

Physics

Elementary Mechanics



PLATO
EDUCATIONAL SOFTWARE

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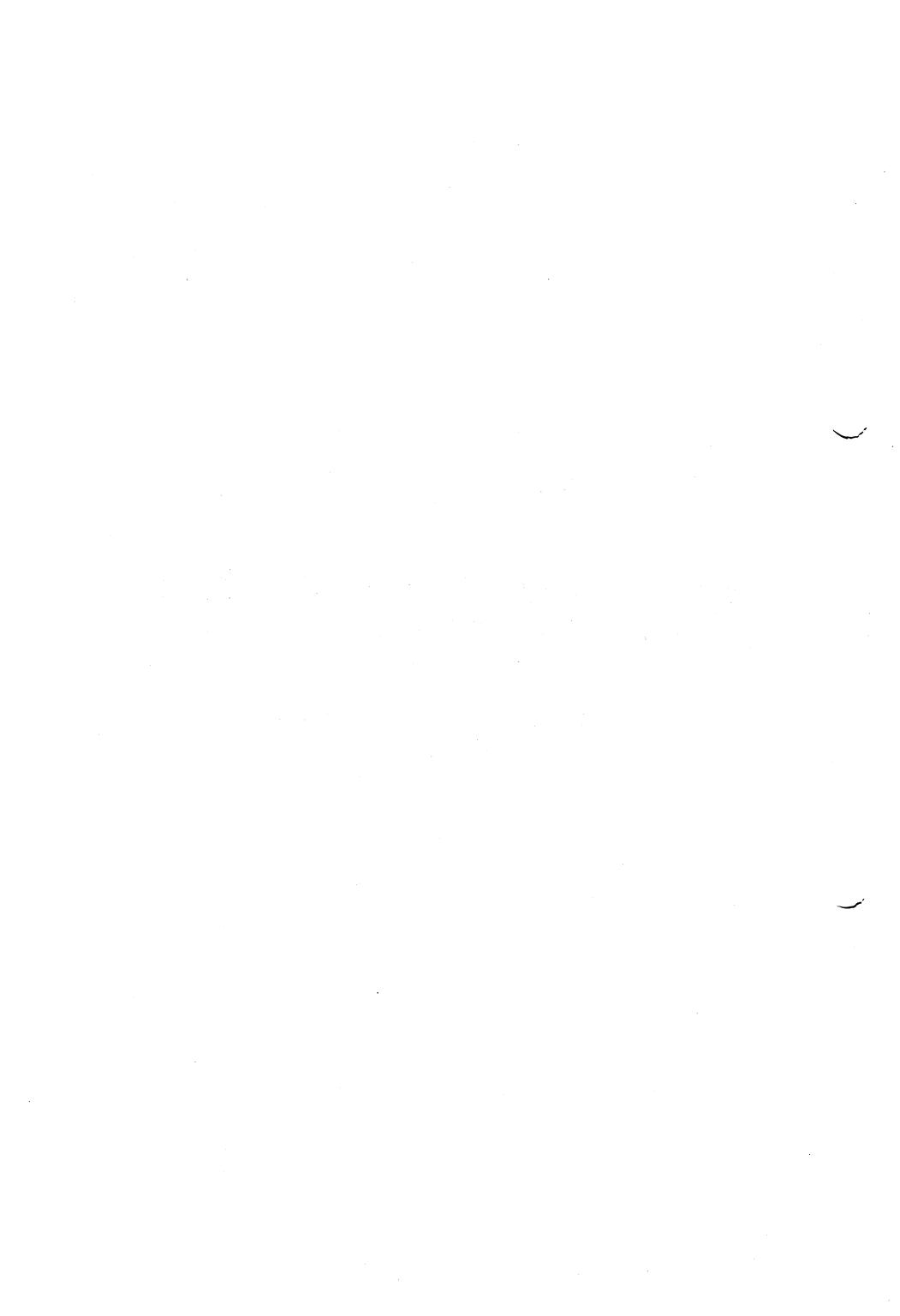
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Adapted From:
PHIZQUIZ

**A PROBLEM-SOLVING TEST
IN ELEMENTARY MECHANICS**

**Written by Brad Peterson
While at the
University of Illinois**

Revised by Dennis Kane



CREDITS

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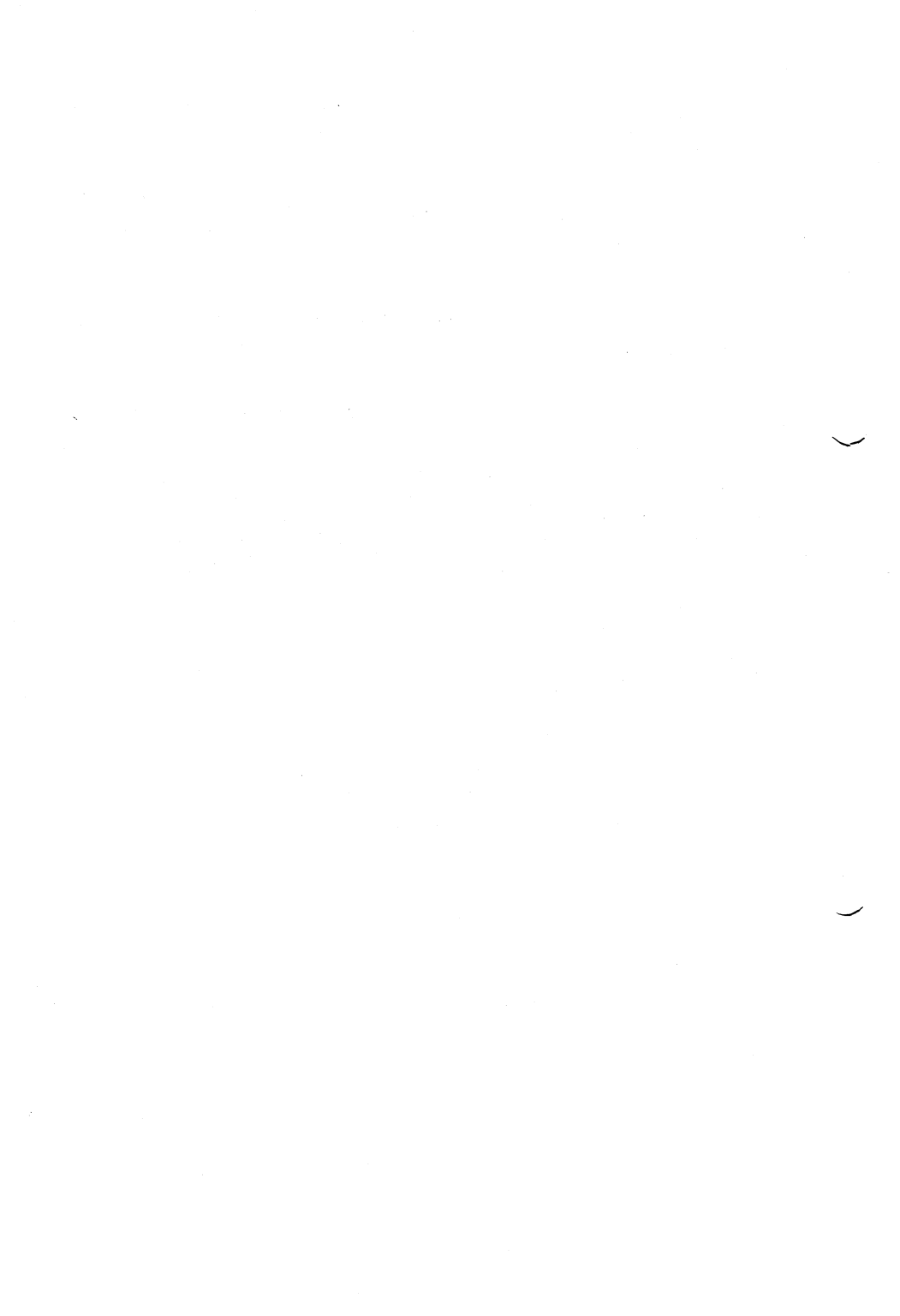
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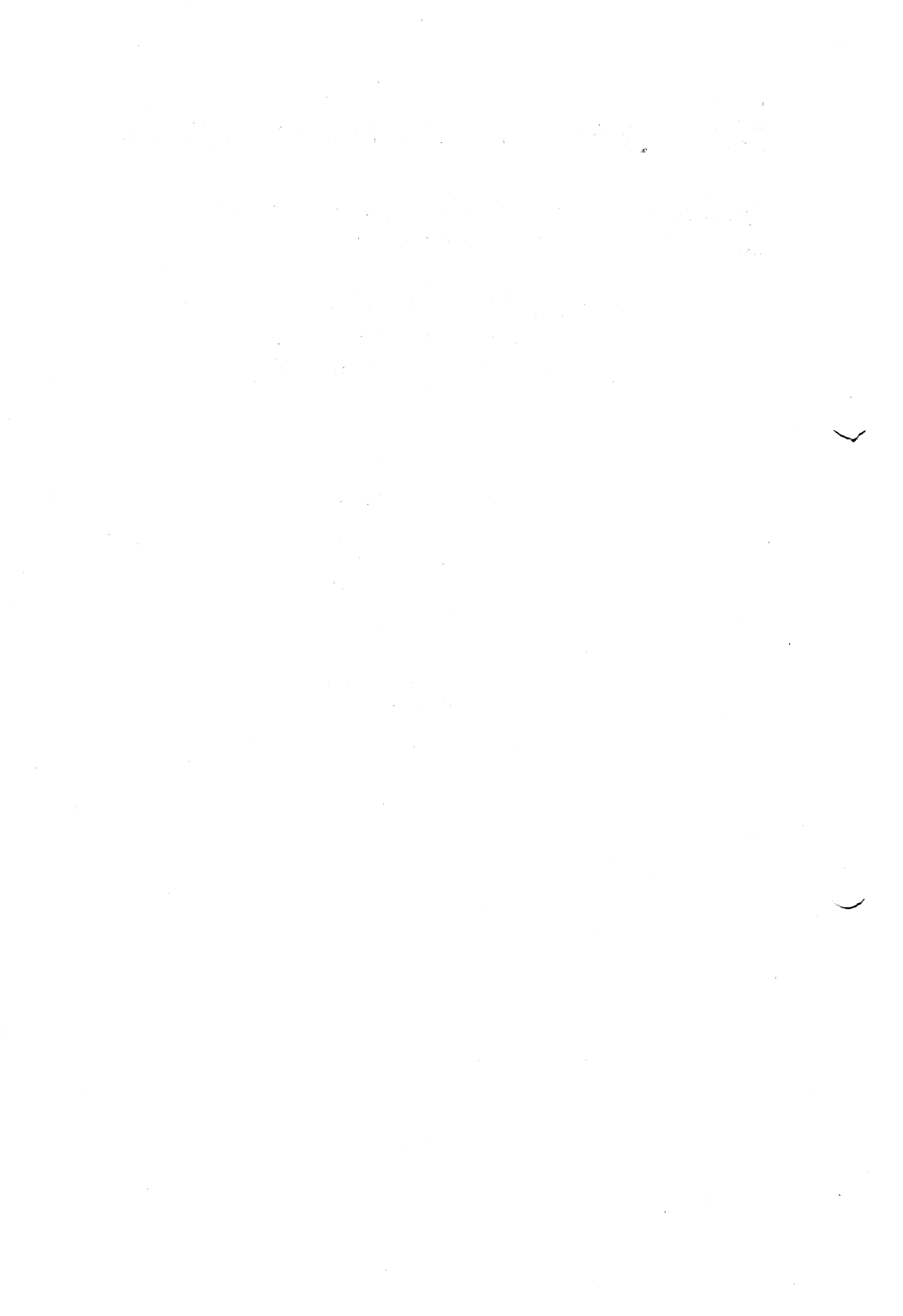
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PREFACE

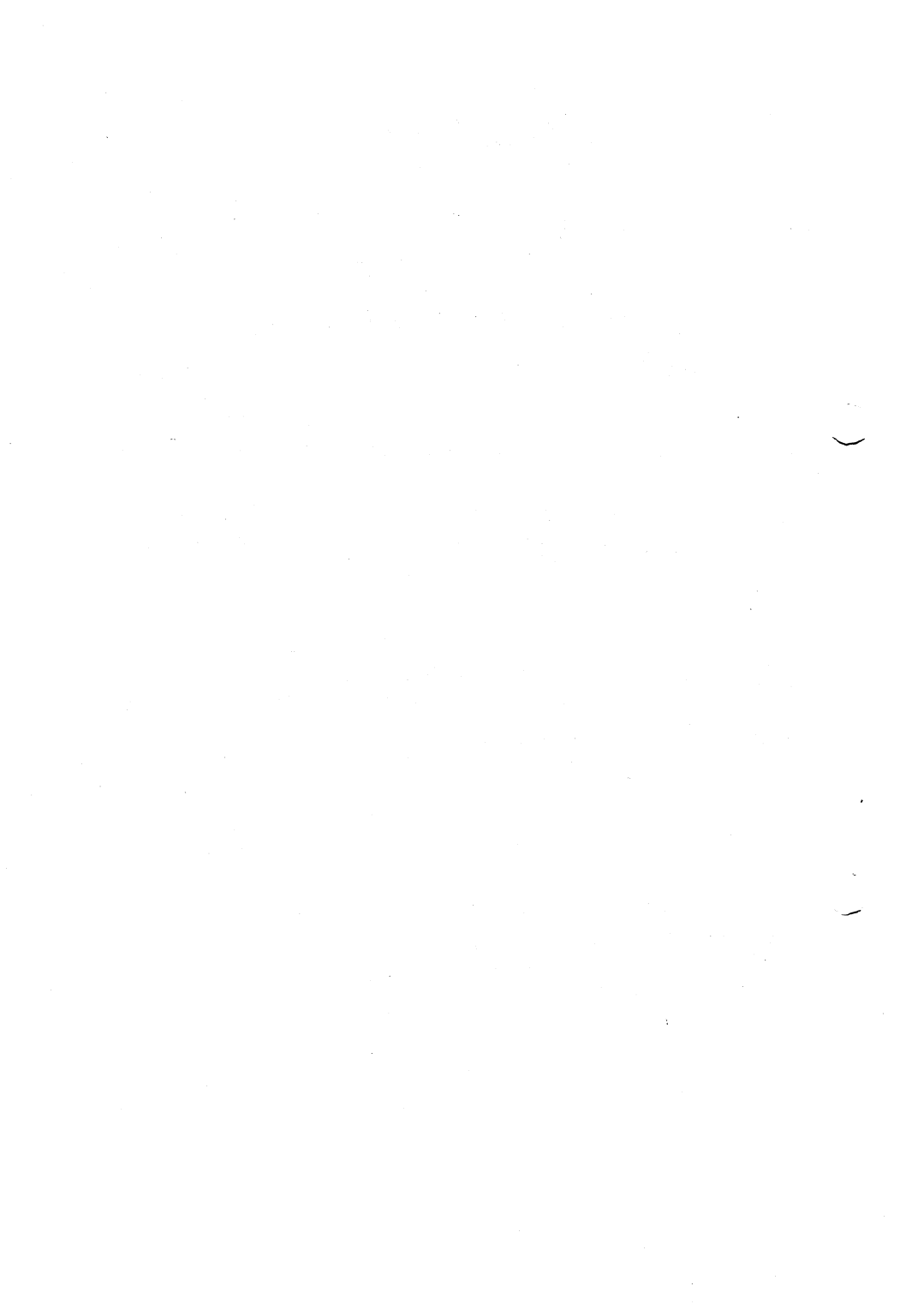
PHYSICS: Elementary Mechanics is a Control Data PLATO educational software package. It is available for use on APPLE II Plus[®], ATARI 800[®], and TEXAS INSTRUMENTS 99/4A[®] microcomputers.

The Phizquiz activity provides eight different exercises in elementary mechanics. The format used for each exercise is an animated physics situation with a question to be answered about that situation. The student must determine what information and concepts are necessary to answer the question correctly.

This text contains an introduction to the Phizquiz activity, the lesson flow and teaching strategies, and samples of related worksheets.

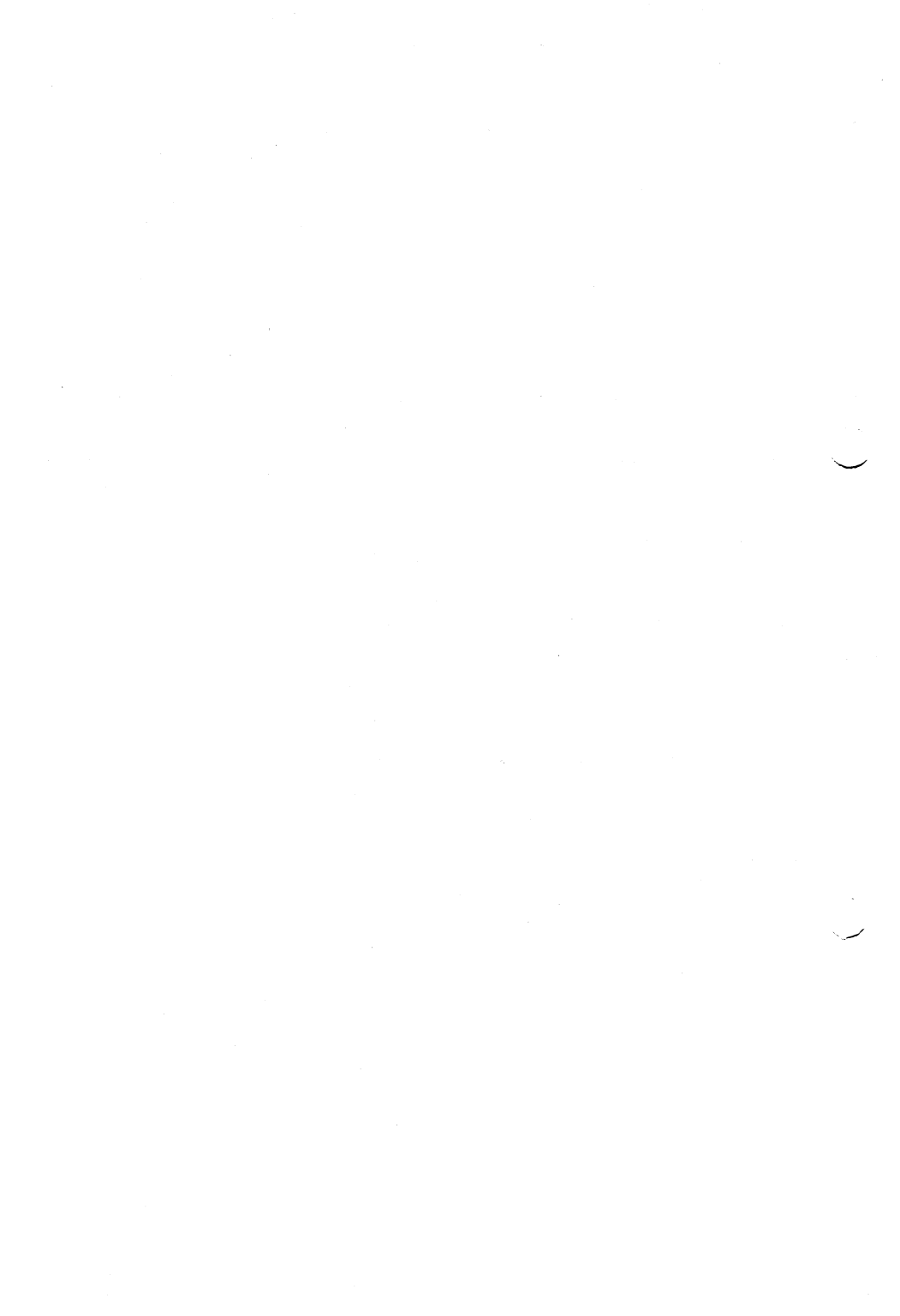
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I. EQUIPMENT CONFIGURATION AND LOADING INSTRUCTIONS

EQUIPMENT CONFIGURATION

In order to run a PLATO computer-based activity, one of the following microcomputer systems is necessary:

1. An APPLE II Plus with the following:
 - a. TV or monitor
 - b. 48K memory
 - c. Disk drive and controller
 - d. DOS 3.3 operating system
2. An ATARI 800 with the following:
 - a. TV or monitor
 - b. 48K memory
 - c. Disk drive and controller
 - d. DOS 2 operating system

3. A TEXAS INSTRUMENTS 99/4A with the following:
 - a. TV or monitor
 - b. 32K memory expansion
 - c. Disk drive and controller
 - d. PLATO Interpreter Cartridge*

LOADING THE MICROCOMPUTER

The Phizquiz activity is contained on a flexible disk that must be inserted into the disk drive. Figure 1 below shows a disk and a disk drive.

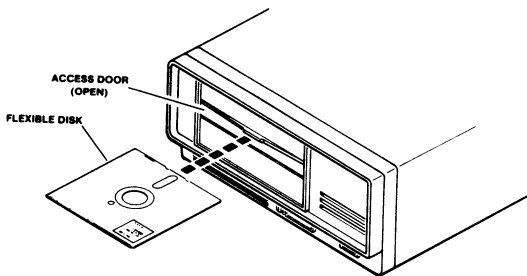


Figure 1. Disk and Disk Drive

To load the Phizquiz activity into the computer, follow the instructions for your microcomputer.

*See the distribution information.

Phizquiz is a multiple disk activity. If only one disk drive is available, the user must change disks to complete the activity.

APPLE II PLUS

1. Make sure the APPLE II Plus is off.
2. Insert the disk into the disk drive (see figure 1) and close the door of the disk drive.
3. Turn on the APPLE II Plus microcomputer.
4. The title page for the Phizquiz activity will appear on the screen.

ATARI 800

1. If the BASIC Computing Language (left cartridge) has not been removed, you must remove it.
2. Make sure that both the ATARI 800 computer and the ATARI 810 Disk Drive are turned off.
3. Turn on the ATARI 810 Disk Drive and wait for the busy light to go out.
4. Insert the disk into the disk drive (see figure 1) and close the door of the disk drive.
5. Now, turn on the ATARI 800 computer.
6. The title page for the Phizquiz activity will appear on the screen.

TEXAS INSTRUMENTS 99/4A

1. Connect the pieces according to the manufacturer's instructions and plug everything into the AC.
2. Turn on the switches in the following order:
 - a. Disk drive
 - b. Disk controller
 - c. RAM expansion
 - d. CPU
 - e. Monitor or TV
3. Insert the PLATO Interpreter Cartridge into the CPU. The Texas Instruments standard display will appear on the screen.
4. Press any key.
5. Follow the prompts that appear on the screen to insert the disk and start the lesson.
6. The title page for the Phizquiz activity will appear on the screen.

II. PUBLISHER'S NOTE

Control Data Publishing Company offers the opportunity to supplement core physics curricula with physics activity packages. Individuals and instructors can use these PLATO microcomputer-based support activities to reinforce concepts taught in physics courses.

The following concepts have been identified as representative of those covered in secondary and post-secondary physics programs.

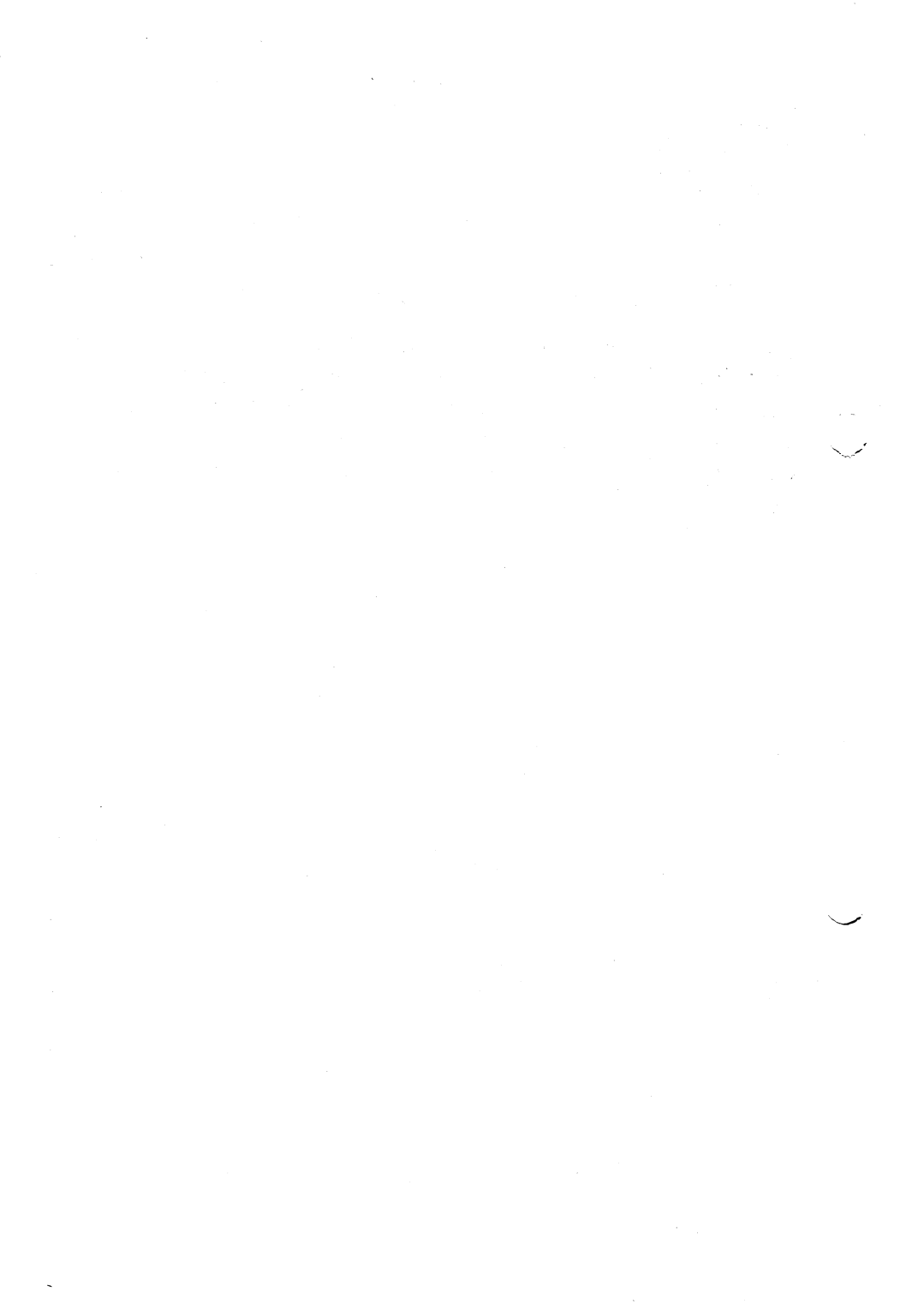
1. Fundamental Concepts
 - a. Units
 - b. Measurements
 - c. Vectors
2. Mechanics
 - a. One and two-dimensional kinetics: position, velocity, and acceleration
 - b. Newton's Laws of Motion: mass force, and gravity
 - c. Work, energy, and power
 - d. Momentum
 - e. Rotational kinetics

- f. Rotational Dynamics: torque, angular momentum, and rotational energy
 - g. Oscillations
 - h. Waves: reflections, refraction, diffraction, interference
 - i. Sound
- 3. Optics
 - a. Mirrors
 - b. Lenses
 - c. Diffraction
 - d. Polarization
- 4. Heat and Thermodynamics
- 5. Electricity
 - a. Current
 - b. Voltage
 - c. Resistance
 - d. Circuits
 - e. Magnetism
 - f. Electromagnetism

6. Modern Physics

- a. The atom
- b. The nucleus

The **PHYSICS: Elementary Mechanics** package can be used as a component in most standard physics curricula. It provides practice on the principles of elementary mechanics. Control Data Publishing is working toward a comprehensive coverage of topics in physics and other subject matter areas.



III. ACTIVITY PACKAGE SUMMARY

Description: **PHYSICS: Elementary Mechanics** is a PLATO educational software package. It contains the Phizquiz computer-based activity and a support manual.

Objective: The Phizquiz activity is intended to provide practice in analyzing and evaluating a problem in elementary mechanics and in identifying the elements necessary to arrive at a correct answer.

Activity: The Phizquiz activity presents animated examples of physical situations. A question about the situation is then asked. The student must determine what information is necessary to answer the question and what concepts should be used to arrive at the correct answer. In addition, a fixed amount of "money" is available to buy the necessary information. The less help a student needs before correctly answering the question, the less money he or she will spend.

Manual: The support manual supplements the computer-based activity with the following material:

Lesson flow The Lesson Flow section of the manual describes the steps in the Phizquiz activity, presents the features and options available, and defines the scoring method.

Strategies The Strategies section of the manual is intended for instructors wishing to use the Phizquiz activity in conjunction with classroom material. The Phizquiz activity is primarily an individual or small-group exercise. It may be used as a review exercise, lab or homework assignment, an assessment tool, or a motivational exercise.

**Student
materials**

**The Student Materials
section of the manual
contains sample
worksheets related to the
Phizquiz activity. These
materials are intended
for secondary and post-
secondary level students.**



IV. INTRODUCTION TO THE PHIZQUIZ ACTIVITY

The Phizquiz activity is designed to be an educationally sound learning tool that provides practice in the reasoning skills necessary to solve problems in elementary mechanics. It tests and evaluates a student's knowledge of the principles of mechanics.

Simulated physical situations are presented in an animated format in order to define each circumstance as clearly as possible. A question is asked about the situation portrayed. The student is challenged to find the answer to the question by using the least possible amount of system-supplied help and information. This challenge is reinforced by providing the student with "money" (\$25 per problem) to use in buying help and information.

There are nine separate lessons or exercises presented in the Phizquiz activity. Each exercise requires the student to solve the problem presented by the physical situation portrayed. The first exercise is a sample to introduce the student to the activity. After completing the sample exercise, the student may choose to do any number of the other eight exercises in any order desired.

In order to answer the questions, the computer provides four types of assistance.

1. It answers a student's typed-in questions about a situation. For example, "Distance?", "Time?", or "Mass?"
2. It lists formulas.
3. It provides a help function that explains the situation presented in the exercise and the important concepts necessary to solve the problem.
4. It provides a calculator function to assist the student with the necessary computations.

While much of the material in this manual is intended for classroom use, it is also applicable as a guide for individual use at home or as part of a library of support materials for any group studying elementary mechanics.

PURPOSE

- To test a student's knowledge of the principles of elementary mechanics
- To provide an analytical exercise that requires a student to determine what information is necessary to solve a problem

CONCEPTS

Students must be able to apply the following principles of mechanics:

- Newton's Laws of Motion in two dimensions
- Newton's Law of Universal Gravitation
- Conservation of linear momentum
- Conservation of angular momentum
- Conservation of mechanical energy
- Two-dimensional kinetics with constant acceleration
- Kinetics and dynamics of uniform circular motion
- Kinetics and dynamics of a mass-spring system
- Friction
- Torque

PREREQUISITES

The student must be able to perform the following mathematical functions:

- Rearrange algebraic expressions to isolate a given quantity
- Solve two equations in two unknowns
- Add and resolve vectors both graphically and analytically
- Solve triangles using trigonometric functions and the Pythagorean theorem
- Draw free body diagrams
- Solve relative motion problems

NOTE

NO CALCULUS IS NEEDED

V. LESSON FLOW

LESSON

The Phizquiz activity is a problem-solving test in elementary mechanics. The primary concern of the student should be to answer the questions correctly.

Instructions on how to perform the exercises appear on the screen during the initial phase of the activity. The principal elements of the Phizquiz activity are as follows:

1. For each exercise, the student receives “money” (\$25 per problem) with which to buy help and information. The object is to solve the problem using no more money than necessary.
2. The first problem is a sample exercise. After the sample exercise is completed, an index listing all nine problems appears. The student may refer back to this index at any time.
3. A physical situation is presented in an animated diagram; for example, a car moves from point A to point B.
4. The computer asks a question about the situation; for example, “How long does it take the car to drive from point A to point B?”

5. The student must analyze the problem and determine what information is necessary to solve it. This information is obtained by requesting answers to questions the student enters. The student should be as concise as possible; for example, entering the word “distance” will obtain the distance from A to B.
6. The computer will answer the student’s question if it is applicable. If the student asks for inappropriate information, the computer will respond with a message informing the student that no answer is available. The answers to the questions will be returned to the original screen display of the problem when that display is recalled to the screen.
7. Each answerable question will cost the student \$2.00.
8. A list of possible formulas and constants to use in solving the problem is also available. If the student asks for formulas, a list of formulas is returned.
9. A list of formulas and constants will cost the student \$5.00.
10. A help function is available if the student is having difficulty conceptualizing the problem and determining what information to request.

The help function will interpret the physical situation and offer suggestions about what information is needed or what principles are involved. Using the help function will cost the student \$5.00.

11. The system-supplied information is available to the student at any time while performing the exercise.
12. The student may use the calculator to solve the problem once the correct values and formulas have been obtained. Use of the calculator function will not cost the student any money.
13. The student may now answer the question. Wrong answers cost the student \$5.00 and, therefore, will deplete the student's money supply.
14. If the student is unable to arrive at the correct answer, the computer will allow the student to perform the key function that displays the answer after he or she has used all the money.
15. When the exercise is completed, the student refers back to the index page and selects another problem.
16. The student has the option of stopping in the middle of one problem, going on to another, and then coming back. All the information requested remains intact as does the record of how much money is left.

17. The Phizquiz activity may be performed more than once. Each time the activity is performed, different values will be assigned to some problem. In this way, students can practice the concepts presented in the exercises over and over again.

THE CALCULATOR FUNCTION

As part of the lesson program, the Phizquiz activity includes a calculator. Instructions on how to use the calculator are provided in the lesson. The calculator performs the following mathematical and trigonometric functions:

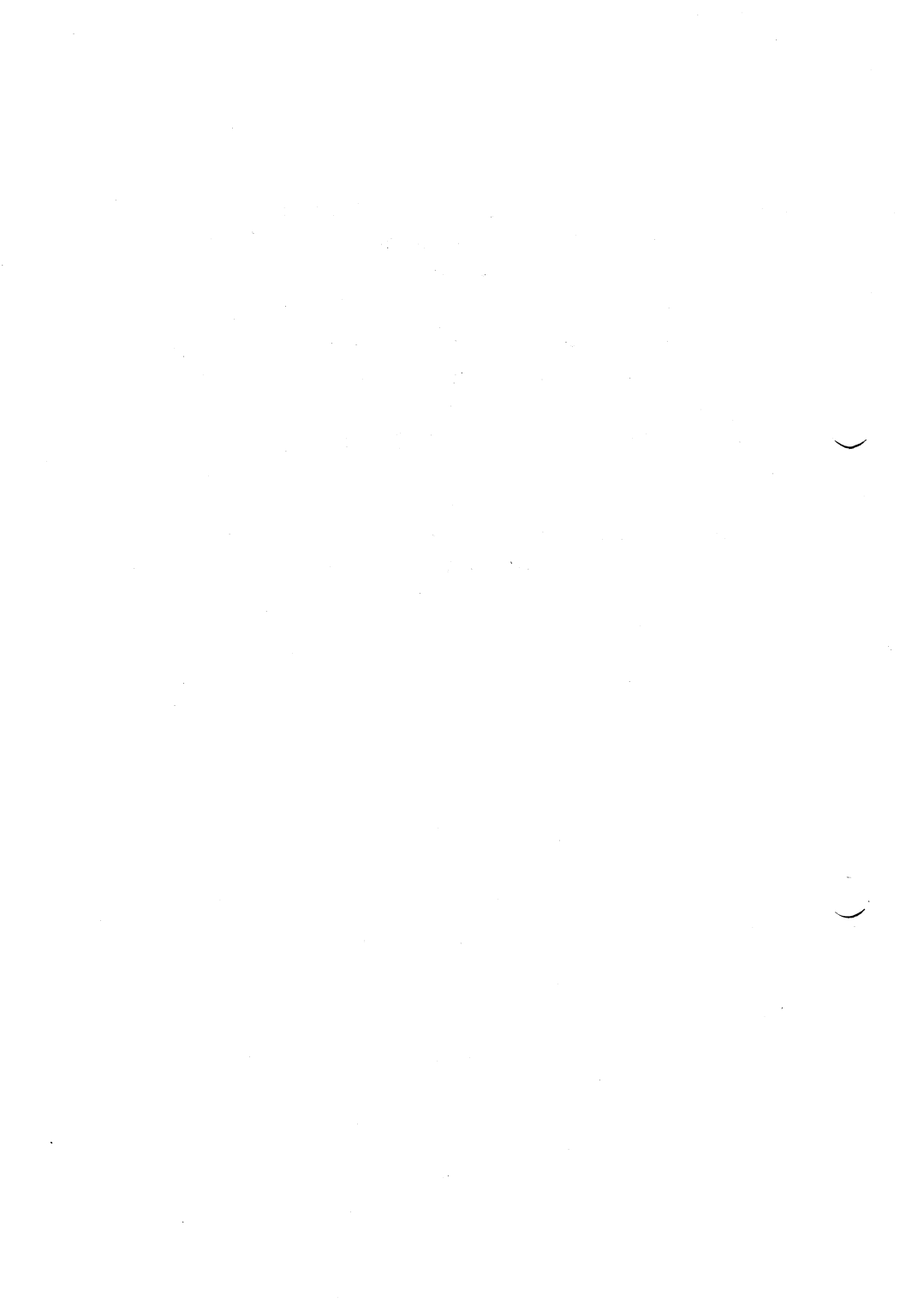
- Standard mathematical operations
- Powers
- Square roots
- Sines and cosines (degrees and radians)
- Tangents and arctangents
- Logarithms
- Natural logs
- Absolute values

Unlike the other help functions available, use of the calculator does not deplete the student's money supply. It is available at any time during the problem-solving phase of the lesson.

SCORING

The scoring method used by the Phizquiz activity is the “money.” The computer keeps track of how much money the student has spent to solve each problem. The amount of money remaining for each problem solved appears next to that problem in the index. In addition, a total appears telling the student how much money he or she has remaining for all the problems. When a student exits the lesson, all scoring is lost.

The better a student understands the problems, the more money there will be remaining at the end of the activity.



VI. TEACHING STRATEGIES

The Phizquiz activity is designed to reinforce concepts taught in elementary mechanics courses. It can be effectively used by instructors and individuals in several ways. The following strategies are suggestions for instructional use of the activity. Instructors and students are also encouraged to vary these suggestions to develop additional uses for the Phizquiz activity.

INDIVIDUAL USE

The Phizquiz activity can be a valuable addition to a library of support materials for an elementary mechanics course. The availability of the activity affords students the opportunity to self-test their understanding of concepts and to review and check the logic and reasoning in their approaches to problems.

DRY LAB

The instructor may assign one or more of the exercises in the Phizquiz activity to a student who has missed a lab session demonstrating a concept.

The animated format, the deductive reasoning requirements, and the system-supplied lesson help to clarify a concept for a student who has read the class material but missed a demonstration.

ASSESSMENT

An instructor may assign exercises in the Phizquiz activity to assess a transfer student's level of understanding. This should be particularly helpful in assisting the instructor in determining whether a student needs extra help in order to reach the competence level of the rest of the class.

If an instructor questions a student's grasp of a particular principle, exercises may be assigned as a quiz for concepts. The performance of a student on a Phizquiz exercise can assist an instructor in determining whether a student has achieved an acceptable level of comprehension.

GROUP ACTIVITIES

Students may work together in groups of two or three to solve the problems presented by the Phizquiz activity. The Phizquiz activity may be used in a situation where one student uses the activity to teach concepts to another. Two students may work together to find the answers to the questions,

learning from one another's approaches to the problems. Three students may work together as a team where one is the predictor, one the operator, and one the scorer.

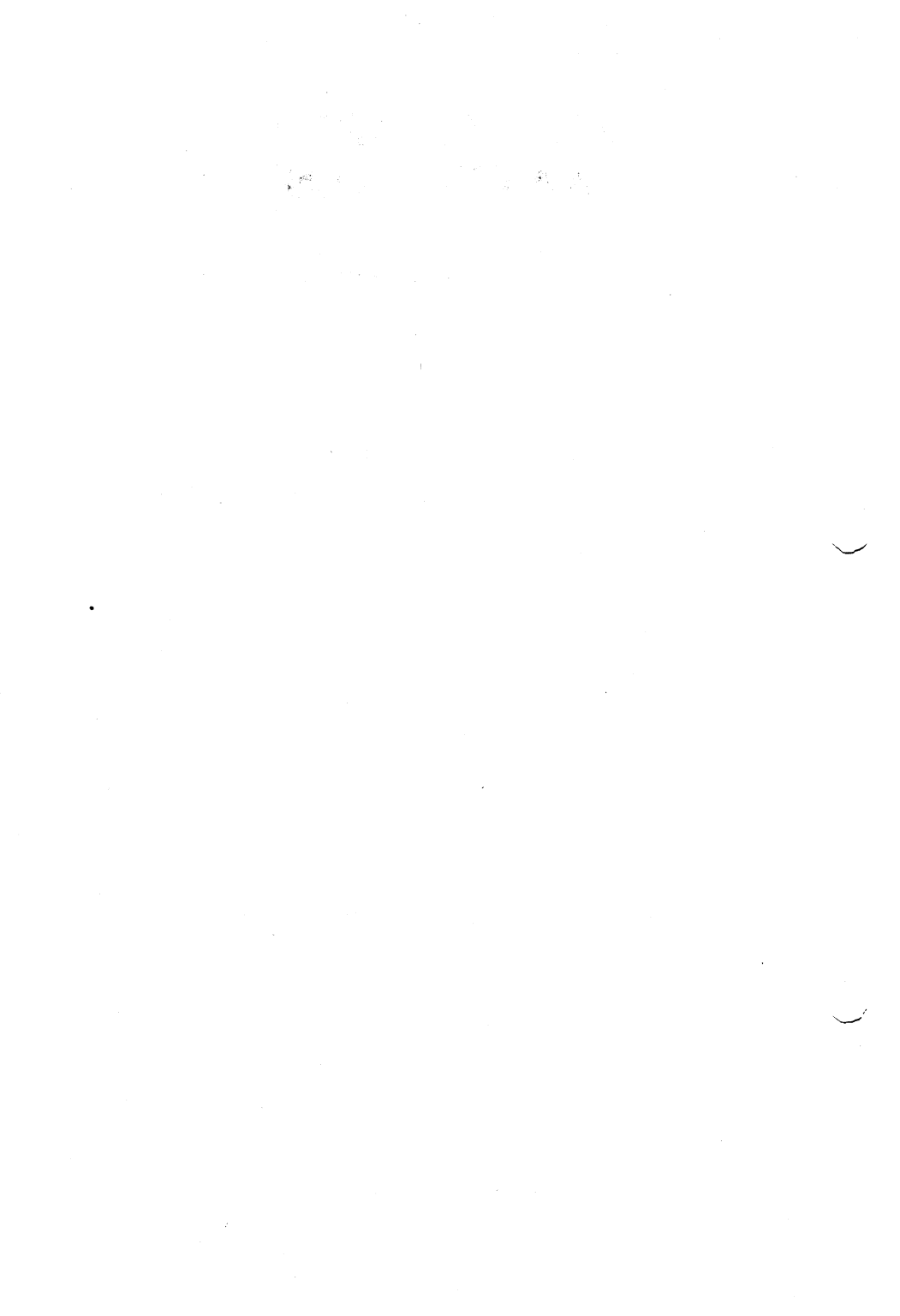
CHALLENGE

An instructor may have one student use a text as a reference to solve a problem while another student uses the computer with its system-supplied help. They can then compare times to see which student works the fastest.



VII. STUDENT MATERIALS

The following section contains sample problems relating to Phizquiz. Instructors may copy and use the actual samples included or use them as models.



PHIZQUIZ

Problem 1

Name: _____ Date: _____ Hour: _____

A boy rides his bike to and from school. He is in a hurry on the way to school (he overslept) so he rides three times as fast to school as he does on his way home.

What is his average speed for the round trip?

1. What information do you need to answer the question?

2. Form a plan that would give you the answer if you had the information.
3. Assign values to the information and solve the problem.

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PHIZQUIZ

Problem 2

Name: _____ Date: _____ Hour: _____

The builder of the Great Pyramid is finished except for the last stone, which must be taken up a ramp and placed on top.

Ignoring friction, how many pounds of force must be exerted on the final stone to move it up the ramp?

1. What information is necessary to answer the question?

2. Form a plan that would give you the answer if you had the information.

3. Assign values to the information and solve the problem.

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PHIZQUIZ

Problem 3

Name: _____ Date: _____ Hour: _____

A river flows from north to south. A boat captain prepares to leave the west shore and cross the river by the shortest route.

On what compass heading will the captain steer the boat?

1. What information do you need to answer the question?

2. Form a plan that would give you the answer if you had the information.
3. Assign values to the information and solve the problem.

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PHIZQUIZ

Problem 4

Name: _____ Date: _____ Hour: _____

A boy is standing on a cliff. He throws a small stone horizontally away from the cliff.

How long does it take for the stone to hit the ground?

1. What information do you need to answer the question?

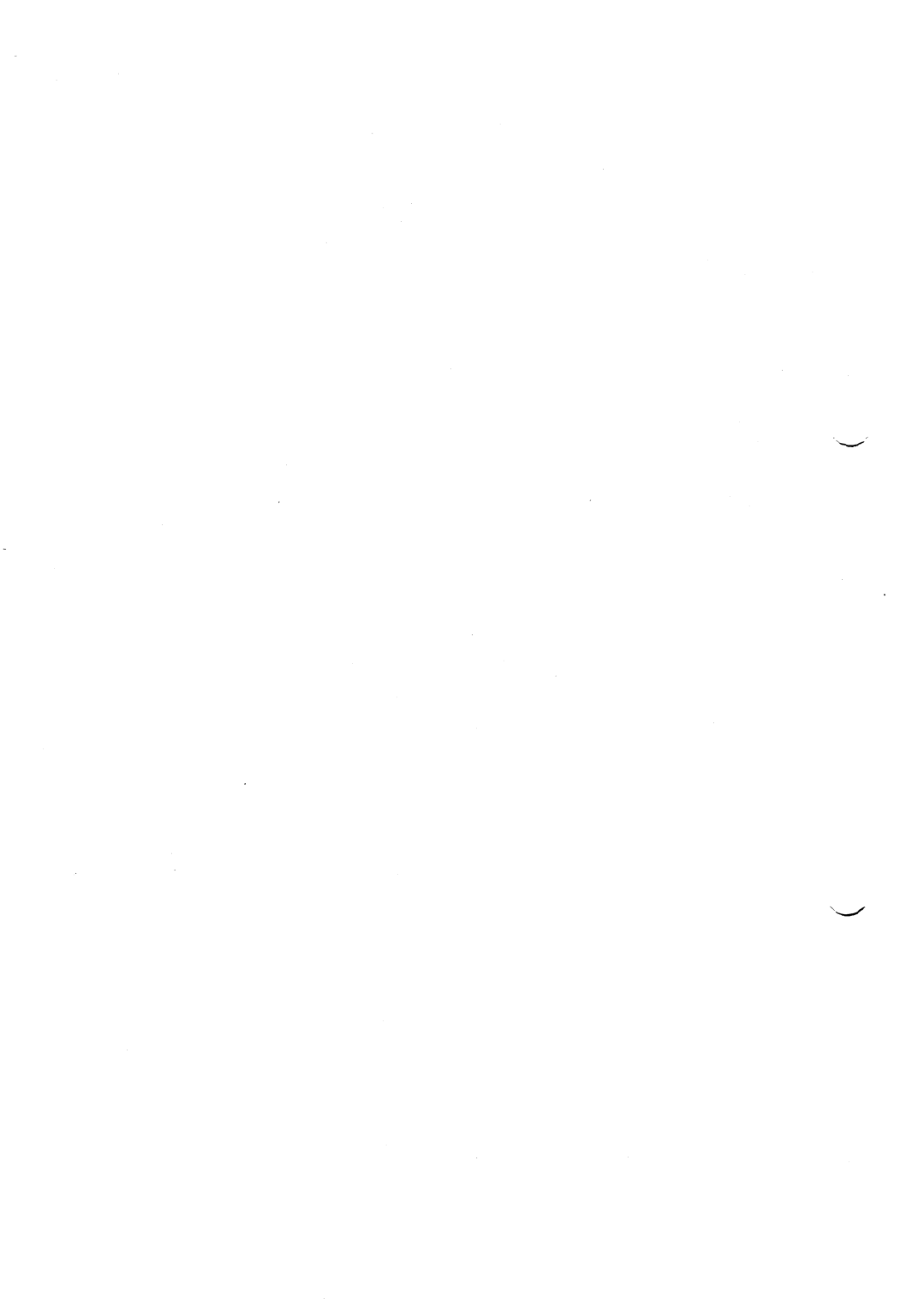
2. Form a plan that would give you the answer if you had the information.

3. Assign values to the information and solve the problem.

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PHIZQUIZ

Problem 5

Name: _____ Date: _____ Hour: _____

Two boys are standing face to face and are talking.

What gravitational force exists between them?

1. What information do you need to answer the question?

2. Form a plan that would give you the answer if you had the information.

3. Assign values to the information and solve the problem.

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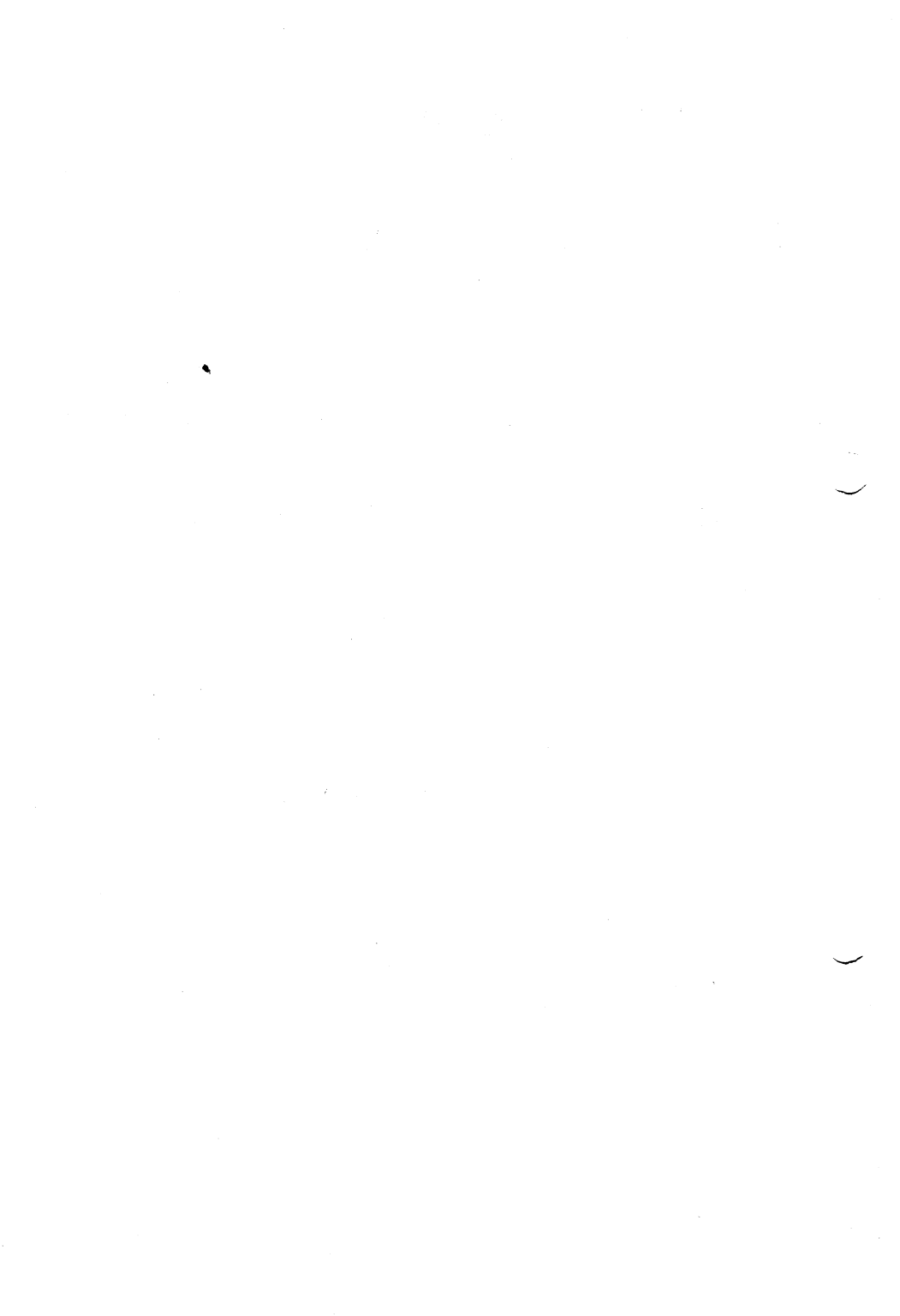
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VIII. ANSWER KEY

The answers given to each problem are samples. Students may find more than one way to solve the problems; and, of course, the values will be different.



Problem 1

1. Information

Two of the following three units:

- a. Speed traveling to school or from school
- b. Time traveling to school or from school
- c. Distance between home and school

2. Plan

- a. If only speed and time are given, determine the distance.

If only speed and distance are given, determine the time.

Distance formula: $D = rt$

- b. Determine the average velocity (\bar{v})

Average velocity = total distance \div total time

3. Sample Values

1. Speed—15 mph to school or 5 mph from school
2. Time—6 minutes (0.1 hr) to school or 18 minutes (0.3 hr) from school
3. Distance—1.5 miles

4. Answer

$$\bar{v} = \frac{d_1 + d_2}{t_1 + t_2}$$

$$\bar{v} = \frac{1.5 + 1.5}{0.1 + 0.3}$$

$$\bar{v} = 7.5 \text{ mph}$$

Problem 2

There are two common methods for working this problem. An example of each is provided here.

1. Information

Method A

- a. Weight (force due to gravity) of the stone
- b. Height of the pyramid
- c. Length of the ramp

Method B

- a. Weight (force due to gravity) of the stone
- b. Height of the pyramid
- c. Angle of the ramp.

2. Plan

- a. Realize that work is energy. The energy to lift the stone straight up must be the same as that required to move the stone along a ramp to the same height.

Work (lift straight up) = Work (along the ramp)

- b. Realize that here energy is the product of the force on an object and the displacement (distance) of the object.

$$F_1 \times (\text{height of pyramid}) = F_2 \times (\text{length of ramp})$$

Where:

F_1 = the force of the stone due to gravity alone

F_2 = the force of the stone due to gravity and the mechanical advantage of the ramp

- c. Solve for F_2

Problem 2 (Cont.)

3. Sample Values

- a. Height of pyramid (h) = 450 ft
- b. Weight of the stone (w) = 80,000 lbs
- c. Length of the ramp (l) = 1800
- d. Angle of the ramp (Θ) = 14°

4. Answer

Method A

$$F_1 \times h = F_2 \times l$$

$$80,000 \times 450 = F_2 \times 1800$$

$$F_2 = \frac{80,000 \times 450}{1800}$$

$$F_2 = 20,000 \text{ lbs}$$

Method B

$$F_1 \times h = F_2 \times l$$

$$\frac{F_2}{F_1} = \frac{h}{l} = \frac{\text{height of pyramid}}{\text{length of ramp}} = \sin \Theta$$

$$\frac{F_2}{F_1} = \sin \Theta \text{ or } F_2 = F_1 \times \sin \Theta$$

$$F_2 = (80,000) \times (\sin 14^\circ)$$

$$F_2 = (80,000) \times (.25)$$

$$F_2 = 20,000 \text{ lbs}$$

Problem 3

1. Information

- a. Velocity of the river
- b. Velocity of the boat

2. Plan

- a. Realize that the boat must be headed up river in order to compensate for the river's current.
- b. Break the problem into a vector quantity problem, and determine the angle upriver from the direct route.

$$\sin \Theta = \frac{\text{River velocity}}{\text{boat velocity}}$$

- c. North being 0° , determine the compass heading.

$$\text{Compass heading} = 90^\circ - \Theta$$

3. Sample Values

- a. River velocity - 2 mph
- b. Boat velocity - 6 mph

4. Answer

$$\sin \Theta = 2/6 = .33$$

$$\Theta = 19^\circ$$

$$\text{Compass heading} = 90^\circ - 19^\circ$$

$$\text{Compass heading} = 71^\circ$$

Problem 4

1. Information

- a. Height of the cliff
- b. Gravitational Acceleration

2. Plan

- a. Realize that, neglecting air friction, the horizontal velocity of the stone is meaningless. The only force acting on the stone after release is the force of gravity. A stone dropped from the cliff at the same time that the other is thrown from the cliff would land at the same time.
- b. Therefore, knowing the height of the cliff, solve for time using the free-falling body formula.

$$D = \frac{1}{2} gt^2$$

3. Sample Values

- a. Height of cliff - 144 ft.
- b. $g = 32 \text{ ft/sec}^2$

4. Answer

$$144' = \frac{1}{2} gt^2$$

$$144' = \frac{1}{2} (32'/\text{sec}^2)t^2$$

$$288' = (32'/\text{sec}^2)t^2$$

$$\frac{288'}{(32'/\text{sec}^2)} = t^2$$

$$t^2 = 9 \text{ sec}^2$$

$$t = 3 \text{ seconds}$$

Problem 5

1. Information

- Distance between the two boys
- Mass of boy 1 and mass of boy 2
- Gravitational Constant

2. Plan

- Realize that ignoring the force of gravity of the earth, the determination of the gravitational force between the two boys can be considered a simple problem of gravitational attraction between two bodies.
- Apply Newton's formula for gravitational force to solve for force (f).

$$F = G \frac{M_1 \times M_2}{R^2}$$

3. Sample Values

- Mass of boy 1 - $M_1 = 4.5 \times 10^4$ grams
- Mass of boy 2 - $M_2 = 3.6 \times 10^4$ grams
- Distance - 1.0×10^3 cm
- Gravitational constant - 6.66×10^{-8}

4. Answer

$$F = G \frac{M_1 M_2}{R^2}$$

$$F = \frac{(6.67 \times 10^{-11}) \times (50 \times 60)}{3^2}$$

$$F = \frac{(6.67 \times 10^{-11}) (3 \times 10^3)}{3^2}$$

$$F = 2.2 \times 10^{-8}$$

INFORMATION ON ADDITIONAL PRODUCTS

BASIC NUMBER FACTS

Practice in basic numbers including addition without carrying, subtraction without borrowing, and multiplication/division with single digits. A “Speedway” format allows children to “race” against time to build up their speed in these math areas. Designed for elementary students or any student requiring practice with basic whole number operations.

WHOLE NUMBERS

Practice in whole number operations. Interest is developed by use of a simulated pinball game to build skills in addition, subtraction, multiplication, division, and mixed numbers. Designed for elementary and junior high math students.

FRACTIONS

Practice locating fractions on a number line. Students are challenged to “burst” balloons by “throwing” darts at the correct location on the number line. Balloons may be burst in any order, on

a trial-and-error basis, until none are left. The exercise may be carried out with or without negative numbers. The difficulty adjusts to the student's performance. Designed for elementary math students.

DECIMALS

Practice locating decimal numbers on the number line. Children are challenged to “burst” balloons by “throwing” darts at the correct location on the number line. Numbers are entered on a trial-and-error basis. Difficulty adjusts to the student's performance. Designed for elementary math students.

FRENCH VOCABULARY BUILDER

Students are given a basic vocabulary of 500 words including useful verbs, number words, words commonly used in traveling, shopping, in restaurants, or in the home. The format of either “hangperson” or “pyramid building” in structured groups of related words provides students with context and similarity clues to help them increase their proficiency. Designed to supplement introductory-level and refresher courses.

SPANISH VOCABULARY BUILDER

Students are given a basic vocabulary of 500 words including useful verbs, number words, words commonly used in traveling, shopping, in restaurants, or in the home. The format of either “hangperson” or “pyramid building” in structured groups of related words provides students with context and similarity clues to help them increase their proficiency. Designed to supplement introductory-level and refresher courses.

GERMAN VOCABULARY BUILDER

Students are given a basic vocabulary of 500 words including useful verbs, number words, words commonly used in traveling, shopping, in restaurants, or in the home. The format of either “hangperson” or “pyramid building” in structured groups of related words provides students with context and similarity clues to help them increase their proficiency. Designed to supplement introductory-level and refresher courses.

COMPUTER LITERACY- INTRODUCTION

This lesson is a foundation for a full curriculum in computer literacy or simple programming. It gives a brief introduction to the history, uses, and issues surrounding computers in today's society presented in a friendly, nonintimidating manner with touches of humor and simple supportive graphics. Designed for junior or senior high and vocational school students.

These lessons have been designed for use by students at specific grade levels, but you don't have to be a student to enjoy these lessons as refresher exercises, skill building tools, or recreation.

NOTES

