THERE IS NO REAL LOCUS FOR YOUR EQUATION."
510 GO TO 550
520 PRINT "THE GRAPH OF YOUR EQUATION IS A HYPERBOLA."
530 GO TO 550
540 PRINT "THE GRAPH OF YOUR EQUATION IS A PARABOLA."
550 PRINT
560 PRINT "ANOTHER RUN (1=YES, 0=NO) : ";
570 INPUT A
575 PRINT
580 IF A=1 THEN 130
590 IF A<>0 THEN 560
600 END
```

DISCIPLINE MATHEMATICS 9th YEAR

SUBJECT PROPORTIONS

PROGRAM NAME RATIO

DESCRIPTION:

This program solves a proportion of the type A/B = C/D. A, B, C, or D can be unknown.

OBJECTIVES:

A. To teach the student(s) the relationships in a proportion.

B. To aid in teaching the solution of proportions.

PRELIMINARY PREPARATION:

A. Student - no particular preparation necessary

B. Materials - see discussion

DISCUSSION:

The student is given the opportunity to see any number of solutions to proportions. The program then asks a series of questions designed to allow the student to discover that in a proportion, the product of the means equals the product of the extremes. The program can be used either with individual students or with an entire class depending upon the availability of equipment to display the output. The running time varies, depending upon the number of proportions you wish to solve. In 10 to 15 minutes, the program can be run with about 100 proportion problems. Included in this time is a built-in variable pause for observation of the tabulated results. Another value of using this program is that the teacher can easily handle numbers in proportions that heretofore were too difficult.

```
THIS PROGRAM SOLVES FOR THE UNKNOWN IN THE PROPORTION
A/B AS C/D. USE A ZERO AS A DUMMY VALUE FOR THE UNKNOWN.

HOW MANY PROPORTIONS DO YOU WISH TO SOLVE? 4
WHAT ARE THE VALUES FOR A,B,C,D? 3,[illegible],8,9
YOU FORGOT TO INPUT A ZERO FOR YOUR
UNKNOWN.  TRY AGAIN.? 3,4,6,0
                                                3 / 4  AS  6 / 8
WHAT ARE THE VALUES FOR A,B,C,D? 1,10,0,50
                                                1 / 10  AS  5 / 50
WHAT ARE THE VALUES FOR A,B,C,D? 36,0,1,2
                                                36 / 72  AS  1 / 2
WHAT ARE THE VALUES FOR A,B,C,D? 0,45,3,5
                                                27 / 45  AS  3 / 5


TAKE A GOOD LOOK AT THE PROPORTIONS.  THE TWO MIDDLE
POSITION NUMBERS ARE CALLED THE 'MEANS'; THE TWO
END POSITION NUMBERS ARE CALLED THE 'EXTREMES'.

LOOK AT THE 'MEANS' AND THE 'EXTREMES'  -    SEE IF
YOU CAN FIND SOME KIND OF RELATIONSHIP BETWEEN THEM.
WHEN YOU THINK YOU HAVE FOUND A RELATIONSHIP BETWEEN
THE 'MEANS' AND THE 'EXTREMES', TYPE 1 AND HIT THE RETURN KEY.
? 1


DID YOU SEE THAT IF YOU MULTIPLY THE 'MEANS'
AND MULTIPLY THE 'EXTREMES', THE PRODUCTS ARE EQUAL?

IN THE LAST PROPORTION  45 X 3 EQUALS 27 X 5
CHECK THE OTHERS, TOO.  WHEN YOU ARE READY TO CONTINUE,
TYPE 1 AND HIT THE RETURN KEY.
? 1


IF YOU WISH TO USE THIS PROGRAM AGAIN TYPE 1, IF NOT TYPE 0
? 0

READY
```


200

```
100 REM W. TEPPER WYANDANCH M.S.   -   MATHEMATICS
105 REM  REVISED BY C.LOSIK  8-5-70
106 REM  A/B = C/D, TOTALLY OBVIOUS,  ALSO USES GOSUB TO SIMULATE PAUSE
110 REM THIS PROGRAM SOLVES FOR THE UNKNOWN IN THE PROPORTION"
120 REM OF THE TYPE A/B AS C/D
130 PRINT "THIS PROGRAM SOLVES FOR THE UNKNOWN IN THE PROPORTION"
140 PRINT "A/B AS C/D. USE A ZERO AS A DUMMY VALUE FOR THE UNKNOWN."
150 PRINT
160 PRINT "HOW MANY PROPORTIONS DO YOU WISH TO SOLVE";
170 INPUT N
180 FOR K=1 TO N
190 PRINT "WHAT ARE THE VALUES FOR A,B,C,D";
200 INPUT A,B,C,D
210 IF A=0 THEN 270
220 IF B=0 THEN 290
230 IF C=0 THEN 310
240 IF D=0 THEN 330
250 PRINT "YOU FORGOT TO INPUT A ZERO FOR YOUR"
255 PRINT "UNKNOWN.  TRY AGAIN.";
260 GO TO 200
270 LET A=B*C/D
280 GO TO 340
290 LET B=A*D/C
300 GO TO 340
310 LET C=A*D/B
320 GO TO 340
330 LET D=B*C/A
340PRINT"                                            ";A"/"B" AS "C"/"D
345 NEXT K
350 PRINT
360 PRINT
370 PRINT "TAKE A GOOD LOOK AT THE PROPORTIONS.  THE TWO MIDDLE"
380 PRINT "POSITION NUMBERS ARE CALLED THE 'MEANS', THE TWO"
390 PRINT "END POSITION NUMBERS ARE CALLED THE 'EXTREMES'."
395 PRINT
400 PRINT "LOOK AT THE 'MEANS' AND THE 'EXTREMES'   -    SEE IF"
410 PRINT "YOU CAN FIND SOME KIND OF RELATIONSHIP BETWEEN THEM."
420 PRINT "WHEN YOU THINK YOU HAVE FOUND A RELATIONSHIP BETWEEN"
430 PRINT "THE 'MEANS' AND THE 'EXTREMES', ";
450 GO SUB 610
460 PRINT "DID YOU SEE THAT IF YOU MULTIPLY THE 'MEANS'"
470 PRINT "AND MULTIPLY THE 'EXTREMES', THE PRODUCTS ARE EQUAL?"
475 PRINT
480 PRINT "IN THE LAST PROPORTION "B"X"C"EQUALS" A"X"D
490 PRINT "CHECK THE OTHERS, TOO.  WHEN YOU ARE READY TO CONTINUE,"
510 GO SUB 610
540 PRINT
550 PRINT "IF YOU WISH TO USE THIS PROGRAM AGAIN TYPE 1, IF NOT TYPE 0"
560 INPUT X
570 IF X=1 THEN 200
580 IF X=0 THEN 640
590 PRINT "TYPE 1 OR 0 AS DIRECTED."
600 GO TO 560
610 PRINT "TYPE 1 AND HIT THE RETURN KEY."
620 INPUT X
623 IF X<>1 THEN 620
625 PRINT
627 PRINT
630 PRINT
635 RETURN
640 END
```

DISCIPLINE MATHEMATICS

SUBJECT QUADRATIC EQUATIONS

PROGRAM NAME ROOTS2

DESCRIPTION:

This program describes the nature of the roots of a quadratic equation, and finds the roots whether real or complex.

OBJECTIVES:

A. To familiarize the student with quadratic function.

B. To review and drill exercise... to study the nature of roots.

C. To emphasize that roots of $f(x) = 0$ are the same as x-intercepts of $f(x) = y$.

D. To impress the student with geometric interpretation(s) of the nature of roots.

E. To provide "lead-in" material for the introduction of further study of the real number line, the real cartesian plane, complex numbers, quadratic inequalities, etc.

PRELIMINARY PREPARATION:

A. Student - The teacher can use the program to introduce the students to the quadratic formula, to conclude discussion of the quadratic formula... or both.

B. Materials - none

DISCUSSION:

The program uses the "discriminant" to determine the nature of the roots of the quadratic equation. Regardless of the nature of the roots, the student is asked to graph $y = F(x)$, and to compare his graph with the kind of roots he finds for a specific $F(x) = 0$. He should be impressed with the picture: and he should understand (ultimately) the reasonableness and validity of the analytic methods presented in class.

```
THIS PROGRAM HANDLES ALL POSSIBLE CASES OF SOLUTION OF THE EQUATION :

     A * X ↑ 2  +  B * X  +  C  =  0

TYPE IN YOUR VALUES FOR A, B, AND C : ? 1,2,3

DISCRIMINANT IS LESS THAN ZERO, SO ROOTS ARE IMAGINARY.
THEY ARE OF THE FORM :  P+I*Q , P-I*Q , WHERE :
P =-1           Q = 1.414214

                              ***

DO YOU WANT ANOTHER RUN ( 0 = NO , 1 = YES ) : ? 1

TYPE IN YOUR VALUES FOR A, B, AND C : ? 1,7,3

DISCRIMINANT IS GREATER THAN ZERO, SO ROOTS ARE REAL.
ROOTS ARE X1 AND X2 .
X1 =-.4586187 X2 =-6.541381

                              ***

DO YOU WANT ANOTHER RUN ( 0 = NO , 1 = YES ) : ? 1

TYPE IN YOUR VALUES FOR A, B, AND C : ? 1,6,9

DISCRIMINANT IS EQUAL TO ZERO, SO ROOTS ARE EQUAL.  X =-3

                              ***

DO YOU WANT ANOTHER RUN ( 0 = NO , 1 = YES ) : ? 1

TYPE IN YOUR VALUES FOR A, B, AND C : ? 2,8,6

DISCRIMINANT IS GREATER THAN ZERO, SO ROOTS ARE REAL.
ROOTS ARE X1 AND X2 .
X1 =-1          X2 =-3

                              ***

DO YOU WANT ANOTHER RUN ( 0 = NO , 1 = YES ) : ? 0

READY
```

```
100 REM  THE ULTIMATE QUADRATIC SOLVER, UNTIL THE NEXT VERSION
110 REM  CHARLES LOSIK, PIB, 7/21/70, BASIC
120 PRINT "THIS PROGRAM HANDLES ALL POSSIBLE CASES OF SOLUTION OF";
125 PRINT " THE EQUATION :"
130 PRINT
140 PRINT "     A * X ↑ 2  +  B * X  +  C  =  0"
150 PRINT
160 PRINT "TYPE IN YOUR VALUES FOR A, B, AND C : ";
165 REM  INPUT VALUES FOR A,B,C
170 INPUT A,B,C
171 PRINT
175 REM  FOR ALL CASES, CHECK A=0. IF SO, THEN LINEARITY
180 IF A=0 THEN 802
185 REM  D IS THE DISCRIMINANT
190 LET D=B*B-4*A*C
195 LET Z=2*A
200 IF D=0 THEN 710
210 IF D>0 THEN 610
300 REM  D<0, IMAGINARY RESULTS
310 PRINT "DISCRIMINANT IS LESS THAN ZERO, SO ROOTS ARE IMAGINARY."
320 PRINT "THEY ARE OF THE FORM :  P+I*Q , P-I*Q , WHERE :"
330 PRINT "P ="-B/Z,"Q ="SQR(ABS(D))/Z
340 GO TO 900
600 REM  D>0, SO REAL ROOTS
610 PRINT "DISCRIMINANT IS GREATER THAN ZERO, SO ROOTS ARE REAL."
620 PRINT "ROOTS ARE X1 AND X2 ."
630 PRINT "X1 ="(-B+SQR(D))/Z,"X2 ="(-B-SQR(D))/Z
640 GO TO 900
700 REM  EQUAL ROOTS (D=0)
710 PRINT "DISCRIMINANT IS EQUAL TO ZERO, SO ROOTS ARE EQUAL.  X ="-B/Z
720 GO TO 900
800 REM  A=0, SO X=-C/B, UNLESS B=0
802 IF B<>0 THEN 810
803 IF C=0 THEN 807
804 PRINT "MEANINGLESS STATEMENT."
806 GO TO 900
807 PRINT "OK, ZERO = ZERO."
808 GO TO 900
810 PRINT "THE EQUATION IS LINEAR.  X ="-C/B
900 PRINT
901 PRINT TAB(30);"***"
905 PRINT
910 PRINT
920 PRINT "DO YOU WANT ANOTHER RUN ( 0 = NO , 1 = YES ) : ";
930 INPUT Z
940 IF Z=1 THEN 150
950 IF Z<>0 THEN 920
999 END
```

DISCIPLINE MATHEMATICS - JR. HIGH

SUBJECT INTERSECTION AND UNION OF SETS

PROGRAM NAME SETS

DESCRIPTION:

This program finds the intersection and union of any two numerical sets.

OBJECTIVES:

A. To motivate students to find the union and intersection of any two sets.

B. To learn the logic involved in finding the union and intersection.

PRELIMINARY PREPARATION:

A. Student - no special preparation necessary.

B. Materials - see discussion

DISCUSSION:

This program may be used with individuals, small groups, or class-size groups. The elements of the two sets are entered as per instructions. Incidently, one or both of the sets may be empty. The computer then types back the elements in the union and intersection. The speed with which the computer operates enables the students to see a great many examples, giving them the opportunity to make discoveries about what is the union and what is an intersection of two sets. The teacher may use the flow chart that follows to explain the logic behind finding the union and intersection.

It is suggested that when used with large groups, a supplementary device be used to display output.

```
THIS PROGRAM FINDS THE UNION AND INTERSECTION OF ANY TWO
NUMERICAL SETS.

  HOW MANY ELEMENTS IN THE FIRST SET? 5

THESE ARE - (HIT THE RETURN KEY AFTER ENTERING EACH ELEMENT).
? 1
? 2
? 3
? 4
? 5

  HOW MANY ELEMENTS IN THE SECOND SET? 5

THESE ARE:
? 2
? 4
? 6
? 8
? 10

THE INTERSECTION CONTAINS  2  4
THE UNION CONTAINS 2  4  6  8  10  1  3  5

DO YOU WANT ANOTHER RUN (1=YES, 0=NO) : ? 1

  HOW MANY ELEMENTS IN THE FIRST SET? 8

THESE ARE - (HIT THE RETURN KEY AFTER ENTERING EACH ELEMENT).
? 1
? 2
? 3
? 4
? 6
? 8
? 10
? 12

  HOW MANY ELEMENTS IN THE SECOND SET? 10

THESE ARE:
? 1
? 2
? 3
? 4
? 5
? 6
? 7
? 8
? 9
? 10


THE INTERSECTION CONTAINS  1  2  3  4  6  8  10
THE UNION CONTAINS 1  2  3  4  5  6  7  8  9  10  12

DO YOU WANT ANOTHER RUN (1=YES, 0=NO) : ? 0


READY
```

```
100REM W. TEPPER, WYANDANCH HS, 7/29/69
101 REM  REVISED BY C.LOSIK  6-10-70
103 DIM A(30),B(30)
110 REM  UP TO 30 ELEMENTS PER SET ARE ALLOWED(UNLESS DIM IS CHANGED)
120PRINT"THIS PROGRAM FINDS THE UNION AND INTERSECTION OF ANY TWO"
130PRINT"NUMERICAL SETS."
140PRINT
150PRINT"  HOW MANY ELEMENTS IN THE FIRST SET";
160INPUT N
163 IF N=0 THEN 230
166 IF N=INT(N) THEN 170
167 PRINT "ONLY AN INTEGER NUMBER OF ELEMENTS IS POSSIBLE."
169 GO TO 140
170 IF N<=30 THEN 180
173 PRINT "THE MACHINE CANNOT HOLD MORE THAN 30 ELEMENTS.";
175 PRINT "  SEE YOUR TEACHER."
177 GO TO 690
180 IF N>0 THEN 189
183 PRINT "THERE CANNOT BE A NEGATIVE NUMBER OF ELEMENTS."
186 GO TO 140
189 PRINT
190PRINT"THESE ARE - (HIT THE RETURN KEY AFTER ENTERING EACH ELEMENT)."
200FOR K=1TON
210INPUTA(K)
220NEXT K
230PRINT
240 PRINT "  HOW MANY ELEMENTS IN THE SECOND SET";
250INPUT J
253 IF J=0 THEN 550
256 IF J=INT(J) THEN 260
257 PRINT "ONLY AN INTEGER NUMBER OF ELEMENTS IS POSSIBLE."
259 GO TO 230
260 IF J>30 THEN 173
270 IF J>0 THEN 279
273 PRINT "THERE CANNOT BE A NEGATIVE NUMBER OF ELEMENTS."
276 GO TO 230
279 PRINT
280 PRINT"THESE ARE:"
290 FOR K1=1TO J
300 INPUT B(K1)
310 NEXT K1
311 PRINT
312 PRINT
315 IF N<=0 THEN 640
320 PRINT "THE INTERSECTION CONTAINS ";
330 FOR K=1 TO N
340 FOR L=1 TO J
```

```
350 IF A(K)=B(L)THEN 380
360 NEXT L
370 GO TO 400
380 PRINT A(K);
390 LET X=X+1
400 NEXT K
410 IF X>0THEN 430
420 PRINT"  EMPTY SET....NO ELEMENTS"
430PRINT
440 PRINT"THE UNION CONTAINS";
450 FOR L=1 TO J
460 PRINT B(L);
470 NEXT L
480 FOR K=1 TO N
490 FOR L=1 TO J
500 IF A(K)=B(L)THEN 530
510 NEXT L
520 PRINT A(K);
530 NEXT K
540 GO TO 690
550 IF N<=0 THEN 620
560 PRINT "INTERSECTION IS EMPTY"
570 PRINT "UNION CONTAINS";
580 FOR K=1 TO N
590 PRINT A(K);
600 NEXT K
610 GO TO 690
620 PRINT "UNION AND INTERSECTION ARE EMPTY"
630 GO TO 690
640 PRINT "INTERSECTION IS EMPTY"
650 PRINT "UNION CONTAINS";
660 FOR K=1 TO J
670 PRINT B(K);
680 NEXT K
690 PRINT
700 PRINT
720 PRINT "DO YOU WANT ANOTHER RUN (1=YES, 0=NO) : ";
730 INPUT N
740 IF N=1 THEN 140
750 IF N<>0 THEN 720
760 END
```

DISCIPLINE ALGEBRA

SUBJECT SIMULTANEOUS EQUATIONS

PROGRAM NAME SIMEQN

DESCRIPTION:

This program finds the simultaneous solution set for sets of simultaneous linear equations (up to 10x10)

OBJECTIVES:

1. To eliminate the tedium of solution of sets of simultaneous equations.

2. To provide a means for checking solutions obtained by other means.

PRELIMINARY PREPARATIONS:

Presentation of concepts of simultaneous equations and methods for finding solutions.

```
THIS PROGRAM SOLVES ANY NUMBER OF SETS OF SIMULTANEOUS
EQUATIONS OF UP TO 10 EQUATIONS PER SET.  ENTER YOUR SETS
OF EQUATIONS IN DATA STATEMENTS IN LINES 700-800,
PRECEDED BY THE NUMBER OF EQUATIONS IN EACH SET.
EXAMPLE:  TO SOLVE THE SYSTEM
  1*X(1) + 2*X(2) = 3
  4*X(1) + 9*X(2) = 10
ENTER DATA AS FOLLOWS:
  700 DATA 2
  701 DATA 1,2,3
  702 DATA 4,9,10
THEN TYPE:
  1 GO TO 110
  RUN
THE COMPUTER WILL PRINT A MATRIX OF YOUR EQUATIONS, FOLLOWED
BY THE SOLUTION TO THE EQUATIONS.


READY

700 DATA 2
701 DATA 1,2,3
702 DATA 4,9,10
1 GO TO 110
RUN

 1               2               3
 4               9               10

X( 1 )=          7
X( 2 )=         -2



READY

700 DATA 2
701 DATA 3,2,16
702 DATA -6,-4,-32
1 GO TO 110
RUN

 3               2               16
-6              -4              -32

NO UNIQUE SOLUTION
```


210

```
READY

700 DATA 3
701 DATA 3,2,5,10
702 DATA -1,4,7,-21
703 DATA 1,1,-1,14
1 GO TO 110
RUN

 3              2              5              10
-1              4              7             -21
 1              1             -1              14

X( 1 )=         7.413044
X( 2 )=         2.956522
X( 3 )=        -3.630435


READY
```

```
10 REMARK  D.SOBIN, BKLYN POLY, 11-69
15 REM  REVISED BY C.LOSIK, 9-25-70
20 PRINT "THIS PROGRAM SOLVES ANY NUMBER OF SETS OF SIMULTANEOUS"
25 PRINT "EQUATIONS OF UP TO 10 EQUATIONS PER SET.  ENTER YOUR SETS"
30 PRINT "OF EQUATIONS IN DATA STATEMENTS IN LINES 700-800,"
35 PRINT "PRECEDED BY THE NUMBER OF EQUATIONS IN EACH SET."
40 PRINT "EXAMPLE:  TO SOLVE THE SYSTEM"
45 PRINT "  1*X(1) + 2*X(2) = 3"
50 PRINT "  4*X(1) + 9*X(2) = 10"
60 PRINT "ENTER DATA AS FOLLOWS:"
62 PRINT "  700 DATA 2"
64 PRINT "  701 DATA 1,2,3"
66 PRINT "  702 DATA 4,9,10"
70 PRINT "THEN TYPE:"
72 PRINT"  1 GO TO 110"
74 PRINT "  RUN"
80 PRINT "THE COMPUTER WILL PRINT A MATRIX OF YOUR EQUATIONS, FOLLOWED"
85 PRINT "BY THE SOLUTION TO THE EQUATIONS."
90 STOP
100 DIM E(10,11), X(10)
110 READ N
120 IF N=0 THEN 999
130 FOR I=1 TO N
140     FOR K=1 TO N+1
150 READ E(I,K)
155 PRINT E(I,K),
160     NEXT K
165 PRINT " "
170 NEXT I
185 REMARK  EVALUATE MATRIX
190 FOR J=1 TO N-1
200 IF E(J,J)=0 THEN 560
210 FOR I=J+1 TO N
220 LET Q=E(I,J)/E(J,J)
230 FOR K=J TO N+1
240 LET E(I,K)=E(I,K)-E(J,K)*Q
250 NEXT K
260 NEXT I
270 NEXT J
340 REMARK SOLVE FOR X(N)
350 IF E(N,N)=0 THEN 520
360 LET I=N+1
370 LET X(N)=E(N,I)/E(N,N)
380     FOR J=1 TO N-1
390     LET S=0
400       FOR K=1 TO J
410       LET S=S+E(N-J,I-K)*X(I-K)
```


212

```
420         NEXT K
430         LET X(N-J)=(E(N-J,I)-S)/E(N-J,N-J)
440      NEXT J
450 REMARK PRINT VALUES
455 PRINT
460 FOR J=1 TO N
470 PRINT "X("J")=",X(J)
480 NEXT J
500 GO TO 530
520 PRINT
525 PRINT "NO UNIQUE SOLUTION"
530 PRINT
535 PRINT
540 PRINT
550 GOTO 110
560 FOR T= J+1 TO N
570 IF E(T,J)<>0 THEN 600
580 NEXT T
590 GOTO 520
600 FOR C=J TO N+1
610 LET A=E(J,C)
620 LET E(J,C)=E(T,C)
630 LET E(T,C)=A
640 NEXT C
650 GOTO 210
801 DATA 0
999 END
```

DISCIPLINE CALCULUS - GRADE 13

SUBJECT TANGENT SLOPE FOR ANY FUNCTION

PROGRAM NAME SLOPE

DESCRIPTION:

This program considers a function which is differentiable at $x = a$, and at all points in the interval $[a, a+1]$. The value of the derivative at $x = a$ is approximated through secant slopes.

OBJECTIVES:

A. The preliminary discussion of the method whereby the machine solves the problem enhances the students' comprehension of the techniques. These techniques are then used in developing the analytic method for finding the slope of the tangent line.

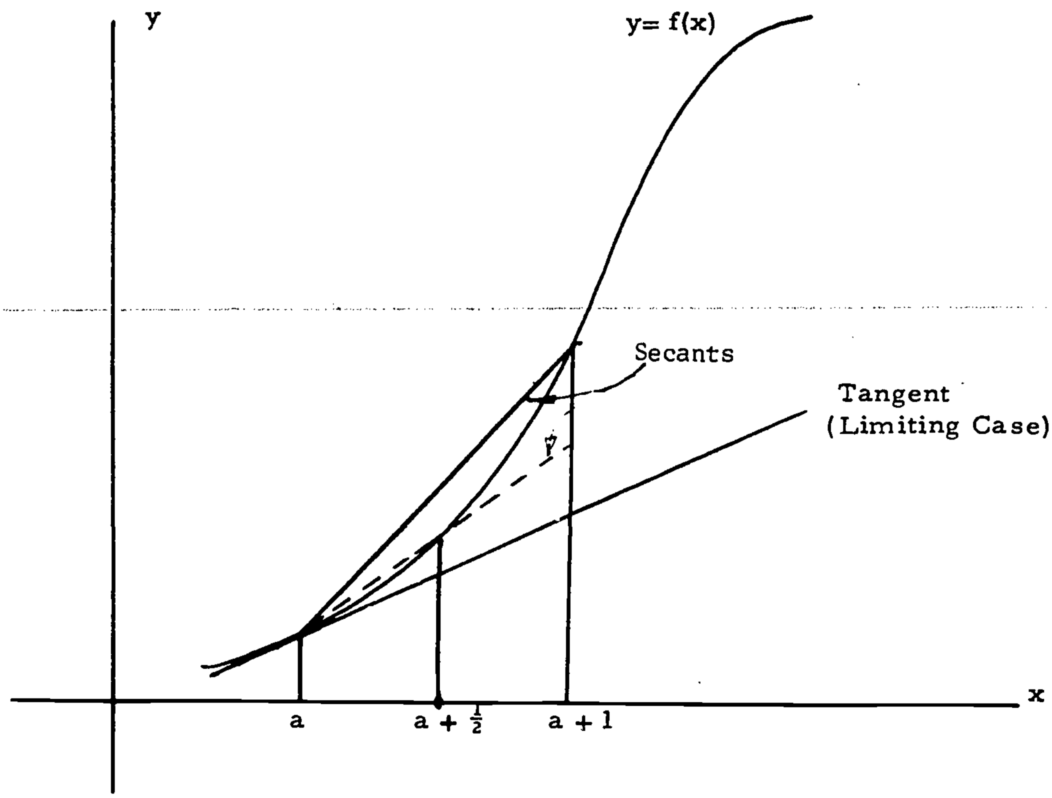
B. The type-out of successive approximations to the tangent slope clarifies and dramatizes the nature of the limiting processes.

C. Time-saving factor through the elimination of lengthy computations.

PRELIMINARY PREPARATION:

Materials

The diagram below may be shown to the students on a blackboard, or an overhead projector, to explain the computations geometrically.



DISCUSSION:

The use of the computer and the attendant discussion of the program dramatically introduces the idea of differentiation.

SECANT SLOPE OF A CURVE - THE DERIVATIVE

THIS PROGRAM CONSIDERS A FUNCTION OF X (Y=F(X)) WHICH IS DIFFERENTIABLE AT X=A AND AT ALL POINTS IN THE INTERVAL (A,A+1). THE VALUE OF THE DERIVATIVE AT X=A IS APPROXIMATED THROUGH SECANT SLOPES.

AFTER THE PROGRAM STOPS, TYPE IN THE FOLLOWING:
(END EACH LINE, INCLUDING 'RUN', WITH A 'CARRIAGE RETURN')

```
1 GO TO 300
300 DEF FNY(X)=....(YOUR FUNCTION OF X)....
RUN
```

FOR EXAMPLE, TO FIND THE SLOPE OF THE EQUATION Y=X↑3
YOU WOULD TYPE AS FOLLOWS:

```
1 GO TO 300
300 DEF FNY(X)=X↑3
RUN
```

YOU MIGHT TRY THAT AS YOUR FIRST RUN.
FOR SUBSEQUENT RUNS, YOU NEED ONLY CHANGE LINE 300 FOR A NEW FUNCTION, FOLLOWED BY 'RUN'.

READY

```
1 GO TO 300
300 DEF FNY(X)=X↑3
RUN
```

FOR WHAT VALUE OF A IS THE SLOPE TO BE EVALUATED? 2

'CHANGE IN X' IS THE DISTANCE FROM 'A', AND 'CHANGE IN Y' IS THE DISTANCE FROM 'F(A)' UPON WHICH THE SLOPE IS CALCULATED.

CHANGE IN X	CHANGE IN Y	SECANT SLOPE	% CHANGE IN SLOPE
1/ 1	19	19	NO PREVIOUS VALUE
1/ 2	7.625	15.25	19.73684
1/ 4	3.390625	13.5625	11.06557
1/ 8	1.595703	12.76562	5.875576
1/ 16	.7736816	12.37891	3.029376
1/ 32	.3808899	12.18848	1.53834
1/ 64	.1889687	12.09399	.7751783
1/ 128	.09411669	12.04694	.3891031
1/ 256	.04696667	12.02347	.1948049
1/ 512	.02346039	12.01172	.09771946
1/ 1024	.01172447	12.00586	.04878049
1/ 2048	5.860806E-3	12.00293	.02440215

*****

DO YOU WISH TO USE A DIFFERENT VALUE OF X (1=YES, 0=NO)? 0
TO CHANGE YOUR FUNCTION SEE THE INSTRUCTIONS.
IF YOU ARE FINISHED, TYPE '1', AND THE 'RETURN' KEY AFTER THE PROGRAM STOPS.

READY

1

```
100 REM SECANT SLOPE OF A CURVE - G. J. O'CONNOR  8-12-68
101 REM REVISED 8-7-70 (D. PESSEL)  (COMBINATION OF SLCUQ AND DIFFQ)
102 REM IMPORTANT VARIABLES:  S-SECANT SLOPE; P-PERCENT CHANGE;
103 REM D-CHANGE IN X; Y-CHANGE IN Y
105 LET S1=0
110 PRINT TAB(10);"SECANT SLOPE OF A CURVE - THE DERIVATIVE"
120 PRINT
130 PRINT "THIS PROGRAM CONSIDERS A FUNCTION OF X (Y=F(X)) WHICH IS"
131 PRINT "DIFFERENTIABLE AT X=A AND AT ALL POINTS IN THE INTERVAL"
132 PRINT "(A,A+1).  THE VALUE OF THE DERIVATIVE AT X=A IS"
133 PRINT "APPROXIMATED THROUGH SECANT SLOPES."
134 PRINT
139 PRINT "AFTER THE PROGRAM STOPS, TYPE IN THE FOLLOWING:"
140 PRINT "(END EACH LINE, INCLUDING 'RUN', WITH A 'CARRIAGE RETURN')"
141 PRINT
142 PRINT "           1 GO TO 300"
143 PRINT "           300 DEF FNY(X)=.....(YOUR FUNCTION OF X)...."
145 PRINT "           RUN"
146 PRINT
147 PRINT "FOR EXAMPLE, TO FIND THE SLOPE OF THE EQUATION Y=X↑3"
148 PRINT "YOU WOULD TYPE AS FOLLOWS:"
149 PRINT
150 PRINT "           1 GO TO 300"
151 PRINT "           300 DEF FNY(X)=X↑3"
153 PRINT "           RUN"
154 PRINT
155 PRINT "YOU MIGHT TRY THAT AS YOUR FIRST RUN."
156 PRINT "FOR SUBSEQUENT RUNS, YOU NEED ONLY CHANGE LINE 300 FOR"
157 PRINT "A NEW FUNCTION, FOLLOWED BY 'RUN'."
160 STOP
290 REM CALCULATION OF SLOPE AND PRINTOUT
300 DEF FNY(X)=X↑3
305 PRINT "FOR WHAT VALUE OF A IS THE SLOPE TO BE EVALUATED";
306 INPUT A
310 PRINT
311 PRINT "'CHANGE IN X' IS THE DISTANCE FROM 'A', AND 'CHANGE IN Y'"
312 PRINT "IS THE DISTANCE FROM 'F(A)' UPON WHICH THE SLOPE IS CALCU";
313 PRINT "LATED."
316 PRINT
317 PRINT
320 PRINT "CHANGE IN X","CHANGE IN Y","SECANT SLOPE","% CHANGE IN SLOPE"
321 PRINT "------ -- -","------ -- -","------ -----","- ------ -- -----"
410 FOR N=0 TO 11
420 LET D=2↑N
430 LET Y=FNY(A+1/D)-FNY(A)
440 LET S=D*Y
444 IF S1>0 THEN 447
445 PRINT "1/"D,Y,S,"NO PREVIOUS VALUE"
446 GO TO 455
447 LET P=((ABS(S1-S))/S1)*100
450 PRINT "1/"D,Y,S,P
455 LET S1=S
460 NEXT N
470 PRINT
480 PRINT "*****"
490 PRINT
500 PRINT "DO YOU WISH TO USE A DIFFERENT VALUE OF X (1-YES, 0-NO)";
501 INPUT Q2
502 IF Q2>0 THEN 305
510 PRINT "TO CHANGE YOUR FUNCTION SEE THE INSTRUCTIONS."
520 PRINT "IF YOU ARE FINISHED, TYPE '1', AND THE 'RETURN' KEY"
530 PRINT "AFTER THE PROGRAM STOPS."
540 END
```

DISCIPLINE MATHEMATICS

SUBJECT ALGEBRA(9TH and 12TH GRADE)

PROGRAM NAME SQRT

DESCRIPTION:

This program finds the square root of counting numbers up to five decimal places.

OBJECTIVES:

A. To demonstrate and familiarize the students with square roots.

B. The method utilizes "pinching" $\sqrt{Z}$ between the endpoints of smaller and smaller domains.

PRELIMINARY PREPARATION:

A. Student - 1) The definition of square root as the inverse operation of squaring; and 2) Drill in estimating square roots to the nearest tenth, hundredth, etc.

B. Materials - none

DISCUSSION:

This program provides an "introduction to," and a "review of" evolution and involution. Limiting the neighborhood of $\sqrt{Z}$ to find successively closer approximations of the square root of a number, demonstrates to the student that he is able to determine the square root to any degree.

The program may be effectively utilized for introducing the limiting process.

218

```
PROGRAM FINDS SQUARE ROOT OF ANY POSITIVE NUMBER
BY 'PINCHING' IT WITHIN A SMALLER AND SMALLER INTERVAL.

WHAT IS THE NUMBER WHOSE SQUARE ROOT YOU SEEK? 54

LOWER LIMIT                                     UPPER LIMIT
----- -----                                     ----- -----
 0           < SQ.RT. OF 54 <                    54
 5.4         < SQ.RT. OF 54 <                    10.8
 7.02        < SQ.RT. OF 54 <                    7.56
 7.344       < SQ.RT. OF 54 <                    7.398
 7.344       < SQ.RT. OF 54 <                    7.3494
 7.348319    < SQ.RT. OF 54 <                    7.348859
 7.348427    < SQ.RT. OF 54 <                    7.348481
 7.348465    < SQ.RT. OF 54 <                    7.34847
 7.348469    < SQ.RT. OF 54 <                    7.34847

APPROXIMATION NOW CORRECT TO AN ACCURACY OF 1.000000E-5
YOU MAY USE EITHER 7.348469 OR 7.34847 AS THE SQUARE ROOT OF 54

WANT TO TRY ANOTHER NUMBER (1=YES, 0=NO) : ? 1

WHAT IS THE NUMBER WHOSE SQUARE ROOT YOU SEEK? 39

LOWER LIMIT                                     UPPER LIMIT
----- -----                                     ----- -----
 0           < SQ.RT. OF 39 <                    39
 3.9         < SQ.RT. OF 39 <                    7.8
 6.24        < SQ.RT. OF 39 <                    6.63
 6.24        < SQ.RT. OF 39 <                    6.279
 6.2439      < SQ.RT. OF 39 <                    6.2478
 6.24468     < SQ.RT. OF 39 <                    6.24507
 6.244992    < SQ.RT. OF 39 <                    6.245031
 6.244996    < SQ.RT. OF 39 <                    6.245

APPROXIMATION NOW CORRECT TO AN ACCURACY OF 1.000000E-5
YOU MAY USE EITHER 6.244996 OR 6.245 AS THE SQUARE ROOT OF 39

WANT TO TRY ANOTHER NUMBER (1=YES, 0=NO) : ? 0

READY
```

```
100  REM  T. BURNS, JOHN GLENN HS,  8-6-69
110  REM  REVISED BY C.LOSIK   8-27-70
120  REM  A=LOWER LIMIT, B=UPPER LIMIT, Z=STEP IN INTERVAL
121  REM  E IS THE ACCURACY YOU DESIRE
125 LET E=.00001
130 PRINT "PROGRAM FINDS SQUARE ROOT OF ANY POSITIVE NUMBER"
140 PRINT "BY 'PINCHING' IT WITHIN A SMALLER AND SMALLER INTERVAL."
150 PRINT
160 PRINT
170 PRINT "WHAT IS THE NUMBER WHOSE SQUARE ROOT YOU SEEK";
180 INPUT Z
185 PRINT
190 IF Z>0 THEN 220
200 PRINT "YOUR NUMBER MUST BE POSITIVE !!!"
210 GO TO 160
220 PRINT
230 PRINT "LOWER LIMIT"," "," ","UPPER LIMIT"
235 PRINT "----- -----"," "," ","----- -----"
240 LET A=0
250 LET B=Z
260 LET S=(B-A)/10
270 PRINT A,"< SQ.RT. OF"Z"<",B
275 IF ABS(A*B-Z)<E THEN 360
280 FOR I=A TO B STEP S
290 IF Z<I*I THEN 310
300 NEXT I
301 LET B=B*10
302 GO TO 260
310 LET B=I
320 LET A=I-S
350 GO TO 260
360 PRINT
370 PRINT "APPROXIMATION NOW CORRECT TO AN ACCURACY OF"E
380 PRINT "YOU MAY USE EITHER"A"OR"B"AS THE SQUARE ROOT OF"Z
390 PRINT
400 PRINT
410 PRINT "WANT TO TRY ANOTHER NUMBER (1=YES, 0=NO) : ";
420 INPUT Z
430 IF Z=1 THEN 150
440 IF Z<>0 THEN 400
450 END
```

DISCIPLINE MATHEMATICS-TEACHER ASSISTANCE

SUBJECT ARITHMETIC MEAN (AVERAGE)

PROGRAM STATAL

DESCRIPTION:

This program finds the average (arithmetic mean), median, and standard deviation of up to one hundred numbers.

OBJECTIVES:

A. To familiarize the student with the concepts of arithmetic mean (average), median, and standard deviation of a group of numbers.

B. To impress him with the speed and accuracy of the computer as a calculating device.

C. To provide teachers with handy means of computing averages.

PRELIMINARY PREPARATION:

A. Student - "Arithmetic mean", "average", "median", and "standard deviation" must be well-defined.

B. Materials - None

DISCUSSION:

Given N terms, "A(1), A(2)...., A(N-1), A(N)", students will have learned the average of these N terms is "$\frac{A(1)+A(2)+...A(N-1)+A(N)}{N}$".

The program prints out the median value of the user's data when there is an odd number of data values. When there is an even number, the median value printed is the average between the N/2 and the (N+2)/2 terms.

The program serves as an excellent vehicle for drill in division and addition, and helps strengthen the concept of arithmetic mean (average).

This program is useful in demonstrating a simple "loop" routine for students interested in programming.

```
              MEAN, MEDIAN, AND DEVIATION OF A SET OF NUMBERS.

 ENTER YOUR NUMBERS IN DATA STATEMENTS ON LINES
 1000 - 2000.  FOR EXAMPLE, YOU MIGHT TYPE :

              1000 DATA  1,2,3,4  ETC. (YOUR DATA GOES HERE)

 WHEN YOUR DATA HAS BEEN ENTERED,  TYPE :

              1 GO TO 300
              RUN

 THEN RELAX WHILE THE MACHINE GRINDS OUT THE ANSWERS.

 IF A 'SUBSCRIPT ERROR' APPEARS, INCREASE THE SIZE OF THE
 ARRAY IN LINE 295.

 WARNING -- THE NUMBER 9999 IS USED AS AN INTERNAL DATA
 VALUE.  IF THIS VALUE IS ONE OF YOUR DATA VALUES, SIMPLY
 RE-TYPE LINES 999 AND 2001 WITH A COMMON DATA VALUE WHICH
 YOU WILL NOT USE.


READY

1000 DATA 244,182,112,2,198,10,314,169,18,38
1 GO TO 300
RUN


 THESE ARE YOUR NUMBERS :
 244   182   112   2   198   10   314   169   18   38

 THESE ARE YOUR NUMBERS (HIGHEST TO LOWEST) :
 314   244   198   182   169   112   38   18   10   2


 NUMBER OF VALUES IS 10
 SUM OF THE VALUES IS 1287
 THE MEAN VALUE IS 128.7
 THE MEDIAN VALUE IS 140.5
 THE STANDARD DEVIATION IS 209.5409


 FOR ANOTHER RUN, RE-ENTER DATA ON LINES
 1000 - 2000, TAKING CARE TO ELIMINATE OLD DATA
 BY TYPING THOSE LINE NUMBERS WHICH YOU DO NOT USE AGAIN;
 THEN TYPE 'RUN'.


READY

1

1000
```

```
100  REM  CHARLES M. LOSIK, BKLYN POLY, MEAN-MEDIAN-DEVIATION
110  REM  (7-66 IN FORTRAN II) ; (8-26-70 IN BASIC)
115 REM REVISED 9-24-70
120  REM  YOU PUT YOUR NUMBERS IN DATA STATEMENTS AND
130  REM  YOU GET WHAT YOU PAY FOR.
140 PRINT " ","MEAN, MEDIAN, AND DEVIATION OF A SET OF NUMBERS."
150 PRINT
160 PRINT " ENTER YOUR NUMBERS IN DATA STATEMENTS ON LINES"
170 PRINT " 1000 - 2000.  FOR EXAMPLE, YOU MIGHT TYPE :"
171 PRINT
172 PRINT " ","1000 DATA  1,2,3,4  ETC. (YOUR DATA GOES HERE)"
173 PRINT
174 PRINT " WHEN YOUR DATA HAS BEEN ENTERED,  TYPE :"
180 PRINT
190 PRINT " ","1 GO TO 300"
200 PRINT " ","RUN"
210 PRINT
220 PRINT " THEN RELAX WHILE THE MACHINE GRINDS OUT THE ANSWERS."
222 PRINT
225 PRINT " IF A 'SUBSCRIPT ERROR' APPEARS, INCREASE THE SIZE OF THE"
227 PRINT " ARRAY IN LINE 295."
230 PRINT
240  REM  A(I) ARE THE NUMBERS, S IS THEIR SUM,
250  REM  S2 IS THE SUM OF THEIR SQUARES.
260 REM
270 PRINT " WARNING -- THE NUMBER 9999 IS USED AS AN INTERNAL DATA"
275 PRINT " VALUE.  IF THIS VALUE IS ONE OF YOUR DATA VALUES, SIMPLY"
280 PRINT " RE-TYPE LINES 999 AND 2001 WITH A COMMON DATA VALUE WHICH"
285 PRINT " YOU WILL NOT USE."
290 STOP
295 DIM A(100)
300 PRINT
303 PRINT " THESE ARE YOUR NUMBERS :"
305 LET I=1
310 READ E
315 LET S=0
316 LET S2=0
320 READ A(I)
330 IF E = A(I) THEN 370
340 PRINT A(I) ;
345 LET S = S + A(I)
347 LET S2 = S2 + A(I) * A(I)
350 LET I = I + 1
360 GO TO 320
370 LET N = I - 1
380 PRINT
390 PRINT
399  REM  ***** BUBBLE SORT*****
400 PRINT " THESE ARE YOUR NUMBERS (HIGHEST TO LOWEST) :"
405 FOR I = 1 TO N - 1
```

```
410 FOR J = I + 1 TO N
420 IF A(I) > A(J) THEN 460
430 LET T = A(I)
440 LET A(I) = A(J)
450 LET A(J) = T
460 NEXT J
465 PRINT A(I) ;
470 NEXT I
475 PRINT A(N)
480 PRINT
490 PRINT
500 PRINT " NUMBER OF VALUES IS";N
510 PRINT " SUM OF THE VALUES IS";S
520 PRINT " THE MEAN VALUE IS" ; S / N
530 PRINT " THE MEDIAN VALUE IS" ;
540 IF N / 2 <> INT ( N / 2 ) THEN 570
550 PRINT ( A(N/2) + A((N+2)/2))/2
560 GO TO 600
570 PRINT A((N+1)/2)
600 PRINT " THE STANDARD DEVIATION IS" ; SQR ( N * S2 + S * S ) / N
610 PRINT
620 PRINT
630 PRINT " FOR ANOTHER RUN, RE-ENTER DATA ON LINES"
640 PRINT " 1000 - 2000, TAKING CARE TO ELIMINATE OLD DATA"
642 PRINT " BY TYPING THOSE LINE NUMBERS WHICH YOU DO NOT USE AGAIN;"
645 PRINT " THEN TYPE 'RUN'."
650 STOP
999 DATA 9999
2001 DATA 9999
2010 END

READY
```

DISCIPLINE MATHEMATICS, SOCIAL STUDIES

SUBJECT THE STOCK MARKET

PROGRAM NAME STOCK

DESCRIPTION:

This program simulates the stock market. Each student is given $10,000 with which he may buy and/or sell shares in five fictitious issues.

OBJECTIVES:

A. To give the student a simple understanding of the operations of the stock market.

B. To motivate the student to reinforce his basic arithmetic skills.

C. To give an example of the use of everyday mathematics and economics in everyday life.

PRELIMINARY PREPARATION:

A. Student - no special preparation

B. Materials - possibly graph paper

DISCUSSION:

This program can be used as a good motivation device in the teaching of basic stock-market concepts, and the basic mathematical skills involved. The computer starts each student with $10,000, and allows him to buy and/or sell shares. Precautionary tests are included for the student who tries to purchase more shares than he has money for, or to sell more shares than he actually owns. The program continues for as many trading days as the student desires.

The stock values rise and fall on a semi-random basis. On each trading day all stocks undergo a small random price change, a trend change (based on a random trend), and the possibility--on a random basis--of a large price change. The structure of the formula is:

new price=old price + (trend x old price) + (small random price change) + (possible large price change)

The trend is a random number between -.1 and +.1. It remains constant for a random number of days, at which time the trend is changed randomly. The trend affects all stocks equally, and attempts to simulate general market trends. The small random change ranges between -3 and +3 points. It occurs every day to every stock. The possible large price change is either +10 or -10 points. The + and - changes each occur at random day intervals, and to random stocks. That is, there may be no large change on some trading days, only a +10 change on others, a -10 change on still others, and both large and small changes on others. In all large-change cases, the change affects only one random stock when it occurs.

Because of the random generation of stock values and their fluctuations, the program does not exactly simulate the real market. It does, however, provide a simplified view of what does happen, and familiarizes the student with the basic functions involved. This should be explained to the students, along with some real causes of stock-market fluctuations.

Graph paper might be used to plot the daily stock values and the exchange average. In this way, the trend will become evident.

```
                    THE STOCK MARKET
DO YOU WANT THE INSTRUCTIONS (YES-TYPE 1, NO-TYPE 0)? 1

THIS PROGRAM PLAYS THE STOCK MARKET.  YOU WILL BE GIVEN
$10,000 AND MAY BUY OR SELL STOCKS.  THE STOCK PRICES WILL
BE GENERATED RANDOMLY AND THEREFORE THIS MODEL DOES NOT
REPRESENT EXACTLY WHAT HAPPENS ON THE EXCHANGE.  A TABLE
OF AVAILABLE STOCKS, THEIR PRICES, AND THE NUMBER OF SHARES
IN YOUR PORTFOLIO WILL BE PRINTED.  FOLLOWING THIS, THE
INITIALS OF EACH STOCK WILL BE PRINTED WITH A QUESTION
MARK.  HERE YOU INDICATE A TRANSACTION.  TO BUY A STOCK
TYPE +NNN, TO SELL A STOCK TYPE -NNN, WHERE NNN IS THE
NUMBER OF SHARES.  A BROKERAGE FEE OF 1% WILL BE CHARGED
ON ALL TRANSACTIONS.  NOTE THAT IF A STOCK'S VALUE DROPS
TO ZERO IT MAY REBOUND TO A POSITIVE VALUE AGAIN.  YOU
HAVE $10,000 TO INVEST.  USE INTEGERS FOR ALL YOUR INPUTS.
(NOTE:  TO GET A 'FEEL' FOR THE MARKET RUN FOR AT LEAST
10 DAYS)
-----GOOD LUCK!-----

STOCK                            INITIALS       PRICE/SHARE
INT. BALLISTIC MISSILES            IBM           85.75
RED CROSS OF AMERICA               RCA           85.5
LICHTENSTEIN, BUMRAP & JOKE        LBJ           155.25
AMERICAN BANKRUPT CO.              ABC           138
CENSURED BOOKS STORE               CBS           104.25

NEW YORK STOCK EXCHANGE AVERAGE:  113.75

TOTAL STOCK ASSETS ARE     $ 0
TOTAL CASH ASSETS ARE      $ 10000
TOTAL ASSETS ARE           $ 10000

WHAT IS YOUR TRANSACTION IN
IBM? 2
RCA? 3
LBJ? 1
ABC? 1
CBS? 1

**********  END OF DAY'S TRADING

STOCK           PRICE/SHARE    HOLDINGS      VALUE         NET PRICE CHANGE
IBM              96.5            2            193           10.75
RCA              81              3            243           -4.5
LBJ              153.5           1            153.5         -1.75
ABC              135.5           1            135.5         -2.5
CBS              99              1            99            -5.25

NEW YORK STOCK EXCHANGE AVERAGE:  113.1    NET CHANGE: -.65

TOTAL STOCK ASSETS ARE     $ 824
TOTAL CASH ASSETS ARE      $ 9166.25
TOTAL ASSETS ARE           $ 9990.25

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 5
RCA? 1
LBJ? 1
ABC? 1
CBS? 0
```


227

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	98.75	7	691.25	2.25
RCA	82.5	4	330	1.5
LBJ	154	2	308	.5
ABC	133.5	2	267	-2
CBS	102.75	1	102.75	3.75

NEW YORK STOCK EXCHANGE AVERAGE: 114.3 NET CHANGE: 1.2

TOTAL STOCK ASSETS ARE $ 1699
TOTAL CASH ASSETS ARE $ 8305.23
TOTAL ASSETS ARE $ 10004.23

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 3
RCA? 2
LBJ? 5
ABC? -1
CBS? 3

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	99.25	10	992.5	.5
RCA	82.25	6	493.5	-.25
LBJ	154.75	7	1083.25	.75
ABC	133.5	1	133.5	0
CBS	103.25	4	413	.5

NEW YORK STOCK EXCHANGE AVERAGE: 114.6 NET CHANGE: .3

TOTAL STOCK ASSETS ARE $ 3115.75
TOTAL CASH ASSETS ARE $ 6882.5
TOTAL ASSETS ARE $ 9998.25

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 5

RCA? 3
LBJ? 5
ABC? 3
CBS? 4

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	96.75	15	1451.25	-2.5
RCA	80.5	9	724.5	-1.75
LBJ	150	12	1800	-4.75
ABC	132	4	528	-1.5
CBS	98.75	8	790	-4.5

NEW YORK STOCK EXCHANGE AVERAGE: 111.6 NET CHANGE: -3

TOTAL STOCK ASSETS ARE $ 5293.75
TOTAL CASH ASSETS ARE $ 4526.95
TOTAL ASSETS ARE $ 9820.7

```
DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 0
RCA? -5
LBJ? -7
ABC? 0
CBS? -5

**********  END OF DAY'S TRADING

STOCK          PRICE/SHARE   HOLDINGS     VALUE        NET PRICE CHANGE
IBM              96.75         15          1451.25      0
RCA              66.75         4           267         -13.75
LBJ              150.75        5           753.75       .75
ABC              132           4           528          0
CBS              95.75         3           287.25      -3

NEW YORK STOCK EXCHANGE AVERAGE:  108.4    NET CHANGE: -3.2

TOTAL STOCK ASSETS ARE     $ 3287.25
TOTAL CASH ASSETS ARE      $ 6455.74
TOTAL ASSETS ARE           $ 9742.99

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? -10
RCA? -2
LBJ? 2
ABC? 2
CBS? 0

**********  END OF DAY'S TRADING

STOCK          PRICE/SHARE   HOLDINGS     VALUE        NET PRICE CHANGE
IBM              87.5          5           437.5       -9.25
RCA              58            2           116         -8.75
LBJ              135.25        7           946.75      -15.5
ABC              122.5         6           735         -9.5
CBS              98.75         3           296.25       3

NEW YORK STOCK EXCHANGE AVERAGE:  100.4    NET CHANGE: -8

TOTAL STOCK ASSETS ARE     $ 2531.5
TOTAL CASH ASSETS ARE      $ 6974.58
TOTAL ASSETS ARE           $ 9506.08

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? -4
RCA? -1
LBJ? -6
ABC? -2
CBS? -2
```

229

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	80	1	80	-7.5
RCA	51	1	51	-7
LBJ	121.75	1	121.75	-13.5
ABC	109.5	4	438	-13
CBS	91.5	1	91.5	-7.85

NEW YORK STOCK EXCHANGE AVERAGE: 90.75 NET CHANGE: -9.65

TOTAL STOCK ASSETS ARE $ 782.25
TOTAL CASH ASSETS ARE $ 8619.96
TOTAL ASSETS ARE $ 9402.21

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 0
RCA? 0
LBJ? 0
ABC? -3
CBS? 0

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	77.5	1	77.5	-2.5
RCA	52.25	1	52.25	1.25
LBJ	119.25	1	119.25	-2.5
ABC	107	1	107	-2.5
CBS	92.25	1	92.25	.75

NEW YORK STOCK EXCHANGE AVERAGE: 89.65 NET CHANGE: -1.1

TOTAL STOCK ASSETS ARE $ 448.25
TOTAL CASH ASSETS ARE $ 8945.18
TOTAL ASSETS ARE $ 9393.43

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 0
RCA? 0
LBJ? 0
ABC? 0
CBS? 10

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	74.5	1	74.5	-3
RCA	54	1	54	1.75
LBJ	107	1	107	-12.25
ABC	108	1	108	1
CBS	90.75	11	998.25	-1.5

230

```
NEW YORK STOCK EXCHANGE AVERAGE:  86.85    NET CHANGE: -2.8

TOTAL STOCK ASSETS ARE    $ 1341.75
TOTAL CASH ASSETS ARE     $ 8013.46
TOTAL ASSETS ARE          $ 9355.21

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 5
RCA? 6
LBJ? 10
ABC? 10
CBS? 10


**********  END OF DAY'S TRADING


STOCK         PRICE/SHARE     HOLDINGS     VALUE       NET PRICE CHANGE
IBM            73              6            438         -2.5
RCA            52.5            7            367.5       -1.5
LBJ            105             11           1155        -2
ABC            103.25          11           1135.75     -4.75
CBS            91.5            21           1921.5       .75


NEW YORK STOCK EXCHANGE AVERAGE:  84.85    NET CHANGE: -2

TOTAL STOCK ASSETS ARE    $ 5011.75
TOTAL CASH ASSETS ARE     $ 4221.92
TOTAL ASSETS ARE          $ 9233.67

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 0
HOPE YOU HAD FUN!!

READY
```

```
100 REM STOCK MARKET SIMULATION     -STOCK-
101 REM REVISED 6/18/70 (D. PESSEL, L. BRAUN, C. LOSIK)
102 REM IMP VRBLS: A-MRKT TRND SLP; B5-BRKRGE FEE; C-TTL CSH ASSTS;
103 REM C5-TTL CSH ASSTS (TEMP); C(I)-CHNG IN STK VAL; D-TTL ASSTS;
104 REM E1,E2-LRG CHNG MISC; I-STCK #; I1,I2-STCKS W LRG CHNG;
105 REM N1,N2-LRG CHNG DAY CNTS; P5-TTL DAYS PRCHSS; P(I)-PRTFL CNTNTS;
106 REM Q9-NEW CYCL?; S4-SGN OF A; S5-TTL DYS SLS; S(I)-VALUE/SHR;
107 REM T-TTL STCK ASSTS; T5-TTL VAL OF TRNSCTNS;
108 REM V3-LRG CHNG; X1-SMLL CHNG(<$1); Z4,Z5,Z6-NYSE AVE.; Z(I)-TRNSCTN
109  PRINT TAB(20);"THE STOCK MARKET"
110  DIM S(5),P(5),Z(5),C(5)
112 REM SLOPE OF MARKET TREND:A  (SAME FOR ALL STOCKS)
113  RANDOMIZE
114  LET A=INT((RND(X)/10)*100+.5)/100
115  LET T5=0
116  LET X9=0
117  LET N1=0
118  LET N2=0
119  LET E1=0
120  LET E2=0
121 REM INTRODUCTION
122  PRINT "DO YOU WANT THE INSTRUCTIONS (YES-TYPE 1, NO-TYPE 0)";
123  INPUT Z9
124  PRINT
125  PRINT
126  IF Z9<1 THEN 200
130  PRINT "THIS PROGRAM PLAYS THE STOCK MARKET.  YOU WILL BE GIVEN"
132  PRINT "$10,000 AND MAY BUY OR SELL STOCKS.  THE STOCK PRICES WILL"
134  PRINT "BE GENERATED RANDOMLY AND THEREFORE THIS MODEL DOES NOT"
135  PRINT "REPRESENT EXACTLY WHAT HAPPENS ON THE EXCHANGE.  A TABLE"
136  PRINT "OF AVAILABLE STOCKS, THEIR PRICES, AND THE NUMBER OF SHARES"
137  PRINT "IN YOUR PORTFOLIO WILL BE PRINTED.  FOLLOWING THIS, THE"
138  PRINT "INITIALS OF EACH STOCK WILL BE PRINTED WITH A QUESTION"
139  PRINT "MARK.  HERE YOU INDICATE A TRANSACTION.  TO BUY A STOCK"
140  PRINT "TYPE +NNN, TO SELL A STOCK TYPE -NNN, WHERE NNN IS THE"
141  PRINT "NUMBER OF SHARES.  A BROKERAGE FEE OF 1% WILL BE CHARGED"
142  PRINT "ON ALL TRANSACTIONS.  NOTE THAT IF A STOCK'S VALUE DROPS"
143  PRINT "TO ZERO IT MAY REBOUND TO A POSITIVE VALUE AGAIN.  YOU"
144  PRINT "HAVE $10,000 TO INVEST.  USE INTEGERS FOR ALL YOUR INPUTS."
145  PRINT "(NOTE:  TO GET A 'FEEL' FOR THE MARKET RUN FOR AT LEAST"
146  PRINT "10 DAYS)"
147  PRINT "-----GOOD LUCK!-----"
200 REM GENERATION OF STOCK TABLE; INPUT REQUESTS
210 REM INITIAL STOCK VALUES
220  LET S(1)=100
230  LET S(2)=85
240  LET S(3)=150
250  LET S(4)=140
260  LET S(5)=110
265 REM INITIAL T8 - # DAYS FOR FIRST TREND SLOPE (A)
266  LET T8=INT(4.99*RND(X)+1)
267 REM RANDOMIZE SIGN OF FIRST TREND SLOPE (A)
268  IF RND(X)>.5 THEN 270
269  LET A=-A
270 REM RANDOMIZE INITIAL VALUES
280  GOSUB 830
285 REM INITIAL PORTFOLIO CONTENTS
290  FOR I=1 TO 5
300  LET P(I)=0
305  LET Z(I)=0
310  NEXT I
320  PRINT
```

```
330  PRINT
333 REM INITIALIZE CASH ASSETS:C
335  LET C=10000
338 REM PRINT INITIAL PORTFOLIO
340  PRINT "STOCK";" ","INITIALS","PRICE/SHARE"
350  PRINT "INT. BALLISTIC MISSILES","  IBM",S(1)
352  PRINT "RED CROSS OF AMERICA","  RCA",S(2)
354  PRINT "LICHTENSTEIN, BUMRAP & JOKE","  LBJ",S(3)
356  PRINT "AMERICAN BANKRUPT CO.","  ABC",S(4)
358  PRINT "CENSURED BOOKS STORE","  CBS",S(5)
360  PRINT
361 REM NYSE AVERAGE:Z5; TEMP. VALUE:Z4; NET CHANGE:Z6
363  LET Z4=Z5
364  LET Z5=0
365  LET T=0
370  FOR I=1 TO 5
375  LET Z5=Z5+S(I)
380  LET T=T+S(I)*P(I)
390  NEXT I
391  LET Z5=INT(100*(Z5/5)+.5)/100
392  LET Z6=INT((Z5-Z4)*100+.5)/100
393 REM TOTAL ASSETS:D
394  LET D=T+C
395  IF X9>0 THEN 398
396  PRINT "NEW YORK STOCK EXCHANGE AVERAGE: "Z5
397  GO TO 399
398  PRINT "NEW YORK STOCK EXCHANGE AVERAGE: "Z5"   NET CHANGE: "Z6
399  PRINT
400  LET T=INT(100*T+.5)/100
401  PRINT "TOTAL STOCK ASSETS ARE   $";T
403  LET C=INT(100*C+.5)/100
405  PRINT "TOTAL CASH ASSETS ARE    $";C
407  LET D=INT(100*D+.5)/100
408  PRINT "TOTAL ASSETS ARE         $";D
410  PRINT
411  IF X9=0 THEN 416
412  PRINT "DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)";
413  INPUT Q9
414  IF Q9<1 THEN 998
416 REM INPUT TRANSACTIONS
420  PRINT "WHAT IS YOUR TRANSACTION IN"
430  PRINT "IBM";
440  INPUT Z(1)
450  PRINT "RCA";
460  INPUT Z(2)
470  PRINT "LBJ";
480  INPUT Z(3)
490  PRINT "ABC";
500  INPUT Z(4)
510  PRINT "CBS";
520  INPUT Z(5)
525  PRINT
530 REM TOTAL DAY'S PURCHASES IN $:P5
540  LET P5=0
550 REM TOTAL DAY'S SALES IN $:S5
560  LET S5=0
570  FOR I=1 TO 5
575  LET Z(I)=INT(Z(I)+.5)
580  IF Z(I)<=0 THEN 610
590  LET P5=P5+Z(I)*S(I)
600  GO TO 620
610  LET S5=S5-Z(I)*S(I)
612  IF -Z(I)<=P(I) THEN 620
614  PRINT "YOU HAVE OVERSOLD A STOCK; TRY AGAIN."
616  GO TO 420
620  NEXT I
```

```
622 REM TOTAL VALUE OF TRANSACTIONS:T5
625  LET T5=P5+S5
630 REM BROKERAGE FEE:B5
640  LET B5=INT(.01*T5*100+.5)/100
650 REM CASH ASSETS=OLD CASH ASSETS-TOTAL PURCHASES
652 REM -BROKERAGE FEES+TOTAL SALES:C5
654  LET C5=C-P5-B5+S5
656  IF C5>=0 THEN 674
658  PRINT "YOU HAVE USED $"-C5" MO
RE THEN YOU HAVE."
660  GO TO 420
674  LET C=C5
675 REM CALCULATE NEW PORTFOLIO
680  FOR I=1 TO 5
690  LET P(I)=P(I)+Z(I)
700  NEXT I
710 REM CALCULATE NEW STOCK VALUES
720  GOSUB 830
730 REM PRINT PORTFOLIO
751 REM BELL RINGING-DIFFERENT ON MANY COMPUTERS
752  FOR I=1 TO 20
753  PRINT CHR$(135);
754  NEXT I
755  PRINT
756  PRINT "**********  END OF DAY'S TRADING"
757  PRINT
758  PRINT
759  IF X9<1 THEN 769
769  PRINT "STOCK","PRICE/SHARE","HOLDINGS","VALUE","NET PRICE CHANGE"
770  PRINT "IBM", S(1), P(1), S(1)*P(1), C(1)
771  PRINT "RCA", S(2), P(2), S(2)*P(2), C(2)
772  PRINT "LBJ", S(3), P(3), S(3)*P(3), C(3)
773  PRINT "ABC", S(4), P(4), S(4)*P(4), C(4)
774  PRINT "CBS", S(5), P(5), S(5)*P(5), C(5)
775  LET X9=1
780  PRINT
790  PRINT
810  GO TO 360
829 REM NEW STOCK VALUES - SUBROUTINE
830 REM RANDOMLY PRODUCE NEW STOCK VALUES BASED ON PREVIOUS
831 REM DAY'S VALUES
832 REM N1,N2 ARE RANDOM NUMBERS OF DAYS WHICH RESPECTIVELY
833 REM DETERMINE WHEN STOCK I1 WILL INCREASE 10 PTS. AND STOCK
834 REM I2 WILL DECREASE 10 PTS.
840 REM IF N1 DAYS HAVE PASSED, PICK AN I1, SET E1, DETERMINE NEW N1
841  IF N1>0 THEN 850
845  LET I1=INT(4.99*RND(X)+1)
846  LET N1=INT(4.99*RND(X)+1)
847  LET E1=1
850 REM IF N2 DAYS HAVE PASSED, PICK AN I2, SET E2, DETERMINE NEW N2
851  IF N2>0 THEN 860
855  LET I2=INT(4.99*RND(X)+1)
856  LET N2=INT(4.99*RND(X)+1)
857  LET E2=1
860 REM DEDUCT ONE DAY FROM N1 AND N2
861  LET N1=N1-1
862  LET N2=N2-1
890 REM LOOP THROUGH ALL STOCKS
900  FOR I=1 TO 5
910  LET X1=RND(X)
915  IF X1>.25 THEN 920
```

```
916  LET X1=.25
917  GO TO 935
920  IF X1>.50 THEN 925
921  LET X1=.50
922  GO TO 935
925  IF X1>.75 THEN 930
926  LET X1=.75
927  GO TO 935
930  LET X1=0.0
931 REM BIG CHANGE CONSTANT:V3  (SET TO ZERO INITIALLY)
935  LET V3=0
936  IF E1<1 THEN 945
937  IF INT(I1+.5)<>INT(I+.5) THEN 945
938 REM ADD 10 PTS. TO THIS STOCK;  RESET E1
939  LET V3=10
943  LET E1=0
945  IF E2<1 THEN 955
947  IF INT(I2+.5)<>INT(I+.5) THEN 955
948 REM SUBTRACT 10 PTS. FROM THIS STOCK;  RESET E2
949  LET V3=V3-10
953  LET E2=0
954 REM C(I) IS CHANGE IN STOCK VALUE
955  LET C(I)=INT(A*S(I))+X1+INT(3-6*RND(X)+.5)+V3
956  LET C(I)=INT(100*C(I)+.5)/100
957  LET S(I)=S(I)+C(I)
960  IF S(I)>0 THEN 967
964  LET C(I)=0
965  LET S(I)=0
966  GO TO 970
967  LET S(I)=INT(100*S(I)+.5)/100
970  NEXT I
972 REM AFTER T8 DAYS RANDOMLY CHANGE TREND SIGN AND SLOPE
973  LET T8=T8-1
974  IF T8<1 THEN 985
980  RETURN
985 REM RANDOMLY CHANGE TREND SIGN AND SLOPE (A), AND DURATION OF
986 REM OF TREND (T8)
990  LET T8=INT(4.99*RND(X)+1)
992  LET A=INT((RND(X)/10)*100+.5)/100
993  LET S4=RND(X)
994  IF S4<=.5 THEN 997
995  LET A=-A
997  RETURN
998  PRINT "HOPE YOU HAD FUN!!"
999  END
```

233-B

DISCIPLINE CALCULUS-GRADE 13

SUBJECT AREA OF A SURFACE OF REVOLUTION

PROGRAM NAME SURFAR

DESCRIPTION:

This program approximates the area of a surface of revolution, by computing lateral areas of frustrums of cones of revolution.

OBJECTIVES:

A. The saving of time in computations.

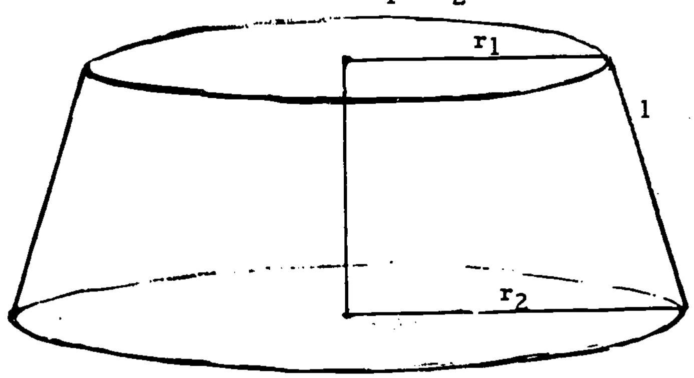
B. The speedy demonstration of limiting processes.

C. The focusing of attention upon those processes needed to develop the analytic approach.

PRELIMINARY PREPARATION:

Before running this program, the lateral area of a frustrum of a cone should be discussed. Many students in the Advanced Placement Program have not taken a course in Solid Geometry and may be unfamiliar with the formula:

$$\text{Lateral Area} = \pi\, l\, (r_1 + r_2)$$



Frustrum of a Cone

Whether or not this formula is derived in class will depend on the amount of time available. Most likely it will merely be stated; students who have not taken Solid Geometry may be asked to look up the derivation on their own.

AREA OF A SURFACE OF REVOLUTION

THIS PROGRAM APPROXIMATES THE AREA OF A SURFACE OF REVOLUTION BY COMPUTING LATERAL AREAS OF FRUSTUMS OF CONES OF REVOLUTION. TYPE IN YOUR FUNCTION OF X (Y=F(X)), WHOSE GRAPH WILL BE ROTATED ABOUT THE X AXIS, AS FOLLOWS:

```
1 GO TO 200
300 DEF FNY(X)=...(YOUR FUNCTION OF X)...
RUN
```

FOR EXAMPLE, TO USE THE FUNCTION Y=X↑2 YOU WOULD TYPE:

```
1 GO TO 200
300 DEF FNY(X)=X↑2
RUN
```

YOU MIGHT TRY THAT AS YOUR FIRST RUN.
END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY.

READY

```
1 GO TO 200
300 DEF FNY(X)=X↑2
RUN
```

WHAT ARE THE ABSCISSAS OF THE END POINTS OF THE SECTION TO BE CONSIDERED (SMALLER FIRST: P,Q)? -3,2

NUMBER OF SUBINTERVALS	SUM OF APPROXIMATING AREAS	% CHANGE IN SUM
1	288.7871	NO PREVIOUS VALUE
2	324.6229	11.68411
4	317.6819	2.161263
8	315.3346	.7416313
16	314.7434	.1876635
32	314.5933	.04769154
64	314.5557	.01197374
128	314.5461	3.025796E-3

WOULD YOU LIKE TO TRY NEW END POINTS (1-YES, 0-NO)? 0
TO ENTER A NEW FUNCTION YOU NEED ONLY RETYPE LINE 300 AND 'RUN'. SEE INSTRUCTIONS FOR MORE DETAILS.
IF YOU ARE FINISHED, TYPE '1' AND THE 'RETURN' KEY.

READY

1

235

```
100 REM AREA OF A SURFACE OF REVOLUTION, Q. J. O'CONNOR, 7/12/68
101 REM REVISED 8/21/70 (D. PESSEL)
105 PRINT TAB(17); "AREA OF A SURFACE OF REVOLUTION"
106 PRINT
110 PRINT "    THIS PROGRAM APPROXIMATES THE AREA OF A SURFACE OF"
120 PRINT "REVOLUTION BY COMPUTING LATERAL AREAS OF FRUSTUMS OF CONES"
130 PRINT "OF REVOLUTION.  TYPE IN YOUR FUNCTION OF X (Y=F(X)),"
131 PRINT "WHOSE GRAPH WILL BE ROTATED ABOUT THE X AXIS, AS FOLLOWS:"
150 PRINT
160 PRINT "        1 GO TO 200"
170 PRINT "        300 DEF FNY(X)=...(YOUR FUNCTION OF X)..."
180 PRINT "        RUN"
185 PRINT
186 PRINT "FOR EXAMPLE, TO USE THE FUNCTION Y=X^2 YOU WOULD TYPE:"
187 PRINT
188 PRINT "        1 GO TO 200"
189 PRINT "        300 DEF FNY(X)=X^2"
190 PRINT "        RUN"
191 PRINT
192 PRINT "YOU MIGHT TRY THAT AS YOUR FIRST RUN."
193 PRINT "END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY."
195 STOP
200 REM COMPUTATION SECTION OF PROGRAM
220 PRINT "WHAT ARE THE ABSCISSAS OF THE END POINTS OF THE SECTION"
230 PRINT "TO BE CONSIDERED (SMALLER FIRST: P,Q)";
240 INPUT P,Q
245 IF P<=Q THEN 250
246 PRINT "P CANNOT BE GREATER THAN Q!"
247 GO TO 220
250 PRINT
260 PRINT "NUMBER OF       SUM OF                        % CHANGE"
270 PRINT "SUBINTERVALS    APPROXIMATING AREAS           IN SUM"
280 PRINT "------------    -------------------           --------"
285 LET E1=0
300 DEF FNY(X)=X^2
305 FOR N=1 TO 9
310 LET E=2^(N-1)
320 LET H=(Q-P)/E
330 LET S=0
340 FOR I=0 TO (E-1)
350 LET G=FNY(P+I*H+H)+FNY(P+I*H)
360 LET M=FNY(P+I*H+H)-FNY(P+I*H)
370 LET L=3.14159*G*SQR(M*M+H*H)
380 LET S=S+L
390 NEXT I
395 IF S1=0 THEN 405
396 LET W=100*(ABS(S-S1))/((S+S1)/2)
399 IF S1=0 THEN 405
400 PRINT E,S," ",W
402 IF W<1E-2 THEN 420
404 GO TO 407
405 PRINT E,S," ","NO PREVIOUS VALUE"
407 LET S1=S
410 NEXT N
420 PRINT
430 PRINT "WOULD YOU LIKE TO TRY NEW END POINTS (1-YES, 0-NO)";
431 INPUT Q1
432 IF Q1>0 THEN 220
440 PRINT "TO ENTER A NEW FUNCTION YOU NEED ONLY RETYPE LINE"
450 PRINT "300 AND 'RUN'.  SEE INSTRUCTIONS FOR MORE DETAILS."
460 PRINT "IF YOU ARE FINISHED, TYPE '1' AND THE 'RETURN' KEY."
500 END
```

236

DISCIPLINE CALCULUS - GRADE 13

SUBJECT VOLUME OF ANY SOLID OF REVOLUTION, (ANALYTICALLY DEFINED)

PROGRAM NAME VOLSOL

DESCRIPTION:

Through the use of cylindrical discs, the program approximates the volume of a solid of revolution generated by rotating about the x-axis the area bounded by $y = f(x)$, the x-axis, and the vertical lines $x = a$ and $x = b$.

OBJECTIVES:

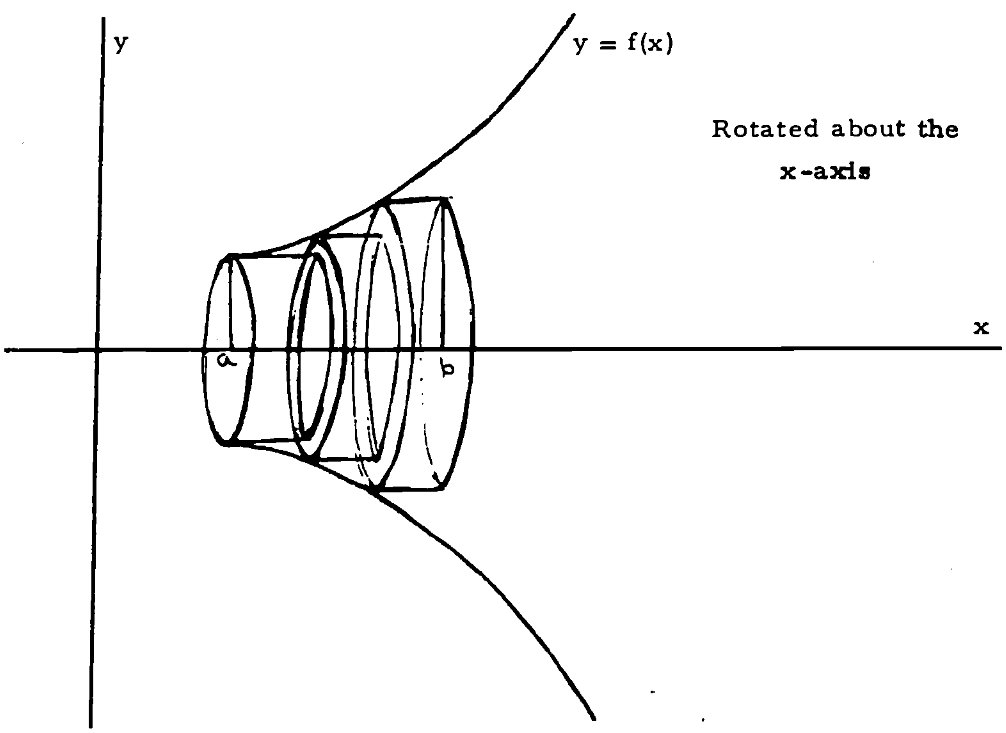
To help the student understand the analytic procedures and to appreciate the nature of the limiting process.

PRELIMINARY PREPARATION:

The class should be reminded of the formula for the volume of a cylinder, and the way in which a cylinder is generated by rotating a rectangle about one of its sides.

DISCUSSION:

It would be desirable to make use of an overhead projector transparency to display the cylindrical discs generated.



Approximation of Volume of Revolution by Cylindrical Discs

VOLUME OF A SOLID OF REVOLUTION

THIS PROGRAM USES CYLINDRICAL DISCS TO APPROXIMATE THE VOLUME OF A SOLID OF REVOLUTION. THE SOLID IS GENERATED BY ROTATING ABOUT THE X-AXIS THE AREA BOUNDED BY Y=F(X), THE LINES X=A AND X=B, AND THE X-AXIS.

TO INPUT YOUR FUNCTION OF X (Y=F(X)) TYPE AS FOLLOWS:

```
1 GO TO 200
220 DEF FNY(X)=....(YOUR FUNCTION OF X)....
RUN
```

FOR EXAMPLE, TO USE THE FUNCTION Y=X↑2 YOU WOULD TYPE:

```
1 GO TO 200
220 DEF FNY(X)=X↑2
RUN
```

YOU MIGHT TRY THAT AS YOUR FIRST EXAMPLE.
END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY.

```
READY

1 GO TO 200
220 DEF FNY(X)=X↑2
RUN

WHAT ARE YOUR VALUES FOR A AND B (SMALLER FIRST: A,B)? 0,5
```

NUMBER OF CYLINDERS	SUM OF CYLINDER VOLUMES	% CHANGE IN SUM
1	0	NO PREV. VALUE, OR IT WAS ZERO
2	306.7959	NO PREV. VALUE, OR IT WAS ZERO
4	939.5624	206.25
8	1400.955	49.10714
16	1669.476	19.16702
32	1813.291	8.614392
64	1887.594	4.097653
128	1925.344	1.999911
256	1944.369	.9881206
512	1953.918	.4911339

```
WOULD YOU LIKE TO TRY YOUR OWN 'NUMBER OF CYLINDERS' (1-YES, 0-NO)? 1
HOW MANY CYLINDERS WOULD YOU LIKE TO TRY? 700

FOR  700  CYLINDERS THE VOLUME IS  1956.487  .

WOULD YOU LIKE TO TRY AGAIN (1-YES, 0-NO)? 0

*****

WOULD YOU LIKE TO TRY NEW VALUES OF A AND B (1-YES, 0-NO)? 0
TO USE A NEW FUNCTION YOU NEED ONLY RETYPE LINE 220 AND
'RUN'.  SEE INSTRUCTIONS FOR MORE DETAILS.
IF YOU ARE FINISHED, TYPE '1' AND THE 'RETURN' KEY.

READY

1
```

```
100 REM VOLUME OF A SOLID OF REVOLUTION, Q. J. O'CONNOR, 8/1/68
101 REM REVISED 8/24/70 (D. PESSEL)
110 PRINT TAB(15);"VOLUME OF A SOLID OF REVOLUTION"
111 PRINT
115 PRINT"      THIS PROGRAM USES CYLINDRICAL DISCS TO APPROXIMATE"
117 PRINT"THE VOLUME OF A SOLID OF REVOLUTION.  THE SOLID IS GENE-"
120 PRINT"RATED BY ROTATING ABOUT THE X-AXIS THE AREA BOUNDED BY"
130 PRINT"Y=F(X), THE LINES X=A AND X=B, AND THE X-AXIS."
135 PRINT
140 PRINT"TO INPUT YOUR FUNCTION OF X (Y=F(X)) TYPE AS FOLLOWS:"
141 PRINT
145 PRINT"            1 GO TO 200"
150 PRINT"            220 DEF FNY(X)=....(YOUR FUNCTION OF X)...."
160 PRINT"            RUN"
161 PRINT
165 PRINT"FOR EXAMPLE, TO USE THE FUNCTION Y=X↑2 YOU WOULD TYPE:"
166 PRINT
167 PRINT"            1 GO TO 200"
168 PRINT"            220 DEF FNY(X)=X↑2"
169 PRINT"            RUN"
170 PRINT
175 PRINT"YOU MIGHT TRY THAT AS YOUR FIRST EXAMPLE."
176 PRINT"END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY."
180 STOP
199 PRINT
200 PRINT"WHAT ARE YOUR VALUES FOR A AND B (SMALLER FIRST: A,B)";
210 INPUT A,B
211 IF A<B THEN 214
212 PRINT"A MUST BE SMALLER THAN B!"
213 GO TO 200
214 PRINT
215 PRINT"NUMBER OF           SUM OF                 % CHANGE"
216 PRINT"CYLINDERS       CYLINDER VOLUMES            IN SUM"
217 PRINT"---------       ----------------           --------"
218 LET V1=0
220 DEF FNY(X)=X↑2
230 FOR N=1 TO 10
240 LET D=2↑(N-1)
250 LET H=(B-A)/D
260 LET V=0
270 FOR I=0 TO (D-1)
280 LET Y=FNY(A+I*H)
290 LET V=V+3.14159*Y*Y*H
300 NEXT I
305 IF V1=0 THEN 315
307 LET P=100*(ABS(V-V1))/V1
310 PRINT D,V," ",P
```

```
312 IF P<.5 THEN 330
313 GO TO 318
315 PRINT D,V,"     NO PREV. VALUE, OR IT WAS ZERO"
318 LET V1=V
320 NEXT N
330 PRINT
333 PRINT
334 PRINT"WOULD YOU LIKE TO TRY YOUR OWN 'NUMBER OF CYLINDERS' (1-YES";
335 PRINT", 0-NO)";
336 INPUT Q5
337 IF Q5<1 THEN 377
338 PRINT"HOW MANY CYLINDERS WOULD YOU LIKE TO TRY";
339 INPUT D1
340 IF D1>1 THEN 343
341 PRINT"NUMBER OF CYLINDERS MUST BE GREATER THAN ZERO!"
342 GO TO 338
343 IF D1<1000 THEN 347
344 PRINT"THIS IS A VERY LARGE NUMBER OF CYLINDERS AND MAY TAKE"
345 PRINT"A LONG TIME TO RUN."
347 LET V2=0
348 LET H1=(B-A)/D1
349 LET D1=INT(D1+.5)
350 FOR I=0 TO (D1-1)
352 LET Y1=FNY(A+I*H1)
354 LET V2=V2+3.14159*Y1*Y1*H1
356 NEXT I
358 PRINT
360 PRINT "FOR "D1" CYLINDERS THE VOLUME IS "V2" ."
362 PRINT
363 PRINT"WOULD YOU LIKE TO TRY AGAIN (1-YES, 0-NO)";
364 INPUT Q6
365 IF Q6>0 THEN 338
377 PRINT
378 PRINT"*****"
379 PRINT
380 PRINT"WOULD YOU LIKE TO TRY NEW VALUES OF A AND B (1-YES, 0-NO)";
382 INPUT Q1
384 IF Q1>0 THEN 199
386 PRINT"TO USE A NEW FUNCTION YOU NEED ONLY RETYPE LINE 220 AND"
388 PRINT"'RUN'.  SEE INSTRUCTIONS FOR MORE DETAILS."
390 PRINT"IF YOU ARE FINISHED, TYPE '1' AND THE 'RETURN' KEY."
500 END
```

HUNTINGTON COMPUTER PROJECT

A TEACHER'S MANUAL

(COMPUTER - RELATED MATERIALS)

Second Edition

January 31, 1971

Director: Dr. Ludwig Braun
Assistant Director: Dr. Marian Visich, Jr.

Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

Developed by the Huntington Computer Project during the period May, 1968 and September, 1970. This effort was supported by the National Science Foundation under Grant No. J000079.

The enclosed material is a compilation of computer programs developed during the period May, 1968 to September, 1970. These programs were developed by teachers and students in the high schools which participated with us, and by the Project staff.

All of the enclosed programs have been tested on a Digital Equipment Corporation TSS-8 time-shared computer during the summer of 1970. To the best of our ability, we have assured ourselves that the programs actually run. It should be pointed out, however, that we were not able to make an exhaustive exploration of the programs. There may be undiscovered bugs (if there aren't, it may be the first time in the history of computing). We would appreciate hearing of any which emerge in the future.

These programs run in the version of BASIC which existed on the TSS-8 in August, 1970, and should run on most other versions of BASIC. The major potential problem on other machines is the output format (DEC uses 14 columns per print zone, while some other manufacturers use 15; we used the TAB function, which doesn't exist in all BASIC compiles). It may be necessary to make some minor changes in programs to adjust this format. Another possible problem is in the use of the RANDOMIZE command in some programs to start the random-number generator at a random point. If this command is not available, some other means should be devised for randomizing the start.

It is our sincere hope that these programs and their supporting documentation will be helpful to educators who are exploring the uses of computers in education.

We are anxious to hear of any bugs, errors, or improvements in these programs, and are especially anxious to hear of any novel ways of using them.

Ludwig Braun
Marian Visich, Jr.

TABLE OF CONTENTS

Volume I

Volume II

CHEMISTRY

Volume III

MATHEMATICS

MATHEMATICS (con't)

Volume IV

PHYSICS

Volume V

SOCIAL STUDIES

TEACHER ASSISTANCE

DISCIPLINE PHYSICS

SUBJECT MAGNETIC FIELDS

PROGRAM NAME BFIELD

DESCRIPTION:

Student may visualize the effects of current on the magnetic field produced about a single conductor. The student may also explore the fields produced by the current flow in two parallel wires. The current in the two wires may be chosen in the same direction or in opposite directions.

OBJECTIVES:

To acquaint student with the magnetic fields produced by current carrying conductors.

PRELIMINARY PREPARATION:

A. Student - Prior preparation involving currents and fields.

B. Materials - None

DISCUSSION:

Student may qualitatively explore the effects of currents on the production of magnetic fields by successively increasing or decreasing the current. The resulting magnetic field is printed out showing the relative magnitude of the field in relation to the position of the current.

The student may also view the magnetic field due to two currents in the same or opposite direction.

This program may also be used to introduce groups to the field concept. In addition, minor modification of the program will produce a series of plots which will demonstrate an expanding field resulting from an increasing current.

```
WOULD YOU LIKE TO TRY TWO DIFFERENT CURRENTS AT THE SAME
TIME (YES=1; NO=0)? 0
WOULD YOU RATHER TRY ANOTHER CURRENT (YES=1; NO=0)? 1
ENTER YOUR VALUE OF CURRENT? 6

THE MAGNITUDE OF THE FIELD DECREASES FROM 9 TO 0.
9 IS THE HIGHEST POSSIBLE FIELD STRENGTH, AND 0
(WHICH MEANS A ZERO FIELD) THE LOWEST.


                        METERS
          -1.2      -.6        0         .6       1.2
METERS    .+.........+.........+.........+.........+.
     1.2  .        2222222222222222222222222        .
     1.1  .      22222222222222222222222222222      .
     1    .    222222222222         222222222222    .
     .9   .  2222222222                 2222222222  .
     .8   . 22222222     3333333333333     22222222 .
     .7   .22222222   333333       333333   22222222.
     .6   .222222    3333  444444444  3333    222222.
     .5   .22222   3333  44   555   44  3333   22222.
     .4   .2222   333  44 55 66666 55 44  333   2222.
     .3   .2222   33  44 5 67 888 76 5 44  33   2222.
     .2   .222   333 44 56  9     9  65 44 333   222.
     .1   .222   33  4 5   9       9   5 4  33   222.
     0    .222   33  4 56 8    +    8 65 4  33   222.
    -.1   .222   33  4 5   9       9   5 4  33   222.
    -.2   .222   333 44 56  9     9  65 44 333   222.
    -.3   .2222   33  44 5 67 888 76 5 44  33   2222.
    -.4   .2222   333  44 55 66666 55 44  333   2222.
    -.5   .22222   3333  44   555   44  3333   22222.
    -.6   .222222    3333  444444444  3333    222222.
    -.7   .22222222   333333       333333   22222222.
    -.8   . 22222222     3333333333333     22222222 .
    -.9   .  2222222222                 2222222222  .
    -1    .    222222222222         222222222222    .
    -1.1  .      22222222222222222222222222222      .
    -1.2  .        2222222222222222222222222        .
          .+.........+.........+.........+.........+.
```

```
WOULD YOU LIKE TO TRY TWO DIFFERENT CURRENTS AT THE SAME
TIME (YES=1; NO=0)? 1
THE TWO CURRENTS WILL BE SEPARATED BY 1.0 METER. (NOTE:  IF
THE CURRENTS ARE TO BE OPPOSITELY DIRECTED, STATE ONE OF THEM
AS A NEGATIVE VALUE).
ENTER THE TWO CURRENTS? 4,-8


                          METERS
            -1.2      -.6        0         .6       1.2
METERS      .+.........+.........+.........+.........+.
     1.2    . 11111111111      222222222222222222222  .
     1.1    . 111111111     22222222222222222222222222.
     1      . 11111111    2222222               222222.
      .9    . 1111111   22222     333333333333     222.
      .8    . 111111   2222   3333333      333333    2.
      .7    . 11111   222  3333    4444444444   3333  .
      .6    . 11111  222 333  4444   555555  444  333 .
      .5    . 1111  22  3  44   555  666666  55 44  33.
      .4    .  111  2 3344 555  666 77     7 6 55 4  3.
      .3    .  111 2 3 45 66   777 8 9        76 5 4  .
      .2    .  111 2   678   8888 9           876 544 .
      .1    .  111 23469      9999             8 65 4 .
     0      .  1112 3 7  +               -     8765 4 .
     -.1    .  111 23469      9999             8 65 4 .
     -.2    .  111 2   678   8888 9           876 544 .
     -.3    .  111 2 3 45 66   777 8 9        76 5 4  .
     -.4    .  111  2 3344 555  666 77     7 6 55 4  3.
     -.5    . 1111  22  3  44   555  666666  55 44  33.
     -.6    . 11111  222 333  4444   555555  444  333 .
     -.7    . 11111   222  3333    4444444444   3333  .
     -.8    . 111111   2222   3333333      333333    2.
     -.9    . 1111111   22222     333333333333     222.
     -1     . 11111111    2222222               222222.
     -1.1   . 111111111     22222222222222222222222222.
     -1.2   . 11111111111      222222222222222222222  .
            .+.........+.........+.........+.........+.

WANT TO TRY AGAIN (YES=1; NO=0)? 1
THE TWO CURRENTS WILL BE SEPARATED BY 1.0 METER. (NOTE:  IF
THE CURRENTS ARE TO BE OPPOSITELY DIRECTED, STATE ONE OF THEM
AS A NEGATIVE VALUE).
ENTER THE TWO CURRENTS? 4,4
```

```
                        METERS
          -1.2       -.6        0          .6       1.2
METERS    .+.........+.........+.........+.........+.
   1.2    .222222222222222222222222222222222222222222.
   1.1    .222222222                         222222222.
   1      .22222                                22222.
   .9     .22         3333333333333333333         22.
   .8     .       3333333333333333333333333333        .
   .7     .    3333333333333333333333333333333333     .
   .6     .   33333         3333333          33333    .
   .5     .3333   44444444   33333   44444444   3333.
   .4     .333  444   555 444 33333 444 555   444  333.
   .3     .33   44 5   666 5 4 33333 4 5 666  5 44  33.
   .2     .3  44 56   8 8 6543   2   3456 8 8  65 44  3.
   .1     .3 44 5  8      8 432 1 234 8      8  5 44 3.
   0      .3 44 567    +  64  101  46   +    765 44 3.
  -.1     .3 44 5  8      8 432 1 234 8      8  5 44 3.
  -.2     .3  44 56   8 8 6543   2   3456 8 8  65 44  3.
  -.3     .33   44 5   666 5 4 33333 4 5 666  5 44  33.
  -.4     .333  444   555 444 33333 444 555   444  333.
  -.5     .3333   44444444   33333   44444444   3333.
  -.6     .   33333         3333333          33333    .
  -.7     .    3333333333333333333333333333333333     .
  -.8     .       3333333333333333333333333333        .
  -.9     .22         3333333333333333333         22.
  -1      .22222                                22222.
  -1.1    .222222222                         222222222.
  -1.2    .222222222222222222222222222222222222222222.
          .+.........+.........+.........+.........+.
```

WANT TO TRY AGAIN (YES=1; NO=0)? 1
THE TWO CURRENTS WILL BE SEPARATED BY 1.0 METER. (NOTE: IF THE CURRENTS ARE TO BE OPPOSITELY DIRECTED, STATE ONE OF THEM AS A NEGATIVE VALUE).
ENTER THE TWO CURRENTS? 4,-4

```
                      METERS
         -1.2      -.6       0         .6        1.2
METERS   .+.........+.........+.........+.........+.
    1.2  .      11111111111111111111111111111      .
    1.1  .   11111111111111111111111111111111111   .
    1    . 111111111111111111111111111111111111111 .
     .9  .111111111111                 111111111111.
     .8  .11111111       22222222222       11111111.
     .7  .111111    222222222222222222222    111111.
     .6  .1111   22222                 22222   1111.
     .5  .111   222  3333333333333333333  222   111.
     .4  .11  222 33  44444444444444444  33 222  11.
     .3  .1  222 3 4 55  55555555555  55 4 3 222  1.
     .2  .1  22 3     88 7 66   66 7 88     3 22  1.
     .1  .  22 3 4 7     9 7 666 7 9     7 4 3 22  .
    0    .  22 3  6   +     7   7     -   6  3 22  .
    -.1  .  22 3 4 7     9 7 666 7 9     7 4 3 22  .
    -.2  .1  22 3     88 7 66   66 7 88     3 22  1.
    -.3  .1  222 3 4 55  55555555555  55 4 3 222  1.
    -.4  .11  222 33  44444444444444444  33 222  11.
    -.5  .111   222  3333333333333333333  222   111.
    -.6  .1111   22222                 22222   1111.
    -.7  .111111    222222222222222222222    111111.
    -.8  .11111111       22222222222       11111111.
    -.9  .111111111111                 111111111111.
    -1   . 111111111111111111111111111111111111111 .
    -1.1 .   11111111111111111111111111111111111   .
    -1.2 .      11111111111111111111111111111      .
         .+.........+.........+.........+.........+.

WANT TO TRY AGAIN (YES=1; NO=0)? 0
WELL I GUESS YOU'RE ALL THROUGH. THANKS-- SEE Y'A

READY
```

```
1REM A.C. CAGGIANO; PATCHOGUE H.S.; PHYSICS; 7-'69
2 REM  THIS PROGRAM PERMITS A STUDENT TO VISUALIZE THE MAGNETIC
3 REM INDUCTION ABOUT A SINGLE CONDUCTER AND THE INFLUENCE OF THE
4 REM CURRENT ON THE MAGNITUDE OF THE FIELD. THE STUDENT MAY ALSO
5 REM VIEW THE MAGNETIC FIELD DUE TO TWO CURRENTS IN THE
6 REM SAME OR OPPOSITE DIRECTIONS.
7 REM
8REM IT SHOULD BE NOTED THAT THE PRINTOUT FOR EACH FIELD PLOT TAKES
9 REM ABOUT 4 MINUTES
10 REM
11 REM  REVISED BY L. BRAUN AND C. LOSIK  7-28-70
12 REM
13 GO TO 240
20 PRINT"THIS PROGRAM WILL PERMIT YOU TO EXPLORE THE MAGNETIC FIELD"
30 PRINT"ABOUT A CURRENT DIRECTED INTO THE PAGE AS A FUNCTION OF THE"
40 PRINT"CURRENT MAGNITUDE."
50 PRINT
60 PRINT"WHAT WILL BE YOUR INITIAL CURRENT (SELECT POSITIVE VALUES"
70 PRINT"BETWEEN 1 AND 8 AMPERES)."
80 PRINT"ENTER YOUR VALUE OF CURRENT";
90 INPUT I1
95 IF ABS(I1)>8 THEN 110
100 IF ABS(I1)>=1 THEN 130
110 PRINT"C'MON NOW-- ENTER PROPER VALUES."
120 GOTO 80
130 IF K>0 THEN 180
140 PRINT
150 PRINT "THE MAGNITUDE OF THE FIELD DECREASES FROM 9 TO 0. "
155 PRINT "9 IS THE HIGHEST POSSIBLE FIELD STRENGTH, AND 0"
160 PRINT "(WHICH MEANS A ZERO FIELD) THE LOWEST."
170 PRINT
180 GOSUB 440
190 LET K=K+1
200 PRINT
210 IF K=2 THEN 240
220 PRINT"SELECT A DIFFERENT CURRENT."
230 GOTO 80
240 PRINT"WOULD YOU LIKE TO TRY TWO DIFFERENT CURRENTS AT THE SAME"
250 PRINT"TIME (YES=1; NO=0)";
260 INPUT Q
270 IF Q=1 THEN 330
275 IF Q<>0 THEN 240
280 PRINT"WOULD YOU RATHER TRY ANOTHER CURRENT (YES=1; NO=0)";
290 INPUT P
300 IF P=1 THEN 80
305 IF P<>0 THEN 280
310 PRINT"WELL I GUESS YOU'RE ALL THROUGH. THANKS-- SEE Y'A"
320 STOP
330 PRINT"THE TWO CURRENTS WILL BE SEPARATED BY 1.0 METER. (NOTE: IF"
340 PRINT"THE CURRENTS ARE TO BE OPPOSITELY DIRECTED, STATE ONE OF THEM"
350 PRINT"AS A NEGATIVE VALUE)."
360 PRINT"ENTER THE TWO CURRENTS";
370 INPUT I1,I2
380 PRINT
390 GOSUB 440
400 PRINT"WANT TO TRY AGAIN (YES=1; NO=0)";
410 INPUT P
420 IF P=1 THEN 330
423 IF P=0 THEN 310
425 GO TO 400
440 PRINT
450 PRINT " "," ","METERS"
460 PRINT" ","-1.2       -.6        0        .6        1.2"
```


257

```
470 PRINT "      METERS",".+.........+.........+.........+.........+."
480 FOR Y=1.2 TO -1.2 STEP(-.1)
500 PRINT "          ";INT(10*Y+.5)/10,".";
530 FOR Z=-2 TO 2 STEP(.1)
540 LET X=.6*Z
545 LET Y2=Y*Y
550 IF Q<>1 THEN 730
560 IF ABS(Y)>.001 THEN 640
570 IF ABS(Z+.8)>.001 THEN 610
580 IF I1>0 THEN 600
590 PRINT "-";
595 GO TO 945
600 PRINT "+";
605 GO TO 945
610 IF ABS(Z-.8)>.001 THEN 640
620 IF I2>0 THEN 600
630 GO TO 590
635 REM  R1 AND R2 ARE SQUARES !!!
640 LET X1=X+.5
650 LET X2=X-.5
660 LET R1=X1*X1+Y2
670 LET R2=X2*X2+Y2
680 REM  PARALLEL WIRES
690 LET H1=I1*Y/R1+I2*Y/R2
695 REM  H2 IS REALLY MINUS OF WHAT WE HAVE
700 LET H2=I1*X1/R1+I2*X2/R2
710 LET B=SQR(H1*H1+H2*H2)
720 GO TO 760
730 LET R=SQR(X*X+Y2)
740 IF ABS(R)<.001 THEN 580
750 LET B=ABS(I1/R)
760 IF B>.001 THEN 800
770 PRINT "0";
780 GO TO 945
800 FOR J=1 TO 9
810 IF ABS(B-2.5*J)<.75 THEN 840
820 NEXT J
825 PRINT " ";
830 GO TO 945
840 IF J>5 THEN 900
850 IF J<>1 THEN 860
853 PRINT "1";
856 GO TO 945
860 IF J<>2 THEN 870
863 PRINT "2";
866 GO TO 945
870 IF J<>3 THEN 880
873 PRINT "3";
876 GO TO 945
880 IF J<>4 THEN 890
883 PRINT "4";
886 GO TO 945
890 IF J<>5 THEN 900
893 PRINT "5";
896 GO TO 945
900 IF J<>6 THEN 910
903 PRINT "6";
906 GO TO 945
910 IF J<>7 THEN 920
913 PRINT "7";
916 GO TO 945
920 IF J<>8 THEN 930
923 PRINT "8";
926 GO TO 945
930 IF J<>9 THEN 825
933 PRINT "9";
945 NEXT Z
950 PRINT "."
955 NEXT Y
960 PRINT " ",".+.........+.........+.........+.........+."
970 PRINT
980 RETURN
990 END
```

2 5 8

DISCIPLINE PHYSICS

SUBJECT THE BOHR ATOM AND PHOTON EMISSION

PROGRAM NAME BOHR

DESCRIPTION:

The student may choose to have the Lyman, Balmer, or Paschen Series of the hydrogen emission spectrum displayed. He then must decide which energy level transitions are responsible for the lines of the spectrum that he has chosen. If he is successful, an energy-level diagram is presented and he must determine the energies of the photons emitted by the electron as it falls between randomly-selected energy levels.

OBJECTIVES:

To give an increased understanding of the Bohr atom and of how emission spectra are formed.

PRELIMINARY PREPARATION:

A. Student - The student should have been introduced to the Bohr atom, quantum theory, and ideally, have measured the wavelengths of the bright lines of the hydrogen spectrum.

B. Materials - A piece of paper and a pencil.

DISCUSSION:

After the student selects the series he wishes to see, it is displayed and he tries to discover which quantum level jumps by the electron are responsible for the first two of three lines in the series. If he is successful three times, a statement as to how the lines of that series are formed is printed and he may then elect to try another series or move on to work with the energy-level diagram for hydrogen.

After a brief explanation concerning the energy of a photon emitted during the transition of the electron from a higher to a lower energy level, the student is given a chance to show what he has learned. Energy levels are randomly selected and he must calculate the energy of the emitted photon. If the student is not successful, he gets a further explanation. After six trials the program ends.

```
YOU MAY VIEW THE 1. LYMAN  2.BALMER  OR 3. PASCHEN
SERIES BY TYPING IN THE NUMBER OF THE SERIES YOU WANT
DISPLAYED, OR TYPE 4 FOR AN ENERGY LEVEL DIAGRAM.

  CHOOSE THE NUMBER OF THE PART YOU WOULD LIKE TO SEE.
? 2

 7000  A
 6900  A
 6800  A
 6700  A
 6600  A
 6500  A---------- 6564.706
 6400  A
 6300  A
 6200  A
 6100  A
 6000  A
 5900  A
 5800  A
 5700  A
 5600  A
 5500  A
 5400  A
 5300  A
 5200  A
 5100  A
 5000  A
 4900  A
 4800  A---------- 4862.745
 4700  A
 4600  A
 4500  A
 4400  A
 4300  A---------- 4341.737
 4200  A
 4100  A---------- 4102.941
 4000  A
 3900  A---------- 3971.242
 3800  A---------- 3890.196
 3700  A
 3600  A---------- 3647.059 -----SERIES LIMIT
 3500  A
 3400  A
 3300  A
 3200  A
 3100  A
 3000  A
```

```
  ACCORDING TO THE BOHR THEORY EACH OF THESE LINES RESULTS
FROM THE EMISSION OF A PHOTON DURING THE TRANSITION OF THE
ORBITAL ELECTRON OF AN EXCITED HYDROGEN ATOM FROM A HIGHER
ENERGY STATE (ORBIT) TO A LOWER ONE.  IN A PARTICULAR SERIES
THE TRANSITION (JUMP) IS ALWAYS INTO THE SAME LOWER LEVEL
(ORBIT) FROM ANY HIGHER ONE.
  LET'S SEE IF YOU CAN DETERMINE WHICH TWO ORBITS THE ELECTRON
JUMPED BETWEEN TO GIVE THE LINES THAT HAVE BEEN DISPLAYED.
  THE LOWEST ENERGY LEVEL (GROUND STATE) IS NUMBERED ONE.
HIGHER ENERGY LEVELS HAVE HIGHER NUMBERS IN SEQUENCE.


  FOR EXAMPLE: FROM 4 TO 1 ENTER AS 4,1? 3,4

HEY!! FROM A HIGHER TO A LOWER ENERGY LEVEL.


  FOR EXAMPLE: FROM 4 TO 1 ENTER AS 4,1? 3,2

GOOD START.  THAT GIVES A WAVELENGTH OF 6564.706
THE NEXT LINE IS FORMED BY WHICH TRANSITION? 42-,2

BY GEORGE!! I THINK YOU'VE GOT IT!! THE WAVELENGTH IS 4862.745
TRY ONE MORE - THE NEXT ONE.  ENTER NOW.? 5,2


  ANY TRANSITION FROM A HIGHER ENERGY LEVEL INTO THE
SECOND ENERGY LEVEL YIELDS A PHOTON OF THE BALMER SERIES.

IF YOU WOULD LIKE TO TRY ANOTHER SERIES TYPE IN THE NUMBER
OF THAT SERIES.  IF YOU WANT TO GO ON TO A NEW PART OF
THE PROGRAM TYPE 4
WHICH?? 4


  YOU WILL NOW GET AN ENERGY LEVEL DIAGRAM FOR HYDROGEN.
IT SHOWS THE ENERGY OF THE ELECTRON IN THE VARIOUS ENERGY
LEVELS.  THE DIFFERENCE BETWEEN THE ENERGY OF THE ELECTRON
IN A HIGHER LEVEL AND THAT IN A LOWER LEVEL IS THE ENERGY
OF THE EMITTED PHOTON.   E(PHOTON) = E (HIGHER) - E (LOWER)
```

```
        CONTINUUM

N= .....INFINITY..... E=     000000
N= 6    --------------- E= - .370001
N= 5    --------------- E= - .540001
N= 4    --------------- E= - .850001

N= 3    --------------- E= - 1.510001



N= 2    --------------- E= - 3.400001









N= 1    --------------- E= - 13.6

FIND THE ENERGIES OF THE PHOTONS GIVEN OFF FOR THE
TRANSITIONS GIVEN BELOW.

FROM LEVEL 2  TO LEVEL 1  THE ENERGY OF THE PHOTON IS?? 10.2

GOOD. TRY ANOTHER

FROM LEVEL 4  TO LEVEL 2  THE ENERGY OF THE PHOTON IS?? 2.65

THE ENERGY OF LEVEL 4  IS-.85
THE ENERGY OF LEVEL 2  IS-3.4

THEIR DIFFERENCE = PHOTON ENERGY = 2.55

FROM LEVEL 4  TO LEVEL 2  THE ENERGY OF THE PHOTON IS?? 2.55

GOOD. TRY ANOTHER

FROM LEVEL 2  TO LEVEL 1  THE ENERGY OF THE PHOTON IS?? 10.2

GOOD. TRY ANOTHER

FROM LEVEL 5  TO LEVEL 2  THE ENERGY OF THE PHOTON IS?? 2.86

GOOD. TRY ANOTHER

FROM LEVEL 5  TO LEVEL 2  THE ENERGY OF THE PHOTON IS?? 2.86

THANK YOU, AND GOODBYE.


READY
```

262

```
1 REM JOHN HOSIE - NORTHPORT HIGH - 7/23/69
90 LET T=2
100 REM  REVISED BY C.LOSIK  8-21-70
105 REM  M IS WHICH PROBLEM, L IS A SERIES WAVELENGTH,A AND B ARE
106 REM  UPPER AND LOWER LIMITS OF POSSIBLE SERIES VALUES
120 RANDOMIZE
130 PRINT "YOU MAY VIEW THE 1. LYMAN  2.BALMER  OR 3. PASCHEN"
140 PRINT "SERIES BY TYPING IN THE NUMBER OF THE SERIES YOU WANT"
150 PRINT "DISPLAYED, OR TYPE 4 FOR AN ENERGY LEVEL DIAGRAM."
160 PRINT
170 PRINT "  CHOOSE THE NUMBER OF THE PART YOU WOULD LIKE TO SEE.";
180 PRINT
190 LET G=1
200 DIM S(10)
210 LET J=0
220 INPUT M
222 FOR Q=1 TO 4
224 IF M=Q THEN 235
226 NEXT Q
228 PRINT "1, 2, 3, OR 4 ONLY, PLEASE!"
230 GO TO 220
235 PRINT
240 IF M=4 THEN 1200
250 LET N=M+1
260 LET D=12400*M↑2/13.6
270 LET D1=INT (.01*D)
280 GO TO 450
290 FOR I=A TO B STEP -1
300 LET E=13.6*(1/M↑2-1/N↑2)
310 LET L=12400/E
320 LET P=INT (.01*L)
330 IF I=D1 THEN 430
340 IF I=P THEN 370
350 PRINT 100*I" A"
360 GO TO 410
370 LET J=J+1
380 LET S(J)=L
390 PRINT 100*I" A----------"L
400 LET N=N+1
410 NEXT I
420 GO TO 590
430 PRINT 100*I" A----------"12400*M*M/13.6"-----SERIES LIMIT"
440 GO TO 410
450 LET Y=12400*(M↑2*N↑2)/(13.6*(N↑2-M↑2))
460 LET Y=INT(.01*Y)
470 IF Y<15 THEN 500
480 IF Y<70 THEN 530
490 IF Y<190 THEN 560
500 LET A=15
510 LET B=5
520 GO TO 290
530 LET A=70
540 LET B=30
550 GO TO 290
560 LET A=190
570 LET B=78
575 IF G>1 THEN 680
580 GO TO 290
590 PRINT
600 PRINT "  ACCORDING TO THE BOHR THEORY EACH OF THESE LINES RESULTS"
```

263

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610 PRINT "FROM THE EMISSION OF A PHOTON DURING THE TRANSITION OF THE"
620 PRINT "ORBITAL ELECTRON OF AN EXCITED HYDROGEN ATOM FROM A HIGHER"
630 PRINT "ENERGY STATE (ORBIT) TO A LOWER ONE.  IN A PARTICULAR SERIES"
640 PRINT "THE TRANSITION (JUMP) IS ALWAYS INTO THE SAME LOWER LEVEL"
650 PRINT "(ORBIT) FROM ANY HIGHER ONE."
655 LET G=G+1
660 PRINT "  LET'S SEE IF YOU CAN DETERMINE WHICH TWO ORBITS THE ELECTRO
670 PRINT "JUMPED BETWEEN TO GIVE THE LINES THAT HAVE BEEN DISPLAYED."
680 PRINT "  THE LOWEST ENERGY LEVEL (GROUND STATE) IS NUMBERED ONE."
690 PRINT "HIGHER ENERGY LEVELS HAVE HIGHER NUMBERS IN SEQUENCE."
700 LET F=1
710 PRINT
720 PRINT
730 PRINT "  FOR EXAMPLE: FROM 4 TO 1 ENTER AS 4,1";
735 LET T=T+1
740 INPUT N,M1
750 PRINT
760 IF N>M1 THEN 820
770 IF F<>1 THEN 800
780 PRINT "HEY!! FROM A HIGHER TO A LOWER ENERGY LEVEL."
790 GO TO 710
800 PRINT "OOPS - FROM HIGHER TO LOWER."
810 GO TO 710
820 LET L1=12400*(M1↑2*N↑2)/(13.6*(N↑2-M1↑2))
830 IF ABS(L1-S(F))<.005 THEN 890
840 IF F>1 THEN 870
850 PRINT "NOPE!! TRY AGAIN."
860 GO TO 710
870 PRINT "SORRY.  TRY AGAIN!  YOUR FINAL ENERGY LEVEL SHOULD BE"M
880 GO TO 710
890 IF F=1 THEN 930
900 IF M=1 THEN 1010
910 IF F=2 THEN 970
920 GO TO 1010
930 PRINT "GOOD START.  THAT GIVES A WAVELENGTH OF"L1
940 PRINT "THE NEXT LINE IS FORMED BY WHICH TRANSITION";
950 LET F=F+1
960 GO TO 740
970 PRINT "BY GEORGE!! I THINK YOU'VE GOT IT!! THE WAVELENGTH IS"L1
980 PRINT "TRY ONE MORE - THE NEXT ONE.  ENTER NOW.";
990 LET F=F+1
1000 GO TO 740
1010 PRINT
1020 PRINT "  ANY TRANSITION FROM A HIGHER ENERGY LEVEL INTO THE"
1030 IF M=1 THEN 1080
1040 IF M=2 THEN 1110
1050 PRINT "THIRD ENERGY LEVEL CAUSES THE EMISSION OF A PHOTON OF THE"
1060 PRINT "PASCHEN SERIES."
1070 GO TO 1120
1080 PRINT "GROUND STATE IS ACCOMPANIED BY THE EMISSION OF A PHOTON OF"
1090 PRINT "LIGHT BELONGING TO THE LYMAN SERIES."
1100 GO TO 1120
1110 PRINT "SECOND ENERGY LEVEL YIELDS A PHOTON OF THE BALMER SERIES."
1120 PRINT
1130 PRINT "IF YOU WOULD LIKE TO TRY ANOTHER SERIES TYPE IN THE NUMBER"
1140 PRINT "OF THAT SERIES.  IF YOU WANT TO GO ON TO A NEW PART OF"
1150 PRINT "THE PROGRAM TYPE 4"
1160 PRINT "WHICH?";
1190 GO TO 220
1200 PRINT
1210 PRINT "  YOU WILL NOW GET AN ENERGY LEVEL DIAGRAM FOR HYDROGEN."
1220 PRINT "IT SHOWS THE ENERGY OF THE ELECTRON IN THE VARIOUS ENERGY"
1230 PRINT "LEVELS.  THE DIFFERENCE BETWEEN THE ENERGY OF THE ELECTRON"
1240 PRINT "IN A HIGHER LEVEL AND THAT IN A LOWER LEVEL IS THE ENERGY"
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1250 PRINT "OF THE EMITTED PHOTON.   E(PHOTON) = E (HIGHER) - E (LOWER)"
1260 PRINT
1270 PRINT "          CONTINUUM"
1280 PRINT
1290 PRINT "N= .....INFINITY..... E=    000000"
1300 LET N=6
1310 FOR I=1 TO 40
1320 LET Y=INT(40/N↑2+.56)
1330 IF I=Y THEN 1360
1340 PRINT
1350 GO TO 1380
1360 PRINT "N="N"  --------------- E= -"INT(1360/N↑2)/100+.000001
1370 LET N=N-1
1380 NEXT I
1390 PRINT
1400 PRINT "FIND THE ENERGIES OF THE PHOTONS GIVEN OFF FOR THE"
1410 PRINT "TRANSITIONS GIVEN BELOW."
1420 LET J=0
1430 FOR I=0 TO T*Q
1440 LET Y3=RND(I)
1450 NEXT I
1460 FOR I=1 TO 20
1470 LET Y3=INT(1+(5*RND(I)))
1480 LET Y4=INT(1+(5*RND(I+1)))
1490 IF Y4>Y3 THEN 1510
1500 NEXT I
1510 PRINT
1520 PRINT "FROM LEVEL"Y4" TO LEVEL"Y3" THE ENERGY OF THE PHOTON IS?";
1530 INPUT E1
1
1540 LET J=J+1
1550 PRINT
1560 LET E=-13.6*(1/(Y4↑2)-1/(Y3↑2))
1570 IF ABS(E1-E)>.005 THEN 1610
1580 IF J=6 THEN 1660
1590 PRINT "GOOD. TRY ANOTHER"
1600 GO TO 1460
1610 PRINT "THE ENERGY OF LEVEL"Y4 " IS"-13.6/(Y4↑2)
1620 PRINT "THE ENERGY OF LEVEL"Y3 " IS"-13.6/(Y3↑2)
1630 PRINT
1640 PRINT "THEIR DIFFERENCE = PHOTON ENERGY ="E
1650 GO TO 1460
1660 PRINT "THANK YOU, AND GOODBYE."
1670 END
```

DISCIPLINE PHYSICS

SUBJECT CALORIMETRY

PROGRAM NAME CALORI

DESCRIPTION:

Calorimetry experiments are simulated by the computer permitting the student to enter the mass and temperatures of two quantities of water. The computer calculates and prints out the equilibrium temperature of the mixture. The student must then determine the heat energy, in calories, to be supplied (or removed) from each mass to obtain the equilibrium temperature.

OBJECTIVES:

A. To acquaint the students with conservation of energy concepts involving calorimetry.

B. To determine the equations governing these relationships.

PRELIMINARY PREPARATION:

A. Student - Must know definitions for calorie and specific heat.

B. Materials - Table of Specific heats

DISCUSSION:

Calorimetry, in its simplest form, is presented as part of a class lesson. The concept of heat energy balance is developed by presenting several examples, with the computer, based on the definition of the " calorie. " Specific heat is introduced by a similar approach (replacing the water of the initial examples, with alcohol; specific heat of .6 cal/gm-0°C.)

The program can be modified (with relative ease) to incorporate different materials or combinations of different materials.

When this program was used as an introduction to calorimetry, it was noted that many students were able to determine the equations describing the phenomenon by utilizing the stated results from the computer.

```
                HEAT AND CALORIMETRY

YOU HAVE TWO BEAKERS OF WATER .
WHAT IS THE MASS (IN GRAMS) AND THE TEMP (IN DEGREES) OF THE
 WATER IN THE FIRST BEAKER? 80,50

WHAT IS THE MASS (IN GRAMS) AND THE TEMP (IN DEGREES) OF THE
 WATER IN THE SECOND BEAKER? 40,60

THE FINAL TEMPERATURE OF THE MIXTURE IS  53.33  DEGREES.

HOW MANY CALORIES WERE INVOLVED IN CHANGING THE TEMP OF
THE  FIRST  BEAKER FROM  50  TO  53.33  DEGREES? 260

YOU'RE CLOSE ENOUGH. THE CORRECT ANSWER IS  266.4  CALORIES.

HOW MANY CALORIES WERE INVOLVED IN CHANGING THE TEMP OF
THE  SECOND  BEAKER FROM  60  TO  53.33  DEGREES? 240

YOU'RE MORE THAN 3 PERCENT OFF. YOU SHOULD HAVE SAID
 266.8  CALORIES.


WANT TO TRY AGAIN (1=YES, 0=NO) : ? 1
CHOOSE A LIQUID : 0=WATER, 1=ALCOHOL.  WHICH? 1

YOU HAVE TWO BEAKERS OF ALCOHOL .
WHAT IS THE MASS (IN GRAMS) AND THE TEMP (IN DEGREES) OF THE
 ALCOHOL IN THE FIRST BEAKER? 100,50

WHAT IS THE MASS (IN GRAMS) AND THE TEMP (IN DEGREES) OF THE
 ALCOHOL IN THE SECOND BEAKER? 100,70

THE FINAL TEMPERATURE OF THE MIXTURE IS  60  DEGREES.

HOW MANY CALORIES WERE INVOLVED IN CHANGING THE TEMP OF
THE  FIRST  BEAKER FROM  50  TO  60  DEGREES? 1000

YOU'RE MORE THAN 3 PERCENT OFF. YOU SHOULD HAVE SAID
 600  CALORIES.

HOW MANY CALORIES WERE INVOLVED IN CHANGING THE TEMP OF
THE  SECOND  BEAKER FROM  70  TO  60  DEGREES? 600

YOU'RE CLOSE ENOUGH. THE CORRECT ANSWER IS  600  CALORIES.


WANT TO TRY AGAIN (1=YES, 0=NO) : ? 0


READY
```

207

```
1 REM A.C. CAGGIANO; PATCHOGUE H.S.; PHYSICS; 2-'69
2 REM THIS PROGRAM INVOLVES CALORIMETRY EXPERIMENTS OR THEIR
3 REM SIMULATION.
5 REM  REVISED BY C.LOSIK 8-25-70
6 REM  K TELLS WHICH LIQUID, J TELLS WHICH BEAKER,
7 REM  M(J) ARE THE MASSES OF LIQUID, T(J) ARE THEIR TEMPERATURES
80 LET K=0
90 DIM M(2),T(2)
100 PRINT " ","HEAT AND CALORIMETRY"
110 PRINT
112 PRINT
114 PRINT "##########"
116 PRINT
120 PRINT"YOU HAVE TWO BEAKERS OF";
130 GOSUB 590
140 PRINT"."
150 FOR J=1 TO 2
160 PRINT"WHAT IS THE MASS (IN GRAMS) AND THE TEMP (IN DEGREES) OF THE"
170 GOSUB 590
180 PRINT"IN THE";
190 GOSUB 540
200 PRINT"BEAKER";
210 INPUT M(J),T(J)
220 PRINT
230 NEXT J
240 LET T3=(M(1)*T(1)+M(2)*T(2))/(M(1)+M(2))
245 LET T3=INT(100*T3+.5)/100
250 PRINT"THE FINAL TEMPERATURE OF THE MIXTURE IS "T3" DEGREES."
260 PRINT
270 FOR J=1 TO 2
280 PRINT"HOW MANY CALORIES WERE INVOLVED IN CHANGING THE TEMP OF"
290 PRINT"THE ";
300 GOSUB 540
310 PRINT" BEAKER ";
320 PRINT"FROM "T(J)" TO "T3" DEGREES";
330 INPUT H
335 PRINT
340 LET G=ABS(H)
350 LET T=ABS(T3-T(J))
360 IF G<>0 THEN390
370 IF S*M(J)*T=0 THEN 400
380 GOTO 430
390 IF ABS((G-S*M(J)*T)/G)>.03 THEN 430
400 PRINT"YOU'RE CLOSE ENOUGH. THE CORRECT ANSWER IS ";
405 GOTO 440
410 PRINT
420 GOTO460
430 PRINT"YOU'RE MORE THAN 3 PERCENT OFF. YOU SHOULD HAVE SAID"
440 PRINT INT(100*S*M(J)*T+.5)/100 " CALORIES."
450 PRINT
460 NEXT J
465 PRINT
470 PRINT "WANT TO TRY AGAIN (1=YES, 0=NO) : ";
475 INPUT Q
480 IF Q=0 THEN 660
483 IF Q<>1 THEN 465
485 PRINT "CHOOSE A LIQUID : 0=WATER, 1=ALCOHOL.  WHICH";
490 INPUT K
500 IF K*(K-1)<>0 THEN 485
510 GO TO 110
540 IF J=2 THEN 570
550 PRINT" FIRST ";
560 GOTO 580
570 PRINT" SECOND ";
580 RETURN
590 IF K=1 THEN 630
600 PRINT" WATER ";
610 LET S=1
620 GOTO650
630 PRINT" ALCOHOL ";
640 LET S=.6
650 RETURN
660 END
```

268

DISCIPLINE PHYSICS

SUBJECT RADIOACTIVE DECAY

PROGRAM NAME DECAY1

DESCRIPTION:

Radioactive decay is treated pseudo-quantitatively, by permitting the student to determine the approximate number of radioactive particles remaining after various times.

OBJECTIVES:

To induce a "feel" for exponential decay, by repeated exercises.

PRELIMINARY PREPARATION:

A. Student - Awareness of terms: half-life, exponential, and radioactivity

B. Materials - none

DISCUSSION:

The concept of radioactive decay is presented playfully as a game, allowing the student to challenge his own ability in determining (with 5, 10, or 20% error), the number of radioactive "chips" remaining after various times. The number of chips successively decreases with each trial, increasing the level of difficulty as the program runs. In each case, the exact number remaining is given, following the students' entered value.

Individuals or small groups, find this program exciting. They enjoy the game approach, at least the first time through it, and seem to be motivated by the opportunity to " break the bank."

This program can be used as an integral part of a class lesson to introduce the concept, or to motivate group discussion and participation concerning the phenomena.

```
---THE NEW CLEA CASINO---

     MR. A. TOM MICK, GENERAL MANAGER OF THE NEW CLEA CASINO,
HAS, AT TIME  T=0,  DISCOVERED  100,000 RADIOACTIVE PLAYING
CHIPS AT HIS TABLE. THEIR HALF-LIFE IS 10 MINUTES. EACH CHIP
TRANSMUTES SPONTANEOUSLY AND COMPLETELY IN A RANDOM FASHION.

     AT VARIOUS TIMES T, AFTER T=0, YOU MUST DETERMINE WITHIN
A CERTAIN PERCENTAGE, HOW MANY CHIPS ARE LEFT.

     TO FURTHER THE INTEREST OF THE GAME, YOU WILL START WITH
$1,000 AND THE HOUSE WITH AN UNSPECIFIED AMOUNT.  HALF THE
MONEY YOU HAVE WILL RIDE ON EACH GUESS YOU TAKE.  LET'S SEE
IF YOU CAN BREAK THE HOUSE BEFORE THE CHIPS RUN OUT.

THE HOUSE OFFERS THE FOLLOWING ODDS:
     2) 2 TO 1 ODDS FOR GUESSING WITHIN 20 PERCENT
     4) 4 TO 1 ODDS FOR GUESSING WITHIN 10 PERCENT
     8) 8 TO 1 ODDS FOR GUESSING WITHIN  5 PERCENT.

ENTER THE NUMBER 2, 4, OR 8 FOR THE ODDS YOU WANT AFTER THE
QUESTION MARK IN THE COLUMN LABELLED ODDS.

YOUR $         HOUSE $         TIME (MIN)     ODDS

 1000          1.000000E+6     7.2            ? 8
HOW MANY CHIPS LEFT ? 60700
ACTUAL NUMBER LEFT IS  60716
YOU WON. TRY AGAIN.

 5000          996000          13.9           ? 8
HOW MANY CHIPS LEFT ? 38150
ACTUAL NUMBER LEFT IS  38164
YOU WON. TRY AGAIN.

 25000         976000          26.9           ? 8
HOW MANY CHIPS LEFT ? 15500
ACTUAL NUMBER LEFT IS  15502
YOU WON. TRY AGAIN.

 125000        876000          30.7           ? 8
HOW MANY CHIPS LEFT ? 11900
ACTUAL NUMBER LEFT IS  11913
YOU CAN BREAK THE HOUSE IF YOU TRY A LONG SHOT.

 625000        376000          48.4           ? 8
HOW MANY CHIPS LEFT ? 3500
ACTUAL NUMBER LEFT IS  3494
YOU BROKE THE HOUSE. YOU NEEDED ONLY THE MINIMUM NUMBER OF GUESSES.
CONGRATULATIONS.
YOU MUST KNOW A LOT ABOUT RADIOACTIVITY AND THINGS.
THANKS FOR PLAYING..

-------------------------------------------------------------

                                     CHECK NO. 3499

                                  DATE: -------------19--


 PAY TO THE ORDER OF--------CASH------$ 1.001000E+6


 THE NEW CLEA CASINO                    A. TOM MICK
                                        GENERAL MANAGER

-------------------------------------------------------------

DONT SPEND IT ALL IN ONE PLACE.

READY
```

```
100 REM  RICHARD F. PAV, PATCHOGUE H.S., (PHYSICS)  REVISED NOV. 26,1968
105 RANDOMIZE
110 REM  THIS IS A GAME BASED ON RADIOACTIVE DECAY.
120 PRINT "                  ---THE NEW CLEA CASINO---"
130 PRINT
140 PRINT "     MR. A. TOM MICK, GENERAL MANAGER OF THE NEW CLEA CASINO,
150 PRINT "HAS, AT TIME  T=0,  DISCOVERED  100,000 RADIOACTIVE PLAYING"
160 PRINT "CHIPS AT HIS TABLE. THEIR HALF-LIFE IS 10 MINUTES. EACH CHIP"
170 PRINT "TRANSMUTES SPONTANEOUSLY AND COMPLETELY IN A RANDOM FASHION."
180 PRINT
190 PRINT "     AT VARIOUS TIMES T, AFTER T=0, YOU MUST DETERMINE WITHIN
200 PRINT "A CERTAIN PERCENTAGE, HOW MANY CHIPS ARE LEFT."
210 PRINT
220 PRINT "     TO FURTHER THE INTEREST OF THE GAME, YOU WILL START WITH
230 PRINT "$1,000 AND THE HOUSE WITH AN UNSPECIFIED AMOUNT.  HALF THE"
240 PRINT "MONEY YOU HAVE WILL RIDE ON EACH GUESS YOU TAKE.  LET'S SEE"
250 PRINT "IF YOU CAN BREAK THE HOUSE BEFORE THE CHIPS RUN OUT."
260 PRINT
270 PRINT "THE HOUSE OFFERS THE FOLLOWING ODDS:"
280 PRINT "     2) 2 TO 1 ODDS FOR GUESSING WITHIN 20 PERCENT"
290 PRINT "     4) 4 TO 1 ODDS FOR GUESSING WITHIN 10 PERCENT"
300 PRINT "     8) 8 TO 1 ODDS FOR GUESSING WITHIN  5 PERCENT."
310 PRINT
320 PRINT "ENTER THE NUMBER 2, 4, OR 8 FOR THE ODDS YOU WANT AFTER TH
330 PRINT "QUESTION MARK IN THE COLUMN LABELLED ODDS."
340 PRINT
350 PRINT "YOUR $",  "HOUSE $",  "TIME (MIN)",  "ODDS"
360 LET A=0
370 LET B=0
380 LET T=0
390 LET Y=1000
400 LET C=0
410 PRINT
420 IF ABS(G-D)<1500 THEN 450
430 LET G=5
440 LET D=2
450 LET B=B+1
460 FOR I=1 TO 3+A+ABS(G-D)
470 LET T3=INT(100*RND(-Y))/10
480 NEXT I
490 LET T=T+T3
500 LET D=INT(1E5*EXP(-.0693*T))
510 IF D=0 THEN 860
520 PRINT Y,1001000-Y,T,
530 INPUT A
540 IF A=2 THEN 610
550 IF A=4 THEN 610
560 IF A=8 THEN 610
570 PRINT "SORRY PAL, WE DONT OFFER THOSE ODDS."
580 IF C=1 THEN 620
590 LET C=1
600 GOTO 520
610 PRINT "HOW MANY CHIPS LEFT ";
620 INPUT G
630 PRINT "ACTUAL NUMBER LEFT IS ";D
640 IF A=2 THEN 700
650 IF A=4 THEN 680
660 LET P=.05
670 GOTO 710
680 LET P=.1
690 GOTO 710
700 LET P=.2
```


271

```
710 LET T=10*B
720 IF ABS(D-G)<=P*D THEN 770
730 LET Y=INT(Y-Y/2)
740 IF Y<=50 THEN 820
750 PRINT "TOO BAD, YOU LOST. TRY AGAIN."
760 GOTO 400
770 LET Y=INT(Y+A*Y/2)
780 IF 1000000-Y<1 THEN 890
790 IF Y>2E5 THEN 840
800 PRINT "YOU WON. TRY AGAIN."
810 GOTO 400
820 PRINT "IT SEEMS YOU JUST CANT GET THE HANG OF IT. SAVE YOUR BREAD."
830 GOTO 960
840 PRINT "YOU CAN BREAK THE HOUSE IF YOU TRY A LONG SHOT."
850 GOTO 400
860 PRINT "OOOOPS... SORRY PAL, THE LAST CHIP JUST DISINTEGRATED."
870 PRINT "THE HOUSE IS CLOSED."
880 GOTO 960
890 PRINT "YOU BROKE THE HOUSE. YOU NEEDED ONLY ";
895 LET Y=1001000
900 IF B>5 THEN 930
910 PRINT "THE MINIMUM NUMBER OF GUESSES."
920 GOTO 940
930 PRINT B;"GUESSES."
940 PRINT "CONGRATULATIONS."
950 PRINT "YOU MUST KNOW A LOT ABOUT RADIOACTIVITY AND THINGS."
960 PRINT "THANKS FOR PLAYING.."
970 PRINT
980 PRINT "------------------------------------------------------------"
990 PRINT
1000 PRINT "                                           CHECK NO.";B+D
1010 PRINT
1020 PRINT "                                        DATE: ";
1030 PRINT "-------------19--"
1040 PRINT
1050 PRINT
1060 PRINT " PAY TO THE ORDER OF--";
1070 PRINT "------CASH------";
1080 PRINT "$";Y
1090 PRINT
1100 PRINT
1110 PRINT " THE NEW CLEA CASINO                          A. TOM MICK"
1120 PRINT "                                              GENERAL MANAGER"
1130 PRINT
1140 PRINT "------------------------------------------------------------"
1150 PRINT
1160 PRINT "DONT SPEND IT ALL IN ONE PLACE."
1170END
```

DISCIPLINE CHEMISTRY-PHYSICS

SUBJECT NUCLEAR DECAY

PROGRAM NAME DECAY2

DESCRIPTION:

This program will do the following:

A. Calculate half-life from 2 readings on a geiger counter, and the time between them.

B. Calculate mass of a radioactive sample remaining after some given amount of time.

C. Prints out a table showing mass or number of particles of a radioactive sample remaining vs. some range of time.

OBJECTIVES:

A. To provide tables and graphs for a better understanding of the exponential decay of a radioactive substance.

B. To provide a calculator for determining the amount of mass of a radioactive sample remaining after some given amount of time.

C. To provide a calculator for half-life experiments.

PRELIMINARY PREPARATION:

A. Student - The student should have a general introduction to half-life before the use of the program.

B. Materials - none

DISCUSSION:

It is difficult to teach about the exponential (logarithmic) manner by which radioactive elements decay without meaningful illustrations and simulations.

DISCUSSION: (con't)

With this pro . number of interesting possibilities are available. For examp .ne initial mass is 100 g and the time is equal to 10 half-lives with an increment equal to the half-life, the student will see the mass decrease to 0.1 g during that time. More important, the example may be generalized to show that for any radioactive sample:

after 1 half-life 50% of the substance remains
after 2 half-life 25% of the substance remains
after 3 half-life 12.5% of the substance remains
after 10 half-life 0.1% of the substance remains

You may also illustrate nuclear decay by using particles instead of mass. Use Avogadro's number of particles with students who feel comfortable with scientific notation. For the others, you may use a number up to 1,000,000 without having exponential numbers print out in the table.

The fact that the teletype unit takes about 8 seconds to type out a line provides you with cute little gimmicks. Set up a run with 8 seconds (or any multiple of 8) and the print-out of the table will keep time with the decay of the sample substance.

Please note that the half-life calculations are not accurate for a small number of particles, thus it is misleading to make runs go to zero mass or zero particles.

```
DO YOU WANT INSTRUCTIONS (1=YES, 0=NO) : ? 1
 THIS PROGRAM WILL DO THE FOLLOWING:
        CHOICE 1 - CALCULATES HALF-LIFE FROM TWO READINGS
                   ON A GEIGER COUNTER.
        CHOICE 2 - CALCULATES HOW MUCH OF A RADIOACTIVE SAMPLE
                   WILL REMAIN AFTER SOME GIVEN AMOUNT OF TIME
        CHOICE 3 - PRINTS OUT A TABLE SHOWING MASS OF SAMPLE
                   VS. TIME OR NO. OF PARTICLES VS. TIME.
                   (GRAPH OPTIONAL) NOTE: FOR THE TABLE YOU
                   MUST INPUT TOTAL TIME AND TIME INCREMENT.
                    EXAMPLE: IF TOTAL TIME=100 AND TIME
                   INCREMENT=10, THEN TIME IN THE TABLE WILL
                   BE 10,20,30,............,100.
         CHOICE 4 - END OF PROGRAM

                   NOTE: IN ANY ONE PROBLEM,TIME MUST
                   ALWAYS BE INPUTED IN THE SAME UNITS
                   OF MEASURE (IE: SECS.,MINS.,ETC.)

**********

WHAT IS YOUR CHOICE? 1

 WHAT IS THE INITIAL READING ON THE GEIGER COUNTER,
 THE SECOND READING, AND THE TIME BETWEEN READINGS.
? 1500,3000,36

INITIAL READING= 3000 SECOND READING= 1500 TIME= 36
HALF-LIFE= 35.99755

**********

WHAT IS YOUR CHOICE? 1

 WHAT IS THE INITIAL READING ON THE GEIGER COUNTER,
 THE SECOND READING, AND THE TIME BETWEEN READINGS.
? 775 , 1256 ,212
INITIAL READING= 1256 SECOND READING= 775 TIME= 212
HALF-LIFE= 304.3265

**********

WHAT IS YOUR CHOICE? 2

WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE, AND
TOTAL TIME OF DECAY? 18,56,76

HALF-LIFE= 18 INITIAL MASS= 56 TOTAL TIME= 76
MASS OF SAMPLE REMAINING= 3.000952

**********

WHAT IS YOUR CHOICE? 3

DO YOU WANT TO WORK WITH PARTICLES OR MASS? (ANSWER 1 FOR
 PARTICLES OR 2 FOR MASS) ? 1

 WHAT IS THE HALF-LIFE, INITIAL NUMBER OF PARTICLES IN THE
 SAMPLE, TOTAL ELAPSED TIME FOR DECAY, AND THE
 INCREMENT OF ELAPSED TIME? 10,6.02E23,100,10

HALF-LIFE= 10 INITIAL NO. OF PARTICLES= 6.020000E+23
TOTAL TIME= 100 INCREMENT= 10
```

TIME	PARTICLES	PART. LOSS	TOTAL PART. LOSS
0	6.020000E+23	0	0
10	3.010142E+23	3.009858E+23	3.009858E+23
20	1.505142E+23	1.505000E+23	4.514858E+23
30	7.526065E+22	7.525355E+22	5.267393E+23
40	3.763210E+22	3.762855E+22	5.643679E+23
50	1.881694E+22	1.881516E+22	5.831831E+23
60	9.408913E+21	9.408026E+21	5.925911E+23
70	4.704679E+21	4.704235E+21	5.972953E+23
80	2.352450E+21	2.352228E+21	5.996475E+23
90	1.176281E+21	1.176170E+21	6.008237E+23
100	5.881581E+20	5.881126E+20	6.014118E+23

DO YOU WANT THE ABOVE DATA GRAPHED? (1-YES, 0-NO)? 1

```
                                          MASS (OR PARTICLES) REMAINING

                  0
6.020000E+23
TIME              I---------I---------I---------I---------I---------
 0                I
 10               I                             *
 20               I                *
 30               I     *
 40               I  *
 50               I *
 60               I*
 70               *
 80               *
 90               *
 100              *
```

****

WHAT IS YOUR CHOICE? 3

DO YOU WANT TO WORK WITH PARTICLES OR MASS? (ANSWER 1 FOR PARTICLES OR 2 FOR MASS) ? 2

WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE,TOTAL ELAPSED TIME FOR DECAY, AND THE INCREMENT OF ELAPSED TIME? 15,100,150,15

HALF-LIFE= 15 INITIAL MASS= 100 TOTAL TIME= 150 INCREMENT= 15

TIME	MASS	MASS LOSS	TOTAL MASS LOSS
0	100	0	0
15	50.00236	49.99764	49.99764
30	25.00236	25	74.99764
45	12.50177	12.50059	87.49823
60	6.25118	6.25059	93.74882
75	3.125737	3.125443	96.87426
90	1.562942	1.562795	98.43706
105	.7815081	.7814344	99.21849
120	.3907725	.3907356	99.60923
135	.1953955	.195377	99.8046
150	.09770234	.09769313	99.90229

```
DO YOU WANT THE ABOVE DATA GRAPHED? (1=YES, 0=NO)? 1


                                 MASS (OR PARTICLES) REMAINING
              0                                                100
TIME          I---------I---------I---------I---------I---------I
 0            I                                                 *
 15           I                        *
 30           I            *
 45           I     *
 60           I  *
 75           I *
 90           I*
 105          *
 120          *
 135          *
 150          *

**********

WHAT IS YOUR CHOICE? 4


READY
```

```
100 REM R. DORFMAN+ J. MARCHISOTTO PIB 7/24/69
105 REM  REVISED BY J.LUSIN  6-12-70
110 REM CALCULATION OF HALF-LIFE AND REMAINING MASS INCLUDING
120 REM TABLES AND GRAPHS.
122 PRINT "DO YOU WANT INSTRUCTIONS (1=YES, 0=NO) : ";
124 INPUT A
126 IF A=0 THEN 300
128 IF A<>1 THEN 122
130 PRINT "  THIS PROGRAM WILL DO THE FOLLOWING:"
140 PRINT "         CHOICE 1 - CALCULATES HALF-LIFE FROM TWO READINGS"
150 PRINT "                    ON A GEIGER COUNTER."
160PRINT"          CHOICE 2 - CALCULATES HOW MUCH OF A RADIOACTIVE SAMPLE"
170PRINT"                     WILL REMAIN AFTER SOME GIVEN AMOUNT OF TIME."
180 PRINT "        CHOICE 3 - PRINTS OUT A TABLE SHOWING MASS OF SAMPLE"
190 PRINT"                    VS. TIME OR NO. OF PARTICLES VS. TIME."
200 PRINT"                    (GRAPH OPTIONAL) NOTE: FOR THE TABLE YOU"
210 PRINT"                    MUST INPUT TOTAL TIME AND TIME INCREMENT."
220PRINT"                     EXAMPLE: IF TOTAL TIME=100 AND TIME"
230 PRINT"                    INCREMENT=10, THEN TIME IN THE TABLE WILL"
240 PRINT"                    BE 10,20,30,............,100."
250 PRINT"         CHOICE 4 - END OF PROGRAM"
260 PRINT
270 PRINT"                    NOTE: IN ANY ONE PROBLEM,TIME MUST"
280 PRINT"                    ALWAYS BE INPUTED IN THE SAME UNITS"
290 PRINT"                    OF MEASURE (IE: SECS.,MINS.,ETC.)"
300 PRINT
310 PRINT "**********"
320 PRINT
330 PRINT "WHAT IS YOUR CHOICE";
340 INPUT A
350PRINT
360 IF A=1 THEN 410
370 IF A=2 THEN 490
380 IF A=3 THEN 570
390 IF A<>4 THEN 320
400 STOP
410PRINT" WHAT IS THE INITIAL READING ON THE GEIGER COUNTER,"
420 PRINT" THE SECOND READING, AND THE TIME BETWEEN READINGS."
430 INPUT B,A,C
433 IF A>B THEN 440
435 PRINT "INITIAL READING IS ALWAYS LESS THAN FINAL READING."
437  GO TO 430
440 LET D=(.6931*C)/LOG(A/B)
450 PRINT
460 PRINT "INITIAL READING="A;"SECOND READING="B;"TIME="C
470 PRINT "HALF-LIFE="D
480 GO TO 300
490 PRINT "WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE, AND"
500 PRINT "TOTAL TIME OF DECAY";
510 INPUT E,F,G
520 LET H=F*EXP(-.6931*G/F)
530 PRINT
540PRINT"HALF-LIFE="E;"INITIAL MASS="F;"TOTAL TIME="G
550 PRINT "MASS OF SAMPLE REMAINING="H
560 GO TO 300
570 PRINT "DO YOU WANT TO WORK WITH PARTICLES OR MASS? (ANSWER 1 FOR"
580 PRINT" PARTICLES OR 2 FOR MASS) ";
590 INPUT J
600 PRINT
610 IF J=1 THEN 760
615 IF J<>2 THEN 570
620 PRINT" WHAT IS THE HALF-LIFE, INITIAL MASS OF SAMPLE,TOTAL"
630 PRINT"ELAPSED TIME FOR DECAY, AND THE INCREMENT OF "
640 PRINT"ELAPSED TIME";
650 INPUT E,F,K,M
660LET W=0
670 LET Q=0
```

```
680 LET Z=F
690 PRINT
700 IF U=1 THEN 800
710 PRINT"HALF-LIFE="E;"INITIAL MASS="F;"TOTAL TIME="K;"INCREMENT="M
720 PRINT
730 PRINT "TIME", "MASS", "MASS LOSS", "TOTAL MASS LOSS"
740 PRINT "----", "----", "---- ----", "----- ---- ----"
750 GO TO 850
760 PRINT" WHAT IS THE HALF-LIFE, INITIAL NUMBER OF PARTICLES IN THE"
770 PRINT" SAMPLE, TOTAL ELAPSED TIME FOR DECAY, AND THE "
780 PRINT" INCREMENT OF ELAPSED TIME";
790 GO TO 650
795 PRINT
800 PRINT"HALF-LIFE="E;"INITIAL NO. OF PARTICLES="F
810 PRINT"TOTAL TIME="K;"INCREMENT="M
820 PRINT
830 PRINT" TIME", " PARTICLES", "PART. LOSS", "TOTAL PART. LOSS"
840 PRINT" ----", " ---------", "----- ----", "----- ----- ----"
850 PRINT
860 FOR G = 0 TO K STEP M
870 LET H=F*EXP(-.6931*G/E)
880 LET W=ABS(H-Z)
890 LET Q=Q+W
900 IF F >1E6 THEN 920
910 IF U=1 THEN 940
920 PRINT G,H,W,Q
930 GO TO 950
940 PRINT INT(G+.5),INT(H+.5),INT(W+.5),INT(Q+.5)
950 LET Z=H
960 NEXT G
970 PRINT
980 PRINT
990 PRINT
1000 PRINT" DO YOU WANT THE ABOVE DATA GRAPHED? (1-YES, 0-NO)";
1010 INPUT R
1020 IF R=0 THEN 300
1023 IF R<>1 THEN 1000
1030 PRINT
1040 PRINT
1050 PRINT
1060 PRINT TAB(30);"MASS (OR PARTICLES) REMAINING"
1070 PRINT
1080 PRINT " ","0";TAB(62);F
1100PRINT"TIME","I---------I---------I---------I---------I---------I"
1120 FOR G = 0 TO K STEP M
1130 LET H=F*EXP(-.6931*G/E)
1140 LET H1=INT(H/F*50+.5)
1150 IF H1<=50 THEN 1170
1160 LET H1=50
1170 PRINT G,"I";TAB(H1+14.5);"*"
1250 NEXT G
1260 GO TO 300
1280 END
```

279

DISCIPLINE PHYSICS

SUBJECT ELECTRIC FIELD STRENGTH

PROGRAM NAME EFIELD

DESCRIPTION:

The electric-field strength at a point near a fixed charge is calculated and printed. A line of charge is then generated by adding charges to either side of the fixed charge. As each additional charge is added, the new electric-field strength is calculated and selected values are printed.

Similarly, the field strength at a point near a plane of charge is calculated and printed as the plane is generated with the addition of other lines to the previous line of charge.

In both cases, the fields can be seen to approach a limiting value which is then printed for an infinite line and plane.

OBJECTIVES:

A. To show that the electric-field strength approaches limiting values for a line and a plane of charge.

B. To let the student discover how the field strength depends upon the distance from a point to a line of and to a plane of charge.

PRELIMINARY PREPARATION:

A. Student - A knowledge of Coulomb's law and the vector addition of electric fields.

B. Materials - none

DISCUSSION:

The operator chooses a distance (y) away from a fixed charge (Q_2) at which he wishes to know the field strength. He also chooses the number of charges (N), and their spacing (C), that he wishes to add to each side of the fixed charge to generate a line of charge. After the [illegible] has been generated, the operator enters the number of such lines (M) that he w[illegible] to use in building up the plane of charge.

Actual values of force are not given, only relative values. When the fixed charge (Q_2) is at a distance Y= 1 from the test charge (Q_1), the force is 1 unit. The force may be calculated in Newtons if all distances are in meters, and the program

280

is slightly changed so that Q_1 and Q_2 are in coulombs. If both of these charges were to be taken as single elementary charges, then the following changes should be made:

```
280  LET Q1 = 1.6*E-19
290  LET Q2 = 1.6*E-19
300  LET K = 9*E9
```

If the spacing (C) is taken as .1 and the number of charges (N) as 1000, then three runs through the program using the distance between the test charge and the fixed charge (y) as 1, 2, and 4 should be sufficient for the relationships to be determined. A casual inspection of the exact values of the field strength for these three distances should yield the following conclusions:

1. The field strength varies inversely with the square of the distance away from a single point charge.
2. The field strength varies inversely with the distance from a line of charge.
3. The field strength remains constant even though the distance from a plane of charge changes.

It should be noted in 2 and 3 above, that the spacing between charges must be small as compared to the distance away from the line · plane of charge, and of course that the line be so long and the plane so broad that any further increase in length or breadth be insignificant.

An interesting bonus to this program is discov·red when distances from test charge to plane is decreased to .00., .0001, and .00001. Here it can be seen that the field no longer is constant, but changes as an inverse square law for a single charge because the test charge begins to "see" the fixed charge instead of the whole plane. The "EXACT VALUE...," is calculated for charges smeared over the whole plane and not in discrete point charges as we have here; hence, the disagreement with actual field values.

This program may be run by an individual student after proper introductory explanation concerning vector addition of electric fields, contributions of the charges being added in the line or lines to the plane. It may also be used as a class demonstration and discussion. When used with a whole class it is best to have a television camera and monitor available for immediate display of print out. A summary table constructed either by the teacher on the board or by students at their desks is useful in analysis of the data.

```
THIS PROGRAM WILL CALCULATE THE FORCE ON A TEST CHARGE
THAT IS PLACED SOME DISTANCE, Y, AWAY FROM ANOTHER CHARGE;
A LINE OF CHARGE; AND A PLANE OF CHARGE.
YOU MUST ENTER THE DISTANCE AWAY, Y; THE SPACING DESIRED
BETWEEN CHARGES, C, AND ALSO BETWEEN LINES OF CHARGE THAT
MAKE UP THE PLANE OF CHARGE.
YOU MUST ALSO CHOOSE THE NUMBER OF CHARGES (N) IN THE LINE OF
CHARGE THAT YOU WOULD LIKE TO USE (500 IS A GOOD VALUE IF
YOU USE A SPACING OF .1 FOR C.
JUST SO THE CALCULATIONS DON'T GO TOO FAR I'VE INCLUDED
A STOP THAT DEPENDS UPON THE ANGLE FROM TEST CHARGE TO THE
LAST CHARGE TO BE CALCULATED.  IF THE ANGLE IS LESS
THAN 2 DEGREES, CALCULATIONS WILL CEASE.

INPUT Y,C,N? 1,.1,1000


NO. OF CHGS.
ON EACH SIDE  FORCE
------------  -----
 0            1
 1            2.97
 2            4.86
 3            6.61
 4            8.21
 5            9.65
 6            10.91
 7            12.01
 8            12.96
 9            13.78
 10           14.49
 20           17.98
 30           19
 40           19.42
 50           19.62
 60           19.73
 70           19.8
 80           19.85
 90           19.88
 100          19.9
 200          19.98
 287          19.99
EXCESSIVE COMPUTER TIME WOULD BE REQUIRED TO CALCULATE
THE FORCE FOR ADDITIONAL CHARGES.


THE EXACT VALUE FOR AN INFINITELY LONG LINE OF CHARGE IS 20
```

```
NOW ADD ROWS ON EITHER SIDE OF THE LINE OF CHARGE JUST
CALCULATED.  THE SPACING BETWEEN ROWS WILL BE THE SAME AS
THE SPACING BETWEEN THE CHARGES.
ENTER THE NUMBER OF EQUALLY SPACED ROWS YOU WANT ON EACH SIDE
? 500


NO. OF LINES
ON EACH SIDE  FORCE
------------  -----
 0             20
 1             59.58
 2             98.02
 3             134.69
 4             169.16
 5             201.14
 6             230.53
 7             257.36
 8             281.73
 9             303.82
 10            323.81
 20            446.55
 30            501.31
 40            531.18
 50            549.8
 60            562.47
 70            571.62
 80            578.54
 90            583.96
 100           588.3
 200           608.03
 287           614.05
EXCESSIVE COMPUTER TIME WOULD BE REQUIRED TO CALCULATE
THE FORCE FOR ADDITIONAL LINES OF CHARGE.

THE EXACT VALUE FOR AN INFINITE PLANE OF CHARGE IS 628.318

DO YOU WANT ANOTHER RUN (1=YES, 0=NO) : ? 0

READY
```

```
100 REM   JOHN HOSIE   -  NORTHPORT HIGH -- 3/14/69
105 REM  REVISED BY C.LOSIK  8-25-70
106 REM  SEE BELOW FOR IMPORTANT VARIABLES
107 REM  'F' TYPE VARIABLES ARE FORCES
110 REM I'VE CHOSEN THE ELECTROSTATIC CONSTANT TO BE ONE AND
120 REM ALL CHARGES TO BE ONE SO THAT THE FORCE CALCULATED
130 REM IS JUST A RELATIVE FORCE.  IF YOU WOULD LIKE YOU MAY CHANGE
140 REM THINGS WHEN YOU RUN IT TO GET EXACT FORCES IN NEWTONS AND
150 REM USE CHARGES IN MICROCOULOMBS OR WHAT EVER ELSE YOU WISH.
160 PRINT "THIS PROGRAM WILL CALCULATE THE FORCE ON A TEST CHARGE"
170 PRINT "THAT IS PLACED SOME DISTANCE, Y, AWAY FROM ANOTHER CHARGE;"
180 PRINT "A LINE OF CHARGE; AND A PLANE OF CHARGE."
190 PRINT "YOU MUST ENTER THE DISTANCE AWAY, Y; THE SPACING DESIRED"
200 PRINT "BETWEEN CHARGES, C, AND ALSO BETWEEN LINES OF CHARGE THAT"
210 PRINT "MAKE UP THE PLANE OF CHARGE."
220 PRINT "YOU MUST ALSO CHOOSE THE NUMBER OF CHARGES (N) IN THE LINE OF
230 PRINT "CHARGE THAT YOU WOULD LIKE TO USE (500 IS A GOOD VALUE IF"
240 PRINT "YOU USE A SPACING OF .1 FOR C."
250 PRINT "JUST SO THE CALCULATIONS DON'T GO TOO FAR I'VE INCLUDED"
260 PRINT "A STOP THAT DEPENDS UPON THE ANGLE FROM TEST CHARGE TO THE"
270 PRINT "LAST CHARGE TO BE CALCULATED.  IF THE ANGLE IS LESS"
275 REM  Q1 AND Q2 ARE THE CHARGES
280 LET Q1=1
290 LET Q2=1
295 REM  K IS THE ELECTROSTATIC CONSTANT
300 LET K=1
305 REM  A IS THE CUTOFF ANGLE. THIS MAY BE CHANGED TO YOUR PREFERENCE
310 LET A=2
315 PRINT "THAN"A"DEGREES, CALCULATIONS WILL CEASE."
320 LET S=SIN(3.14159*A/180)
330 PRINT
340 PRINT "INPUT Y,C,N";
350 LET F1=0
353 INPUT Y,C,N
356 IF C<=0 THEN 365
358 IF Y<=0 THEN 365
360 IF N>=0 THEN 370
365 PRINT "ONE OF YOUR VALUES IS UNREASONABLE."
367 GO TO 330
370 PRINT
380 PRINT
390 PRINT "NO. OF CHGS."
400 PRINT "ON EACH SIDE","FORCE"
410 PRINT "------------","-----"
420 FOR I=0 TO N
430 LET X=I*C
440 LET R=SQR(X*X+Y*Y)
450 LET F=K*Q1*Q2/(R*R)
```


281

```
460 IF I<>0 THEN 490
470 LET F1=F
480 GO TO 510
490 LET F1=F1+2*F*(Y/R)
510 IF I<=10 THEN 580
520 IF I=1000*INT(I/1000) THEN 580
530 IF I>1000 THEN 600
540 IF I=100*INT(I/100) THEN 580
550 IF I>100 THEN 600
560 IF I=10*INT (I/10) THEN 580
570 GO TO 600
580 PRINT I,INT(100*F1+.5)/100
590 IF N=0 THEN 330
600 IF Y/R<S THEN 612
610 NEXT I
611 GO TO 620
612 PRINT I,INT(100*F1+.5)/100
613 PRINT "EXCESSIVE COMPUTER TIME WOULD BE REQUIRED TO CALCULATE"
614 PRINT "THE FORCE FOR ADDITIONAL CHARGES."
620 PRINT
625 PRINT
630 PRINT "THE EXACT VALUE FOR AN INFINITELY LONG LINE OF CHARGE IS";
640 PRINT 2*(K*Q1/C)/Y
650 PRINT
660 PRINT
670 PRINT
680 PRINT "NOW ADD ROWS ON EITHER SIDE OF THE LINE OF CHARGE JUST"
683 PRINT "CALCULATED.  THE SPACING BETWEEN ROWS WILL BE THE SAME AS"
686 PRINT "THE SPACING BETWEEN THE CHARGES."
690PRINT"ENTER THE NUMBER OF EQUALLY SPACED ROWS YOU WANT ON EACH SIDE"
700 INPUT M
702 IF M>=0 THEN 710
704 PRINT "NO NEGATIVE VALUES, PLEASE."
706 GO TO 690
710 PRINT
720 PRINT
730 PRINT "NO. OF LINES"
740 PRINT "ON EACH SIDE","FORCE"
750 PRINT "------------","-----"
760 FOR P=0 TO M
770 LET Z=P*C
780 LET R1=SQR(Z*Z+Y*Y)
790 IF P<>0 THEN 850
830 LET F3=2*(K*Q1/C)/Y
840 GO TO 870
850 LET F3=F3+2*F1*(Y↑2)/(R1↑2)
870 IF P=1000*INT(P/1000) THEN 930
880 IF P>1000 THEN 940
890 IF P=100*INT(P/100) THEN 930
900 IF P>100 THEN 940
910 IF P=10*INT(P/10) THEN 930
920 IF P>10 THEN 940
930 PRINT P,INT(100*F3+.5)/100
```

```
940 IF Y/R1<S THEN 952
950 NEXT P
951 GO TO 960
952 PRINT P,INT(100*F3+.5)/100
953 PRINT "EXCESSIVE COMPUTER TIME WOULD BE REQUIRED TO CALCULATE"
954 PRINT "THE FORCE FOR ADDITIONAL LINES OF CHARGE."
960 PRINT
965 PRINT
970 PRINT "THE EXACT VALUE FOR AN INFINITE PLANE OF CHARGE IS";
[illegible] PRINT 2*3.14159*(K*Q1)/(C*C)
[illegible] PRINT
[illegible] PRINT
[illegible] PRINT "DO YOU WANT ANOTHER RUN (1=YES, 0=NO) : ";
[illegible] INPUT C
[illegible] IF C>0 THEN 330
1050 END
```

DISCIPLINE PHYSICS

SUBJECT KINEMATICS REVIEW

PROGRAM NAME KINERV

DESCRIPTION:

Questions are asked concerning the motion of a ball thrown vertically upwards at various velocities. Neglecting air resistance, the student is to determine such quantities as 1) maximum obtainable height; 2) time of flight; and 3) the height reached at different times.

OBJECTIVES:

To develop and review basic skills in solving projectile motion problems.

PRELIMINARY PREPARATION:

A. Student - previous classroom instruction and a working knowledge of algebra.

B. Materials - none

DISCUSSION:

The student is presented with various problems concerning the motion of the ball. In each case, the initial velocity V_o of the ball is given. There are five basic questions asked:

1. Determine maximum height reached;
2. Find the height after t seconds;
3. Find the velocity when the ball is at height h;
4. Determine the time of flight; and
5. Find the velocity after t seconds.

The quantities V_o, h, and t are randomly determined for each question asked and the correct answers are given following the student response.

The program is designed to serve as a review of typical motion problems discussed in class and to aid in overcoming student "uncertainty" in the solution of numerical problems.

The program may be modified to cover other areas of review by entering new questions in place of those presently offered (see listing).

```
---REVIEW OF KINEMATICS---

     A BALL IS THROWN STRAIGHT UP AT VARIOUS VELOCITIES.
AIR FRICTION IS NEGLIGIBLE. THE UPWARD DIRECTION IS TAKEN
AS POSITIVE, AND THE DOWNWARD DIRECTION AS NEGATIVE.

THE LOCAL ACCELERATION DUE TO GRAVITY IS -10 METERS/SECOND/SEC.

ALL VALUES ARE IN M.K.S. METRIC UNITS.

     FOR VARIOUS THROWING SPEEDS, YOU MUST ANSWER CERTAIN
QUESTIONS ABOUT THE BALL IN FLIGHT.


 1 . THE UPWARD THROWING SPEED IS  25  METERS/SECOND.
WHAT IS THE VELOCITY WHEN IT REACHES A HEIGHT OF  18.45
METERS ABOVE THE GROUND ? 16
YOU'RE CORRECT WITHIN 5 PERCENT. THE CORRECT ANSWER IS  16  .


 2 . THE UPWARD THROWING SPEED IS  16  METERS/SECOND.
WHAT IS THE VELOCITY AFTER  2  SECONDS OF FLIGHT? 14
YOU'RE OFF MORE THAN 5 PERCENT. THE CORRECT ANSWER IS -4  .


 3 . THE UPWARD THROWING SPEED IS  35  METERS/SECOND.
HOW HIGH ABOVE THE GROUND WILL THE BALL GO? 70
YOU'RE OFF MORE THAN 5 PERCENT. THE CORRECT ANSWER IS  61.25  .


 4 . THE UPWARD THROWING SPEED IS  29  METERS/SECOND.
HOW LONG WILL IT TAKE THE BALL TO RETURN TO THE GROUND? 6.0
YOU'RE CORRECT WITHIN 5 PERCENT. THE CORRECT ANSWER IS  5.8  .


 5 . THE UPWARD THROWING SPEED IS  21  METERS/SECOND.
WHAT IS THE VELOCITY WHEN IT REACHES A HEIGHT OF  10.35
METERS ABOVE THE GROUND ? 12
YOU'RE OFF MORE THAN 5 PERCENT. THE CORRECT ANSWER IS  15.29706  .


OUT OF  5  QUESTIONS, YOU GOT  2  RIGHT.
DON'T YOU KNOW ANYTHING ABOUT THROWING THINGS UP???

WANT TO TRY ANOTHER 5 PROBLEMS (1=YES, 0=NO) : ? 0


READY
```

```
100 REM RICHARD F. PAV; PATCHOGUE H.S.; 1-24-69; PHYSICS
110REM THIS PROGRAM IS DESIGNED TO SERVE AS A REVIEW TEST IN KINEMATICS.
120 REM  REVISED BY C.LOSIK  8-25-70
130 REM  V IS VERTICAL VELOCITY, ALL ELSE IS 'A' (FOR COMPARISONS)
140 REM  WE GENERATE A V RANDOMLY AND RANDOMLY PICK A QUESTION
145 RANDOMIZE
150 LET P=0
155 LET R=0
160 PRINT"                    ---REVIEW OF KINEMATICS---"
170 PRINT
180 PRINT"      A BALL IS THROWN STRAIGHT UP AT VARIOUS VELOCITIES."
190 PRINT"AIR FRICTION IS NEGLIGIBLE. THE UPWARD DIRECTION IS TAKEN"
200 PRINT"AS POSITIVE, AND THE DOWNWARD DIRECTION AS NEGATIVE."
210 PRINT
220 PRINT"THE LOCAL ACCELERATION DUE TO GRAVITY IS -10 METERS/SECOND/SEC
230 PRINT
240 PRINT"ALL VALUES ARE IN M.K.S. METRIC UNITS."
250 PRINT
260 PRINT"      FOR VARIOUS THROWING SPEEDS, YOU MUST ANSWER CERTAIN"
270 PRINT"QUESTIONS ABOUT THE BALL IN FLIGHT."
280PRINT
290PRINT
300 LET U=RND(X)
330 IF Q=0THEN 350
340 IF Q/5=INT(Q/5) THEN 770
350LET V=5+INT(35*U)
360LETZ=1+INT(4.999*U)
370 IF(Z-P)*(V-R)=0 THEN 300
380 LETP=Z
390 LET Q=Q+1
400 LET R=V
410 PRINT
420 PRINT Q". THE UPWARD THROWING SPEED IS "V" METERS/SECOND."
430 IFZ=1 THEN 540
440 IF Z=2 THEN 590
450 IF Z=3 THEN 630
460 IF Z=4 THEN 500
470 LET A=.05*V*V
480 PRINT"HOW HIGH ABOVE THE GROUND WILL THE BALL GO";
490 GOTO670
500 LET A=V/5
510 PRINT"HOW LONG WILL IT TAKE THE BALL TO RETURN TO THE GROUND";
520 GOTO670
540 LET T=1+ INT(2*V*U)/10
550LET A=V*T-5*T*T
560 PRINT"HOW HIGH ABOVE THE GROUND WILL THE BALL BE AFTER ";T
570 PRINT"SECONDS OF FLIGHT";
580 GOTO670
590 LET T=1+INT(2*V*U)/10
600 LET A=V-10*T
610 PRINT"WHAT IS THE VELOCITY AFTER "T" SECONDS OF FLIGHT";
620 GO TO 670
630 LET S=.5*INT(V*V*U)/10
640 LET A=SQR(V*V-20*S)
650 PRINT"WHAT IS THE VELOCITY WHEN IT REACHES A HEIGHT OF ";S
660 PRINT"METERS ABOVE THE GROUND ";
670 INPUT G
680 PRINT"YOU'RE";
690 IF ABS((G-A)/A)>.05 THEN 730
700 LET C=C+1
710 PRINT " CORRECT WITHIN ";
720 GOTO740
730 PRINT" OFF MORE THAN ";
740 PRINT"5 PERCENT. THE CORRECT ANSWER IS "A" ."
750PRINT
760GOTO300
770 PRINT
780 PRINT"OUT OF "Q" QUESTIONS, YOU GOT "C" RIGHT."
790 IFC/Q>=.7 THEN810
800 PRINT"DON'T YOU KNOW ANYTHING ABOUT THROWING THINGS UP???"
810 PRINT
820 PRINT "WANT TO TRY ANOTHER 5 PROBLEMS (1=YES, 0=NO) ; ";
830 INPUT M
835 LET U=RND(X)
840 IF M=1 THEN 350
850 IF M<>0 THEN 810
860 END
```

DISCIPLINE PHYSICS

SUBJECT LENSES

PROGRAM NAME LENSES

DESCRIPTION:

The focal length, object distance, image distance, image size, or object size, may be calculated if sufficient information is entered by the student.

OBJECTIVES:

A. To solve for focal length of a lens from laboratory data.

B. To check image position and size from lab data.

C. To solve lens problems.

PRELIMINARY PREPARATION:

A. Student - Data from a lens experiment.

B. Materials - none

DISCUSSION:

If this program is used in conjunction with a lens laboratory, the student may check his calculations of focal length.

He may also check his image size and position from known object size and position.

```
THIS PROGRAM MAY BE USED TO SOLVE LENS PROBLEMS.
IN THE ORDER GIVEN ENTER THE VALUES FOR THE FOLLOWING:
FOCAL LENGTH, OBJECT DISTANCE, IMAGE DISTANCE, OBJECT
SIZE, IMAGE SIZE.  INPUT 0 (ZERO) FOR UNKNOWN VALUES.
EVERY TIME THE COMPUTER ASKS 'READY?', ENTER 1 IF YOU HAVE
MORE PROBLEMS TO DO, OR 0 TO END THE PROGRAM.

*** READY ? 1

WHAT ARE YOUR VALUES FOR F, P, Q, O, I? 1,2,3,4,5

YOUR Q IS NOT CORRECT FOR THE F AND P YOU HAVE ENTERED
NOTE CHANGED Q.  THE PERCENT ERROR ON YOUR Q IS:
 50  PERCENT.
YOUR I IS NOT CORRECT FOR THE O YOU HAVE ENTERED
NOTE CHANGED I.  THE PERCENT ERROR ON YOUR I IS:
 25  PERCENT.

F= 1          P= 2          Q= 2          O= 4          I= 4


*** READY ? 1

WHAT ARE YOUR VALUES FOR F, P, Q, O, I? 1,2,2.04,4,3.9

YOUR Q IS CORRECT TO WITHIN 2 %
NOTE CORRECTED Q.
YOUR I IS CORRECT TO WITHIN 4.411765 %
NOTE CORRECTED I.

F= 1          P= 2          Q= 2.04       O= 4          I= 4.08


*** READY ? 1

WHAT ARE YOUR VALUES FOR F, P, Q, O, I? 0,5,8,4,4
```


291

```
YOUR I IS NOT CORRECT FOR THE O YOU HAVE ENTERED
NOTE CHANGED I.  THE PERCENT ERROR ON YOUR I IS:
 37.5  PERCENT.

F= 3.076923   P= 5           Q= 8          O= 4           I= 6.4


*** READY ? 1

WHAT ARE YOUR VALUES FOR F, P, Q, O, I? 46,53,0,34,32

YOUR I IS NOT CORRECT FOR THE O YOU HAVE ENTERED
NOTE CHANGED I.  THE PERCENT ERROR ON YOUR I IS:
 85.67775  PERCENT.

F= 46          P= 53          Q= 348.2857    O= 34          I= 223.4286


*** READY ? 1

WHAT ARE YOUR VALUES FOR F, P, Q, O, I? 4857,2,6,0,0

YOUR Q IS NOT CORRECT FOR THE F AND P YOU HAVE ENTERED
NOTE CHANGED Q.  THE PERCENT ERROR ON YOUR Q IS:
 399.8765  PERCENT.

F= 4857        P= 2           Q=-2.000824
```

```
100 REM JOHN W. HOSIE - NORTHPORT HIGH - PHYSICS
101 REM REVISED 11-18-70, L.BRAUN
110 PRINT "THIS PROGRAM MAY BE USED TO SOLVE LENS PROBLEMS."
120PRINT
130PRINT"IN THE ORDER GIVEN ENTER THE VALUES FOR THE FOLLOWING:"
140PRINT
150PRINT"FOCAL LENGTH, OBJECT DISTANCE, IMAGE DISTANCE, OBJECT"
160PRINT
170PRINT"SIZE, IMAGE SIZE.  INPUT 0 (ZERO) FOR UNKNOWN VALUES."
180PRINT
182 PRINT "EVERY TIME THE COMPUTER ASKS 'READY?', ENTER 1 IF YOU HAVE"
183 PRINT
184 PRINT "MORE PROBLEMS TO DO, OR 0 TO END THE PROGRAM."
186 PRINT
188 PRINT
190 PRINT "*** READY ";
191 INPUT F
192 IF F=0 THEN 780
193 IF F<>1 THEN 188
195PRINT
196 PRINT "WHAT ARE YOUR VALUES FOR F, P, Q, O, I";
200 INPUT F,P,Q,O,I
210 LET P=ABS(P)
220 LET O=ABS (O)
230 PRINT
240 IF F=0 THEN 390
250 IF P<>F THEN 280
260 PRINT "THE IMAGE IS AT INFINITY"
270 GO TO 186
280 IF P =0 THEN 360
290 LET Z=P*F/(P-F)
300 IF Q=0 THEN 340
310 IF Z=Q THEN 420
312 IF ABS(Q-Z)<0.05*Z THEN 344
320 PRINT "YOUR Q IS NOT CORRECT FOR THE F AND P YOU HAVE ENTERED"
330 PRINT "NOTE CHANGED Q.  THE PERCENT ERROR ON YOUR Q IS:"
335 PRINT 100*ABS(Z-Q)/ABS(Z); " PERCENT."
340 LET Q=Z
342 GO TO 420
344 PRINT"YOUR Q IS CORRECT TO WITHIN";100*ABS(Q-Z)/ABS(Z)"%"
346 PRINT"NOTE CORRECTED Q."
350 GOTO 420
360 IF Q=0 THEN 560
370 LET P=Q*F/(Q-F)
380 GO TO 420
390 IF P=0 THEN 550
400 IF Q=0 THEN 490
410 LET F=Q*P/(Q+P)
420 IF O=0 THEN 730
430 IF I=0 THEN 470
```

```
435 LET Z9=O*Q/P
440 IF I=Z9 THEN 660
445 IF ABS(I-Z9)<0.05*Z9 THEN 474
450 PRINT "YOUR I IS NOT CORRECT FOR THE O YOU HAVE ENTERED"
460 PRINT "NOTE CHANGED I.  THE PERCENT ERROR ON YOUR I IS:"
465 PRINT 100*ABS(I-Z9)/ABS(Z9); " PERCENT."
470 LET I=Z9
472 GO TO 660
474 PRINT"YOUR I IS CORRECT TO WITHIN";100*ABS(I-Z9)/ABS(Z9)"%"
476 PRINT"NOTE CORRECTED I."
478 LET I=Z9
480 GO TO 660
490 IF O<>0 THEN 520
500 PRINT "IF F,Q, AND O OR I = 0; CANNOT CALCULATE - TRY AGAIN."
510 GO TO 186
520 IF I=0 THEN 500
530 LET Q=P*I/O
540 GO TO 650
550 IF Q<>0 THEN 590
560 PRINT "THE FOCAL LENGTH CANNOT BE CALCULATED IF BOTH OBJECT"
570 PRINT "AND IMAGE DISTANCES ARE ZERO."
580 GO TO 186
590 IF O=0 THEN 610
600 IF I<>0 THEN 640
610 PRINT "MUST KNOW BOTH OBJECT AND IMAGE SIZE TO FIND FOCAL"
620 PRINT "LENGTH AND OBJECT DISTANCE."
630 GO TO 186
640 LET P=Q*O/I
650 LET F=Q*P/(P+Q)
660 PRINT
665 PRINT "F="F, "P="P, "Q="Q, "O="O, "I="I
670 PRINT
680 PRINT
690 GO TO 186
700 PRINT "INFORMATION ABOUT EITHER FOCAL LENGTH OR BOTH OBJECT"
710 PRINT "AND IMAGE SIZE NEEDED FOR COMPLETE SOLUTION."
720 GO TO 186
730 IF I=0 THEN 760
740 LET O=I*P/Q
750 GOTO 660
760 PRINT
765 PRINT "F="F, "P="P, "Q="Q
770 GO TO 670
780 END
```

DISCIPLINE PHYSICS

SUBJECT MASS DEFECT

PROGRAM NAME MASSD

DESCRIPTION:

A classroom presentation that could be used to calculate mass defect, and give the answer in terms of usable energy (kw-hr. of electricity).

OBJECTIVES:

A. To calculate and explain mass defect.

B. To introduce the concept of binding energy.

C. Conversion of mass to energy. (atomic power)

PRELIMINARY PREPARATION:

A. Student - The student should have an understanding of nuclear particles, and the law of conservation of mass and energy.

B. Materials - The teacher should make available a table of isotopes that lists the actual mass. (Handbook of Chemistry and Physics, Chemical Rubber Company)

DISCUSSION:

It should be noted that the masses used here include the electrons. The very small difference which would be obtained if the bare nuclear mass were known is negligible for the purpose of this calculation.

Time permitting, it would be beneficial to have the student investigate the conversion of atomic mass units(AMU) to calories and kilowatt-hours in order to recognize the significance of the units and the magnitude of the numbers involved.

```
THIS PROGRAM IS DESIGNED TO INVESTIGATE MASS DEFECT

  WHICH OF THE ELEMENTS WOULD YOU LIKE TO CONSIDER?
 REMEMBER WE ARE DEALING WITH A SINGLE ATOM, THEREFORE
 IN ADDITION TO THE ATOMIC NUMBER WE ARE GOING TO NEED THE
 ACTUAL MASS (IN AMU) AND THE MASS NUMBER OF THE ISOTOPE
 YOU WANT TO WORK WITH.

 WHEN THE MACHINE TYPES A QUESTION MARK (?) TYPE IN
 YOUR ANSWER THEN HIT RETURN KEY. USE NUMBERS OF UP TO
 SIX SIGNIFICANT FIGURES. ROUND IF NECESSARY TO 6 DIGITS.
IN THE VALUES FOR MASS DEFECT.


 THE ATOMIC NUMBER IS ? 8
 THE ACTUAL MASS IS ? 15.9949
 THE MASS NUMBER IS ? 16

 THE SUM OF THE MASS OF THE 8 PROTONS AND THE 8 NEUTRONS
 PLUS THE WEIGHT OF THE 8 ELECTRONS IS THE CALCULATED
 MASS.

  CALCULATED MASS  -  ACTUAL MASS  =  MASS DEFECT
      16.13199     -    15.9949    =     .1371

 THE MASS DEFECT IN TERMS OF ENERGY IS THE EQUIVALENT OF
 2936 X 10↑9 CAL. PER MOLE OF THIS SUBSTANCE,
OR 184 X 10↑9 CAL. PER GRAM.

 IF WE DIVIDE THIS BINDING ENERGY BY THE NUMBER OF
 PARTICLES IN THE NUCLEUS, WE GET A RATIO KNOWN AS THE
 BINDING ENERGY PER NUCLEON, WHICH IS A MEASURE OF THE
 STABILITY OF THE NUCLEUS.  THE MORE 'BINDING'
 PER NUCLEON, THE MORE STABLE IS THE NUCLEUS.
 THE BINDING ENERGY PER NUCLEON IS : 1.276744E-5 ERGS. PER NUCLEON, OR
 3.047121E-13 CAL. PER NUC.,
 WHICH IS MORE COMMONLY EXPRESSED AS 800 MEV.

 THE AMOUNT OF ENERGY (BINDING ENERGY) CONTAINED IN ONE
 GRAM OF THIS SUBSTANCE WOULD BE SUFFICIENT TO SUPPLY ALL
 THE ELECTRICAL NEEDS IN AN AVERAGE ONE FAMILY HOUSE USING
 15 KW-HRS. PER DAY FOR A PERIOD OF 14245 DAYS OR
 39 YEARS.

 IF YOU WOULD LIKE TO RUN ANOTHER PROBLEM TYPE IN 1,
 IF NOT TYPE IN 0.
? 0

               ***************

READY
```

```
100 REM JOHN MARCHISOTTO  PIB SUMMER 69   BASIC
105 REM  REVISED BY C.LOSIK  7-22-70
106 REM  AT NO=A, MASS=B, MASS NO=C
107 REM  MASS DEFECT IS F
130 PRINT"    THIS PROGRAM IS DESIGNED TO INVESTIGATE MASS DEFECT"
140 PRINT
150 PRINT"   WHICH OF THE ELEMENTS WOULD YOU LIKE TO CONSIDER? "
160 PRINT" REMEMBER WE ARE DEALING WITH A SINGLE ATOM, THEREFORE"
170 PRINT" IN ADDITION TO THE ATOMIC NUMBER WE ARE GOING TO NEED THE"
180 PRINT" ACTUAL MASS (IN AMU) AND THE MASS NUMBER OF THE ISOTOPE"
190 PRINT" YOU WANT TO WORK WITH."
200 PRINT
210 PRINT " WHEN THE MACHINE TYPES A QUESTION MARK (?) TYPE IN"
220 PRINT " YOUR ANSWER THEN HIT RETURN KEY. USE NUMBERS OF UP TO"
230 PRINT " SIX SIGNIFICANT FIGURES. ROUND IF NECESSARY TO 6 DIGITS."
237 PRINT "IN THE VALUES FOR MASS DEFECT."
238 PRINT
240 PRINT
250 PRINT " THE ATOMIC NUMBER IS ";
260 INPUT A
270 PRINT " THE ACTUAL MASS IS ";
280 INPUT C
290 PRINT " THE MASS NUMBER IS ";
300 INPUT B
310 PRINT
320 REM  G IS AVOGADRO'S NUMBER
330 LET G=6.023E23
340 LET D = B - A
350 LET E=(1.00728*A)+(1.00867*D)+(5.48597E-4*A)
360 LET F=INT(1E4*(E-C)+.5)/1E4
370 PRINT " THE SUM OF THE MASS OF THE"A"PROTONS AND THE"D"NEUTRONS"
380 PRINT " PLUS THE WEIGHT OF THE"A"ELECTRONS IS THE CALCULATED"
390 PRINT " MASS."
400 PRINT
410 PRINT"  CALCULATED MASS  -  ACTUAL MASS  =  MASS DEFECT"
420 PRINT"      "E,"     -  "C;"     =     "F
430 PRINT
440 REM   CONVERSION FACTORS:
450 REM         1.49 X 10-3 ERGS PER AMU
460 REM         4.19 X 10 7 ERGS PER CAL.
470 REM         3.6  X 10 13 ERGS PER KW-H
475 REM          931.0 MEV PER AMU
480 LET H=(1.49E-3*F*G)/4.19E7
490 PRINT " THE MASS DEFECT IN TERMS OF ENERGY IS THE EQUIVALENT OF"
500 PRINT INT(H/1E9+.5)"X 10↑9 CAL. PER MOLE OF THIS SUBSTANCE,"
510 PRINT "OR"INT((H/C)/1E9+.5)"X 10↑9 CAL. PER GRAM."
```

```
511 PRINT
512 PRINT " IF WE DIVIDE THIS BINDING ENERGY BY THE NUMBER OF"
513 PRINT " PARTICLES IN THE NUCLEUS, WE GET A RATIO KNOWN AS THE"
514 PRINT " BINDING ENERGY PER NUCLEON, WHICH IS A MEASURE OF THE"
515 PRINT " STABILITY OF THE NUCLEUS.  THE MORE 'BINDING'"
516 PRINT " PER NUCLEON, THE MORE STABLE IS THE NUCLEUS."
517 PRINT " THE BINDING ENERGY PER NUCLEON IS :";
518 PRINT 1.49E-3*F/B"ERGS. PER NUCLEON, OR";
519 PRINT 1.49E-3*F/(B*4.19E7)"CAL. PER NUC.,"
520PRINT" WHICH IS MORE COMMONLY EXPRESSED AS"100*INT(931*F/B+.5)"MEV."
522 LET J = ((H/C)*4.19E7/3.6E13)/15
525 PRINT
530 PRINT " THE AMOUNT OF ENERGY (BINDING ENERGY) CONTAINED IN ONE"
540 PRINT " GRAM OF THIS SUBSTANCE WOULD BE SUFFICIENT TO SUPPLY ALL"
550 PRINT " THE ELECTRICAL NEEDS IN AN AVERAGE ONE FAMILY HOUSE USING"
560 PRINT " 15 KW-HRS. PER DAY FOR A PERIOD OF"INT(J+.5)"DAYS OR"
565 PRINT INT((J/365)+.5)"YEARS."
570 PRINT
580 PRINT " IF YOU WOULD LIKE TO RUN ANOTHER PROBLEM TYPE IN 1,"
590 PRINT " IF NOT TYPE IN 0."
600 INPUT M
610 PRINT
620 PRINT " ","***************"
630 IF M=1 THEN 240
640 IF M<>0 THEN 580
650 END
```

DISCIPLINE PHYSICS

SUBJECT FORCES + DISPLACEMENTS

PROGRAM NAME NEWTN2

DESCRIPTION:

A problematic situation is presented to the student which requires repeated applications of Newton's 2nd law. By selecting various angles and forces, the operator can observe the resulting motion produced. To successfully complete the program, the student must complete a specified displacement within ten attempts.

OBJECTIVES:

To aid in the development of skills in applying the equations of motion.

PRELIMINARY PREPARATION:

A. Student - An awareness of Newton's 2nd law is required. In addition, some familiarity of force components (resolution of vectors) is necessary.

B. Materials - Graph paper is helpful to students with below-to-average ability.

DISCUSSION:

A. Operational Suggestions

This program was designed for operation by individual students or small groups, but the program may be used with a class as a "lead-in" demonstration of forces and vectors. The presentation is also helpful in describing two dimensional motion under the influence of a constant external force.

When executed by small groups of average students, it has been noted that programs of this type stimulate discussions and involvement for those participating.

B. Suggested Follow-up

The student is confronted with a situation which requires that he overcome a given force (the wind), in moving a boat across a channel 10 Km. wide. The magnitude of the force produced by the wind on the boat varies with each "run", but the direction of the vector is always southwest, i.e 45 deg. with respect to the direction EAST. The student may vary his paddling force (limited to values less than 200 Newtons), and direction at intervals during his displacement. After each choice of variables, he is given his position, as well as the resulting speed and direction of the boat. A certificate is presented for successful completion of the task.

```
HINT: GRAPH PAPER IS HELPFUL IN RUNNING THIS PROGRAM.

              F' MA SPEED,...
              ---------------

YOU'RE TRYING TO ESCAPE FROM DEVIL'S ISLAND ON A SMALL BOAT.
DEVIL'S ISLAND IS LOCATED AT COORDINATES (0,0).
TO SUCCEED, YOU MUST REACH A CHANNEL 50 METERS WIDE AND
10000 METERS DUE EAST, AT ABOUT (10000,0).

IN ADDITION, YOU MUST GET THERE IN FIVE MINUTES OR LESS OR
SUFFER RECAPTURE ---  (HEH,HEH,HEH--)

WHAT DO YOU WEIGH (IN POUNDS)? 170

YOUR SITUATION IS AS FOLLOWS:

THE WIND IS BLOWING FROM THE NORTHEAST (45 DEGREES) EXERTING
A FORCE OF 100 NEWTONS ON YOUR BOAT. YOU MAY PADDLE WITH
ANY FORCE IN THE EASTWARD DIRECTION (ZERO DEGREES IS EAST)
TO ACCELERATE YOUR BOAT ACROSS THE BAY AND THUS
REACH THE OPPOSITE SHORE (AND FREEDOM).
(NOTE: THE MASS OF THE BOAT WITH YOU ABOARD IS 177 KILOGRAMS).

WITH WHAT FORCE (IN NEWTONS) AND DIRECTION (IN DEGREES) WILL
YOU PADDLE? 199,25
T= .5          X= 276        Y= 32         V(X)= 18       V(Y)= 2

WANT TO CHANGE FORCE OR DIRECTION (1=YES, 0=NO) : ? 1

WITH WHAT FORCE (IN NEWTONS) AND DIRECTION (IN DEGREES) WILL
YOU PADDLE? 199,23
T= 1           X= 1111       Y= 112        V(X)= 37       V(Y)= 3

WANT TO CHANGE FORCE OR DIRECTION (1=YES, 0=NO) : ? 1

WITH WHAT FORCE (IN NEWTONS) AND DIRECTION (IN DEGREES) WILL
YOU PADDLE? 199,20
T= 1.5         X= 2523       Y= 199        V(X)= 57       V(Y)= 3

WANT TO CHANGE FORCE OR DIRECTION (1=YES, 0=NO) : ? 0
T= 2           X= 4520       Y= 269        V(X)= 76       V(Y)= 2

WANT TO CHANGE FORCE OR DIRECTION (1=YES, 0=NO) : ? 0
T= 2.5         X= 7103       Y= 321        V(X)= 96       V(Y)= 1

WANT TO CHANGE FORCE OR DIRECTION (1=YES, 0=NO) : ? 1

WITH WHAT FORCE (IN NEWTONS) AND DIRECTION (IN DEGREES) WILL
YOU PADDLE? 150,10
T= 3           X= 10173      Y= 248        V(X)= 109      V(Y)=-6
YOU HAVE REACHED THE OPPOSITE SHORE,
BUT ARE 248 METERS OFF COURSE.
ALL THAT WORK FOR NOTHING!
YOU'RE LOST IN THE SWAMPS FOREVER!  GOODBYE.

SEE IF YOU CAN IMPROVE YOUR ABILITY LATER.

READY
```

3 00

```
100REM A.C. CAGGIANO; PATCHOGUE H.S.; DEC.4,68
105 REM  REVISED BY C.LOSIK  8-18-70
106 REM  X AND Y COORDINATES ARE USED WITH 1-TYPE VARIABLES IN
107 REM  X DIRECTION  AND 2-TYPE VARIABLES IN THE Y DIRECTION
108 REM  IT IS BEST TO CHECK THE EQUATIONS BELOW
110REM THIS IS A PHYSICS PROGRAM WHICH ATTEMPTS TO DEVELOP A
120REM    'FEEL' FO THE F=MA RELATIONSHIP
130 PRINT"HINT: GRAPH PAPER IS HELPFUL IN RUNNING THIS PROGRAM."
140LETX=0
150 LET Y=0
160LETV1=0
170LETV2=0
180 PRINT
190LETQ=0
200PRINT" "," ";"F'  MA  SPEED,..."
210PRINT" "," ";"----------------"
220PRINT
230PRINT"YOU'RE TRYING TO ESCAPE FROM DEVIL'S ISLAND ON A SMALL BOAT."
235 PRINT "DEVIL'S ISLAND IS LOCATED AT COORDINATES (0,0)."
240PRINT"TO SUCCEED, YOU MUST REACH A CHANNEL 50 METERS WIDE AND"
250PRINT"10000 METERS DUE EAST, AT ABOUT (10000,0)."
260PRINT
270PRINT"IN ADDITION, YOU MUST GET THERE IN FIVE MINUTES OR LESS OR"
280PRINT"SUFFER RECAPTURE ---  (HEH,HEH,HEH--)"
290PRINT
300PRINT"WHAT DO YOU WEIGH (IN POUNDS)";
310INPUTW
320 RANDOMIZE
360LETP1=RND(X)*8
380LET P=20*INT(P1+.5)
390 LET M=INT(W/2.2+100.5)
400 LET T1=0
410 LET T=30
420PRINT
430PRINT"YOUR SITUATION IS AS FOLLOWS:"
440PRINT
450PRINT"THE WIND IS BLOWING FROM THE NORTHEAST (45 DEGREES) EXERTING"
460PRINT"A FORCE OF"P"NEWTONS ON YOUR BOAT. YOU MAY PADDLE WITH"
470 PRINT "ANY FORCE IN THE EASTWARD DIRECTION (ZERO DEGREES IS EAST)"
475 PRINT "TO ACCELERATE YOUR BOAT ACROSS THE BAY AND THUS"
477 PRINT "REACH THE OPPOSITE SHORE (AND FREEDOM)."
480PRINT"(NOTE: THE MASS OF THE BOAT WITH YOU ABOARD IS"M"KILOGRAMS)."
490PRINT
500PRINT"WITH WHAT FORCE (IN NEWTONS) AND DIRECTION (IN DEGREES) WILL"
510PRINT"YOU PADDLE";
520 INPUT F,A
530 IF ABS(F-100)<100 THEN 610
540LETQ=Q+1
550 IF Q>2 THEN 970
560IFQ>1THEN590
570PRINT"YOU MUST THINK YOU'RE SUPERMAN. BE PRACTICAL."
580 GOTO490
590PRINT"IF YOU'RE THAT STRONG, JUMP THE CHANNEL---"
600 GOTO490
610 IF ABS(A)<90 THEN 640
620PRINT"YOU'RE HEADING THE WRONG WAY. TRY AGAIN."
630 GOTO490
640 LET A0=.0175*A
650 LET A1=(F*COS(A0)-.717*P)/M
660 LET A2=(F*SIN(A0)-.717*P)/M
670 LET X=A1*T*T/2+V1*T+X
680 LET Y=A2*T*T/2+V2*T+Y
```

```
690 LET V1=A1*T+V1
700 LET V2=A2*T+V2
710 LET T1=T1+.5
720 PRINT "T="T1,"X="INT(X+.5),"Y="INT(Y+.5),"V(X)="INT(V1+.5),
721 PRINT "V(Y)="INT(V2+.5)
722 IF X>0 THEN 730
724 PRINT "NO HELP THAT WAY. YOU'RE GOING BACKWARDS."
726 GO TO 490
730 IF X>10000 THEN 800
735 IF T1>5 THEN 900
740 PRINT
750 PRINT "WANT TO CHANGE FORCE OR DIRECTION (1=YES, 0=NO) : ";
760 INPUT R
770 IF R=1 THEN 490
780 IF R=0 THEN 650
790 GO TO 750
800 PRINT "YOU HAVE REACHED THE OPPOSITE SHORE,"
810 IF ABS(Y)<200 THEN 830
820 PRINT "BUT ARE"INT(Y+.5)"METERS OFF COURSE."
825 PRINT "ALL THAT WORK FOR NOTHING!"
826 PRINT "YOU'RE LOST IN THE SWAMPS FOREVER;  GOODBYE."
827 GO TO 950
830 IF ABS(Y)<100 THEN 850
840 PRINT "AND YOU MIGHT MAKE IT, THOUGH YOU ARE OFF COURSE."
843 GO TO 950
850 IF ABS(Y)<25 THEN 870
860 PRINT "BUT YOU'RE CLOSE ENOUGH TO GET AWAY.  GOOD LUCK!"
863 GO TO 950
870 PRINT "AND HAVE REACHED THE CHANNEL."
880 PRINT "HOW SWEET SUCCESS IS !!!"
890 GO TO 950
900 PRINT "YOUR TIME IS UP."
910 IF X<=10000 THEN 800
920 PRINT "YOU HAVE NOT REACHED THE CHANNEL, AND ARE ONLY"
930 PRINT INT(SQR(X*X+Y*Y)+.5)"METERS FROM WHERE YOU STARTED."
940 PRINT "YOU MUST SUFFER RECAPTURE."
945 PRINT "SORRY, CHUM, BUT THAT'S PHYSICS."
950 PRINT
960 PRINT "SEE IF YOU CAN IMPROVE YOUR ABILITY LATER."
970 END
```

DISCIPLINE PHYSICS

SUBJECT PHOTOELECTRIC EFFECT

PROGRAM NAME PHOTEL

DESCRIPTION:

An experiment involving the photoelectric effect is simulated by the computer, to enable students to develop a qualitative understanding of the phenomenon.

OBJECTIVES:

To demonstrate a "critical wavelength" for photo-electronic emission.

PRELIMINARY PREPARATION:

A. Student

1. Prior discussion of the phenomenon as an introduction to modern physics
2. Students must be previously aware of such properties of light as wavelength and intensity.

B. Materials - none

DISCUSSION:

The student is permitted to select any one of five metals, which is subsequently subjected to ultraviolet radiation. The electrons are "counted" by an ammeter incorporated in the simulated experimental set-up.

The data collected is tabulated for three trials, indicating the current measured for various wavelengths. The data will indicate that:

1. The photoelectric emission is a function of wavelength:
2. For light of wavelength less than the critical value, the number of electrons emitted is dependent upon the incident light intensity: and
3. For wavelengths greater than the critical value. light intensity has no effect on the emission of electrons.

The program is designed for individual qualitative investigation of the phenomena, but may also be utilized by small groups.

It should be noted that this program is advantageous where limited or non-existent lab equipment hinders actual experimentation.

THE PHOTOELECTRIC EFFECT

WHEN LIGHT OF SHORT WAVELENGTH FALLS ON A METAL SURFACE, ELECTRONS ARE EJECTED FROM THE METAL. ACCORDING TO THE DESCRIPTION OF THIS PHENOMENON BY EINSTEIN, THERE IS A MAXIMUM WAVELENGTH FOR EACH METAL ABOVE WHICH NO ELECTRONS ARE EMITTED. IN THIS EXPERIMENT WE WILL DETERMINE THE CRITICAL WAVELENGTH AT WHICH THIS OCCURS.

THE METAL SELECTED WILL BE PLACED IN A VACUUM WHERE IT WILL BE BOMBARDED BY SOFT X-RAYS. THE NUMBER OF ELECTRONS EJECTED WILL BE COLLECTED AND COUNTED WITH AN AMMETER. (NOTE:THE CURRENT IS RELATED TO THE NUMBER OF ELECTRONS EMITTED BY THE METAL).

SELECT ONE OF THE METALS LISTED BY TYPING ITS NUMBER.

1) SILVER
2) BISMUTH
3) CADMIUM
4) LEAD
5) PLATINUM

? 3

	MEASURED CURRENT (MICROAMPERES)		
WAVELENGTH	TRIAL 1	TRIAL 2	TRIAL 3
2380	20.7	20.3	20.1
2500	20.6	20.3	20.4
2631	20.5	20.1	20.8
2777	20.8	20.6	20.2
2941	20.1	20.8	20.8
3125	20.2	20	20.8
3333	2.2	3.6	3
3571	4	2.8	4
3846	1	3.5	3.5

DO YOU WISH TO INCREASE THE LIGHT INTENSITY?
(1=YES, 0=NO) : ? 1

BY WHAT FACTOR? (SELECT FACTOR BETWEEN 1 AND 10).
? 7

	MEASURED CURRENT (MICROAMPERES)		
WAVELENGTH	TRIAL 1	TRIAL 2	TRIAL 3
2380	140	140	140
2500	140.1	140.1	140.1
2631	140	140	140.1
2777	140	140.1	140.1
2941	140.1	140	140.1
3125	140.1	140	140
3333	4.5	4.9	3.3
3571	1.4	1.7	2
3846	4	0	3.7

```
DO YOU WISH TO INCREASE THE LIGHT INTENSITY?
(1=YES, 0=NO) : ? 0

DO YOU WISH TO TRY ANOTHER METAL (1=YES, 0=NO) : ? 1
SELECT ONE OF THE METALS LISTED BY TYPING ITS NUMBER.

                1) SILVER
                2) BISMUTH
                3) CADMIUM
                4) LEAD
                5) PLATINUM

? 2
```

	MEASURED CURRENT (MICROAMPERES)		
WAVELENGTH	TRIAL 1	TRIAL 2	TRIAL 3
2380	10.6	10.7	11.1
2500	10.4	11	10.5
2631	11	11	11.4
2777	11.4	10.6	10
2941	11.1	11.6	10.9
3125	3.3	4.8	1.7
3333	4.2	3.6	2
3571	3.9	4	4.2
3846	1	1.7	3.3

```
DO YOU WISH TO INCREASE THE LIGHT INTENSITY?
(1=YES, 0=NO) : ? 0

DO YOU WISH TO TRY ANOTHER METAL (1=YES, 0=NO) : ? 0

NOW BY PLOTTING THE WAVELENGTH VS. THE MEASURED CURRENT,
(AVERAGE OF THREE TRIALS), THE PHOTOELECTRIC EFFECT AS
DESCRIBED BY EINSTEIN WILL BECOME APPARENT.

THANK YOU.

READY
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```
100 REM A.C. CAGGIANO;PATCHOGUE H.S. PHYSICS; 7-16-68
105 REM  REVISED BY C.LOSIK  8-21-70
106 REM  A IS WHICH METAL, L IS THE PRINTED WAVELENGTH,
107 REM  N ARE THE CURRENTS, K IS INTENSITY, F IS INCREASING INTENSITY
110 PRINT " ","THE PHOTOELECTRIC EFFECT"
120PRINT
130PRINT
140PRINT"WHEN LIGHT OF SHORT WAVELENGTH FALLS ON A METAL SURFACE,"
150PRINT"ELECTRONS ARE EJECTED FROM THE METAL. ACCORDING TO THE"
160PRINT"DESCRIPTION OF THIS PHENOMENON BY EINSTEIN, THERE IS A"
170PRINT"MAXIMUM WAVELENGTH FOR EACH METAL ABOVE WHICH NO ELECTRONS"
180 PRINT"ARE EMITTED. IN THIS EXPERIMENT WE WILL DETERMINE THE"
190PRINT"CRITICAL WAVELENGTH AT WHICH THIS OCCURS."
200PRINT
210PRINT"THE METAL SELECTED WILL BE PLACED IN A VACUUM WHERE IT"
220PRINT"WILL BE BOMBARDED BY SOFT X-RAYS. THE NUMBER OF ELECTRONS"
230PRINT"EJECTED WILL BE COLLECTED AND COUNTED WITH AN AMMETER."
240PRINT"(NOTE:THE CURRENT IS RELATED TO THE NUMBER OF ELECTRONS"
250PRINT"EMITTED BY THE METAL)."
260PRINT
270PRINT"SELECT ONE OF THE METALS LISTED BY TYPING ITS NUMBER."
280PRINT
290PRINT" ","1) SILVER"
300PRINT" ","2) BISMUTH"
310PRINT" ","3) CADMIUM"
320PRINT" ","4) LEAD"
330PRINT" ","5) PLATINUM"
340PRINT
345 RANDOMIZE
350INPUT A
360 IF A>1 THEN 380
370 LET V0=.308
380 IF A<>2 THEN 400
390 LET V0=.338
400 IF A<>3 THEN 420
410 LET V0=.318
420 IF A<>4 THEN 440
430LET V0=.340
440 IF A<5 THEN 460
450 LET V0=.385
460 LET K=INT(1+2*RND(X))
470 PRINT
480 PRINT" ","MEASURED CURRENT (MICROAMPERES)"
490PRINT "WAVELENGTH","TRIAL 1","TRIAL 2","TRIAL 3"
500 FOR L=.420 TO .250 STEP -.02
510 LET M=INT(1000/L)
520 PRINT M,
530 FOR J=1 TO 3
540 IF L> V0 THEN 570
550 LET I=SQR(INT(25*RND(X)))
560 GO TO 580
570 LET I=SQR(K*K*100+INT(35*RND(X)))
580 LET N=INT(10*I+.5)/10
590 PRINT N,
```

```
600 NEXT J
610 PRINT
620 NEXT L
630PRINT
640PRINT"DO YOU WISH TO INCREASE THE LIGHT INTENSITY?"
650 PRINT "(1=YES, 0=NO) : ";
660 INPUT G
670 IF G=0 THEN 730
675 IF G<>1 THEN 650
680 PRINT
690 PRINT"BY WHAT FACTOR? (SELECT FACTOR BETWEEN 1 AND 10)."
700 INPUT F
705 IF ABS(F-5.5)>4.5 THEN 690
710 LET K=K*F
720 GO TO 470
730 PRINT
740PRINT"DO YOU WISH TO TRY ANOTHER METAL (1=YES, 0=NO) : ";
750 INPUT H
760 IF H=1 THEN 270
765 IF H<>0 THEN 740
770 PRINT
780PRINT"NOW BY PLOTTING THE WAVELENGTH VS. THE MEASURED CURRENT,"
790PRINT"(AVERAGE OF THREE TRIALS), THE PHOTOELECTRIC EFFECT AS"
800PRINT"DESCRIBED BY EINSTEIN WILL BECOME APPARENT."
810PRINT
820PRINT"THANK YOU."
830 END
```

DISCIPLINE PHYSICS

SUBJECT ENERGY LEVELS

PROGRAM NAME PHOTON

DESCRIPTION:

The student fires 15 shots, from a photon gun, at a mythical gaseous element with 4 randomly-selected energy levels. After each shot,the computer prints out the energies of photons, if any, emitted by the gas. The student is to construct an energy level diagram for the element from a knowledge of the energies of the photons emitted.

OBJECTIVES:

To promote a better understanding of how energy levels are determined from a knowledge of the emissions of excited atoms.

PRELIMINARY PREPARATION:

A. Student - It is desirable that he have run BOHR, but it is not a necessity.

B. Materials - none

DISCUSSION:

The computer randomly selects 4 energy levels for the element. The energies range between 1×10^{-19} and 15×10^{-19} joules .

The energies of the students' 15 shots are picked at random, but cover the range from 1 to 15. Whenever one of the photons shot by the student is capable of exciting the atom all of the possible photon emissions from that excited state are printed.

By examining the photons emitted as a result of the 15 shots the student can construct an energy-level diagram of the element and account for each photon.

IMAGINE THAT YOU HAVE A PHOTON GUN THAT FIRES PHOTONS WITH RANDOMLY SELECTED ENERGIES.

YOU WANT TO FIND SOME OF THE ENERGY LEVELS OF A GAS THAT YOU HAVE ISOLATED FROM A SAMPLE OF MOON ROCK. YOU WILL DO IT BY FIRING PHOTONS INTO THE GAS AND MEASURING THE ENERGIES OF PHOTONS EMITTED BY THE GAS. THE GAS WILL EMIT ONLY IF THE PHOTON YOU FIRED IS CAPABLE OF EXCITING ITS ATOMS TO HIGHER ENERGY STATES.

TO FIRE A BURST OF SINGLE ENERGY PHOTONS INTO THE GAS TYPE 1
TO CEASE FIRING PHOTONS TYPE 0
YOU HAVE 15 SHOTS TO DETERMINE THE ENERGY LEVELS.

	SHOT NUMBER	ENERGY OF EMITTED PHOTONS (E-19 JOULES)
FIRE!!? 1	1	0
FIRE!!? 1	2	0
FIRE!!? 1	3	0
FIRE!!? 1	4	0
FIRE!!? 1	5	14 7 5 3 11 4 2 9
FIRE!!? 1	6	5 3 2 9
FIRE!!? 1	7	3 9
FIRE!!? 1	8	0
FIRE!!? 1	9	0
FIRE!!? 1	10	0
FIRE!!? 1	11	0
FIRE!!? 1	12	7 5 3 4 2
FIRE!!? 1	13	0
FIRE!!? 1	14	0
FIRE!!? 1	15	0

FIND THE ENERGY LEVELS OF OUR ELEMENT - MYSTERIUM AND ACCOUNT FOR EACH OF THE EMITTED PHOTONS BY DRAWING AN ENERGY LEVEL DIAGRAM AND SHOWING WHICH TRANSITIONS GIVE RISE TO THE PHOTONS.

READY

```
110 REM   JOHN W. HOSIE - NORTHPORT HIGH - PHYSICS   8/1/69
113 REM  REVISED BY L.BRAUN  8-20-70
115 REM  R(I) ARE THE ENERGY LEVELS
120 RANDOMIZE
125 DIM R(25),K(15),E(6)
130 FOR J=0 TO 6
140 LET E(J)=0
150 NEXT J
170 PRINT"IMAGINE THAT YOU HAVE A PHOTON GUN THAT FIRES PHOTONS WITH"
180 PRINT"RANDOMLY SELECTED ENERGIES."
190 PRINT
200 PRINT"YOU WANT TO FIND SOME OF THE ENERGY LEVELS OF A GAS THAT"
210 PRINT"YOU HAVE ISOLATED FROM A SAMPLE OF MOON ROCK.  YOU WILL"
220 PRINT"DO IT BY FIRING PHOTONS INTO THE GAS AND MEASURING THE"
230 PRINT"ENERGIES OF PHOTONS EMITTED BY THE GAS.  THE GAS WILL EMIT"
240 PRINT"ONLY IF THE PHOTON YOU FIRED IS CAPABLE OF EXCITING ITS"
250 PRINT"ATOMS TO HIGHER ENERGY STATES."
260 PRINT
270 PRINT
300 REM  THIS GENERATES A RANDOM NO. IN RANGE 0-15
310 LET K=INT(15*RND(X)+.5)
320 FOR I=2 TO 5
330 IF K=E(I) THEN 310
340 NEXT I
350 FOR J=2 TO 5
360 IF E(J)=0 THEN 390
370 NEXT J
380 GO TO 410
390 LET E(J)=K
400 GO TO 310
410 FOR J=1 TO 4
420 FOR I=J+1 TO 5
430 IF E(J)<E(I) THEN 470
440 LET K=E(J)
450 LET E(J)=E(I)
460 LET E(I)=K
470 NEXT I
480 NEXT J
490 PRINT"TO FIRE A BURST OF SINGLE ENERGY PHOTONS INTO THE GAS TYPE 1"
500 PRINT"TO CEASE FIRING PHOTONS TYPE 0"
510 PRINT"YOU HAVE 15 SHOTS TO DETERMINE THE ENERGY LEVELS."
530 PRINT
540 PRINT " ","SHOT NUMBER","ENERGY OF EMITTED PHOTONS (E-19 JOULES)"
550 PRINT
560 IF D=15 THEN 950
570 PRINT "FIRE!!";
580 INPUT F
583 IF F=0 THEN 950
586 IF F<>1 THEN 570
590 LET D=D+1
600 LET N=0
620 LET P=INT(15*RND(X)+.5)
630 FOR I=1 TO 15
640 IF P=K(I) THEN 620
650 NEXT I
660 LET K(D)=P
670 FOR I=1 TO 5
680 IF P=E(I) THEN 720
690 NEXT I
700 PRINT " ",D,"0"
710 GO TO 560
720 FOR H=1 TO I
```

310

```
730 FOR J=1 TO I
740 LET N=N+1
750 LET R(N)=E(I+1-J)-E(H)
760 NEXT J
770 NEXT H
780 PRINT" ",D,
790 FOR I=1 TO 25
800 IF R(I)>0 THEN 830
810 LET R(I)=0
820 GO TO 870
830 FOR J=1 TO 25-I
840 IF R(I)<>R(I+J) THEN 860
850 LET R(I+J)=0
860 NEXT J
870 NEXT I
880 FOR N=1 TO 25
890 IF R(N)=0 THEN 920
900 PRINT R(N);
920 NEXT N
930 PRINT" "
940 GO TO 560
950 PRINT
960 PRINT
970 PRINT"FIND THE ENERGY LEVELS OF OUR ELEMENT - MYSTERIUM"
980 PRINT"AND ACCOUNT FOR EACH OF THE EMITTED PHOTONS BY DRAWING"
990 PRINT"AN ENERGY LEVEL DIAGRAM AND SHOWING WHICH TRANSITIONS"
1000 PRINT"GIVE RISE TO THE PHOTONS."
1010 END
```

DISCIPLINE PHYSICS

SUBJECT PHOTOELECTRIC EFFECT

PROGRAM NAME PLANK

DESCRIPTION:

This program simulates an experiment to determine Planck's constant, threshold frequency, and work function of a metal.

OBJECTIVES:

A. To enable the student to do an experiment on the computer that he is not likely to be able to do in a high-school laboratory.

B. A better understanding of the photoelectric effect.

PRELIMINARY PREPARATION:

A. Student

1. He should have read and studied about threshold frequency, cut-off potential, and know (schematically) how the experimental apparatus used in such an experiment works.
2. It is desirable that he have run PHOTEL- though not a necessity.

B. Materials - Graph paper

DISCUSSION:

The student may choose one of the five metals in the program, the intensity of the x-rays used, and the number of different x-ray frequencies he would like to use. The computer then randomly chooses an x-ray frequency, and prints it for the student to see. The student enters voltages to be used as retarding potentials in the simulated tube and the computer prints a current for each potential entered until the current is zero when the cut-off potential is reached. A new frequency x-ray is then used and the student again tries to find the correct potential for cut-off.

Finally, a table of frequencies and cut-off potentials are printed and an assignment given (plot a graph and answer questions).

The student may then run the program again with a different intensity and the same metal, or he may change the metal and intensity.

IN THIS EXPERIMENT YOU WILL BE GIVEN THE FREQUENCY OF THE X-RAYS BEING USED AND YOU ARE TO DETERMINE THE VOLTAGE SETTING (RETARDING POTENTIAL) NECESSARY TO CAUSE THE COLLECTOR CURRENT TO DECREASE TO ZERO.

FIRST CHOOSE THE METAL YOU WISH TO USE FOR YOUR PHOTOSENSITIVE SURFACE.

1 SILVER, 2 BISMUTH, 3 CADMIUM, 4 LEAD, 5 PLATINUM

WHICH METAL DO YOU CHOOSE? 4

WHAT INTENSITY OF X-RAYS WILL YOU USE (FROM 1 TO 5)? 3

HOW MANY DIFFERENT X-RAY FREQUENCIES WOULD YOU LIKE TO USE TO RADIATE YOUR SAMPLE (FROM 5 TO 8)? 7

THE X-RAY FREQUENCY IS 14.59 E15

VOLTAGES HIGHER THAN CUT OFF WILL GIVE CURRENT READINGS OF ZERO SO TRY LOWER ONES. I'LL NOTIFY YOU OF CUT OFF.

FIND THE CUT OFF (STOPPING) VOLTAGE.

```
V=? 24
          I=0
V=? 20
          I= 9.780632   E-6
V=? 23
          I= 2.232173   E-6
V=? 23.5
          I= .9982259   E-6
V=? 23.6
          I= .747686   E-6
V=? 23.8
           CUT OFF   I=0
```

THE X-RAY FREQUENCY IS 18.24 E15

FIND THE CUT OFF (STOPPING) VOLTAGE.

```
V=? 24
          I= 23.08785   E-6
V=? 28
          I= 16.97117   E-6
V=? 35
          I= 6.16513   E-6
V=? 40
          I=0
V=? 38
          I= 1.580219   E-6
V=? 39.5
          I=0
V=? 39
           CUT OFF   I=0
```

THE X-RAY FREQUENCY IS 9.06 E15

FIND THE CUT OFF (STOPPING) VOLTAGE.

```
V=? 10
          I=0
V=? 5
          I=0
V=? 1
           CUT OFF   I=0
```

```
THE X-RAY FREQUENCY IS 13.2   E15

  FIND THE CUT OFF (STOPPING) VOLTAGE.

V=? 20
          I=0
V=? 17
          I= 3.755741   E-6
V=? 19
          I=0
V=? 18
          I= .4778505   E-6
V=? 18.5
          I=0
V=? 18.2
           CUT OFF   I=0

THE X-RAY FREQUENCY IS 12.44   E15

  FIND THE CUT OFF (STOPPING) VOLTAGE.

V=? 15
           CUT OFF   I=0

THE X-RAY FREQUENCY IS 9.43   E15

  FIND THE CUT OFF (STOPPING) VOLTAGE.

V=? 10
          I=0
V=? 5
          I=0
V=? 2
          I= 12.50934   E-6
V=? 3
          I=0
V=? 2.7
          I=0
V=? 2.5
           CUT OFF   I=0

THE X-RAY FREQUENCY IS 8.65   E15

  FIND THE CUT OFF (STOPPING) VOLTAGE.

V=? 1
          I=0
V=? .4
          I=0
V=? .2
THIS FREQUENCY IS TOO LOW TO CAUSE PHOTOELECTRIC EMISSION
I'LL GIVE YOU A NEW FREQUENCY.

THE X-RAY FREQUENCY IS 10.55   E15

  FIND THE CUT OFF (STOPPING) VOLTAGE.

V=? 10
          I=0
V=? 8
          I=0
V=? 5
          I= 18.15371   E-6
V=? 6
          I= 9.785334   E-6
V=? 7
          I= 1.385315   E-6
V=? 7.5
          I=0
V=? 7.3
          I=0
V=? 7.2
           CUT OFF   I=0
```

X-RAY FREQUENCY E15 FPS	CUT OFF VOLTAGE VOLTS
14.59	23.0
16.24	39
9.06	1
13.2	18.2
12.44	15
9.43	2.5
10.55	7.2

PLOT A GRAPH OF CUT OFF VOLTAGES (Y AXIS) VS. FREQUENCY

WHAT IS THE MEANING OF THE POINT AT WHICH THE EXTRAPOLATED GRAPH INTERCEPTS THE VOLTAGE AXIS?

WHAT IS THE LOWEST FREQUENCY THAT WILL CAUSE EMISSION OF PHOTOELECTRONS FROM THIS METAL?

REMEMBER THAT THE RETARDING POTENTIAL APPLIED BETWEEN THE EMITTER AND THE COLLECTOR AT CUT OFF, EXPRESSED IN ELECTRON VOLTS, IS EQUAL TO THE KINETIC ENERGY OF THE FASTEST ELECTRONS ESCAPING FROM THE EMITTER. FIND THE SLOPE OF THE GRAPH BUT EXPRESS THE STOPPING POTENTIAL IN JOULES.

WHAT IS THE VALUE OF THE SLOPE OF THE GRAPH AND WHAT SPECIAL NAME IS GIVEN TO THIS CONSTANT?

THE SAME METAL WITH A DIFFERENT INTENSITY IS WORTH INVESTIGATING. WHEN YOU DO THIS EXPLAIN THE MEANING OF ITS GRAPH WHEN COMPARED TO THE PREVIOUS ONE.

YOU MAY ALSO WISH TO TRY A DIFFERENT METAL AND EXPLAIN THE MEANING OF ITS GRAPH WHEN COMPARED TO YOUR OTHER ONES, OR COMPARED WITH THOSE OF ANOTHER STUDENT.

DO YOU WISH TO TRY A DIFFERENT INTENSITY OR A DIFFERENT METAL (1=YES, 0=NO) : ? 0

READY

```
100 REM JOHN W. HOSIE  - NORTHPORT HIGH -  7/29/69
105 REM  REVISED BY C.LOSIK  8-21-70
106 REM  M IS WHICH METAL,C IS X-RAY INTENSITY, K IS NO. OF FREQS.
107 REM  F(S) ARE THE FREQS. USED, V(S) ARE THE CUT OFF POINTS
110 LET P=0
120 PRINT
130 PRINT "  IN THIS EXPERIMENT YOU WILL BE GIVEN THE FREQUENCY OF THE"
140PRINT "X-RAYS BEING USED AND YOU ARE TO DETERMINE THE VOLTAGE SET-"
150 PRINT "TING (RETARDING POTENTIAL) NECESSARY TO CAUSE THE COLLECTOR"
160 PRINT "CURRENT TO DECREASE TO ZERO."
170 PRINT
180 PRINT "  FIRST CHOOSE THE METAL YOU WISH TO USE FOR YOUR PHOTO-"
190 PRINT "SENSITIVE SURFACE."
200 PRINT
210 PRINT "  1 SILVER,  2 BISMUTH,  3 CADMIUM,  4 LEAD,  5 PLATINUM"
220 PRINT
230 LET K=0
240 PRINT "WHICH METAL DO YOU CHOOSE";
250 INPUT M
260 IF M>=1 THEN 280
270 GO TO 430
280 IF M>1 THEN 310
290 LET F0=9.74
300 GO TO 450
310 IF M>2 THEN 340
320 LET F0=8.86
330 GO TO 450
340 IF M>3 THEN 370
350 LET F0=9.43
360 GO TO 450
370 IF M>4 THEN 400
380 LET F0=8.82
390 GO TO 450
400 IF M>5 THEN 430
410 LET F0=7.79
420 GO TO 450
430 PRINT "SORRY - THE METALS HAVE NUMBERS FROM 1 TO 5"
440 GO TO 240
450 DIM F(10),V(10)
460 PRINT
480 PRINT "WHAT INTENSITY OF X-RAYS WILL YOU USE (FROM 1 TO 5)";
490 INPUT C
500 IF C>5 THEN 480
510 IF C<1 THEN 480
520 LET S=0
530 PRINT
540 PRINT"HOW MANY DIFFERENT X-RAY FREQUENCIES WOULD YOU LIKE TO"
550 PRINT"USE TO RADIATE YOUR SAMPLE (FROM 5 TO 8)";
560 INPUT K
570 PRINT
580 IF K>=5 THEN 610
590 PRINT "I SAID BETWEEN 5 AND 8 FREQUENCIES."
600 GO TO 530
610 IF K<=8 THEN 650
620 PRINT "TOO MANY TRIALS FOR THE AVAILABLE TIME."
630 GO TO 530
650 RANDOMIZE
670 LET R=0
680 FOR I=1 TO 100
690 LET P=RND(X)
```

```
700 LET F=INT(2000*F+.5)/100
710 IF F>7 THEN 730
720 NEXT I
730 LET V=4.14*(F-F0)
740 LET J=0
750 PRINT "THE X-RAY FREQUENCY IS"F"  E15"
760 PRINT
770 IF R>0 THEN 800
780 PRINT "VOLTAGES HIGHER THAN CUT OFF WILL GIVE CURRENT READINGS OF"
790 PRINT "ZERO SO TRY LOWER ONES.  I'LL NOTIFY YOU OF CUT OFF."
800 PRINT "  FIND THE CUT OFF (STOPPING) VOLTAGE."
810 PRINT
820 PRINT "V=";
830 INPUT V1
840 LET R=R+1
850 LET J=J+1
860 LET I=(20*C*(V-V1))/V+.05*RND(X)
870 IF I<C*20.5 THEN 890
880 LET I=20*C+.1*RND(X)
890 IF V-V1>0 THEN 910
900 LET I=0
910 IF ABS(V-V1)<.1 THEN 1000
920 IF V>0 THEN 950
930 LET I=0
940 IF J=3 THEN 1020
950 IF I=0 THEN 980
960 PRINT "              I="I"  E-6"
970 GO TO 820
980 PRINT "              I=0"
990 GO TO 820
1000 PRINT "              CUT OFF    I=0"
1010 GO TO 1060
1020 PRINT "THIS FREQUENCY IS TOO LOW TO CAUSE PHOTOELECTRIC EMISSION"
1030 PRINT "I'LL GIVE YOU A NEW FREQUENCY."
1040 PRINT
1050 GO TO 680
1060 LET S=S+1
1070 LET F(S)=F
1080 LET V(S)=V1
1090 PRINT
1100 IF S<>K THEN 680
1110 PRINT "  X-RAY","CUT OFF"
1120 PRINT "FREQUENCY","VOLTAGE"
1130 PRINT " E15 FPS"," VOLTS"
1140 PRINT "---------","-------"
1150 PRINT
1160 FOR S=1 TO K
1170 PRINT F(S),V(S)
1180 NEXT S
1190 LET P=P+1
1210 PRINT
1220 PRINT"  PLOT A GRAPH OF CUT OFF VOLTAGES (Y AXIS) VS. FREQUENCY"
1230 PRINT
1235 IF P>1 THEN 1460
1240 PRINT"WHAT IS THE MEANING OF THE POINT AT WHICH THE EXTRAPOLATED"
1250 PRINT"GRAPH INTERCEPTS THE VOLTAGE AXIS?"
1260 PRINT
1270 PRINT"WHAT IS THE LOWEST FREQUENCY THAT WILL CAUSE EMISSION OF"
1280 PRINT"PHOTOELECTRONS FROM THIS METAL?"
1290 PRINT
1300 PRINT"REMEMBER THAT THE RETARDING POTENTIAL APPLIED BETWEEN THE"
1310 PRINT"EMITTER AND THE COLLECTOR AT CUT OFF, EXPRESSED IN ELECTRON"
1320 PRINT"VOLTS, IS EQUAL TO THE KINETIC ENERGY OF THE FASTEST"
1330 PRINT"ELECTRONS ESCAPING FROM THE EMITTER.  FIND THE SLOPE OF THE"
```

```
1340 PRINT"GRAPH BUT EXPRESS THE STOPPING POTENTIAL IN JOULES."
1350 PRINT
1360 PRINT"WHAT IS THE VALUE OF THE SLOPE OF THE GRAPH AND WHAT SPECIAL"
1370 PRINT"NAME IS GIVEN TO THIS CONSTANT?"
1380 PRINT
1390 PRINT"THE SAME METAL WITH A DIFFERENT INTENSITY IS WORTH"
1400 PRINT"INVESTIGATING.  WHEN YOU DO THIS EXPLAIN THE MEANING"
1410 PRINT"OF ITS GRAPH WHEN COMPARED TO THE PREVIOUS ONE."
1420 PRINT
1430 PRINT"YOU MAY ALSO WISH TO TRY A DIFFERENT METAL AND EXPLAIN"
1440 PRINT"THE MEANING OF ITS GRAPH WHEN COMPARED TO YOUR OTHER ONES,"
1450 PRINT "OR COMPARED WITH THOSE OF ANOTHER STUDENT."
1460 PRINT
1470 PRINT "DO YOU WISH TO TRY A DIFFERENT INTENSITY OR A"
1480 PRINT "DIFFERENT METAL (1=YES; 0=NO) : ";
1490 INPUT Q
1500 IF Q=1 THEN 170
1510 IF Q<>0 THEN 1460
1520 END
```

DISCIPLINE	PHYSICS
SUBJECT	PROJECTILE MOTION
PROGRAM NAME	PRJTL

DESCRIPTION:

By entering the firing angle and initial speed, the computer calculates the coordinates, vertical and horizontal velocities, and speed of a projectile for equal time intervals.

OBJECTIVES:

To show the independence of the horizontal and vertical velocities of a projectile, and to facilitate the plotting of its path by eliminating tedious calculations.

PRELIMINARY PREPARATION:

A. Student - Knowledge of motion at constant velocity and at constant acceleration; and the vector nature of velocity and acceleration.

B. Materials - graph paper

DISCUSSION:

The student enters an angle and an initial speed of a projectile. A table of time, X and Y coordinates, horizontal and vertical velocities, and speed of the projectile is printed.

The student may then plot a graph of the position of the projectile, and draw vectors at each coordinate point to show the vertical and horizontal components of its velocity.

```
SUPPOSE YOU ARE GOING TO FIRE A PROJECTILE INTO THE AIR.
IF YOU ENTER A VALUE FOR ANGLE OF ELEVATION AND INITIAL
VELOCITY, THE RANGE AND HEIGHT WILL BE EVALUATED. ENTER
YOUR INFORMATION IN THE FORM A,V AFTER THE QUESTION MARK.
(REMEMBER, THE ANGLE IS IN DEGREES AND THE INITIAL
VELOCITY IS IN METERS/SECOND.)

WHAT ARE YOUR VALUES? 30,  200

THE TOTAL FLIGHT TIME WAS 20.39431 SECONDS
THE RANGE WAS 3532.399 METERS
THE MAXIMUM HEIGHT WAS 509.8573 METERS

BECAUSE THERE IS NO FRICTION, THE HORIZONTAL VELOCITY IS
CONSTANT.  HORIZONTAL VELOCITY = 173.2051

   THE FOLLOWING ARE POINTS ON THE CURVE AT VARIOUS TIME INTERVALS:

                                                VERTICAL
TIME            X-COORD         Y-COORD         VELOCITY        SPEED
----            -------         -------         --------        -----
0               0               0               99.99992        200
1.854028        321.1272        168.5479        81.81812        191.5574
3.708056        642.2543        303.3861        63.63632        184.5253
5.562084        963.3815        404.5148        45.45451        179.0702
7.416112        1284.509        471.9338        27.27271        175.3391
9.27014         1605.636        505.6432        9.090902        173.4435
11.12417        1926.763        505.643         -9.090901       173.4435
12.9782         2247.89         471.9332        -27.27271       175.3391
14.83222        2569.017        404.5136        -45.45451       179.0702
16.68625        2890.144        303.3848        -63.63631       184.5253
18.54028        3211.272        168.5462        -81.81812       191.5574
20.39431        3532.399        0               -99.99992       200

THE ANGLE AT WHICH YOU FIRED THE PROJECTILE DOES NOT YIELD THE MAX
IMUM RANGE.  WHAT ANGLE DOES? 45

45 DEGREES GIVES THE MAXIMUM RANGE OF 4077.654

WOULD YOU LIKE ANOTHER RUN WITH DIFFERENT A AND V?
(1=YES, 0=NO) : ? 0

READY
```

```
100 REM J.CARACCIOLO, LONGWOOD H.S., 10-26-68,    BASIC
101 REM REVISED 8/25/70 (C. LOSIK)
110 REM PHYSICS        PROJECTILE MOTION
120 PRINT "SUPPOSE YOU ARE GOING TO FIRE A PROJECTILE INTO THE AIR."
130 PRINT "IF YOU ENTER A VALUE FOR ANGLE OF ELEVATION AND INITIAL"
140 PRINT "VELOCITY, THE RANGE AND HEIGHT WILL BE EVALUATED.  ENTER"
150 PRINT "YOUR INFORMATION IN THE FORM A,V AFTER THE QUESTION MARK."
160 PRINT "(REMEMBER, THE ANGLE IS IN DEGREES AND THE INITIAL"
170 PRINT "VELOCITY IS IN METERS/SECOND.)"
180 PRINT
190 PRINT
200 PRINT "WHAT ARE YOUR VALUES";
220 INPUT A,V0
230 IF V0=0 THEN 690
240 IF A=0 THEN 690
250 IF V0<0 THEN 720
260 IF A<0 THEN 720
270 IF A>=90 THEN 750
280 LET A=A*3.14159/180
290 LET K=V0*SIN(A)
300 LET L=V0*COS(A)
310 LET T=2*K/9.80665
320 LET R=2*K*L/9.80665
330 LET H=(K↑2)/19.6133
340 PRINT
350 PRINT
360 PRINT"THE TOTAL FLIGHT TIME WAS";T;"SECONDS"
370 PRINT"THE RANGE WAS";R;"METERS"
380 PRINT"THE MAXIMUM HEIGHT WAS";H;"METERS"
390 PRINT
393 PRINT "BECAUSE THERE IS NO FRICTION, THE HORIZONTAL VELOCITY IS"
396 PRINT "CONSTANT.  HORIZONTAL VELOCITY ="L
400 PRINT
410 PRINT"   THE FOLLOWING ARE POINTS ON THE CURVE AT VARIOUS ";
420 PRINT "TIME INTERVALS:"
430 PRINT
440 PRINT
445 PRINT " "," "," "," VERTICAL "
450 PRINT" TIME "," X-COORD "," Y-COORD "," VELOCITY "," SPEED "
460 PRINT" ---- "," ------- "," ------- "," -------- "," ----- "
470 LET N=T/11
480 LET T1=T
490 FOR T=0 TO T1 STEP N
491 LET Q=K*T-4.90333*T↑2
492 IF Q>0 THEN 495
493 LET Q=0
495 LET V1=K-9.80665*T
500 PRINT T,L*T,Q,V1,SQR(V1*V1+L*L)
510 NEXT T
520 IF ABS(A-.785398)<.00001 THEN 610
530 PRINT
540 PRINT
550 PRINT"THE ANGLE AT WHICH YOU FIRED THE PROJECTILE DOES NOT ";
560 PRINT "YIELD THE MAXIMUM RANGE.  WHAT ANGLE DOES";
580 INPUT A
590 LET A=A*3.14159/180
600 GO TO 520
610 PRINT
620PRINT"45 DEGREES GIVES THE MAXIMUM RANGE OF"2*(V0↑2)*(.707↑2)/9.8066
640 PRINT
642 PRINT "WOULD YOU LIKE ANOTHER RUN WITH DIFFERENT A AND V?"
```


321

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644 PRINT "(1=YES, 0=NO) : ";
645 INPUT V1
646 IF V1=0 THEN 780
648 IF V1<>1 THEN 644
649 PRINT
650 PRINT"ENTER NEW VALUES FOR A,V AFTER THE QUESTION MARK."
660 GO TO 180
690 PRINT "  DON'T ENTER VALUES OF ZERO.";
700 GO TO 180
720 PRINT "  NO NEGATIVE VALUES.  PLEASE ENTER THEM CORRECTLY";
730 GO TO 180
750 PRINT "  GREAT SHOT.  YOU COULD KILL YOURSELF THAT WAY, YOU KNOW."
760 PRINT "  TRY AGAIN (NOT TO KILL YOURSELF, THAT IS) ";
770 GO TO 180
780 END
```

DISCIPLINE PHYSICS

SUBJECT PRINCIPLE OF LEAST TIME

PROGRAM NAME REFLCT

DESCRIPTION:

An analogy is given for a light-ray reflected from a plane surface to demonstrate the "least-time" principle and its relationship to the reflection laws of light.

OBJECTIVES:

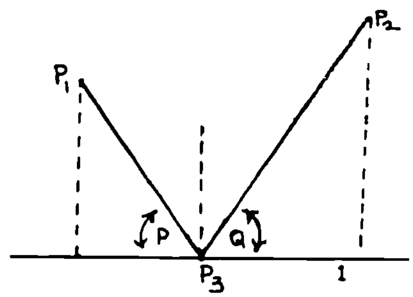
To demonstrate the consequences of the "least-time" principle.

PRELIMINARY PREPARATION:

A. Student - Should be familiar with the reflection laws of light.

B. Materials - graph paper

DISCUSSION:



Given points P_1 and P_2 and the line 1, the student can vary the point P_3 to note thee ffects on angles P and Q and their relationship to the time required to traverse the path $\overrightarrow{P_1P_3P_2}$.

The program is presented as a game in which a horse (lightray) must complete a journey within a specified time. The student is limited to seven choices of P_3 to complete the task. After a successful journey, the student may vary the point P_2 to further establish the principle of least time.

This program has been extremely helpful in developing the least-time concept and its relationship to the laws of reflection.

It is applicable to a classroom situation as well as small study groups.

```
YOU ARE CAMPING OUT WEST IN COORDINATE NATIONAL PARK ON
ORDINATE MOUNTAIN, LOCATED 10 MILES NORTH OF THE
DESERTED TOWN OF ORIGIN, WHICH IS CONVENIENTLY LOCATED
AT (0,0) ON THE LOCAL MAP.

A CALAMITY STRIKES!  THE NEAREST HELP IS AT THE
BAR 30:30 RANCH, LOCATED AT COORDINATES (30,30).
TO GET THERE, YOU MUST RIDE AN OLD HORSE
(NAMED LIGHTRAY)  WHO :
              A) WILL ONLY WALK 5 MILES PER HOUR
              B) WILL CEASE TO WALK (AND EXIST) AFTER 10 HOURS
              C) MUST HAVE A DRINK OF WATER SOMEWHERE ALONG THE
              ABSCISSA RIVER, WHICH (IF YOU HAVEN'T GUESSED) RUNS
              ALONG THE ABSCISSA IN COORDINATE PARK

HERE IS YOUR PROBLEM:  YOU MUST PICK A SPOT
(FROM 0 TO 30) ALONG THE ABSCISSA RIVER DURING THE
TRIP TO GIVE LIGHTRAY A DRINK, AND STILL MAKE IT TO
THE BAR 30:30 WITHIN THE TIME ALLOWED.  LIGHTRAY, USING
HORSE SENSE, KNOWS ALL THE ANGLES, SO WE WILL GIVE
THEM TO YOU, TOO.

WHERE WILL LIGHTRAY STOP FOR A DRINK? 7

ANGLE APPROACHING RIVER IS 55 DEGREES.
ANGLE LEAVING RIVER IS 53 DEGREES.

WHERE WILL LIGHTRAY STOP FOR A DRINK? 7.25

ANGLE APPROACHING RIVER IS 54 DEGREES.
ANGLE LEAVING RIVER IS 53 DEGREES.
WELL, YOU ARE CLOSER THAN LAST TIME.
KEEP AN EYE ON THOSE ANGLES, THOUGH.
LET'S GO BACK FOR ANOTHER HORSE.

WHERE WILL LIGHTRAY STOP FOR A DRINK? 7.3

ANGLE APPROACHING RIVER IS 54 DEGREES.
ANGLE LEAVING RIVER IS 53 DEGREES.
C'MON -- YOU TRIED THAT LAST TIME.

WHERE WILL LIGHTRAY STOP FOR A DRINK? 7.35

ANGLE APPROACHING RIVER IS 54 DEGREES.
ANGLE LEAVING RIVER IS 53 DEGREES.
C'MON -- YOU TRIED THAT LAST TIME.

WHERE WILL LIGHTRAY STOP FOR A DRINK? 7.4

ANGLE APPROACHING RIVER IS 53 DEGREES.
ANGLE LEAVING RIVER IS 53 DEGREES.
NICE WORK.  YOU MADE IT.
THE TRIP TOOK ABOUT 10.00007  HOURS.
YOU CAN SEE THAT USING HORSE SENSE, LIGHTRAY KNOWS THAT
THE ANGLES HAVE TO BE EQUAL OF REFLECTION FOR A
MINIMUM TIME TRIP.

IF YOU WANT TO MOVE THE RANCH, TYPE 1
IF YOU WANT TO SEE SOMETHING ELSE, TYPE 2
IF YOU WANT TO QUIT, TYPE 3
? 3

              THANK YOU FOR PLAYING.


READY
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100 REM  PROGRAM BY GERARD M. DAMM, WYANDANCH HS,  8/68
101 REM  REVISED BY C.LOSIK  8-16-70
110 DIM A(7),B(7),C(7)
115 REM  INTRODUCTION
120 PRINT "YOU ARE CAMPING OUT WEST IN COORDINATE NATIONAL PARK ON"
130 PRINT "ORDINATE MOUNTAIN, LOCATED 10 MILES NORTH OF THE"
140 PRINT "DESERTED TOWN OF ORIGIN, WHICH IS CONVENIENTLY LOCATED"
150 PRINT "AT (0,0) ON THE LOCAL MAP."
155 PRINT
160 PRINT "A CALAMITY STRIKES!  THE NEAREST HELP IS AT THE"
170 PRINT "BAR 30:30 RANCH, LOCATED AT COORDINATES (30,30)."
180 PRINT "TO GET THERE, YOU MUST RIDE AN OLD HORSE"
190 PRINT "(NAMED LIGHTRAY)  WHO :"
200 PRINT " ","A) WILL ONLY WALK 5 MILES PER HOUR"
210 PRINT " ","B) WILL CEASE TO WALK (AND EXIST) AFTER 10 HOURS"
220 PRINT " ","C) MUST HAVE A DRINK OF WATER SOMEWHERE ALONG THE"
230 PRINT " ","ABSCISSA RIVER, WHICH (IF YOU HAVEN'T GUESSED) RUNS"
240 PRINT " ","ALONG THE ABSCISSA IN COORDINATE PARK"
245 PRINT
250 PRINT "HERE IS YOUR PROBLEM:  YOU MUST PICK A SPOT"
260 PRINT "(FROM 0 TO 30) ALONG THE ABSCISSA RIVER DURING THE"
270 PRINT "TRIP TO GIVE LIGHTRAY A DRINK, AND STILL MAKE IT TO"
280 PRINT "THE BAR 30:30 WITHIN THE TIME ALLOWED.  LIGHTRAY, USING"
290 PRINT "HORSE SENSE, KNOWS ALL THE ANGLES, SO WE WILL GIVE"
295 PRINT "THEM TO YOU, TOO."
300 REM  FIRST RUN, INITIALIZE RANCH
310 LET A=30
320 LET B=30
330 LET T9=10
335 LET R=180/3.14159
340 GO TO 500
345 REM  SECOND RUN (OPTIONAL)
350 PRINT
360 PRINT "ENTER TWO NUMBERS, SEPARATED BY A COMMA, FOR THE NEW"
370 PRINT "RANCH COORDINATES  ";
380 INPUT A,B
390 LET X=10*A/(B+10)
400 LET T9=(SQR(X*X+100)+SQR((A-X)*(A-X)+B*B))/5
410 PRINT "O.K., LIGHTRAY WILL LAST ABOUT"T9+.001"HOURS THIS TIME."
499 REM  LOOP FOR SEVEN TRYS - EXIT LOOP IF CORRECT
500 FOR I=1 TO 7
505 PRINT
510 PRINT "WHERE WILL LIGHTRAY STOP FOR A DRINK";
520 INPUT X
530 LET A(I)=INT(R*ATN(10/X)+.5)
535 PRINT
540 LET B(I)=INT(R*ATN(B/(A-X))+.5)
550 PRINT "ANGLE APPROACHING RIVER IS"A(I)"DEGREES."
560 PRINT "ANGLE LEAVING RIVER IS"B(I)"DEGREES."
570 IF A(I)=B(I) THEN 660
580 LET C(I)=ABS(A(I)-B(I))
585 IF I=1 THEN 700
590 IF C(I)>C(I-1) THEN 630
592 IF C(I)<C(I-1) THEN 600
594 PRINT "C'MON -- YOU TRIED THAT LAST TIME."
596 GO TO 700
600 PRINT "WELL, YOU ARE CLOSER THAN LAST TIME."
610 PRINT "KEEP AN EYE ON THOSE ANGLES, THOUGH."
615 PRINT "LET'S GO BACK FOR ANOTHER HORSE."
620 GO TO 700
630 PRINT "HEY - THIS TRIP TAKES LONGER!"
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640 PRINT "YOU HAVE A DEAD HORSE ON YOUR HANDS.  TRY AGAIN."
650 GO TO 700
660 PRINT "NICE WORK.  YOU MADE IT."
670 PRINT "THE TRIP TOOK ABOUT"(SQR(X*X+100)+SQR((A-X)*(A-X)+B*B))/5;
675 PRINT " HOURS."
680 PRINT "YOU CAN SEE THAT USING HORSE SENSE, LIGHTRAY KNOWS THAT"
690 PRINT "THE ANGLES HAVE TO BE EQUAL OF REFLECTION FOR A"
692 PRINT "MINIMUM TIME TRIP."
695 GO TO 800
700 NEXT I
710 PRINT
790 PRINT "TOO MANY GUESSES; WE ARE OUT OF HORSES."
800 PRINT
810 PRINT "IF YOU WANT TO MOVE THE RANCH, TYPE 1"
820 PRINT "IF YOU WANT TO SEE SOMETHING ELSE, TYPE 2"
830 PRINT "IF YOU WANT TO QUIT, TYPE 3"
840 INPUT X
850 IF X=1 THEN 350
860 IF X=2 THEN 900
870 IF X=3 THEN 920
880 GO TO 840
900 PRINT "TIME FOR AN ACTUAL LIGHTRAY TO COMPLETE THE TRIP IS:"
910 PRINT (SQR(X*X+100)+SQR((A-X)*(A-X)+B*B))/1.86E5;" SECONDS."
920 PRINT
930 PRINT " ","THANK YOU FOR PLAYING."
940 END
```

DISCIPLINE PHYSICS

SUBJECT YOUNG'S DOUBLE SLIT EXP

PROGRAM NAME SLITS

DESCRIPTION:

Young's Double Slit Experiment is simulated by the computer to permit greater exploration of the influence of wavelength and slit-separation on the interference pattern. (This is a plotting program).

OBJECTIVES:

To determine, qualitatively, the effects of slit-separation, inter-screen spacing distance (d) and wavelength (w), in altering the location of the maxima and minima of the intensity bands of light.

PRELIMINARY PREPARATION:

A. Student - An instruction sheet is helpful in leading the student through a logical approach. It is also recommended that students understand the superposition of waves before executing this program.

B. Materials - none

DISCUSSION:

A. Operational Suggestions

1. The objectives of this program are best accomplished with small groups (3 to 4 students) to permit discussion and development of ideas concerning the relationships involved.
2. The program has worked well with highly-motivated students and has often led into detailed discussions of related topics. However, it has been found to be relatively ineffectual with poorly-motivated students.

B. Suggested Follow-up

This program permits the exploration of the parameters involved in double-slit interference patterns without the requirement of extensive equipment and/or set-ups. It is recommended that this simulated experiment be employed after the student has familiarized himself with the normal lab experiment.

Follow-up (con't)

To enhance the operation of this program, it is further recommended that an instruction sheet (see attachment) be constructed to enable efficient exploration of this phenomenon. By varying the slit-separation (d), the student can observe the effects by noting the relative separations between adjacent maxima. In a similar manner, changes effectuated by the various wavelengths can also be noted.

Computer Instruction Sheet for Young's Double-Slit Experiment

The crucial experiment for the establishment of the wave nature of light was Young's double-slit experiment. The experiment clearly demonstrated diffraction and interference of light: a phenomenon characteristic of a wave-like nature. Realizing this wave property of light, we can now use the double-slit set-up to further study light sources.

Young's double-slit experiment is illustrated in figure 1, showing a symmetrical layout about line AB. The slits are located on an opaque screen a distance L from the observation screen. The slits are separated a distance d from center to center.

A wave front from the coherent light source reaches the opaque screen as a train of plane waves. Each slit then acts as a new light source (in phase with each other) which interfere with each other creating rays of high-intensity light (constructive interference); and rays of low-intensity light (destructive interference). These rays are most easily observed on the screen.

In this program we will attempt to determine the effects of the slit-separation distance (d) and the wavelength of the light on the interference (intensity) pattern.

ADDRESS COMPUTER PROGRAM SLITS

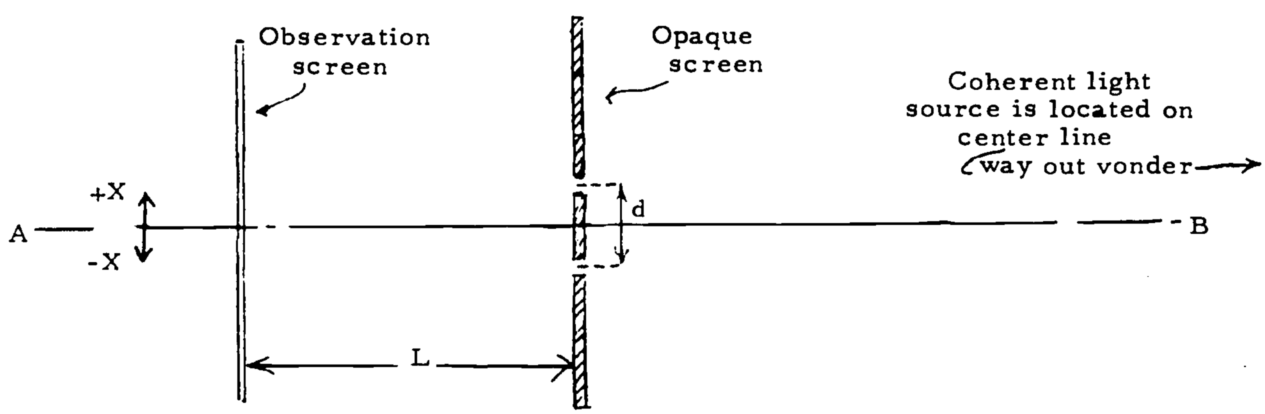


Figure 1

After addressing the program, type RUN. The teletype will then print out the intensity pattern observed when:

L = 2 meters; d = .5 millimeters; and W = 6000 Angstroms.

The left-hand margin shows the distance measured above (positive) and below (negative) the center line. This measurement (x) is in centimeters. This measurement is used to determine the position of the maxima (points of high-intensity light) and/or minima (points of low-intensity light).

The teletype will now ask you to specify a new value of d.

STUDY: How is the intensity pattern affected by changing the slit separation distance? (try several values, if necessary, to determine its effect).

DETERMINE: What happens to the distance x between maxima and minima as d is halved or doubled? Can you determine this relationship?

When you have varied d to your satisfaction, type 100 when asked to specify a new value of d. The teletype will then ask you to specify a new wavelength.

STUDY: How is the intensity pattern affected by changes in the wavelength? (Try several values if necessary).

DETERMINE: What happens to the distance between maxima and minima as W is halved or doubled? Can you determine this relationship?

You can test your ideas by typing 100 when asked to specify a new wavelength. You will then be asked to pick one of four light sources whose wavelength is unknown to you. You will also be asked to specify the value of d you will use in determining the unknown wavelength. You will have the opportunity of changing the d if you so desire.

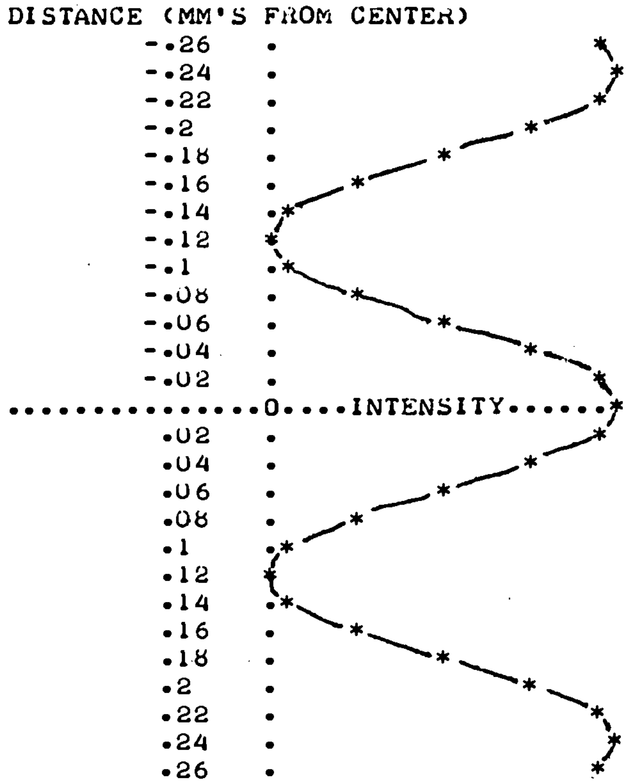
If you are successful, or if time permits, you may try all four tests.

NOTE: To terminate the program during operation, type STOP after any of the question marks that appear; then return carriage.

To sign off the air, type BYE.

YOUNG'S DOUBLE SLIT EXPERIMENT

L = 2 METERS W = 6000 ANGSTROMS D = .5 MILLIMETERS



ABOVE IS AN ILLUSTRATIVE RUN WITH PRE-DETERMINED VALUES FOR WAVELENGTH (W), DISTANCE BETWEEN SLITS AND SCREEN (L), AND SLIT SEPARATION - CENTER TO CENTER (D). NOW YOU MAY VARY THESE PARAMETERS, ONE AT A TIME.

*****

```
WHAT IS THE NEW SLIT SEPARATION (D) IN MILLIMETERS? 1

L = 2 METERS     W = 6000 ANGSTROMS     D = 1 MILLIMETERS

DISTANCE (MM'S FROM CENTER)
       -.26   .              *
       -.24   .                   *
       -.22   .              *
       -.2    .    *
       -.18   *
       -.16   .    *
       -.14   .              *
       -.12   .                   *
       -.1    .              *
       -.08   .    *
       -.06   *
       -.04   .    *
       -.02   .              *
..............0....INTENSITY......*
        .02   .              *
        .04   .    *
        .06   *
        .08   .    *
        .1    .              *
        .12   .                   *
        .14   .              *
        .16   .    *
        .18   *
        .2    .    *
        .22   .              *
        .24   .                   *
        .26   .              *

WOULD YOU LIKE TO TRY ANOTHER VALUE OF D (1-YES, 0-NO)? 1
WHAT IS THE NEW SLIT SEPARATION (D) IN MILLIMETERS? .25

L = 2 METERS     W = 6000 ANGSTROMS     D = .25 MILLIMETERS
```

```
DISTANCE (MM'S FROM CENTER)
        -.26   *
        -.24   *
        -.22   *
        -.2    .*
        -.18   .  *
        -.16   .    *
        -.14   .      *
        -.12   .         *
        -.1    .            *
        -.08   .              *
        -.06   .                *
        -.04   .                  *
        -.02   .                   *
..............0....INTENSITY......*
         .02   .                   *
         .04   .                  *
         .06   .                *
         .08   .              *
         .1    .            *
         .12   .         *
         .14   .      *
         .16   .    *
         .18   .  *
         .2    .*
         .22   *
         .24   *
         .26   *

WOULD YOU LIKE TO TRY ANOTHER VALUE OF D (1-YES, 0-NO)? 0

*****

WHAT IS THE NEW WAVELENGTH (W) IN ANGSTROMS? 3000
```

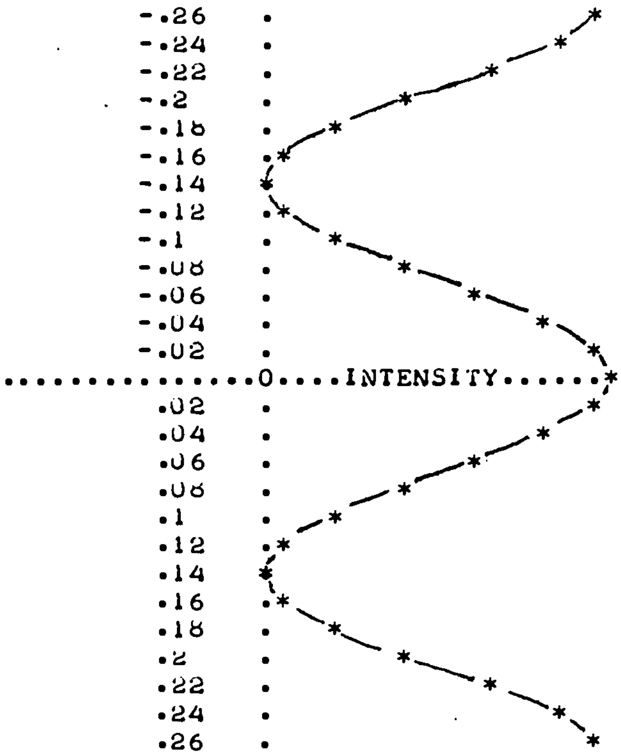
```
L = 2 METERS     W = 3000 ANGSTROMS     D = .5 MILLIMETERS

DISTANCE (MM'S FROM CENTER)
        -.26   .              *
        -.24   .                   *
        -.22   .              *
        -.2    .    *
        -.18   *
        -.16   .    *
        -.14   .              *
        -.12   .                   *
        -.1    .              *
        -.08   .    *
        -.06   *
        -.04   .    *
        -.02   .              *
...............0....INTENSITY......*
         .02   .              *
         .04   .    *
         .06   *
         .08   .    *
         .1    .              *
         .12   .                   *
         .14   .              *
         .16   .    *
         .18   *
         .2    .    *
         .22   .              *
         .24   .                   *
         .26   .              *

WOULD YOU LIKE TO TRY ANOTHER VALUE OF W (1-YES, 0-NO)? 1
WHAT IS THE NEW WAVELENGTH (W) IN ANGSTROMS? 15000
A WAVELENGTH OF  15000  IS INFRARED LIGHT AND NOT VISIBLE.
THE INTERFERENCE PATTERN WILL BE VISIBLE USING DETECTORS
ONLY.  TRY ANOTHER WAVELENGTH.
WHAT IS THE NEW WAVELENGTH (W) IN ANGSTROMS? 6900
```

L = 2 METERS   W = 6900 ANGSTROMS   D = .5 MILLIMETERS

DISTANCE (MM'S FROM CENTER)



WOULD YOU LIKE TO TRY ANOTHER VALUE OF W (1-YES, 0-NO)? 0

*****

WHAT IS THE NEW DISTANCE FROM SLITS TO SCREEN (L) IN METERS? 5

```
L = 5 METERS     W = 6000 ANGSTROMS     D = .5 MILLIMETERS

DISTANCE (MM'S FROM CENTER)
        -.26   .*
        -.24   . *
        -.22   .  *
        -.2    .    *
        -.18   .      *
        -.16   .        *
        -.14   .          *
        -.12   .            *
        -.1    .              *
        -.08   .                *
        -.06   .                 *
        -.04   .                  *
        -.02   .                   *
...............O....INTENSITY......*
         .02   .                   *
         .04   .                  *
         .06   .                 *
         .08   .                *
         .1    .              *
         .12   .            *
         .14   .          *
         .16   .        *
         .18   .      *
         .2    .    *
         .22   .  *
         .24   . *
         .26   .*

WOULD YOU LIKE TO TRY ANOTHER VALUE OF L (1-YES, 0-NO)? 0

*****

YOU WILL NOW BE GIVEN A LIGHT SOURCE OF UNKNOWN
WAVELENGTH.  YOU WILL SPECIFY THE SLIT SEPARATION (D),
AND THE DISTANCE FROM SLITS TO SCREEN (L).
WHAT IS THE NEW SLIT SEPARATION (D) IN MILLIMETERS? .5
WHAT IS THE NEW DISTANCE FROM SLITS TO SCREEN (L) IN METERS? 3000
ALTHOUGH ANY DISTANCE LARGER THAN  5.000000E-3  METERS
IS VALID, ABOVE 5 METERS BECOMES HARD TO SEE.  TRY ANOTHER VALUE.
WHAT IS THE NEW DISTANCE FROM SLITS TO SCREEN (L) IN METERS? 4
```

```
L = 4 METERS     W = ? ANGSTROMS     D = .5 MILLIMETERS

DISTANCE (MM'S FROM CENTER)
        -.26   *
        -.24   *
        -.22   *
        -.2    .*
        -.18   .  *
        -.16   .    *
        -.14   .      *
        -.12   .         *
        -.1    .            *
        -.08   .              *
        -.06   .                *
        -.04   .                  *
        -.02   .                   *
...............O....INTENSITY......*
         .02   .                   *
         .04   .                  *
         .06   .                *
         .08   .              *
         .1    .            *
         .12   .         *
         .14   .      *
         .16   .    *
         .18   .  *
         .2    .*
         .22   *
         .24   *
         .26   *

WOULD YOU LIKE A PLOT FOR OTHER VALUES OF D AND L (1-YES, 0-NO)? 0
WHAT DO YOU THINK THE UNKNOWN WAVELENGTH (W) IS? 6000
PRETTY GOOD! THE WAVELENGTH WAS  6000  ANGSTROMS.
WOULD YOU LIKE TO TRY ANOTHER UNKNOWN WAVELENGTH(1-YES, 0-NO)? 0

*****

WOULD YOU LIKE A PLOT WITH YOUR OWN VALUES FOR WAVELENGTH
 (W), SLIT SEPARATION (D), AND DISTANCE FROM SLITS TO
SCREEN (L) (1-YES, 0-NO)? 1
WHAT IS THE NEW WAVELENGTH (W) IN ANGSTROMS? 5500
WHAT IS THE NEW SLIT SEPARATION (D) IN MILLIMETERS? .75
WHAT IS THE NEW DISTANCE FROM SLITS TO SCREEN (L) IN METERS? 3
```


337

```
L = 3 METERS     W = 5500 ANGSTROMS     D = .75 MILLIMETERS

DISTANCE (MM'S FROM CENTER)
        -.26   .              *
        -.24   .                  *
        -.22   .                    *
        -.2    .                  *
        -.18   .              *
        -.16   .        *
        -.14   .  *
        -.12   *
        -.1    *
        -.08   .  *
        -.06   .        *
        -.04   .             *
        -.02   .                 *
..............0....INTENSITY......*
         .02   .                  *
         .04   .             *
         .06   .        *
         .08   .  *
         .1    *
         .12   *
         .14   .  *
         .16   .        *
         .18   .             *
         .2    .                 *
         .22   .                   *
         .24   .                 *
         .26   .             *

ANOTHER ONE (1-YES, 0-NO)
? 0

**********

HOPE YOU HAD FUN!

READY
```


338

```
100 REM YOUNG'S DOUBLE SLIT EXPERIMENT
101 REM A.C. CAGGIANO
102 REM REVISED 7/28/70 (L. BRAUN, D. PESSEL)
103 REM IMPORTANT VARIABLES:  L-DISTANCE BETWEEN SLITS+SCREEN;
104 REM W-WAVELENGTH; D-SLIT SEPARATION(CENTER TO CENTER)
105 REM
106 REM U:  PRINT PARAMETER FOR UNKNOWN WAVELENGTH
107 LET U=0
110 PRINT " ", "YOUNG'S DOUBLE SLIT EXPERIMENT"
111 PRINT
120 REM ILLUSTRATIVE RUN
130 LET L=2
140 LET W=6000
150 LET D=.5
160 REM PLOT ROUTINE
170 GOSUB 850
171 PRINT
180 PRINT "ABOVE IS AN ILLUSTRATIVE RUN WITH PRE-DETERMINED"
181 PRINT "VALUES FOR WAVELENGTH (W), DISTANCE BETWEEN SLITS"
182 PRINT "AND SCREEN (L), AND SLIT SEPARATION - CENTER TO"
183 PRINT "CENTER (D).  NOW YOU MAY VARY THESE PARAMETERS,"
184 PRINT "ONE AT A TIME."
186 PRINT
187 PRINT "*****"
188 PRINT
190 REM D INPUT SUBROUTINE
200 GOSUB 920
210 REM PLOT ROUTINE
220 GOSUB 850
221 PRINT
230 PRINT "WOULD YOU LIKE TO TRY ANOTHER VALUE OF D (1-YES, 0-NO)";
240 INPUT Q1
250 IF Q1>0 THEN 190
260 PRINT
261 PRINT "*****"
262 PRINT
270 REM RESET D
280 LET D=.5
290 REM W INPUT SUBROUTINE
300 GOSUB 942
310 REM PLOT SUBROUTINE
320 GOSUB 850
321 PRINT
330 PRINT "WOULD YOU LIKE TO TRY ANOTHER VALUE OF W (1-YES, 0-NO)";
340 INPUT Q2
350 IF Q2>0 THEN 290
360 PRINT
```

```
361 PRINT "*****"
362 PRINT
370 REM RESET W
380 LET W=6000
390 REM L INPUT SUBROUTINE
400 GOSUB 900
410 REM PLOT SUBROUTINE
420 GOSUB 850
421 PRINT
430 PRINT "WOULD YOU LIKE TO TRY ANOTHER VALUE OF L (1-YES, 0-NO)";
440 INPUT Q3
450 IF Q3>0 THEN 390
460 PRINT
461 PRINT "*****"
462 PRINT
470 REM RESET L
480 LET L=2
490 PRINT "YOU WILL NOW BE GIVEN A LIGHT SOURCE OF UNKNOWN"
491 PRINT "WAVELENGTH.  YOU WILL SPECIFY THE SLIT SEPARATION (D),"
492 PRINT "AND THE DISTANCE FROM SLITS TO SCREEN (L)."
507 REM Q5 DETERMINES IF W IS TO BE CHANGED
508 LET Q5=0
520 REM D INPUT SUBROUTINE
530 GOSUB 920
550 REM L INPUT SUBROUTINE
560 GOSUB 900
565 REM CHANGE W?
566 IF Q5>0 THEN 600
570 REM RANDOMLY DETERMINE WAVELENGTH
580 RANDOMIZE
590 LET W=1000*INT(3*RND(X)+4.5)
600 REM PLOT SUBROUTINE (UNKNOWN W)
601 LET U=1
605 GOSUB 850
606 PRINT
610 PRINT "WOULD YOU LIKE A PLOT FOR OTHER VALUES OF D AND L ";
611 PRINT "(1-YES, 0-NO)";
620 INPUT Q5
630 IF Q5>0 THEN 520
640 PRINT "WHAT DO YOU THINK THE UNKNOWN WAVELENGTH (W) IS";
650 INPUT W1
660 IF ABS(W1-W)<.1*W THEN 700
670 PRINT "YOU ARE MORE THEN 10% OFF.  TO HELP YOU, YOU MAY ";
680 PRINT "OBTAIN MORE PLOTS."
690 GO TO 610
700 PRINT "PRETTY GOOD!  THE WAVELENGTH WAS "W" ANGSTROMS."
701 PRINT "WOULD YOU LIKE TO TRY ANOTHER UNKNOWN WAVELENGTH";
702 PRINT "(1-YES, 0-NO)";
703 INPUT Q6
704 IF Q6<1 THEN 967
705 PRINT "YOU MAY SPECIFY A NEW SLIT SEPARATION (D) AND DISTANCE"
706 PRINT "FROM SLITS TO SCREEN (L)."
707 GO TO 508
```

```
849 REM
850 REM PLOT ROUTINE
855 PRINT
856 PRINT
857 REM U>0 DO NOT PRINT WAVELENGTH
858 IF U>0 THEN 870
860 PRINT "L ="L"METERS    W ="W"ANGSTROMS    D ="D"MILLIMETERS"
861 PRINT
865 GO TO 875
870 PRINT "L ="L"METERS    W = ? ANGSTROMS    D ="D"MILLIMETERS"
871 PRINT
875 PRINT "DISTANCE (MM'S FROM CENTER)"
880 REM A:PLOT LOWER LIMIT (MM'S); B:UPPER LIMIT (MM'S)
881 LET A=-.26
882 LET B=.26
883 REM R:PRELIMINARY CALC. FOR INTENSITY; 10E4:CONVERSION FACTOR
884 LET R=(3.1416*D*10E4)/(W*L)
885 REM LOOP TO CALCULATE PATTERN AND PLOT IT
886 FOR X=A TO B STEP .02
887 REM Y:INTENSITY
888 REM 20:SCALE FACTOR FOR PLOT; X:DISTANCE (MM'S)
889 LET Y=20*COS(R*X)*COS(R*X)
890 IF ABS(X)<.0001 THEN 893
891 PRINT TAB(8);INT(X*100+.5)/100;TAB(15); ".";  TAB(INT(Y+15.5)); "*"
892 GO TO 895
893 PRINT "...............0....INTENSITY......*"
895 NEXT X
896 LET U=0
897 PRINT
898 RETURN
899 REM
900 REM L INPUT SUBROUTINE
902 PRINT "WHAT IS THE NEW DISTANCE FROM SLITS TO SCREEN (L) ";
903 PRINT "IN METERS";
904 INPUT L
905 REM 1000:  CONVERT L(METERS) TO L(MILLIMETERS)
906 IF 1000*L>= 10*D THEN 912
907 PRINT "THIS DISTANCE IS TOO SMALL FOR GOOD INTERFERENCE PATTERNS."
908 PRINT "TRY ANOTHER VALUE."
910 GO TO 902
912 IF L<=5 THEN 918
913 PRINT "ALTHOUGH ANY DISTANCE LARGER THAN "10*D/1000" METERS"
914 PRINT "IS VALID, ABOVE 5 METERS BECOMES HARD TO SEE.";
915 PRINT "  TRY ANOTHER VALUE."
916 GO TO 902
918 RETURN
919 REM
920 REM D INPUT SUBROUTINE
922 PRINT "WHAT IS THE NEW SLIT SEPARATION (D) IN MILLIMETERS";
924 INPUT D
926 IF D>=.1 THEN 932
928 PRINT "SLITS ARE SO CLOSE THEY APPROXIMATE A SINGLE SLIT."
```


341

```
929 PRINT "TRY ANOTHER VALUE."
930 GO TO 920
932 IF D<=.1*1000*L THEN 940
933 PRINT "FOR A VALID INTERFERENCE PATTERN, THE SLIT SEPARATION"
934 PRINT "SHOULD BE LESS THAN ".1*1000*L" MILLIMETERS.  TRY";
935 PRINT " ANOTHER VALUE."
938 GO TO 920
940 RETURN
941 REM
942 REM W INPUT SUBROUTINE
944 PRINT "WHAT IS THE NEW WAVELENGTH (W) IN ANGSTROMS";
946 INPUT W
947 IF W>=300 THEN 954
948 IF W<1000 THEN 959
949 PRINT "A WAVELENGTH OF "W" IS ULTRAVIOLET LIGHT AND NOT VISIBLE."
950 GO TO 956
952 GO TO 944
954 IF W<=8000 THEN 965
955 PRINT "A WAVELENGTH OF "W" IS INFRARED LIGHT AND NOT VISIBLE."
956 PRINT "THE INTERFERENCE PATTERN WILL BE VISIBLE USING DETECTORS"
957 PRINT "ONLY.  TRY ANOTHER WAVELENGTH."
958 GO TO 944
959 PRINT "A WAVELENGTH OF "W" IS X-RAYS AND NOT VISIBLE."
960 GO TO 956
965 RETURN
966 REM
967 PRINT
968 PRINT "*****"
969 PRINT
970 REM MISCELLANEOUS RUNS
972 PRINT "WOULD YOU LIKE A PLOT WITH YOUR OWN VALUES FOR WAVELENGTH"
973 PRINT " (W), SLIT SEPARATION (D), AND DISTANCE FROM SLITS TO"
974 PRINT "SCREEN (L) (1-YES, 0-NO)";
976 INPUT Q9
980 IF Q9<1 THEN 995
982 GOSUB 942
984 GOSUB 920
986 GOSUB 900
988 GOSUB 850
990 PRINT "ANOTHER ONE (1-YES, 0-NO)"
992 INPUT Q8
993 IF Q8>0 THEN 982
994 REM
995 PRINT
996 PRINT "**********"
997 PRINT
998 PRINT "HOPE YOU HAD FUN!"
999 END

READY
```

DISCIPLINE PHYSICS

SUBJECT SNELL'S LAW

PROGRAM NAME SNELL

DESCRIPTION:

Snell's law is presented pictorially by plotting the path of a light ray as it crosses a boundary separating two different media.

OBJECTIVES:

To permit students to "see" the refraction of light, including the case when the critical angle is exceeded and reflection occurs.

PRELIMINARY PREPARATION:

A. Student - The terms associated with Snell's law, such as refraction, media, normals, etc.; must be presented prior to the running of this program.

B. Materials - No additional supplies or materials are necessary.

DISCUSSION:

Snell's law can be investigated independently by students by altering the angle of incidence, and/or the indices of refraction. The pictorial presentation is especially beneficial to students with reading problems, since the concepts implied by the mathematical relationships are presented hueristically.

In addition, the critical angle may be approached and exceeded, in the special case where n_2 (second medium) is less than n_1 (initial medium).

Queries are included as part of the program to reinforce the concepts.

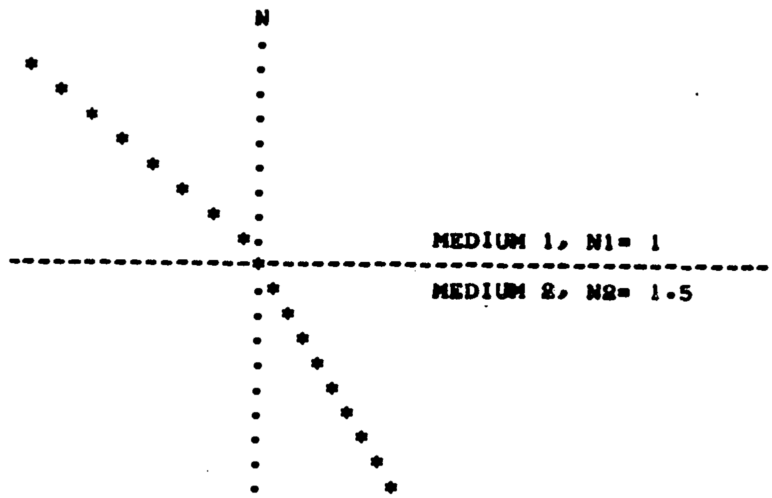
The program is well suited for small groups or individuals, but may be utilized for large group presentation without program modification.

313

---REFRACTION OF LIGHT---

THIS PROGRAM WILL HELP YOU VISUALIZE THE REFRACTION OF LIGHT AS IT CROSSES A BOUNDARY SEPARATING TWO DIFFERENT MEDIA.

THE DIAGRAM BELOW SHOWS LIGHT INCIDENT TO THE BOUNDARY AT 45 DEGREES. THE INDICES OF REFRACTION ARE N1=1.0 AND N2=1.5 RESPECTIVELY.

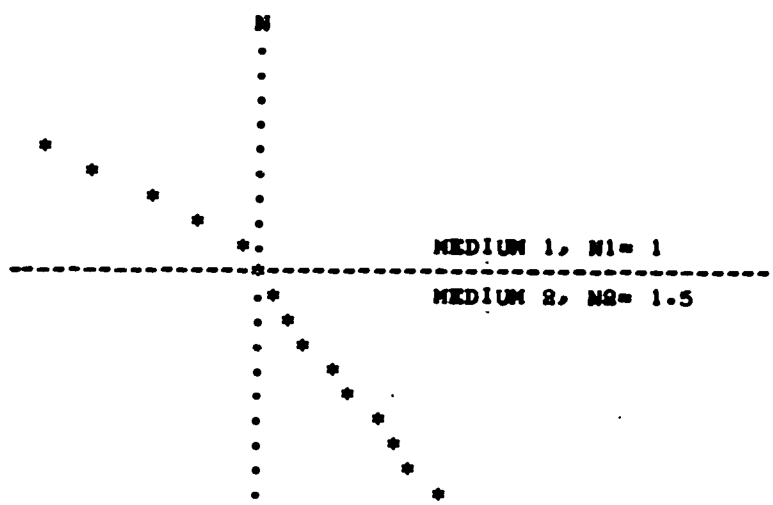


WHAT DO YOU THINK THE ANGLE OF REFRACTION IS? 30
YOU ARE WITHIN 10 PERCENT.
THE ANGLE OF REFRACTION, A2= 28.126

DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 1

NOW YOU CAN CHANGE THE INCIDENT ANGLE. THE REFRACTIVE INDICES WILL REMAIN AS N1=1.0 AND N2=1.5 .

REMEMBER, ONLY POSITIVE ANGLES BETWEEN 0 AND 90 DEGREES ARE PERMISSIBLE ENTRIES.
SO, WHAT ANGLE DO YOU WANT? 60



WHAT DO YOU THINK THE ANGLE OF REFRACTION IS? 35
YOU ARE WITHIN 10 PERCENT.
THE ANGLE OF REFRACTION, A2= 35.264

314

```
DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 1

     NOW SPECIFY NEW VALUES FOR  N1, N2, AND ANGLE 1.
SEPARATE WITH COMMAS.  OKAY, WHAT VALUES? 2,3.5,15
VALUE OF N2 IS UNREASONABLE.
YOU MUST RE-TYPE ALL THREE NUMBERS.

 OKAY, WHAT VALUES? 1.5,2.5,15

                N
           *    .
            *   .
            *   .
             *  .
             *  .
              * .
              * .
               *.
               *.           MEDIUM 1, N1= 1.5
----------------*---------------------------------
                .*          MEDIUM 2, N2= 2.5
                .*
                .*
                .*
                . *
                . *
                . *
                .  *
                .  *

WHAT DO YOU THINK THE ANGLE OF REFRACTION IS? 10
YOU ARE MORE THAN 10 PERCENT OFF.
THE ANGLE OF REFRACTION, A2= 8.934

DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 1
SPECIFY NEW VALUES FOR  N1, N2, AND ANGLE 1.
SEPARATE WITH COMMAS.  OKAY, WHAT VALUES? .05,1,45
VALUE OF N1 IS UNREASONABLE.
YOU MUST RE-TYPE ALL THREE NUMBERS.

 OKAY, WHAT VALUES? .25,1,45
VALUE OF N1 IS UNREASONABLE.
YOU MUST RE-TYPE ALL THREE NUMBERS.

 OKAY, WHAT VALUES? .5,1,45
VALUE OF N1 IS UNREASONABLE.
I SUGGEST YOU LEARN MORE ABOUT REFRACTION SO YOU CAN
ENTER MORE MEANINGFUL INDICES AND ANGLES.

READY
```

Physics
SNELL

---REFRACTION OF LIGHT---

THIS PROGRAM WILL HELP YOU VISUALIZE THE REFRACTION OF LIGHT AS IT CROSSES A BOUNDARY SEPARATING TWO DIFFERENT MEDIA.

THE DIAGRAM BELOW SHOWS LIGHT INCIDENT TO THE BOUNDARY AT 45 DEGREES. THE INDICES OF REFRACTION ARE N1=1.0 AND N2=1.5 RESPECTIVELY.

```
                N
                .
 *              .
   *            .
     *          .
       *        .
         *      .
           *    .
             *  .
               *.           MEDIUM 1, N1= 1
----------------+----------------------------------
                .*          MEDIUM 2, N2= 1.5
                . *
                .  *
                .   *
                .    *
                .     *
                .      *
                .       *
                .        *
```

WHAT DO YOU THINK THE ANGLE OF REFRACTION IS? 30
YOU ARE WITHIN 10 PERCENT.
THE ANGLE OF REFRACTION, A2= 28.126

DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 1

NOW YOU CAN CHANGE THE INCIDENT ANGLE. THE REFRACTIVE INDICES WILL REMAIN AS N1=1.0 AND N2=1.5 .

REMEMBER, ONLY POSITIVE ANGLES BETWEEN 0 AND 90 DEGREES ARE
PERMISSIBLE ENTRIES.
SO, WHAT ANGLE DO YOU WANT? 60

```
                N
                .
                .
                .
                .
  *             .
     *          .
         *      .
            *   .
               *.           MEDIUM 1, N1= 1
----------------*---------------------------------
                .*          MEDIUM 2, N2= 1.5
                . *
                .  *
                .    *
                .     *
                .       *
                .        *
                .         *
                .           *
```

WHAT DO YOU THINK THE ANGLE OF REFRACTION IS? 35
YOU ARE WITHIN 10 PERCENT.
THE ANGLE OF REFRACTION, A2= 35.264

DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 1

NOW SPECIFY NEW VALUES FOR N1, N2, AND ANGLE 1.
SEPARATE WITH COMMAS. OKAY, WHAT VALUES? 2,3.5,15
VALUE OF N2 IS UNREASONABLE.
YOU MUST RE-TYPE ALL THREE NUMBERS.

OKAY, WHAT VALUES? 1.5,2.5,15

```
                N
           *    .
            *   .
            *   .
             *  .
             *  .
              * .
              * .
               *.
               *.           MEDIUM 1, N1= 1.5
----------------*---------------------------------
                .*          MEDIUM 2, N2= 2.5
                .*
                .*
                .*
                . *
                . *
                . *
                .  *
                .  *
```


347

```
WHAT DO YOU THINK THE ANGLE OF REFRACTION IS? 9
YOU ARE WITHIN 10 PERCENT.
THE ANGLE OF REFRACTION, A2= 8.934

DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 1
SPECIFY NEW VALUES FOR  N1, N2, AND ANGLE 1.
SEPARATE WITH COMMAS.  OKAY, WHAT VALUES? 2,1,75

                N
                .
                .
                .
                .                                     *
                .                             *
                .                      *
 *              .              *
        *       .       *
               *.*           MEDIUM 1, N1= 2
----------------*---------------------------------
                             MEDIUM 2, N2= 1
YOU WENT PAST THE CRITICAL ANGLE.

WHAT DO YOU THINK THE ANGLE OF REFLECTION IS? 75
THAT'S RIGHT, THE ANGLE OF REFLECTION IS 75 DEGREES.

DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ? 0

READY
```

```
100 REM  RICHARD F. PAV    PATCHOGUE H.S.    OCT.'68
110 REM  THIS PROGRAM IS DESIGNED TO HELP A STUDENT VISUALIZE
120 REM  SNELL'S LAW.
130 REM  REVISED BY C.LOSIK  8-25-70
140 REM  A AND A1 ARE ANGLES, N1 AND N2 INDICES OF REFRACTION
160 PRINT " ","---REFRACTION OF LIGHT---"
170 PRINT
180 PRINT "      THIS PROGRAM WILL HELP YOU VISUALIZE THE REFRACTION"
190 PRINT "OF LIGHT AS IT CROSSES A BOUNDARY SEPARATING TWO DIFFERENT"
200 PRINT "MEDIA."
210 PRINT
220 PRINT "THE DIAGRAM BELOW SHOWS LIGHT INCIDENT TO THE BOUNDARY AT"
230 PRINT "45 DEGREES.  THE INDICES OF REFRACTION ARE  N1=1.0 AND"
240 PRINT "N2=1.5  RESPECTIVELY."
250 PRINT
260 LET N1=1
270 LET N2=1.5
280 LET A=45
290 GOSUB 820
300 PRINT
310 PRINT "      NOW YOU CAN CHANGE THE INCIDENT ANGLE. THE REFRACTIVE"
320 PRINT "INDICES WILL REMAIN AS  N1=1.0  AND  N2=1.5 ."
330 PRINT
340 PRINT "REMEMBER, ONLY POSITIVE ANGLES BETWEEN 0 AND 90 DEGREES ARE"
350 PRINT "PERMISSIBLE  ENTRIES."
360 PRINT"SO, WHAT ANGLE DO YOU WANT";
370 INPUT A1
380 LET A=A1
390 IF A<90 THEN 490
400 LET A=60
410 GOSUB 820
420 GO TO 520
430 PRINT
440PRINT"YOUR VALUE FOR THE INCIDENT ANGLE (";A1;"DEGREES) DIDN'T MAKE"
450 PRINT "SENSE SO I AUTOMATICALLY MADE IT 60 DEGREES."
460 PRINT
470 LET A1=60
480 GO TO 1580
490 IF A<0 THEN 400
510 GO SUB 820
520 PRINT
530 PRINT "     NOW ";
540 PRINT "SPECIFY NEW VALUES FOR  N1, N2, AND ANGLE 1."
550 PRINT "SEPARATE WITH COMMAS. ";
570 PRINT " OKAY, WHAT VALUES";
580 INPUT N1,N2,A
590 IF N1<=3 THEN 630
610 PRINT "VALUE OF N1 IS UNREASONABLE."
620 GOTO 640
630 IF N1<1 THEN 610
640 IF N2<=3 THEN 670
650 PRINT "VALUE OF N2 IS UNREASONABLE."
660 GOTO 680
670 IF N2<1 THEN 650
680 IF A<90 THEN 710
690 PRINT "VALUE OF ANGLE 1 IS UNREASONABLE."
700 GOTO 780
710 IF A<0 THEN 690
720 IF N1>3 THEN 780
730 IF N1<1 THEN 780
740 IF N2>3 THEN 780
750 IF N2<1 THEN 780
760 GOSUB 820
770 GOTO 540
780 LET B=B+1
785 IF B>=3 THEN 1730
790 PRINT "YOU MUST RE-TYPE ALL THREE NUMBERS."
800 PRINT
810 GO TO 570
820 LET B=0
```

319

```
830 PRINT
840 PRINT "                 N"
850 LET C=(N1/N2)*SIN(A*1.74533E-2)
860 IF C>=1 THEN 1300
870 GOSUB 1520
880 FOR Y=8 TO 1 STEP -1
890 LET X=2*Y*((SIN(A*1.74533E-2))/(COS(A*1.74533E-2)))
900 IF X>16 THEN 960
910 PRINT TAB(16-X);"*";
950 GOTO 970
960 LET X=16
970 PRINT TAB(16);".";
1010 NEXT Y
1020 PRINT "               *.          MEDIUM 1, N1=";N1
1030 PRINT "---------------*-----------------------------------"
1040 PRINT "                .*         MEDIUM 2, N2=";N2
1050 FOR Y=1 TO 8 STEP 1
1060 LET X=2*Y*C/SQR(1-C*C)
1070 PRINT TAB(16);".";
1110 IF X>40 THEN 1160
1120 PRINT TAB(17+X);"*";
1160 PRINT " "
1170 NEXT Y
1180 PRINT
1190 GOSUB 1560
1200 PRINT "THE ANGLE OF REFRACTION, A2=";A2
1210 PRINT
1211 PRINT "DO YOU WANT TO CONTINUE (1=YES, 0=NO) : ";
1212 INPUT J
1213 IF J=0 THEN 1750
1214 IF J<>1 THEN 1210
1220 RETURN
1230 PRINT "               *.*         MEDIUM 1, N1="N1
1240 PRINT "---------------*-----------------------------------"
1250 PRINT "                           MEDIUM 2, N2=";N2
1260 PRINT "YOU WENT PAST THE CRITICAL ANGLE."
1270 GOSUB 1650
1280 PRINT "THE ANGLE OF REFLECTION IS";A;"DEGREES."
1290 GOTO 1210
1300 FOR Y=8 TO 1 STEP -1
1310 LET X=2*Y*((SIN(A*1.74533E-2))/(COS(A*1.74533E-2)))
1320 LET X2=X
1330 IF X>16 THEN 1390
1340 PRINT TAB(16-X);"*";
1380 GOTO 1400
1390 LET X=16
1400 PRINT TAB(16);".";
1440 IF X2>40 THEN 1490
1450 PRINT TAB(17+X2);"*";
1490 PRINT " "
1500 NEXT Y
1510 GOTO 1230
1520 LET F=C/SQR(1-C*C)
1530 LET G=ATN(F)
1540 LET A2=INT(1000*(G/1.74533E-2)+.5)/1000
1550 RETURN
1560 IF A1>=90 THEN 430
1570 IF A1<0 THEN 430
1580 PRINT "WHAT DO YOU THINK THE ANGLE OF REFRACTION IS";
1590 INPUT A3
1600 IF ABS(A2-A3)>.1*A2 THEN 1630
1610 PRINT "YOU ARE WITHIN 10 PERCENT."
1620 GOTO 1640
1630 PRINT "YOU ARE MORE THAN 10 PERCENT OFF."
1640 RETURN
1650 PRINT
1660 PRINT "WHAT DO YOU THINK THE ANGLE OF REFLECTION IS";
1670 INPUT A4
1680 IF A4<>A THEN 1710
1690 PRINT "THAT'S RIGHT, ";
1700 GOTO 1720
1710 PRINT "YOU HAD BETTER STUDY THE LAWS OF REFLECTION."
1720 RETURN
1730 PRINT "I SUGGEST YOU LEARN MORE ABOUT REFRACTION SO YOU CAN"
1740 PRINT "ENTER MORE MEANINGFUL INDICES AND ANGLES."
1750 END
```

350

DISC.PLINE PHYSICS

SUBJECT ORBITAL MOTION

PROGRAM NAME SPACE

AVG. EXECUTION TIME 3 min.

DESCRIPTION:

The effects of speed on orbital motion can be demonstrated by incrementally altering the tangential velocity of an orbitting spacecraft. Limiting cases are included, i.e. exceeding the escape velocity and/or crashing into the earth.

OBJECTIVES:

To demonstrate the effects of speed on orbital motion.

PRELIMINARY PREPARATION:

A. Student - Student should be familiar with circular motion, central forces, and have some knowledge of conic sections.

B. Materials - None

DISCUSSION:

Orbital motion is described in terms of the eccentricity (E) of the orbit. the period (T), and the maximum and minimum tangential velocities. The student selects the initial apogee and perigee (in miles) to define the orbit.

After describing the initial orbit the limiting changes required to produce circular and parabolic orbits are given, as well as the changes required to produce an orbit that will be tangent to the earth's surface.

The speed at the apogee and perigee is given and the student may alter either of these values (+ or -) incrementally. The new orbit will again be described in terms of E, T, and the velocities.

SPACECRAFT ORBITS

```
WHAT IS THE MINIMUM AND MAXIMUM ALTITUDE OF THE SPACECRAFT
ABOVE THE SURFACE OF THE EARTH IN MILES? 150,230

THE ECCENTRICITY OF THE ORBIT IS 9.640877E-3

THE VELOCITY AT THE PERIGEE IS  25593.36  FEET/SECOND.

THE VELOCITY AT THE APOGEE IS  25104.58  FEET/SECOND.

THE PERIOD OF THE ORBIT IS  90.50426  MINUTES.

ADDING A VELOCITY INCREMENT TO THE PERIGEE
OF  10427.89  FT/SEC WOULD RESULT IN A
PARABOLIC ORBIT-- CAUSING THE SPACECRAFT TO FLY OFF INTO SPACE.

A CHANGE OF -122.4863  FT/SEC WOULD PRODUCE A
CIRCULAR ORBIT. HOWEVER, A VELOCITY INCREMENT
OF -360.3738  FT/SEC WOULD PRODUCE AN ORBIT
THAT WOULD BE TANGENT TO THE EARTH'S SURFACE.

ADDING A VELOCITY INCREMENT TO THE APOGEE
OF  10571.05  FT/SEC WOULD RESULT IN A
PARABOLIC ORBIT-- CAUSING THE SPACECRAFT TO FLY OFF INTO SPACE.

A CHANGE OF  121.8972  FT/SEC WOULD PRODUCE A
CIRCULAR ORBIT. HOWEVER, A VELOCITY INCREMENT
OF -236.6951  FT/SEC WOULD PRODUCE AN ORBIT
THAT WOULD BE TANGENT TO THE EARTH'S SURFACE.


DO YOU WANT TO ADD A VELOCITY INCREMENT AT THE
PERIGEE(TYPE 1) OR AT THE APOGEE(TYPE 2)  ? 1

WHAT VELOCITY INCREMENT IS TO BE ADDED? -250

THE NEW ORBIT IS ELLIPTICAL
 WITH AN ECCENTRICITY OF 9.987444E-3

THE POINT WHERE THE VELOCITY INCREMENT WAS ADDED
CORRESPONDS TO THE APOGEE OF THE NEW ORBIT
THE PERIGEE OF THE NEW ORBIT IN MILES IS 68.73486

 THE VELOCITY AT THE PERIGEE IS  25854.69  FT/SEC.

THE PERIOD OF THE NEW ORBIT IS  87.8788  MINUTES.

*****

BASED ON YOUR ORIGINAL ALTITUDES OF  150  AND  230  MILES
WOULD YOU LIKE TO TRY DIFFERENT VELOCITY INCREMENTS
(1-YES, 0-NO)? 0

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)? 0

*****


READY
```

```
100 REM SPACECRAFT ORBITS, M. VISICH, JR., 12/09/68
101 REM REVISED 8/25/70  (D. PESSEL)
120 DIM V(2),R(2)
130 REM THIS PROGRAM CAN BE USED TO DETERMINE THE EFFECT OF
140 REM ADDING A VELOCITY INCREMENT TO A SPACECRAFT INITIALLY IN
150 REM AN ELLIPTIC ORBIT AROUND THE EARTH. VELOCITY INCREMENTS
160 REM CAN ONLY BE ADDED AT THE APOGEE OR PERIGEE OF THE INITIAL ORBIT
170 REM AND ONLY IN A DIRECTION TANGENT TO THE INITIAL ORBIT.
171 LET Q5=0
173 LET Y=1.40753E16
175 PRINT TAB(20);"SPACECRAFT ORBITS"
176 PRINT
180 PRINT "WHAT IS THE MINIMUM AND MAXIMUM ALTITUDE OF THE SPACECRAFT"
190 PRINT"ABOVE THE SURFACE OF THE EARTH IN MILES";
200 INPUT H1,H2
205 IF H1>0 THEN 208
206 PRINT "BOTH ALTITUDES MUST BE POSITIVE!"
207 GO TO 180
208 IF H2>0 THEN 210
209 GO TO 206
210 PRINT
220 GOSUB 960
225 IF Q5>0 THEN 307
230 PRINT"THE ECCENTRICITY OF THE ORBIT IS" E
240 PRINT
250 PRINT"THE VELOCITY AT THE PERIGEE IS "V1" FEET/SECOND."
270 PRINT
280 PRINT"THE VELOCITY AT THE APOGEE IS "V2" FEET/SECOND."
300 PRINT
304 PRINT"THE PERIOD OF THE ORBIT IS "T" MINUTES."
305 PRINT
307 LET V(1)=V1
308 LET V(2)=V2
309 LET R(1)=R1
310 LET R(2)=R2
311 IF Q5>0 THEN 334
312 LET V(2)=V2
313 LET R(1)=R1
314 LET R(2)=R2
315 FOR J=1 TO 2
316 PRINT"ADDING A VELOCITY INCREMENT TO THE ";
317 IF J=1 THEN 320
318 PRINT"APOGEE"
319 GOTO321
320 PRINT"PERIGEE"
321 PRINT"OF "SQR(2*Y/R(J))-V(J)" FT/SEC WOULD RESULT IN A"
322 PRINT"PARABOLIC ORBIT-- CAUSING THE SPACECRAFT TO FLY OFF INTO SPACE
323 PRINT
324 PRINT"A CHANGE OF "SQR(Y/R(J))-V(J)" FT/SEC WOULD PRODUCE A"
325 PRINT"CIRCULAR ORBIT. HOWEVER, A VELOCITY INCREMENT "
327 LET R=5280*3959
329 LET E2=(R-R(J))/(R+R(J))
330 PRINT"OF "SQR(Y*(1+E2)/R(J))-V(J)" FT/SEC WOULD PRODUCE AN ORBIT".
331 PRINT"THAT WOULD BE TANGENT TO THE EARTH'S SURFACE."
332 PRINT
333 NEXT J
334 PRINT
340 PRINT"DO YOU WANT TO ADD A VELOCITY INCREMENT AT THE"
350 PRINT"PERIGEE(TYPE 1) OR AT THE APOGEE(TYPE 2)",
360 INPUT N
370 PRINT
380 IF (N-1)*(N-2)=0 THEN 420
```


353

```
400 PRINT"YOU WERE TO PICK EITHER 1 OR 2-TRY AGAIN"
410 GO TO 340
420 PRINT"WHAT VELOCITY INCREMENT IS TO BE ADDED";
440 INPUT V3
450 PRINT
460 GOSUB 1050
470 PRINT"THE NEW ORBIT IS ";
480 IF E1=0 THEN860
490 IF E1=1 THEN 900
500 IF E1>1 THEN 930
505 PRINT"ELLIPTICAL "
510 PRINT" WITH AN ECCENTRICITY OF"E1
520 PRINT
530 IF V9>1 THEN 680
540 IF H3<0 THEN 660
550 PRINT"THE POINT WHERE THE VELOCITY INCREMENT WAS ADDED"
560 PRINT"CORRESPONDS TO THE APOGEE OF THE NEW ORBIT"
570 PRINT "THE PERIGEE OF THE NEW ORBIT IN MILES IS"H3
580 PRINT
590 PRINT" THE VELOCITY AT THE PERIGEE IS "V1" FT/SEC."
600 PRINT
610 LET R2=R3
620 GOSUB 1010
640 PRINT"THE PERIOD OF THE NEW ORBIT IS "T" MINUTES."
650 GO TO 1230
660 PRINT"YOU CRASHED INTO THE EARTH"
670 GO TO 1230
680 PRINT"THE POINT WHERE THE VELOCITY INCREMENT WAS ADDED"
690 PRINT"CORRESPONDS TO THE PERIGEE OF THE NEW ORBIT"
700 PRINT
710 PRINT"THE APOGEE OF THE NEW ORBIT IS "H4" MILES."
720 PRINT
730 PRINT"THE VELOCITY AT THE APOGEE IS "V2" FT/SEC."
740 PRINT
750 LET R2=R4
760 GOSUB 1010
780 PRINT"THE PERIOD OF THE NEW ORBIT IS "T" MINUTES."
790 PRINT
800 GOTO 1230
860 PRINT"CIRCULAR."
890 GOTO 1230
900 PRINT"PARABOLIC, "
910 PRINT "WITH AN ECCENTRICITY OF"E1
920 GO TO 1230
930 PRINT"HYPERBOLIC, "
940 PRINT "WITH AN ECCENTRICITY OF"E1
950 GO TO 1230
960 LET R1=(H1+3959)*5280
970 LET R2=(H2+3959)*5280
980 LET E=(R2-R1)/(R1+R2)
990 LET V1=SQR(Y*(1+E)/R1)
1000 LET V2=V1*R1/R2
1010 LET A=(R1+R2)/2
1020 LET P=39.479*A*A*A/Y
1030 LET T=SQR(P)/60
1040 RETURN
1050 IF N=1 THEN 1080
1060 LET V1=V2
1070 LET R1=R2
1080 LET V5=V1+V3
1090 LET V7=SQR(Y/R1)
1100 LET V9=V5/V7
1110 LET E1=ABS(V9*V9-1)
1120 IF V9>1 THEN 1180
1140 LET R3=(1-E1)*R1/(1+E1)
```

```
1150 LET H3=R3/5280-3959
1160 LET V1=V5*R1/R3
1170 GOTO 1220
1180 LET R4=(1+E1)*R1/(1-E1)
1200 LET H4=R4/5280-3959
1210 LET V2=V5*R1/R4
1220 RETURN
1230 PRINT
1231 PRINT "*****"
1232 PRINT
1234 PRINT "BASED ON YOUR ORIGINAL ALTITUDES OF "H1" AND "H2" MILES"
1235 PRINT "WOULD YOU LIKE TO TRY DIFFERENT VELOCITY INCREMENTS"
1236 PRINT "(1-YES, 0-NO)";
1237 INPUT Q5
1238 PRINT
1241 IF Q5>0 THEN 220
1250 PRINT "WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)";
1251 INPUT Q6
1252 PRINT
1253 PRINT "*****"
1254 PRINT
1255 IF Q6>0 THEN 180
1260 END
```

355

DISCIPLINE PHYSICS

SUBJECT ELECTRICAL POTENTIAL ENERGY

PROGRAM NAME VFIELD

DESCRIPTION:

This program plots a picture of the relative potential field strengths of regions surrounding two point charges.

OBJECTIVES:

To give the student a feel for how the electric potential field is altered by changing the positions of two point charges.

PRELIMINARY PREPARATION:

A. Student - The concept of electric potential for a point charge should be understood, as well as equipotential lines and potential hills or wells.

B. Materials - none needed

DISCUSSION:

One run of this program requires much time, so it is not advised for use with a whole class. Individual students or small groups will derive the greatest benefit, or, alternatively, the teacher may make several runs before class and display the resulting plots during a class discussion.

The coordinate plane occupied by the charges is 30 x 30.

NOTE: The numbers in the plots indicate relative field strengths.

```
THIS PROGRAM PLOTS A PICTURE OF THE RELATIVE ELECTRICAL
POTENTIAL FIELD STRENGTHS IN THE REGION SURROUNDING TWO
POINT CHARGES.  THE CHARGES ARE IN A COORDINATE PLANE
30 BY 30.  THE CHARGES MAY HAVE ANY VALUE WHOSE
MAGNITUDE IS LESS THAN 10 , AND MAY BE ANYWHERE BETWEEN
0 AND 30 ON THE X AND Y AXES.
THE MAGNITUDE OF THE FIELD DECREASES FROM 9 TO 1, 0, A TO J
THAT IS, 9 TO 1 IS A POSITIVE POTENTIAL, 0 IS ROUGHLY 0,
AND A=-1, B=-2, ... J=-9. (THERE IS NO 'I'.)

WHAT VALUES OF CHARGES DO YOU WISH TO STUDY?
TO STUDY ONLY ONE CHARGE, MAKE THE SECOND CHARGE 0.
ENTER TWO VALUES OF CHARGE : ? 10,-3.5
WHERE SHALL THE FIRST CHARGE BE LOCATED? 15,15
WHERE SHALL THE SECOND CHARGE BE LOCATED? 15,25

          *0        6         12        18        24        30*
          *I---------I---------I---------I---------I---------I*
   30     *               000000000000000000000                *
   29     *               000000000000000000000                *
   28     *                000000  AAA  000000                 *
   27     *                00000 AABBBAA 00000                 *
   26     *      111        000 A CDEDC A 000         111      *
   25     * 111111111111    000 ABD - DBA 000     111111111111 *
   24     *1111111111111111   00 ABDEDBA 00   111111111111111*
   23     *1111111111111111111  00 AAA 00  111111111111111111*
   22     *11111111111111111111111         1111111111111111111111*
   21     *111111111111111                      11111111111111*
   20     *111111111111  2222222        2222222   111111111111*
   19     *1111111111  22222 333  444  333 22222   1111111111*
   18     *111111111  2222 33 4455 6 5544 33 2222   111111111*
   17     *11111111  2222 33 45  89998  54 33 2222   11111111*
   16     *11111111 2222  3 4  79     97  4 3  2222  11111111*
   15     *1111111  2222 33 4568   +   8654 33 2222   1111111*
   14     *1111111  2222 33 45679     97654 33 2222   1111111*
   13     *1111111  2222 -334456789 987654433  2222   1111111*
   12     *1111111  22222 33 4455666665544 33 22222   1111111*
   11     *11111111  22222 333 444   444 333 22222  11111111*
   10     *11111111   22222  3333     3333  22222   11111111*
   9      *111111111   222222  333333333  222222   111111111*
   8      *1111111111   22222222        22222222   1111111111*
   7      *11111111111     2222222222222222222     11111111111*
   6      *1111111111111     222222222222222     1111111111111*
   5      *111111111111111          2          111111111111111*
   4      *11111111111111111               111111111111111111*
   3      *11111111111111111111111111111111111111111111111111*
   2      *11111111111111111111111111111111111111111111111111*
   1      *11111111111111111111111111111111111111111111111111*
   0      *11111111111111111111111111111111111111111111111111*
          *I---------I---------I---------I---------I---------I*

DO YOU WISH TO VIEW ANOTHER PLOT (1=YES, 0=NO) : ? 0


READY
```

```
100 REM  JOHN HOSIE - NORTHPORT HS - 7-8-69
105 REM  REVISED BY C.LOSIK  8-21-70
110 REM  YOU HAVE MY BLESSING TO USE COMPUTED GO-TO'S AND
111 REM  STRINGS IF YOU HAVE THEM (WE DIDN'T)
113 REM  V IS THE FIELD STRENGTH, R1,R2,Q1,Q2 ARE STANDARD NOT.
116 REM  THIS MAY BE CHANGED TO ALLOW HIGHER VALUED CHARGES
117 LET Q9=10
120 PRINT "THIS PROGRAM PLOTS A PICTURE OF THE RELATIVE ELECTRICAL"
130 PRINT "POTENTIAL FIELD STRENGTHS IN THE REGION SURROUNDING TWO"
140 PRINT "POINT CHARGES.  THE CHARGES ARE IN A COORDINATE PLANE"
150 PRINT "30 BY 30.  THE CHARGES MAY HAVE ANY VALUE WHOSE"
160 PRINT "MAGNITUDE IS LESS THAN"Q9", AND MAY BE ANYWHERE BETWEEN"
170 PRINT "0 AND 30 ON THE X AND Y AXES."
171 PRINT "THE MAGNITUDE OF THE FIELD DECREASES FROM 9 TO 1, 0, A TO J"
172 PRINT "THAT IS, 9 TO 1 IS A POSITIVE POTENTIAL, 0 IS ROUGHLY 0,"
173 PRINT "AND A=-1, B=-2, ... J=-9. (THERE IS NO 'I'.)"
178 PRINT
179 PRINT "WHAT VALUES OF CHARGES DO YOU WISH TO STUDY?"
180 PRINT "TO STUDY ONLY ONE CHARGE, MAKE THE SECOND CHARGE 0."
185 PRINT "ENTER TWO VALUES OF CHARGE : ";
190 INPUT Q1,Q2
195 IF Q1=0 THEN 180
200 IF ABS(Q1)<=Q9 THEN 230
210 PRINT "VALUES MUST BE IN THE RANGE ("-Q9","Q9")."
220 GO TO 185
230 IF ABS(Q2)>Q9 THEN 210
232 REM  FOR EFFICIENCY, WE 'HIDE' THE ELECTROSTATIC CONSTANT HERE
233 LET Q1=2*Q1
236 LET Q2=2*Q2
240 PRINT "WHERE SHALL THE FIRST CHARGE BE LOCATED";
250 INPUT X1,Y1
260 LET X1=INT(X1+.5)
270 LET Y1=INT(Y1+.5)
280 IF ABS(X1-15)<=15 THEN 310
290 PRINT "VALUES MUST BE IN THE RANGE (0,30)."
300 GO TO 240
310 IF ABS(Y1-15)>15 THEN 290
320 IF Q2=0 THEN 410
330 PRINT "WHERE SHALL THE SECOND CHARGE BE LOCATED";
340 INPUT X2,Y2
350 LET X2=INT(X2+.5)
360 LET Y2=INT(Y2+.5)
370 IF ABS(X2-15)<=15 THEN 400
380 PRINT "VALUES MUST BE IN THE RANGE (0,30)."
390 GO TO 330
400 IF ABS(Y2-15)>15 THEN 380
410 PRINT
420 PRINT
430 PRINT " ","*0         6         12        18        24        30*"
440 PRINT " ","*I---------I---------I---------I---------I---------I*"
450 FOR Y=30 TO 0 STEP -1
453 PRINT "            ";INT(Y+.5),"*";
456 LET Y6=(Y-Y1)*(Y-Y1)
457 LET Y7=(Y-Y2)*(Y-Y2)
459 REM  THIS IS FOR 50 ITERATIONS
460 FOR X=0 TO 30 STEP .6
465 LET X6=X-X1
470 LET R1=SQR(X6*X6+Y6)
475 LET X7=X-X2
480 LET R2=SQR(X7*X7+Y7)
483 IF R1<.5 THEN 800
486 IF R2<.5 THEN 850
```


358

```
488 REM  THE ELECTROSTATIC CONSTANT IS 2
490 LET V=Q1/R1+Q2/R2
498 FOR J=-9 TO 9
500 IF ABS(V-J)<.35 THEN 508
502 NEXT J
504 PRINT " ";
506 GO TO 700
508 IF J>0 THEN 610
510 IF J<>-9 THEN 520
513 PRINT "J";
516 GO TO 700
520 IF J<>-8 THEN 530
523 PRINT "H";
526 GO TO 700
530 IF J<>-7 THEN 540
533 PRINT "G";
536 GO TO 700
540 IF J<>-6 THEN 550
543 PRINT "F";
546 GO TO 700
550 IF J<>-5 THEN 560
553 PRINT "E";
556 GO TO 700
560 IF J<>-4 THEN 570
563 PRINT "D";
566 GO TO 700
570 IF J<>-3 THEN 580
573 PRINT "C";
576 GO TO 700
580 IF J<>-2 THEN 590
583 PRINT "B";
586 GO TO 700
590 IF J<>-1 THEN 600
593 PRINT "A";
596 GO TO 700
600 IF J<>0 THEN 610
603 PRINT "0";
606 GO TO 700
610 IF J<>1 THEN 620
613 PRINT "1";
616 GO TO 700
620 IF J<>2 THEN 630
623 PRINT "2";
626 GO TO 700
630 IF J<>3 THEN 640
633 PRINT "3";
636 GO TO 700
640 IF J<>4 THEN 650
643 PRINT "4";
646 GO TO 700
650 IF J<>5 THEN 660
653 PRINT "5";
656 GO TO 700
660 IF J<>6 THEN 670
663 PRINT "6";
666 GO TO 700
670 IF J<>7 THEN 680
673 PRINT "7";
676 GO TO 700
```

```
680 IF J<>8 THEN 690
683 PRINT "8";
686 GO TO 700
690 IF J<>9 THEN 504
693 PRINT "9";
700 NEXT X
710 PRINT "*"
720 NEXT Y
730 PRINT " ","*I---------I---------I---------I---------I---------I*"
740 PRINT
750 PRINT
760 PRINT "DO YOU WISH TO VIEW ANOTHER PLOT (1=YES, 0=NO) : ";
770 INPUT Q1
775 PRINT
776 PRINT
780 IF Q1=1 THEN 178
790 IF Q1=0 THEN 999
795 GO TO 750
800 IF Q1>0 THEN 830
810 PRINT "-";
820 GO TO 700
830 PRINT "+";
840 GO TO 700
850 IF Q2=0 THEN 490
860 IF Q2>0 THEN 830
870 GO TO 810
999 END
```

DISCIPLINE PHYSICS

SUBJECT INSTANTANEOUS VELOCITY

PROGRAM NAME VLOCTY

DESCRIPTION:

A graph of distance vs. time is plotted for a body accelerating at 1m/sec/sec. The average velocity is found for a point on the graph several times using V average $=(d_2 - d_1)/(T_2 - T_1)$ as $(T_2 - T_1)$ gets smaller and smaller.

The program prints the instantaneous velocity at the points and allows the student to change some of the parameters involved.

OBJECTIVES:

To aid the student in understanding the meaning of instantaneous velocity and taking a limit.

PRELIMINARY PREPARATION:

A. Student - should know the definitions of average and instantaneous velocity

B. Materials - none

DISCUSSION:

A good tutorial program or teaching aid. Student should realize that the slope of the line drawn between the points d1, T1, and d2, T2 is the average velocity. As the second point is made to approach the first, the slope of this line approaches the value of the slope of the tangent line drawn to the first point - which is called the instantaneous velocity.

The student may then change the acceleration, time at which he wants to know the average speed, and the time interval, delta T.

A more theoretical view of this same problem will be obtained by running the program SLOPE.

AVERAGE AND INSTANTANEOUS VELOCITY

```
THIS PROGRAM CONSIDERS DISTANCE AS A FUNCTION OF TIME,
D=F(T). IT WILL CALCULATE THE AVERAGE VELOCITY DURING
THE TIME INTERVAL T1,T2 BY EVALUATING D AT THOSE TIMES
GIVING D1 AND D2. THE RESULT OF (D2-D1)/(T2-T1) YIELDS
THE AVERAGE VELOCITY. AS T2 IS BROUGHT CLOSER AND CLOSER
TO T1 THE RESULTANT AVERAGE VELOCITY WILL APROACH THE
INSTANTANEOUS VELOCITY AT T1.

AFTER THE PROGRAM STOPS, TYPE IN THE FOLLOWING:
(END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY)

          1 GO TO 300
          300 DEF FND(T)=....(YOUR FUNCTION OF TIME)....
          RUN

FOR EXAMPLE, TO USE THE EQUATION D=A*T*T WITH A=1
YOU WOULD TYPE AS FOLLOWS:

          1 GO TO 300
          300 DEF FND(T)=1*T*T
          RUN

YOU MIGHT TRY THAT AS YOUR FIRST RUN.
FOR SUBSEQUENT RUNS, YOU NEED ONLY CHANGE LINE 300 FOR
A NEW FUNCTION, FOLLOWED BY 'RUN'.


READY

1 GO TO 300
300 DEF FND(T)=1*T*T
RUN


*****

WHAT ARE YOUR VALUES OF T1 AND T2 (SMALLER FIRST: T1,T2)? 5,50

THE DISTANCE TRAVELED DURING THE INTERVAL IS  2475
THE AVERAGE VELOCITY IS  55

WOULD YOU LIKE TO CHANGE T2 (1-YES, 0-NO)? 1
WHAT IS YOU NEW VALUE FOR T2 (T2 MUST BE GREATER THAN T1)? 105

THE DISTANCE TRAVELED DURING THE INTERVAL IS  11000
THE AVERAGE VELOCITY IS  110

WOULD YOU LIKE TO CHANGE T2 (1-YES, 0-NO)? 0

NOW WATCH THE AVERAGE VELOCITY AS T2 APPROACHES T1.

 T1 =  5                        D1 =  25
```

T2	T2-T1	D2	D2-D1	(D2-D1)/(T2-T1)
--	-----	--	-----	---------------
105	100	11025	11000	110
55	50	3025	3000	60
30	25	900	875	35
17.5	12.5	306.25	281.25	22.5
11.25	6.25	126.5625	101.5625	16.25
8.125	3.125	66.01563	41.01563	13.125
6.5625	1.5625	43.06641	18.06641	11.5625
5.78125	.78125	33.42285	8.422852	10.78125
5.390625	.390625	29.05884	4.058838	10.39063
5.195313	.1953125	26.99127	1.991272	10.19531
5.097656	.09765625	25.9861	.9860992	10.09766
5.048828	.04882813	25.49067	.4906654	10.04883
5.024414	.02441406	25.24474	.2447367	10.02441
5.012207	.01220703	25.12228	.1222193	10.01221
5.006104	6.103516E-3	25.06107	.06107235	10.00609
5.003052	3.051758E-3	25.03053	.03052688	10.00305
5.001526	1.525879E-3	25.01526	.01526117	10.00156
5.000763	7.629395E-4	25.00763	7.629871E-3	10.00063

```
NOTE THAT THE AVERAGE VELOCITY CHANGES VERY LITTLE
AS T2 APPROACHES T1.  T2 CAN NEVER EQUAL T1 SINCE
(D2-D1)/(T2-T1) WOULD THEN RESULT IN A DIVISION BY ZERO.

*****

WOULD YOU LIKE TO TRY DIFFERENT VALUES OF T1 AND T2
(1-YES, 0-NO)? 0
TO CHANGE YOUR FUNCTION SEE THE INSTRUCTIONS.
IF YOU ARE FINISHED, TYPE '1', AND THE 'RETURN' KEY
AFTER THE PROGRAM STOPS.

READY

1
```

363

```
100 REM VELOCITY, J. HOSIE, Q. J. O'CONNOR, 8/12/68
101 REM REVISED 8/26/70 (D. PESSEL)
102 REM IMPORTANT VARIABLES:  S-SECANT SLOPE; P-PERCENT CHANGE;
103 REM D-INVERSE OF CHANGE IN X; Y-CHANGE IN Y
104 REM SEE SLOPE FOR A MORE THEORETICAL APPROACH TO THE SAME PROBLEM
105 LET S1=0
110 PRINT TAB(10);"AVERAGE AND INSTANTANEOUS VELOCITY"
120 PRINT
130 PRINT "THIS PROGRAM CONSIDERS DISTANCE AS A FUNCTION OF TIME,"
131 PRINT "D=F(T).  IT WILL CALCULATE THE AVERAGE VELOCITY DURING"
132 PRINT "THE TIME INTERVAL T1,T2 BY EVALUATING D AT THOSE TIMES"
133 PRINT "GIVING D1 AND D2.  THE RESULT OF (D2-D1)/(T2-T1) YIELDS"
134 PRINT "THE AVERAGE VELOCITY.  AS T2 IS BROUGHT CLOSER AND CLOSER"
135 PRINT "TO T1 THE RESULTANT AVERAGE VELOCITY WILL APROACH THE"
136 PRINT "INSTANTANEOUS VELOCITY AT T1."
138 PRINT
139 PRINT "AFTER THE PROGRAM STOPS, TYPE IN THE FOLLOWING:"
140 PRINT "(END EACH LINE, INCLUDING 'RUN', WITH THE 'RETURN' KEY)"
141 PRINT
142 PRINT "           1 GO TO 300"
143 PRINT "           300 DEF FND(T)=....(YOUR FUNCTION OF TIME)...."
145 PRINT "           RUN"
146 PRINT
147 PRINT "FOR EXAMPLE, TO USE THE EQUATION D=A*T*T WITH A=1"
148 PRINT "YOU WOULD TYPE AS FOLLOWS:"
149 PRINT
150 PRINT "           1 GO TO 300"
151 PRINT "           300 DEF FND(T)=1*T*T"
153 PRINT "           RUN"
154 PRINT
155 PRINT "YOU MIGHT TRY THAT AS YOUR FIRST RUN."
156 PRINT "FOR SUBSEQUENT RUNS, YOU NEED ONLY CHANGE LINE 300 FOR"
157 PRINT "A NEW FUNCTION, FOLLOWED BY 'RUN'."
160 STOP
290 REM CALCULATION OF SLOPE AND PRINTOUT
300 DEF FND(T)=1*T*T
301 PRINT
302 PRINT "*****"
303 PRINT
305 PRINT "WHAT ARE YOUR VALUES OF T1 AND T2 (SMALLER FIRST: T1,T2)";
306 INPUT T1,T2
307 IF T2>T1 THEN 310
308 PRINT "T2 MUST BE GREATER THAN T1!"
309 GO TO 305
310 PRINT
311 PRINT "THE DISTANCE TRAVELED DURING THE INTERVAL IS "FND(T2)-FND(T1)
312 PRINT "THE AVERAGE VELOCITY IS "(FND(T2)-FND(T1))/(T2-T1)
313 PRINT
314 PRINT "WOULD YOU LIKE TO CHANGE T2 (1-YES, 0-NO)";
315 INPUT Q1
316 IF Q1<1 THEN 330
317 PRINT "WHAT IS YOU NEW VALUE FOR T2 (T2 MUST BE GREATER THAN T1)";
318 INPUT T2
319 IF T2>T1 THEN 310
320 PRINT "T2 MUST BE GREATER THAN T1!"
321 GO TO 317
330 PRINT
331 PRINT "NOW WATCH THE AVERAGE VELOCITY AS T2 APPROACHES T1."
335 PRINT
344 LET D1=FND(T1)
345 PRINT " T1 = "T1," "," D1 = "FND(T1)
346 PRINT
```

361

```
350 PRINT " T2"," T2-T1"," D2"," D2-D1"," (D2-D1)/(T2-T1)"
352 PRINT " --"," -----"," --"," -----"," ---------------"
361 LET D2=FND(T2)
370 PRINT T2,T2-T1,D2,D2-D1,(D2-D1)/(T2-T1)
380 IF ABS(T2-T1)<.001 THEN 390
382 LET T2=T2-.5*(T2-T1)
384 GO TO 361
390 PRINT
400 PRINT "NOTE THAT THE AVERAGE VELOCITY CHANGES VERY LITTLE"
401 PRINT "AS T2 APPROACHES T1.  T2 CAN NEVER EQUAL T1 SINCE"
402 PRINT "(D2-D1)/(T2-T1) WOULD THEN RESULT IN A DIVISION BY ZERO."
470 PRINT
480 PRINT "*****"
490 PRINT
495 PRINT "WOULD YOU LIKE TO TRY DIFFERENT VALUES OF T1 AND T2"
496 PRINT "(1-YES, 0-NO)";
498 INPUT Q5
500 IF Q5>0 THEN 300
510 PRINT "TO CHANGE YOUR FUNCTION SEE THE INSTRUCTIONS."
520 PRINT "IF YOU ARE FINISHED, TYPE '1', AND THE 'RETURN' KEY"
530 PRINT "AFTER THE PROGRAM STOPS."
540 END
```

DISCIPLINE PHYSICS

SUBJECT WAVES

PROGRAM NAME WAVES

DESCRIPTION:

This program finds the sum of two waves: one predetermined by the program, and the other determined by the student. There are options of either displaying both waves and their sum, or just their sum.

OBJECTIVES:

To enable the student to study, independently, the effect of changes in wavelength, amplitude,and phase on the superposition pattern formed by two waves.

PRELIMINARY PREPARATION:

A. Student - Some experience with "SLINKY" wave superposition: knowledge of phase, amplitude, and wave length.

B. Materials - none

DISCUSSION:

The student controlled wave ("B") may have wavelengths ranging from 2 to 8, though only a wave length of 4 may be fully displayed. Its amplitude can be varied between 5 and 11, and its phase can be any decimal part of a wavelength.

The fixed wave ("A") has a wavelength of 4, and an amplitude of 10.

The display consists of both waves, side by side, and their superposition, or just their superposition.

```
              WAVES AND THEIR SUPERPOSITION
DO YOU NEED INSTRUCTIONS (1=YES, 0=NO) : ? 1

IN THIS PROGRAM YOU MAY OBSERVE THE EFFECTS OF
CHANGING WAVELENGTH, AMPLITUDE, AND PHASE ON TWO
WAVES AND ON THEIR SUM (OR SUPERPOSITION).

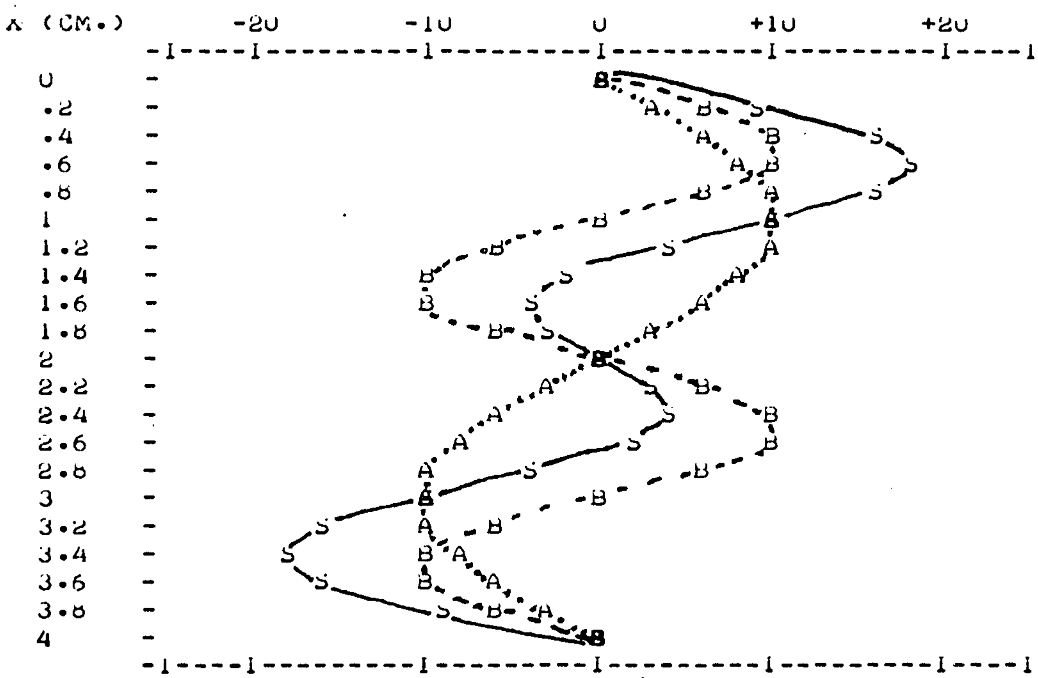
WAVE 'A' IS FIXED.  ITS WAVELENGTH IS 4, ITS AMPLITUDE
IS 10, AND ITS PHASE IS 0.

WAVE 'B' MAY BE CHANGED BY YOU.  FOR BEST RESULTS :
              WAVELENGTH (L) BETWEEN 2 AND 4
              AMPLITUDE (A) BETWEEN 5 AND 10
              PHASE (P) BETWEEN 0 AND 1
              (FOR EXAMPLE, .5 PHASE = 1/2 WAVELENGTH

IT IS EASIEST TO SEE THE EFFECTS OF CHANGES IN EACH
PARAMETER IF YOU HOLD TWO CONSTANT AND VARY THE OTHER,
ALTHOUGH ALL THREE MAY BE VARIED AT ONCE.

WHAT IS YOUR CHOICE OF WAVELENGTH, AMPLITUDE, AND PHASE? 2,10,0

NOTATION:     A = 'A' WAVE
              B = 'B' WAVE
              S = SUPERPOSITION WAVE
```

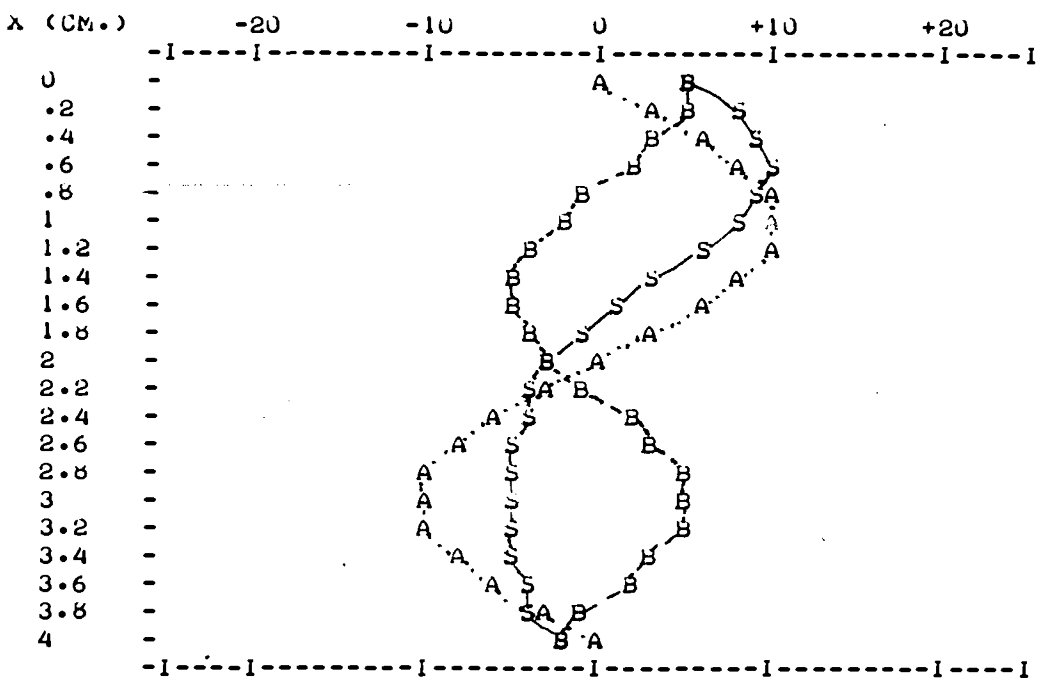


367

```
            WAVES AND THEIR SUPERPOSITION
DO YOU NEED INSTRUCTIONS (1=YES, 0=NO) : ? 0

WHAT IS YOUR CHOICE OF WAVELENGTH, AMPLITUDE, AND PHASE? 3,5,0.25

NOTATION:       A = 'A' WAVE
                B = 'B' WAVE
                S = SUPERPOSITION WAVE
```



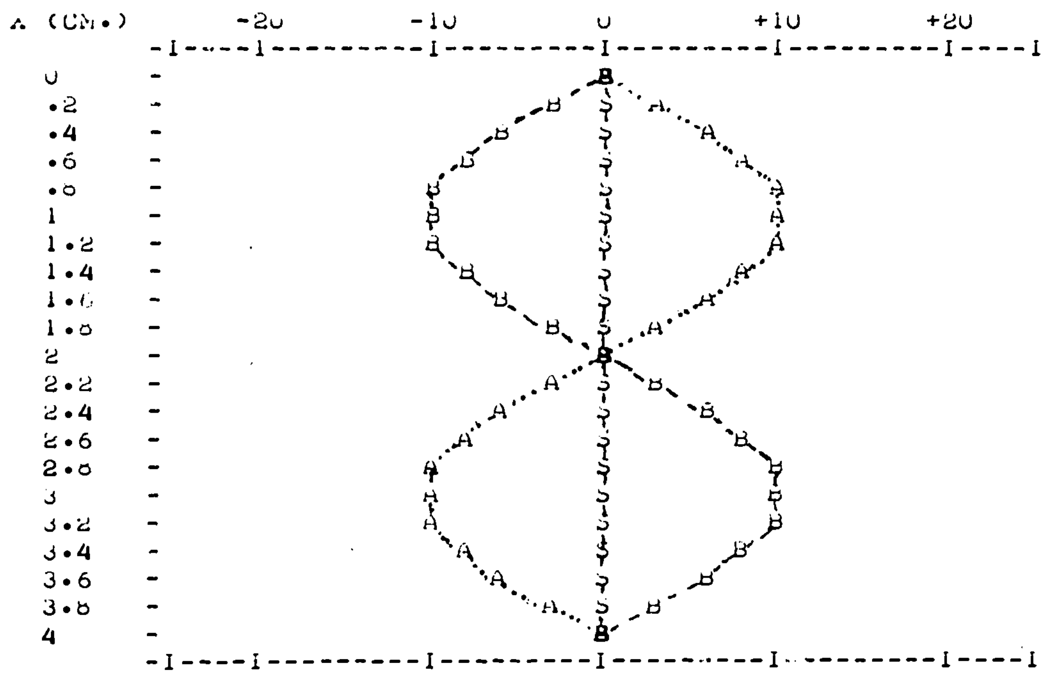

```
WANT TO TRY ANOTHER SET OF VALUES (1=YES, 0=NO) : ? 0

READY
```

```
          WAVES AND THEIR SUPERPOSITION
DO YOU NEED INSTRUCTIONS (1=YES, 0=NO) : ? 0

WHAT IS YOUR CHOICE OF WAVELENGTH, AMPLITUDE, AND PHASE? 4,10,.5

NOTATION:       A = 'A' WAVE
                B = 'B' WAVE
                S = SUPERPOSITION WAVE
```



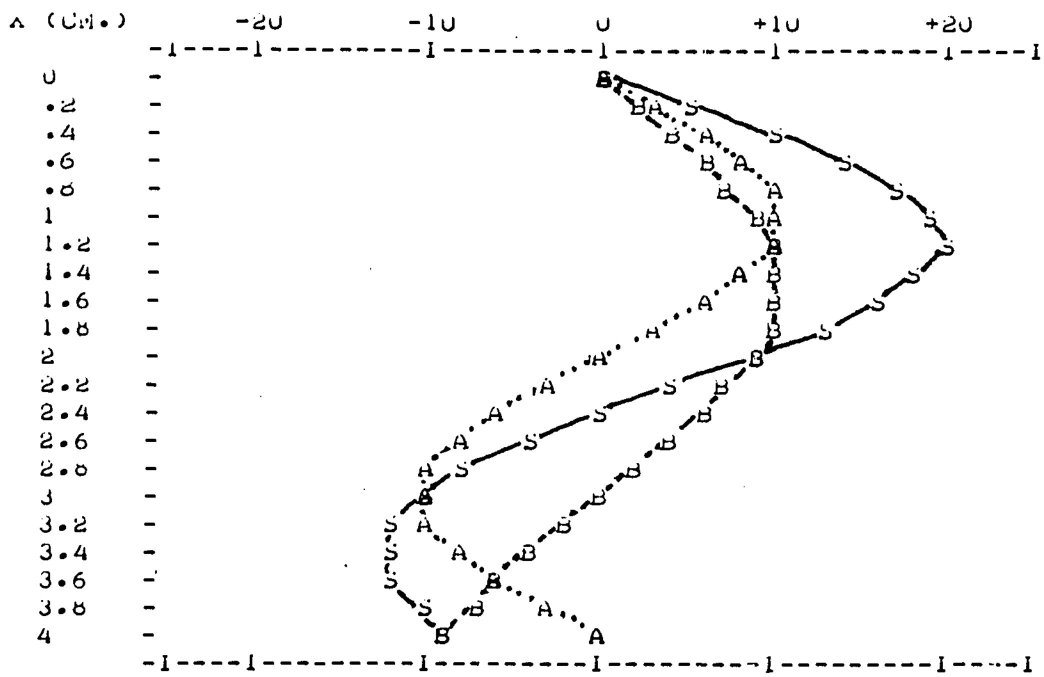

```
WANT TO TRY ANOTHER SET OF VALUES (1=YES, 0=NO) : ? 0

READY
```

```
... TO TRY ANOTHER SET OF VALUES (1=YES, 0=NO) : ? 1

WHAT IS YOUR CHOICE OF WAVELENGTH, AMPLITUDE, AND PHASE? 6,10,0

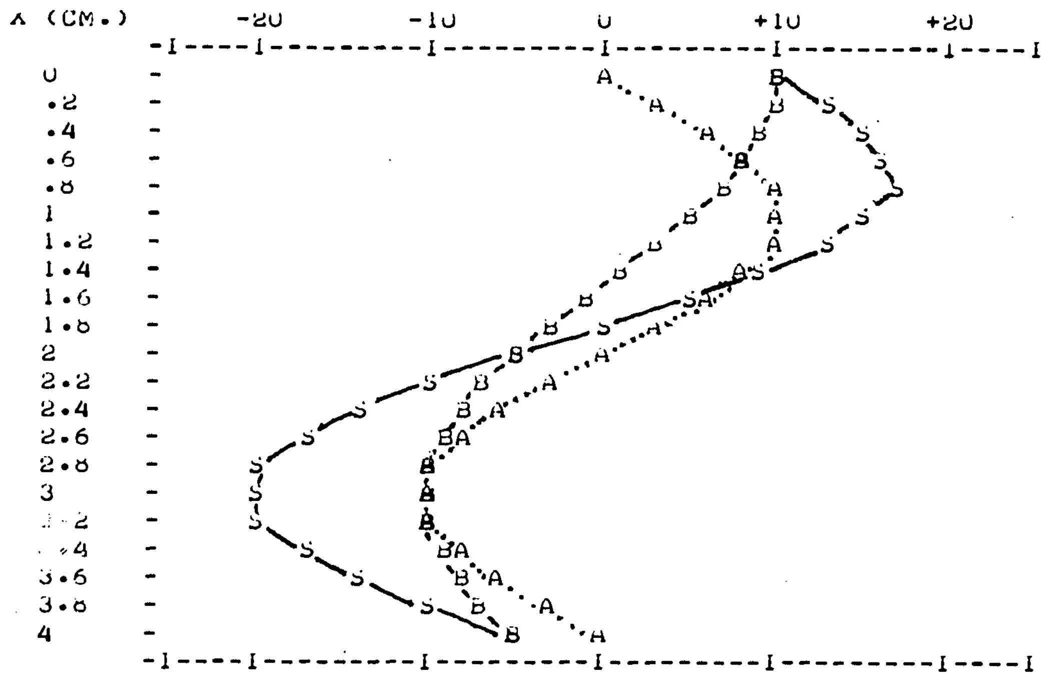
NOTATION:      A = 'A' WAVE
               B = 'B' WAVE
               S = SUPERPOSITION WAVE
```




```
WANT TO TRY ANOTHER SET OF VALUES (1=YES, 0=NO) : ? 1
```

```
WHAT IS YOUR CHOICE OF WAVELENGTH, AMPLITUDE, AND PHASE? 6,10,0.25

NOTATION:      A = 'A' WAVE
               B = 'B' WAVE
               S = SUPERPOSITION WAVE
```




```
WANT TO TRY ANOTHER SET OF VALUES (1=YES, 0=NO) : ? 0

READY
```

```
100 REM  JOHN W. HOSIE, NORTHPORT HS, PHYSICS, 8/9/68
105 REM  REVISED BY C.LOSIK  8-17-70
110 REM  WE SORT THE W(I) TO PLOT THE WAVE VALUES.
115 REM  L,A,P ARE WAVELENGTH, AMPLITUDE, AND PHASE
120 DIM W(3)
124 REM  TWO PI !
125 LET P2=2*3.14159
130 PRINT " ","WAVES AND THEIR SUPERPOSITION"
140 PRINT "DO YOU NEED INSTRUCTIONS (1=YES, 0=NO) : ";
150 INPUT A
160 IF A=0 THEN 350
170 IF A<>1 THEN 140
180 PRINT
190 PRINT "IN THIS PROGRAM YOU MAY OBSERVE THE EFFECTS OF"
200 PRINT "CHANGING WAVELENGTH, AMPLITUDE, AND PHASE ON TWO"
210 PRINT "WAVES AND ON THEIR SUM (OR SUPERPOSITION)."
220 PRINT
230 PRINT "WAVE 'A' IS FIXED.  ITS WAVELENGTH IS 4, ITS AMPLITUDE"
240 PRINT "IS 10, AND ITS PHASE IS 0."
250 PRINT
260 PRINT "WAVE 'B' MAY BE CHANGED BY YOU.  FOR BEST RESULTS :"
270 PRINT " ","WAVELENGTH (L) BETWEEN 2 AND 4"
280 PRINT " ","AMPLITUDE (A) BETWEEN 5 AND 10"
290 PRINT " ","PHASE (P) BETWEEN 0 AND 1"
300 PRINT " ","(FOR EXAMPLE, .5 PHASE = 1/2 WAVELENGTH"
310 PRINT
320 PRINT "IT IS EASIEST TO SEE THE EFFECTS OF CHANGES IN EACH"
330 PRINT "PARAMETER IF YOU HOLD TWO CONSTANT AND VARY THE OTHER,"
340 PRINT "ALTHOUGH ALL THREE MAY BE VARIED AT ONCE."
350 PRINT
360 PRINT "WHAT IS YOUR CHOICE OF WAVELENGTH, AMPLITUDE, AND PHASE";
370 INPUT L,A,P
373 IF L>0 THEN 380
375 PRINT "WAVELENGTH IS ALWAYS A POSITIVE QUANTITY."
377 GO TO 350
380 IF L<=8 THEN 410
390 PRINT "YOUR WAVELENGTH IS TOO LONG FOR GOOD DISPLAY."
400 GO TO 350
410 IF L>=1 THEN 415
412 PRINT "YOUR WAVELENGTH IS TOO SHORT FOR GOOD DISPLAY."
413 GO TO 350
415 IF ABS(A)<=15 THEN 440
420 PRINT "YOUR AMPLITUDE IS TOO LARGE FOR DISPLAY."
430 GO TO 350
440 IF ABS(P-.5)<=.5 THEN 470
450 PRINT "YOUR PHASE CAN ONLY BE BETWEEN 0 AND 1."
460 GO TO 350
470 PRINT
```

```
480 PRINT "NOTATION:","A = 'A' WAVE"
490 PRINT " ","B = 'B' WAVE"
500 PRINT " ","S = SUPERPOSITION WAVE"
510 PRINT
520 PRINT "       X (CM.)","      -20         -10         0         +10
530 PRINT " ","-I----I---------I---------I---------I---------I----I"
540 FOR X=0 TO 4 STEP .2
545 PRINT "          "; INT(10*X+.5)/10,"-";
550 LET W(1)=INT(10*SIN(P2*X/4)+.5)
560 LET W(2)=INT(A*SIN(P2*(X/L+P))+.5)
570 LET W(3)=INT(W(1)+W(2)+.5)
580 REM  FIND WHICH IS SMALLEST, THEN PRINT IT AND MAXIMIZE IT
600 FOR Q=1 TO 3
605 LET K=1E20
610 FOR I=1 TO 3
620 IF W(I)>K THEN 640
630 LET K=W(I)
640 NEXT I
650 PRINT TAB(K+40);
660 FOR I=1 TO 3
670 IF ABS(W(I)-K)<.0001 THEN 700
680 NEXT I
690 STOP
700 IF I<>1 THEN 730
710 PRINT "A";
720 GO TO 780
730 IF I<>2 THEN 760
740 PRINT "B";
750 GO TO 780
760 IF I<>3 THEN 690
770 PRINT "S";
780 LET W(I)=1E25
790 NEXT Q
795 PRINT " "
800 NEXT X
810 PRINT " ","-I----I---------I---------I---------I---------I----I"
820 PRINT
830 PRINT "WANT TO TRY ANOTHER SET OF VALUES (1=YES, 0=NO) : ";
840 INPUT A
850 IF A=1 THEN 350
860 IF A<>0 THEN 820
870 END

READY
```

HUNTINGTON COMPUTER PROJECT

A TEACHER'S MANUAL

(COMPUTER - RELATED MATERIALS)

Second Edition

January 31, 1971

Director: Dr. Ludwig Braun
Assistant Director: Dr. Marian Visich, Jr.

Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

Developed by the Huntington Computer Project during the period May, 1968 and September, 1970. This effort was supported by the National Science Foundation under Grant No. J000079.

The enclosed material is a compilation of computer programs developed during the period May, 1968 to September, 1970. These programs were developed by teachers and students in the high schools which participated with us, and by the Project staff.

All of the enclosed programs have been tested on a Digital Equipment Corporation TSS-8 time-shared computer during the summer of 1970. To the best of our ability, we have assured ourselves that the programs actually run. It should be pointed out, however, that we were not able to make an exhaustive exploration of the programs. There may be undiscovered bugs (if there aren't, it may be the first time in the history of computing). We would appreciate hearing of any which emerge in the future.

These programs run in the version of BASIC which existed on the TSS-8 in August, 1970, and should run on most other versions of BASIC. The major potential problem on other machines is the output format (DEC uses 14 columns per print zone, while some other manufacturers use 15; we used the TAB function, which doesn't exist in all BASIC compiles). It may be necessary to make some minor changes in programs to adjust this format. Another possible problem is in the use of the RANDOMIZE command in some programs to start the random-number generator at a random point. If this command is not available, some other means should be devised for randomizing the start.

It is our sincere hope that these programs and their supporting documentation will be helpful to educators who are exploring the uses of computers in education.

We are anxious to hear of any bugs, errors, or improvements in these programs, and are especially anxious to hear of any novel ways of using them.

Ludwig Braun
Marian Visich, Jr.

TABLE OF CONTENTS

Volume I

CHEMISTRY

Volume III

MATHEMATICS

MATHEMATICS (con't)

Volume IV

PHYSICS

PHYSICS (con't)

Volume V

SOCIAL STUDIES

TEACHER ASSISTANCE

DISCIPLINE SOCIAL STUDIES

SUBJECT DISTINCTION BETWEEN BALANCE OF TRADE AND BALANCE OF PAYMENTS

PROGRAM NAME BALANC

DESCRIPTION:

This program demonstrates the distinction between "balance of trade" and "balance of payments." Also shown are the components that make up the "balance of payments" account, and their individual impacts.

OBJECTIVES:

A. To emphasize the important distinction between "Balance of Trade," and "Balance of Payments."

B. To demonstrate the impact of any specific foreign expenditure on our "Balance of Payments."

PRELIMINARY PREPARATION:

A. Student must obtain data for components of balance of payments for a given year and country.

B. Discussion of the concepts "balance of trade" and "balance of payments", would be helpful but are not necessary.

DISCUSSION:

A. Student level - average

B. Curriculum location - advanced economics: Unit on U. S. Economy in the world.

C. This program may be used either as a group exercise, or for individual study.

```
THERE'S A DISTINCTION BETWEEN TRADE BALANCE AND
BALANCE OF PAYMENTS.

TRADE BALANCE = EXPORTS-IMPORTS.

BALANCE OF PAYMENTS= ALL OVERSEAS EXCHANGES+
ALL OVERSEAS EXPENDITURES.

WHEN INFORMATION IS REQUESTED, INPUT VALUES IN
MILLIONS OF DOLLARS (E.G. 6 = 6 MILLION DOLLARS)

A.
INPUT A FIGURE FIRST FOR ALL MILITARY AID, THEN
FOR ALL OTHER AID TO OTHER NATIONS.
? 12,13

B.
INPUT A FIGURE FIRST FOR EXPORTS, THEN FOR IMPORTS.
? 256,23

C.
INPUT A FIGURE FIRST FOR FOREIGNERS TRAVELING IN
YOUR COUNTRY, THEN FOR YOUR COUNTRYMEN TRAVELING
ABROAD.
? 254,6-56

D.
INPUT A FIGURE FIRST FOR INCOME FROM FOREIGN INVEST-
MENTS, THEN FOR FOREIGN INVESTMENT ITSELF.
? 259,21


A. FOREIGN AID =               25

B. BALANCE OF TRADE =          233

C. TRAVEL BALANCE =            198

D. INVESTMENT BALANCE =        238

----------                    ----------

BALANCE OF PAYMENTS =          644

(REMEMBER, IF A MINUS FIGURE APPEARS ABOVE,YOUR
COUNTRY HAS A DEFICIT IN ITS BALANCE OF PAYMENTS)

HOPE YOU UNDERSTAND THE DISTINCTION BETWEEN THE
BALANCE OF TRADE AND THE BALANCE OF PAYMENTS
BETTER NOW.


READY
```

```
1REMPROGRAM BY J.V.SWARTZ, HALF HOLLOW HILLS,7/68
5PRINT"THERE'S A DISTINCTION BETWEEN TRADE BALANCE AND"
7PRINT"BALANCE OF PAYMENTS."
8PRINT
10PRINT"TRADE BALANCE = EXPORTS-IMPORTS."
15PRINT
20PRINT"BALANCE OF PAYMENTS= ALL OVERSEAS EXCHANGES+"
22PRINT"ALL OVERSEAS EXPENDITURES."
23 PRINT
25 PRINT "WHEN INFORMATION IS REQUESTED, INPUT VALUES IN"
27 PRINT "MILLIONS OF DOLLARS (E.G. 6 = 6 MILLION DOLLARS)"
30PRINT
33 PRINT "A."
35PRINT"INPUT A FIGURE FIRST FOR ALL MILITARY AID, THEN"
36PRINT"FOR ALL OTHER AID TO OTHER NATIONS."
45 INPUT F1,F2
50LETF=F1+F2
52PRINT
54 PRINT "B."
55PRINT"INPUT A FIGURE FIRST FOR EXPORTS, THEN FOR IMPORTS."
65INPUT S1,S2
70LETS=S1-S2
72PRINT
74 PRINT "C."
75PRINT"INPUT A FIGURE FIRST FOR FOREIGNERS TRAVELING IN"
76PRINT"YOUR COUNTRY, THEN FOR YOUR COUNTRYMEN TRAVELING"
77PRINT"ABROAD."
85INPUTT1,T2
90LET T=T1-T2
92PRINT
94 PRINT "D."
95PRINT"INPUT A FIGURE FIRST FOR INCOME FROM FOREIGN INVEST-"
96PRINT"MENTS, THEN FOR FOREIGN INVESTMENT ITSELF."
105INPUT I1,I2
110LET I=I1-I2
115LETP=-F+S+T+I
117PRINT
118PRINT
120 PRINT "A. FOREIGN AID =",F
125PRINT
130 PRINT "B. BALANCE OF TRADE =",S
140PRINT
145 PRINT "C. TRAVEL BALANCE =",T
150PRINT
155 PRINT "D. INVESTMENT BALANCE =",I
158PRINT
160 PRINT "----------"," ","----------"
162PRINT
170 PRINT "BALANCE OF PAYMENTS =",P
171PRINT
172PRINT"(REMEMBER, IF A MINUS FIGURE APPEARS ABOVE,YOUR"
173PRINT"COUNTRY HAS A DEFICIT IN ITS BALANCE OF PAYMENTS)"
181PRINT
185PRINT"HOPE YOU UNDERSTAND THE DISTINCTION BETWEEN THE"
186PRINT"BALANCE OF TRADE AND THE BALANCE OF PAYMENTS"
187PRINT"BETTER NOW."
190END
```

DISCIPLINE MATHEMATICS-SOCIAL SCIENCE

SUBJECT FINANCIAL PROBLEMS

PROGRAM NAME BANK

DESCRIPTION:

This program solves financial problems concerning installment buying, long-term loans, and savings accounts. The program gives you a choice of these three types of problems, and asks for the information needed to do said problems.

OBJECTIVES:

A. This program aids students in learning the terms used in certain financial problems.

B. Student will hopefully be motivated to learn the mathematical logic behind the solution of these problems.

PRELIMINARY PREPARATION:

A. Student - A review of decimals and fractions would be helpful.

B. Materials - A terminal, and a means by which to display the output to an entire class (e.g. overhead projector, closed circuit TV, etc.)

DISCUSSION:

A type of problem may be demonstrated through the use of the computer, then the mathematical logic behind the solution of the problem may be developed through the use of a flow chart similar to the one that follows.

Terminology may be taught when the computer asks for input (see sample run).

Since the execution time of one run is extremely short, many more problems may be demonstrated. Depending upon the ability of the class or student, a variety of relationships may be discovered.

FINANCIAL PROBLEMS

THIS PROGRAM SOLVES THREE TYPES OF PROBLEMS:

(1) INTEREST ON INSTALLMENT BUYING
(2) PAYMENTS ON LONG TERM LOAN
(3) BALANCE OF A SAVINGS ACCOUNT

WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)7 1

*****

THIS SECTION WILL DETERMINE THE ACTUAL INTEREST YOU PAY
WHEN YOU PURCHASE SOMETHING ON CREDIT.

WHAT IS THE CASH PRICE OF THE ARTICLE ($)7 88.99
DOWN PAYMENT ($)7 10
NUMBER OF PAYMENTS EXCLUDING THE DOWN PAYMENT7 18
NUMBER OF PAYMENTS PER MONTH7 1
AMOUNT PER PAYMENT ($)7 4.85

THE RATE OF INTEREST CHARGED WAS 5.69 PERCENT.

*****

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)7 1
WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)7 2

*****

THIS SECTION WILL DETERMINE PAYMENTS FOR A LONG TERM LOAN.

WHAT IS THE AMOUNT BORROWED ($)7 3000
INTEREST CHARGED (%)7 8
INTERVAL BETWEEN PAYMENTS (MONTHS)7 1
TERM OF THE LOAN (YEARS)7 2

DO YOU WISH TO SEE THE TOTALS ONLY - INSTEAD OF THE ENTIRE
TABLE - (1-YES, 0-NO)7 0

PERIOD	OUTSTANDING PRINCIPAL AT BEGINNING OF PERIOD	INTEREST DUE AT END OF PERIOD	PRINCIPAL REPAID AT END OF PERIOD
1	3000	20	115.68
2	2884.32	19.23	116.45
3	2767.87	18.45	117.23
4	2650.64	17.67	118.01
5	2532.63	16.88	118.8
6	2413.83	16.09	119.59
7	2294.24	15.29	120.39
8	2173.85	14.49	121.19
9	2052.66	13.68	122
10	1930.66	12.87	122.81
11	1807.85	12.05	123.63
12	1684.22	11.23	124.45
13	1559.77	10.4	125.28
14	1434.49	9.56	126.12
15	1308.37	8.72	126.96
16	1181.41	7.88	127.8
17	1053.61	7.02	128.66
18	924.95	6.17	129.51
19	795.44	5.3	130.38
20	665.06	4.43	131.25
21	533.81	3.56	132.12
22	401.69	2.68	133
23	268.69	1.79	133.89
24	134.8	.9	134.78
TOTALS		256.34	3000

YOUR MONTHLY PAYMENT IS $ 135.68 AND TOTALS $ 3256.34

```
*****

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)? 1
WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)? 3

*****

THIS SECTION CALCULATES THE BALANCE OF A SAVINGS ACCOUNT
IN WHICH DEPOSITS ARE MADE REGULARLY.

WHAT IS THE AMOUNT DEPOSITED PER INTEREST PERIOD ($)? 10000
HOW OFTEN IS THE INTEREST COMPOUNDED (MONTHS)? 3
WHAT IS THE RATE OF INTEREST PAID (%)? 5
FOR HOW LONG WILL YOU DEPOSIT MONEY (YEARS)? 5

THE BALANCE OF YOUR ACCOUNT AFTER  5 YEARS WILL BE $ 202500

*****

WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)? 0

READY
```

```
100 REM FINANCIAL PROBLEMS   A. WEBB  12/67
101 REM REVISED 8/25/70 (D. PESSEL)
110 PRINT TAB(20);"FINANCIAL PROBLEMS"
115 REM REVISED BY W. TEPPER,  WYANDANCH H.S.  7/10/69
120 PRINT
130 PRINT"THIS PROGRAM SOLVES THREE TYPES OF PROBLEMS:"
132 PRINT
134 PRINT"      (1) INTEREST ON INSTALLMENT BUYING"
136 PRINT"      (2) PAYMENTS ON LONG TERM LOAN"
138 PRINT"      (3) BALANCE OF A SAVINGS ACCOUNT"
140 PRINT
142 PRINT"WHICH PROBLEM WOULD YOU LIKE TO WORK WITH (TYPE 1, 2 OR 3)";
144 INPUT Q1
146 PRINT
147 PRINT"*****"
148 PRINT
150 IF Q1>2 THEN 820
155 IF Q1>1 THEN 260
160 GO TO 590
260PRINT "THIS SECTION WILL DETERMINE PAYMENTS FOR A LONG TERM LOAN."
270 PRINT
280 PRINT"WHAT IS THE AMOUNT BORROWED ($)";
281 INPUT A
285 PRINT"              INTEREST CHARGED (%)";
286 INPUT I
290 PRINT"              INTERVAL BETWEEN PAYMENTS (MONTHS)";
291 INPUT P
295 PRINT"              TERM OF THE LOAN (YEARS)";
296 INPUT Y
300 PRINT
360 PRINT"DO YOU WISH TO SEE THE TOTALS ONLY - INSTEAD OF THE ENTIRE"
361 PRINT"TABLE - (1-YES, 0-NO)";
362 INPUT P5
370 PRINT
375 IF P5>0 THEN 430
380 PRINT"           OUTSTANDING"
390 PRINT"           PRINCIPAL AT                         PRINCIPAL"
400 PRINT"           BEGINNING       INTEREST DUE AT      REPAID AT"
410 PRINT"PERIOD     OF PERIOD       END OF PERIOD        END OF PERIOD"
420 PRINT
430 LET Z=(Y*12)/P
440 LET K=(I*(P/12))/100
445 LET E=A*K/(1-1/(1+K)↑Z)
446 LET E=INT(E*100+.5)/100
450 LET C=A
460 LET F=0
461 LET D1=0
470 LET T1=0
480 LET T1=T1+1
490 IF T1>Z THEN 554
500 LET B=T1
510 LET C=C-F
520 LET D=C*K
522 LET F=E-D
525 LET C=INT(C*100+.5)/100
530 LET D=INT(D*100+.5)/100
535 LET F=INT(F*100+.5)/100
541 LET D1=D1+D
548 IF P5>0 THEN 480
550 PRINT B;TAB(11);C;TAB(29);D;TAB(48);F
```

```
552 GO TO 480
554 IF P5<1 THEN 561
555 PRINT
556 LET D1=INT(D1*100+.5)/100
558 PRINT"TOTAL INTEREST PAID - $"D1
559 PRINT"TOTAOL PRINCIPAL REPAID - $"A
560 GO TO 565
561 PRINT"                              ---------------     -------------"
564 PRINT"TOTALS";TAB(29);D1;TAB(48);A
565 LET E5=INT((D1+A)*100+.5)/100
566 PRINT
567 LET E6=E5/((Y*12)/P)
568 LET E6=INT(100*E6+.5)/100
569 PRINT"YOUR MONTHLY PAYMENT IS $"E6" AND TOTALS $"E5
570 GO TO 1060
590 PRINT"THIS SECTION WILL DETERMINE THE ACTUAL INTEREST YOU PAY"
600 PRINT"WHEN YOU PURCHASE SOMETHING ON CREDIT."
610 PRINT
620 PRINT"WHAT IS THE CASH PRICE OF THE ARTICLE ($)";
621 INPUT C
630 PRINT"                 DOWN PAYMENT ($)";
631 INPUT D
640 PRINT"                 NUMBER OF PAYMENTS EXCLUDING THE DOWN PAYMENT";
641 INPUT N
650 PRINT"                 NUMBER OF PAYMENTS PER MONTH";
651 INPUT S
660 PRINT"                 AMOUNT PER PAYMENT ($)";
661 INPUT R
690 PRINT
720 LET B=R*N+D
730 LET I=B-C
740 LET M=N/(S*12)
750 LET T=I*100/(B*M)
760 PRINT
770 PRINT
775 LET T=INT(100*T+.5)/100
780PRINT "THE RATE OF INTEREST CHARGED WAS"T" PERCENT."
790 GO TO 1060
820 PRINT"THIS SECTION CALCULATES THE BALANCE OF A SAVINGS ACCOUNT"
830 PRINT"IN WHICH DEPOSITS ARE MADE REGULARLY."
840 PRINT
860 PRINT"WHAT IS THE AMOUNT DEPOSITED PER INTEREST PERIOD ($)";
861 INPUT A
870 PRINT"HOW OFTEN IS THE INTEREST COMPOUNDED (MONTHS)";
871 INPUT B
880 PRINT"WHAT IS THE RATE OF INTEREST PAID (%)";
881 INPUT C
890 PRINT"FOR HOW LONG WILL YOU DEPOSIT MONEY (YEARS)";
891 INPUT D
950 LET F=0
960 LET E=(C/100)/(12/B)
970 LET G=(12/B)*D
980 LET T1=0
990 LET T1=T1+1
1000 IF T1=G+1 THEN 1030
1010 LET F=(E*A)+(A+F)
1020 GO TO 990
1030 PRINT
1040 PRINT
1045 LET F=INT(100*F+.5)/100
1050 PRINT"THE BALANCE OF YOUR ACCOUNT AFTER "D"YEARS WILL BE $"F
1060 PRINT
1070 PRINT
1080 PRINT
1081 PRINT"*****"
1082 PRINT
1084 PRINT"WOULD YOU LIKE TO RUN THE PROGRAM AGAIN (1-YES, 0-NO)";
1086 INPUT Q4
1090 IF Q4>0 THEN 142
1100 END
```

DISCIPLINE SOCIAL STUDIES

SUBJECT CIRCULAR FLOW BETWEEN BUSINESS AND CONSUMER

PROGRAM NAME CIRFLW

DESCRIPTION:

Simulation of the circular flow of goods, services, and money, between business and the consumer in a free enterprise economy without government control.

OBJECTIVES:

A. To explore the effect of personal consumption upon business' demand for productive services from the individual, and upon personal income.

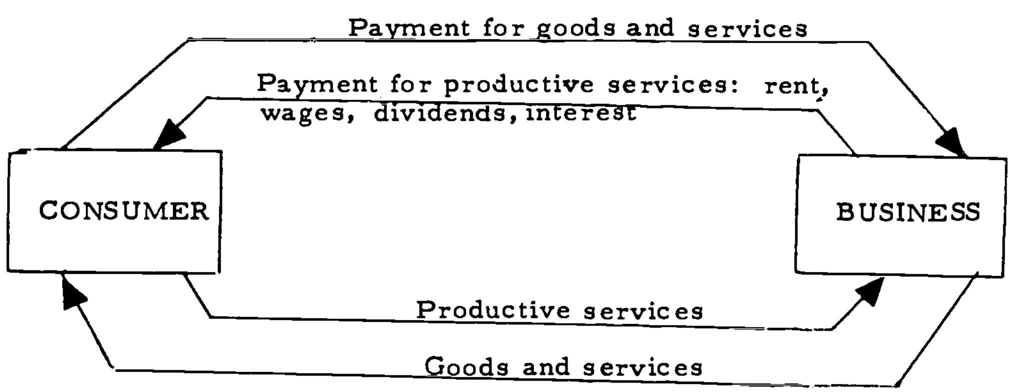
B. To demonstrate that widespread uninvested savings can cause a general drop in income.

C. To demonstrate how credit buying can raise personal income, in general.

PRELIMINARY PREPARATION:

A. Student

1. Terms to define:
   a. propensity to consume
   b. savings
   c. credit
   d. circular flow of goods, services, and money
2. Concepts for explanation or discussion:



CIRCULAR FLOW

DISCUSSION:

A. Operational Suggestions

1. Student level-average to above average ability
2. Placement in curriculum- Unit: Economic growth and stability
3. Group size- may be used individually, with small groups, or as a teacher demonstration.

B. Follow-up

Suggested classroom activities:

1. Use the circular flow chart to illustrate one or more of the program "run-offs".
2. Discuss the lack of aggregate demand as a cause for recession; and the rise in aggregate demand as a cause for growth or inflation.

THE FOLLOWING WILL SIMULATE THE EFFECT ON THE CIRCULAR FLOW OF GOODS, SERVICES AND MONEY WHEN ALL THE INDIVIDUALS IN THE ECONOMY SPEND ALL THEIR INCOME. IF THE AVERAGE INCOME IS $2,500 AND EVERY INDIVIDUAL SPENDS 100 PERCENT OF IT, EACH INCOME WILL BE IN EQUILIBRIUM--THEY WILL EARN BACK FROM BUSINESS $2500
THE FOLLOWING WILL BE A COMPUTATION OF THE VALUES IN THE CIRCULAR FLOW

AVERAGE INCOME- 2500

PROPENSITY TO CONSUME IS
100 PERCENT

INDIVIDUAL'S PAYMENTS FOR
GOODS AND SERVICES- 2500

THE VALUE OF GOODS
AND SERVICES- 2500

THE PERCENT OF PRODUCTIVE
SERVICES BUSINESS WANTS
IS 100 PERCENT.

THE RETURN INCOME
TO INDIVIDUAL-2500.

THE ABOVE REPRESENTS THE AVERAGE OF ALL INDIVIDUAL INCOMES IN THE ECONOMY. SINCE ALL INDIVIDUALS CONSUMED 100 PERCENT OF THEIR INCOME,THEIR RETURN INCOMEIS 100 PERCENT OF THEIR PREVIOUS INCOME. THIS HAPPENS BECAUSE BUSINESS NEEDS 100 PERCENT OF THE PREVIOUS PRODUCTIVE SERVICES TO MEET THE DEMAND.

THE RETURN INCOME TO THE INDIVIDUAL FROM BUSINESS DEPENDS TO A LARGE EXTENT ON HOW MUCH ALL INDIVIDUALS SPEND(THEIR PROPENSITY TO CONSUME). COMMON SENSE TELLS US THAT IF AN INDIVIDUAL SAVES PART OF HIS INCOME AND INVESTS IT IN A BANK, HE WILL RAISE HIS INCOME BY MEANS OF THE INTEREST ON HIS SAVINGS. BUT IF ALL OR MANY OF THE INDIVIDUAL CONSUMERS IN THE ECONOMY CUT THEIR CONSUMPTION, THEN THE OVERALL RETURN INCOME TO THOSE INDIVIDUALS WILL PROBABLY DROP.
BY CHANGING THE PERCENTAGE OF YOUR PROPENSITY TO CONSUME YOU CAN CHANGE YOUR INCOME.

A PROPENSITY TO CONSUME OF 100 PERCENT WILL, IN THIS SIMULATION, GIVE YOU A RETURN INCOME EQUAL TO YOUR ORIGINAL INCOME. ANY VALUE MORE OR LESS THAN 100 PERCENT WILL CHANGE YOUR RETURN INCOME.

TYPE IN A VALUE FOR THE PROPENSITY TO CONSUME, A PERCENTAGE MORE OR LESS THAN 100 PERCENT.
PUT IT IN IN DECIMAL FORM (E.G. .75=75 PERCENT)

```
WHAT IS THE VALUE? .75
BECAUSE YOUR PROPENSITY TO CONSUME IS LESS THAN
YOUR INCOME, YOU ARE SAVING MONEY.  WE WILL ASSUME
THAT YOU DIDN'T PUT IT IN A BANK BUT
RATHER STUFFED IT UNDER YOUR MATTRESS, SO
YOU WON'T RAISE YOUR INCOME WITH INTEREST

INDIVIDUAL'S PAYMENTS FOR
GOODS AND SERVICES- 1875

VALUE OF GOODS AND SERVICES
FROM BUSINESS- 1875

PERCENT OF PRODUCTIVE
SERVICES IN DEMAND- .75

RETURN INCOME TO IN-
DIVIDUAL- 1875

YOUR RETURN INCOME
HAS DROPPED THE FOLLOWING
PERCENTAGE POINTS FROM
100 PERCENT- 25
IF YOU WISH TO PUT IN ANOTHER PERCENTAGE VALUE
FOR THE PROPENSITY TO CONSUME, TYPE 0
IF YOU WISH TO STOP THE PROGRAM, TYPE 1
? 1


READY
```

305

```
100REM THIS PROGRAM BY JAMESEDER, NORTHPORT HS, 8/68
105 REM  REVISED BY C.LOSIK  8-27-70
110REM IT'S DESIGNED TO DEMONSTRATE THE CIRCULAR FLOW OF
120REM GOODS AND SERVICES IN THE U.S. ECONOMY.
130REM THE FOLLOWING ARE DEFINITIONS OF THE SYMBOLS USED:
140REM PER CAPITA INCOME IS I,IO;PROPENSITY TO CONSUME IS C,CO;
150REM PAYMENT FOR GOODS + SERVICES IS P,PO;VALUE OF GOODS IS
160REM V,VO;PERCENT OF PRODUCTIVE SERVICES IS S,SO;
170REM RETURN INCOME IS R,RO
180PRINT"THE FOLLOWING WILL SIMULATE THE EFFECT ON THE"
190PRINT"CIRCULAR FLOW OF GOODS, SERVICES AND MONEY WHEN"
200PRINT"ALL THE INDIVIDUALS IN THE ECONOMY SPEND ALL THEIR"
210PRINT"INCOME.  IF THE AVERAGE INCOME IS $2,500 AND"
220PRINT"EVERY INDIVIDUAL SPENDS 100 PERCENT OF IT,"
230PRINT"EACH INCOME WILL BE IN EQUILIBRIUM--THEY WILL"
240PRINT"EARN BACK FROM BUSINESS $2500"
250PRINT"THE FOLLOWING WILL BE A COMPUTATION OF THE"
260PRINT"VALUES IN THE CIRCULAR FLOW"
270READI,C,IO
280DATA 2500,1,2500
290PRINT
300PRINT"AVERAGE INCOME-";I
310PRINT
320PRINT
330PRINT"PROPENSITY TO CONSUME IS"
340PRINT"100 PERCENT"
350LET P=C*I
360PRINT
370PRINT"INDIVIDUAL'S PAYMENTS FOR"
380PRINT"GOODS AND SERVICES-";P
390LETV=P
400PRINT
410PRINT"THE VALUE OF GOODS"
420PRINT"AND SERVICES-";V
430PRINT
440PRINT
450PRINT"THE PERCENT OF PRODUCTIVE"
460PRINT"SERVICES BUSINESS WANTS"
470PRINT"IS 100 PERCENT."
480PRINT
490PRINT
500PRINT"THE RETURN INCOME"
510PRINT"TO INDIVIDUAL-2500."
520PRINT
530PRINT"THE ABOVE REPRESENTS THE AVERAGE OF ALL INDIVIDUAL"
540PRINT"INCOMES IN THE ECONOMY.  SINCE ALL INDIVIDUALS CONSUMED"
550PRINT"100 PERCENT OF THEIR INCOME,THEIR RETURN INCOMEIS"
560PRINT"100 PERCENT OF THEIR PREVIOUS INCOME. THIS HAPPENS"
570PRINT"BECAUSE BUSINESS NEEDS 100 PERCENT OF THE PREVIOUS"
580PRINT"PRODUCTIVE SERVICES TO MEET THE DEMAND."
590PRINT
600PRINT"THE RETURN INCOME TO THE INDIVIDUAL FROM"
610PRINT"BUSINESS DEPENDS TO A LARGE EXTENT ON HOW"
620PRINT"MUCH ALL INDIVIDUALS SPEND(THEIR PROPENSITY TO"
630PRINT"CONSUME).  COMMON SENSE TELLS US THAT IF AN IN-"
640PRINT"DIVIDUAL SAVES PART OF HIS INCOME AND INVESTS IT"
650PRINT"IN A BANK, HE WILL RAISE HIS INCOME BY MEANS OF"
660PRINT"THE INTEREST ON HIS SAVINGS.  BUT IF ALL OR MANY"
670PRINT"OF THE INDIVIDUAL CONSUMERS IN THE ECONOMY CUT"
680PRINT"THEIR CONSUMPTION, THEN THE OVERALL RETURN INCOME"
690PRINT"TO THOSE INDIVIDUALS WILL PROBABLY DROP."
700PRINT"BY CHANGING THE PERCENTAGE OF YOUR PROPENSITY "
710PRINT"TO CONSUME YOU CAN CHANGE YOUR INCOME."
720PRINT
730PRINT"A PROPENSITY TO CONSUME OF 100 PERCENT WILL,"
740PRINT"IN THIS SIMULATION, GIVE YOU A RETURN INCOME"
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750PRINT"EQUAL TO YOUR ORIGINAL INCOME.  ANY VALUE"
760PRINT"MORE OR LESS THAN 100 PERCENT WILL CHANGE"
770PRINT"YOUR RETURN INCOME."
780PRINT
790LETN=1
800 PRINT "TYPE IN A VALUE FOR THE PROPENSITY TO CONSUME,"
810 PRINT "A PERCENTAGE MORE OR LESS THAN 100 PERCENT."
820 PRINT "PUT IT IN IN DECIMAL FORM (E.G. .75=75 PERCENT)"
830 PRINT
840 PRINT "WHAT IS THE VALUE";
850INPUTCO
860IFCO<1 THEN 960
870IFCO>1THEN 1030
890IFN=3 THEN930
900PRINT"WE'LL GO BACK"
910LETN=N+1
920GOTO 800
930PRINT"EITHER YOU WERE CARELESS OR YOU WERE BEING "
940PRINT"WISE. IN EITHER CASE, SUFFER THE CONSEQUENCES."
950 STOP
960PRINT"BECAUSE YOUR PROPENSITY TO CONSUME IS LESS THAN"
970PRINT"YOUR INCOME, YOU ARE SAVING MONEY.  WE WILL ASSUME"
980PRINT"THAT YOU DIDN'T PUT IT IN A BANK BUT"
990PRINT"RATHER STUFFED IT UNDER YOUR MATTRESS, SO"
1000PRINT"YOU WON'T RAISE YOUR INCOME WITH INTEREST"
1010GOTO1070
1020PRINT
1030PRINT"BECAUSE YOUR PROPENSITY TO CONSUME IS GREATER"
1040PRINT"THAN YOUR INCOME, YOU ARE BUYING ON CREDIT."
1050PRINT"THAT MEANS YOU ARE BUYING NOW WITH WHAT YOU EXPECT "
1060PRINT"TO EARN IN THE FUTURE."
1070LETPO=IO*CO
1080PRINT
1090PRINT"INDIVIDUAL'S PAYMENTS FOR"
1100PRINT"GOODS AND SERVICES-";PO
1110PRINT
1120LET VO=PO
1130PRINT"VALUE OF GOODS AND SERVICES"
1140PRINT"FROM BUSINESS-";VO
1150LETSO=CO
1160PRINT
1170PRINT"PERCENT OF PRODUCTIVE"
1180PRINT"SERVICES IN DEMAND-";SO
1190LET RO=IO*SO
1200PRINT
1210PRINT"RETURN INCOME TO IN-"
1220PRINT"DIVIDUAL-";RO
1230PRINT
1240IFRO<2500 THEN 1270
1250IFRO>=2500THEN 1320
1260PRINT
1270 LET P2=INT(100-100*CO+.5)
1280PRINT"YOUR RETURN INCOME"
1290PRINT"HAS DROPPED THE FOLLOWING"
1300PRINT"PERCENTAGE POINTS FROM"
1310PRINT"100 PERCENT-";P2
1320PRINT"IF YOU WISH TO PUT IN ANOTHER PERCENTAGE VALUE"
1330PRINT"FOR THE PROPENSITY TO CONSUME, TYPE 0"
1340PRINT"IF YOU WISH TO STOP THE PROGRAM, TYPE 1"
1350INPUT W
1355 PRINT
1360IF W=0 THEN 800
1365 IF W<>1 THEN 1320
1370END
```

397

DISCIPLINE SOCIAL STUDIES

SUBJECT DEPRESSION/EQUILIBRIUM

PROGRAM NAME CONSMP

DESCRIPTION:

This program simulates economic depression and equilibrium as effects of consumption.

OBJECTIVES:

A. Depression or recession results when consumption drops below the capacity to produce.

B. Equilibrium results when consumption equals the capacity to produce.

C. One cause for "over-production" is a time-lag in discovering a drop in consumption.

PRELIMINARY PREPARATION:

A. Student - terms to define and explain:

1. Depression
2. Recession
3. Equilibrium
4. Under-consumption
5. Overproduction
6. Investment
7. Savings
8. GNP
9. Productive Services

B. Materials - Introduce this program with the Circular Flow model of goods, services and money. (See program CIRFLW)

DISCUSSION:

A. Operational Suggestions

1. Student level - above average
2. Curriculum location - advanced economics unit on economic growth and stability.

B. Suggested Follow-up

Discussion topics:

1. Consider possible causes for a drop in consumption.
2. With advanced students, discuss the (Keynesian) concept of "equilibrium at less than full employment."

```
THIS PROGRAM SIMULATES THE EFFECTS OF CONSUMPTION ON THE
GNP. IT PRINTS OUT THE VALUES FOR THE COMPONENTS OF THE
CIRCULAR FLOW MODEL OF GOODS, SERVICES AND MONEY.

ASSUME GNP IS 100 BILLION.
TYPE IN A VALUE FOR PROPENSITY TO CONSUME.
MAKE THE VALUE BETWEEN 0 AND .75
? .75

ORIGINAL GNP- 100

PROPENSITY TO
CONSUME- .75

CONSUMPTION- 75

VALUE OF GOODS
+ SERVICES- 75

SAVINGS- 25

INVEST.- 25

LABOR- .75

RETURN GNP- 100

EQUILIBRIUM.


TO PUT IN ANOTHER CONSUMPTION VALUE,TYPE 0.
TO STOP, TYPE 1
? 0
TYPE IN A VALUE FOR PROPENSITY TO CONSUME.
MAKE THE VALUE BETWEEN 0 AND .75
? .80
READ CAREFULLY;INPUT AGAIN.
? 7-.70
IF STARTING ,TYPE 100(GNP);IF NOT
STARTING,TYPE VALUE OF RETURN GNP.
? 100

ORIGINAL GNP- 100

PROPENSITY TO
CONSUME- .7

CONSUMPTION- 70

VALUE- 70

SAVINGS- 30

INVESTMENT BY PERIODS:
1-3MONTHS 5
4-6MONTHS 4.9375
7-9MONTHS 4.875
10-12MONTHS 4.8125
END OF 12TH MONTH 4.75
TOTAL FOR YEAR 24.375
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399

```
OVER-INVESTMENT

LABOR:
1-3MONTHS- .15
4-6MONTHS- .1475
7-9MONTHS- .145
10-12MONTHS- .1425
END OF 12MONTH- .14
TOTAL FOR YEAR- .725

GNP:
1-3MONTHS- 15
4-6MONTHS- 14.9875
7-9MONTHS- 14.975
10-12MONTHS- 14.9625
END OF 12 MONTH- 14.95
TOTAL FOR YEAR- 94.375

RECESSION
INVENTORY OVERPRODUCED- 23.125
TYPE DECIMAL VALUE FOR PROPENSITY TO
CONSUME
? .65
IF STARTING ,TYPE 100(GNP);IF NOT
STARTING,TYPE VALUE OF RETURN GNP.
? 94.375

ORIGINAL GNP- 100

PROPENSITY TO
CONSUME- .65

CONSUMPTION- 61.34375

VALUE- 61.34375

SAVINGS- 33.03125

GNP- 63.21875
TYPE DECIMAL VALUE FOR PROPENSITY TO
CONSUME
? .60
IF STARTING ,TYPE 100(GNP);IF NOT
STARTING,TYPE VALUE OF RETURN GNP.
? 63.21875

ORIGINAL GNP- 100

PROPENSITY TO
CONSUME- .6

CONSUMPTION- 37.93125

VALUE- 37.93125

SAVINGS- 25.2875

GNP- 41.68125
TYPE DECIMAL VALUE FOR PROPENSITY TO
CONSUME
? .55
IF STARTING ,TYPE 100(GNP);IF NOT
STARTING,TYPE VALUE OF RETURN GNP.
? 41.68125
```

```
ORIGINAL GNP- 100

PROPENSITY TO
CONSUME- .55

CONSUMPTION- 22.92469

VALUE- 22.92469

SAVINGS- 18.75656

GNP- 28.54969
TYPE DECIMAL VALUE FOR PROPENSITY TO
CONSUME
?
↑C

READY
```

401

```
100REM--PROGRAM BY JAMES EDER, NORTHPORT HS, 8/68
110REM--REVISED--8/12/69--<ROD>
115 REM  REVISED BY C.LOSIK  8-27-70
120PRINT"THIS PROGRAM SIMULATES THE EFFECTS OF CONSUMPTION ON THE"
130PRINT"GNP. IT PRINTS OUT THE VALUES FOR THE COMPONENTS OF THE"
140PRINT"CIRCULAR FLOW MODEL OF GOODS, SERVICES AND MONEY."
170PRINT
180READY,P1
190DATA100,.75
200PRINT"ASSUME GNP IS 100 BILLION."
210 PRINT "TYPE IN A VALUE FOR PROPENSITY TO CONSUME."
220 PRINT "MAKE THE VALUE BETWEEN 0 AND .75"
230LETC1=Y*P1
240LETI1=Y-C1
250 LET N=0
260INPUT P2
265 LET N=N+1
266 IF P2<0 THEN 220
270IFP2=.75THEN420
280IFP2<.75THEN770
310IFN=2THEN360
320IFN=3THEN390
330PRINT"READ CAREFULLY;INPUT AGAIN."
350GOTO0260
360PRINT"COME ON...I'M WARNING YOU."
380GOTO0260
390PRINT"OK WISE GUY,YOU'RE OFF."
400GOTO1930
410PRINT
420LETV1=C1
430LETS1=Y-C1
440LETL1=P1
450LETY1=C1+I1
460PRINT
470PRINT"ORIGINAL GNP-";Y
480PRINT
490PRINT"PROPENSITY TO"
500PRINT"CONSUME-";P2
510PRINT
520PRINT"CONSUMPTION-";C1
530PRINT
540PRINT"VALUE OF GOODS"
550PRINT"+ SERVICES-";V1
560PRINT
570PRINT"SAVINGS-";S1
580PRINT
590PRINT"INVEST.-";I1
600PRINT
610PRINT"LABOR-";L1
620PRINT
630PRINT"RETURN GNP-";Y1
640PRINT
650PRINT"EQUILIBRIUM."
660PRINT
670PRINT
680PRINT
690PRINT"TO PUT IN ANOTHER CONSUMPTION VALUE,TYPE 0."
700PRINT"TO STOP, TYPE 1"
710INPUTQ8
720IFQ8=0THEN210
730IFQ8=1THEN1930
740PRINT"TYPE DECIMAL VALUE FOR PROPENSITY TO"
```

```
750PRINT"CONSUME"
760GOTO260
770PRINT"IF STARTING ,TYPE 100(GNP);IF NOT"
780PRINT"STARTING,TYPE VALUE OF RETURN GNP."
790INPUTY8
800LETC2=P2*Y8
810LETV2=C2
820LETS2=Y8-C2
830PRINT
840PRINT"ORIGINAL GNP-";Y
850PRINT
860PRINT"PROPENSITY TO "
870PRINT"CONSUME-";P2
880PRINT
890PRINT"CONSUMPTION-";C2
900PRINT
910PRINT"VALUE-";V2
920PRINT
930PRINT"SAVINGS-";S2
940PRINT
950LETQ=(I1)*(P1-P2)
960LETI2=I1
970LETZ2=I2*.20
980LETI3=I1-(.25*Q)
990LETZ3=I3*.20
1000LETI4=I1-(.50*Q)
1010LETZ4=I4*.20
1020LETI5=I1-(.75*Q)
1030LETZ5=I5*.20
1040LETI6=I1-Q
1050LETZ6=I6*.20
1060LETI7=Z2+Z3+Z4+Z5+Z6
1070LETF=(C2+I2)-0
1080LETO=I7-Q
1090LETF1=F-O1
1100LETO1=F-Q
1110LETF2=F1-O2
1120LETO2=F1-Q
1130LETF3=F2-O3
1140LETO3=F2-Q
1150LETF4=F3-O4
1160LETO4=F3-Q
1170LETF5=F4-O5
1180LETO5=F4-Q
1190LETF6=F5-O6
1200LETO6=F5-Q
1210IFF<Y7THEN1760
1220IFF1<FTHEN1780
1230IFF2<F1THEN1800
1240IFF3<F2THEN1820
1250IFF4<F3THEN1840
1260IFF5<F4THEN1860
1270IFF6<F5THEN1880
1280PRINT"INVESTMENT BY PERIODS:"
1290PRINT"1-3MONTHS";Z2
1300PRINT"4-6MONTHS";Z3
1310PRINT"7-9MONTHS";Z4
1320PRINT"10-12MONTHS";Z5
1330PRINT"END OF 12TH MONTH";Z6
1340PRINT"TOTAL FOR YEAR";I7
1350PRINT
1360PRINT"OVER-INVESTMENT"
```

```
1370PRINT
1380LETQ2=P1-P2
1390LETL2=P1
1400LETX2=L2*.20
1410LETL3=P2+(.75*Q2)
1420LETX3=L3*.20
1430LETL4=P2+(.50*Q2)
1440LETX4=L4*.20
1450LETL5=P2+(.25*Q2)
1460LETX5=L5*.20
1470LETL6=P2
1480LETX6=P2*.20
1490LETL7=X2+X3+X4+X5+X6
1500PRINT"LABOR:"
1510PRINT"1-3MONTHS-";X2
1520PRINT"4-6MONTHS-";X3
1530PRINT"7-9MONTHS-";X4
1540PRINT"10-12MONTHS-";X5
1550PRINT"END OF 12MONTH-";X6
1560PRINT"TOTAL FOR YEAR-";L7
1570PRINT
1580LETY2=(C2+Z2)*.20
1590LETY3=(C2+Z3)*.20
1600LETY4=(C2+Z4)*.20
1610LETY5=(C2+Z5)*.20
1620LETY6=(C2+Z6)*.20
1630LETY7=C2+I7
1640PRINT"GNP:"
1650PRINT"1-3MONTHS-";Y2
1660PRINT"4-6MONTHS-";Y3
1670PRINT"7-9MONTHS-";Y4
1680PRINT"10-12MONTHS-";Y5
1690PRINT"END OF 12 MONTH-";Y6
1700PRINT"TOTAL FOR YEAR-";Y7
1710PRINT
1720PRINT"RECESSION"
1730LETO=I7-Q
1740PRINT"INVENTORY OVERPRODUCED-";O
1750GOTO740
1760PRINT"GNP-";F
1770IFF>0THEN740
1780PRINT"GNP--";F1
1790IFF1>0THEN740
1800PRINT"GNP--";F2
1810IFF2>0THEN740
1820PRINT"GNP--";F3
1830IFF3>0THEN740
1840PRINT"GNP--";F4
1850IFF4>0THEN740
1860PRINT"GNP--";F5
1870IFF5>0THEN740
1880PRINT"GNP--";F6
1890PRINT
1900PRINT"TOTAL DEPRESSION"
1910GOTO690
1920PRINT
1930END
```

DISCIPLINE MATHEMATICS, SOCIAL STUDIES

SUBJECT THE STOCK MARKET

PROGRAM NAME STOCK

DESCRIPTION:

This program simulates the stock market. Each student is given $10,000 with which he may buy and/or sell shares in five fictitious issues.

OBJECTIVES:

A. To give the student a simple understanding of the operations of the stock market.

B. To motivate the student to reinforce his basic arithmetic skills.

C. To give an example of the use of everyday mathematics and economics in everyday life.

PRELIMINARY PREPARATION:

A. Student - no special preparation

B. Materials - possibly graph paper

DISCUSSION:

This program can be used as a good motivation device in the teaching of basic stock-market concepts, and the basic mathematical skills involved. The computer starts each student with $10,000, and allows him to buy and/or sell shares. Precautionary tests are included for the student who tries to purchase more shares than he has money for, or to sell more shares than he actually owns. The program continues for as many trading days as the student desires.

The stock values rise and fall on a semi-random basis. On each trading day all stocks undergo a small random price change, a trend change (based on a random trend), and the possibility--on a random basis--of a large price change. The structure of the formula is:

new price=old price + (trend x old price) + (small random price change) + (possible large price change)

405

The trend is a random number between -.1 and +.1. It remains constant for a random number of days, at which time the trend is changed randomly. The trend affects all stocks equally, and attempts to simulate general market trends. The small random change ranges between -3 and +3 points. It occurs every day to every stock. The possible large price change is either +10 or -10 points. The + and - changes each occur at random day intervals, and to random stocks. That is, there may be no large change on some trading days, only a +10 change on others, a -10 change on still others, and both large and small changes on others. In all large-change cases, the change affects only one random stock when it occurs.

Because of the random generation of stock values and their fluctuations, the program does not exactly simulate the real market. It does, however, provide a simplified view of what does happen, and familiarizes the student with the basic functions involved. This should be explained to the students, along with some real causes of stock-market fluctuations.

Graph paper might be used to plot the daily stock values and the exchange average. In this way, the trend will become evident.

```
                    THE STOCK MARKET
DO YOU WANT THE INSTRUCTIONS (YES-TYPE 1, NO-TYPE 0)? 1

THIS PROGRAM PLAYS THE STOCK MARKET.  YOU WILL BE GIVEN
$10,000 AND MAY BUY OR SELL STOCKS.  THE STOCK PRICES WILL
BE GENERATED RANDOMLY AND THEREFORE THIS MODEL DOES NOT
REPRESENT EXACTLY WHAT HAPPENS ON THE EXCHANGE.  A TABLE
OF AVAILABLE STOCKS, THEIR PRICES, AND THE NUMBER OF SHARES
IN YOUR PORTFOLIO WILL BE PRINTED.  FOLLOWING THIS, THE
INITIALS OF EACH STOCK WILL BE PRINTED WITH A QUESTION
MARK.  HERE YOU INDICATE A TRANSACTION.  TO BUY A STOCK
TYPE +NNN, TO SELL A STOCK TYPE -NNN, WHERE NNN IS THE
NUMBER OF SHARES.  A BROKERAGE FEE OF 1% WILL BE CHARGED
ON ALL TRANSACTIONS.  NOTE THAT IF A STOCK'S VALUE DROPS
TO ZERO IT MAY REBOUND TO A POSITIVE VALUE AGAIN.  YOU
HAVE $10,000 TO INVEST.  USE INTEGERS FOR ALL YOUR INPUTS.
(NOTE:  TO GET A 'FEEL' FOR THE MARKET RUN FOR AT LEAST
10 DAYS)
-----GOOD LUCK!-----

STOCK                           INITIALS      PRICE/SHARE
INT. BALLISTIC MISSILES           IBM           85.75
RED CROSS OF AMERICA              RCA           85.5
LICHTENSTEIN, BUMRAP & JOKE       LBJ           155.25
AMERICAN BANKRUPT CO.             ABC           138
CENSURED BOOKS STORE              CBS           104.25

NEW YORK STOCK EXCHANGE AVERAGE:  113.75

TOTAL STOCK ASSETS ARE      $ 0
TOTAL CASH ASSETS ARE       $ 10000
TOTAL ASSETS ARE            $ 10000

WHAT IS YOUR TRANSACTION IN
IBM? 8
RCA? 3
LBJ? 1
ABC? 1
CBS? 1

**********  END OF DAY'S TRADING

STOCK          PRICE/SHARE    HOLDINGS     VALUE       NET PRICE CHANGE
IBM             96.5           8           193          10.75
RCA             81             3           243          -4.5
LBJ             153.5          1           153.5        -1.75
ABC             135.5          1           135.5        -2.5
CBS             99             1           99           -5.25

NEW YORK STOCK EXCHANGE AVERAGE:  113.1     NET CHANGE: -.65

TOTAL STOCK ASSETS ARE      $ 824
TOTAL CASH ASSETS ARE       $ 9166.25
TOTAL ASSETS ARE            $ 9990.25

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 5
RCA? 1
LBJ? 1
ABC? 1
CBS? 0
```

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	98.75	7	691.25	2.25
RCA	82.5	4	330	1.5
LBJ	154	2	308	.5
ABC	133.5	2	267	-2
CBS	102.75	1	102.75	3.75

NEW YORK STOCK EXCHANGE AVERAGE: 114.3 NET CHANGE: 1.2

TOTAL STOCK ASSETS ARE $ 1699
TOTAL CASH ASSETS ARE $ 8305.23
TOTAL ASSETS ARE $ 10004.23

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 3
RCA? 2
LBJ? 5
ABC? -1
CBS? 3

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	99.25	10	992.5	.5
RCA	82.25	6	493.5	-.25
LBJ	154.75	7	1083.25	.75
ABC	133.5	1	133.5	0
CBS	103.25	4	413	.5

NEW YORK STOCK EXCHANGE AVERAGE: 114.6 NET CHANGE: .3

TOTAL STOCK ASSETS ARE $ 3115.75
TOTAL CASH ASSETS ARE $ 6882.5
TOTAL ASSETS ARE $ 9998.25

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 5

RCA? 3
LBJ? 5
ABC? 3
CBS? 4

********** END OF DAY'S TRADING

STOCK	PRICE/SHARE	HOLDINGS	VALUE	NET PRICE CHANGE
IBM	96.75	15	1451.25	-2.5
RCA	80.5	9	724.5	-1.75
LBJ	150	12	1800	-4.75
ABC	132	4	528	-1.5
CBS	98.75	8	790	-4.5

NEW YORK STOCK EXCHANGE AVERAGE: 111.6 NET CHANGE: -3

TOTAL STOCK ASSETS ARE $ 5293.75
TOTAL CASH ASSETS ARE $ 4528.95
TOTAL ASSETS ARE $ 9822.7

```
DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 0
RCA? -5
LBJ? -7
ABC? 0
CBS? -5

********** END OF DAY'S TRADING

STOCK          PRICE/SHARE     HOLDINGS      VALUE         NET PRICE CHANGE
IBM             96.75           15            1451.25       0
RCA             66.75           4             267          -13.75
LBJ             150.75          5             753.75        .75
ABC             132             4             528           0
CBS             95.75           3             287.25       -3

NEW YORK STOCK EXCHANGE AVERAGE:  108.4     NET CHANGE: -3.2

TOTAL STOCK ASSETS ARE     $ 3287.25
TOTAL CASH ASSETS ARE      $ 6455.74
TOTAL ASSETS ARE           $ 9742.99

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? -10
RCA? -2
LBJ? 2
ABC? 2
CBS? 0

********** END OF DAY'S TRADING

STOCK          PRICE/SHARE     HOLDINGS      VALUE         NET PRICE CHANGE
IBM             87.5            5             437.5        -9.25
RCA             58              2             116          -8.75
LBJ             135.25          7             946.75       -15.5
ABC             122.5           6             735          -9.5
CBS             98.75           3             296.25        3

NEW YORK STOCK EXCHANGE AVERAGE:  100.4     NET CHANGE: -8

TOTAL STOCK ASSETS ARE     $ 2531.5
TOTAL CASH ASSETS ARE      $ 6974.58
TOTAL ASSETS ARE           $ 9506.08

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? -4
RCA? -1
LBJ? -6
ABC? -2
CBS? -2
```

```
********** END OF DAY'S TRADING

STOCK          PRICE/SHARE    HOLDINGS       VALUE          NET PRICE CHANGE
IBM            80             1              80             -7.5
RCA            51             1              51             -7
LBJ            181.75         1              181.75         -13.5
ABC            109.5          4              438            -13
CBS            91.5           1              91.5           -7.25

NEW YORK STOCK EXCHANGE AVERAGE: 90.75    NET CHANGE: -9.65

TOTAL STOCK ASSETS ARE    $ 782.25
TOTAL CASH ASSETS ARE     $ 8619.96
TOTAL ASSETS ARE          $ 9402.21

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 0
RCA? 0
LBJ? 0
ABC? -3
CBS? 0

********** END OF DAY'S TRADING

STOCK          PRICE/SHARE    HOLDINGS       VALUE          NET PRICE CHANGE
IBM            77.5           1              77.5           -8.5
RCA            52.25          1              52.25           1.25
LBJ            119.25         1              119.25         -2.5
ABC            107            1              107            -2.5
CBS            92.25          1              92.25           .75

NEW YORK STOCK EXCHANGE AVERAGE: 89.65    NET CHANGE: -1.1

TOTAL STOCK ASSETS ARE    $ 448.25
TOTAL CASH ASSETS ARE     $ 8945.18
TOTAL ASSETS ARE          $ 9393.43

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 0
RCA? 0
LBJ? 0
ABC? 0
CBS? 10

********** END OF DAY'S TRADING

STOCK          PRICE/SHARE    HOLDINGS       VALUE          NET PRICE CHANGE
IBM            74.5           1              74.5           -3
RCA            54             1              54              1.75
LBJ            107            1              107            -12.25
ABC            108            1              108             1
CBS            90.75          11             998.25         -1.5
```

```
NEW YORK STOCK EXCHANGE AVERAGE:  86.85     NET CHANGE: -2.8

TOTAL STOCK ASSETS ARE     $ 1341.75
TOTAL CASH ASSETS ARE      $ 8013.46
TOTAL ASSETS ARE           $ 9355.21

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 1
WHAT IS YOUR TRANSACTION IN
IBM? 5
RCA? 6
LBJ? 10
ABC? 10
CBS? 10

**********  END OF DAY'S TRADING

STOCK          PRICE/SHARE   HOLDINGS     VALUE        NET PRICE CHANGE
IBM             72            6            432          -2.5
RCA             52.5          7            367.5        -1.5
LBJ             105           11           1155         -8
ABC             103.25        11           1135.75      -4.75
CBS             91.5          21           1921.5        .75

NEW YORK STOCK EXCHANGE AVERAGE:  84.85     NET CHANGE: -2

TOTAL STOCK ASSETS ARE     $ 5011.75
TOTAL CASH ASSETS ARE      $ 4221.92
TOTAL ASSETS ARE           $ 9233.67

DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)? 0
HOPE YOU HAD FUN!!

READY
```

```
100 REM STOCK MARKET SIMULATION     -STOCK-
101 REM REVISED 8/18/70 (D. PESSEL, L. BRAUN, C. LOSIK)
102 REM IMP VRBLS: A-MRKT TRND SLP; B5-BRKRGE FEE; C-TTL CSH ASSTS;
103 REM C5-TTL CSH ASSTS (TEMP); C(I)-CHNG IN STK VAL; D-TTL ASSTS;
104 REM E1,E2-LRG CHNG MISC; I-STCK #; I1,I2-STCKS W LRG CHNG;
105 REM N1,N2-LRG CHNG DAY CNTS; P5-TTL DAYS PRCHSS; P(I)-PRTFL CNTNTS;
106 REM Q9-NEW CYCL?; S4-SGN OF A; S5-TTL DYS SLS; S(I)-VALUE/SHR;
107 REM T-TTL STCK ASSTS; T5-TTL VAL OF TRNSCTNS;
108 REM W3-LRG CHNG; X1-SMLL CHNG(<$1); Z4,Z5,Z6-NYSE AVE.; Z(I)-TRNSCTN
109  PRINT TAB(20);"THE STOCK MARKET"
110  DIM S(5),P(5),Z(5),C(5)
112 REM SLOPE OF MARKET TREND:A  (SAME FOR ALL STOCKS)
113  RANDOMIZE
114  LET A=INT((RND(X)/10)*100+.5)/100
115  LET T5=0
116  LET X9=0
117  LET N1=0
118  LET N2=0
119  LET E1=0
120  LET E2=0
121 REM INTRODUCTION
122  PRINT "DO YOU WANT THE INSTRUCTIONS (YES-TYPE 1, NO-TYPE 0)";
123  INPUT Z9
124  PRINT
125  PRINT
126  IF Z9<1 THEN 200
130  PRINT "THIS PROGRAM PLAYS THE STOCK MARKET.  YOU WILL BE GIVEN"
132  PRINT "$10,000 AND MAY BUY OR SELL STOCKS.  THE STOCK PRICES WILL"
134  PRINT "BE GENERATED RANDOMLY AND THEREFORE THIS MODEL DOES NOT"
135  PRINT "REPRESENT EXACTLY WHAT HAPPENS ON THE EXCHANGE.  A TABLE"
136  PRINT "OF AVAILABLE STOCKS, THEIR PRICES, AND THE NUMBER OF SHARES"
137  PRINT "IN YOUR PORTFOLIO WILL BE PRINTED.  FOLLOWING THIS, THE"
138  PRINT "INITIALS OF EACH STOCK WILL BE PRINTED WITH A QUESTION"
139  PRINT "MARK.  HERE YOU INDICATE A TRANSACTION.  TO BUY A STOCK"
140  PRINT "TYPE +NNN, TO SELL A STOCK TYPE -NNN, WHERE NNN IS THE"
141  PRINT "NUMBER OF SHARES.  A BROKERAGE FEE OF 1% WILL BE CHARGED"
142  PRINT "ON ALL TRANSACTIONS.  NOTE THAT IF A STOCK'S VALUE DROPS"
143  PRINT "TO ZERO IT MAY REBOUND TO A POSITIVE VALUE AGAIN.  YOU"
144  PRINT "HAVE $10,000 TO INVEST.  USE INTEGERS FOR ALL YOUR INPUTS."
145  PRINT "(NOTE:  TO GET A 'FEEL' FOR THE MARKET RUN FOR AT LEAST"
146  PRINT "10 DAYS)"
147  PRINT "-----GOOD LUCK!-----"
200 REM GENERATION OF STOCK TABLE; INPUT REQUESTS
210 REM INITIAL STOCK VALUES
220  LET S(1)=100
230  LET S(2)=85
240  LET S(3)=150
250  LET S(4)=140
```

```
260  LET S(5)=110
265 REM INITIAL T8 - # DAYS FOR FIRST TREND SLOPE (A)
266  LET T8=INT(4.99*RND(X)+1)
267 REM RANDOMIZE SIGN OF FIRST TREND SLOPE (A)
268  IF RND(X)>.5 THEN 270
269  LET A=-A
270 REM RANDOMIZE INITIAL VALUES
280  GOSUB 830
285 REM INITIAL PORTFOLIO CONTENTS
290  FOR I=1 TO 5
300  LET P(I)=0
305  LET Z(I)=0
310  NEXT I
320  PRINT
330  PRINT
333 REM INITIALIZE CASH ASSETS:C
335  LET C=10000
338 REM PRINT INITIAL PORTFOLIO
340  PRINT "STOCK"," ","INITIALS","PRICE/SHARE"
350  PRINT "INT. BALLISTIC MISSILES","  IBM",S(1)
352  PRINT "RED CROSS OF AMERICA","  RCA",S(2)
354  PRINT "LICHTENSTEIN, BUMRAP & JOKE","  LBJ",S(3)
356  PRINT "AMERICAN BANKRUPT CO.","  ABC",S(4)
358  PRINT "CENSURED BOOKS STORE","  CBS",S(5)
360  PRINT
361 REM NYSE AVERAGE:Z5; TEMP. VALUE:Z4; NET CHANGE:Z6
363  LET Z4=Z5
364  LET Z5=0
365  LET T=0
370  FOR I=1 TO 5
375  LET Z5=Z5+S(I)
380  LET T=T+S(I)*P(I)
390  NEXT I
391  LET Z5=INT(100*(Z5/5)+.5)/100
392  LET Z6=INT((Z5-Z4)*100+.5)/100
393 REM TOTAL ASSETS:D
394  LET D=T+C
395  IF X9>0 THEN 398
396  PRINT "NEW YORK STOCK EXCHANGE AVERAGE: "Z5
397  GO TO 399
398  PRINT "NEW YORK STOCK EXCHANGE AVERAGE: "Z5"   NET CHANGE: "Z6
399  PRINT
400  LET T=INT(100*T+.5)/100
401  PRINT "TOTAL STOCK ASSETS ARE   $";T
403  LET C=INT(100*C+.5)/100
405  PRINT "TOTAL CASH ASSETS ARE    $";C
407  LET D=INT(100*D+.5)/100
408  PRINT "TOTAL ASSETS ARE         $";D
410  PRINT
411  IF X9=0 THEN 416
```

```
412  PRINT "DO YOU WISH TO CONTINUE (YES-TYPE 1, NO-TYPE 0)";
413  INPUT Q9
414  IF Q9<1 THEN 996
416 REM INPUT TRANSACTIONS
420  PRINT "WHAT IS YOUR TRANSACTION IN"
430  PRINT "IBM";
440  INPUT Z(1)
450  PRINT "RCA";
460  INPUT Z(2)
470  PRINT "LBJ";
480  INPUT Z(3)
490  PRINT "ABC";
500  INPUT Z(4)
510  PRINT "CBS";
520  INPUT Z(5)
525  PRINT
530 REM TOTAL DAY'S PURCHASES IN $:P5
540  LET P5=0
550 REM TOTAL DAY'S SALES IN $:S5
560  LET S5=0
570  FOR I=1 TO 5
575  LET Z(I)=INT(Z(I)+.5)
580  IF Z(I)<=0 THEN 610
590  LET P5=P5+Z(I)*S(I)
600  GO TO 620
610  LET S5=S5-Z(I)*S(I)
612  IF -Z(I)<=P(I) THEN 620
614  PRINT "YOU HAVE OVERSOLD A STOCK; TRY AGAIN."
616  GO TO 420
620  NEXT I
622 REM TOTAL VALUE OF TRANSACTIONS:T5
625  LET T5=P5+S5
630 REM BROKERAGE FEE:B5
640  LET B5=INT(.01*T5*100+.5)/100
650 REM CASH ASSETS=OLD CASH ASSETS-TOTAL PURCHASES
652 REM -BROKERAGE FEES+TOTAL SALES:C5
654  LET C5=C-P5-B5+S5
656  IF C5>=0 THEN 674
658 PRINT "YOU HAVE USED $"-C5" MOR
E THEN YOU HAVE."
660 GO TO 420
674  LET C=C5
675 REM CALCULATE NEW PORTFOLIO
680  FOR I=1 TO 5
690  LET P(I)=P(I)+Z(I)
700  NEXT I
710 REM CALCULATE NEW STOCK VALUES
720  GOSUB 830
750 REM PRINT PORTFOLIO
```

```
751 REM BELL RINGING-DIFFERENT ON MANY COMPUTERS
752  FOR I=1 TO 20
753  PRINT CHR$(135);
754  NEXT I
755  PRINT
756  PRINT "**********  END OF DAY'S TRADING"
757  PRINT
758  PRINT
759  IF X9<1 THEN 769
769  PRINT "STOCK","PRICE/SHARE","HOLDINGS","VALUE","NET PRICE CHANGE"
770  PRINT "IBM", S(1), P(1), S(1)*P(1), C(1)
771  PRINT "RCA", S(2), P(2), S(2)*P(2), C(2)
772  PRINT "LBJ", S(3), P(3), S(3)*P(3), C(3)
773  PRINT "ABC", S(4), P(4), S(4)*P(4), C(4)
774  PRINT "CBS", S(5), P(5), S(5)*P(5), C(5)
775  LET X9=1
780  PRINT
790  PRINT
810  GO TO 360
829 REM NEW STOCK VALUES - SUBROUTINE
830 REM RANDOMLY PRODUCE NEW STOCK VALUES BASED ON PREVIOUS
831 REM DAY'S VALUES
832 REM N1,N2 ARE RANDOM NUMBERS OF DAYS WHICH RESPECTIVELY
833 REM DETERMINE WHEN STOCK I1 WILL INCREASE 10 PTS. AND STOCK
834 REM I2 WILL DECREASE 10 PTS.
840 REM IF N1 DAYS HAVE PASSED, PICK AN I1, SET E1, DETERMINE NEW N1
841  IF N1>0 THEN 850
845  LET I1=INT(4.99*RND(X)+1)
846  LET N1=INT(4.99*RND(X)+1)
847  LET E1=1
850 REM IF N2 DAYS HAVE PASSED, PICK AN I2, SET E2, DETERMINE NEW N2
851  IF N2>0 THEN 860
855  LET I2=INT(4.99*RND(X)+1)
856  LET N2=INT(4.99*RND(X)+1)
857  LET E2=1
860 REM DEDUCT ONE DAY FROM N1 AND N2
861  LET N1=N1-1
862  LET N2=N2-1
890 REM LOOP THROUGH ALL STOCKS
900  FOR I=1 TO 5
910  LET X1=RND(X)
915  IF X1>.25 THEN 920
916  LET X1=.25
917  GO TO 935
920  IF X1>.50 THEN 925
921  LET X1=.50
922  GO TO 935
925  IF X1>.75 THEN 930
926  LET X1=.75
927  GO TO 935
```

```
930  LET X1=0.0
931 REM BIG CHANGE CONSTANT:W3  (SET TO ZERO INITIALLY)
935  LET W3=0
936  IF E1<1 THEN 945
937  IF INT(I1+.5)<>INT(I+.5) THEN 945
938 REM ADD 10 PTS. TO THIS STOCK;  RESET E1
939  LET W3=10
943  LET E1=0
945  IF E2<1 THEN 955
947  IF INT(I2+.5)<>INT(I+.5) THEN 955
948 REM SUBTRACT 10 PTS. FROM THIS STOCK;  RESET E2
949  LET W3=W3-10
953  LET E2=0
954 REM C(I) IS CHANGE IN STOCK VALUE
955  LET C(I)=INT(A*S(I))+X1+INT(3-6*RND(X)+.5)+W3
956  LET C(I)=INT(100*C(I)+.5)/100
957  LET S(I)=S(I)+C(I)
960  IF S(I)>0 THEN 967
964  LET C(I)=0
965  LET S(I)=0
966  GO TO 970
967  LET S(I)=INT(100*S(I)+.5)/100
970  NEXT I
972 REM AFTER T8 DAYS RANDOMLY CHANGE TREND SIGN AND SLOPE
973  LET T8=T8-1
974  IF T8<1 THEN 985
980  RETURN
985 REM RANDOMLY CHANGE TREND SIGN AND SLOPE (A), AND DURATION OF
986 REM OF TREND (T8)
990  LET T8=INT(4.99*RND(X)+1)
992  LET A=INT((RND(X)/10)*100+.5)/100
993  LET S4=RND(X)
994  IF S4<=.5 THEN 997
995  LET A=-A
997  RETURN
998  PRINT "HOPE YOU HAD FUN!!"
999  END
```

HUNTINGTON COMPUTER PROJECT

A TEACHER'S MANUAL

(COMPUTER - RELATED MATERIALS)

Second Edition

January 31, 1971

Director: Dr. Ludwig Braun
Assistant Director: Dr. Marian Visich, Jr.

Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

Developed by the Huntington Computer Project during the period May, 1968 and September, 1970. This effort was supported by the National Science Foundation under Grant No. J000079.

The enclosed material is a compilation of computer programs developed during the period May, 1968 to September, 1970. These programs were developed by teachers and students in the high schools which participated with us, and by the Project staff.

All of the enclosed programs have been tested on a Digital Equipment Corporation TSS-8 time-shared computer during the summer of 1970. To the best of our ability, we have assured ourselves that the programs actually run. It should be pointed out, however, that we were not able to make an exhaustive exploration of the programs. There may be undiscovered bugs (if there aren't, it may be the first time in the history of computing). We would appreciate hearing of any which emerge in the future.

These programs run in the version of BASIC which existed on the TSS-8 in August, 1970, and should run on most other versions of BASIC. The major potential problem on other machines is the output format (DEC uses 14 columns per print zone, while some other manufacturers use 15; we used the TAB function, which doesn't exist in all BASIC compiles). It may be necessary to make some minor changes in programs to adjust this format. Another possible problem is in the use of the RANDOMIZE command in some programs to start the random-number generator at a random point. If this command is not available, some other means should be devised for randomizing the start.

It is our sincere hope that these programs and their supporting documentation will be helpful to educators who are exploring the uses of computers in education.

We are anxious to hear of any bugs, errors, or improvements in these programs, and are especially anxious to hear of any novel ways of using them.

Ludwig Braun
Marian Visich, Jr.

TABLE OF CONTENTS

Volume I

Volume II

CHEMISTRY

Volume III

MATHEMATICS

Volume IV

PHYSICS

Volume V

SOCIAL STUDIES

Volume VI

TEACHER ASSISTANCE

DESCRIPTION:

This program will average any number of grades. A passing grade must be inputed by the teacher, and the computer will list the numerical value of the curve and the respective adjusted grades.

```
600 DATA 65,78,76,48,65,78,82,69,71,56,90,67,59,60,70,74,62,57,66
601 DATA 64,63,65,59,60,56,48,66
RUN

PASSING GRADE FOR THIS TEST IS ? 70

THE AVERAGE OF ALL GRADES ENTERED IS 65.7037 .

THE AVERAGE FALLS BELOW THE PASSING GRADE BY 4  POINTS.
(ROUNDED TO NEAREST WHOLE NUMBER.)

ADJUSTED GRADE = ORIGINAL GRADE + 4

STUDENT          ORIGINAL         ADJUSTED
NUMBER            GRADE            GRADE
=======          ========         ========
 1                 65               69
 2                 78               82
 3                 76               80
 4                 48               52
 5                 65               69
 6                 78               82
 7                 82               86
 8                 69               73
 9                 71               75
 10                56               60
 11                90               94
 12                67               71
 13                59               63
 14                60               64
 15                70               74
 16                74               78
 17                62               66
 18                57               61
 19                66               70
 20                64               68
 21                63               67
 22                65               69
 23                59               63
 24                60               64
 25                56               60
 26                48               52
 27                66               70

READY
```

```
100REM COURT, G.M., WALT WHITMAN H.S., REVISED 8/69
105 REM  REVISED BY C.LOSIK  8-26-70
110REM
120REM PROGRAM AVERAGES ANY NUMBER OF GRADES. FOR CURVING PURPOSES
130REM YOU ARE ASKED FOR A PASSING GRADE. IF THE AVERAGE FALLS BELOW
140REM THAT THE DIFFERENCE WILL BE PRINTED OUT AS WELL AS NEWLY CAL-
150REM CULATED GRADES FOR EACH STUDENT. REMEMBER THAT THIS TYPE OF
160REM CURVING IS VALID ONLY IF THE ORIGINAL GRADE DISTRIBUTION
170REM SHOWED A BELL CURVE.
180REM
190REM ENTER GRADES ON DATA LINES 600-700.
200REM
220READX
230IFX=9999THEN260
240LETN=N+1
250GOTO220
260RESTORE
270LETG=0
280PRINT"PASSING GRADE FOR THIS TEST IS ";
290INPUTP
300FORT=1TON
310READA
320LETG=G+A
330NEXTT
340 LET M=G/N
350PRINT
360PRINT"THE AVERAGE OF ALL GRADES ENTERED IS"M"."
365 LET D=0
370IFM>=PTHEN410
380PRINT
390LETD=INT(P-M+.5)
400PRINT"THE AVERAGE FALLS BELOW THE PASSING GRADE BY"D" POINTS."
405 PRINT "(ROUNDED TO NEAREST WHOLE NUMBER.)"
410RESTORE
415 PRINT
417 PRINT "ADJUSTED GRADE = ORIGINAL GRADE +"D
420PRINT
430PRINT"STUDENT","ORIGINAL","ADJUSTED"
440PRINT"NUMBER"," GRADE"," GRADE"
450PRINT"=======","========","========"
460FORX=1TON
470READA
490 PRINT X,A,A+D
500NEXTX
600 DATA 65,78,76,48,65,78,82,69,71,56,90,67,59,60,70,74,62,57,66
601 DATA 64,63,65,59,60,56,48,66
701DATA9999
999END
```

428

DESCRIPTION:

This program will sort and average from 3 to 10 grades. for up to 35 students.

Data is entered in lines 600–609. The data are entered in order of student number for the first test. followed by the grades for the second test in order of student number, followed by the grades on the third test in order of student number, etc.

The program prints a table listing the grades for each student and his average.

```
600 DATA 0,70,72,59,66,70,75,100,77,65
601 DATA 50,65,70,68,70,75,70,65,70,70
602 DATA 75,80,85,90,95,85,85,90,92,87
603 DATA 65,70,75,85,87,77,86,90,75,64
604 DATA 65,70,75,90,85,71,78,89,85,75
605 DATA 75,80,80,80,85,75,90,89,78,67
606 DATA 75,70,80,55,59,67,78,54,76,34
607 DATA 75,75,68,90,95,87,54,67,86,78
608 DATA 80,90,55,75,64,66,86,90,98,78
609 DATA 55,69,78,90,0,0,76,97,58,75

READY

RUN

NUMBER OF STUDENTS IN CLASS IS --- ? 10
NUMBER OF GRADES TO BE AVERAGED IS --- ? 10
```

STUD. GRADES
NO. (LAST COLUMN LISTS AVERAGES)

1	0	50	75	65	65	75	75	75	80	55	68.3
2	70	65	80	70	70	80	70	75	90	69	73.9
3	72	70	85	75	75	80	80	68	55	78	73.8
4	59	68	90	85	90	80	55	90	75	90	78.2
5	66	70	95	87	85	85	59	95	64	0	78.4
6	70	75	85	77	71	75	67	87	66	0	74.8
7	75	70	85	86	78	90	78	54	86	76	77.8
8	100	65	90	90	89	89	54	67	90	97	83.1
9	77	70	92	75	85	78	76	86	98	58	79.5
10	65	70	87	64	75	67	34	78	78	75	69.3

READY

```
100REM PEREZ-COURT, WALT WHITMAN H.S., 7/69
110 REM REVISED 10/70 BY DAVID SOBIN - POLYTECH
120REM
130REM PROGRAM SORTS AND AVERAGES FROM 3 TO 10 GRADES FOR UP TO 35
140REM STUDENTS. THEY ARE THEN PRINTED OUT. THE GRADES MAY BE FROM
150REM TESTS OR QUARTERLY AVERAGES.
160REM
170 REM  NOTE: THE NUMBER OF GRADES PER STUDENT TIMES THE NUMBER
180 REM OF STUDENTS MUST NOT EXCEED 295.
190 REM
200REM THE GRADES ARE ENTERED IN THE SAME ORDER FOR EACH TEST OR
210REM QUARTER, FROM STUDENT NUMBER ONE TO THE LAST IN THE CLASS. THE
220REM PROGRAM WILL SORT OUT AND AVERAGE THE GRADES FOR EACH STUDENT
230REM SEPARATELY. IF A GRADE IS MISSING FOR ANY STUDENT, A ZERO MUST
240REM BE ENTERED. THESE WILL NOT BE AVERAGED IN. IF YOU WANT TO AVERAGE
250REM IN A ZERO AS A GRADE, ENTER A GRADE OF 1 INSTEAD. IT WILL NOT
260REM AFFECT THE AVERAGE SIGNIFICANTLY.
270REM
280REM REMEMBER TO ENTER THE SAME NUMBER OF GRADES FOR EACH STUDENT IN
290REM THE ORDER PRESCRIBED ABOVE. IF THIS IS NOT DONE, THE GRADES
300REM AND AVERAGES WHICH ARE PRINTED OUT WILL NOT BE CORRECT.
310REM
320PRINT" NUMBER OF STUDENTS IN CLASS IS --- ";
330 INPUT N
340 PRINT "NUMBER OF GRADES TO BE AVERAGED IS --- ";
350 INPUT G
360 FOR I=1 TO N*G
370 READ X
380 IF X=9999 THEN 1020
390 NEXT I
400 READ X
410 IF X<>9999 THEN 1020
420 PRINT
430 PRINT
440 PRINT
450 PRINT "STUD.","                GRADES"
460 PRINT " NO.            (LAST COLUMN LISTS AVERAGES)"
470 RESTORE
480 FOR I=1 TO  N
490 PRINT I;
500 GOSUB 850
510 LET S=0
520 LET Z=0
530 IF I=1 THEN 570
540 FOR J=1 TO I-1
550 READ X
560 NEXT J
570 FOR K=1 TO G
580 READ X
```


430

```
590 IF X<>0 THEN 720
600 DATA 0,70,72,59,66,70,75,100,77,65
601 DATA 50,65,70,68,70,75,70,65,70,70
602 DATA 75,80,85,90,95,85,85,90,92,87
603 DATA 65,70,75,85,87,77,86,90,75,64
604 DATA 65,70,75,90,85,71,78,89,85,75
605 DATA 75,80,80,80,85,75,90,89,78,67
606 DATA 75,70,80,55,59,67,78,54,76,34
607 DATA 75,75,68,90,95,87,54,67,86,78
608 DATA 80,90,55,75,64,66,86,90,98,78
609 DATA 55,69,78,90,0,0,76,97,58,75
700 DATA 9999
710 LET Z=Z+1
720 LET S=S+X
730 PRINT X;
740 GOSUB 900
750 IF K=G THEN 790
760 FOR L=1 TO N-1
770 READ X
780 NEXT L
790 NEXT K
800 LET S=S/(G-Z)
810 PRINT INT(10*S+.5)/10
820 RESTORE
830 NEXT I
840 STOP
850 IF I<10 THEN 880
860 GOSUB 990
870 RETURN
880 GOSUB 980
890 RETURN
900 IF X<10 THEN 940
910 IF X<100 THEN 960
930 RETURN
940 GOSUB 980
950 RETURN
960 GOSUB 990
970 RETURN
980 PRINT " ";
990 PRINT" ";
1010 RETURN
1020 PRINT "CHECK YOUR DATA LINES. YOUR ENTRIES DO NOT SHOW"
1030 PRINT "THE SAME NUMBER OF GRADES FOR EACH STUDENT."
1040 END
```

DESCRIPTION:

This program prints a frequency distribution (bar graphs) of grades, for a single test for one or more classes, or for several tests for one student.

```
600 DATA 25,30,35,40,45,50,55,60,65,70,75,80,85,90,95,100
601 DATA 35,40,45,50,55,60,65,70,75,80,85,90,95
602 DATA 50,55,60,65,70,75,80,85,90
603 DATA 55,60,65,70,75,80,85
604 DATA 60,65,70,75,80,85
605 DATA 65,70,75,80
606 DATA 65,70,75,80
607 DATA 70,75

READY

RUN

          GRADE FREQUENCY DISTRIBUTION (BAR GRAPH)
          ----------------------------------------

GRADE            1   5    10   15   20   25   30
-----            I+---+----+----+----+----+----+
 0               I
 5               I
 10              I
 15              I
 20              I
 25              IX
 30              IX
 35              IXX
 40              IXX
 45              IXX
 50              IXXX
 55              IXXXX
 60              IXXXXX
 65              IXXXXXXX
 70              IXXXXXXXX
 75              IXXXXXXXX
 80              IXXXXXXX
 85              IXXXXX
 90              IXXX
 95              IXX
 100             IX

READY
```

```
100REM PEREZ, WALT WHITMAN H.S., REVISED 7/69
105 REM  REVISED BY C.LOSIK  8-26-70
110REM
120REM THIS PROGRAM PRINTS A FREQUENCY DISTRIBUTION OF GRADES.
130REM ENTRIES ARE ROUNDED OFF TO THE NEAREST 5 AND INDICATED ON A
140REM BAR GRAPH. IT MAY BE USED FOR A SINGLE TEST FOR ONE OR MORE
150REM CLASSES OR FOR SEVERAL TESTS FOR ONE STUDENT. THE PROGRAM IS
160REM SET TO ACCEPT UP TO 150 GRADES. LINES 600-700 ARE SET ASIDE
170REM FOR DATA ENTRIES. THEY MAY BE ENTERED IN ANY SEQUENCE.
180REM
190PRINT"          GRADE FREQUENCY DISTRIBUTION (BAR GRAPH)"
200PRINT"          ----------------------------------------"
210PRINT
220PRINT"GRADE"," 1   5   10   15   20   25   30"
230PRINT"-----","I+---+----+----+----+----+----+"
240 DIM F(150),P(100)
250READF
260IFF=9999THEN290
270LETN=N+1
280GOTO250
290RESTORE
292 IF N<=150 THEN 300
294 PRINT "RE-DIMENSION LINE 240.  DELETE LINES 292,294,296."
296 STOP
300FORI=1TON
310READF(I)
320LETF(I)=5*INT(F(I)/5+.5)
330NEXTI
340FORI=1TON
350FORP=0TO100STEP5
360IFP=F(I)THEN380
370NEXTP
380LETP(P)=P(P)+1
390NEXTI
400PRINT" 0","I"
410FORP=5TO100STEP5
420PRINTP,"I";
430IFP(P)>=1THEN460
440 PRINT " "
450GOTO500
460FORL=1TOP(P)
470PRINT"X";
480NEXTL
490 PRINT " "
500NEXTP
600REM BEGIN DATA ENTRIES HERE. TYPE - 600 DATA 1,2,3, ETC.
701DATA9999
999END
```

DESCRIPTION:

This program is useful in determining the grade of an examination consisting of several examples. By inputing the number of incorrect answers, the corresponding grade in percent and the number of correct answers.

NUMBER OF QUESTIONS IN THIS TEST IS ? 15

NUMBER WRONG	GRADE	NUMBER RIGHT
0	100	15
1	93	14
2	87	13
3	80	12
4	73	11
5	67	10
6	60	9
7	53	8
8	47	7
9	40	6
10	33	5
11	27	4
12	20	3
13	13	2
14	7	1
15	0	0

```
100REM PEREZ-COURT, WALT WHITMAN H.S., REVISED 8/69
105 REM  REVISED BY C.LOSIK  8-26-70
110REM
120REM THIS PROGRAM PRINTS OUT THE GRADES OF STUDENTS, IN PERCENTAGES,
130REM NEXT TO THE NUMBER OF QUESTIONS MISSED ON A TEST AND THE
140REM NUMBER ANSWERED CORRECTLY. WHEN THE QUESTION MARK APPEARS , TYPE
150REM IN THE NUMBER OF QUESTIONS ON THE TEST AND HIT THE RETURN KEY.
160REM
170PRINT"NUMBER OF QUESTIONS IN THIS TEST IS ";
180INPUTA
190PRINT
200PRINT"NUMBER                         NUMBER"
210PRINT"WRONG          GRADE           RIGHT"
220PRINT"------         -----           ------"
230FORX=0TOA
240LETZ=Z+1
250LETG=INT((100-(X*100/A))+.5)
260IFG<0THEN330
270PRINTX,G,(A-X)
280IFZ=5THEN300
290NEXTX
295 GO TO 330
300PRINT"................................."
310LETZ=0
320GOTO290
330END
```

DESCRIPTION:

This program counts and prints the number of times questions are missed on a test.

```
600 DATA 1,2,3,4,5,2,3,5,6,7,8,9,10,7,8,9,11,13,14,15,10,13,15,10
RUN

                ITEM ANALYSIS
                -------------

NUMBER OF QUESTIONS IN THE TEST IS? 15

QUESTION           NUMBER OF TIMES MISSED
--------           ----------------------
   1                      1
   2                      2
   3                      2
   4                      1
   5                      2
   6                      1
   7                      2
   8                      2
   9                      2
  10                      3
  11                      1
  12                      0
  13                      2
  14                      1
  15                      2

READY
```

```
100REM PEREZ-COURT, WALT WHITMAN H.S., REVISED 7/69
105 REM  REVISED BY C.LOSIK  8-26-70
110REM
120REM PROGRAM COUNTS AND PRINTS NUMBER OF TIMES QUESTIONS ARE MISSED ON
130REM A TEST. THE NUMBERS OF THE QUESTIONS MISSED ARE ENTERED ON DATA
140REM LINES 600-700. UP TO 200 ITEMS MAY BE ENTERED IN ANY ORDER.
150REM YOU MIGHT , FOR EXAMPLE, FEED IN THE NUMBERS OF THE QUESTIONS
160REM MISSED BY ONE STUDENT, GO ON TO THE NEXT STUDENT, ETC., UNTIL ALL
170REM QUESTIONS MISSED BY A CLASS OR ALL CLASSES HAVE BEEN ENTERED.
180REM
185 REM
190 PRINT " ","ITEM ANALYSIS"
200 PRINT " ","-------------"
205 PRINT
210DIMP(200)
220READX
230IFX=9999THEN260
240LETN=N+1
250GOTO220
260RESTORE
262 IF N<=200 THEN 268
264 PRINT "RE-DIMENSION THE ARRAY. DELETE LINES 262,264,266."
266 STOP
268 PRINT "NUMBER OF QUESTIONS IN THE TEST IS";
270INPUTQ
272 PRINT
274 PRINT "QUESTION","     NUMBER OF TIMES MISSED"
276 PRINT "--------","     ---------------------"
280FORI=1TON
290READX
300FORP=1TOQ
310IFP=XTHEN330
320NEXTP
330LETP(P)=P(P)+1
340NEXTI
350FORP=1TOQ
360 PRINT "  "P," ",P(P)
390NEXTP
600 DATA 1,2,3,4,5,2,3,5,6,7,8,9,10,7,8,9,11,13,14,15,10,13,15,10
701DATA9999
999END
```

11

DESCRIPTION:

This program will sum item analysis for up to five classes. Question numbers and number of students missing will each be printed out, as well as a validity based on between 30 and 70 percent of the students answering that question correctly.

```
600 DATA 1,5,3,6,2,1,5,3,8,4,3,6,10,13,5
601 DATA 3,5,2,4,2,2,7,5,10,4,3,4,12,14,3
602 DAA+TA 0,3,2,5,0,2,5,5,10,1,2,9,14,14,1
603 DATA 2,2,1,3,1,0,4,4,6,3,1,6,10,11,1
RUN

        08-15-69

                    CUMULATIVE ITEM ANALYSIS
                    ------------------------

NUMBER OF QUESTIONS IN TEST IS ---?15
NUMBER OF CLASSES ENTERED IS ---?4
NUMBER OF STUDENTS TAKING TEST IS ---?60

* VALID=BETWEEN 30 AND 70 PER CENT ANSWERED QUESTION CORRECTLY

QUESTIONS                   CLASSES
---------                   -------
              1     2     3     4     5     TOTAL MISSED
              ------------------------------------------
 1            1     3     0     2           6
 2            5     5     3     2           15
 3            3     2     2     1           8
 4            6     4     5     3           18    * VALID
 5            2     2     0     1           5
 6            1     2     2     0           5
 7            5     7     5     4           21    * VALID
 8            3     5     5     4           17
 9            8     10    10    6           34    * VALID
 10           4     4     1     3           12
 11           3     3     2     1           9
 12           6     4     9     6           25    * VALID
 13           10    12    14    10          46
 14           13    14    14    11          52
 15           5     3     1     1           10

READY
```

```
100REM COURT, G.M., WALT WHITMAN H.S., REVISED 8/69
110REM
120REM PROGRAM SUMS ITEM ANALYSES FOR UP TO 5 CLASSES. QUESTION
130REM NUMBERS AND NUMBER OF STUDENTS MISSING EACH WILL BE PRINTED OUT
140REM AS WELL AS A VALIDITY BASED ON BETWEEN 30 AND 70 PERCENT OF THE
150REM STUDENTS ANSWERING THAT QUESTION CORRECTLY. THIS MAY BE BY-PASSED
160REM BY TYPING IN 999 FOR NUMBER OF STUDENTS TAKING TEST.
170REM
180REM
190REM DATA LINES 600-700 HAVE BEEN SET ASIDE FOR ENTRIES. A NUMBER
200REM MUST BE ENTERED FOR EACH QUESTION, IN SEQUENCE, FOR EACH CLASS.
210REM IF NO STUDENT MISSED A PARTICULAR QUESTION, ENTER 0 (ZERO). IT
220REM WOULD BE WISE TO BEGIN ENTRIES OF A NEW CLASS ON A NEW DATA
230REM LINE FOR EASIER VERIFICATION SHOULD AN ERROR OCCUR.
240REM
250DIMA(50),B(50),C(50),D(50),E(50)
260LETS=0
270PRINT"                    CUMULATIVE ITEM ANALYSIS"
280PRINT"                    ------------------------"
290PRINT
300PRINT"NUMBER OF QUESTIONS IN TEST IS ---";
310INPUTQ
320PRINT"NUMBER OF CLASSES ENTERED IS ---";
330INPUTN
340IFN<1THEN790
350IFN>5THEN790
360PRINT"NUMBER OF STUDENTS TAKING TEST IS ---";
370INPUTR
380READX
390IFX=9999THEN420
400LETS=S+1
410GOTO380
420RESTORE
430IFS=Q*NTHEN450
440GOSUB805
450LETT1=0
460FORI=1TOQ
470READA(I)
480NEXTI
490GOSUB760
500FORI=1TOQ
510READB(I)
520NEXTI
530GOSUB760
540FORI=1TOQ
550READC(I)
560NEXTI
570GOSUB760
580FORI=1TOQ
590READD(I)
592NEXTI
600REM BEGIN YOUR DATA ENTRIES HERE. TYPE - 600 DATA 1,2,3, ETC.
701DATA9999
710GOSUB760
720FORI=1TOQ
730READE(I)
740NEXTI
750GOSUB760
760LETT1=T1+1
770IFT1=NTHEN850
780RETURN
```

```
790PRINT"PROGRAM WILL ANALIZE FROM 1 TO 5 CLASSES ONLY."
800GOTO330
805PRINT
810PRINT"THERE MUST BE ONE NUMBER ENTERED FOR EACH QUESTION FOR EACH"
820PRINT"CLASS. REMEMBER, A ZERO IS ENTERED IF NO STUDENT MISSED "
830PRINT"A PARTICULAR QUESTION. CHECK YOUR DATA LINES."
840GOTO1390
850IFR=999THEN880
860PRINT
870PRINT"* VALID=BETWEEN 30 AND 70 PER CENT ANSWERED QUESTION CORRECTLY"
880PRINT
890PRINT"QUESTIONS","            CLASSES"
900PRINT"---------","            -------"
910PRINT" "," 1      2      3      4      5      TOTAL MISSED"
920PRINT" ","---------------------------------------------"
930FORJ=1TOQ
940PRINTJ,
950LETZ=A(J)
960GOSUB1320
970GOSUB1060
980IFT>INT((.7*R)+.5)THEN1020
990IFT<INT((.3*R)+.5)THEN1020
1000PRINT"* VALID"
1010GOTO1030
1020PRINT
1030LETT=0
1040NEXTJ
1050GOTO1390
1060LETT=A(J)
1070IFN>1THEN1130
1080FORI=1TO(5-N)
1090PRINT"             ";
1100NEXTI
1110PRINTT;
1120GOTO980
1130LETZ=B(J)
1140GOSUB1320
1150LETT=T+B(J)
1160IFN>2THEN1180
1170GOTO1080
1180LETZ=C(J)
1190GOSUB1320
1200LETT=T+C(J)
1210IFN>3THEN1230
1220GOTO1080
1230LETZ=D(J)
1240GOSUB1320
1250LETT=T+D(J)
1260IFN>4THEN1280
1270GOTO1080
1280LETZ=E(J)
1290GOSUB1320
1300LETT=T+E(J)
1310GOTO1110
1320PRINTZ;
1330IFZ>99THEN1380
1340IFZ>9THEN1370
1350IFZ>-1THEN1360
1360PRINT" ";
1370PRINT" ";
1380RETURN
1390END
```

DISCIPLINE TEACHER ASSISTANCE

SUBJECT LABORATORY DATA

PROGRAM NAME STAT

DESCRIPTION:

This program treats class sets of laboratory data statistically. Aside from a table of experimental values with errors and percent errors, the teacher has a choice of experimental value distribution with bar graph, ranking by percent error, ranking by experimental value, mean deviation, and standard deviation.

OBJECTIVES:

A. To make percent error in experiments more meaningful.

B. To increase competitive spirit in the laboratory due to ranking portion of statistical analysis.

C. To provide a basis for further discussion of laboratory data and techniques.

PRELIMINARY PREPARATION:

This program is not generally for student use.

DISCUSSION:

Often a teacher is forced to work with some arbitrary percent error scale for marking purposes. With a statistical analysis of the laboratory results, a realistic scale can easily be developed.

Also, it is often desireable to discuss the class results but without a statistical analysis this usually turns out to be rather shallow. The analysis can now be obtained in the few minutes it takes the students to clean their equipment and put it away.

It may be helpful to discuss a few of the ways in which the teacher can input data. First, the teacher may simply call up the program and then either he or his students can input the data as the experiments are finished. Next, with the teletype unit on local, a tape can be made and the analysis can be made at any convenient time. With tapes a teacher can do a statistical analysis of his classes separately or as a group as long as each student gets a different student number.

```
THIS PROGRAM WILL DO THE FOLLOWING:
     1. PRINT OUT A TABLE OF EXPERIMENTAL VALUES, ERRORS,
        AND PERCENT ERRORS INCLUDING AVERAGES FOR ALL.
     2. GIVE YOU A CHOICE OF ALL OF THE FOLLOWING:
              CHOICE 1 - EXPERIMENTAL VALUE DISTRIBUTION
                         INCLUDING A BAR GRAPH
              CHOICE 2 - RANKING BY PERCENT ERROR
              CHOICE 3 - RANKING BY EXPERIMENTAL VALUE
              CHOICE 4 - OTHER INFORMATION
              CHOICE 5 - ALL OF THE ABOVE CHOICES
              CHOICE 6 - ENDS PROGRAM
                     INSTRUCTIONS
 1. LINES 100 TO 110 HAVE BEEN RESERVED FOR DATA.
 2. NOTE: THE FIRST DATA LINE MUST ALWAYS BE NO. 100
          AND LINE 101 MUST ALWAYS BE USED.
 3. THERE IS ROOM FOR DATA FOR A MAXIMUM OF 60 STUDENTS.
 4. INPUT SHOULD BE IN THE FORM:
    100 DATA STUDENT NO., VALUE, STUDENT NO., VALUE, ETC.,
 5. STUDENT NUMBERS MUST RANGE FROM 1-60.
 6. OLD DATA IS ERASED BY INPUTING NEW DATA WITH THE SAME
    LINE NUMBERS DURING SUBSEQUENT RUNS.
 7. IF THE FIRST RUN REQUIRES DATA LINES 100-110 AND THE
    SECOND RUN REQUIRES LINES 100-109, LINE 110 IS TYPED
    IN TO ERASE OLD DATA IN THAT LINE.
 8. NEVER TYPE SAVE DURING THE RUN OF ANY PART OF THIS
    PROGRAM.


TIME:    3 SECS.


TAPE
READY.

100 DATA 1,37.8,2,38.6,3,39.7,4,37.9,5,38.0,6,40.6,7,41.8,8,37.6,9,
101 DATA 39.5,10,40.1,11,39.8,12,39.4,13,35.4,14,33.9,15,42.0,16,39.6,
102 DATA 17,38.7,18,37.6,19,38.5,20,40.1

RUN
WAIT.
```

412

WHAT IS THE TOTAL NO. OF STUDENTS AND THE CALC. VALUE?20,39.0

DATA LISTED BY STUDENT NUMBER
---- ------ -- ------- ------

STUDENT NO.	VALUE	ERROR	PERCENT ERROR
1	37.8	-1.2	3.07692
2	38.6	-.4	1.02564
3	39.7	.7	1.79487
4	37.9	-1.1	2.82051
5	38	-1	2.5641
6	40.6	1.6	4.10256
7	41.8	2.8	7.17949
8	37.6	-1.4	3.58974
9	39.5	.5	1.28205
10	40.1	1.1	2.82051
11	39.8	.8	2.05128
12	39.4	.4	1.02564
13	35.4	-3.6	9.23077
14	33.9	-5.1	13.0769
15	42	3	7.69231
16	39.6	.6	1.53846
17	38.7	-.3	.769231
18	37.6	-1.4	3.58974
19	38.5	-.5	1.28205
20	40.1	1.1	2.82051

THE ARITHMETIC MEAN [AVERAGE] IS 38.83
THE AVERAGE ERROR [ABSOLUTE] IS 1.43
THE AVERAGE PERCENT ERROR IS 3.66667

DO YOU DESIRE ADDITIONAL INFORMATION ? IF SO, TYPE
IN THE NUMBER OF YOUR CHOICE.?5

FOR THE DISTRIBUTION, WHAT LOWER LIMIT, UPPER LIMIT,
AND STEP DO YOU DESIRE ?35,42.5,.5

EXPERIMENTAL VALUE DISTRIBUTION
------------ ----- ------------

FROM	TO LESS THAN	NO.	BAR GRAPH
0	35	1	*
35	35.5	1	*
35.5	36	0	
36	36.5	0	
36.5	37	0	
37	37.5	0	
37.5	38	4	****
38	38.5	1	*
38.5	39	3	***
39	39.5	1	*
39.5	40	4	****
40	40.5	2	**
40.5	41	1	*
41	41.5	0	
41.5	42	1	*
42	42.5	1	*
42.5	INFINITY	0	

RANKING BY PERCENT ERROR
------- -- ------- -----

RANK	STUDENT NO.	PERCENT ERROR
1	17	.769231
2	12	1.02564
3	2	1.02564
4	9	1.28205
5	19	1.28205
6	16	1.53846
7	3	1.79487
8	11	2.05128
9	5	2.5641
10	10	2.82051
11	20	2.82051
12	4	2.82051
13	1	3.07692
14	8	3.58974
15	18	3.58974
16	6	4.10256
17	7	7.17949
18	15	7.69231
19	13	9.23077
20	14	13.0769

RANKING BY EXPERIMENTAL VALUE
------- -- ------------ -----

RANK	STUDENT NO.	EXPER. VALUE
1	14	33.9
2	13	35.4
3	8	37.6
4	18	37.6
5	1	37.8
6	4	37.9
7	5	38
8	19	38.5
9	2	38.6
10	17	38.7
11	12	39.4
12	9	39.5
13	16	39.6
14	3	39.7
15	11	39.8
16	10	40.1
17	20	40.1
18	6	40.6
19	7	41.8
20	15	42

OTHER INFORMATION
----- -----------

THE MEDIAN VALUE IS 38.7
THE LOWEST VALUE IS 33.9
THE HIGHEST VALUE IS 42
THE MEAN DEVIATION [AVERAGE DEVIATION] IS .13
THE STANDARD DEVIATION IS 1.87776
THIS CONCLUDES THE RUN.

144

```
1REMH.DORFMAN,PIB,8/1/69
2 REM STATISTICAL ANALYSIS OF LABORATORY DATA
100 GO TO 1750
101 DATA 0
160DIMA(50),R(50),Y(50),W(50)
170DIMQ(50)
180LETY(0)=0
190FORI=1 TO 50
200LETA(I)=0
210LETR(I)=0
220LETY(I)=0
230LET W(I)=0
240LETQ(I)=0
250NEXTI
260LETA9=0
270LETA8=0
280LETP=0
290LETV=0
300LETC=0
310 PRINT "WHAT IS THE TOTAL NO. OF STUDENTS AND THE CALC. VALUE";
320INPUTB,K
330  PRINT
340FORI=1TOB
350READR(I),A(I)
360NEXTI
370 PRINT "DATA LISTED BY STUDENT NUMBER"
380 PRINT "---- ------ -- ------- ------"
390PRINT
400 PRINT" STUDENT NO.","VALUE","ERROR","PERCENT ERROR"
410 PRINT
420FORI=1TOB
430LETZ=A(I)-K
440LETA8=A8+ABS(Z)/B
450LETP=P+A(I)/B
460LETW(I)=(ABS(Z/K))*100
470LETA9=A9+W(I)/B
480 PRINT R(I),A(I),Z,W(I)
490NEXTI
500PRINT
510 PRINT "THE ARITHMETIC MEAN (AVERAGE) IS    ";P
520 PRINT "THE AVERAGE ERROR (ABSOLUTE) IS     ";A8
530 PRINT "THE AVERAGE PERCENT ERROR IS        ";A9
540PRINT
550PRINT
560 PRINT " DO YOU DESIRE ADDITIONAL INFORMATION ? IF SO, TYPE"
570 PRINT " IN THE NUMBER OF YOUR CHOICE.";
580INPUTN
590IFN=2THEN1010
```

```
600IFN=3THEN1200
610IFN=4THEN1490
620IFN=6THEN1730
630PRINT
640 PRINT "FOR THE DISTRIBUTION, WHAT LOWER LIMIT, UPPER LIMIT,"
650 PRINT "AND STEP DO YOU DESIRE ";
660INPUTE,F,G
670PRINT
680PRINT
690 PRINT "EXPERIMENTAL VALUE DISTRIBUTION"
700 PRINT "------------ ----- ------------"
710PRINT
720FORI=1TOB
730LETM=0
740IFA(I)>=FTHEN850
750IFA(I)>=ETHEN770
760LETY(0)=Y(0)+1
770FORJ=ETO(F-G)STEPG
780LETM=M+1
790IFA(I)>=JTHEN810
800GOTO830
810IFA(I)>=(J+G)THEN830
820LETY(M)=Y(M)+1
830NEXTJ
840GOTO860
850LETY(25)=Y(25)+1
860NEXTI
870LETM=1
880 PRINT "FROM","TO LESS THAN"," NO."," BAR GRAPH"
881 PRINT
882 PRINT 0,E,Y(0),
890LETA5=Y(0)
900GOSUB2000
910FORJ=ETO(F-G)STEPG
920 PRINT J,J+G,Y(M),
930LETA5=Y(M)
940GOSUB2000
950LETM=M+1
960NEXTJ
970 PRINT F,"INFINITY",Y(25),
980LETA5=Y(25)
990GOSUB2000
1000IFN=1THEN540
1010PRINT
1020PRINT
1030 PRINT "RANKING BY PERCENT ERROR"
1040 PRINT "------- -- ------- -----"
1050PRINT
1060 PRINT "RANK","STUDENT NO.","PERCENT ERROR"
1070PRINT
1080FORS=1TOB
1090LETT=1E25
```

```
1100FORI=1TOB
1110IFW(I)>=TTHEN1140
1120LETT=W(I)
1130LETV=I
1140NEXTI
1150PRINTS,V,W(V)
1160LETW(V)=1E25
1170NEXTS
1180PRINT
1190IFN=2THEN540
1200PRINT
1210PRINT
1220PRINT
1230 PRINT "RANKING BY EXPERIMENTAL VALUE"
1240 PRINT "------- -- ------------ -----"
1250PRINT
1260 PRINT" RANK","STUDENT NO.","EXPER. VALUE"
1261 PRINT
1270FORS=1TOB
1280LETT=1E25
1290FORI=1TOB
1300IFA(I)>=TTHEN1330
1310LETT=A(I)
1320LETV=I
1330NEXTI
1340PRINTS,V,A(V)
1350LETQ(S)=A(V)
1360LETA(V)=1E25
1370NEXTS
1380LETF=0
1390LETG7=B/2
1400FORI=1TO31
1410IFG7=ITHEN1470
1420NEXTI
1430LETZ2=INT(G7)
1440LETZ4=INT(G7+1)
1450LETF=(Q(Z2)+Q(Z4))/2
1460GOTO1540
1470LETF=(Q(G7))
1480IFN=3THEN540
1490PRINT
1500PRINT
1510 PRINT "OTHER INFORMATION"
1520 PRINT "----- -----------"
1530PRINT
1540 PRINT "THE MEDIAN VALUE IS  ";F
1550 PRINT "THE LOWEST VALUE IS  ";Q(1)
1560 PRINT "THE HIGHEST VALUE IS ";Q(B)
1570LETM=0
1580LETP9=F
1590FORI=1TOB
1600LETP3=Q(I)-P9
1610LETM=M+P3
1620NEXTI
```

```
1630LETM7=M/B
1640 PRINT "THE MEAN DEVIATION (AVERAGE DEVIATION) IS"M7
1650LETM=0
1660FORI=1TOB
1670LETP3=(Q(I)-P9)↑2
1680LETM=M+P3
1690NEXTI
1700LETM7=SQR(M/B)
1710 PRINT "THE STANDARD DEVIATION IS"M7
1720IFN=4THEN540
1730 PRINT " THIS CONCLUDES THE RUN."
1740STOP
1750 PRINT" THIS PROGRAM WILL DO THE FOLLOWING:"
1760 PRINT"      1. PRINT OUT A TABLE OF EXPERIMENTAL VALUES, ERRORS,"
1770 PRINT"         AND PERCENT ERRORS INCLUDING AVERAGES FOR ALL."
1780 PRINT"      2. GIVE YOU A CHOICE OF ALL OF THE FOLLOWING:"
1790 PRINT"              CHOICE 1 - EXPERIMENTAL VALUE DISTRIBUTION"
1791 PRINT"                         INCLUDING A BAR GRAPH"
1800 PRINT"              CHOICE 2 - RANKING BY PERCENT ERROR"
1810 PRINT"              CHOICE 3 - RANKING BY EXPERIMENTAL VALUE"
1820 PRINT"              CHOICE 4 - OTHER INFORMATION"
1830 PRINT"              CHOICE 5 - ALL OF THE ABOVE CHOICES"
1840 PRINT"              CHOICE 6 - ENDS PROGRAM"
1850 PRINT"                     INSTRUCTIONS"
1860 PRINT" 1. LINES 100 TO 159 HAVE BEEN RESERVED FOR DATA."
1870 PRINT" 2. NOTE: THE FIRST DATA LINE MUST ALWAYS BE NO. 100"
1871 PRINT"           AND LINE 101 MUST ALWAYS BE USED."
1880 PRINT" 3. THERE IS ROOM FOR DATA FOR A MAXIMUM OF 50 STUDENTS."
1890 PRINT" 4. INPUT SHOULD BE IN THE FORM:"
1900 PRINT"    100 DATA STUDENT NO., VALUE, STUDENT NO., VALUE, ETC.,"
1910 PRINT" 5. STUDENT NUMBERS MUST RANGE FROM 1-50."
1920 PRINT" 6. OLD DATA IS ERASED BY INPUTING NEW DATA WITH THE SAME"
1930 PRINT"    LINE NUMBERS DURING SUBSEQUENT RUNS."
1940 PRINT" 7. IF THE FIRST RUN REQUIRES DATA LINES 100-110 AND THE"
1950 PRINT"    SECOND RUN REQUIRES LINES 100-109, LINE 110 IS TYPED"
1960 PRINT"    IN TO ERASE OLD DATA IN THAT LINE."
1970 PRINT" 8. NEVER TYPE SAVE DURING THE RUN OF ANY PART OF THIS"
1980 PRINT"    PROGRAM."
1990PRINT
1995STOP
1996FOR I=1 TO A5
1997PRINT"*";
1998NEXTI
1999PRINT
2000RETURN
2001END
```

DESCRIPTION:

This program will find the mean, median, and deviation of a set of numbers.

```
                MEAN, MEDIAN, AND DEVIATION OF A SET OF NUMBERS.

 ENTER YOUR NUMBERS IN DATA STATEMENTS ON LINES
 1000 - 2000.  FOR EXAMPLE, YOU MIGHT TYPE :

                1000 DATA  1,2,3,4  ETC. (YOUR DATA GOES HERE!)

 WHEN YOUR DATA HAS BEEN ENTERED,  TYPE :

                1 GO TO 300
                RUN

 THEN RELAX WHILE THE MACHINE GRINDS OUT THE ANSWERS.
 IF AN 'OUT OF DATA' APPEARS, ADJUST LINE 295.


READY

1000 DATA 244,182,112,2,198,10,314,160,18,38
1 GO TO 300
RUN


 THESE ARE YOUR NUMBERS :
 244  182  112  2  198  10  314  160  18  38

 THESE ARE YOUR NUMBERS (HIGHEST TO LOWEST) :
 314  244  198  182  160  112  38  18  10  2


 NUMBER OF VALUES IS 10
 SUM OF THE VALUES IS 1278
 THE MEAN VALUE IS 127.8
 THE MEDIAN VALUE IS 136
 THE STANDARD DEVIATION IS 208.2797


 FOR ANOTHER RUN, RE-ENTER DATA ON LINES
 1000 - 2000, TAKING CARE TO ELIMINATE OLD DATA
 BY TYPING THOSE LINE NUMBERS WHICH YOU DO NOT USE AGAIN;
 THEN TYPE 'RUN'.


READY

1000
1
```

```
100  REM  CHARLES M. LOSIK, BKLYN POLY, MEAN-MEDIAN-DEVIATION
110  REM  (7-66 IN FORTRAN II) ; (8-26-70 IN BASIC)
120  REM  YOU PUT YOUR NUMBERS IN DATA STATEMENTS AND
130  REM  YOU GET WHAT YOU PAY FOR.
140 PRINT " ","MEAN, MEDIAN, AND DEVIATION OF A SET OF NUMBERS."
150 PRINT
160 PRINT " ENTER YOUR NUMBERS IN DATA STATEMENTS ON LINES"
170 PRINT " 1000 - 2000.  FOR EXAMPLE, YOU MIGHT TYPE :"
171 PRINT
172 PRINT " ","1000 DATA  1,2,3,4  ETC. (YOUR DATA GOES HERE!)"
173 PRINT
174 PRINT " WHEN YOUR DATA HAS BEEN ENTERED,  TYPE :"
180 PRINT
190 PRINT " ","1 GO TO 300"
200 PRINT " ","RUN"
210 PRINT
220 PRINT " THEN RELAX WHILE THE MACHINE GRINDS OUT THE ANSWERS."
225 PRINT " IF AN 'OUT OF DATA' APPEARS, ADJUST LINE 295."
230 STOP
240  REM  A(I) ARE THE NUMBERS, S IS THEIR SUM,
250  REM  S2 IS THE SUM OF THEIR SQUARES.
260  REM
270  REM  WARNING!  DATA ON LINES 999 AND 2001 MAY NOT BE
280  REM  USED AS ONE OF YOUR NUMBERS.
290  REM  IF THEY ARE, SIMPLY CHANGE 999 AND 2001.
295 DIM A(100)
300 PRINT
303 PRINT " THESE ARE YOUR NUMBERS :"
305 LET I = 1
310 READ E
315 LET S = 0
316 LET S2 = 0
320 READ A(I)
330 IF E = A(I) THEN 370
340 PRINT A(I) ;
345 LET S = S + A(I)
347 LET S2 = S2 + A(I) * A(I)
350 LET I = I + 1
360 GO TO 320
370 LET N = I - 1
380 PRINT
390 PRINT
399  REM  ***** BUBBLE SORT *****
400 PRINT " THESE ARE YOUR NUMBERS (HIGHEST TO LOWEST) :"
405 FOR I = 1 TO N - 1
410 FOR J = I + 1 TO N
420 IF A(I) > A(J) THEN 460
430 LET T = A(I)
440 LET A(I) = A(J)
450 LET A(J) = T
460 NEXT J
465 PRINT A(I) ;
470 NEXT I
475 PRINT A(N)
480 PRINT
490 PRINT
500 PRINT " NUMBER OF VALUES IS" ; N
510 PRINT " SUM OF THE VALUES IS" ; S
520 PRINT " THE MEAN VALUE IS" ; S / N
530 PRINT " THE MEDIAN VALUE IS" ;
540 IF N / 2 <> INT ( N / 2 ) THEN 570
550 PRINT ( A(N/2) + A((N+2)/2) ) / 2
560 GO TO 600
570 PRINT A((N+1)/2)
600 PRINT " THE STANDARD DEVIATION IS" ; SQR ( N * S2 + S * S ) / N
610 PRINT
620 PRINT
630 PRINT " FOR ANOTHER RUN, RE-ENTER DATA ON LINES"
640 PRINT " 1000 - 2000, TAKING CARE TO ELIMINATE OLD DATA"
642 PRINT " BY TYPING THOSE LINE NUMBERS WHICH YOU DO NOT USE AGAIN;"
645 PRINT " THEN TYPE 'RUN'."
650 STOP
999 DATA 9999
2001 DATA 9999
2010 END
```