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ABSTRACT

Utilizing word problems relevant to the data processing field, this workbook presents a concept-oriented approach to competency development in ten areas of basic mathematics: (1) the expression of numbers as figures and words; (2) the multiplication, addition, and division of whole numbers, fractions, and decimals; (3) ratios and proportions; (4) percents; (5) number systems; (6) measurement; (7) introductory algebra; (8) problem-solving; (9) statistics; and (10) illustrative aids such as graphs, charts, and tables. For each competency area, the workbook presents a series of word problems designed to reinforce student learning and to demonstrate the applicability of the concept to the data processing work environment. An answer key for the exercises is appended. (JP)

PERSONAL ACHIEVEMENT

MATHEMATICS

Data Processing

Produced by

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Fund for the Improvement of Postsecondary Education

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CURRICULUM MATERIALS DEVELOPED

UNDER THE AUSPICES OF

FUND TO IMPROVE POST SECONDARY EDUCATION

Prepared By

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Mathematics
Curriculum Developer
1977

The problems found in this booklet are not meant to instruct you in the field of Data Processing. They are practices of the various mathematical concepts and are content oriented to help show the practicality of each concept.

Study each mathematical competency in the general learning packets before attempting these applied problems.

CONTENTS

INTEREST AREA DATA PROCESSING

Numeration

1. In the data processing lingo, K stands for approximately 1000 (actually 1024). Thus, a 64K has approximately _____ memory units.

2. A data processing machine can do one million two hundred thousand operations per second. Express in numeric form.

3. The ValComp Company recently had a theft of eight million seven hundred thousand dollars worth of circuit boards and computer memories. Express in numeric notation.

4. Graphnet Systems is a data communications network which has $3,300,000 in equipment. Express in words.

5. Applied Data Research had a net income of $375,000 in 1976 on a revenue of $3,9000,000,000. Express the numbers in words.

6. Applied Data Research in 1975 had a gross income of two billion nine hundred million dollars and a net profit of ninety seven thousand seven hundred and thirty four dollars. Express in numeric form.

Addition & Subtraction

1. Software systems for computers are sold by the manufacturers of the computers. If you had a DEC system and wished to provide COBOL ($7,000), DOS ($1,700), SORT ($3,130), APL ($1,500), and BASIC ($750), for your users, how much would all of these systems cost?

2. A 36 inch digital plotter sells for $7,600 with additional options of a 12 inch paper handling drum ($900), a paper take-up spool ($300), a plexiglass cover ($450), and a paper tear-off bar ($125). The total cost of the plotter with all its options would be _____.

3. There are 80 columns on an IBM card. If 5 columns are used for statement numbers, 1 column for a continuation symbol, 72 columns for program statements, how many columns are left unused?

4. A computer system had a fast core memory of 494K (actually 494304 bytes), slow core memory 1500K (actually 1,482,912 bytes), and a disk pack with 2,916,600 bytes of storage. What is the total memory storage (in bytes) of the system?

5. A typical line printer can print 132 characters across the page. If you have a title which is 49 characters long and wish to center it in the page, how many spaces should be allowed before beginning the title?

Multiplication

1. A new IBM data processing system, model #278, is proposed to rent for $85K/month. The yearly rental cost would be _____.

2. A video terminal display will show 24 lines with 80 characters per line. The total number of characters which can be displayed at one time is _____.

3. United Airlines sells computing time on its IBM 360-195 for 57¢ per second. How much would it cost per hour?

4. A Kodak KOM-85 microfilmer can microfilm 24,000 pages per hour. How many pages can it do in an eight-hour day?

5. A computing system had auxiliary memory stores consisting of 8 disk packs, each disk pack having 200 cylinders of 20 tracks, each track holding 7,294 bytes of 8 bits. What is the total number of bits in the memory store?

6. A computer scores one hundred fifth answers from each of 3000 examination papers in a very short time. How many total answers were scored?

Division

1. In a study of data terminal systems, 250 companies used 1771 terminals. What is the average number of terminals per company (round to the nearest whole number)?

2. If a computer system rents for $300/hour, how much is the cost per second?

3. If you rented an IBM 278 for $85K/month, how much would you have to charge customers for its use for each hour of its time? (Assume 425 hours of use each month.)

4. If a line printer can print 1285 lines per minute, how long will it take to print 24,700 lines?

5. If the line printer prints 61 lines/page, and 1285 lines per minute, approximately how many pages can it print per minute?

Fractions, + −

1. In creating new software programs and maintaining the programs after creation, $\frac{1}{8}$ of the time is spent on designing the program, $\frac{1}{8}$ is spent on testing the program, and $\frac{1}{16}$ is spent on coding. The remainder of the time is spent on maintenance. The fraction of the time spent on maintenance is _____.

2. In recording on magnetic tape, the total tape space utilized depends on the recording density, the length of the record, and the inter-record gap. A record of 1000 bytes, recorded at a density of 800 bytes per inch would take $1\frac{1}{8}$ inch. The inter-record gap is $\frac{3}{4}$ inch, so the total space required for a 1000 byte record is _____ inches.

3. The standard print spacing is 10 characters per inch. 132 characters takes up $13\frac{1}{5}$ inch. The paper width, between guideline sprocket holes is $17\frac{1}{8}$ inch. The amount of margin space left (total) is _____ inches.

4. Using a print train which prints 12 characters per inch, a title is to be centered on thesis paper forms which is $8\frac{1}{2}$ inches wide (neglecting the tear-off sprocketed guide strips). If the title is 32 characters long, how many inches from the left hand margin should the title begin?

5. Fraction decimal numbers are expressed in hexadecimal form as so many $\frac{1}{16}$'s, $\frac{1}{256}$'s, $\frac{1}{4,096}$'s, etc. A hexadecimal fraction 0.9999 is equivalent to $\frac{9}{16} + \frac{9}{256} + \frac{9}{4,096} + \frac{9}{65,536}$. Add the fractions to obtain the number equivalent.

6. The model 82 card sort will sort a card in $\frac{1}{11}$ of a second where as the model 83 will sort a card in $\frac{1}{16}$ of a second. What is the difference in these two sorting times?

Multiplying Fractions

1. A record of 2000 bytes recorded at 800 bpi (bytes per inch) will occupy $3\frac{1}{4}$ inches on the magnetic tape (including $\frac{3}{4}$ inch for the inter-record gap). How much space will 800 records of 2000 bytes occupy?

2. An IBM card is $3\frac{1}{4}$ inches by $7\frac{3}{8}$ inches. What is the area of the card in square inches?

3. If a desk pack has a capacity of $7\frac{1}{4}$ million characters, what is the capacity of 6 disk packs?

4. A tape transport can move tape 1 inch in $\frac{1}{25}$ of a second when it is up to writing speed. If the transport writes 800 bytes per inch, so that each byte takes $\frac{1}{800}$ of an inch, what is the length of time needed to write each byte? Express your answer both as a fraction and as a decimal number.

5. An advertisement claims that a programming language, MARK IV, requires $\frac{1}{10}$ of the program statements of COBOL. COBOL, in turn, requires only $\frac{2}{3}$ of the statements of FORTRAN, which requires only $\frac{1}{2}$ of the statements of BASIC. What fraction of statements of BASIC does MARK IV require?

Dividing Fractions

1. A record of 2000 bytes recorded at 800 bpi (bytes per inch) will require $3\frac{1}{4}$ inches (including $\frac{3}{4}$ inches for the inter-record gap) on magnetic tape. How many records can be put on a 2400 foot tape?

2. If $2\frac{1}{2}$ million characters of disk storage cost $\frac{1}{2}$K collars per month, how much is the cost per character?

3. If a character on a video display takes $\frac{3}{20}$ inches in width, how many characters can be put in a line on a 12 inch video tube?

4. A typical video display character can be considered as a dot matrix which is 10 x 15 dots in dimension. The character itself occupies a 5 x 7 grid, leaving the rest of the matrix for spacing. If the character width is $\frac{3}{20}$ of an inch, how many dots are there per inch across the screen?

5. Using the data from problem #4, what is the number of lines per inch down the video tube? (NOTE: The depth of the character is $\frac{3}{2}$ the width.)

Introduction To Decimals

1. In a computer a basic operation can be done in a "nano second" or one billionth of a second. Write that number in decimal form.

2. The basic clock rate of a microcomputer is 4 megahertz (4 x 10 cycles per second). If a basic operation takes 8 clock cycles, what fraction of a second does the operation take? Write the answer in decimal form.

3. A card reader reads 600 cards/minute, so that the time per card is $\frac{1}{600}$th of a minute. Express in decimal form.

4. A wire matrix printer can print up to 1000 lines per minute. Express the length of time to print a line in decimal form.

5. In a magnetic tape unit, the tape moves at speeds up to 24 inches per second. Express the length moved in one second in decimal form.

Addition & Subtraction Decimals

1. The average time between the billing date of an oil company credit office and the postmark on the bill is 3.65 days. The average time lag between the postmark date and the date the bill is received is 8.35 days. The total average time between billing by the oil company and receipt of the bill by the customer is _____.

2. In a microprocessor with a cycle time of 0.5 microseconds, operations take 2 to 7 cycles for completion. If a series of operations takes 1.0, 2.5, 2.0, 1.5, and 3.5 microseconds for completion, the total time required is _____.

3. In conversion of hexadecimal fractions to decimal fractions, 0.1 (H) in hexadecimal = 0.0625 (D)
   0.2 (H) = 0.125 (D)
   0.3 (H) = 0.1875 (D)
   0.4 (H) = 0.250 (D), etc.
   Thus, 0.5 (H) = 0.1 (H) + 0.4 (H) = 0.062 (D) + 0.250 (D) = _____.

4. The hexadecimal fraction $0.01(H) = \frac{1}{256} = 0.0039065$;

$0.02(H) = \frac{2}{256} = 0.0078125$;

$0.03(H) = \frac{2}{256} = 0.1171875$;

$0.04(H) = \frac{4}{256} = 0.015625$.

The hexadecimal number $0.14(H) = 0.0625 + 0.015625 =$ _____.

The hexadecimal number $0.99(H) = 0.4(H) + 0.4(H) + 0.1(H) + 0.04(H) + 0.04(H) + 0.01(H) =$
$0.250 + 0.250 + 0.0625 + 0.015625 + 0.015625 + 0.00390625 =$ _____.

5. A record on magnetic tape consists of the bit patter of the record itself recorded at 800 bpi (bytes per inch) plus a longitudinal check sum with a gap of 0.012 inches, a cyclic redundancy check character at a gap of 0.00125 inches and an inter-record gap of 0.625 inches. A record of 1200 bytes thus requires 1.500 inches + 0.012 inches + 0.00125 inches + 0.625 inches + _____.

Multiplying Decimals

1. A decimal fraction can be converted to a hexadecimal fraction by repeated multiplication by 16, clearing off the integer portion as the first hexadecimal character, multiplying the remaining fraction again by 16 to get the second hexadecimal character, etc.
   An example: The decimal fraction 0.25.

   .25 x 16 = 4.0 ====> 0.4(H)

   The decimal fraction 0.1

   .1 x 16 = 1.6 ====> 0.1(H)

   .6 x 16 = 9.6 ====> 0.19(H)

   .6 x 16 = 9.6 ====> 0.199(H)

   A. Convert the decimal fraction 0.4375 to hexadecimal.

   B. Convert the decimal fraction 0.01 to hexadecimal.

2. A record of 1200 bytes recorded on 800 bpi magnetic tape takes 0.1786 feet. How many feet do 540 records take?

3. If a byte of memory costs $0.02, how much do 2.5 x 10^6 bytes of memory cost?

4. In recording data on IBM cards, 80 bytes can be stored on 3.25" x 7.375". The area of the card is _____. The area per byte is $\frac{1}{80}$ of this value. Find the area per byte.

5. On punched paper tape, punches are located 0.1" apart and 8 punches (one byte) are placed across a 1" paper tape. How much area do 80 bytes take on paper tape?

6. Many high speed computer memories have transfer times of 275 nanoseconds (one billionth of a second). How long would it take to transfer 120 pieces of information? Express in decimal form.

Dividing Decimals

1. The cost of a reel of magnetic tape for use with computers is about $15 for a 2400 foot reel. What is the cost of magnetic paper per foot?

2. A disk storage device provides 2.5×10^6 characters of storage. If it rents for $516/month, how much does one character of memory storage cost per month?

3. A microprocessor memory board costs $90 for 4.096×10^3 bytes of memory. What is the cost per byte?

4. If a character takes 0.15" in width on a video display, how many characters can be displayed on an 11" width video screen?

5. The Series/1 mini-computer from IBM has an average instruction execute time of 310×10^{-6} seconds for model 5. How many instructions can it do per second?

Ratio and Proportion

1. Computer Power, Inc., a data processing service, handles work for banks totalling 1,250,000 mortgages and loans valued at 24 billion dollars. What is the average value of a loan?

2. If a computer can do 230,000 instructions per second, how many can it do per minute?

3. If a 300' reel of magnetic tape can hold 1300 records of 1600 bytes each corresponding to 26,000 IBM card images, how many card images can be put on a 2400' magnetic tape using the same recording format?

4. There are 7294 bytes per track on an IBM 2314 disk unit. How many bytes are there in 400 tracks?

5. An IBM card of 24 square inches can hold 80 bytes of information. An 8 channel punched paper tape can hold 10 bytes per square inch. How many feet of paper tape are required to hold the information of a box (2000) of IBM cards?

Percent

1. In 1976 John Hancock Insurance Company, through the use of a network of 550 terminals called Hanstar, handled an increase of 18% in data transactions, more than a quarter of a million transactions, without increased staff or transaction time. What was the total number of transactions handled per year?

2. With an old form of data base, the central processor unit was involved 100% of its time while retrieving data. Using a random access management information system, the CPU time was reduced so that it was involved only 28% of the time. By how much was the CPU time reduced?

3. A communications satellite network system had a per station cost of $3,000,000 in 1965, but in 1976, the per station cost was $37,000. What percent is the 1976 cost of that in 1965?

4. A study of the clients of a billing agency showed that while 20% of them had a legitimate reason to complain, only 1% of the clients did so. What percentage of the clients who had reason to complain did not write letters?

5. A department store billing office had an average time lag of 7.12 days between the billing date and the postmark date. The average time lag between postmark and the date received was 10.53 days. What percent of the time between billing and the receipt of the bill was due to delays in the billing office?

Measurement

1. Currently, magnetic tape reels are sized in feet, i.e., 300', 1200', and 2400' reels. What is the length of each of these reels in meters?

2. An IBM card is 3.25" x 7.375". What are its dimensions in centimeters?

3. The typical running speed of a magnetic tape transport is 24" per second. What is its speed in centimeters/second?

4. A line printer prints 10 characters per inch horizontally and 6 lines per inch vertically. What are the dimensions (in centimeters) for 131 characters across the page?

5. If the recording density on magnetic tape is 1600 bytes per inch, how many bytes is this per centimeter?

Introduction To Algebra

1. The amount when the interest and the principal is compounded annually is:
   $A = P(1 + i)^n$. Solve for the principal (P).

2. At simple interest, the amount after n years is the principal multiplied by the quantity: one plus the number of years times the interest rate. Express as an algebraic expression.

3. For efficient evaluation of a polynomial, the operations can be nested as follows:
   $y = (Ex + D)x + C\ x\ + B\ x + A$

   Expand this expression to show the form of the polynomial.

4. The volume of a cylindrical tank with hemispherical ends can be expressed in terms of the diameter of the tank and the length of the cylindrical portion. The volume is equal to the quantity: the length plus $\frac{2}{3}$ the diameter multiplied by pi times the diameter squared divided by 4. Express in algebraic form.

Problem Solving

1. The shugart mini-floppy disk has 110K byte storage and a data transfer rate of 125K bits per second. How long would it take to transfer all of the information on a floppy disk at this data transfer rate? (1 byte = 8 bits; K = 1000).

2. In storing information on magnetic tape, 800 bytes can be stored per inch. $\frac{3}{4}$" is required between storage records for start and stop of the tape unit. If a record contains 800 bytes, how many bytes can be stored in 10 feet of tape?

3. An IBM 2314 disk has 400 tracks which can hold 7294 bytes per track. In backing up a disk on magnetic tape, the entire disk contents are to be stored on magnetic tape at 1600 bpi (bytes per inch) with the records blocked at 7294 bytes. The inter-record gap is $\frac{5}{8}$". How many feet of tape are required for this backup?

4. In evaluating a polynomial with terms up to the 4th power in the variable requires loading 2 registers, 4 multiply operations, and 4 addition operations. If loading a register requires 1.5 microseconds, an addition requires 4.1 microseconds, and a multiplication requires 4.3 microseconds, what is the total time to evaluate the polynomial?

5. What is the most economical way to store data: IBM cards at 80 bytes per card, 1000 cards/$1.00; paper tape, 8 bytes per inch, 1000' roll @ $1.28/roll; magnetic tape, 800 bytes per inch, 2400' reel @ $15.00/reel.

Numbers Systems and Bases

1. A decimal integer number can be converted to any base number by repeated dividing by the base number, keeping the remainders in order from the least significant to the most significant digit.

Example: 100(D) = ? in hexadecimal

100 + 16 = 6, remainder 4
6 + 16 = 0, remainder 6

100(D) = 64(H)

A. Express 1000(D) in hexadecimal.

Example: 500(D) + ? in octal

500 + 8 = 62, remainder 4
62 + 8 = 7, remainder 6
7 + 8 = 0, remainder 7

500(D) = 764(octal)

B. Express 4095(D) in octal.

2. A decimal fraction can be converted to any base number fraction by repeated multiplication by the base number. The integers formed are kept in order as the most significant to the least significant. The fraction remaining is multiplied by the base.

Example: Express 0.3(D) in hexadecimal.

0.3 x 16 = 4.8
0.8 x 16 = 12.8
0.8 x 16 = 12.8 , etc.

(Hexadecimal numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F)

A. Express 0.01(D) in hexadecimal.

Example: Express 0.432(D) in octal.

0.432 x 8 = 3.456
0.456 x 8 = 3.618
0.618 x 8 = 4.944
0.944 x 8 = 7.552
0.552 x 8 = 4.416

OR

0.432(D) = 0.33474 (octal).

B. Express 0.203125(D) in octal.

3. Using problems #1 and #2, express pi = 3.1416 in
   (a) hexadecimal

   (b) in octal

4. In the ABEND dump of a computer run, the starting memory location of the program was at 38778(H). The program status work at ABEND was 48760(H). Find the relative location in the program at which the ABEND occurred.

5. In conversion from a hexadecimal or octal number to a decimal number, the same operations are performed as in problems #1 and #2, i.e., repeated dividing by the new base (or repeated multiplication by the new base).

   Example: Convert 4CA3(H) to decimal

   4CA3 ÷ A = 7A9, remainder 9
   7A9 ÷ A = 01, remainder 4
   C1 ÷ A = 13, remainder 3
   13 ÷ A = 1, remainder 9
   1 ÷ A = 0, remainder 1

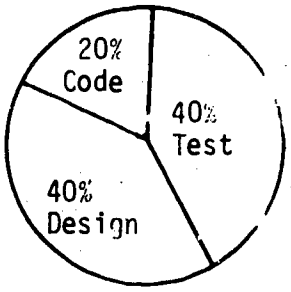
   OR

   4CA3(H) = 19349(D)

   A. Convert F1F(H) to decimal.

Graphs

1. A speaker on software indicated that the conventional distribution of time shown at the right was incorrect: that it should be design, 12%; Code 6%; Test 12%; and Maintenance, 70%. Draw a new circle graph to show the correct relationships.



2. From the table below, what is the largest capacity of a drum memory?

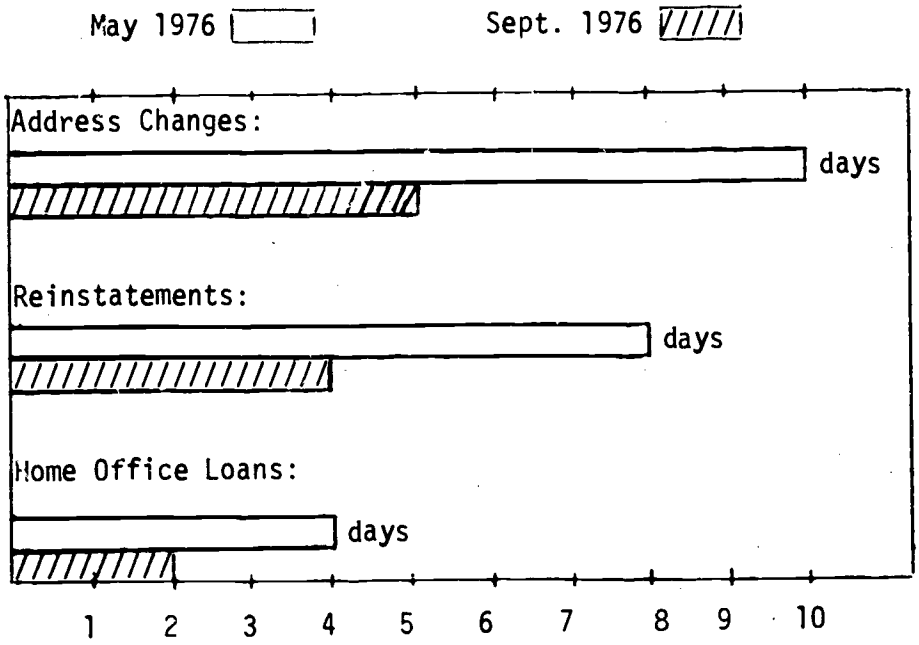
MEMORY CAPABILITIES

METHOD	TRANSFER RATE (million bps)		CAPACITY (million bits)		AVERAGE ACCESS TIME (milliseconds)		COST/BIT (¢)	
	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Drum	1.6	12.5	6	600	4.2	20.0	0.06	1.60
Disc and disc pack	0.3	7.71	6	9660	73.8	339.2	0.01	0.48

SOURCE: W. Sharpe, *The Economics of Computers* (New York: Columbia University Press, 1969), pp. 402, 514.

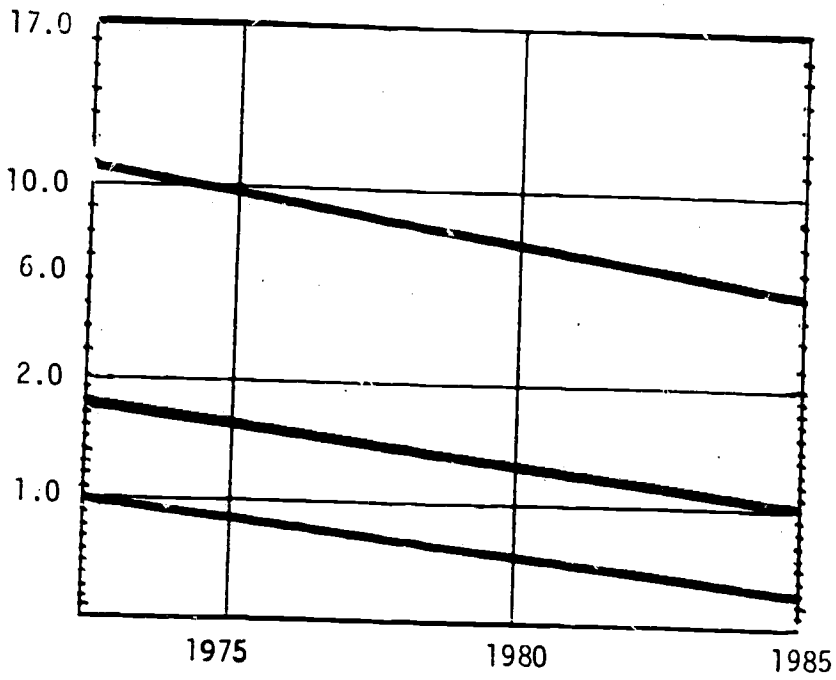
3. The adoption of IBM's MVS (multiple virtual storage) system by John Hancock Mutual Life Insurance Company in 1976 gave the results shown in the bar graph below:

How much time reduction occurred in making policy reinstatements?



4. In a technology forecast made in 1975, the following predictions were made for data transmission costs:

What is the predicted cost of transmission at 2400 bps in 1980?



Numeration

1. 64,000 memory units
2. 1,200,000 operations/second
3. $8,700,000
4. three million, three hundred thousand dollars in equipment
5. three hundred seventy-five thousand dollars
   ERROR: in writing the numeral
6. $2,900,000,000 income
   $97,734 profit

Addition & Subtraction

1. $14,080
2. $9,375
3. 2 columns unused
4. 4,893,816 bytes
5. 41 spaces

Multiplication

1. $1,020,000/year
2. 1920 characters
3. $2052
4. 192,000 pages
5. 1,867,264,000
6. ERROR: fifty not fifth
   450,000 answers

Division

1. 7 terminals/company
2. 8.3¢/second
3. $200
4. 19 minutes
5. about 21 pages

Fractions + -

1. $\frac{11}{16}$ spent on maintenance
2. ERROR: $1\frac{1}{4}$" not $1\frac{1}{8}$" 2 in.
3. $3\frac{27}{40}$"
4. $2\frac{11}{12}$"
5. $\frac{39321}{65536}$
6. $\frac{5}{176}$ of a second

Multiplying fractions

1. 2600"
2. $23\frac{31}{32}$
3. $6 \cdot 7\frac{1}{4} = 43\frac{1}{2}$ million characters
4. $\frac{1}{20000}$ sec. = .00005 sec.
5. $\frac{1}{30}$

Dividing Fractions

1. about 8861 records
2. $\frac{1}{5,000,000}$ dollars/character
3. 80 characters
4. $33\frac{1}{3}$ dots/inch
5. $\frac{56}{27}$ lines per in.

Introduction to Decimals

1. 0.000000001 seconds
2. ERROR: (4×10^6 cycles per second)
   0.000002 seconds
3. $0.00\overline{16}$
4. 0.001 min/line
5. 24.0 inches/second

Addition & Subtraction Decimals

1. 12 days
2. 10.5 micro seconds
3. 0.3125 (D)
4. 0.078125 (D)
   0.59765625 (D)
5. 2.13825 inches

Multiplying Decimals

1. $.\overline{028F5C}$
2. 96.444 ft.
3. $50,000
4. 0.2996 sq. in./byte
5. 8 sq. in.
6. 0.000033 seconds

Dividing Decimals

1. $0.00625/ft.
2. $.0002064/characters

3. $0.02197/byte
4. 73 characters
5. 3225 instructions/second

Ratio & Proportion

1. $19,200
2. 13,800,000 instructions/second
3. 208,000 images
4. 2,917,600 bytes
5. NOTE: 8 channel tape is 1" wide
   $1333\frac{1}{4}$ ft.

Percent

1. 1,388,889 transactions
2. 72%
3. 1.23%
4. 95%
5. 40.3%

Measurement

1. 91 meters; 366 meters; 732 meters
2. 8.26 cm x 18.73 cm
3. 60.9 cm/sec.
4. 33.27 cm
5. 630 bytes/cm

Introduction to Algebra

1. $P = A(1 + i)^{-n}$
2. $A = P(1 + nr)$
3. ERROR $y = (((Ex + D)x + C)x + B)x + A$
   $y = Ex^4 + DX^3 + CX^2 + BX + A$
4. $V = ((L + \frac{2}{3}d)\pi d^2) \div 4$

Problem Solving

1. 7.04 seconds
2. 55,200 bytes
3. 173'
4. 36.6 micro seconds
5. magnetic tape

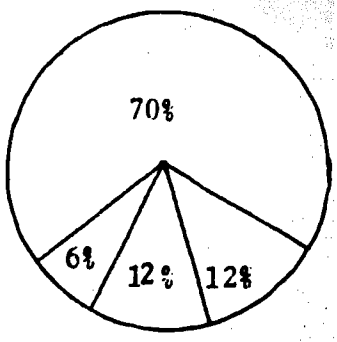
Numbers, Systems and Bases

All "+" signs should be "•" except in example 2 500 (D) "+" should be "=" sign.

1. A. 3 E 8 (H) B. 7777 (octal)
2. A. 0.028F5C (H) B. 0.15 (octal)
3. A. 3.243FE5C9 (H) B. 3.11037745 (octal)
4. FFE8 (H)
5. A. 3871

Graphs

1.



2. 600 million bits
3. 4 days
4. Impossible. Graph not labeled