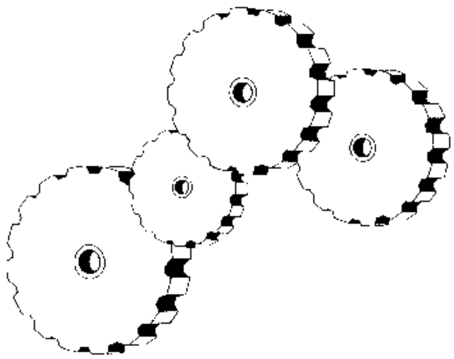


Section One

The Nature of Matter

To the Teacher

Everything around us is matter of one form or another. The air we breathe, the food we eat, the books we read, our bodies—all of these things are made of various types of chemicals and substances. The topic of this section is very broad and is related to many other science topics. No attempt has been made to be comprehensive, but only to expose students to a few of the basic properties and relationships of matter. Activities have been selected that involve materials and supplies common to the school or the home, in preference to those requiring sophisticated equipment.

It is recommended that after a study of the nature of matter, you seek opportunities to apply the general concepts learned while studying other science topics. For example, in a study of weather, air, or water, the principles of evaporation and condensation are essential. The effect of temperature change on expansion and contraction is another idea common to weather, air, water, and the topic of this section. In a study of plants, animals, or the human body, the nature of matter has many applications.

The following activities are designed as discovery activities that students can usually perform quite independently. You are encouraged to provide students (usually in small groups) with the materials listed and a copy of the activity from the beginning through the "Procedure." The section titled "Teacher Information" is not intended for student use, but rather to assist you with the discussion following the hands-on activity, as students share their observations. Discussion of conceptual information prior to completing the hands-on activity can interfere with the discovery process.

Regarding the Early Grades

With verbal instructions and slight modifications, many of these activities can be used with kindergarten, first-grade, and second-grade students. With some activities, steps that involve procedures that go beyond the level of the child can simply be omitted and yet offer the child an experience that plants the seed for a concept that will germinate and grow later on.

Teachers of the early grades will probably choose to bypass many of the "For Problem Solvers" sections. That's okay. These sections are provided for those who are especially motivated and want to go beyond the investigation provided by the activity outlined. Use the outlined activities and enjoy worthwhile learning experiences together with your young students. Also consider, however, that many of the "For Problem Solvers" sections can be used appropriately with young children as group activities or as demonstrations, still giving students the advantage of an exposure to the experience, and laying groundwork for connections that will be made later on.

Correlation with National Standards

The following elements of the National Standards are reflected in the activities of this section.

K–4 Content Standard A: Science as Inquiry

As a result of activities in grades K–4, all students should develop:

1. Abilities necessary to do scientific inquiry
2. Understanding about scientific inquiry

K–4 Content Standard B: Physical Science

As a result of activities in grades K–4, all students should develop understanding of

1. Properties of objects and materials
2. Position and motion of objects
3. Light, heat, electricity, and magnetism

5–8 Content Standard A: Science as Inquiry

As a result of activities in grades 5–8, all students should develop:

1. Abilities necessary to do scientific inquiry
2. Understanding about scientific inquiry

5–8 Content Standard B: Physical Science

As a result of activities in grades 5–8, all students should develop understanding of

1. Properties and changes of properties in matter
2. Motions and forces
3. Transfer of energy

ACTIVITY 1.1

How Can You Make a Balance from Two Clothes Hangers?

Materials Needed

- Wire coat hangers
- Skirt hangers with a straight bar and two clips, as shown in Figure 1.1–1.
- Small plastic cups (or paper cups)

Procedure

1. Pull down at the middle of the bottom bar of the coat hanger until the coat hanger is approximately the shape of a rectangle. (See Figure 1.1–2.)

Figure 1.1–1. Skirt Hanger

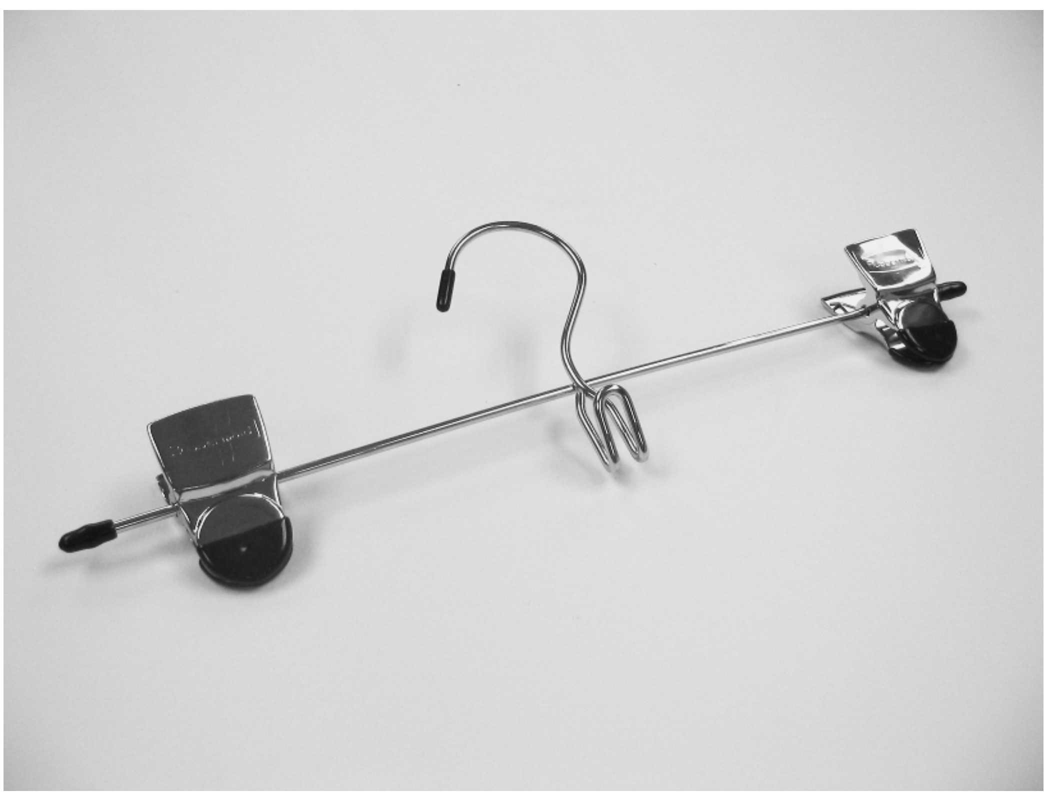
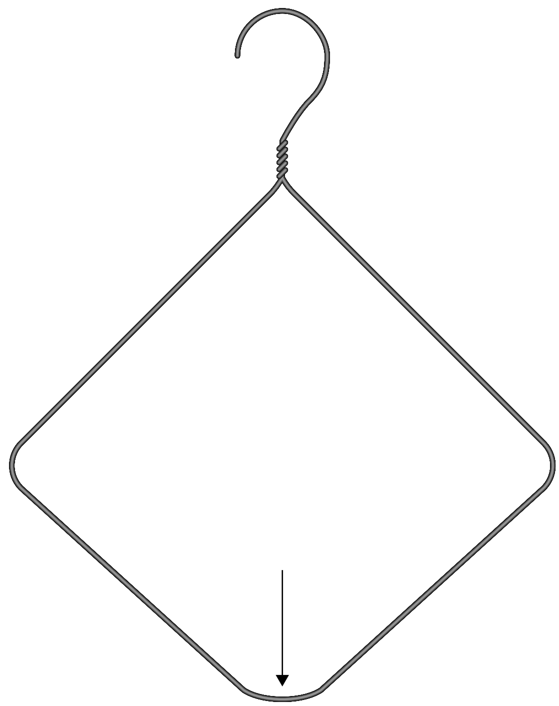


Figure 1.1–2. Preparing the Coat Hanger



2. Fold the stretched coat hanger forward at the corners so it will stand by itself.
3. Turn the hook around and down, to face inward and upward, as in Figure 1.1–3. This is your wire stand.

Figure 1.1–3. Completed Stand for Two-Hanger Balance

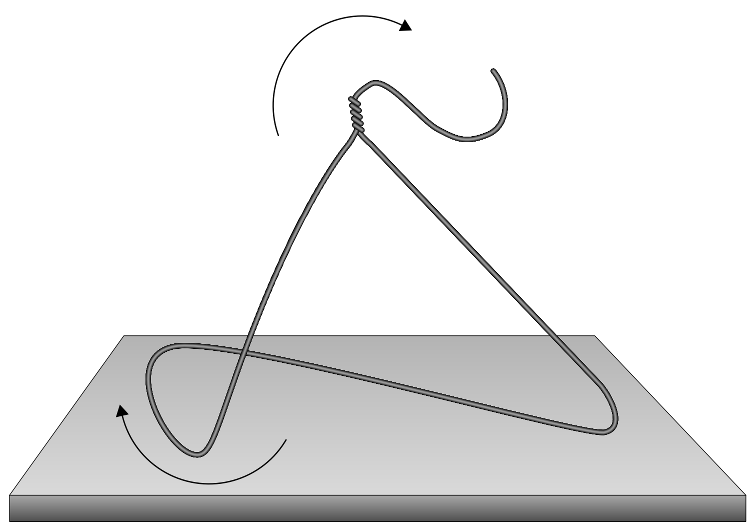
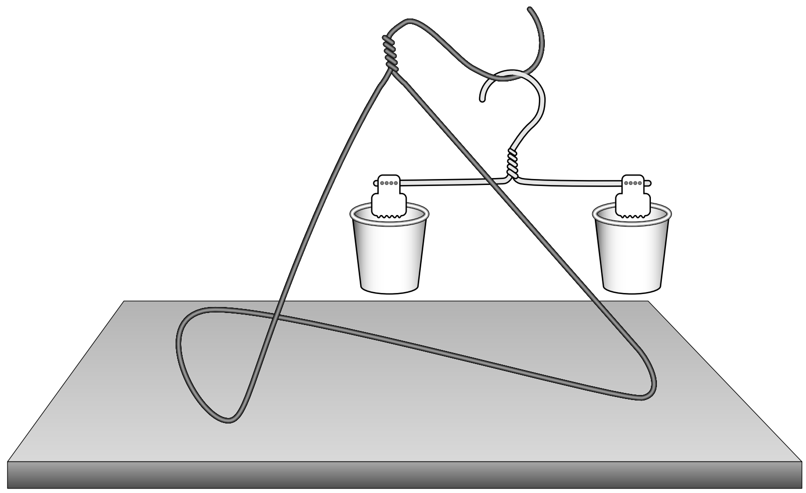


Figure 1.1-4. Complete Two-Hanger Balance



4. Hang the skirt hanger on the wire stand.
5. Fasten one cup to each of the clips of the skirt hanger. This is now your balance beam, and your two-hanger balance is complete and should look like Figure. 1.1–4.
6. Your next task is to balance the balance beam. The clips should both be near the ends of the balance beam (skirt hanger). If necessary, slide them out until they are. Then slide one or both of the clips back and forth slightly until the balance beam is balanced, that is, level.
7. Your two-hanger balance is ready to use.

Teacher Information

Some skirt hangers are designed in such a way that the clips hang lower from the hook. The one that is shown holds the clips higher off the table. Also, most skirt hangers are designed such that the clips slide back and forth to accommodate various sizes of clothing articles. When used as the balance beam for the two-hanger balance, this provides a built-in fine-tuning device for balancing the balance beam before use.

If a skirt hanger is not available, a second wire coat hanger will substitute quite nicely. Simply remove the bottom bar, straighten out the side bars, and install a clothespin on each end such that the clothespin grasps both the balance beam and the cup. Fine-tuning of the balance beam is done by sliding clothespins back and forth as needed, until the two ends are equal distance from the top of the table.

With the cups attached to the clips, and the crossbeam balanced, the two-hanger balance is complete and ready for use. Students will enjoy comparing the masses of small objects. Using nonstandard measures, they can place an object in one cup, then place paper clips or other small objects in the other cup, and then determine how many paper clips or other objects weigh. They will know that an eraser, for instance, weighs a given number of paper clips. If they need to know the actual weight of something, you can provide a set of gram masses. The commercial masses can then be used to make the students' own set of masses by finding an object that balances with each of the needed gram masses and identifying which is 1 gram, which is 2 grams, 5, 10, and so forth.

Integrating

Math, language arts

Science Process Skills

Observing, communicating, measuring

ACTIVITY 1.2

How Can You Make a More Precise Balance from a Ruler?

(Teacher-directed activity)

Materials Needed

- Copies of Figure 1.2–1 for each small group
- Wooden rulers (fairly sturdy)
- Small plastic cups (or paper cups)
- Toothpicks (wooden)
- String
- Paper punches
- Latex cement
- Drill with 1/8-inch bit

Procedure

1. Construct the ruler balance as shown in Figure 1.2–1.
2. Punch three holes near the top of each cup and equal distance apart.
3. Drill two holes near the bottom edge of each end of the ruler. Each pair of holes should be about 2 cm (3/4 in.) apart. The cups will be suspended from these positions.
4. Drill one hole near the top edge of the ruler exactly in the middle of the ruler. The ruler will be suspended from this position.
5. Tie a piece of string (about 30 cm [12 in.]) to the hole at the middle of the ruler.
6. Tie a piece of string (about 20 cm [8 in.]) to one end of the ruler. Loop the string around the two holes in the ruler and tie it quite close to the ruler.
7. Do the same at the other end of the ruler with another piece of string.
8. Cut three pieces of string about 20 cm (8 in.) long. Make a cup hanger by tying one end of each string to one of the three holes in one cup. Tie the other end of these three strings together.

9. Do the same with the other cup.
10. Tie the string that is attached to one end of the ruler to the knot in the three strings of one cup. Tie the other cup to the other end of the ruler in the same way.
11. Hang the ruler balance by tying the middle string to an upper support, such as the handle of a cabinet door.
12. The ruler is your balance beam. Balance it by sliding one or both of the end strings back and forth slightly between the two holes they are attached to.
13. When the balance beam is level, glue the toothpick at the middle of the ruler pointing upward. The toothpick should be in line with the support string. Let the glue dry thoroughly before you use the ruler balance or move it.
14. Your ruler balance is complete and ready to use. Each time you use it, hang it from an upper support and set the balance beam in balance by adjusting the end strings until the toothpick is pointing straight up, in line with the support string.

Teacher Information

This is another way to construct a simple balance scale. This one is a little more difficult to construct; it is also more precise. As with the two-hanger balance, students will enjoy using nonstandard measures to compare masses (weights) of different objects and making their own sets of standard masses. They will know that an eraser, for instance, weighs a given number of paper clips, marbles, pennies, or other item. If they need to know the actual weight of something, you can provide a set of gram masses. The commercial masses can then be used to make the students' own set of masses by finding an object that balances with each of the needed gram masses and identifying which is 1 gram, which is 2 grams, 5, 10, and so forth.

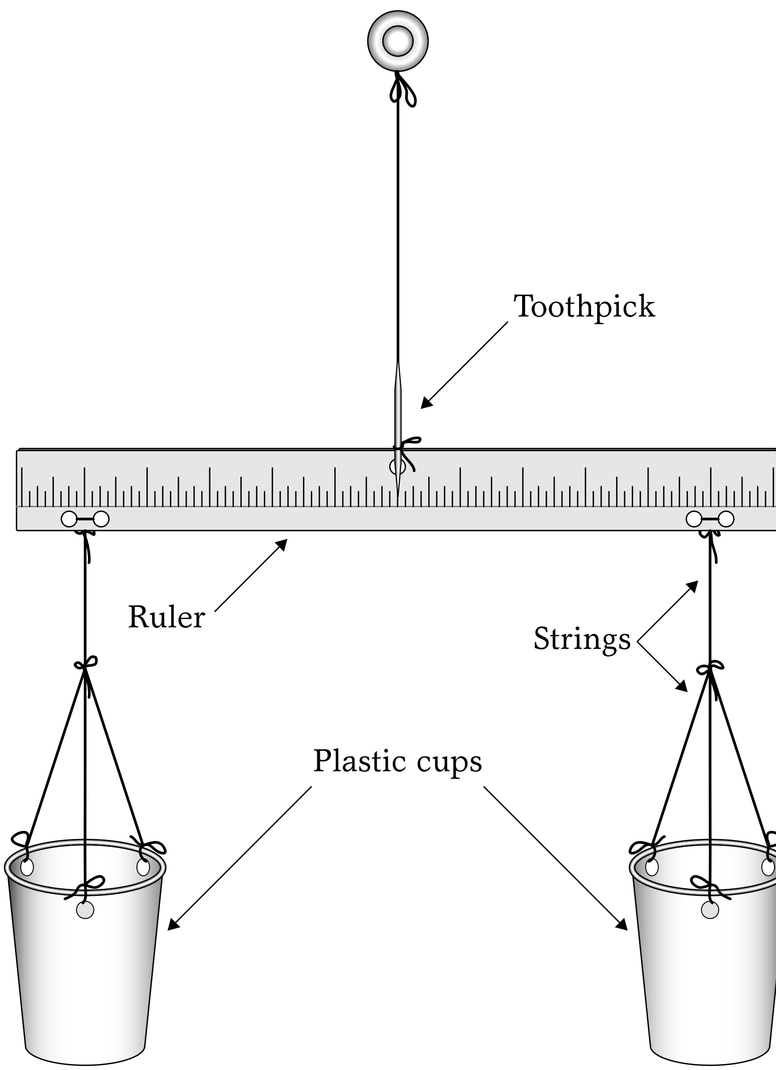
Integrating

Math, language arts

Science Process Skills

Observing, inferring, comparing and contrasting

Figure 1.2-1. Ruler Balance



ACTIVITY 1.3

What Is the Shape of a Drop of Water?

(Take home and do with family and friends.)

Materials Needed

- Waxed paper
- Water
- Eyedroppers
- Pencils

Procedure

1. Draw some water into the dropper.
2. Put several drops on the waxed paper, keeping each separate from the others. Hold the dropper about 1 cm (1/2 in.) above the waxed paper as you squeeze lightly on the bulb.
3. Examine the drops of water. What is their shape? How do they compare in size?
4. Put the point of your pencil into a drop of water, observing carefully to see how the water responds. What did the drop of water do at the surface? Do the water molecules seem to be more attracted to the pencil lead or to each other?
5. Push one of the drops around with your pencil point, observing its behavior.
6. Push two drops together, then three or four. What did they do as they came near each other?
7. What can you say about the attraction of water molecules for each other? For the pencil lead? For the waxed paper?
8. If you could put a drop of water out in space where there is no gravity, what do you think it would look like? What shape would it have? Discuss your ideas with your group.

For Problem Solvers

Place a drop of water on various surfaces and examine each drop with a hand lens. Try it on a sheet of plastic, a sheet of paper, and aluminum foil. Try it on a paper towel. What is the shape of the drop of water? What differences do you see?

Place a drop of water on a penny. Now what is its shape? How many more drops do you think you could put on the penny? Write your prediction, then try it and test your prediction.

Teacher Information

Water molecules attract one another. The attraction of like molecules for one another is called cohesion. Within the liquid, the force of this attraction is balanced, as each molecule is attracted by other molecules all the way around. The molecules on the surface are pulled downward and sideways by neighboring water molecules. This creates a skin-like effect on the surface, called "surface tension." The roundness of the drops on the waxed paper is an indication of surface tension. When several drops are put together they flatten out more, because of the increased effect of gravity as the drop gets larger.

Because of surface tension, a drop of water in the absence of gravity would take on the shape of a perfect sphere. However, a drop of water out in space would evaporate almost instantly.

The surface tension of water forms a bond strong enough to support the weight of a paper clip laid carefully on the water. When a drop of detergent is added to the water, the surface tension is broken and the floating object will sink.

Many other substances have surface tension. It has been suggested that better ball bearings could be formed in space than in factories on the earth because a drop of molten steel would naturally form a perfect sphere.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, predicting, communicating

ACTIVITY 1.4

How Dry Can You Wring a Wet Sponge?

(Take home and do with family and friends.)

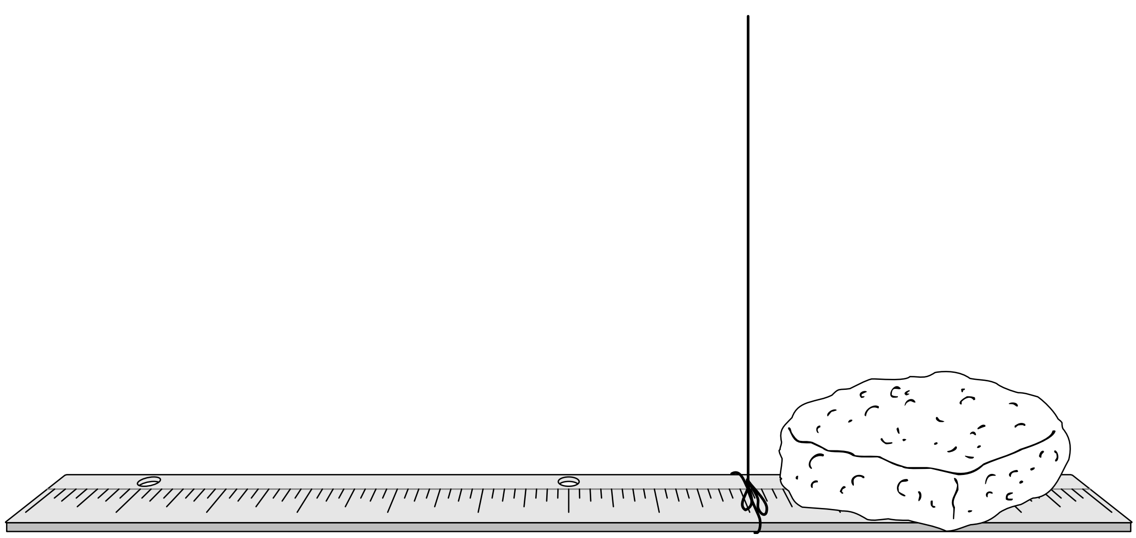
Materials Needed

- Meter stick (or yardstick)
- Sponge
- Paper and pencil
- String
- Water

Procedure

1. Wet the sponge, then wring all the water you can out of it.
2. Tie the sponge to one end of the meter stick.
3. Tie a string near the middle of the meter stick; then suspend it by tying it to something overhead. Slide the string on the meter stick to cause it to hang level, as in Figure 1.4–1.
4. Record the time and draw a picture of the setup as it appeared when you prepared it.

Figure 1.4–1. Balanced Meter Stick



5. Every 15 minutes for two hours, record the time and draw a picture of the setup.
6. What happened to the meter stick during the two hours? Explain why you think this happened. How can you find out whether you were right?

For Problem Solvers

How much water is in a sponge after you wring it out as dry as you can? Can you measure it? *Clue:* How much does the sponge weigh?

After you figure that out, find out how much water is in your bath towel after you dry yourself following a shower. If you live in a humid area, find out whether there is more water in a "dry" towel within a few hours after the towel comes out of the dryer than there was right after the towel was dried. Think about what you did with the sponge.

Teacher Information

The sponge cannot be wrung completely dry. As it sits for the two-hour period, much if not all, of the remaining moisture will evaporate. As the water evaporates, the sponge becomes lighter and the system will no longer be balanced. The process of drawing the position of the setup several times will make students aware of the change as it is taking place. Students will probably want to feel the sponge. This should be avoided until the end of the investigation because of the risk of sliding the string on the stick and nullifying the results.

Students who do the "For Problem Solvers" section will need access to a gram balance or other sensitive weighing device in order to determine the amount of water that is in the wrung-out sponge. With the bath towel activity, they might be able to detect a before/after difference with their bathroom scales at home. To get an accurate measurement, they will need greater precision—perhaps back to the gram balance. They might be amazed to find out how much water is on their bodies when they get out of the shower or bathtub. To measure the water absorbed from the air by a towel in humid conditions, they will again need the gram balance.

Integrating

Math

Science Process Skills

Observing, comparing and contrasting, measuring, using space-time relationships

ACTIVITY 1.5

What Is Condensation?

(Teacher-supervised activity)

Materials Needed

- Saucepan
- Water
- Pie tin (preferably cold)
- Hot plate

Procedure

1. Put about 1 cm (1/2 in.) of water in the saucepan.
2. Heat the water until it boils.
3. Hold the pie tin over the boiling water.
4. Observe the pie tin carefully. What do you see forming on the bottom of the pie tin? Discuss why you think this happens.

For Problem Solvers

Have you noticed that your bathroom mirror is clean and shiny before you get in the shower or bathtub, but that it gets foggy as the hot water runs? Where does the water come from that gets on the mirror? Try to explain how it happens.

Notice the outside of the windows of cars and houses on a cool summer morning. Often you will find moisture on them. Where did the moisture come from? Investigate and find out how this happened. If you live in a cold climate, you will sometimes find frost on the windows. Where does it come from?

Teacher Information

As water is heated, the rate of evaporation increases. Water molecules acquire additional energy from the heat source, and the speed of the molecules increases. At a certain velocity, the molecules are able to escape the surface of the liquid and go into the air. The pie tin held over the escaping water vapor cools the vapor and causes it to condense into liquid form, as shown by the drops of water forming on the bottom. This process will be speeded up if the pie tin is cooled first.

Similar evidence of condensation can be observed by placing a pitcher (or other container) of ice water out on a table. Water vapor in the nearby air is cooled by the pitcher, and drops of water form on the table's surface.

Integrating

Math, language arts

Science Process Skills

Observing, inferring

ACTIVITY 1.6

What Are Mixtures and Solutions?

Materials Needed

- Glass jars
- Spoons (or stirrers)
- Sugar
- Water
- Marbles or small rocks
- Paper clips
- Toothpicks
- Bits of paper
- Paper and pencils

Procedure

1. Fill two jars about half full of water.
2. Put the marbles, paper clips, toothpicks, and bits of paper in one jar and a spoonful of sugar in the other jar.
3. Stir both jars and observe what happens to the materials in the water.
4. Compare the results in the two jars. One is a mixture and the other is a solution.
5. Try other substances in water, such as sand, powdered milk, or powdered chocolate. Make a list of those you think will produce mixtures and those that will produce solutions. Explain the differences you observe.

For Problem Solvers

Try to identify mixtures and solutions that are already in your environment. What about the soil in a flowerbed at home or at school? What about the air you breathe? Make a list of all the mixtures you can find in nature and another list of all the solutions you can find. Notice different food products in your cupboards at home or on grocery-store shelves. Add these to your lists.

Teacher Information

A mixture consists of two or more substances that retain their separate identities when mixed together. Solutions result when the substance placed in a liquid seems to become part of the liquid. A solution is really a special kind of mixture—one in which the particles are all molecular in size.

Materials listed can easily be substituted or supplemented with other soluble and nonsoluble materials.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, classifying, comparing and contrasting

ACTIVITY 1.7

How Can You Separate a Mixture of Salt and Pepper?

(Take home and do with family and friends.)

Materials Needed

- Plastic bag
- One-half cup of salt
- 1 teaspoon of pepper

Procedure

1. Mix the salt and the pepper together in the bag.
2. Now your challenge is to get the pepper out of the salt. How might you do it?
3. Test your ideas, and discuss your observations with your group.

Teacher Information

This activity is intended to help children learn to conduct and evaluate problem-solving procedures. There is no "right" answer but some procedures may be more effective or efficient than others. For example, picking the pepper out is slow and tedious, but it works. Dissolving the salt in water and straining the solution through a cloth is more efficient. Encourage the children to think of and try as many ways as possible. This could introduce a discussion of the way science and technology have combined to find easier and more efficient ways to do things.

Integrating

Math, language arts

Science Process Skills

Observing, inferring

ACTIVITY 1.8

What Happens to Water When You Add Salt?

Materials Needed

- One hard-boiled egg for each small group
- One raw egg for each small group
- Large cups
- Salt
- Measuring spoons

Procedure

1. One of the eggs is raw and the other hard-boiled. Can you tell which of the eggs you received is the hard-boiled egg?
2. Put both eggs in the cup and fill the cup with water.
3. Add salt to the cup, a tablespoon at a time, stirring until the salt dissolves, until something happens to the eggs.
4. What happened?
5. Why do you think salt makes this difference? Share your ideas with other students, and learn from one another.

For Problem Solvers

Did the two eggs respond to the salt water at the same time, or did one of them require more salt than the other? If they were different, which one responded first? Try it again and again, if necessary, until you are sure.

Try spinning a raw egg and a boiled egg. Do they spin equally well? If not, which one spins better? Why do you think it does?

Teacher Information

When the eggs are put in the untreated water, they will both sink to the bottom of the cup. As salt is added to the water, the eggs will rise to the top. This is because salt increases the density of the water. The eggs are more dense than tap water, but less dense than salt water.

Floating an egg in brine solution is the method some people use to tell when the brine is just right for pickling.

It is hoped that your problem solvers noticed that the raw egg rises before the boiled egg does. For these students, the activity shows not only that salt water is more dense, and therefore more buoyant, but that boiled eggs are more dense than raw eggs. The challenge for these young researchers is to find out why.

Hard-boiled eggs also spin better than raw ones. Have students spin a raw egg, stop it, and let it go, and it will begin to spin again. Because of inertia, the inside of the egg continues to move after the outside of the egg stops. Sometimes you can hear or feel the inside of a raw egg if you shake it. The boiled egg is solid, so the spinning action isn't affected by movement of materials inside the egg.

Integrating

Math, reading, language arts

Science Process Skills

Observing, inferring, measuring, communicating, comparing and contrasting, researching

ACTIVITY 1.9

How Does a Hydrometer Work?

(Take home and do with family and friends.)

Materials Needed

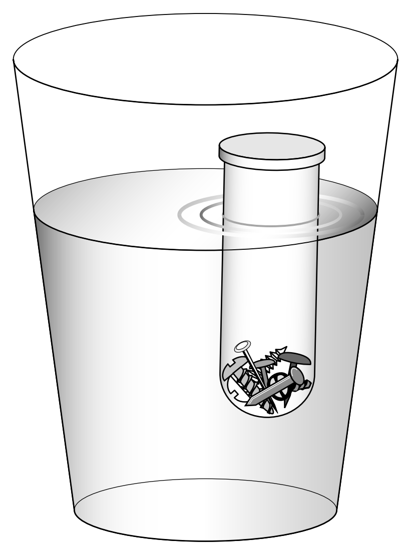
- A copy of the "Science Investigation Journaling Notes" for this activity for each student
- Lipstick tube cap (or small test tube)
- Several BBs (or other small weights)
- Tape (or gummed label)
- Plastic tumbler
- Water
- Salt
- Variety of liquids
- Marker
- Paper and pencil

Procedure

1. As you complete this activity you will keep a record of what you do, just as scientists do. Obtain a copy of the form "Science Investigation Journaling Notes" from your teacher and write the information that is called for, including your name and the date.
2. For this activity you will learn what a hydrometer is and how it works. For item 1, the question is provided for you on the form.
3. Item 2 asks for what you already know about the question. If you know anything about hydrometers, write your ideas.
4. For item 3, write a statement of how hydrometers work, or how you think they might work, according to what you already know, and that will be your hypothesis.
5. Now continue with the following instructions. Complete your Journaling Notes as you go. Steps 6 through 12 below will help you with the information you need to write on the form for items 4 and 5.

6. Fill the tumbler about two-thirds full of water.
7. Place a few BBs in the lipstick cap.
8. Put the gummed label or a piece of tape lengthwise on the lipstick cap.
9. Place the lipstick cap, open end up, in the glass of water. Add or remove weights until the cap floats vertically, as shown in Figure 1.9–1.
10. Mark the water level on the cap.
11. Your cap can now be used as a hydrometer. Hydrometers are used for measuring density of liquids, comparing them with the density of water. If the density of another liquid is greater than that of water, the cap will float higher than it floats in water. If the density of the other liquid is less than that of water, the cap will sink deeper into the water.
12. Dissolve about one-fourth cup of salt in your glass of water. Without changing the number of weights in your hydrometer, put the hydrometer in the salt water. Does your hydrometer float deeper than it did in plain water, or does it float higher? What does this tell you about the density of salt water?
13. Complete your "Science Investigation Journaling Notes." Are you ready to explain what a hydrometer is and how it works? Discuss it with your group.

Figure 1.9–1. A Hydrometer.



For Problem Solvers

Obtain several plastic tumblers and fill them about half full, each with a different liquid, such as water, salt water, cooking oil, and rubbing alcohol. Line up the containers in order of least dense to most dense, according to your prediction. Use your hydrometer to compare the liquids, and then arrange the liquids in order, with the liquid of least density on the left and the liquid of greatest density on the right. Did you predict them correctly?

Gather a variety of small objects that are made of plastic, wood, or metal. Place these items in the liquids, one at a time. Try to find at least one item that will float on each liquid but not on the next liquid to the left.

Ask a mechanic (or anyone who services his or her own car) to show you the instrument they use to test radiator fluid. What is it called? Think about it in terms of this activity. Compare it to your hydrometer and explain similarities and differences.

Teacher Information

Any object that floats displaces an amount of liquid equal to its own weight (Archimedes' Principle). If the specific gravity (density) of the liquid is less than that of water, the object floats deeper into the surface of the liquid, as the object has to displace more liquid to equal its own weight. If the hydrometer floats higher, it is in a liquid of greater density.

Hydrometers are used to test such liquids as antifreeze and battery acid, following the Archimedes' Principle.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting

Name ____________________ Date ____________________

Science Investigation

Journaling Notes for Activity 1.9

1. Question: *How does a hydrometer work?*
2. What we already know:

____

____

3. Hypothesis:

____

____

4. Materials needed:

____

____

5. Procedure:

____

____

____

6. Observations/New information:

____

____

7. Conclusion:

____

____

ACTIVITY 1.10

How Can the Depth of a Bathyscaph Be Controlled?

(Teacher-supervised activity)

Materials Needed

- Copy of the "Science Investigation Journaling Notes" for this activity for each student
- Fish tank (or bucket) full of water
- Plastic bottle with lid that seals
- Latex cement
- Several marbles (or other weights)
- Plastic tubing
- Drill with a set of bits

Procedure

1. As you complete this activity you will keep a record of what you do, just as scientists do. Use a copy of the form "Science Investigation Journaling Notes" your teacher will give you and write the information that is called for, including your name and the date.
2. For this activity, you will learn how the depth of a bathyscaph can be controlled. For item 1, the question is provided for you on the form.
3. Item 2 asks for what you already know about the question. If you have some ideas about how bathyscaphs work, write your ideas.
4. For item 3, write a statement of how the depth of a bathyscaph can be controlled, according to what you already know, and that will be your hypothesis.
5. Now continue with the following instructions. Complete your Journaling Notes as you go. Steps 6 through 13 below will help you with the information you need to write on the form for items 4 and 5.
6. Drill one hole in the bottle lid. The hole should be just large enough to insert the tube through it.

7. Insert one end of the tubing through the hole in the lid and put latex cement on the lid around the tubing to seal it from leakage of water or air. Allow the cement at least an hour to dry.
8. Drill one tiny hole (about 1/8 inch or smaller) in the bottom of the bottle.
9. Place several marbles in the bottle, put the lid on tight, and place the bottle in the water. The marbles will help to hold the bottom of the bottle down, keeping the tiny hole in the water.
10. Put the end of the tube in your mouth and adjust the amount of water in the bottle by blowing or drawing on the end of the tube until the bottle floats just beneath the surface. The tiny open hole in the bottom of the bottle allows you to control the amount of water in the bottle.
11. Now draw on the tube very slightly to allow a little more water to enter the bottle. What happened to the bottle?
12. Blow and draw on the tube to change the amount of water in the bottle. What happens to the bottle?
13. How could this idea be used in a bathyscaph designed to study the ocean at different depths?
14. Complete your "Science Investigation Journaling Notes." Are you ready to explain how the depth of a bathyscaph can be controlled? Discuss it with your group.

Teacher Information

Caution: Careful supervision is required with the use of the drill.

A vessel in water can be caused to float at different depths by altering the density of the vessel. Density can be increased by displacing a chamber of air (or a portion of it) with water or decreased by displacing the water with air. This is one way the depth of an underwater vessel can be adjusted.

The bottle shown in Figures 1.10–1, 1.10–2, and 1.10–3 has a capacity of approximately 10 ounces. Larger bottles can be used if the tank is large enough to accommodate them. Such bottles are easier to control than are tiny bottles because any given change in the amount of water in the bottle results in a smaller change in the density of the bottle, thus allowing for more control on the "fine-tuning" of the density.

This bit of "technology" cannot be credited to the genius of mankind. It is but one of the many adaptations people have learned from observing nature. Fish are equipped with a swim bladder, a small sac in the abdomen which allows them to maintain buoyancy. The sac inflates if the fish needs to rise in the water and deflates if the fish needs to move to a lower depth.

The hot air balloon also uses the principle of altering density to float at differing altitudes. Instead of adjusting the amount of air to control density, it adjusts the temperature of the air. Temperature change results in density adjustment.

Integrating

Math, language arts, social studies

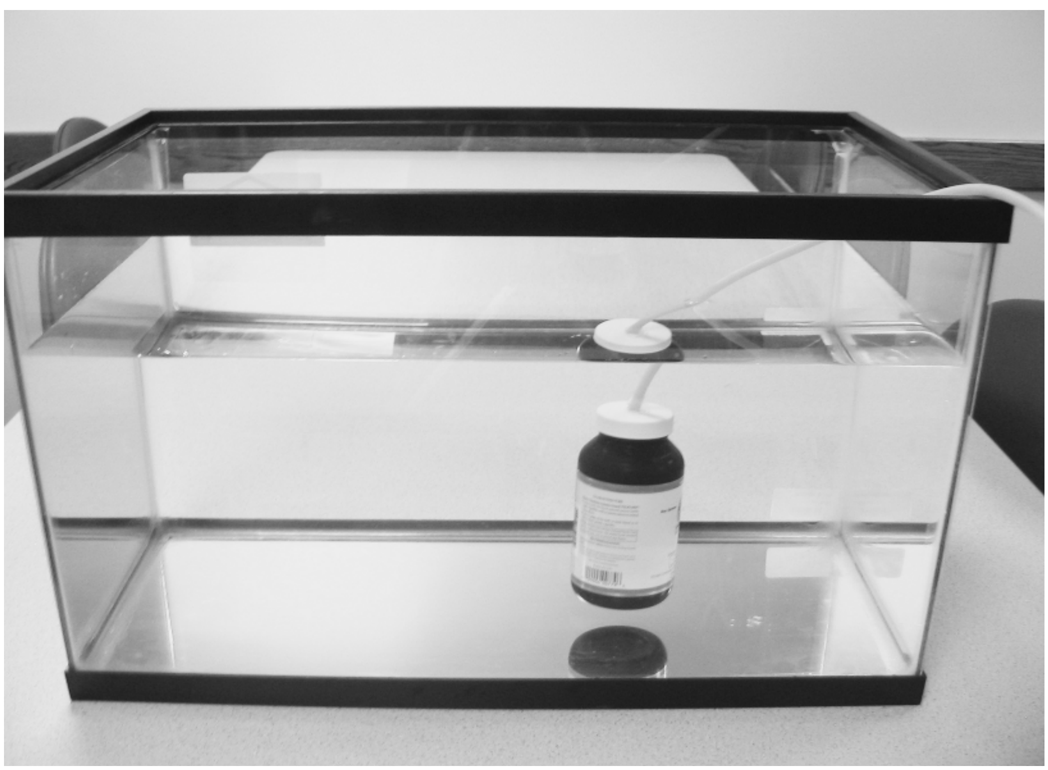
Science Process Skills

Observing, inferring, predicting, communicating, identifying and controlling variables

Figure 1.10-1. Bathyscaph Lowering into Water

Figure 1.10-2.

Figure 1.10-3.



Name ______________________________ Date ______________

Science Investigation

Journaling Notes for Activity 1.10

1. Question: *How can the depth of a bathyscaph be controlled?*
2. What we already know:

____

____

3. Hypothesis:

____

____

4. Materials needed:

____

____

5. Procedure:

____

____

____

6. Observations/New information:

____

____

7. Conclusion:

____

____

ACTIVITY 1.11

What Are Solids, Liquids, and Gases?

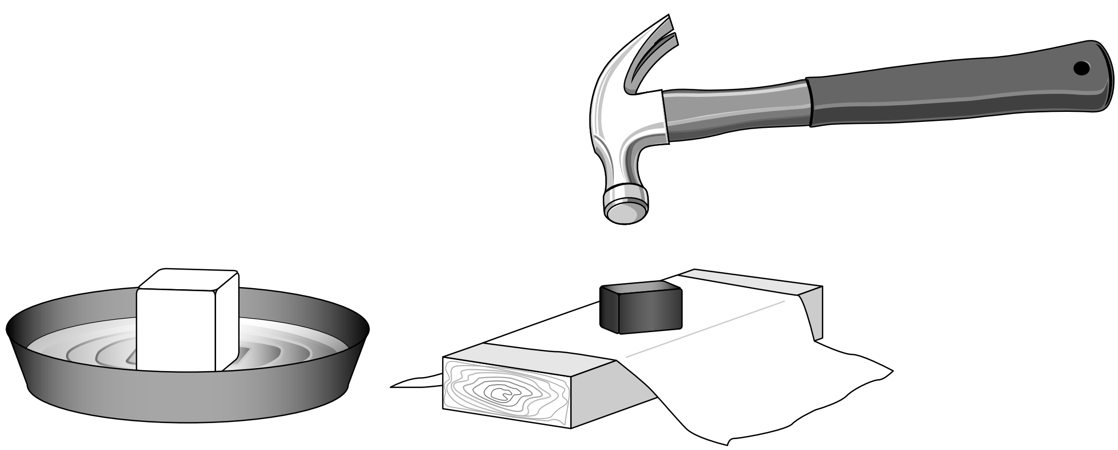
(Teacher-supervised activity)

Materials Needed

- Charcoal briquettes or small pieces of coal
- Hammer
- Safety glasses
- Blocks of wood
- Ice cubes
- Dishes
- Paper towels
- Paper and pencils
- Small plastic bags

Procedure

1. Put the ice cube in the dish and place the block of wood and the dish on a table.
2. Place the paper towel over the block of wood and the charcoal on the paper towel. The purpose of the wood is to provide a pounding block.



3. Examine and describe the charcoal and the ice cube. How are they alike? How are they different? Tell whether you think each is a solid, liquid, or gas.
4. Put on the safety glasses and crush the piece of charcoal with the hammer. Be sure it is on the paper towel and the wood block as you do this. Pound lightly with the hammer so the pieces don't scatter. For additional safety, you can put the briquette in a plastic bag (such as a sandwich bag) before pounding.
5. Examine the charcoal again. In what ways is it the same as it was before? How is it different? Is it a solid, liquid, or gas?
6. Let the ice cube remain in the dish. Examine and describe it after a few minutes, after an hour, and after a day. Each time, decide whether it is a solid, a liquid, or a gas.
7. After the last observation, again compare the charcoal with the ice cube. How did they respond differently when they were left undisturbed? Why do you think this happened?
8. Make a list of solids, a list of liquids, and a list of gases.
9. Share and discuss your observations with your group.

For Problem Solvers

If ice cubes are placed in room-temperature conditions, they will become liquid before evaporating as a gas. Sometimes, however, ice cubes slowly evaporate as they stand in the ice tray, without even being removed from the freezer. Meat will also eventually dehydrate if left too long in the freezer. See whether you can identify any substance that naturally changes from solid to gas at room temperature, without becoming a liquid.

Do some research and find out how many substances you can identify that exist in nature in all three states—solid, liquid, and gas. How many more can you find that exist in nature as both a solid and a liquid?

Teacher Information

Caution: Safety glasses should be used when crushing the charcoal with the hammer.

All matter is either solid, liquid, or gas. Charcoal remains a solid even when powdered. Water has the unusual property of being easily changed to any of the three states. The solid and liquid states are easily observed.

Point out that when water becomes a gas it is invisible. In many substances, including wood and charcoal, certain elements combine with oxygen when burned and produce a gaseous substance, except for a small amount of ash left behind in solid form. As gases form during burning, visible solid and liquid particles are often suspended in the gases. We call this smoke.

Those who choose to accept the "For Problem Solvers" challenge will truly be challenged. Moth balls change from solid to gas at room temperature without becoming liquid. Perhaps these young scientists will find other substances as well. The only common material that exists in nature in all three states is water.

Integrating

Language arts

Science Process Skills

Observing, predicting, comparing and contrasting, using space-time relationships

ACTIVITY 1.12

How Can You Produce a Gas from a Solid and a Liquid?

(Teacher-supervised activity)

Materials Needed

- Two film canisters (empty) per small group
- Water
- Effervescent pain reliever or antacid tablets
- Paper and pencils

Procedure

1. Place about half of an effervescent tablet in one film canister.
2. Put a small amount of water in the second canister (about one-fourth full).
3. Pour the water from the second canister into the first canister, quickly snap the lid on tight, and stand back!
4. What happened?
5. Did this produce a physical change or a chemical change? How can you tell?
6. Discuss your observations with others in the group. Consider both the type of reaction (physical or chemical) and what you observed in terms of states of matter.

Teacher Information

Consider using this activity as a demonstration, rather than providing printed instructions for students, so you can add the element of surprise. If you are using an antacid tablet, you can easily disguise its appearance by pulverizing it in advance. Be prepared for a bit of excitement. If you snap the lid right back on after it blows, the reaction might recur a time or two.

Have paper towels on hand before you begin. After the reaction, when kids and lids are all gathered up, discuss student observations. Was this a chemical change or a physical change? (The production of a gas is a sure sign of a chemical change.) Also make connections with the concept of states of matter; here we saw a gas produced by combining a solid and a liquid (all three states of matter).

Film canisters vary in color and shape. Try all of the types you can find, and have students keep a record and compare them. Let students help decide what to record and compare. Certainly this should include the type of canister and height of the flight (of the lid, that is, not students). Have them predict the result with each change in variable, and compare actual results with predictions. Predictions should be made by each person (silently predict and write down the prediction) before discussing as a group or class, which will encourage each student to think and reason instead of simply going along with someone else.

You can provide a similar experience with baking soda and vinegar. A third option is dry ice, with which you maintain the thrill of the flying lid and the change of state from a solid to a gas, but you lose both the chemical reaction and the production of a gas from combining a liquid and a solid. *Caution:* Dry ice also involves some safety concerns, such as the possibilities of burned fingers and the temptation to swallow a piece of dry ice.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, comparing and contrasting

ACTIVITY 1.13

How Can You Make a Fire Extinguisher?

(Teacher-supervised activity)

Materials Needed

- Large soda bottles (or quart bottles)
- Vinegar
- Baking soda
- Candles
- Matches
- Sink or pans
- Tablespoons
- Measuring cups

Procedure

1. Stand the candle in the sink or pan. Be sure there are no flammable materials nearby. Light the candle.
2. Put one tablespoon of baking soda into the bottle.
3. Measure about three to four ounces of vinegar with the measuring cup and pour it into the bottle with the baking soda.
4. As bubbles form, hold the bottle over the candle flame and tip it as though you were pouring water from the bottle onto the flame, but do not tip it far enough to pour out the vinegar.
5. What happened to the flame? Explain why you think this happened.

For Problem Solvers

Carbon dioxide is heavier than air. Why does that help it to be effective in putting out fires? See what you can learn about fire fighting and what chemicals are commonly used for putting out fires.

Teacher Information

Caution: This activity must be carefully supervised due to the involvement of fire.

Baking soda is sodium bicarbonate. Vinegar contains acetic acid. When the two mix, carbon dioxide (CO_2) is formed. Carbon dioxide is heavier than air, so when the bottle is tipped, the CO_2 pours out. You don't see it pour because carbon dioxide is colorless. As it pours over the flame, the CO_2 deprives the flame of oxygen and the flame is extinguished. Carbon dioxide is commonly used in some fire extinguishers.

Carbon dioxide is one of the more common gases. Humans and other animals produce it and breathe it into the air. Plants absorb it and, in turn, make oxygen. Carbon dioxide is put into soft drinks to give them bubbles, or fizz. Dry ice is carbon dioxide, frozen to make it solid. If dry ice is available, have students repeat this activity, using a small piece of dry ice in place of vinegar and baking soda. *Caution:* Any use of dry ice must be carefully supervised, as it can burn the skin. It should never be put in the mouth. Also, dry ice must not be placed in a sealed bottle (or any other sealed container), because it can build up enough pressure to explode the container.

Integrating

Reading, math

Science Process Skills

Observing, inferring, measuring, predicting, communicating, identifying and controlling variables, experimenting, researching

ACTIVITY 1.14

How Can a Blown-Out Candle Relight Itself?

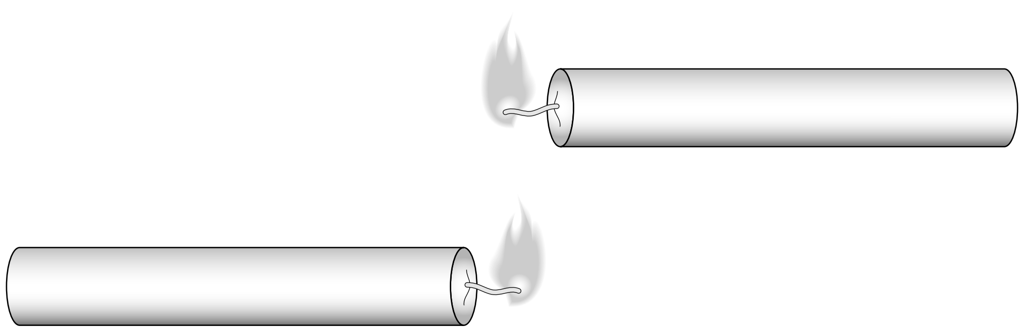
(Teacher-supervised activity)

Materials Needed

- Two candles per small group
- Metal pans
- Matches

Procedure

1. For this activity, keep the candles over the pan and be sure your teacher is with you.
2. Light both candles.
3. Hold the two candles horizontally with one flame about an inch above the other, as shown below.



4. Holding both candles steady, blow out the lower flame and observe for a few seconds.
5. What happened? Can you explain why?

For Problem Solvers

Observe the flame of a burning candle very carefully. Where is the flame resting? Does it seem to be sitting right on the wick, and burning the wick, or is it above the wick? What do you think is burning?

See what you can find out about flames. What part of a flame is the hottest? What causes the colors you see in the flame? Find answers to these questions and to other questions you think of.

Teacher Information

Wax, in solid form, does not burn. Heat changes wax to a vapor, which burns when combined with oxygen in the air. When a candle flame is blown out, hot gases continue to rise for a short time. These gases can ignite and act as a wick if another flame is close by and in their path. The flame will burn down the column of gases and relight the lower candle.

Integrating

Reading, language arts, math

Science Process Skills

Observing, inferring, measuring, predicting, communicating, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting, researching

ACTIVITY 1.15

How Can You Remove the Flame from a Candle Without Putting It Out?

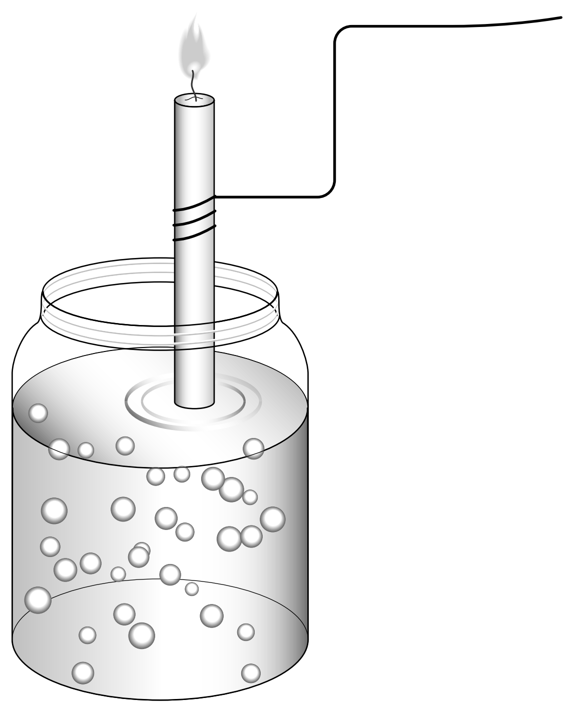
(Teacher-supervised activity)

Materials Needed

- Glass jars with lid
- Birthday candles
- Tablespoons
- 30 cm (1 ft.) of pliable wire per small group
- Baking soda
- Vinegar
- Matches

Procedure

1. Put two tablespoons of vinegar and one tablespoon of baking soda in the bottom of the jar. Bubbles will form.



2. Set the lid upside down on the jar, to cover the jar without sealing it.
3. Let the jar sit until the bubbling has nearly stopped.
4. While you are waiting for the bubbles to stop, form a holder for the candle from the wire.
5. Place the candle in your wire holder and light the candle.
6. Remove the cover from the jar and slowly lower the candle into the jar until the top of the wick is about an inch below the rim of the jar. Then bring the candle back up.
7. Try it again. Explain what happens.

Teacher Information

Caution: Careful supervision is required due to the involvement of fire. Combining vinegar and baking soda forms carbon dioxide, which is heavier than air and therefore drives the air out of the jar, leaving the jar filled with carbon dioxide. As the flame is lowered below the rim of the jar, it is starved for oxygen and the candle actually burns out. Gases continue to rise from the candle for a short time, however, and the flame sits on top of the layer of carbon dioxide, burning the rising gases in the presence of oxygen.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, measuring, predicting, communicating

ACTIVITY 1.16

How Can You Make a Ball Bounce by Itself?

(Teacher-supervised activity)

Materials Needed

- Old tennis balls
- Scissors

Procedure

1. With the scissors, cut the tennis ball in half to make two dish-shaped halves. Ask your teacher to start the cut by punching a hole with the point of the scissors or with a knife.
2. Trim around the edge of one of the halves until its diameter is about 5 cm (2 in.).
3. Turn the ball dish inside out and set it on the floor or on a table. Observe for several seconds.
4. What happened? Explain why you think it behaved this way. What might you do to make it happen faster or more slowly?

For Problem Solvers

Get your friends to help you ask around for and locate several tennis balls that are old and not needed any more. Experiment with the amount that you trim off for this activity. Try to create the ball that will bounce the highest. See whether you can control the delay time (from the time you set it down until it flips up) by how much of the ball you trim off.

Teacher Information

Caution: You should make the starter holes in the tennis balls to avoid injury to students.

After a brief observation, the "dish" should jump. Rubber molecules act like tiny springs, giving rubber the tendency to spring back to its original shape when distorted. This property gives rubber its bounce. With the inverted "dish," the restoring action of the rubber first has to overcome the resistance of the backward bend. When it reaches a certain point, though, the movement is very quick. The edges strike the surface with considerable force and the ball flips into the air.

As students ponder the last question in step 4, you might need to encourage them to try trimming a little more off the edges of the dish or to take the other half of the ball and trim off less than they did with the first one. Trimming less will delay the action and trimming more will speed it up. Your "problem solvers" are encouraged to investigate with these factors.

Integrating

Math

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting, researching

ACTIVITY 1.17

What Is Polyethylene?

Materials Needed

- One polyethylene bag with tie per small group
- One nonpolyethylene plastic bag with tie per small group
- Sharpened pencils
- Water
- Sink or large pans

Procedure

1. Check to be sure one of the bags is polyethylene. It will be indicated on the container.
2. Fill both bags with water and put ties around the tops. Keep them over a sink or large pan.
3. Stab the pencil through the nonpolyethylene bag and observe what happens.
4. Stab the pencil through the polyethylene bag. Compare the results with what happened in step 3.
5. Discuss your observations with your group.

Teacher Information

Polyethylene has the strange property of shrinking together when it is torn. When the bag is punctured, the polyethylene shrinks and stops (or reduces) the flow of water. This property is a factor in puncture-resistant tires.

Integrating

Language arts

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting

ACTIVITY 1.18

Is the Dissolving of Solids a Physical Change or a Chemical Change?

Materials Needed

- Tumblers
- Sugar (or salt)
- Paper and pencils
- Water
- Stirrers
- "Science Investigation Journaling Notes" form for each student

Procedure

1. Do the following as a Science Investigation. Obtain a blank copy of the "Science Investigation Journaling Notes" from your teacher. Write your name, the date, and your question at the top. Plan your investigation through item 5 of the form (Procedure) and have it approved by your teacher. Complete the Journaling Notes as you perform your investigation. When you are finished, share your project with your group, and submit your Journaling Notes to your teacher if requested.
2. Put about two teaspoons of sugar and a small amount of water in a tumbler and stir until the sugar is completely dissolved. Do you think the dissolving of the sugar in the water was a physical change or a chemical change?
3. Put the tumbler where it can remain undisturbed while the water evaporates. Check the tumbler twice each day. Record your observations each time you detect a change.
4. When the water has completely evaporated, record your observations of the tumbler. Do you think the dissolving of the sugar in the water was a physical change or a chemical change? Why do you think as you do? Support your answer with your observations.

For Problem Solvers

Also do this as a Science Investigation. Obtain another copy of the "Science Investigation Journaling Notes." Write your name, the date, and your question at the top. Plan your investigation through item 5 (Procedure) and have it approved by your teacher. Complete the Journaling Notes as you perform your investigation. Share your project with your group, and submit your Journaling Notes to your teacher if requested.

Take a small piece of paper and tear it up into the smallest bits you can. Was that a physical change or a chemical change? Place a drop of lemon juice on a piece of paper and let it dry. Is a physical change or a chemical change taking place? Hold the paper near a light bulb until it begins to look different where the drop of juice was. Is this a physical change or a chemical change? Identify other physical changes and chemical changes that occur in your world. What about a cake as it bakes? What about the soles of your shoes, as they slowly wear away?

Teacher Information

A physical change usually alters only the state of matter, such as from a solid to a liquid or from a liquid to a gas, or the shape, texture, and so on. Physical changes are frequently reversible. For example, water can be obtained by condensing it out of the air or by melting an ice cube. Chemical changes involve changes in molecular structure and are not easily reversible. As the water in this activity evaporates, crystals of sugar appear. They will be massed together and will not look the same, but a taste test will reveal that it is sugar.

You might also burn a bit of sugar for students to compare. After the burned substance has cooled, let someone taste it and determine whether the sugar underwent a physical change or a chemical change. It will no longer taste like sugar, except to the extent that unburned sugar crystals remain. The burning process produces a chemical change. The sugar has been oxidized through heat, leaving a carbon residue.

Integrating

Math

Science Process Skills

Observing, inferring, classifying, measuring, comparing and contrasting

ACTIVITY 1.19

Is Burned Sugar Still Sugar?

(Teacher-supervised activity)

Materials Needed

- Sugar cubes
- Candles
- Matches
- Hand lenses
- Pieces of aluminum foil, about 15 by 15 cm (6 in. by 6 in.)

Procedure

1. Put a sugar cube in the center of one piece of foil.
2. Place the candle in the center of another piece of foil and light the candle with a match.
3. Taking the first piece of foil by the edges, hold it with the sugar cube directly over the lighted candle until some of the sugar turns black.
4. Remove the foil from the flame, set it aside to cool, and blow out the candle.
5. When the burned sugar has cooled, crumble some of it and examine it carefully with the hand lens. Taste some of it.
6. How does the burned sugar compare with sugar that did not burn? Compare both the appearance and the taste of the burned and the unburned sugar.
7. Was this a physical change or a chemical change?
8. Discuss your observations and share your ideas with your group.

Teacher Information

Use caution in having students work with the flame and taste the sugar. This might have to be done as a teacher demonstration in order to comply with the restrictions and guidelines of your school system. Before you ask students to taste anything, be sure there are no food allergies.

To add a measurement experience to this activity, use loose sugar instead of a sugar cube. Have your students measure out one gram of sugar and place the sugar in the center of one piece of foil.

With this activity, most of the hydrogen and oxygen have been driven off into the air as gases. Thus, the burned material left on the foil is carbon, not sugar. Obviously, this is a chemical change. We have no way to recombine oxygen and hydrogen with the carbon and restore the substance as sugar.

As you make connections with science concepts, emphasize that nothing was lost or destroyed, but only changed. The hydrogen, oxygen, and carbon, which together comprised the sugar, still exist. The same atoms that a few minutes earlier formed sugar will likely become a part of many other substances in the future. What a marvelous recycling plan! And incidentally, this recycling process, in one form or another, occurs with almost everything we eat. The body is a chemical plant, and the food we eat is constantly undergoing chemical changes as the body takes the substances we give it and uses them to manufacture the substances we need for life and good health.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, measuring, comparing and contrasting

ACTIVITY 1.20

What Is Rust?

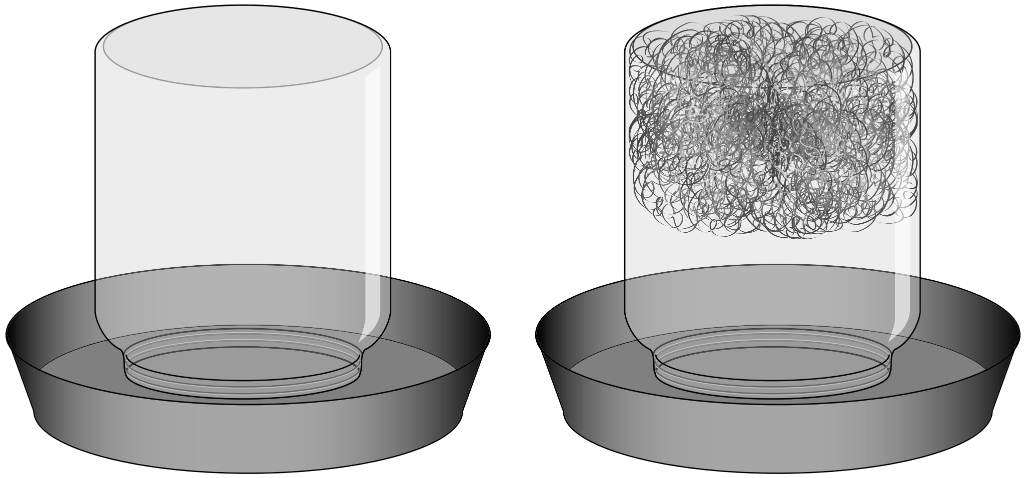
Materials Needed

- Two small identical jars per small group
- Two small identical dishes per small group
- Paper and pencils
- Steel wool
- Water

Procedure

1. Put a small wad of steel wool into one of the jars. Push it clear to the bottom. Pack it just tightly enough that it will stay at the bottom of the jar when the jar is turned upside down.
2. Put about 2 cm (3/4 in.) of water in each of the two dishes. Be sure you put the same amount in each one.
3. Turn the two jars upside down and stand one in each of the dishes. One jar should have steel wool in the bottom and one should be empty, as seen in Figure 1.20–1.
4. Examine the jars each day for one week and record your observations, noting such things as water level and appearance of the steel wool.
5. At the end of one week, study the recorded day-by-day observations and explain the noted changes.

Figure 1.20–1. Dishes with Inverted Jars, One with Steel Wool



For Problem Solvers

Notice the color of the rust that forms on the steel wool. Try to find items that are made of steel or iron and that have been used for a long time and examine them for spots of rust. See whether you can find the same thing on items that are made of plastic. Find out what stainless steel is and then find some items that are made of stainless steel. Can you find rust on them? Look up stainless steel on the Internet or in your encyclopedia and try to find out how stainless steel is different and why it is used.

Teacher Information

As steel wool is exposed to moist air over a period of time, the moisture serves as a medium to bring oxygen molecules in the air in close contact with molecules of iron in the steel wool. Oxygen molecules and iron molecules combine to make iron oxide. This process uses up some of the oxygen in the air inside the jar, reducing the amount of gas (air) in the jar. This, in turn, reduces the air pressure inside the jar. Thus the atmospheric pressure outside the jar is greater than the pressure inside the jar, and water is forced into the jar. Student observations should include the rising water level inside the jar containing steel wool, as well as the rust color forming on the steel wool.

Integrating

Math, reading

Science Process Skills

Observing, inferring, comparing and contrasting, measuring

ACTIVITY 1.21

How Can Chemical Changes Help You Write a Secret Message?

(Take home and do with family and friends.)

Materials Needed

- Small jar
- Milk (only a few drops)
- Toothpick
- White paper
- Lamp with light bulb

Procedure

1. Dip the toothpick into the milk and use it as a pen to write a message on the paper. Let the milk dry.
2. What happens to your message as the milk dries?
3. Hold the paper close to a burning light bulb. What happens as the paper absorbs heat from the light bulb? What can you say about this?

For Problem Solvers

Try the same thing, using lemon juice instead of milk. What other things do you think might work? Try them.

Teacher Information

As the milk dries, the residue blends in with the white paper and becomes invisible. When heat is applied, a chemical reaction takes place in the milk residue, turning it dark and making it easily visible against the white paper.

Integrating

Language arts

Science Process Skills

Observing, inferring, predicting, comparing and contrasting

ACTIVITY 1.22

How Does Temperature Affect the Speed of Molecules?

Materials Needed

- Two tumblers per small group
- Food coloring
- Paper and pencils
- Two eyedroppers per small group
- Hot and cold water
- "Science Investigation Journaling Notes" form for all students

Procedure

1. Do the following as a Science Investigation. Obtain a blank copy of the "Science Investigation Journaling Notes" from your teacher. Write your name, the date, and your question at the top. Plan your investigation through item 5 of the form (Procedure) and have it approved by your teacher. Complete the Journaling Notes as you perform your investigation. When you are finished, share your project with your group and submit your Journaling Notes to your teacher if requested.
2. Put very cold water in one tumbler and hot water in the other. Fill each about halfway full.
3. Draw four or five drops of food coloring into each of the two eyedroppers. Put as near the same amount in each dropper as possible.
4. Hold a dropper over each tumbler and squeeze to empty the contents of both at exactly the same time.
5. Compare the movement of the color in the two containers. In which tumbler did the color spread more rapidly?
6. If you have time, try different colors and different water temperatures. Record your observations.

For Problem Solvers

Obtain another copy of the "Science Investigation Journaling Notes" and try the same investigation, but using color as the variable this time. Put water of the same temperature in both containers. See whether one color of food coloring diffuses (mixes) through the water any faster than another color. Find a stopwatch and keep time to find out how long it takes to fully diffuse so that the water is equal in color throughout.

Next, test water at different temperatures, timing the diffusion at each temperature. Does temperature make a big difference, a small difference, or none at all?

Compare diffusion time of various liquids. Do you think the food coloring will spread through milk at the same rate as through water, if the two liquids are the same temperature? Try it. What other liquids could you compare?

Teacher Information

As temperatures increase, molecules move faster. The food coloring will diffuse noticeably more rapidly in hot water than in cold water. In this experiment, water temperature is the variable. Your "problem solvers" will try the same experiment with color as the variable. For instance, use two tumblers of cold water and put red in one and green (or blue) in the other. They are also encouraged to use a stopwatch and a thermometer and record the actual time required for maximum diffusion (equal color throughout, as judged by the students).

Integrating

Math

Science Process Skills

Observing, inferring, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting

ACTIVITY 1.23

How Does Temperature Affect Solubility?

(Teacher-supervised activity)

Materials Needed

- Two tumblers (equal size) per small group
- Cold water
- Hot water (or a heat source)
- Two spoons (or other stirring instruments) per small group
- Measuring spoons
- Sugar
- Markers
- "Science Investigation Journaling Notes" form for each student

Procedure

1. Do the following as a Science Investigation. Obtain a blank copy of the "Science Investigation Journaling Notes" from your teacher. Write your name, the date, and your question at the top. Plan your investigation through item 5 of the form (Procedure) and have it approved by your teacher. Complete the Journaling Notes as you perform your investigation. When you are finished, share your project with your group and submit your Journaling Notes to your teacher if requested.
2. Be sure the tumblers are equal size.
3. Make a mark on each tumbler about one-fourth of the way down from the top. The mark should be at exactly the same point on each tumbler.
4. Using cold water for one tumbler and hot water (not hot enough to burn you) for the other, fill each exactly to the mark.
5. Using a measuring spoon (a teaspoon is about right) put one level spoonful of sugar in each tumbler.

6. Stir the water in each tumbler until the sugar has completely dissolved in the water.
7. Which dissolved sugar faster, cold water or hot water?
8. Add another level spoonful of sugar and again stir until it is completely dissolved.
9. Continue doing this, counting the spoons full of sugar added to each tumbler. Stop adding sugar when you can no longer make it completely dissolve in the water.
10. Which dissolved more sugar, the cold water or the hot water? How much more? Why do you think this was so?
11. Complete your "Science Investigation Journaling Notes." Are you ready to explain how temperature affects solubility? Discuss it with your group.

For Problem Solvers

Do this project as a Science Investigation also. Obtain a blank copy of the "Science Investigation Journaling Notes." Write your name, the date, and your question at the top. Plan your investigation through item 5 (Procedure) and have it approved by your teacher. Complete the Journaling Notes as you perform your investigation. Share your project with your group, and submit your Journaling Notes to your teacher if requested.

Get some sugar cubes and see whether they dissolve at the same rate as loose sugar. Use a balance scale to see that you have the same amount of loose sugar as is in the sugar cube. Compare them in hot and cold water. Time the dissolving rate with a stopwatch. Measure the temperature of the hot water and the cold water. Considering the dissolving rate for both of these, predict the dissolving rate if the water is halfway between these two temperatures. Try it.

Do you think stirring has an effect on dissolving rate? See what you can do to find out.

Do you think salt dissolves at the same rate as sugar? Do you think water temperature has the same effect on the dissolving rate of salt as it has on sugar? Devise an experiment to find out, and carry out your experiment.

Teacher Information

Hot water molecules move more rapidly than cold water molecules do. The dissolving sugar molecules are therefore dispersed more completely throughout the liquid and more sugar can be dissolved in the hot water.

Your "problem solvers" will compare the dissolving rate of sugar cubes with the dissolving rate of loose sugar. They will also investigate the effect of stirring on the dissolving rate of sugar. If their interest holds, they will find out whether salt dissolves at the same rate as sugar. Your young scientists might think of other variables to test as well.

Caution: Care must be taken to be sure the hot water used is not hot enough to injure someone if spilled.

Integrating

Math

Science Process Skills

Observing, inferring, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting

ACTIVITY 1.24

How Can You Make Large Sugar Crystals from Tiny Ones?

(Teacher-supervised activity)

Materials Needed

- Drinking glasses or jars
- Water
- Cotton string or thread
- Pencils
- Sugar
- Pans
- Heat source
- Stirrers or wooden spoons

Procedure

1. Put a cup of water in the pan and heat it until it boils.
2. When the water begins to boil, turn off the heat and add about 1.5 cups of sugar and stir.
3. If all the sugar dissolves, add a bit more and stir. Keep doing this until no more sugar will dissolve in the water.
4. Let the water cool, and then pour it into a drinking glass.
5. Tie a piece of cotton thread or string to a pencil and lay the pencil across the glass, allowing the string to extend to the bottom of the glass.
6. Place the drinking glass on a shelf where it can remain undisturbed for several days.
7. Examine the contents of the glass, particularly the string, each day and write down your observations. DO NOT MOVE IT OR TOUCH ANY OF IT.
8. When you observe no more changes, try to explain what happened during the days the glass remained on the shelf.

For Problem Solvers

Use the same procedure to experiment with other substances you can find. Include salt and powdered alum among the materials you try. Examine your crystals with a hand lens and with a microscope, if you have one. Observe and compare very carefully and share your observations with others.

Teacher Information

Caution: To avoid injury to students, boiled water should be handled only by the teacher.

As sugar dissolves in water, the crystals break down into molecules so small they cannot be seen, even with a powerful microscope. A molecule of sugar is the smallest particle of sugar that can exist. If it were any smaller, it would no longer be sugar.

In this activity, sugar crystals are dissolved into molecules, forming a supersaturated solution (containing more sugar in solution than could be dissolved at room temperature). Then, as the solution cools, crystals begin coming out of solution and collecting around the string. As this happens, large sugar crystals are formed. You could call it rock candy.

"Problem solvers" will also try forming crystals from other substances, such as salt and/or powdered alum, following the same procedure.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting

ACTIVITY 1.25

What Does Litmus Paper Tell Us About Substances?

Materials Needed

- Red litmus paper
- Blue litmus paper
- Glass containing a small amount of vinegar water (about half vinegar and half water)
- Glass containing a small amount of baking soda mixed in water
- Glass containing a small amount of tap water
- Paper and pencils

Procedure

1. Write "Vinegar Water," "Baking Soda Water," and "Water" across the top of your paper.
2. Write "Blue Litmus Paper," "Red Litmus Paper," and "Acid, Base, or Neutral" down the left side of your paper, as shown in the sample on the next page.
3. Dip one end of a strip of blue litmus paper into the vinegar water.
4. Did it change color? If so, what color is it now?
5. Write the color in the space for vinegar water and blue litmus paper.
6. Dip one end of a strip of red litmus paper into the vinegar water.
7. What happened this time?
8. Write the color in the space for vinegar water and red litmus paper. If the litmus paper stayed the same color, write "no change."
9. Repeat steps 3 through 8 for the baking soda water.
10. Repeat steps 3 through 8 again for the water.
11. If a substance turns blue litmus paper red, we say the substance is an acid. If the substance turns red litmus paper blue, we say the substance is a base. If the substance does not change the color of either litmus paper, we say the substance is neutral.

12. Fill in the bottom line of your chart, identifying each of the three substances as either acid, base, or neutral.
13. Compare your information with others. Did they obtain the same results?

	Vinegar Water	Baking Soda Water	Water
Blue LP			
Red LP			
A, B, N			

For Problem Solvers

Stronger acids turn blue litmus paper darker red, and stronger bases turn red litmus paper darker blue. Find other substances to test with litmus paper. Some of the materials you could test are milk, tea, coffee, window cleaner, bathtub cleaner, and mouthwash. You will think of others as you go. Identify which of the materials you tested are strong acids, which are weak acids, which are strong bases, and which are weak bases.

Test a variety of brands of soft drinks. Before you test them, predict whether they will be acid, base, or neutral. If you think they will be acid or base, predict which drinks will be the strongest. After testing them, list them in the order of their strength, as shown by the litmus test.

Find as many sources of water as you can find in your area. These might include tap water, rain water, pond water, swamp water, river water, and others. Use the litmus paper test on each one, and list them in order according to your litmus test results.

Teacher Information

This activity will provide an introduction to the terms "acids" and "bases" and to the use of litmus paper as an indicator for determining which is which. It will also become a practical and useful experience for your problem solvers who decide to extend the activity into various drinks and into water from various sources. If acid rain is sometimes a problem in your area, you might also want to have your students collect samples of rain water during each storm and keep record of the acid levels from each. Do the same with snow; melt it down and test it.

As a long-term project, consider having your students determine whether the acidity of rain water changes throughout the year in your area.

In the absence of litmus paper, or in addition to it, try red cabbage juice. You can either boil the cabbage, then strain the juice to remove the solids, or put red cabbage and water in a blender, again straining the juice. To use it as an acid/base indicator, take a small amount of juice, such as a spoonful, and add a drop or two of the liquid being tested. Compare the color changes to the changes in litmus paper.

Integrating

Math, social studies

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting, experimenting

ACTIVITY 1.26

How Can Perfume Get into a Sealed Balloon?

Materials Needed

- Two balloons per group
- Two small bowls per group
- Perfume
- Water
- String

Procedure

1. Put one-half cup of water in each of the two bowls.
2. Mix several drops of perfume into the water of one bowl.
3. Blow up both balloons and tie them. Use a string with a bow knot so they can be untied later.
4. Place one balloon in each bowl. Press them into the bowl to create an air-tight seal. (See Figure 1.26–1.)
5. Leave the materials undisturbed for at least two hours.
6. After at least two hours, take the balloons to another room where the perfume from the bowl cannot be smelled.
7. Untie the balloon that was on the nonperfume bowl. Let the air out slowly and smell it.
8. Untie the balloon that was on the perfume bowl. Let the air out slowly and smell it.
9. What did you notice about the air in the balloons? What can you say about this?

For Problem Solvers

Do you think the perfume getting into the balloon would be affected by how tightly the balloon is blown up? Test this question by using three balloons. Be sure the balloons are identical, except that one will be blown up more and one less than before.

How about also testing the permeability of different plastic wraps? Put your perfume water in drinking cups or drinking glasses and seal plastic wrap over the tops of the containers; then see whether you can smell the

Figure 1.26-1. Balloons in Bowls

perfume through the plastic. Compare different brands of plastic wrap, and perhaps even different brands of perfume. Before you begin, make your predictions. Will they be the same? Do you think permeability of plastic wraps matters with foods that are stored in the refrigerator? Why?

Teacher Information

Molecules in the perfume are small enough to permeate the wall of the balloon. When the air is let out of the balloon after a two-hour period, the perfume in the air of the balloon should be evident from the smell.

Foods sometimes take on odors from each other while wrapped and in the refrigerator. Your "problem solvers" will find out why.

Integrating

Math

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting

ACTIVITY 1.27

How Can You Cause Molecules to Move Through Solids?

Materials Needed

- Balloons
- String
- Markers
- Paper and pencils

Procedure

1. Blow up a balloon and tie it.
2. Measure the size of the balloon by wrapping the string around it at the largest point and marking the string. Record the length of string required to go around the balloon.
3. Place the balloon where it will not be disturbed and where the temperature will remain quite constant.
4. For three days, measure the balloon twice a day with the same string and mark the string to indicate the length required to go around the balloon. Each time you measure, record the length of string required.
5. At the end of three days, describe your observations. Try to explain any changes you noted.

For Problem Solvers

Do this project as a Science Investigation. Obtain a blank copy of the "Science Investigation Journaling Notes." Write your name, the date, and your question at the top. Plan your investigation through item 5 (Procedure) and have it approved by your teacher. Complete the Journaling Notes as you perform your investigation. Share your project with your group, and submit your Journaling Notes to your teacher if requested.

Find some balloons of different brands and different quality and repeat this activity. Set up an experiment to compare the different types of balloons. Be sure to use balloons of the same size and shape, to blow them up to the same size, and to tie them in the same way.

Teacher Information

You might check to see that balloons are tied tightly so air cannot leak through the opening. You can do this by submerging them in water to check for air bubbles. As the balloons sit, air molecules actually permeate the balloon walls and they will lose air slowly, even though air is not escaping by any observable means. For the duration of this activity, the air temperature should remain as constant as possible. If air temperature changes, balloons will expand or contract (in warmer and cooler air, respectively), which will reduce the reliability of the results.

Integrating

Math

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting

ACTIVITY 1.28

What Is Viscosity?

Materials Needed

- Four tall olive jars with lids (or other tall, skinny jars) per small group
- Four marbles (different colors) per small group
- Corn syrup
- Mineral oil
- Vegetable oil
- Water
- Paper and pencils

Procedure

1. Be sure all four jars are the same size.
2. Place a marble in each jar.
3. Fill each jar with one of the liquids and put the lid on it. There should be no air under the lid.
4. When all lids are tightly in place, get someone to help you turn all four jars upside down at once. Observe the marbles.
5. Record which marble sank to the bottom first, second, third, and fourth. Repeat and compare the results with your first trial.
6. Test other liquids and compare with these.
7. Discuss your findings with your friends or your teacher.

For Problem Solvers

Read about viscosity in a dictionary. Find an encyclopedia article that tells about the viscosity of oil and read the article. Look up viscosity on the Internet. Ask a mechanic why oil is made at different viscosities for automobile engines. Why does it matter, and what are the advantages of light oil (low viscosity) and of heavy oil (high viscosity)? Some engine oils are even multiple viscosity. What does that mean, and why do they make them that way?

Teacher Information

Other liquids can be substituted for those listed above, but they should vary in viscosity (thickness). The marbles will sink more slowly in liquids with greater viscosity. Viscosity is resistance to flow.

If olive jars or other tall, thin jars are not available, baby food jars can be used. Try to get the larger size, for height. Test tubes work very well, if they are available. They must have stoppers, of course. Sturdy test tubes with threaded caps are sold as mini-bottles, baby soda bottles, and by other names. These are ideal for this activity and are available from science supply companies. They are actually the blanks for two-liter bottles—before they are transformed to their grown-up size.

The activity can even be done using open bowls. Put the liquids in separate bowls and a spoon in each bowl. Students should take a spoonful of the liquid and pour it back into the same bowl, observing how fast it pours out of the spoon. This doesn't have quite the interest or accuracy of the marble activity, but it will work.

As a practical application of this concept, your "problem solvers" will find out why automobile engines use oils of various viscosities. One factor is temperature. As is true of honey, oils become thinner (less viscous) as they become warmer. Heavier oil is generally preferred for hot weather and thinner oil for cold weather. Modern oils are also made in multiple viscosities; they have properties that cause them to behave as a heavier oil in hotter temperatures and as a lighter oil in colder temperatures.

Integrating

Reading, math

Science Process Skills

Observing, inferring, classifying, measuring, predicting, communicating, comparing and contrasting, using space-time relationships, formulating hypotheses, identifying and controlling variables, experimenting, researching

Name ______________________________ Date ______________

Can You Solve This Nature of Matter Word Search?

Try to find the following Nature of Matter terms in the grid below. They could appear in horizontal (left to right), vertical (up or down), or diagonal (upward or downward) position.

dissolve	solution	mixture
gas	condensation	molecules
viscosity	chemical	reaction
states	liquid	solid

R	E	A	C	T	I	O	N	Q	W	E	R
U	Y	V	C	H	E	M	I	C	A	L	T
I	N	M	A	L	K	J	H	S	G	F	D
O	B	D	N	P	G	F	E	D	S	A	S
P	D	I	S	S	O	L	V	E	T	W	A
L	V	U	J	H	U	R	U	Y	R	E	Q
K	C	Q	K	C	U	G	A	S	T	D	W
J	X	I	E	L	P	O	I	T	U	I	E
S	O	L	U	T	I	O	N	A	I	L	R
C	O	N	D	E	N	S	A	T	I	O	N
M	Z	M	I	X	T	U	R	E	B	S	N
H	G	F	V	I	S	C	O	S	I	T	Y

Name ______________________ Date ______________

Can You Create a New Nature of Matter Word Search of Your Own?

Write your Nature of Matter words in the grid below. Arrange them in the grid so they appear in horizontal (left to right), vertical (up or down), or diagonal (upward or downward) position. Fill in the blank boxes with other letters. Trade your Word Search with someone else who has created one of his or her own, and see whether you can solve the new puzzle.

Answer Key for Nature of Matter Word Search

R	**E**	**A**	**C**	**T**	**I**	**O**	**N**	Q	W	E	R
U	Y	V	**C**	**H**	**E**	**M**	**I**	**C**	**A**	**L**	T
I	N	M	A	L	K	J	H	**S**	G	F	D
O	B	**D**	N	P	G	F	**E**	D	S	A	S
P	**D**	**I**	**S**	**S**	**O**	**L**	**V**	**E**	T	W	A
L	V	**U**	J	H	**U**	R	U	Y	R	E	Q
K	C	**Q**	K	**C**	U	**G**	**A**	**S**	T	**D**	W
J	X	**I**	**E**	L	P	O	I	**T**	U	**I**	E
S	**O**	**L**	**U**	**T**	**I**	**O**	**N**	**A**	I	**L**	R
C	**O**	**N**	**D**	**E**	**N**	**S**	**A**	**T**	**I**	**O**	**N**
M	Z	**M**	**I**	**X**	**T**	**U**	**R**	**E**	B	**S**	N
H	G	F	**V**	**I**	**S**	**C**	**O**	**S**	**I**	**T**	**Y**

Name ______________________________ Date ______________

Do You Recall?

Section One: The Nature of Matter

1. Explain why a paper clip can float on water.

2. Why does a dry sponge weigh less than when it was wet?

3. When the grass is dry at night and wet in the morning, but there was no rain and no sprinklers, where did the water that is on the grass come from?

4. What is a mixture?

5. What is a solution?

Do You Recall? *(Cont'd.)*

6. Suppose you were to swim in your local swimming pool, then in a pool of salt water. In which of these would it be easier for you to float on the surface? Why is that?

7. Consider a submarine that contains a large tank. The tank can be filled with water from the sea or the water can be pumped out, leaving the tank empty or partly full. Explain how this can be used to change the depth of the submarine at any given time.

8. What common substance exists in nature in all three states?

9. If a burning candle is lowered into a jar of carbon dioxide, will the flame go out, burn more brightly, or continue burning the same as before?

10. How does a raw egg respond different from a boiled egg when both are placed in a large cup of water and salt is added slowly? Why is that?

Do You Recall? *(Cont'd.)*

11. When wood burns, is it a physical change or a chemical change?

12. When an iron nail rusts, is it a physical change or chemical change?

13. If food coloring is placed in a cup of hot water and in a cup of cold water, will the food coloring disperse through the water:
    a. More rapidly in the hot water?
    b. More rapidly in the cold water?
    c. Equally in both?

14. If salt is placed in a cup of hot water and in a cup of cold water, will the salt dissolve in the water:
    a. More rapidly in the hot water?
    b. More rapidly in the cold water?
    c. Equally in both?

15. When litmus paper is dipped into a liquid, what kind of information does it provide?

Answer Key for Do You Recall?

Section One: The Nature of Matter

Answer	Related Activities
1. Water molecules hold to each other (cohesion).	1.3
2. Water has weight; after the water evaporates, there is less weight.	1.4
3. From the air	1.5
4. Two or more substances mixed together but both retain their separate identities	1.6
5. A substance placed in a liquid seems to become a part of the liquid.	1.6
6. In the pool of salt water	1.8, 1.9
7. More water in the tank increases the density of the submarine, and the submarine moves to a deeper level.	1.10
8. Solid, liquid, and gas; water	1.11
9. The candle will go out. It must have oxygen to burn.	1.13
10. The raw egg will rise first. It is less dense than the boiled egg.	1.8
11. Chemical change; a new substance is formed and it is not reversible	1.19
12. Chemical change	1.20
13. a. More rapidly in the hot water	1.22
14. a. More rapidly in the hot water	1.23
15. Whether the liquid is an acid, a base, or neutral	1.25