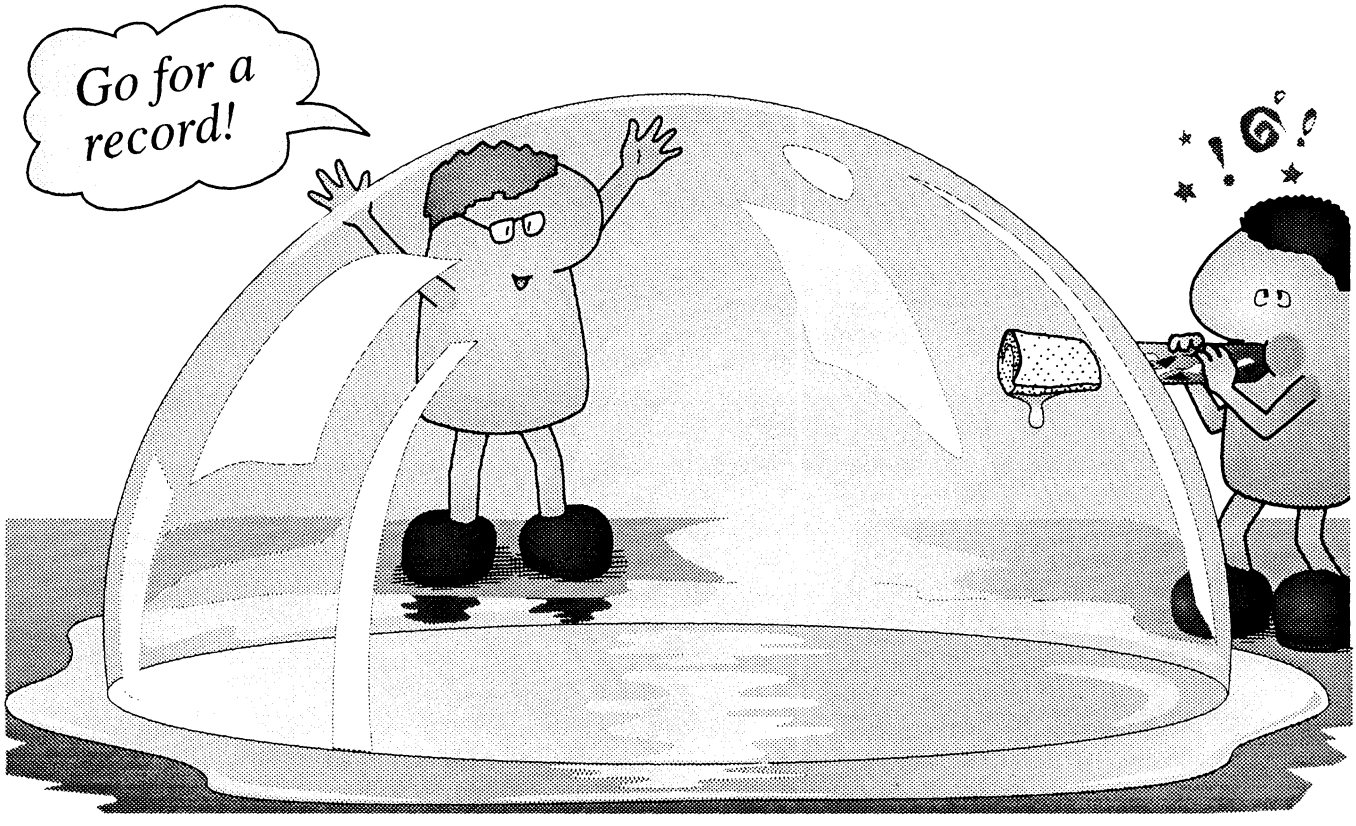
# COHESION/ADHESION




## TASK CARD SERIES

Conceived and written by

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TOPS LEARNING SYSTEMS

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# CONTENTS


## INTRODUCTION




## TEACHING NOTES




## REPRODUCIBLE MATERIALS

# 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.

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 an extra trip to the store, 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:

$Q_1/Q_2/Q_3$

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

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

| | | | | | |
|---|---|---|---|---|---|
| 4/40/40 | dropper bottles & droppers | 1/1/1 | shaker of fine pepper | 1/3/10 | *sets of 8 washable colored markers* |
| 1/3/3 | rolls masking tape | 1/50/50 | aluminum straight pins – see notes 7 | 1/3/10 | rolls clear tape |
| 1/1/1 | bottle blue food coloring with dropper dispenser | 1/1/1 | bar of soap | 1/1/1 | shaker of table salt |
| 1/1/1 | bottle 70% rubbing alcohol | 1/1/1 | *pkg solid camphor – see notes 6* | 1/10/10 | *plastic tubs with lids – see notes 20* |
| 1/1/1 | source of tap water | 2/20/20 | medium styrofoam cups, – see notes 7, 8, 20-23 | 1/1/1 | plastic gallon (4 L) milk jug |
| 1/1/1 | *bottle Joy® or Dawn® liquid detergent – see notes 20* | 1/10/10 | toothpicks | 1/1/1 | *bottle glycerine* |
| 1/1/1 | bottle corn oil | 1/30/30 | plastic drinking straws, about ¼ inch diameter | 1/1/1 | *gallon distilled or deionized water – see notes 20 |
| 1/1/1 | roll waxed paper | 1/10/10 | string pieces, at least 20 cm (10 inches) long | 1/1/1 | spool thread |
| 1/10/10 | small graduated cylinders, 10 mL capacity | 4/20/40 | microscope slides | 2/6/20 | size-D batteries, dead or alive |
| 1/10/10 | *hand calculators | 1/4/10 | candles | 1/10/10 | pieces corrugated cardboard, 5 x 20 cm or larger |
| 1/10/10 | pennies | 1/4/10 | paper clips | 1/3/10 | index cards, 4 x 6 inch |
| 1/1/1 | roll soft paper towels | 5/30/50 | medium or large baby food jars | 1/1/1 | roll aluminum foil |
| 1/10/10 | scissors | 4/20/40 | thin rubber bands | 1/2/10 | *medium test tubes, about 1.5 cm diameter |
| 1/5/10 | large jars or equivalent supports – see activity 3 | 1/4/10 | eyedroppers – notes 11 | 1/2/10 | meter sticks |
| 1/1/1 | clock with second hand (wristwatches) | 1/4/10 | hand lenses | 1/1/1 | *bottle of vinegar |
| 1/10/10 | paper plates, 9 inch diameter | 1/10/10 | sheets newspaper – see notes 13 | | |
| 1/4/10 | drinking glasses | | | | |
| 1/4/10 | shallow bowls | | | | |

# Sequencing Task Cards

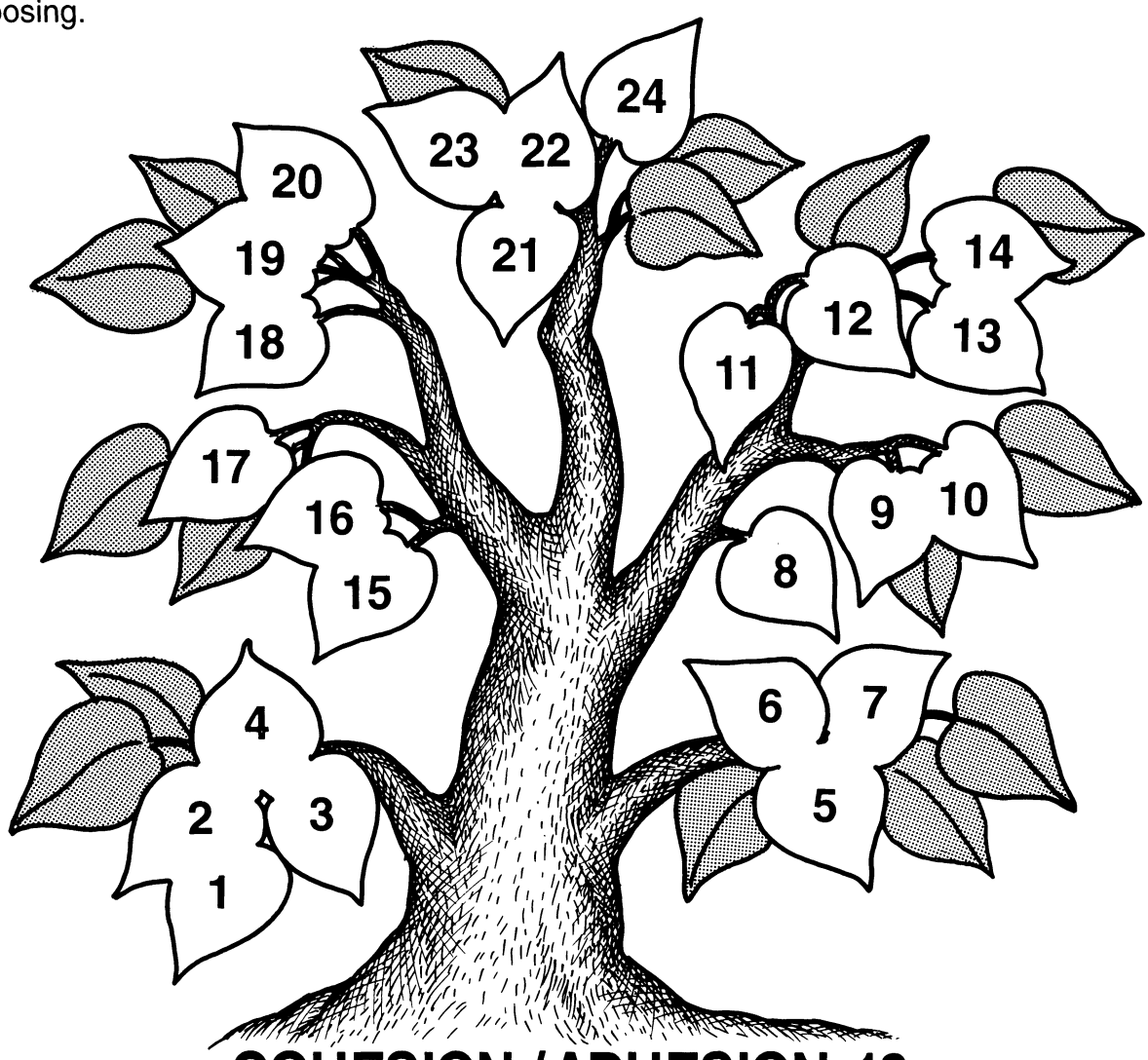
This logic tree shows how all the task cards in this module tie together. In general, students begin at the bottom of the tree and work up through the related branches. As the diagram suggests, upper level activities build on lower level activities.

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 move 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.

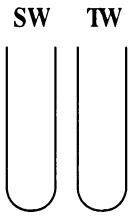


# Review / Test Questions

Photocopy the questions below. On a sheet of blank paper, cut and paste those questions you want to use in your test. Include questions of your own design, as well. Place all these questions on 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.

**tasks 1-2**

Accurately draw the water line in each test tube. Test tube **SW** holds as much Soapy Water as possible. Test tube **TW** holds as much Tap Water as possible.




**tasks 1-4 A**

Where is the cohesion? The adhesion?

a. A drop of rainwater slides down my window.

b. A sand castle holds together as long as the sand is wet.

**tasks 1-4 B**

Which is stronger, cohesion in the liquid or its adhesion to the solid? Explain.

a. Water on a waxed surface.

b. Oil in a metal engine.

**task 5**

Account for the strong cohesive forces between water molecules.

**tasks 5-6**

Predict what happens when you drip a drop of soapy water between 2 toothpicks floating in a bowl of tap water. Give reasons for your prediction.

**tasks 5-7**

A water strider is a bug that walks on water with dry feet. Explain how hydrogen bonds make this possible.

**task 7**

A metal paper clip is resting on the surface of a glass of water. If you push it under, will it float back to the surface? Explain.

**tasks 8-9**

Water tends to dribble down the outside of the spout when poured from a glass pitcher.

a. Why does this happen?

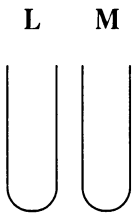
b. How might you use a candle to fix the problem?

**tasks 9-10**

Rainwater that wets the outside surface of a rock also moistens its interior cracks and crevices. How does this happen?

**task 11**

Accurately draw the water line in each test tube. Test tube **L** is filled Less than full. Test tube **M** is filled More than full.




**task 12**

Explain how a tree moves water from its roots below ground to its leaves high in the air.

**tasks 12-13**

A paper towel is cut to the same size as a piece of notebook paper. Which soaks up more water? Why?

**tasks 13-14**

A chromatogram streaks from blue into green into yellow. What color was the original marker? What dye colors does it likely contain?

**task 15**

Oil is spilled in water. What can you spray on the slick to make it easier to clean up? Explain.

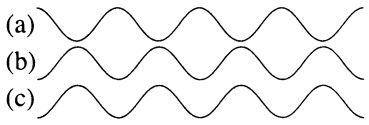
**task 16**

Two oil slicks reflect light to your eyes, but you see colors in only one of them. How are they different?

**task 17**

Which is stronger, the surface tension of pure water or the surface tension of soap film? Defend your answer.

**task 18**




a. Which wave trains are in phase? Out of phase?

b. Which wave trains interfere constructively? Destructively?

**tasks 18-20 A**

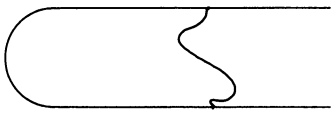
Why does light reflected from a soap bubble produce color?

**tasks 18-20 B**

You dip the rim of a cup is into bubble solution to create a soapy film, then tilt it at an angle to drain. Soon you see bands of color interference in reflected daylight. Are these bands horizontal or vertical? Why?

**tasks 21-22 A**

A piece of wire is shaped like a "U" with a piece of thread tied loosely across its middle, then dipped into bubble solution.



a. Draw the shape of the soap film that forms between wire and thread.

b. Why does the soap film assume this shape and no other?

**tasks 21-22 B**

You blow a bubble in the air. Why is it spherical?

**task 22**

Draw side views that show...

a. Two bubbles of equal size united by a common film.

b. A large bubble and small bubble united by a common film.

**task 23**

Draw top views that show...

a. Two bubbles of equal size united by a common film.

b. One bubble surrounded by three others, all of equal size.

**task 24**

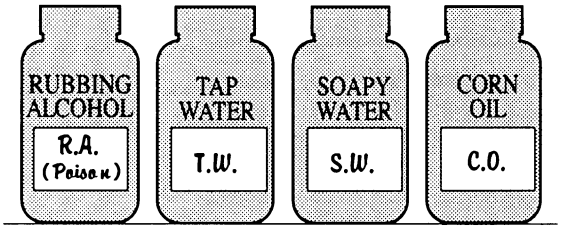
a. Why do bubble domes break?

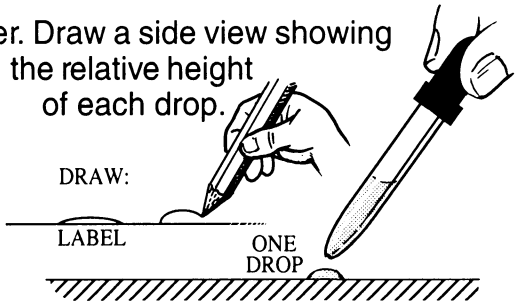
b. How can you make them larger?

**Task Objective (TO)** compare the size and shape of drops of different liquids. To order these liquids according to their relative cohesive strength.

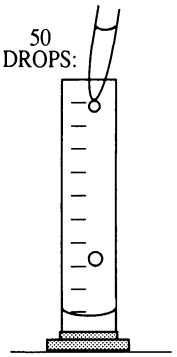
## COHESION ○ Cohesion / Adhesion ( )

1. Place 1 drop of each liquid on wax paper. Draw a side view showing the relative height of each drop.




2. Measure the volume of 50 drops of each liquid in a small graduated cylinder. (Rinse it after each addition and shake out excess water.)



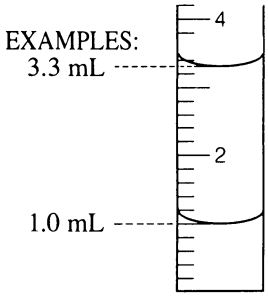

3. Relate volumes in step 2 to your drawing in step 1.

4. *Cohesion* is the force of attraction between *like* molecules: it holds a liquid together.
   a. Which liquid has the strongest cohesion between its molecules? Explain.
   b. Is corn oil more cohesive than alcohol? How do you know?

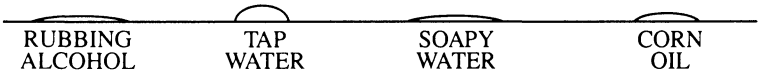
### Introduction

Draw an enlarged view of a 10 mL graduated cylinder on your blackboard. Count the calibrations (...2.0 mL, 2.2 mL, 2.4 mL...) to emphasize that it is divided in increments of 0.2 mL. Draw a water meniscus at various levels and ask students to read the volume.




### Answers / Notes

1.




2. Answers will vary depending on eye dropper openings. Here is one set of results: R.A.=1.0 mL; T.W. = 2.7 mL; S.W. = 1.0 mL; C.O. = 1.6 mL

3. Liquids that heap higher on waxed paper (in step 1) have greater 50-drop volumes (in step 2).

4a. Water molecules hold together with the strongest cohesive force. Tap water forms drops that are higher and rounder, and occupy more volume than any other liquid.

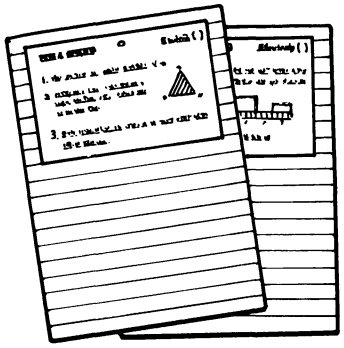
4b. Yes. A drop of corn oil heaps higher on wax paper than does a drop of rubbing alcohol. Moreover, 50 drops of corn oil occupy a volume of 1.6 mL, compared with only 1.0 mL for rubbing alcohol.

### Materials

- ☐ Four clean dropper bottles, with eye droppers of equal size. Use masking tape to label each as underlined:
  - 70% Rubbing Alcohol: R.A. (poison). Purchase this in any drugstore. Tint with 1 drop blue food coloring.
  - Tap Water: T.W. Rinse the bottle of all traces of soap before filling. Tint with 1 drop blue food coloring.
  - Soapy Water: S.W. Add 6 drops of Joy® or Dawn® liquid detergent to the bottle and fill with tap water. (These brands work best in a bubble solution used in activities 20-24.) Tint with 1 drop blue food coloring. *Note: Though soap and detergent are chemically distinct, they have similar surfactant properties that create "soapy" solutions. For lack of a useful substitute, we use the common sense meaning of this word.*
  - Corn Oil: C.O. Purchase this in any grocery store. Do *not* add food coloring.
- ☐ Wax paper.
- ☐ A 10 mL graduated cylinder. Larger capacity cylinders are *not* good substitutes.
- ☐ A source of water.

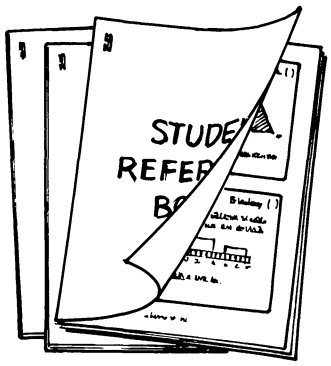
# Task Cards Options

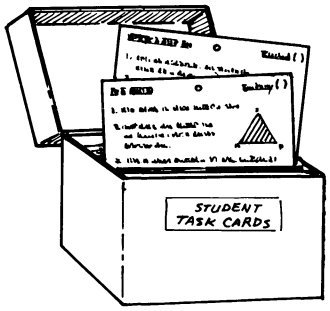
**Here are 3 management options to consider before you photocopy:**



**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.



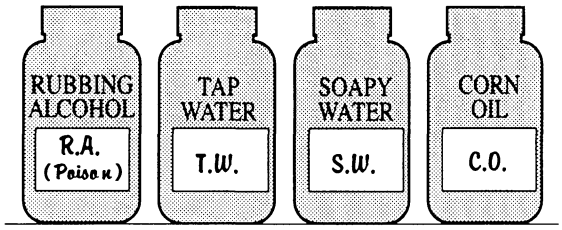


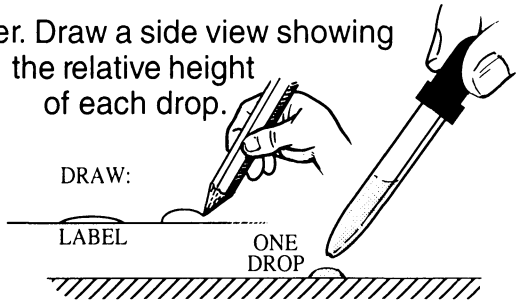

**3. Nonconsumable Task Cards:** Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips 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.

## COHESION

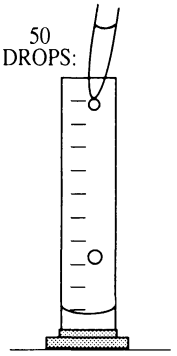
Cohesion / Adhesion ( )

1. Place 1 drop of each liquid on wax paper. Draw a side view showing the relative height of each drop.




2. Measure the volume of 50 drops of each liquid in a small graduated cylinder. (Rinse it after each addition and shake out excess water.)




3. Relate volumes in step 2 to your drawing in step 1.

4. *Cohesion* is the force of attraction between *like* molecules: it holds a liquid together.
   a. Which liquid has the strongest cohesion between its molecules? Explain.
   b. Is corn oil more cohesive than alcohol? How do you know?

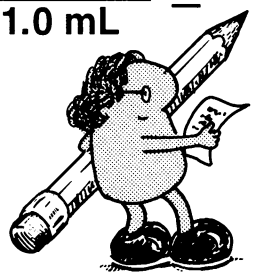



## HEAP O' WATER

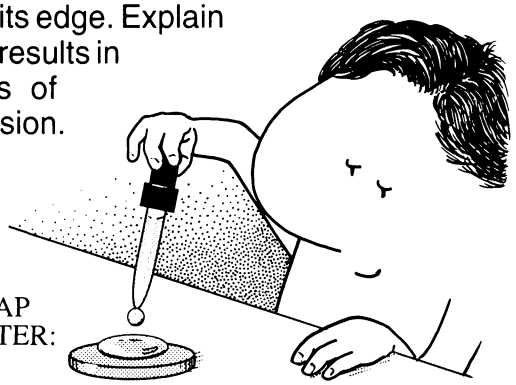
Cohesion / Adhesion ( )

1. Calculate how many drops of tap water add up to 1 mL. Set up a proportion using numbers from the last activity.

$$\frac{\text{X DROPS}}{\text{1.0 mL}} =$$



2. Try to heap 1 mL of tap water on top of a penny without spilling any over its edge. Explain your results in terms of cohesion.




3. Dry the penny. Add 1 drop *less* than a full mL of tap water to the penny without spilling.
   a. Now add 1 drop more of soapy water. What happens?
   b. How does soap affect the cohesion of water?