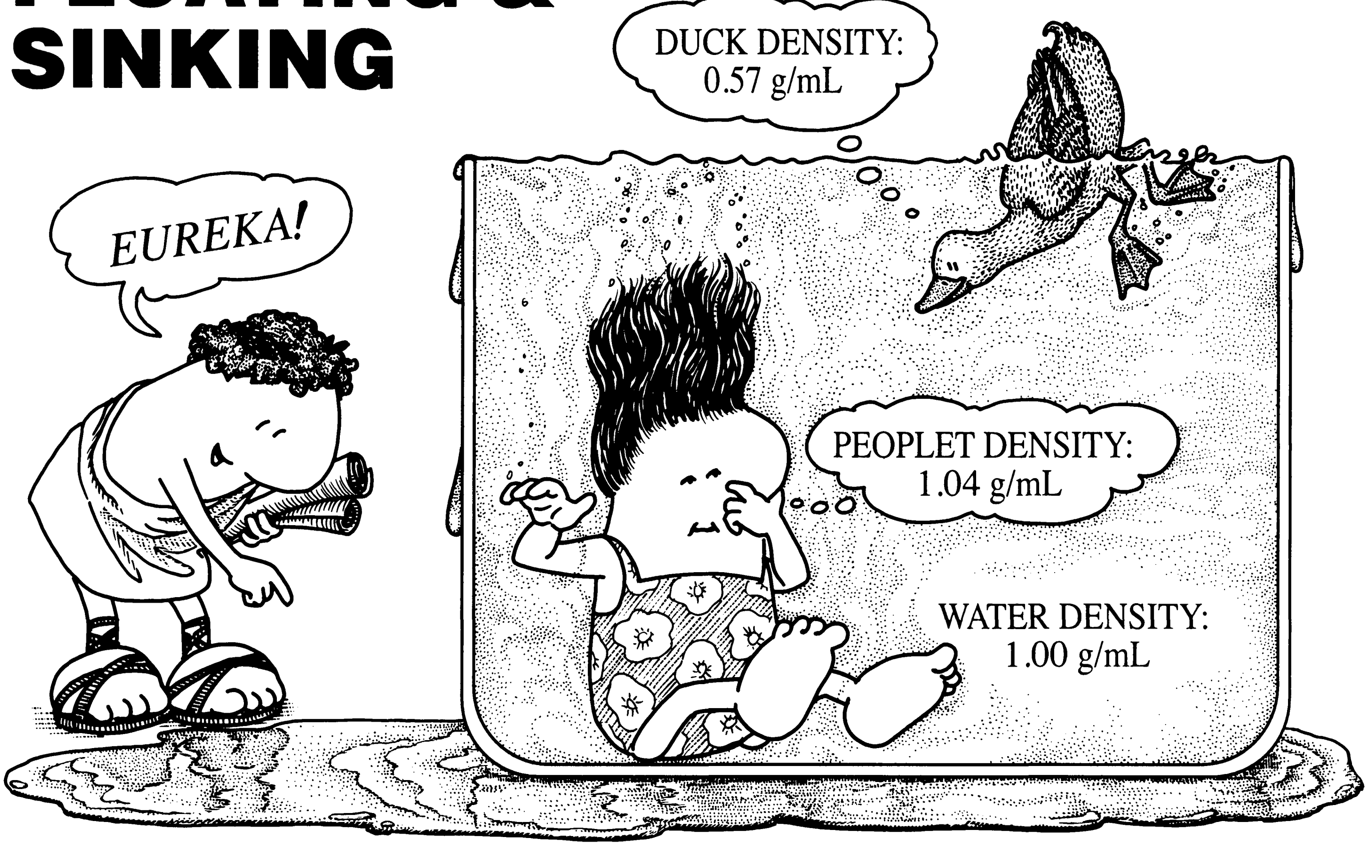
FLOATING & SINKING



TASK CARD SERIES

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TOPS LEARNING SYSTEMS

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CONTENTS

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: 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.	general on-the-shelf materials: 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): 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.	*optional materials: 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 10 lab groups, all self-paced.
- **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

1/10/10	small 10 mL graduated cylinders	1/3/3	toothpicks
1/1/1	source tap water, hot and cold	1/1/1	pkg birthday candles
1/10/10	gram balances – see notes 1	1/10/10	paper drinking cups, 6 oz. or larger
1/1/1	box table salt	1/5/10	medium-sized cans
2/2/2	quart jars or equivalent with lids	1/2/10	*golf balls*
1/1/1	bottle 70% isopropyl rubbing alcohol	2/10/20	size-D batteries, dead or alive
1/1/1	bottle 100% corn oil	1/4/10	centimeter rulers
1/1/1	bottle baby oil (mineral oil)	1/1/1	box plastic wrap
5/45/50	large 6 oz. baby food jars with lids	2/20/20	*natural corks – see notes 13*
5/45/50	eye droppers	1/10/10	plastic sandwich bags
1/1/1	roll paper towels	1/10/10	large cereal boxes – see notes 15
1/2/4	rolls masking tape	2/15/20	large rubber bands
1/5/10	jars or glasses, 8 oz. or more	1/1/1	*roll 28 ga steel wire, annealed or galvanized*
1/10/10	*test tubes (small graduates)	1/3/10	meter sticks
2/15/15	*utility candles – see notes 5*	1/10/10	paper clips
1/1/1	box straight pins	1/1/1	spool of thread
1/2/5	needle-nose pliers with wire cutting edge	1/10/10	*film canisters, plastic 35 mm size*
1/10/10	large 100 mL graduated cylinders	1/3/10	solid rubber stoppers
3/30/30	straight plastic drinking straws	1/3/10	books of matches
1/2/5	paper punchers	1/3/10	plastic lids
1/10/10	hand calculators	1/1/1	pkg BB shot
.5/5/5	cups oil-based modeling clay	1/3/10	tablespoons
1/10/10	scissors	1/1/1	bottle blue food coloring with dispenser
1/10/10	plastic margarine tubs (bowls)	1/10/10	ice cubes
1/10/10	*pieces wood dowel – see notes 8*	1/2/10	helium-filled balloons

Sequencing Task Cards

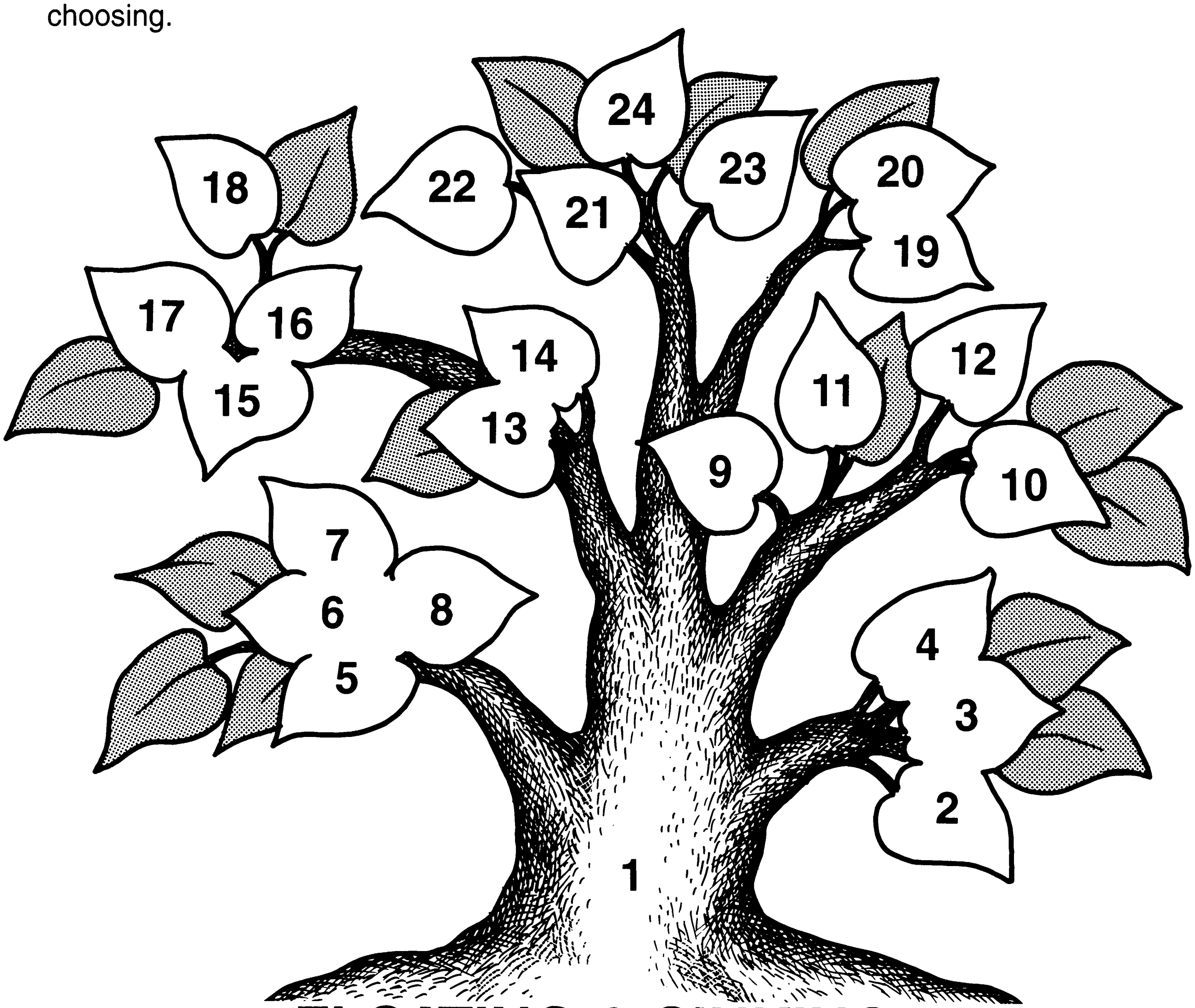
This logic tree shows how all the task cards in this module tie together. In general, students begin at the bottom of the tree and work up through the related branches. As the diagram suggests, upper level activities build on lower level activities.

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.



FLOATING & SINKING 09

Review / Test Questions

task 1-2 A

A small graduated cylinder filled with 6.0 mL water has a mass of 34.7 g. What is the mass of the dry cylinder?

task 1-2 B

Is 10 g of water twice as dense as 20 g of water? Explain.

task 1-2 C

A 10.0 mL volume of kerosene has a mass of 8.2 g. What is the density of kerosene?

task 3-4 A

A block of wood (D = .84 g/mL) is immersed in a glass of kerosene (D = 0.82 g/mL). Will it float or sink? Explain.

task 3-4 B

Kerosene (D = 0.82 g/mL) and carbon tetrachloride (D = 1.56 g/mL) mix together. Neither of these liquids mixes with water. Diagram how a test tube looks:

a. If you add equal portions of carbon tetrachloride, then water, then kerosene.

b. If you add equal portions of kerosene, then water, then carbon tetrachloride.

task 5, 8-9 A

Hand calculator optional.

A 18.3 g rubber stopper is dropped into a graduated cylinder containing 50.0 mL of water and sinks to the bottom. This raises the water level in the cylinder to 65.4 mL. Calculate the density of the stopper.

task 5, 8-9 B

Design an experiment to determine the density of nails.

task 6, 8 A

A 10.0 cm candle sinks into a narrow water-filled cylinder, with only 0.8 cm remaining above the surface. Calculate its specific gravity. What is its density?

task 6, 8 B

An iceberg floats just 8.3% above water. Calculate its specific gravity. What is its density?

task 7, 8, 12, 14

A 25 ton iceberg floats in arctic waters. How much seawater does it displace?

task 4, 9

Solid A floats in liquids x, y and z.
Solid B floats in liquids x and y, but sinks in z.
Solid C floats in liquid x, but sinks in y and z.

Arrange these 6 substances from lowest density to highest density.

task 10

A 30 mL portion of water is emptied into a box that measures 2 cm by 3 cm by 4 cm. Does the box overflow?

task 10-11

You'll need a hand calculator.

A sphere of granite has a radius of 2.0 cm and a density of 2.7 g/mL.

a. What is the volume of this perfectly round rock? ($V = 4/3\pi r^3$)

b. What is its mass?

task 11

A 60.9 g mass of basalt has a density of 2.9 g/mL. What is the volume of this rock?

task 5, 7, 12, 14

An 85 g wood ball and a 715 g steel ball both have a volume of 100 mL. What volume of water will each ball displace? Explain your reasoning.

task 13

Several tablespoons of salt are poured into a tall glass of water without stirring. An egg placed in the glass sinks to the bottom and rests on the salt. Over several days, it rises halfway between the bottom and the surface. What happened?

task 12, 14 A

Iron's density is greater than 7 g/mL. How can boats made from this dense material possibly float in water with a density of only 1 g/mL?

task 12, 14 B

A swimmer tends to float when inhaling air, and sink when exhaling air. Explain this in terms of volume and density.

task 15-17

A 2.8 ton boulder weighs only 1.0 ton in water. What is the buoyancy of water on this boulder?

task 14-18

Write F for Floating body, N for Neutral body and/or S for Sinking body after each statement that applies:

a. Weighs nothing in water.

b. Weighs less in water than in air, but not zero.

c. Displaces its own weight in water.

d. Displaces less than its own weight in water.

e. Displaces its own volume in water.

f. Displaces less than its own volume in water.

task 17-18

Write F for Floating body or S for Sinking body after each statement that applies to fresh water (f.w.) and salt water (s.w.).

a. Weighs the same in f.w. as in s.w.

b. Weighs more in f.w. than in s.w.

c. Displaces less weight in f.w. than s.w.

d. Displaces same weight in f.w. as s.w.

e. Displaces higher volume f.w. than s.w.

f. Displaces same volume f.w. as s.w.

task 17-20

A ship sails out of the fresh water Columbia River into the salt water Pacific Ocean. Did it ride any higher or lower in the river than in the ocean? Use Archimedes' principle to defend your answer.

task 19-20 A

Explain how a hydrometer measures density.

task 19-20 B

You'll need a mm ruler.

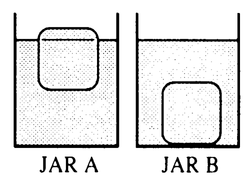
Float levels for water (D = 1.00 g/mL) and rubbing alcohol (D= 0.87 g/mL) are marked on a hydrometer, with a separation of 13 mm. Draw a scale for this hydrometer. Use an arrow to show the float level for corn oil (D = 0.91 mL).

task 3, 4, 21

A blue salt is dissolved in unmarked bottles of alcohol and water. How would you use an eyedropper and a glass of water to tell them apart?

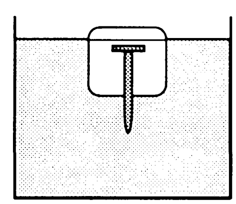
task 22

Which jar holds the half-melted wax? Which holds the half-melted water? Explain.



task 23

A nail is frozen into the ice cube that floats in water at room temperature. Will it eventually sink? Explain.



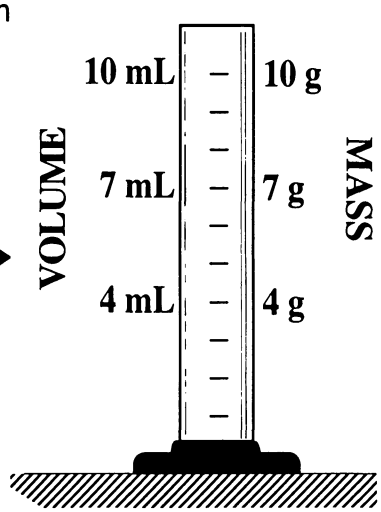
task 24

You notice, just before going to bed, that a balloon left from last week's birthday party has lost enough helium to sink to the floor of your bedroom. Upon rising the next morning, you notice that it has again risen to the ceiling. Did helium pixies recharge the balloon overnight? Offer a more plausible theory in terms of Archimedes' principle.

Task Objective (TO) experimentally confirm that the density of water is very close to 1.00 g/mL, no matter how much water you measure.

DENSITY OF WATER O Floating and Sinking ( )

1. Get a 10 mL graduated cylinder and a gram balance. Center the balance.



a. Show that these *volumes* of water have the indicated *masses*, within the limits of measuring uncertainty:

b. Recenter your balance, as necessary, before finding each new mass.

c. Write a brief report.

2. *Density* is defined as the mass of any substance divided by its volume. Show that the density of water is always close to 1.00 g/mL, no matter what volume you measure.

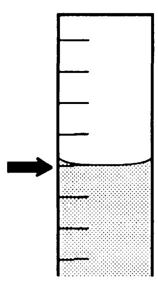
$$D = \frac{\text{mass}}{\text{volume}} = \frac{g}{mL}$$

 1

Introduction

Review, if necessary, these experimental procedures:

a. How to read a graduated cylinder at the bottom of the meniscus.



b. How to center a balance and measure mass in grams.

Materials

☐ A 10 mL capacity graduated cylinder. Larger 100 mL graduated cylinders do not measure volume with enough accuracy.

☐ A source of water. Water is used throughout this module and will hereafter be assumed.

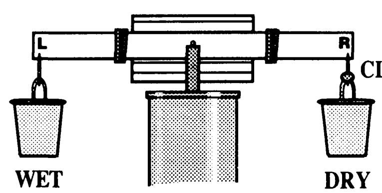
☐ A gram balance. Use the equal-arm balance improvised in TOPS Module 05 Weighing, or any standard lab balance.

Answers / Notes

1. *Sample report for students using a triple-beam balance:*
Weigh a 10 mL graduate with the specified volume of water. Weigh the empty graduate. Find the difference.

volume of water	10.0 mL	7.0 mL	4.0 mL
mass of graduate + water	38.7 g	35.8 g	32.6 g
mass of empty graduate	28.7 g	28.7 g	28.7 g
mass of water	10.0 g	7.1 g	3.9 g

1. *Sample report for students using the TOPS equal-arm balance from 05 Weighing:*



First center the balance with a *wet*, empty cup. Press enough clay onto the clip over the dry cup to counterbalance the extra moisture, with the rubber band riders centered on each arm.

Pour a measured volume of water directly into the wet cup, then add gram masses (lighter ones made of paper, heavier ones made of rock and tape) to the dry cup until the beam rebalances at its centered position.

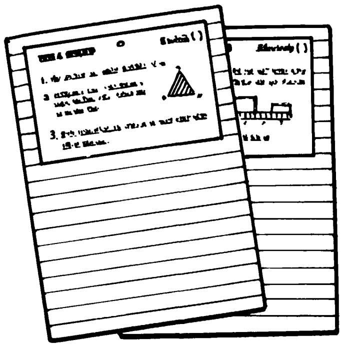
Empty the water cup and recenter the balance after each weighing. After the initial clay placement, do this by shifting the rubber band riders and/or tilting the index card to align with the beam.

volume of water (mL)	10 mL	7 mL	4 mL
mass of water	9.9 g	6.9 g	4.0 g

2. In every case the density of water is always the same:
$D = 10.0\ g/10.0\ mL \approx 7.1 g/7.0\ mL \approx 3.9\ g/4.0\ mL \approx 1.00\ g/mL$

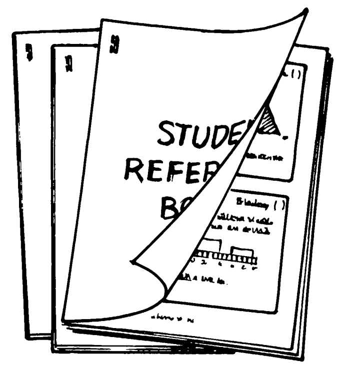
Task Cards Options

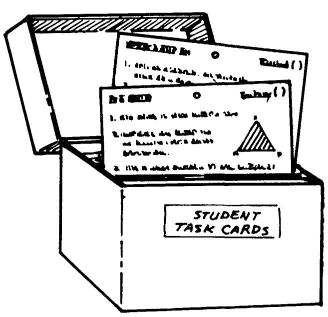
Here are 3 management options to consider before you photocopy:



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.

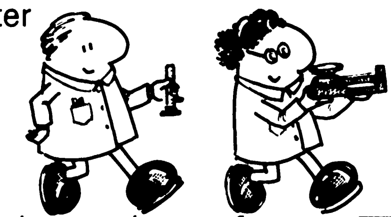




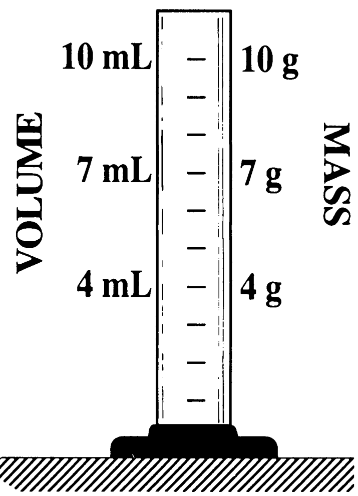
3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and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

DENSITY OF WATER ○ Floating and Sinking ( )

1\. Get a 10 mL graduated cylinder and a gram balance. Center the balance.



a. Show that these *volumes* of water have the indicated *masses*, within the limits of measuring uncertainty:



b. Recenter your balance, as necessary, before finding each new mass.

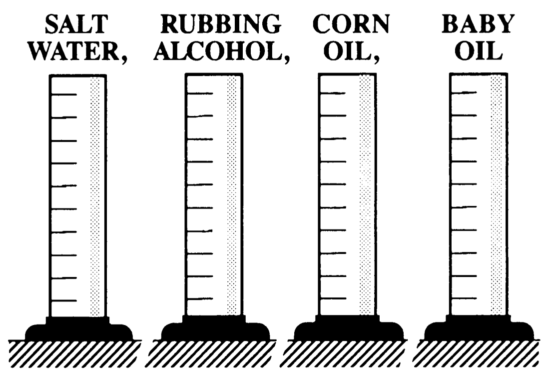
c. Write a brief report.

2\. *Density* is defined as the mass of any substance divided by its volume. Show that the density of water is always close to 1.00 g/mL, no matter what volume you measure.

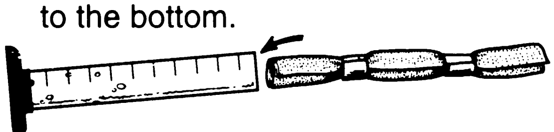
$$D = \frac{\text{mass}}{\text{volume}} = \frac{\text{g}}{\text{mL}}$$

DENSITY OF OTHER LIQUIDS ○ Floating and Sinking ( )

1\. You already found that the density of water is 1.00 g/mL. Now calculate the density of each of these liquids, following the steps below:



a. Rinse and dry your 10 mL cylinder between each new liquid. Roll and tape a paper towel to reach to the bottom.



b. Find the mass of 10.0 mL samples of each liquid to the nearest 0.1 g. Recenter your balance, if necessary, before finding the mass of each new liquid.

c. Report all densities to the nearest 0.01 g/mL. Show your math.

2\. Order these 4 liquids, plus water, from most dense to least dense.

MOST DENSE ⟶ **LEAST DENSE**