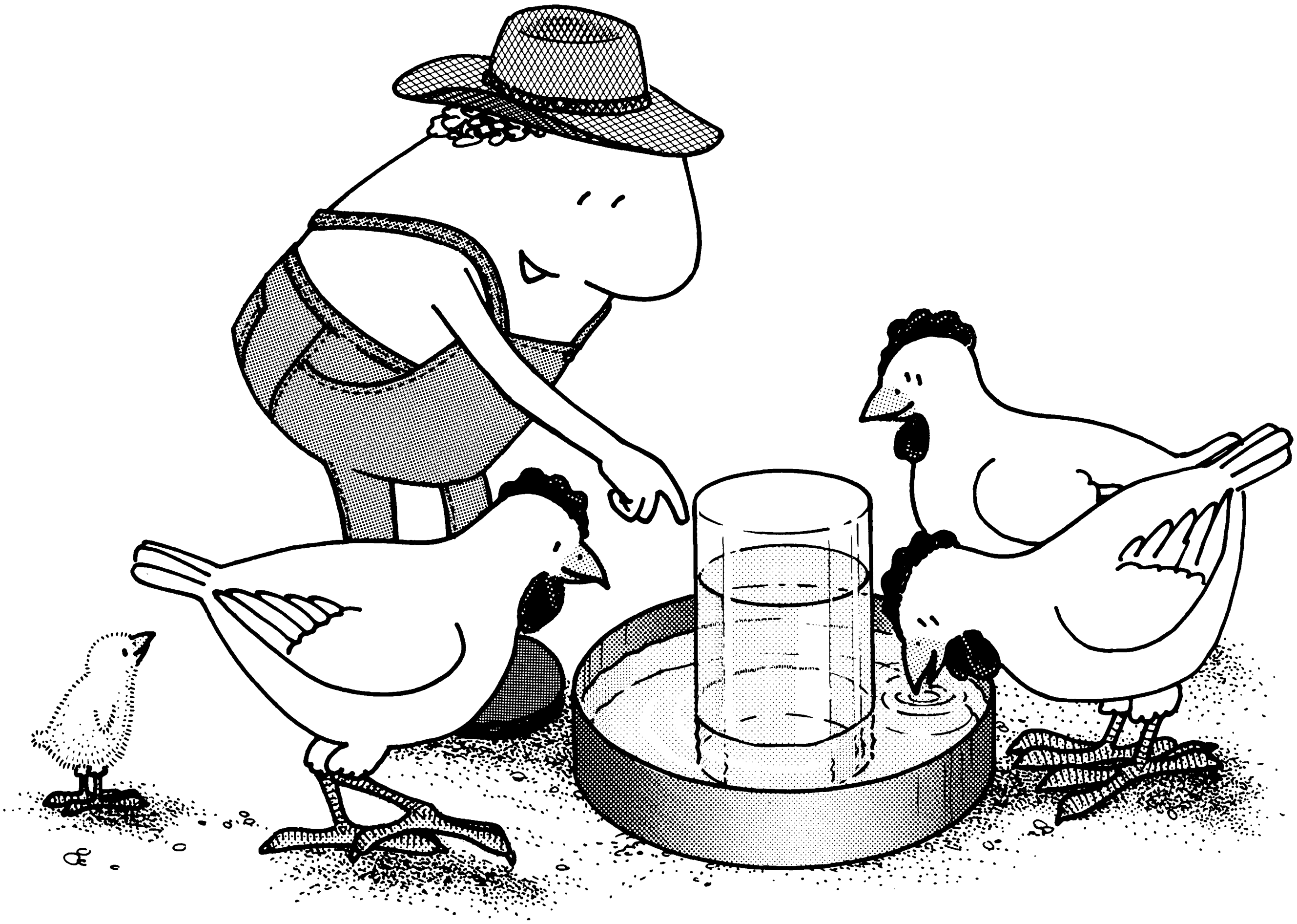
PRESSURE



TASK CARD SERIES

Conceived and
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Illustrated by
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TOPS LEARNING SYSTEMS

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CONTENTS

PART I INTRODUCTION

PART II TEACHING NOTES

PART III REPRODUCIBLE STUDENT TASK CARDS

Gathering Materials

Listed below is everything you'll need to teach this module. You already have many of these items. The rest are available from your supermarket, drugstore and hardware store. Laboratory supplies may be ordered through a science supply catalog. Hobby stores also carry basic science equipment.

Keep this classification key in mind as you review what's needed:

special in-a-box materials:	general on-the-shelf materials:
Italic type suggests that these materials are unusual. Keep these specialty items in a separate box. After you finish teaching this module, label the box for storage and put it away, ready to use again the next time you teach this module.	Normal type suggests that these materials are common. Keep these basics on shelves or in drawers that are readily accessible to your students. The next TOPS module you teach will likely utilize many of these same materials.
(substituted materials):	*optional materials:
Parentheses enclosing any item suggests a ready substitute. These alternatives may work just as well as the original, perhaps better. Don't be afraid to improvise, to make do with what you have.	An asterisk sets these items apart. They are nice to have, but you can easily live without them. They are probably not worth the extra trip, unless you are gathering other materials as well.

Everything is listed in order of first use. Start gathering at the top of this list and work down. Ask students to bring recycled items from home. The teaching notes may occasionally suggest additional student activity under the heading "Extensions." Materials for these optional experiments are listed neither here nor in the teaching notes. Read the extension itself to find out what new materials, if any, are required.

Needed quantities depend on how many students you have, how you organize them into activity groups, and how you teach. Decide which of these 3 estimates best applies to you, then adjust quantities up or down as necessary:

Q_1 / Q_2 / Q_3

- Q_1: **Single Student:** Enough for 1 student to do all the experiments.
- Q_2: **Individualized Approach:** Enough for 30 students informally working in 10 lab groups, all self-paced.
- Q_3: **Traditional Approach:** Enough for 30 students, organized into 10 lab groups, all doing the same lesson.

KEY: *special in-a-box materials* (substituted materials) general on-the-shelf materials *optional materials

.1/1/1 cup oil-based modeling clay
1/10/10 index cards
1/10/10 pair of scissors
1/2/4 *bathroom scales
1/10/10 *calculators
1/5/5 rolls masking tape
5/50/50 straight plastic straws – 1/4 inch diameter or slightly less
2/20/20 *meters 1/4 inch diameter tubing – see notes 3*
3/30/30 plastic sandwich bags
4/40/40 meters string
3/9/30 textbooks
2/20/20 *plastic produce bags*
1/10/10 paper clips
3/30/30 *canning jars with lids and rings that fit – see notes 5*
1/6/10 *small plastic syringes, about 3 cc*
1/4/10 *large plastic syringes, about 30 cc*
1/10/10 small test tubes
1/10/10 large test tubes
1/10/10 plastic dishpans – see notes 7
1/1/1 source of water – see notes 7
1/10/10 baby food jars (beakers)
1/10/10 *clear soft-plastic drinking cups – see notes 8*
1/6/10 large nails, about 8 cm long
1/6/10 needle-nose pliers – see notes 8
6/60/60 *washers to fit 1/4 inch bolts – see notes 8*
1/10/10 small balloons
3/30/30 large rubber bands
2/20/20 eyedroppers
2/20/20 *wooden matches*
1/10/10 cereal boxes
2/20/20 cups sand (gravel or dirt)
1/1/1 bottle food coloring
1/1/1 *jar petroleum jelly*
1/10/10 clothespins
1/4/10 pie tins
1/6/10 medium-sized tin cans
1/4/10 *funnels – long stem is best*
2/20/20 paper towels
1/6/10 Ping-Pong balls
1/6/10 *cardboard toilet tissue tubes*
1/2/5 paper punches
1/6/10 candles and matches
1/10/10 graduated cylinders – 100 ml
1/4/10 *large plastic milk jugs*
2/20/20 *BB shot pellets*
2/20/20 size-D batteries, dead or alive
1/4/10 *gram balances
1/4/10 long clipboards *(plywood squares,* thick telephone books)
1/1/1 *bottle rubbing alcohol
1/4/10 *film canisters (pill containers)*
1/1/1 roll plastic wrap
1/4/10 **flat toothpicks*
1/10/10 **large cider jugs*

Sequencing Task Cards

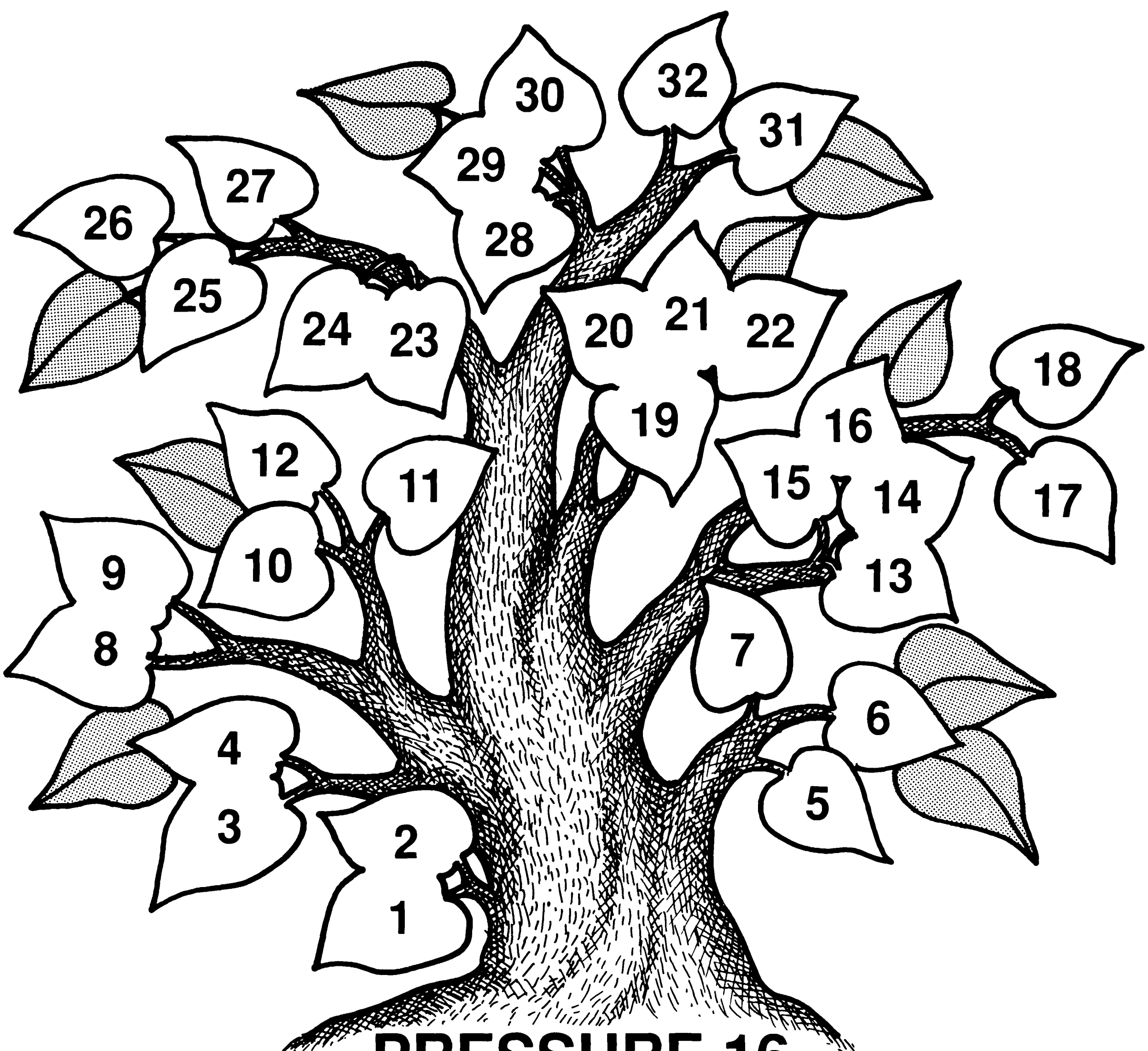
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

At the teacher's discretion, certain activities can be omitted or sequences changed to meet specific class needs. The only activities that must be completed in sequence are indicated by leaves that open *vertically* into the ones above them. In these cases the lower activity is a prerequisite to the upper.

When possible, students should complete the task cards in the same sequence as numbered. If time is short, however, or certain students need to catch up, you can use the logic tree to identify concept-related *horizontal* activities. Some of these might be omitted since they serve only to reinforce learned concepts rather than introduce new ones.

On the other hand, if students complete all the activities at a certain horizontal concept level, then experience difficulty at the next higher level, you might go back down the logic tree to have students repeat specific key activities for greater reinforcement.

For whatever reason, when you wish to make sequence changes, you'll find this logic tree a valuable reference. Parentheses in the upper right corner of each task card allow you total flexibility. They are left blank so you can pencil in sequence numbers of your own choosing.



PRESSURE 16

Review / Test Questions

Photocopy the questions below. On a separate sheet of blank paper, cut and paste those boxes you want to use as test questions. Include questions of your own design, as well. Crowd all these questions onto a single page for students to answer on another paper, or leave space for student responses after each question, as you wish. Duplicate a class set and your custom-made test is ready to use. Use leftover questions as a review in preparation for the final exam.

task 1-2 A

The explorer knew at once she was in quicksand. With lightning speed she pulled off her backpack, then belly-flopped onto the brown ooze. Use concepts of force, area and pressure to explain how these actions enabled her to escape.

task 1-2 B

A 160 pound forest ranger owns a pair of boots (each with a bottom surface area of 40 square inches), and a pair of snow shoes (each with a bottom surface area of 480 square inches). Calculate how much pressure the ranger exerts against snow when wearing each kind of gear.

task 3

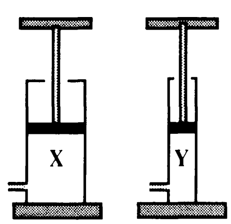
Explain how blowing up a balloon illustrates Pascal's principle.

task 3, 5

How would you use your head (and nothing more) to demonstrate that Earth's atmosphere exerts pressure?

task 1, 4, 6 A

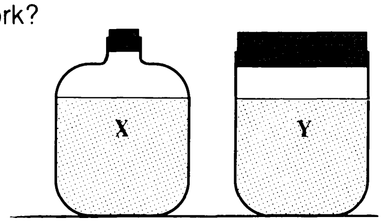
Hand pumps **x** and **y** are both in good working condition. Which one is best to use…



a. for inflating a skinny bicycle tire to a relatively high pressure? Why?
b. for inflating a large tractor tire to a relatively low pressure? Why?

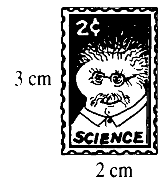
task 1, 4, 6 B

Bottles **x** and **y** contain fizzy soda water under equally high pressure. Which bottle is more likely to pop its cork?



task 2, 5, 6 A

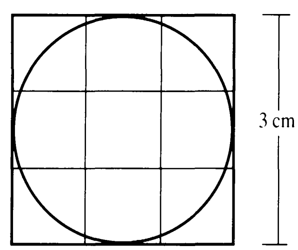
A postage stamp has an area six centimeters square.



a. If our atmosphere exerts a pressure of 10 N/cm^2, calculate the force pushing down on this stamp.
b. If all this force pressed down, why does a stamp need glue?

task 2, 5, 6 B

Atmosphere pressure pushes against this circle with about 10 N/cm^2.



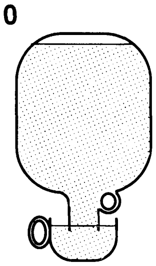
a. What is the pressure acting on 1 square? The force?
b. What is the pressure acting on the whole circle? The force?

task 7

Explain how atmospheric pressure helps you drink a glass of water with a straw.

task 7, 10

A gallon jug of water is inverted into a teacup.



a. Why doesn't water spill over the top of the teacup?
b. How much water would you have to drink (with a straw) to fully empty the cup. Explain.

task 8, 16

A building contractor asks you to inspect a building foundation to insure that it is level on all sides. You say you and a helper can do the job using a garden hose and water. What will you do?

task 9

When you inhale a breath of air, does your diaphragm move up or down? Explain.

task 8, 10, 16, 17

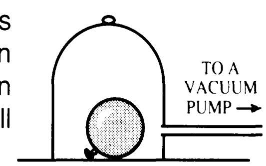
You wish to clean a swimming pool that has no drain. Draw a diagram to illustrate how to siphon all the water out of the pool.

task 11-12

An inverted bottle, almost full of water, just barely floats in a swimming pool on space station Terra Twin. Rodney rests poolside, his body sinking into the lounge chair with artificial gravity set a Earth-standard 1. Suddenly his ears pop, sirens blare, and the bottle sinks. What happened?

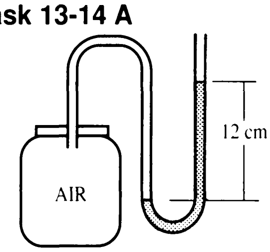
task 9, 11, 12

What happens to this balloon as air is drawn out of the bell jar?



task 13-14 A

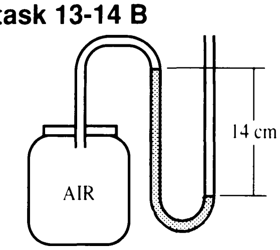
A jar of air is sealed to a U-tube manometer containing water.



a. Is the jar pressurized or evacuated?
b. How much pressure is in the jar?

task 13-14 B

A jar of air is sealed to a U-tube manometer containing water.



a. Is the jar pressurized or evacuated?
b. If atmospheric pressure currently supports 1033 cm of water, what is the total pressure in the jar?

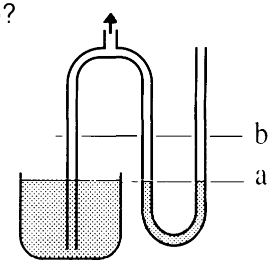
Review / Test Questions (continued)

task 14

A balloon is inflated and tied. How will its size change as this balloon is carried...
a. high into the atmosphere? Explain.
b. deep into the sea? Explain.

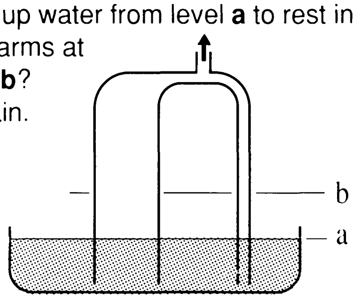
task 15, 17 A

A U-tube and a straight tube both join in an inverted Y. Can you draw up water from level **a**, so both sides rest at level **b**? Explain.



task 15, 17 B

A Y-tube with thick and thin arms is inverted in a jar of water. Can you draw up water from level **a** to rest in both arms at level **b**? Explain.

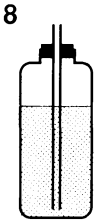


task 16-17

Why are city reservoirs built on towers or hills?

task 11, 16-18

Can thirsty Thad get a drink of water from this jar without removing the cork? Explain.

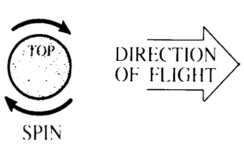


task 19-22 A

When you take a shower, the shower curtain tends to sweep in against you. Why does this happen?

task 19-22 B

Will this ball curve up or down? Explain.

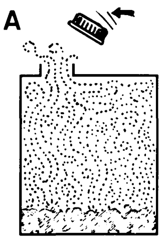


task 19-22 C

Draw streamlines over this airplane wing to illustrate lift.

task 23-24 A

Water is boiled in a can to generate lots of steam. A lid is clamped on airtight, then it is cooled with water. What happens? Why?

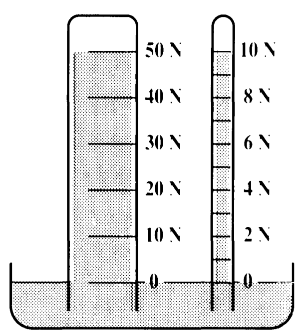


task 23-24 B

Burning paper is thrust into a juice bottle, and a peeled, boiled egg is placed on top. Hot expanding air pushes out past the egg, then the fire goes out. What happens next? Why?

task 25-26

Two glass tubes, one with a 5 cm^2 bore and one with a 1 cm^2 bore, are completely filled with mercury, then inverted into more mercury. The weight of each column is calibrated in Newtons.



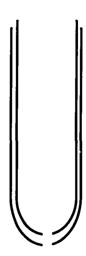
a. Do both tubes show the same outside air pressure? Show your work.
b. Why is there space at the top of each tube? What does this space contain?

task 25-27

The most powerful vacuum pump in the world cannot lift water higher than about 10.3 meters. Why is this so?

task 27

You have 2 test tubes, each with a hole in the bottom. One fits snugly inside the other, yet slides freely. How might you use these tubes and other simple materials to improvise a vacuum pump?



task 28-29

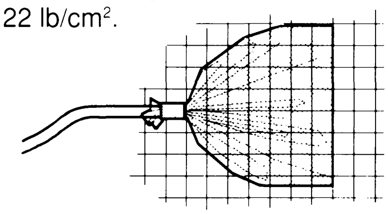
A graduated cylinder with a 7 cm^2 bore is filled with 105 ml of water. What pressure does this much water exert against its bottom?
(1 ml water weighs about .01 N)

task 28-30 A

Your space ship, pressurized at an Earth-like 2.2 lbs/cm^2 is punctured by a meteor in deep space.
a. Which way does air flow through the hole in your ship?
b. Can you plug this hole with your finger if it is pinhole size (.03 cm^2)?
c. Can you plug this hole with your palm if it is golf ball size (16 cm^2)?

task 28-30 B

This baggie can be inflated with a maximum lung pressure of .22 lb/cm^2.



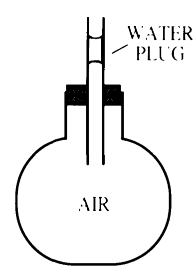
a. If every square represents 1 cm^2, what maximum weight can it lift?
b. Why does the baggie generally lift less than this?

task 31

a. Using a cut-off syringe and a cork, design an experiment to show how pressure changes with volume.
b. Using a heat-proof bottle and a cork, design an experiment to show how pressure changes with temperature.

task 31-32

a. Is this device a barometer? How does it measure changes in pressure?
b. Is this device a thermometer? How does it measure changes in temperature?
c. Can you take both measurements at the same time?



task 32

Is your U-tube manometer an aneroid barometer? Explain.

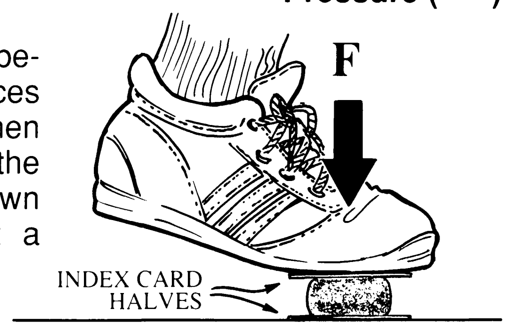
Task Objective (TO) calculate pressures that squeeze clay when you stand on it. To observe how these pressures increase as your applied force is distributed over decreasing areas.

SQUEEZE PLAY

Pressure ( )

1. Roll a lump of clay into the size of a round Ping-Pong ball.

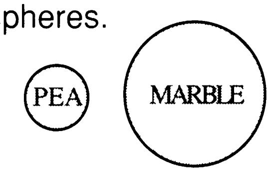
2. Sandwich it between 2 half pieces of index card, then squeeze it with the force of your own weight against a hard floor.



3. Use the Area Estimator (for Square Inches) to estimate the *area* (A) of your newly formed disk. Divide this into the *force* of your own weight (F) to find the *pressure* (P) that you applied.

$$P = \frac{F}{A}$$

4. Repeat steps 1-3 for marble- and pea-sized clay spheres. Save all three clay disks for step 5.



5. Relate the thickness of each disk to the pressures you have calculated.

6. You applied the same force to each lump of clay. Why, then, do the pressures change?

1

Answers / Notes

3. Data and answers will vary. Here is one sample calculation: $P = \frac{F}{A} = \frac{170 \text{ lbs}}{4 \text{ in}^2} = 43 \text{ lbs/in}^2$

To estimate the area of a disk, simply center it on the concentric circles, then read its area at the circumference. If students are not using calculators, they should round off areas to the nearest whole number to simplify long division.

4. Marble: $P = \frac{F}{A} = \frac{170 \text{ lbs}}{1.5 \text{ in}^2} = 113 \text{ lbs/in}^2$ Pea: $P = \frac{F}{A} = \frac{170 \text{ lbs}}{0.6 \text{ in}^2} = 283 \text{ lbs/in}^2$

5. The thickest disk was flattened by much less pressure than the thinnest disk. The Ping-Pong disk, for example, was flattened to about 12 mm thick; the marble to 6 mm; the pea to 2 mm.

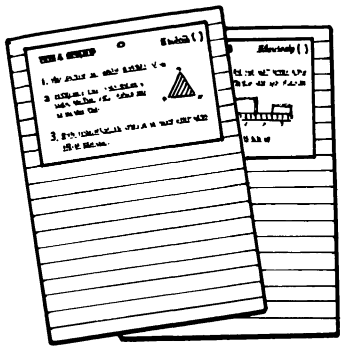
6. Pressures change as the constant weight of the body is applied over different areas. As these areas decrease, the smaller denominators divide into a constant numerator to yield larger quotients.

Materials

- ☐ A lump of clay.
- ☐ An index card.
- ☐ Shoes with relatively smooth soles. In step 2, students wearing track shoes or other “topographically enhanced” soles can step on an old paperback book to prevent lumps.
- ☐ A pair of scissors.
- ☐ An Area Estimator for Square Inches. Photocopy this from the supplementary page at the back of this book.
- ☐ A bathroom scale (optional). Most students already know their own weight. Process is more important in this activity than accuracy.
- ☐ A centimeter ruler. Photocopy this from the supplementary page.
- ☐ A calculator (optional).

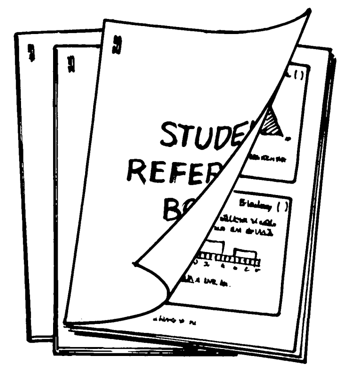
Task Cards Options

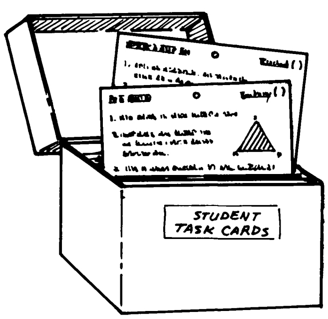
Here are 3 management options to consider before you photocopy:



1. Consumable Worksheets: Copy 1 complete set of task card pages. Cut out each card and fix it to a separate sheet of boldly lined paper. Duplicate a class set of each worksheet master you have made, 1 per student. Direct students to follow the task card instructions at the top of each page, then respond to questions in the lined space underneath.

2. Nonconsumable Reference Booklets: Copy and collate the 2-up task card pages in sequence. Make perhaps half as many sets as the students who will use them. Staple each set in the upper left corner, both front and back to prevent the outside pages from working loose. Tell students that these task card booklets are for reference only. They should use them as they would any textbook, responding to questions on their own papers, returning them unmarked and in good shape at the end of the module.





3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and tape these to the wall); or fix cards to cereal boxes with paper fasteners, 4 to a box; or keep cards on designated reference tables. The important thing is to provide enough task card reference points about your classroom to avoid a jam of too many students at any one location. Two or 3 task card sets should accommodate everyone, since different students will use different cards at different times.

SQUEEZE PLAY

Pressure ( )

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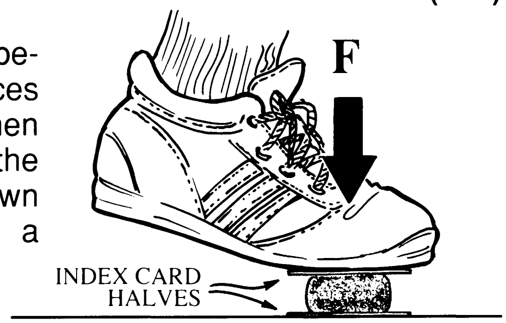

3. Use the Area Estimator (for Square Inches) to estimate the *area* (A) of your newly formed disk. Divide this into the *force* of your own weight (F) to find the *pressure* (P) that you applied.

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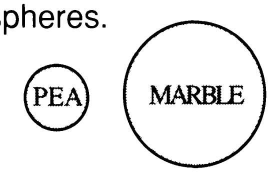
4. Repeat steps 1-3 for marble- and pea-sized clay spheres. Save all three clay disks for step 5.



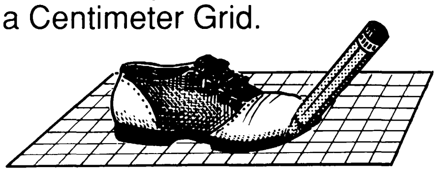
5. Relate the thickness of each disk to the pressures you have calculated.

6. You applied the same force to each lump of clay. Why, then, do the pressures change?

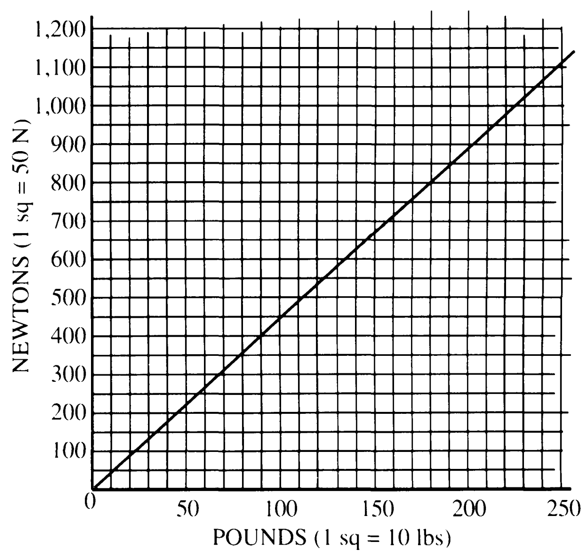
PRESSURE PRINT

Pressure ( )

1. Outline the perimeter of your shoe on a Centimeter Grid.



2. Estimate its area by counting centimeter squares. Count all squares greater than 1/2 as "one," all squares less than 1/2 as "zero."
3. Convert your weight from pounds to Newtons using this graph. What average pressure (in N/cm^2) do you exert when standing on 1 foot?



4. How does this pressure change when standing, with equal balance, on both feet? Explain your reasoning.
5. Earth's atmosphere exerts a pressure of about 10 N/cm^2 against the floor. Describe how you should stand to approximate this much pressure.