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ABSTRACT

Suitable for secondary school students, the workbook provides flowcharting activities to help students understand the logical steps used in problem solving. Before applying the flowcharting procedures to mathematical problems, students are first introduced to familiar non-mathematical problems such as sharpening a pencil or eating peanuts. Section 1 provides an introduction with behavioral objectives, procedures, and useful flowchart symbols. Section 2 gives flowchart samples and in section 3, classroom procedures are flowcharted. In section 4, mathematics-related flowcharts are provided for problems such as finding an average, changing decimals to percent numbers, performing algebraic equations, constructing an isosceles triangle, bisecting an angle, and multiplying and dividing fractions. The final section provides student instructions, a teacher's guide, room arrangement ideas, game rules, sample tests, and a gameboard for a two-day activity in which students follow a flowcharted path representing the steps that must be fulfilled to obtain a driver's license. This simulation can serve as a model for developing flowcharting lessons to fit all types of learning situations. (LH)

PROJECT R-3

A motivational program emphasizing student Readiness, subject Relevance, and learning Reinforcement through individualized instruction, intensive involvement, and gaming simulation.

FLOWCHARTING HANDBOOK

- STATE DEMONSTRATION PROJECT
- TITLE IV C
- RIGHT TO READ MODEL

SAN JOSE UNIFIED SCHOOL DISTRICT
SAN JOSE, CALIFORNIA 95126

PROJECT R-3

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INTRODUCTION TO FLOWCHARTING

INTRODUCTION

Flowcharting is drawing of the logical steps used in problem solving.

The use of flowcharting forces the student to analyze the procedures for solving a given problem. It is intended to fix the idea of first this, next this, then this and so on. It is motivational in that the finished product is a work of art and hopefully will aid the student in understanding the performance objective(s). It reinforces the basic mathematical vocabulary and continues the development of computer language which is relevant to present day technology.

Flowcharting, with its branches, becomes difficult in that the student must anticipate all possibilities. That is, at a given point in the program, the next step in the sequence depends on the answer to the questions of the previous step. A loop is used in flowcharting with branching to show repetition of a process by drawing a "loop" instead of rewriting all the steps.

Flowcharting should be introduced with non-mathematical problems that are familiar to the students. This type problem can develop from simple to complex situations. Confidence and ability should be developed in non-mathematical problems before applying procedure to mathematical problems.

The material contained in this workbook was developed for use in the mathematics component of Project R-3. Some of the flowcharting activities shown have proved to be some of the more successful lessons for our students and can serve as models for developing a variety of flowcharting lessons to fit all types of learning situations.

BEHAVIORAL OBJECTIVES

On the completion of a unit on flowcharting, students (with a reasonable amount of accuracy) should be able to:

1. Understand more fully processes that they have previously taken for granted.
2. Use flowcharting in non-mathematical situations.
3. Use flowcharting in mathematical problem-solving situations.
4. Draw step-by-step procedures used in solving problems.
5. Recognize and be able to use symbols effectively in flowcharting.
6. Recognize situations where it is possible to use flowcharting.

Evaluation of Objective - Students will be considered to have met the objectives of this unit in flowcharting when they can function:

1. In a mathematical problem solving situation.
2. In recalling meaning and notations as they relate to flowcharting.
3. In communicating mathematical ideas in flowcharting to non-mathematical situations.

FLOWCHARTING

WHAT IS IT?

A student draws a picture of the step-by-step procedure used in solving a given type of problem.

WHY USE IT?

It forces the student to think out the process which he has previously taken for granted. Also, the idea of using something connected with the calculator gives an added incentive to their motivation. By means of flowcharting many students are able to see for the first time some of the logical reasoning of problem solving operations which have been confusing to them for years.

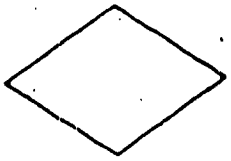
WHO TO USE IT?

For example, one could introduce the idea of flowcharting with a non-mathematical problem such as getting a date. List the steps on the chalkboard or overhead. When the class is satisfied with the number of steps, connect them together with lines and boxes, and arrows to indicate the directions followed. Then give them a template and see if they can construct a solution to a similar problem. Now, whenever a new type of problem is studied, you can use a flowchart as a summary of the problem solving procedure. To help in the process of familiarizing the students with flowcharting, introduce them to the basic operations of a calculator. Be sure to go over the sheet before having the students try them at the machines. It is probably best to keep the number of symbols used to a minimum.

SYMBOLS USED IN FLOWCHARTING

Terminal Symbol

It means Start or Stop.



Decision Symbol

This symbol tells you to decide which direction to go to next.

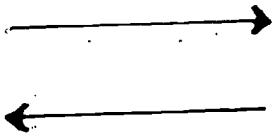
Operation Symbol

Direction should be written inside this box.

Connector Symbol

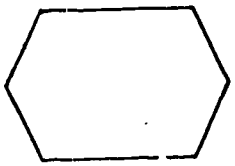
Shows exit from an entry into different parts of a flowchart.

Flow Symbol

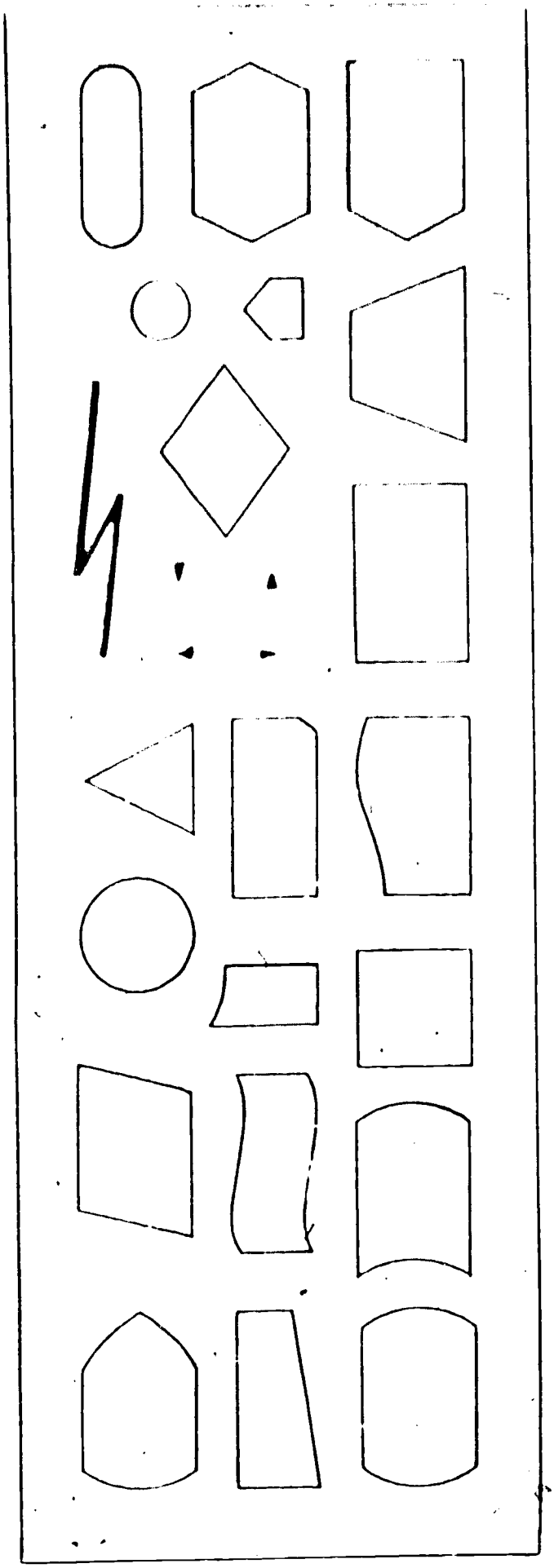


It shows the direction to the next step.

Pre-Defined Process Symbol



Shows operator previously charted.



Template can be cut out and pasted on cardboard as a classroom activity

DATE CLASS NAME

FLOWCHART SYMBOLS

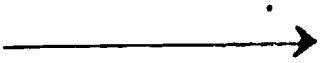
TEST

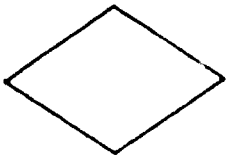
1. What is a flowchart?

Write the name for each of the following symbols and describe how each is used.

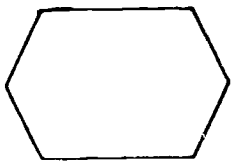
2.  _____

3.  _____

4.  _____

5.  _____

6.  _____

7.  _____

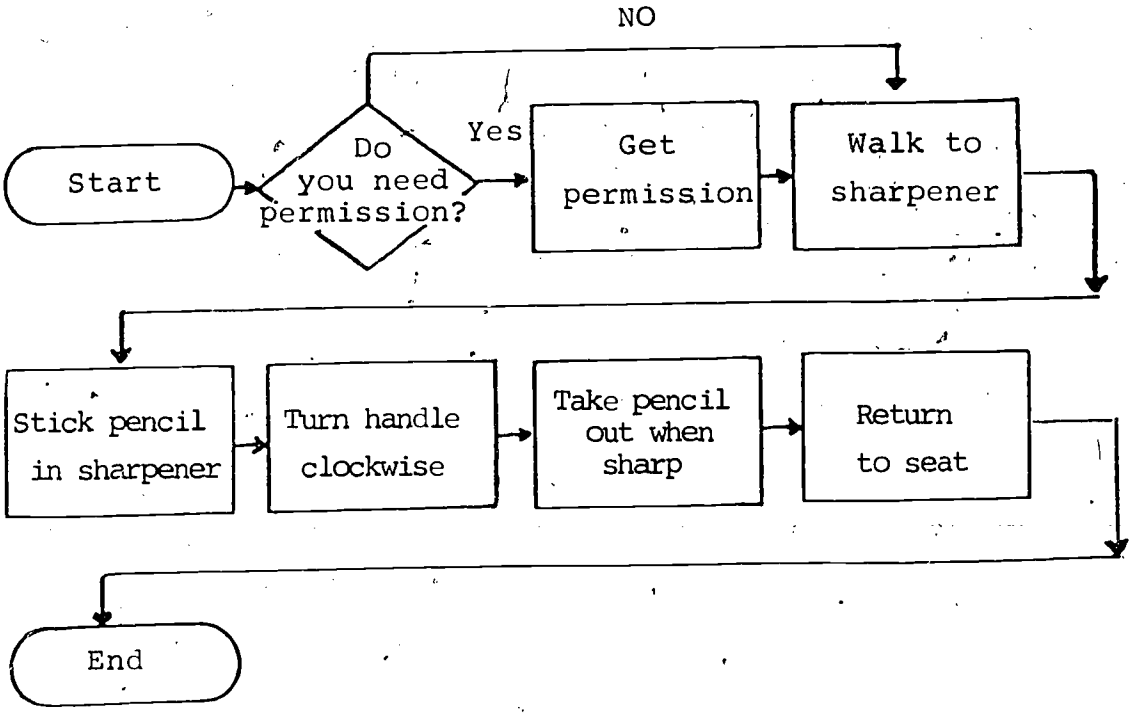
APPLICATION SAMPLES

Flowchart: To sharpen a pencil

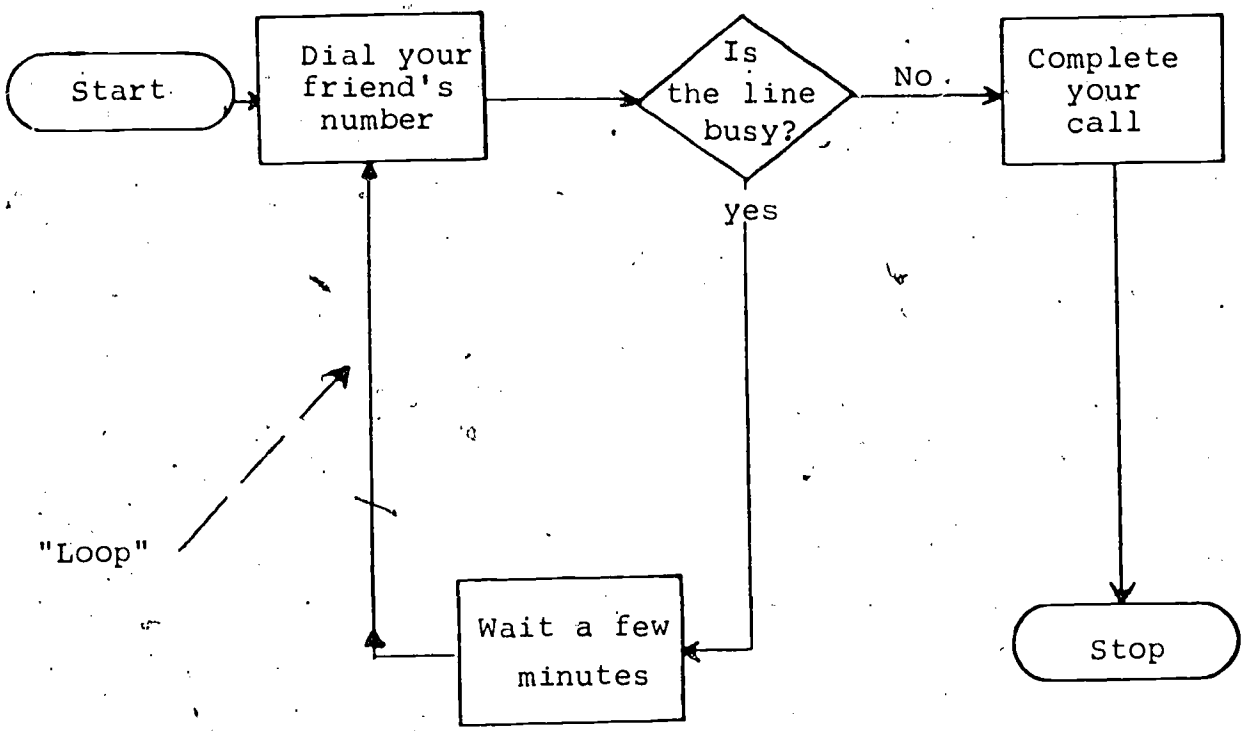
The following steps for sharpening a pencil may be suggested and agreed upon:

a. Do you need permission
b. Get permission
c. Walk to sharpener
d. Stick pencil in sharpener
e. Turn handle clockwise
f. Take pencil out when sharp
g. Return to seat

The flowchart describing steps are:



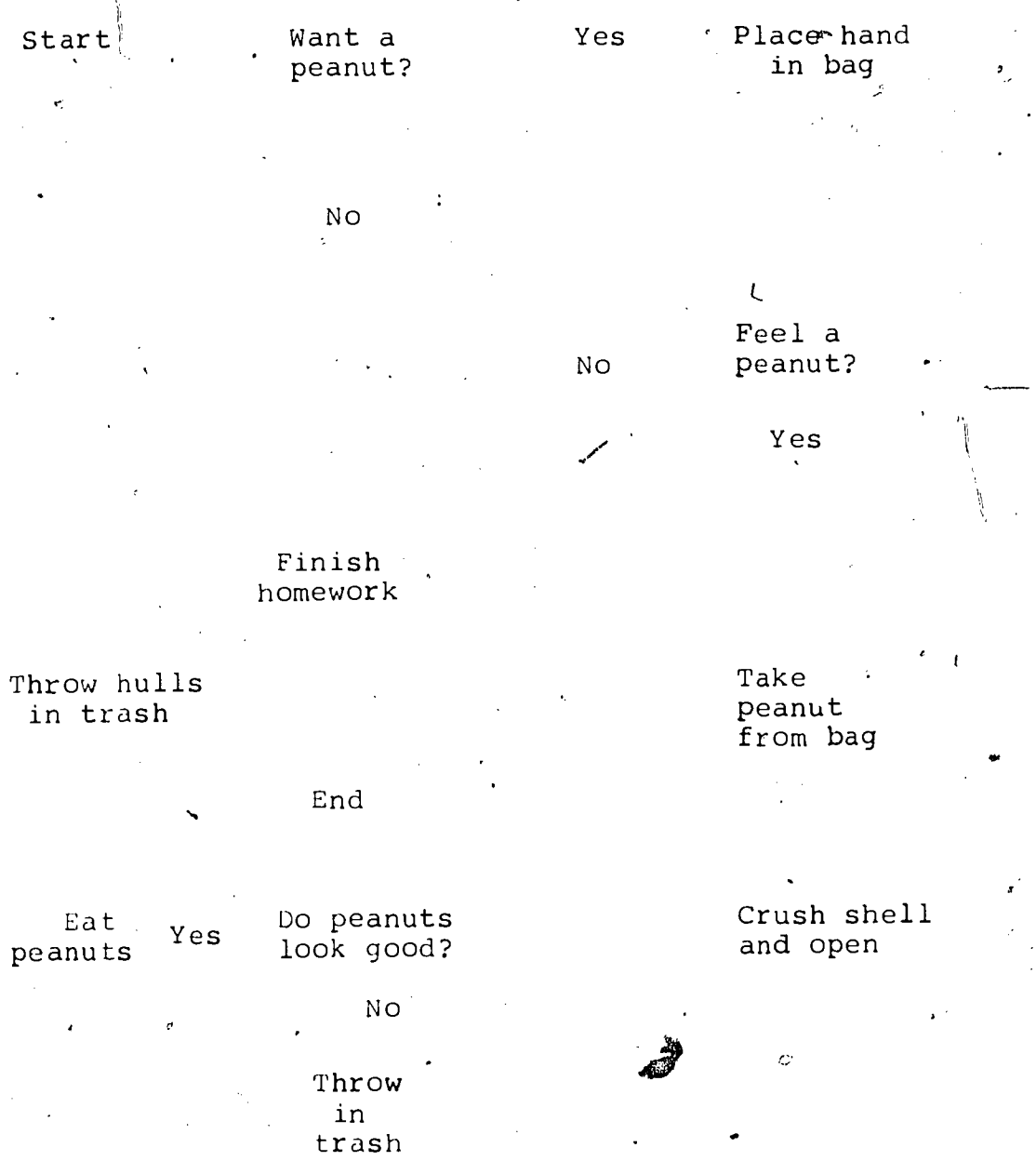
HOW TO MAKE A TELEPHONE CALL TO A FRIEND



FLOWCHART

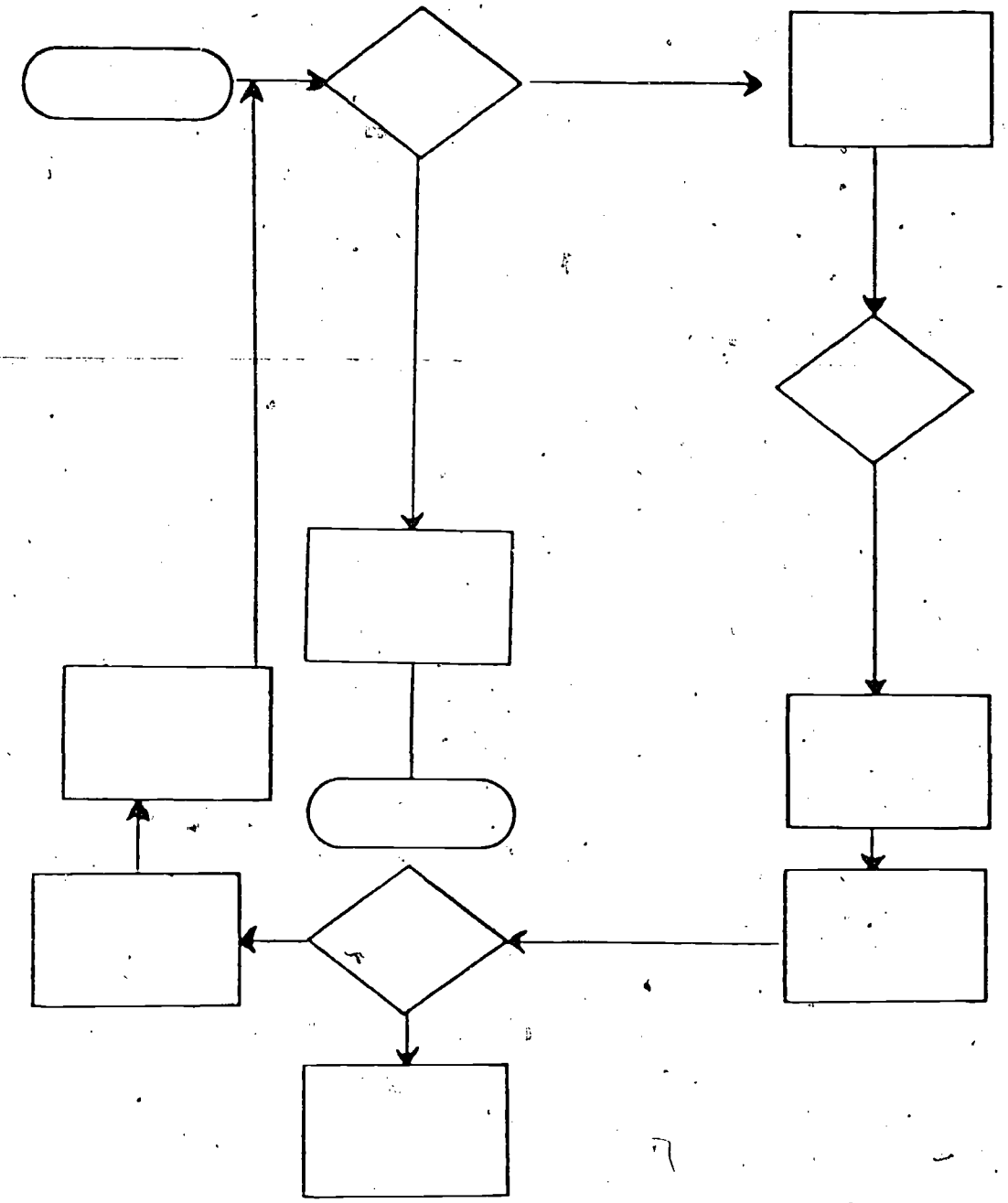
HOW TO EAT PEANUTS

(Choose and Draw the Correct Template Symbols)



KEY

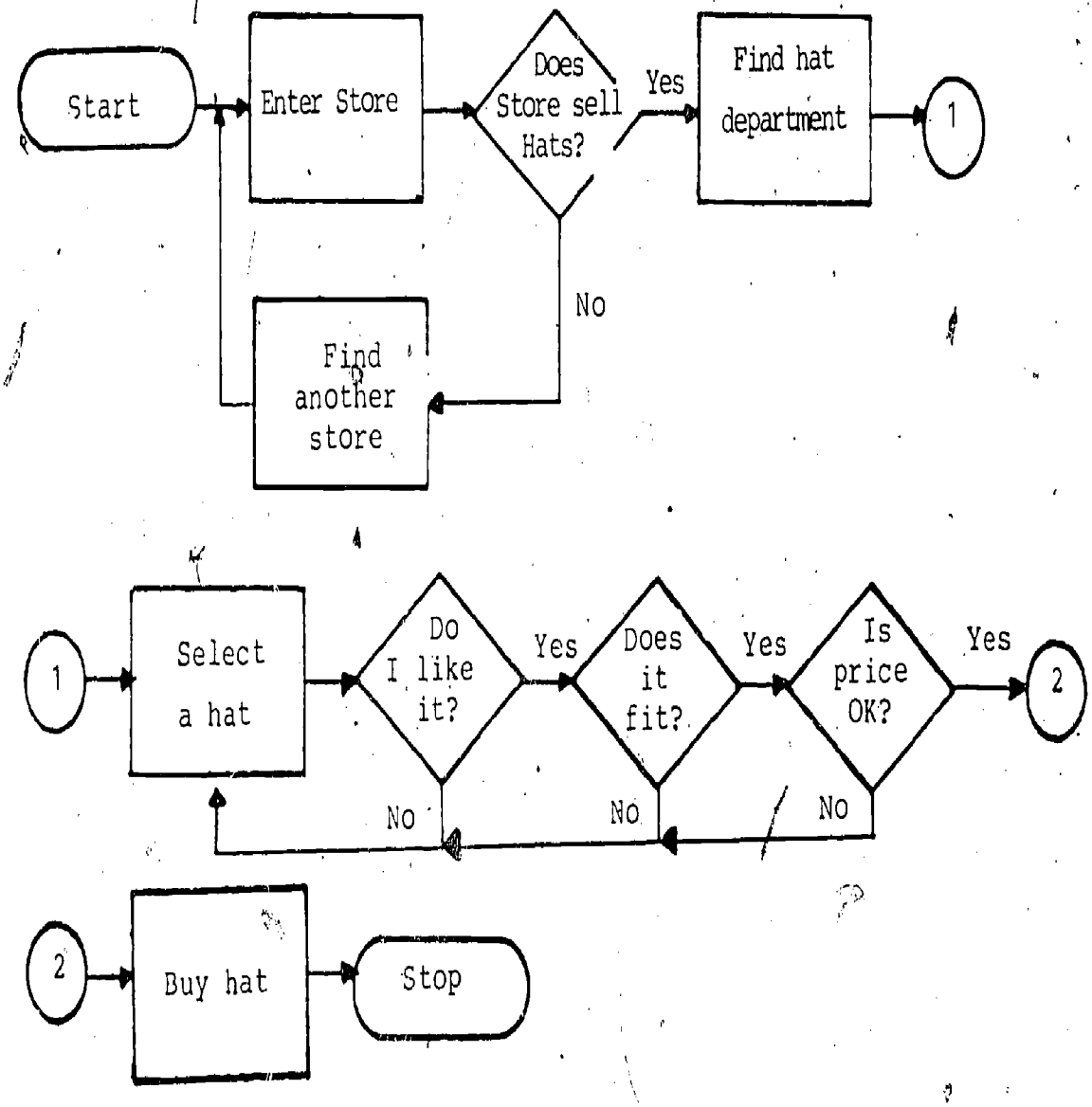
HOW TO EAT PEANUTS



PRACTICE SHEET

Any mathematical problem can be solved more easily if steps to the solution are charted. Select one or more of the following statements, and give an outline step-by-step of how you would flowchart the problem. A flowchart is a picture outline of a series of steps used to solve a problem.

1. How to open your locker.
2. How to operate a television set.
3. How to buy a hat.
4. How to start the car.
5. How to catch a fish.
6. How to mail a letter.
7. How to get a drink.
8. The story game.
9. How to build a model.
10. How to brush your teeth.
11. How to build a campfire.
12. How to boil an egg.
13. How to pack your lunch.
14. How to play a guitar.
15. How to wash dishes.
16. How to drive downtown.
17. How to apply for a job.
18. How to eat peanuts.
19. How to buy a record.
20. How to operate the film-strip projector.

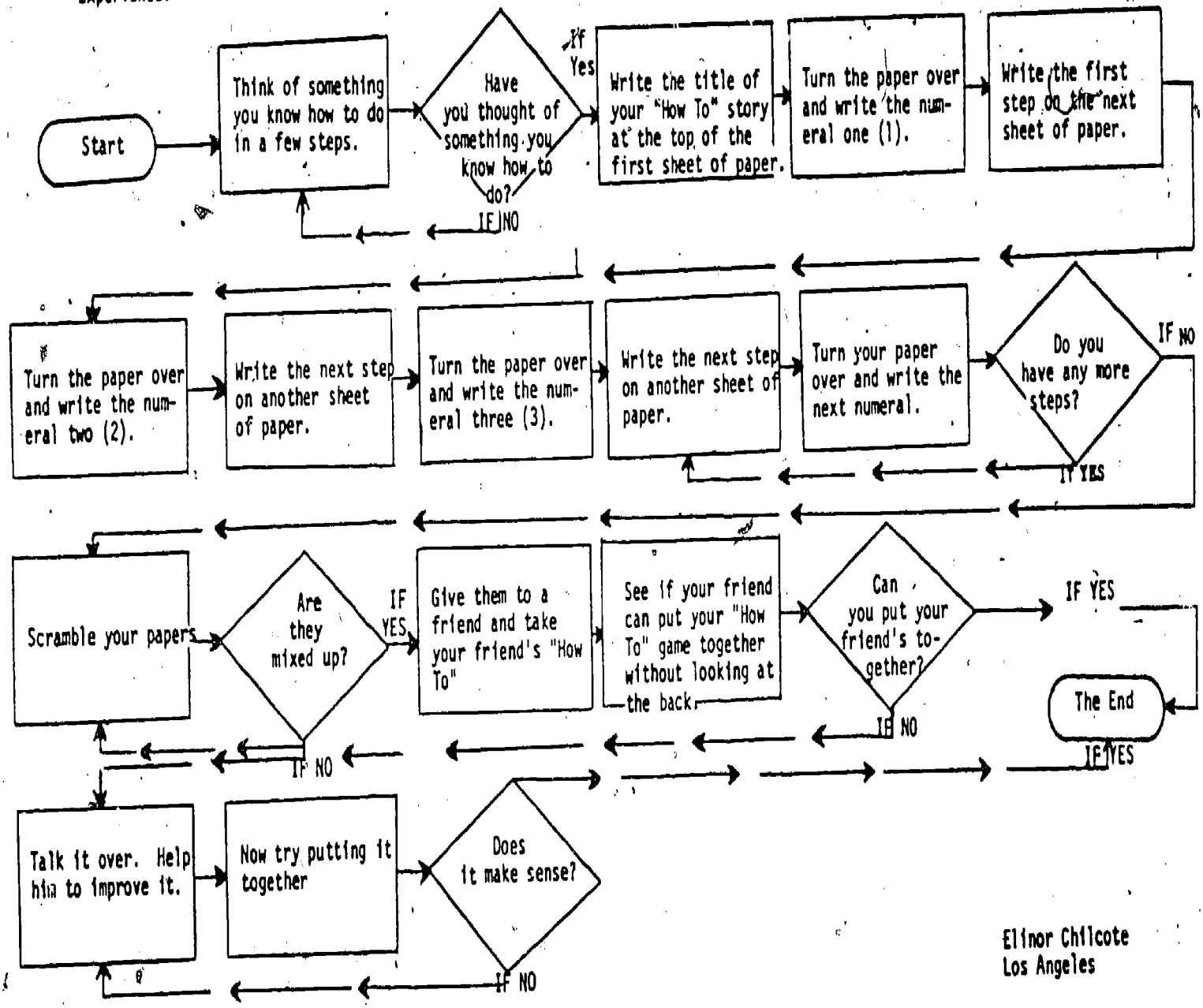


Exercises: Draw flowcharts for the following:

1. How to catch a fish
2. How to draw a picture
3. How to shine shoes

Flowcharts

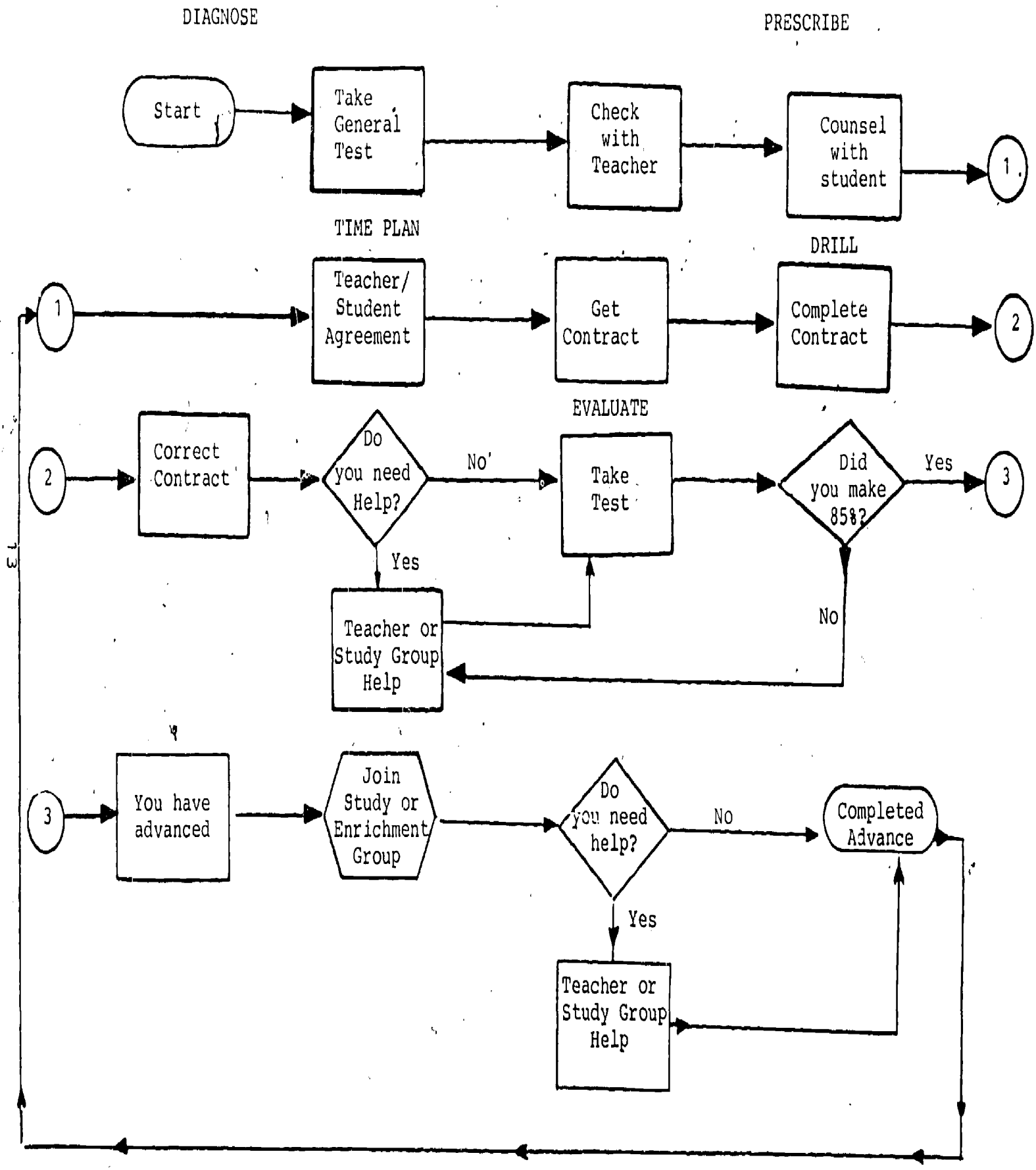
Play a "how to" story game with the children. This is a good exercise in critical thinking, and a valuable language experience.



Elinor Chilcote
Los Angeles

CLASSROOM PROCEDURES FLOWCHARTED

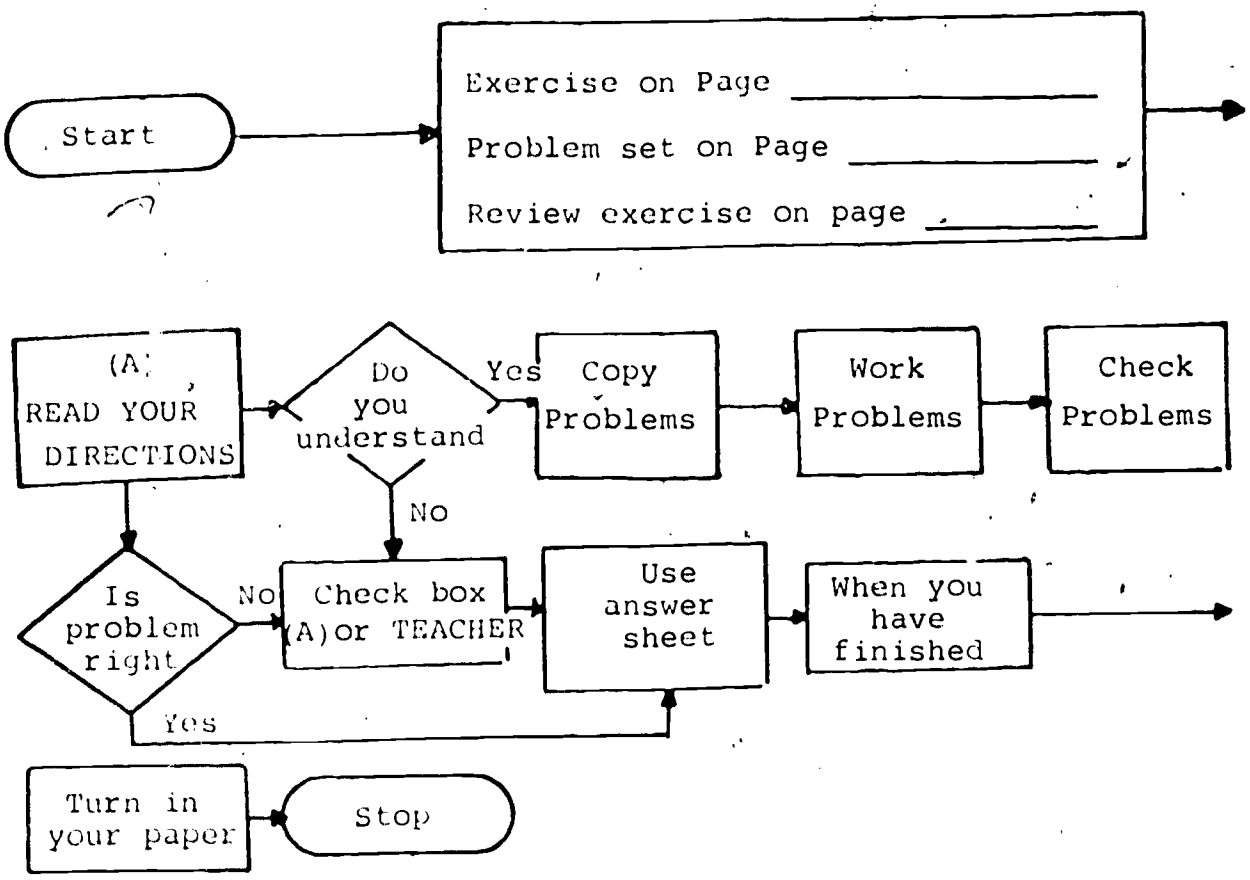
INDIVIDUAL LEARNING USING CONTRACT



LESSON FROM BOOK

NAME _____ DATE _____

Score _____ Time _____ (Min) _____



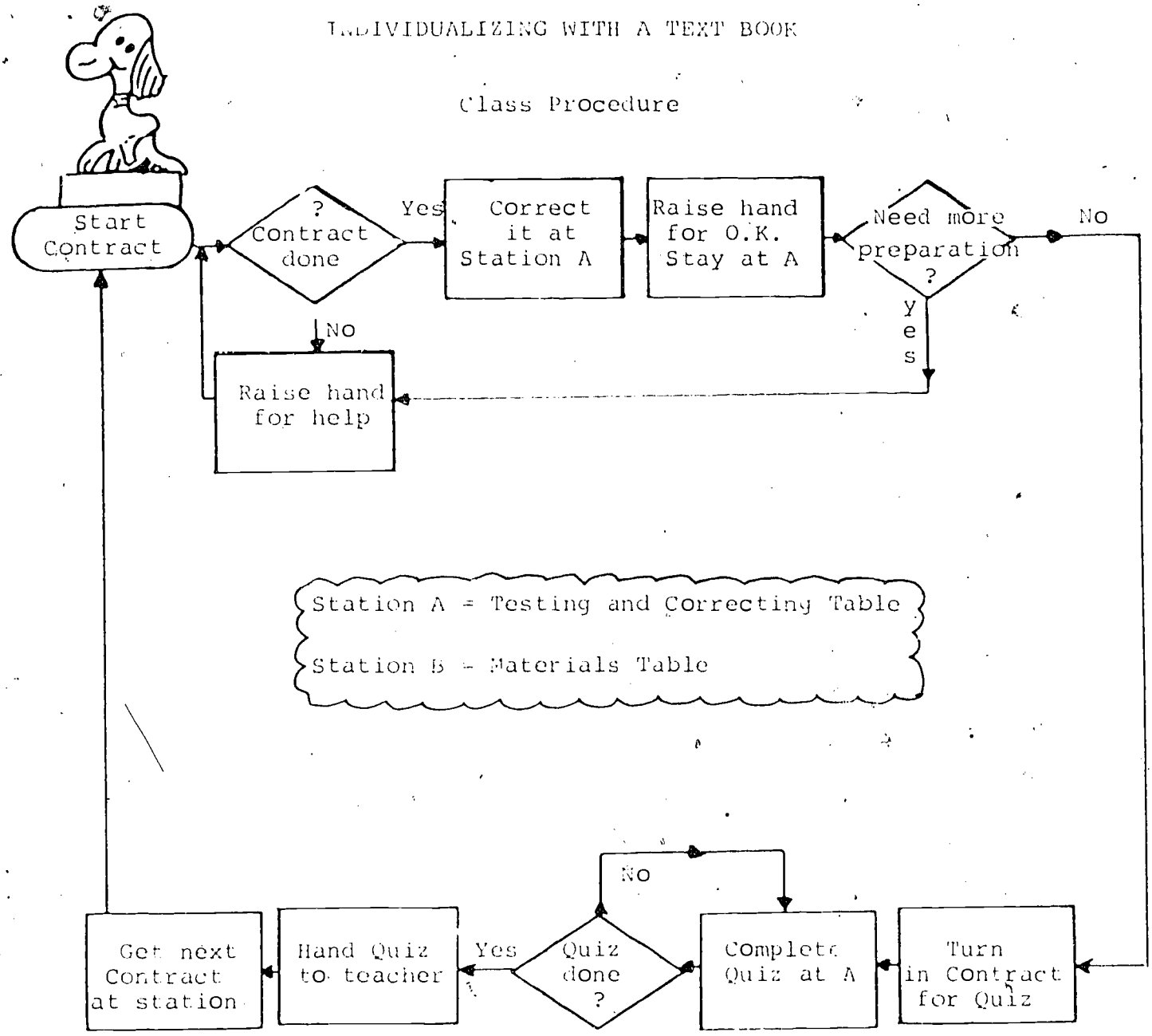
PROBLEMS TO BE WORKED

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

ANSWERS

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Class Procedure



General Directions:

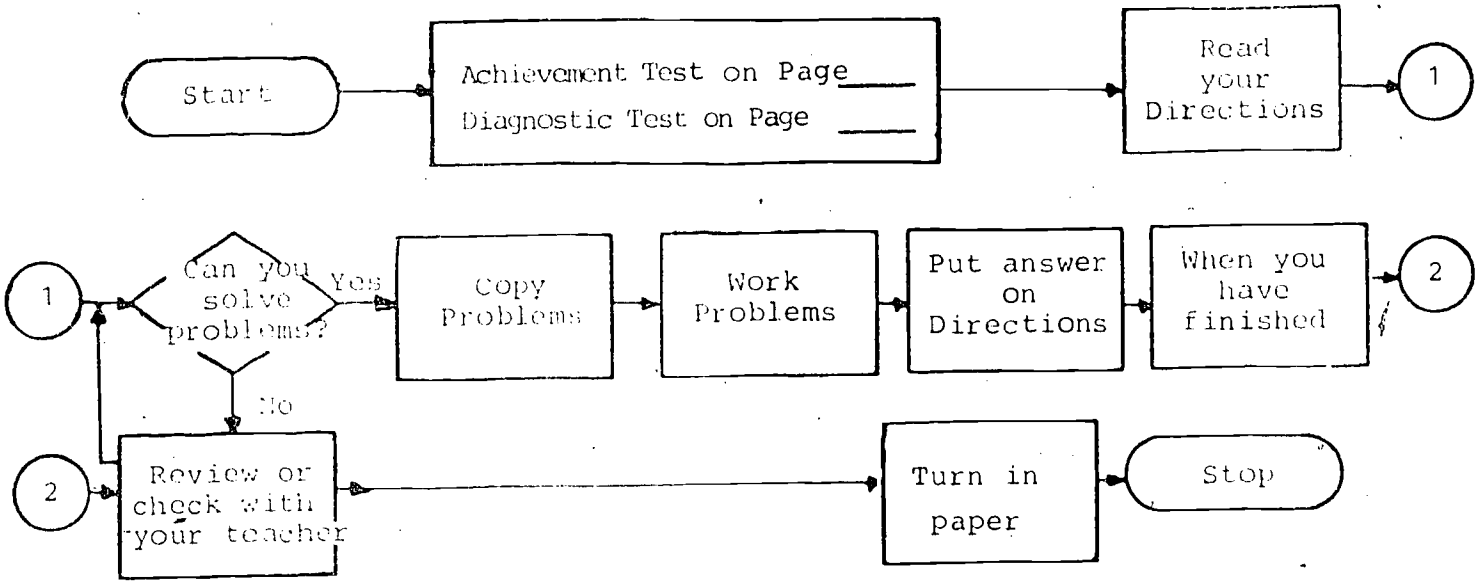
1. Bring a pencil and your book everyday to class.
2. Wait at your seat until roll is done before asking questions.
3. Be sure you have read the book carefully before asking questions.
4. No more than two students should be asking for things at material desk "B".
5. No talking while doing quiz at desk A - Your quiz might self destroy five seconds.
6. Be sure you have fulfilled the week's homework assignment.

EVALUATING

From The Text Book

NAME _____ DATE _____

SCORE _____ TIME _____ (Min.)



PROBLEMS TO BE WORKED

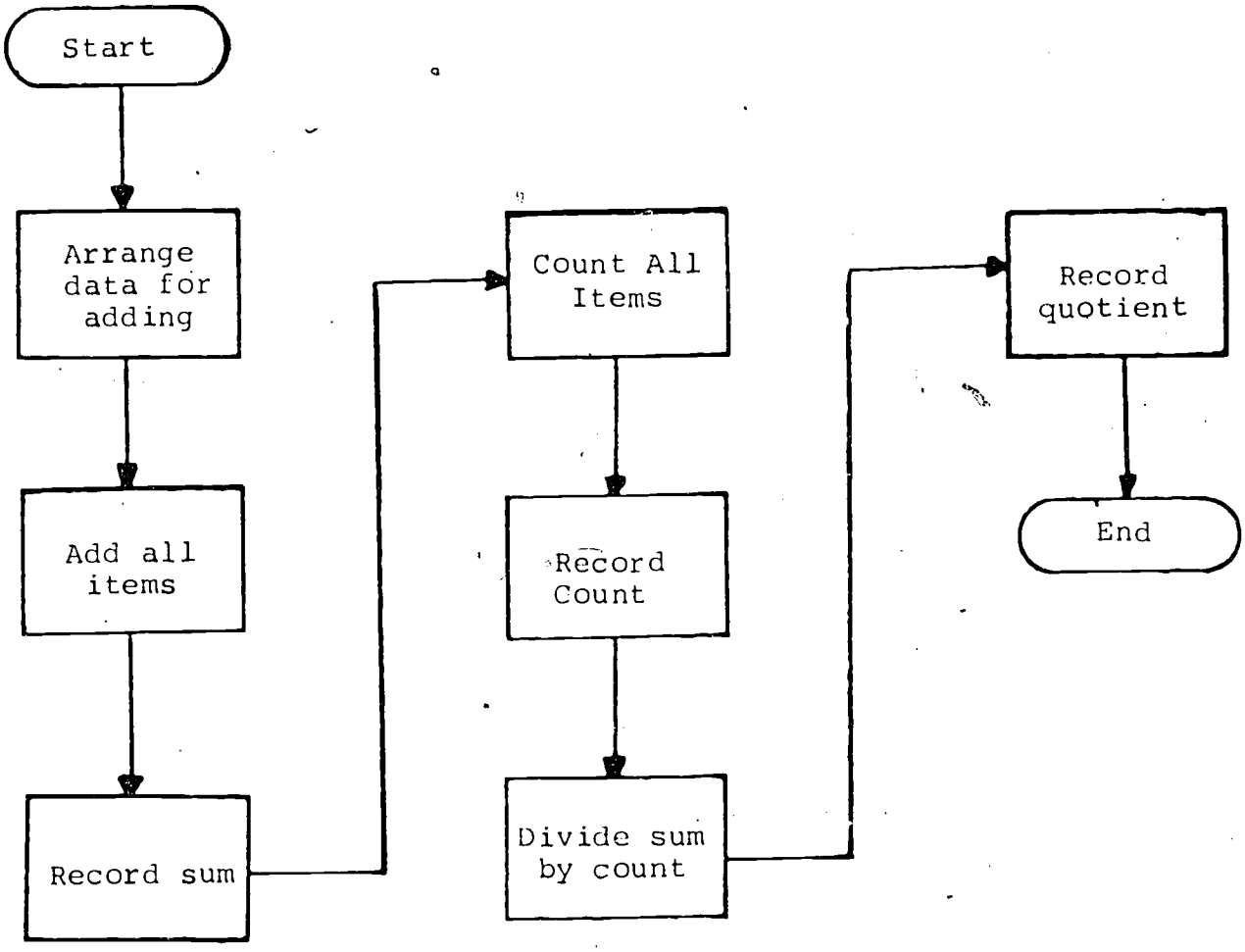
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

ANSWERS

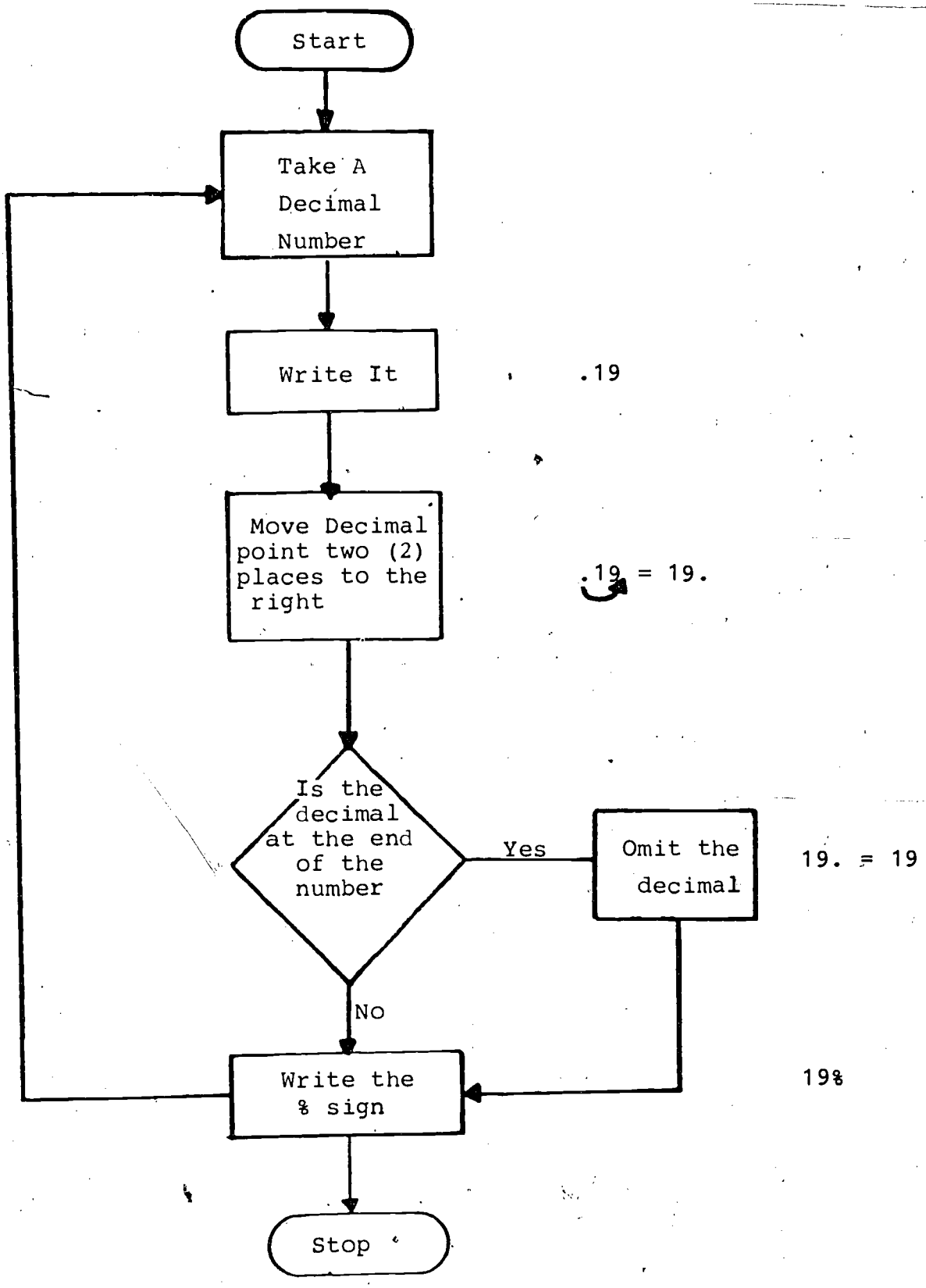
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

MATHEMATICS RELATED FLOWCHARTS

HOW TO FIND AN AVERAGE



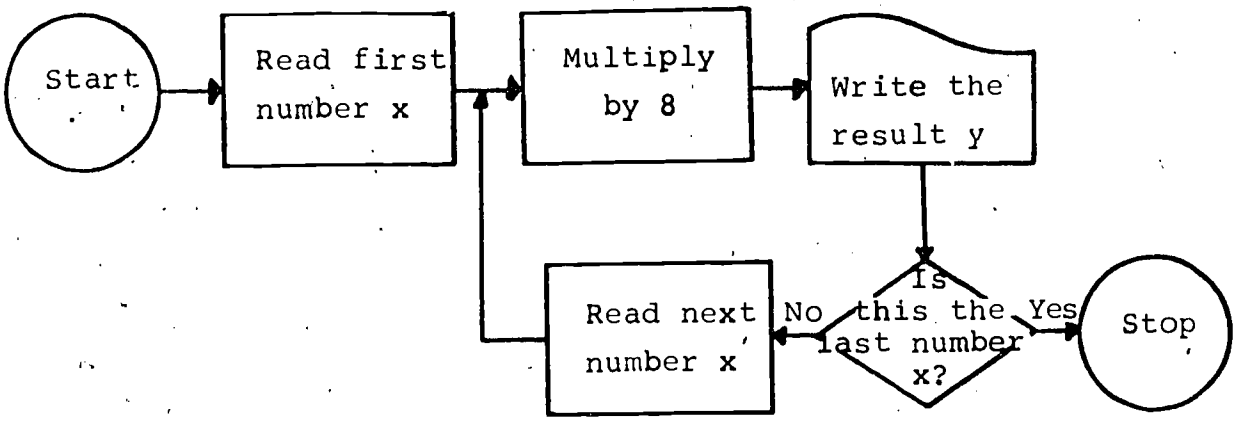
FLOWCHART FOR CHANGING DECIMAL NUMBERS TO PERCENT NUMBERS



FLOWCHARTING ALGEBRA EQUATIONS

Computers may be programmed using flowcharts.

1. You can use a flowchart as another way to manufacture numbers.



a. Use the flowchart above to find the missing numbers in table 1.

The flowchart gives you ordered pairs (first number, second number).

You can replace the flowchart with a rule. The rule tells you how to get the second number when you know the first number.

b. Circle the rule that works for the flowchart above.

1 $y = x+8$ 3 $y = x+7$

2 $y = 8x$ 4 $y = 2x+6$

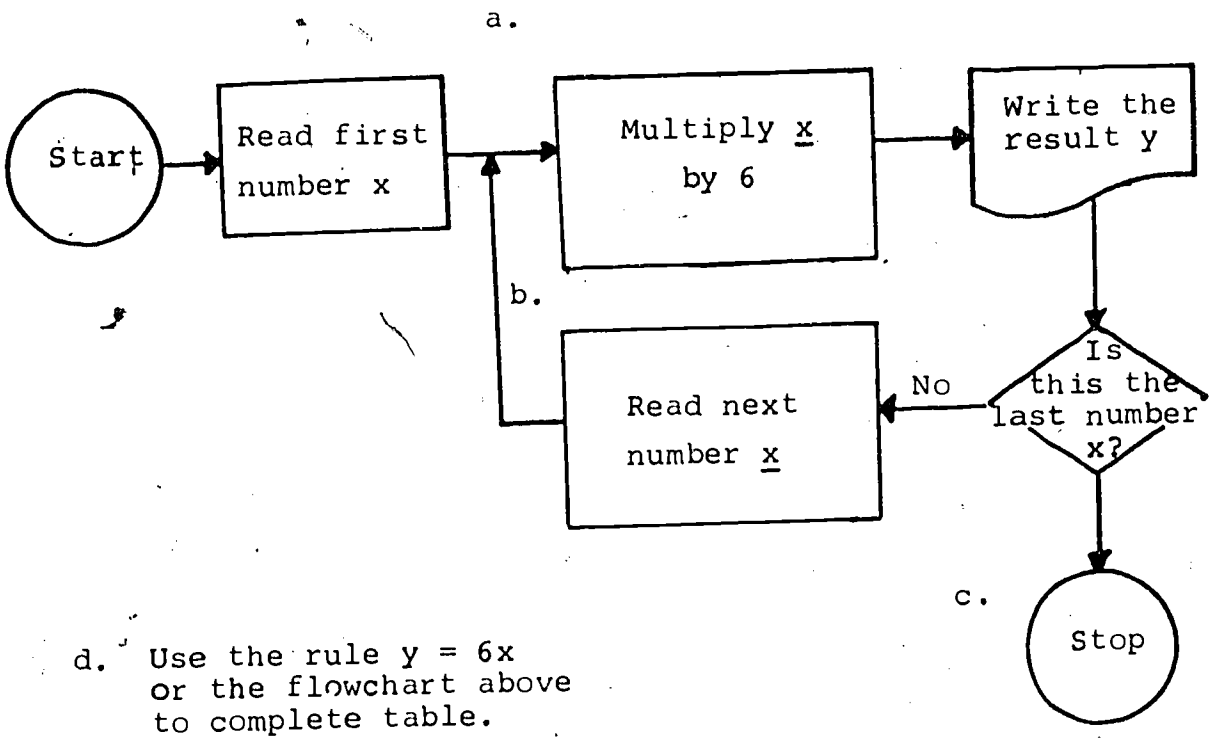
Table 1

First number (x)	Second number (y)
1	8
2	16
3	
5	
8	
9	

If x = 1, then 8 x 1 = 8

The result is that y = 8.

2. Complete this flowchart for the rule y = 6x.



d. Use the rule y = 6x or the flowchart above to complete table.

x	1	2	5	8			
y	6	12			54		72

e. MIND STRETCHER Make up a formula y = _____

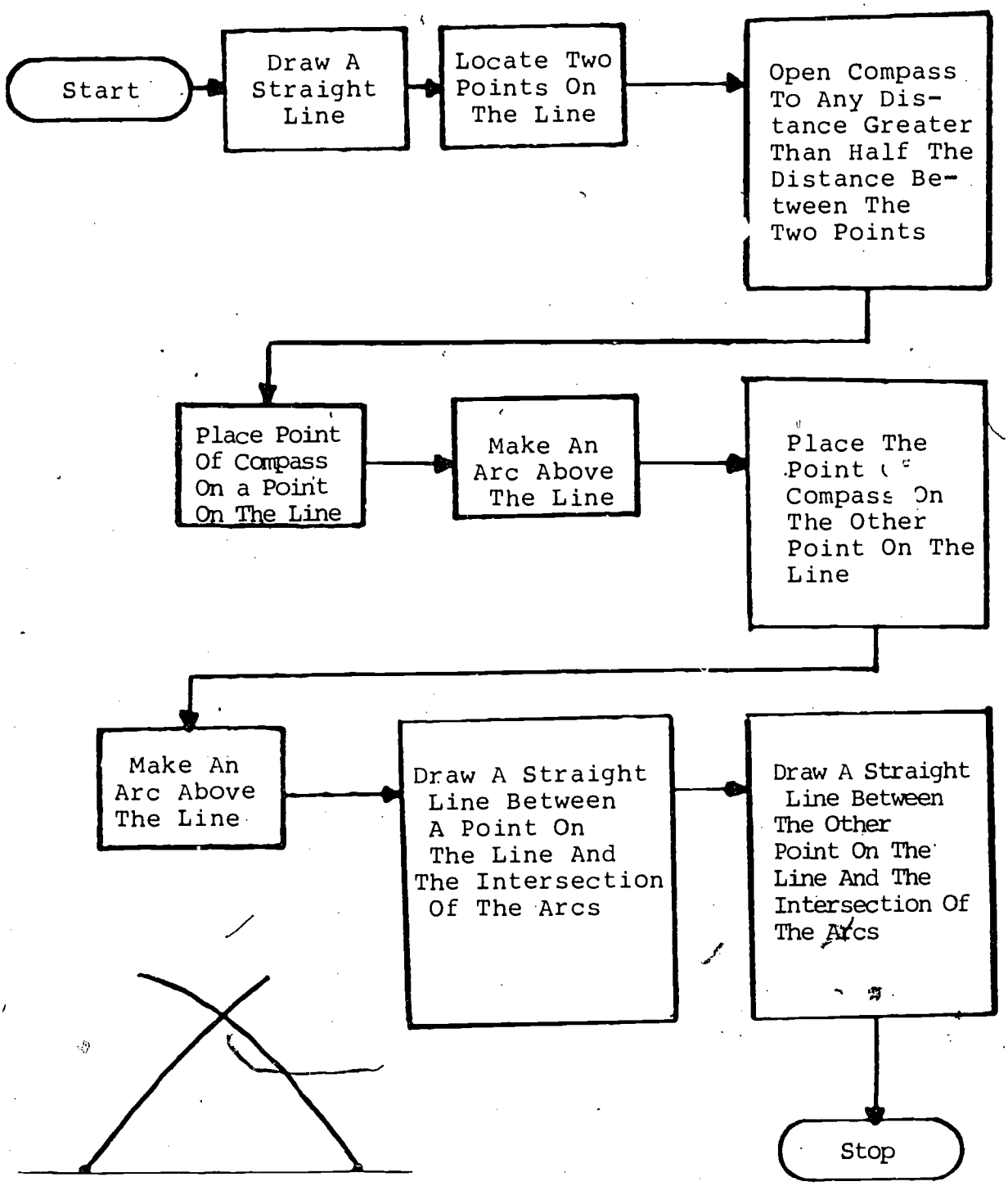
f. In the space below, draw a flowchart for the formula you chose.

g. Use the flowchart you drew to write 5 ordered pairs.

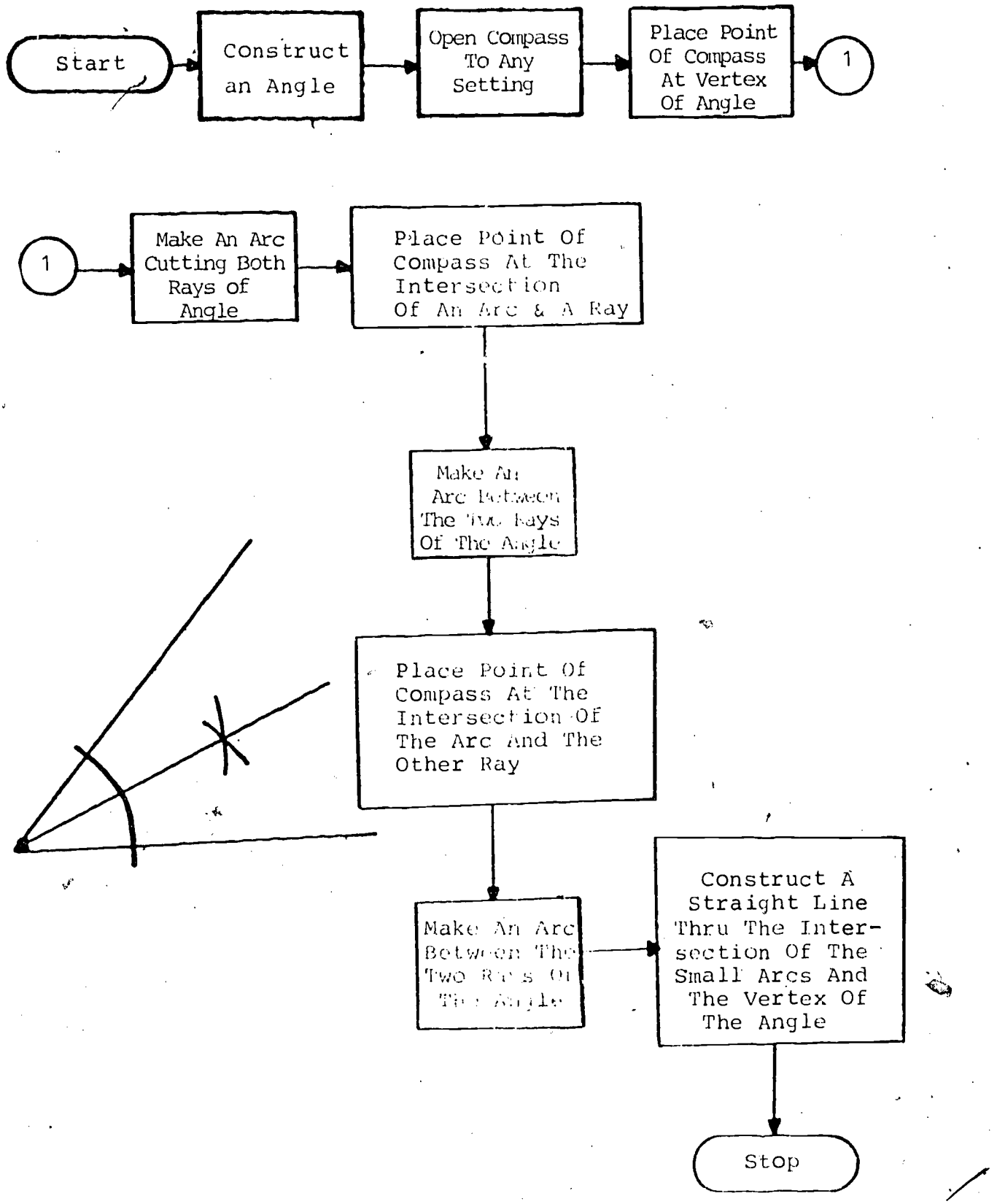
(_____, _____) (_____, _____) (_____, _____)

(_____, _____) (_____, _____)

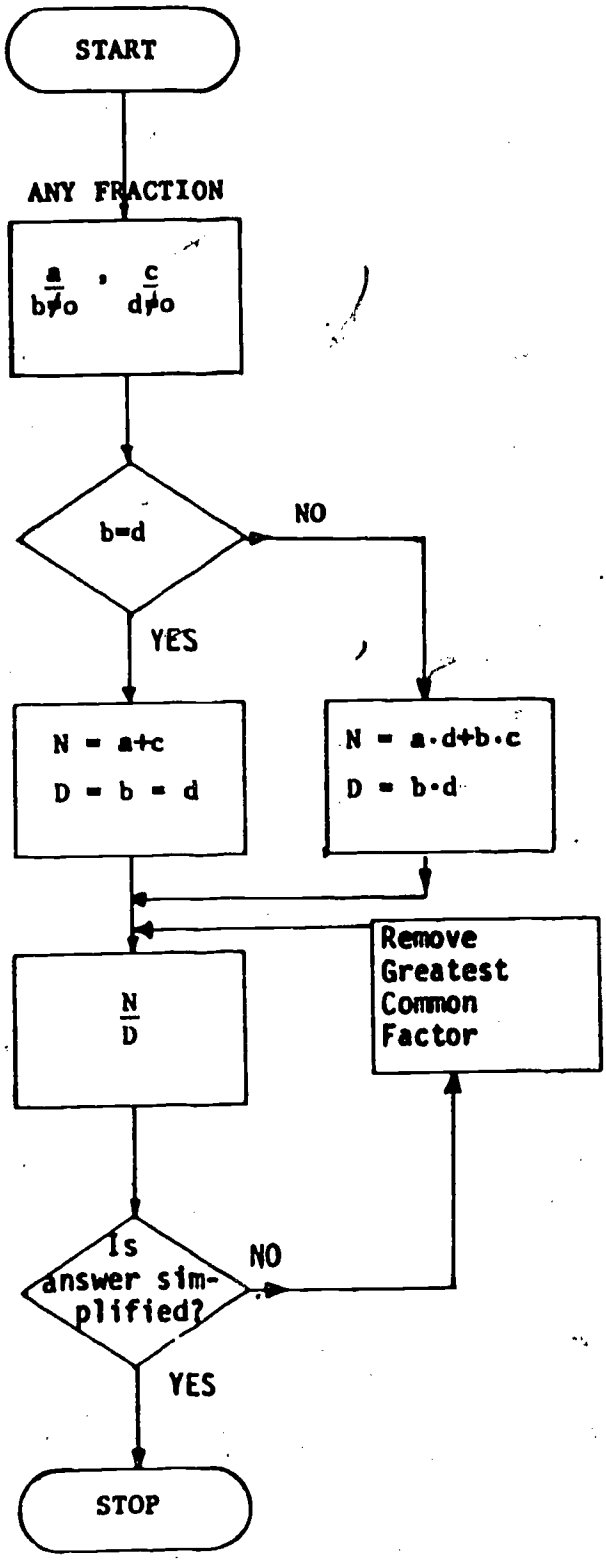
FLOWCHART FOR CONSTRUCTING AN ISOSCELES TRIANGLE



FLOWCHART FOR BISECTING AN ANGLE

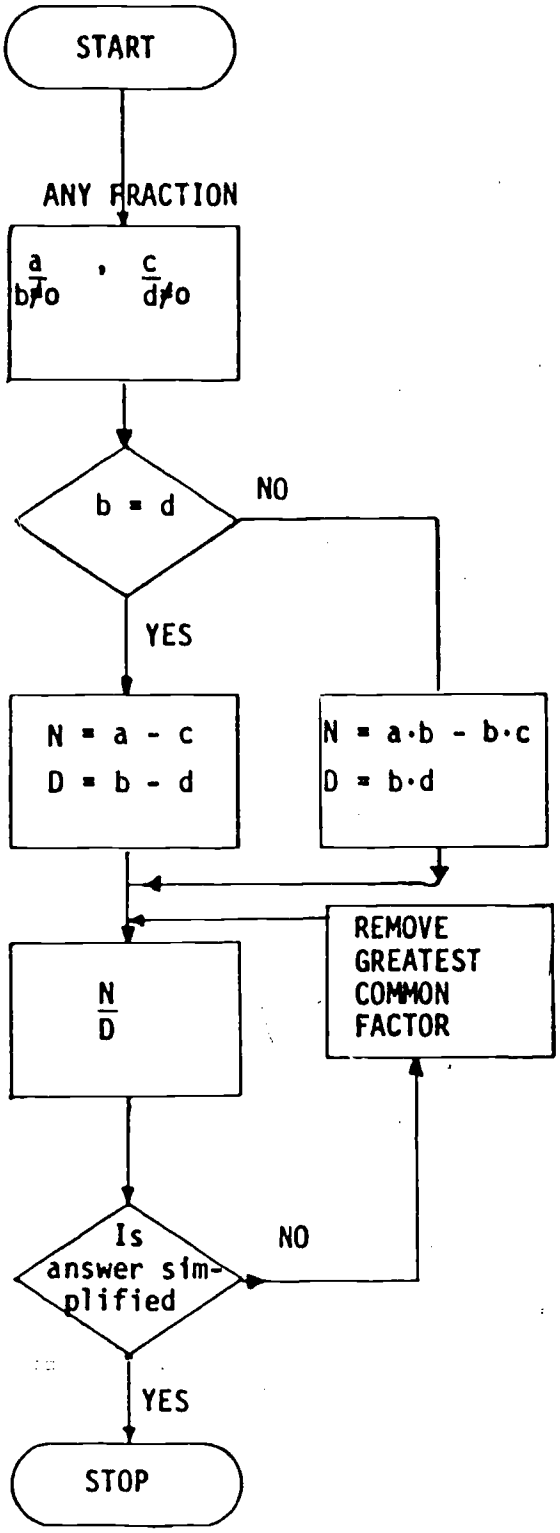


A FLOWCHART FOR ADDITION OF FRACTIONS



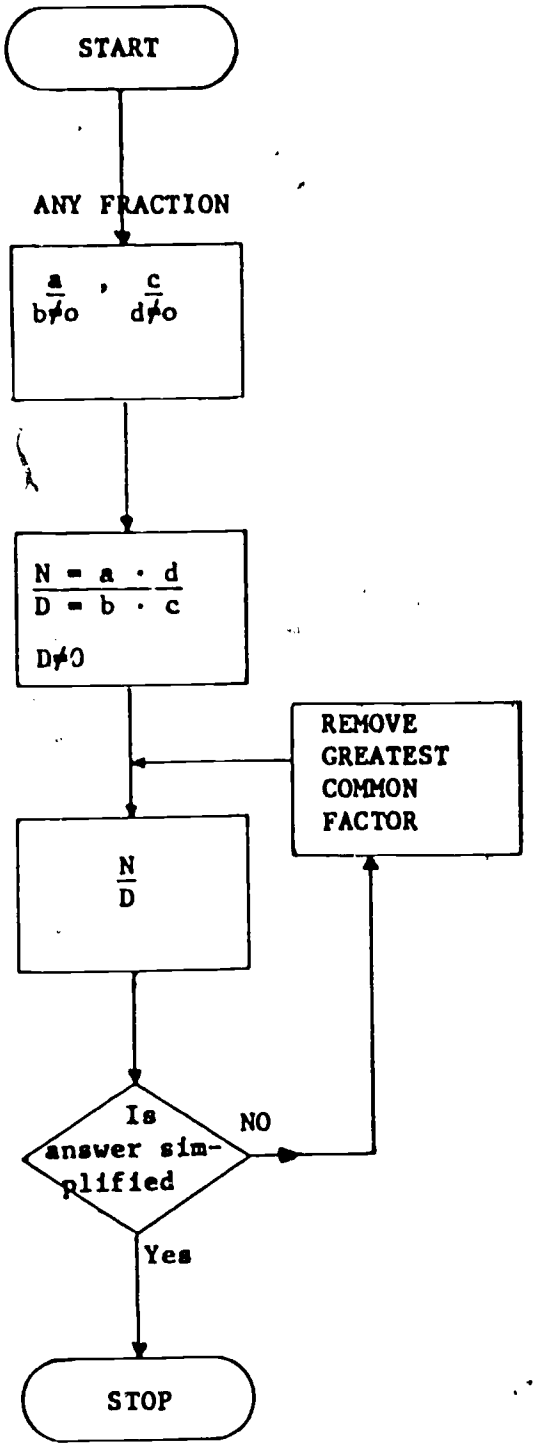
A FLOWCHART FOR SUBTRACTION OF FRACTIONS

$\left(\frac{a}{b} > \frac{c}{d}\right)$

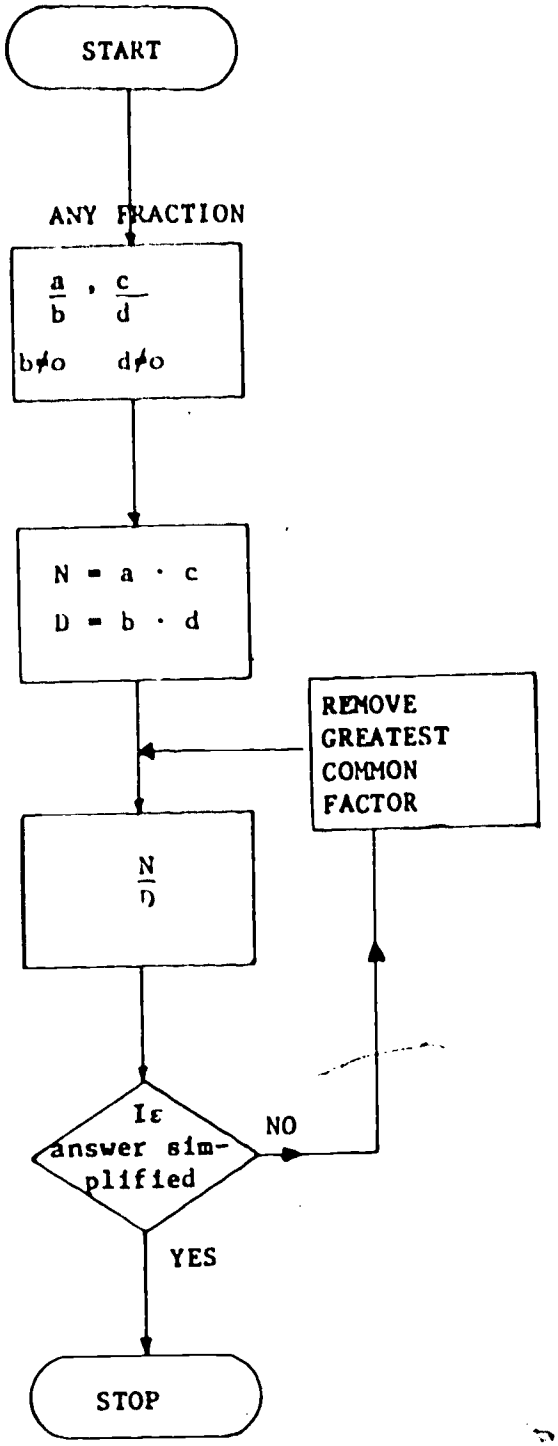


A FLOWCHART FOR DIVISION OF FRACTIONS

($\frac{c}{d}$ the divisor)



A FLOWCHART FOR MULTIPLICATION OF FRACTIONS



SAMPLE FLOWCHART SIMULATION

DRIVER'S LICENSE GAME

SUMMARY

In this two-day activity, students in groups of two, three, or four play at a gameboard whose flowcharted path represents the steps that must be fulfilled to obtain and keep a California Driver's License. Each student moves a marker along the path (tossing a die at decision points), and ultimately arrives in "blocks" that instruct him to take tests. At those points the player leaves the playing board, obtains a copy of the designated test, and takes it. After he completes it, the test is graded, and the student returns to the playing board. The objective of the game is to pass all the tests and be the first to arrive at the end of the flowcharted path.

* Rules and regulations-California Department of Motor Vehicle Code, 1980

SOLO'S

1. Following printed and verbal instructions, the student will correctly follow all flowcharted instructions on the "Driver's License Gamesheet."
2. The student will answer correctly all answers in the three self-administered tests in the "Driver's License Game."

MATERIALS

1. Pencils
2. A small plastic marker for each student
3. A single die for each three students
4. A "Driver's License Gamesheet" for each three students

...continued...

5. ("Driver's License Game Rules") for each student

6. For a class of 20 students (adjust number as required):

20 "Written Exams" (1 page each)

20 "Driver's Tests" (1 page each)

20 "Driving Tests for Parents" (1 page each)

20 "Truck Driver's Tests" (1 page each)

20 "Experienced Driver's Tests" (2 pages each)

DRIVER'S LICENSE GAME

Teacher's Guide

1. This activity should take two days. It "dovetails" with another activity which draws, somewhat, on the knowledge gained in playing the Driver's License Game.

2. Begin the activity by telling the students that the privilege of driving places an enormous responsibility on the driver with respect to numerous vehicle codes. The motor vehicle bureau of each state has the responsibility of assuring that prospective drivers have the physical skills necessary to operate a vehicle safely. These government bureaus are also charged with the responsibility for testing the prospective driver's knowledge of codes on driving.

3. Point out that an enormous effort must be expended to coordinate the findings of the legislature, courts, highway department, etc., and produce the necessary documents, procedures, examinations and records dealing with vehicles and drivers. The net result of many of these efforts is portrayed in flow charted form in the "Driver's License Game."

4. Place the students in groups of three or four and give each group a "Driver's License Gamesheet" and a single die. Also give each student game rules and a small plastic marker. Note: If the class division results in one or two extra students assign good readers to be test scorers".

5. Tell the students to read their "Driver's License Rules." Elaborate on any points that are questioned. Point out the (previously arranged) table that holds packets of "Written Exams," "Driver's Tests," "Driving Tests for Parents," "Truck Driver's Test," and "Experienced Driver's Tests." (See accompanying sketch.) Tell the class that when they play the

game and arrive at a heavily bordered block on the flowchart, they should leave the game, obtain a copy of the test, take the test, and bring it to the test scorers, teacher, or teacher's aide for checking. Instruct the students to read all instructions in the blocks very carefully. The information may be required to pass the experienced driver's test.

6. Point out that if a student does not complete the test to the teacher's or aide's satisfaction, he or she will be required to take the test again before returning to the game.

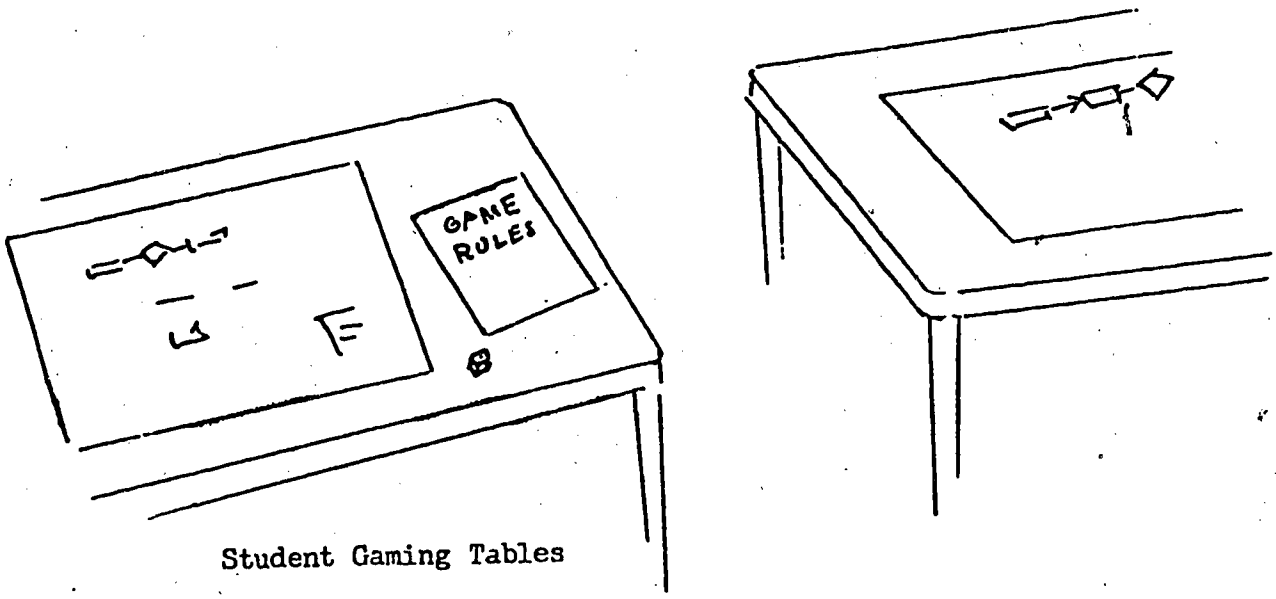
7. Tell the class that the object of the game is to be the first to arrive at the "Stop" symbol at the end of the flowchart process. Correct responses to the tests advance a player's movement along the flowchart path.

8. Have the class start playing the game, and circulate among the students to ascertain that they are following the game rules.

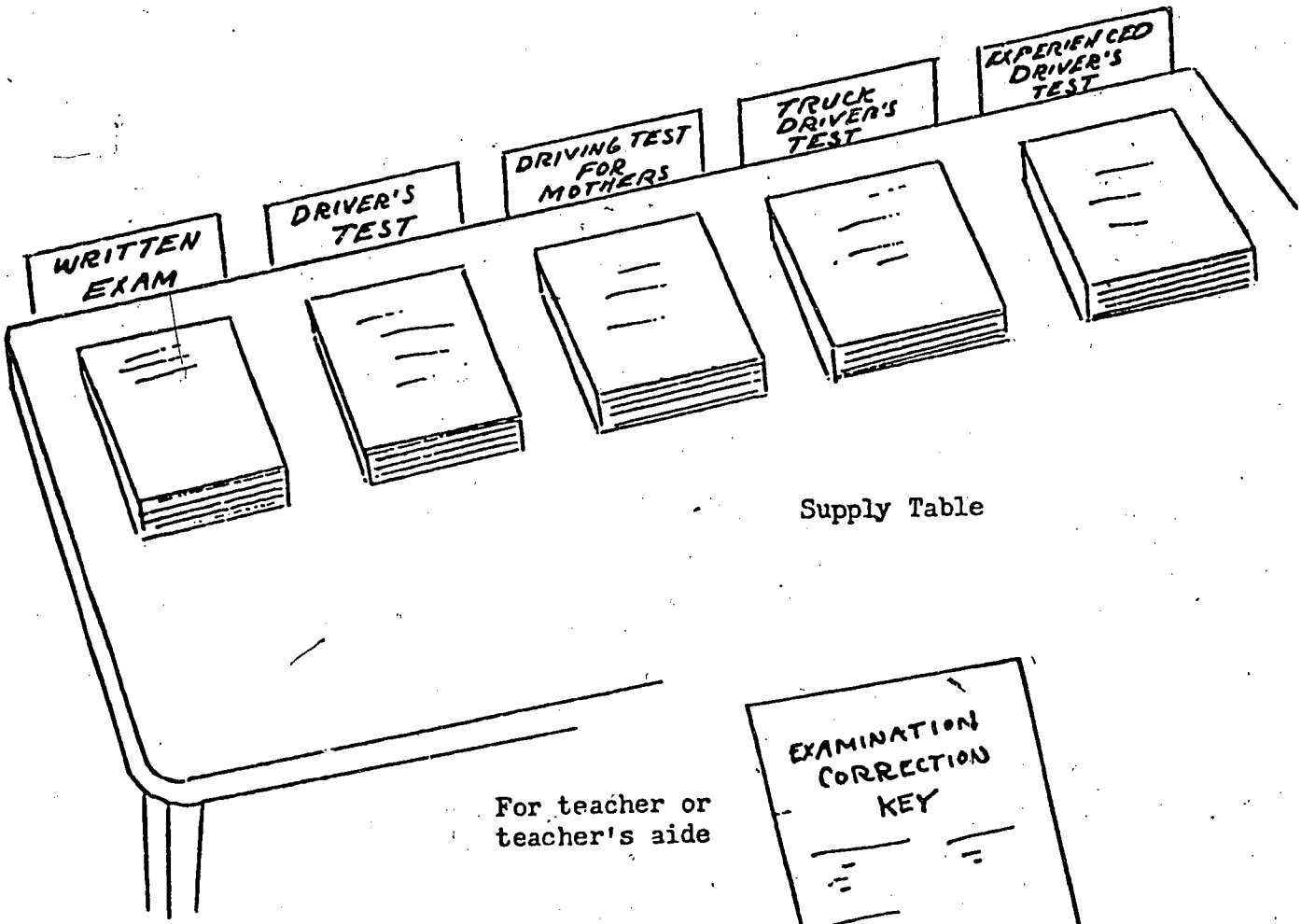
9. At the end of the game-playing session, collect the tests that the students have taken. The completed tests are the basis for SOLO accomplishment.

ROOM SET-UP FOR DRIVER'S LICENSE GAME

TEACHER COPY

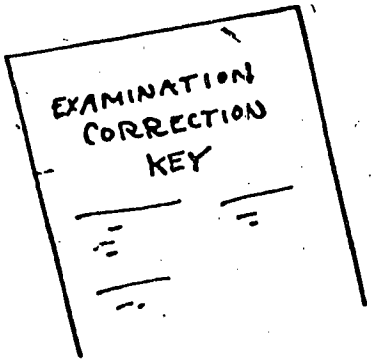


Student Gaming Tables



Supply Table

For teacher or teacher's aide



Written Exam

1. c
2. b
3. a
4. d

Drivers Test

Answer B

Truck Driver's Test

1. d
2. c
3. b
4. a

Driving Test for Parents

1. c
2. a
3. d
4. b

Experienced Driver's Test

1. a
2. a
3. b
4. b
5. d
6. b
7. a
8. c
9. c
10. b

DRIVER'S LICENSE GAME RULES

(Name)

1. You and your opponents will play a game to get your "driver's license." In order to get the license and keep it, you must follow certain steps, pass tests, and comply with California law.

2. Decide who will go first.

   Place your marker on the "start" block.

3. You will take turns and move one block at a time. Follow the flow chart.

   When you land on a decision block, (◇), toss a die and move as follows:

   Even (2, 4, 6, or 8) -Move in "yes" direction

   Odd (1, 3, 5, or 7) -Move in "no" direction

   If you move from one decision block directly to another, wait for your turn and toss again.

   When you land on an operation block (□) follow the instructions in the block, and then wait for your next turn.

4. Read each block carefully. The information in the block may be required to pass your experienced drivers' test.

   If the block has a penalty, you may be required to skip a few turns while others move ahead.

5. When you land on a block with a heavy outline, you must actually take the written "test" named in the block.

   Read the rules and take the written test.

   Grade your own test, using the "Examination Correction Key."

   You must get 100% to pass.

   If you fail the test, study the questions you missed and answer them again.

6. When you finish the game, let your opponents continue.

   Ask your teacher or team leader for the "Experienced Drivers Test."

NAME _____

TRUCK DRIVER'S TEST

Ir ructions

Read the information below on "Rules of the Road" and then answer the questions under the heading "Exam".

Rules of the Road

The maximum speed for a truck or tractor having three or more axles is 55 miles per hour (mph).

A truck rated at 10,000 lbs. or more must be able to stop from 25 mph within 50 feet.

Trucks are required to have mudguards to prevent the spraying of mud or water on following cars.

Turn signals and stop lights must be connected to any vehicle you are towing.

Exam (Circle the correct answer)

1. Trucks rated at 10,000 lbs. or more must be able to stop from 25 miles per hour within:

   (a) 20 ft. (c) 20 yds.

   (b) 50 yds. (d) 50 ft.

2. When you are towing a vehicle, you must connect which of the following to the vehicle being towed?

   (a) headlights (c) turn signals and stop lights

   (b) steering wheel (d) spare tires

3. The maximum speed limit for trucks is:

(a) 65 mph
(b) 55 mph
(c) 45 mph
(d) 75 mph

4. Trucks and trailers are required to have mudguards to:

(a) prevent spraying water
(b) look cool
(c) cut down glare
(d) cut down wind resistance

DRIVER'S TEST

Instructions

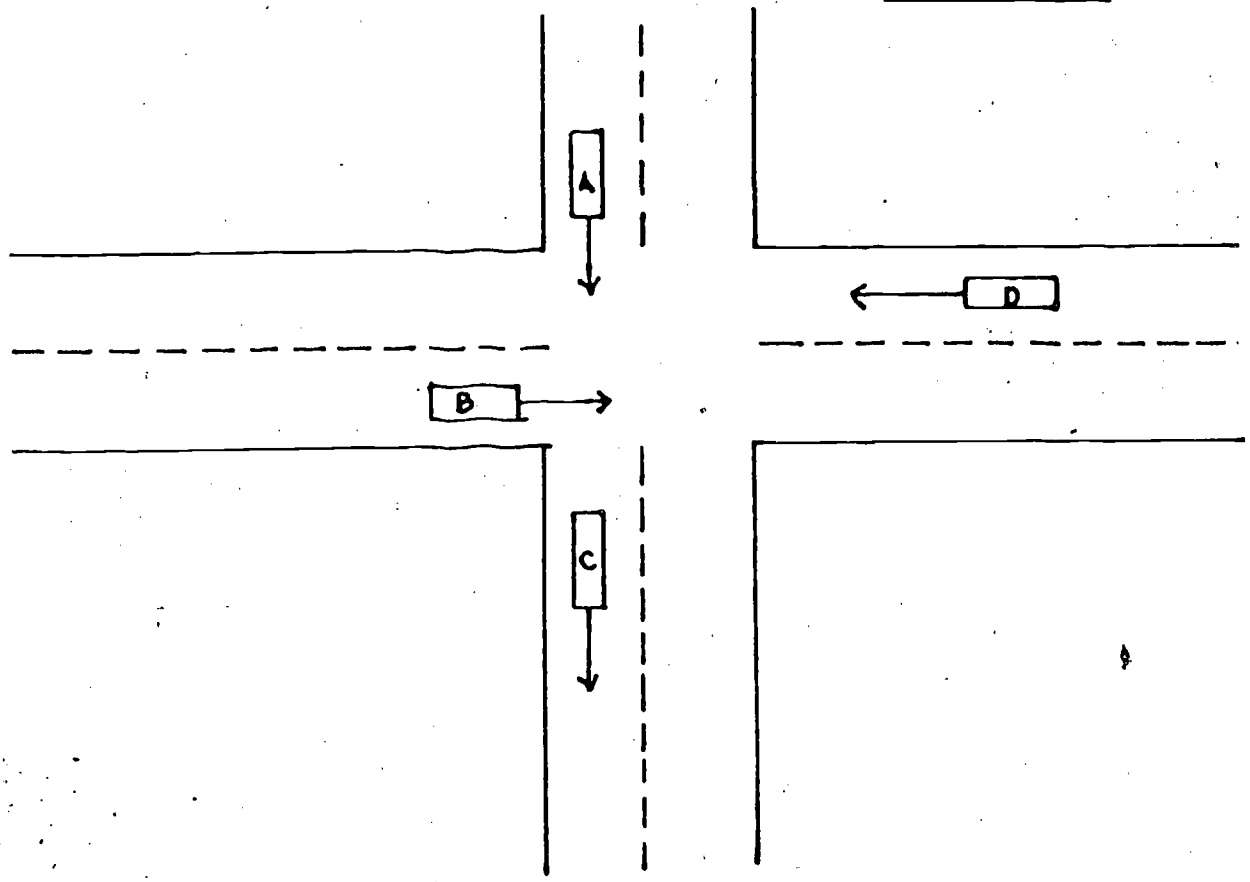
Read the information below on "Right-of-way" and then answer the question under the heading "Exam".

Right-of-Way

When two cars approach an unmarked intersection (no stop or yield sign), the first car reaching the intersection has the right-of-way When two cars approach an unmarked intersection at the same time, the car on the right has the right-of-way. The car that has the right-of-way can enter and cross the intersection (of the street) first.

Exam

Which car shown in the diagram below has the right-of-way to cros the intersection? Circle the correct answer: A B C D



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NAME _____

WRITTEN EXAM

Instructions

Read the information below in "Driving Rules" and then answer the questions under the heading "Exam".

Driving Rules

You must signal a turn continuously for 100 feet before reaching the turning point.

A yellow curb indicates that you can stop for loading or unloading for a limited time only.

Unless otherwise posted, the California speed limit is 55 miles per hour (mph) for passenger cars.

Diamond-shaped signs  warn of road conditions or danger points.

Exam (Circle the correct answer)

1. Unless otherwise posted, the speed limit is California is:

   (a) 70 mph (b) 60 mph (c) 55 mph (d) 75 mph

2. "Warning, Narrow Bridge" would be in which of the following shaped signs?

   (a) 

   (c) 

   (b) 

   (d) 

3. You may stop to load or unload passengers for a limited time only at a:

   (a) yellow curb (c) white curb

   (b) green curb (d) red curb

4. How far in advance must you start signaling for a turn?

   (a) 1,000 ft (b) 200 ft (c) 50 ft (d) 100 ft

NAME _____

DRIVING TEST FOR PARENTS

Instructions

Read the information below on "Rules of the Road" and then answer the questions under the heading "Exam".

Rules of the Road

Children riding in the car should always be in the back seat. Packages should never be stacked so they block the view through the rear window.

Children riding in the car should use a seat belt or harness.

Pets should not be allowed in the front seat since they may interfere with your driving.

Exam (Circle the correct answer)

1. Children riding in the car:

   (a) do not need seat belts

   (b) can help you drive

   (c) should wear a seat belt or harness

   (d) can sit on your lap while you are driving

2. Pets riding in the car:

   (a) should not ride in the front seat

   (b) can lie under your feet

   (c) can lie on your lap

   (d) can sleep in the back window

3. Children in the car with you:

   (a) should ride next to you

   (b) can climb back and forth over the seat

   (c) can play in the back window

   (d) should ride in the back seat

4. When you load your groceries into the car, they should:

   (a) be where you can grab them

   (b) should not block you view

   (c) be stacked high on one side of the car

   (d) be put on the back window ledge

EXPERIENCED DRIVER'S TEST

(Write your answer in the space provided.)

_____ 1. You must report your change of address within:

(a) 10 months (c) 3 months

(b) 3 days (d) 10 days

_____ 2. The license fee for a regular driver's license is:

(a) $3 (c) $2

(b) $1 (d) $4

_____ 3. Which of the following examinations is not required to get a license?

(a) eye (c) written

(b) physical (d) driving

_____ 4. You can get an Instruction Permit when you are how old?

(a) 17 (c) 18

(b) 15 (d) 21

_____ 5. The temporary license is good for:

(a) 3 years (c) 90 days

(b) 1 year (d) 60 days

_____ 6. If you hit a parked car you should:

(a) forget about it
(b) find owner or leave a note
(c) get out of there as fast as you can
(d) tell a bystander

_____ 7. The fee for a duplicate license is:

(a) $1.00
(b) $2.00
(c) $3.00
(d) $4.00

_____ 8. The maximum speed limit in a school zone is:

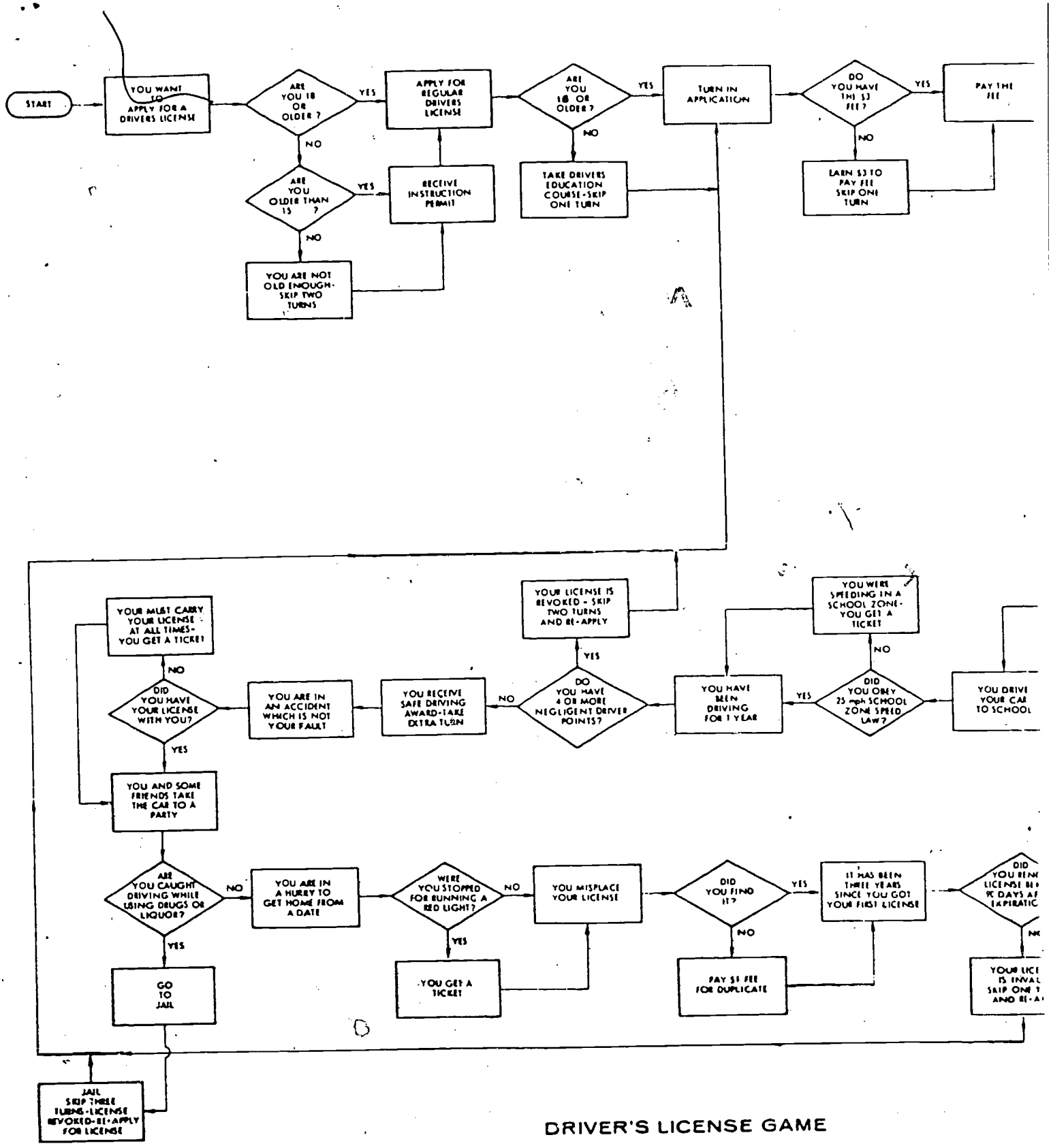
(a) 15 mph
(b) 20 mph
(c) 25 mph
(d) 30 mph

_____ 9. How many negligent driver points must you get in one year before your license is revoked?:

(a) 1
(b) 2
(c) 4
(d) 6

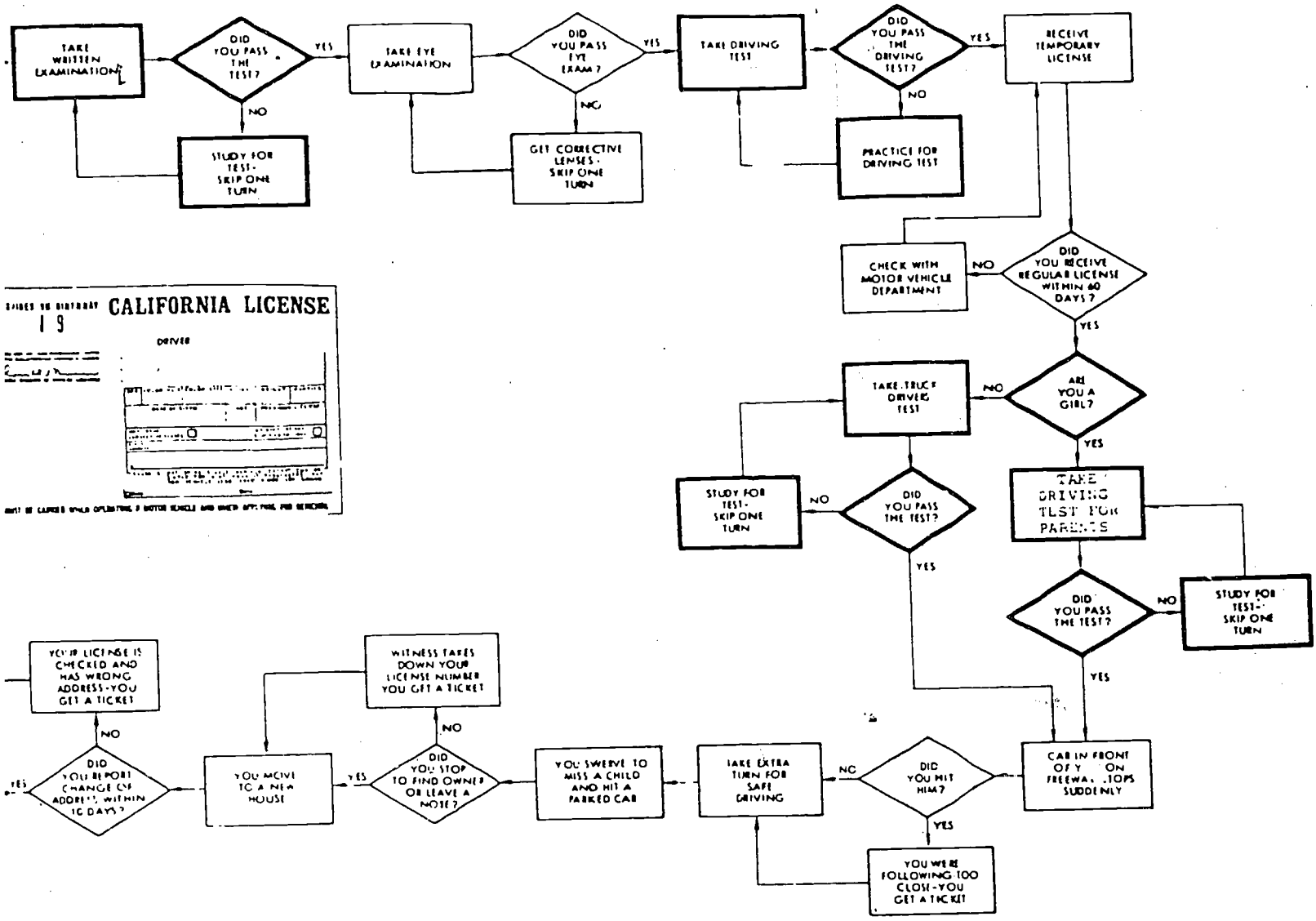
_____ 10. If you are caught driving while using drugs:

(a) nothing will happen
(b) your license will be revoked
(c) no one will know
(d) your license will not be revoked



DRIVER'S LICENSE GAME

* Rules and regulations-California Department of Motor Vehicle Code, 198C



RULE FOR MOVING YOUR MARKER

1. Roll a single die.
2. If the number is odd (1, 3, 5, or 7) move in the NO direction.
3. If the number is even (2, 4, 6, or 8) move in the YES direction.