Section One

Air

To the Teacher

A fundamental understanding of air is important to further studies in such areas as weather, air flight, plants and animals, and pollution. Although children live in an ocean of air, they often have difficulty realizing it really exists.

Air is a vital natural resource. Until recent decades, many people thought the earth's supply of air was so vast that it could not be significantly affected by the actions of living creatures. We now know that this precious resource is vulnerable to the pollutants that are put into the atmosphere every day by humans. We also know that the quality of life for all inhabitants of this planet depends on the way humans care for the huge, yet fragile supply of air that surrounds it.

Air is colorless, odorless, and tasteless. Although it is invisible, it is real, it takes up space, it has weight, and it is held to the earth by gravity. Air pressure, or atmospheric pressure, presses on all surfaces and in all directions. It presses upward and sideways just as hard as it presses downward; this is a characteristic of fluids. (Air is a fluid, as are all gases and liquids.)

The weight of the air at sea level exerts a pressure of about 1 kilogram per square centimeter (14.7 pounds per square inch). At higher altitudes, the pressure decreases because the amount of air above, from any given location of higher altitude, is less.

Air pressure in a sealed container can increase or decrease as certain conditions change. The pressure is caused by the air molecules inside the container striking against the walls of the container. If the pressure on the inside of the container is equal to the pressure on the outside of the container, the container is said to have zero pressure. Pressure inside the container will increase if more air is added (there are more air molecules striking the same amount of inside wall space), if the air inside the container is heated (the air molecules have increased energy and strike the wall with greater force), or if the volume of the container is decreased while the amount of air inside the container stays the same (there are more air molecules per unit of wall space). Pressure inside the container will decrease if some air is removed (there are fewer air molecules striking the same amount of inside wall space), if the air inside the container is cooled (the air molecules have less energy and strike the wall with less force), or if the volume of the container is increased but the amount of air inside remains the same (there is more wall space for the same number of air molecules).

Bernoulli's Principle states that the pressure in a fluid decreases as the speed of the fluid increases. The principle applies to air, water, or any other fluid. If air, for example, is blown across a strip of paper that is in the form of an airfoil, the paper will rise. With air rushing across the top of the paper, air pressure is reduced at that point and the paper is lifted by atmospheric pressure from beneath the paper. Airplane wings are designed with a curved top and a nearly flat bottom to force air to travel faster over the top than across the bottom, reducing the pressure on the top surface, thus providing lift from atmospheric pressure beneath the wing.

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 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. In 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 at a later time.

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 D: Earth and Space Science

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

1. Properties of earth materials
2. Objects in the sky
3. Changes in earth and sky

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 D: Earth and Space Science

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

1. Structure of the earth system
2. Earth's history
3. Earth in the solar system

ACTIVITY 1.1

How Can You Test to See Whether Air Takes Up Space?

(Take home and do with family and friends.)

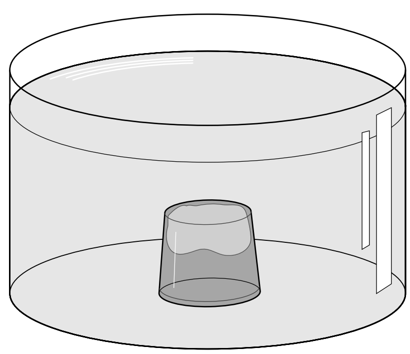
Materials Needed

- Eight-ounce clear plastic cup
- Facial tissue
- Deep bowl filled with water

Procedure

1. Look at the cup. What is in it?
2. Crumple a piece of the tissue and put it in the bottom of the cup.
3. Turn the cup over (be sure the tissue does not fall out) and push it, open end first, into a deep bowl of water.
4. Now remove the cup without tipping it.
5. What happened to the tissue?
6. What can you say about this?

Figure 1.1-1. Bowl of Water with Inverted Cup at Bottom



Teacher Information

When the cup is lowered mouth first into the bowl of water, the air will be trapped inside the cup and prevent water from entering the cup. Thus, the tissue will remain dry. Air is a substance, and it does take up space.

Science Process Skills

Observing, inferring

ACTIVITY 1.2

How Can You Pour Air?

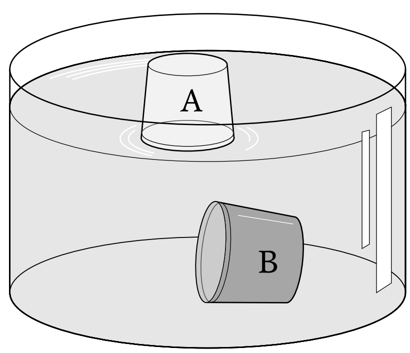
Materials Needed

- Two eight-ounce plastic cups marked A and B
- Deep bowl filled with water

Procedure

1. Look at the cups marked A and B. What is in them?
2. Push cup A, mouth first, into the bowl of water.
3. Turn it on its side. What happened?
4. Push cup B to the bottom of the bowl, mouth (open end) first.
5. Put the mouth of cup A right above cup B and slowly tip cup B on its side.
6. What happened? What can you say about this?

Figure 1.2-1. Bowl of Water Containing Cup A Above Cup B



Teacher Information

When cup A is pushed into the bowl, it will contain air. When it is tipped on its side, the air will bubble out and the cup will fill with water. When cup B is pushed to the bottom and tipped on its side, and if the mouth of cup A is directly above it, the air will bubble from cup B into cup A because air is lighter than water. Students will be able to see the air travel from cup B and force the water from cup A. Water in cup A is displaced by air from cup B, demonstrating that air truly does take up space.

Science Process Skills

Observing, inferring

ACTIVITY 1.3

How Can You Tell Whether Air Has Weight?

(Take home and do with family and friends.)

Materials Needed

- Meter stick
- String
- Whiteboard eraser (or chalkboard eraser)
- Balloon

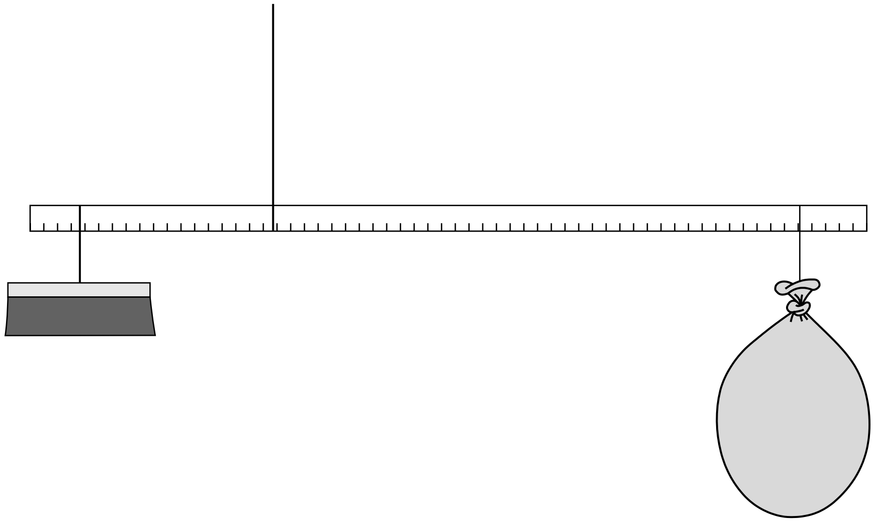
Procedure

1. Suspend a meter stick from a string tied in the middle of the meter stick.
2. Tie the eraser to one end of the meter stick with another piece of string.
3. Using a third piece of string, tie an empty balloon (not inflated) to the other end of the meter stick. Suspend the balloon 5 cm (2 in.) from the end of the meter stick.
4. Now balance the meter stick by sliding the center support string back and forth as needed.
5. Remove the balloon and inflate it. Retie the balloon in the same place (5 cm, or 2 in., from the end). Does it balance? What can you say about this?

For Problem Solvers

Find out the actual weight of air in a balloon. Compare balloons of different sizes and see how much air you can put in them, in grams. For each balloon, weigh it empty on a gram balance, estimate what it will weigh when it's full of air, then blow it up and find out. Can you think of any other way that you can weigh air?

Figure 1.3-1. Eraser Balanced with Balloon



Teacher Information

When the balloon is inflated and hung on the meter stick again, it will tip the balance down, showing that air has weight. Make certain the eraser does not move while the balloon is being removed and inflated. Tape it in place if necessary.

Integrating

Math

Science Process Skills

Observing, inferring, comparing and contrasting, measuring, estimating

ACTIVITY 1.4

How Can You Feel the Weight and Pressure of Air?

(Take home and do with family and friends.)

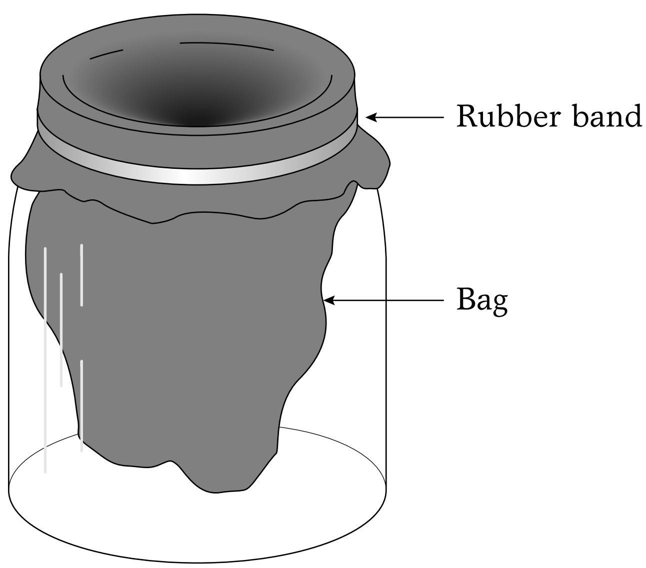
Materials Needed

- Large, wide-mouthed, clear glass (or rigid plastic) jar
- Plastic bag
- Rubber band

Procedure

1. Push the plastic bag down inside the jar with about 5 cm (2 in.) hanging over the rim.
2. Place the rubber band around the rim of the jar, just below the threads (the plastic should be under the rubber band all the way around).
3. Reach inside the jar and gently pull the plastic upward.
4. What happened? What can you say about this?

Figure 1.4-1. Plastic Bag Hanging Inside Glass Jar



Teacher Information

When the student pulls up on the plastic bag, the space inside the bottle is increased and the air pressure is reduced. The outside air pushing down on the plastic bag will keep it from being pulled out. You can feel the weight of the air. This can be a group activity, but be sure each child has a chance to feel the pressure holding the bag inside the jar as he or she tugs lightly on the bag.

Integrating

Math

Science Process Skills

Observing, inferring

ACTIVITY 1.5

What Is Another Way to Feel Air Pressure?

Materials Needed

- Two suction-cup plungers
- Water
- A partner

Procedure

1. Moisten the edges of the two plungers.
2. With the help of a partner, push the plungers together. Now try to pull them apart.
3. What happened?
4. What can you say about this?

For Problem Solvers

Suction cups are used to hold directional compasses onto automobile windshields, to mount pencil sharpeners onto desktops, to pull out car body panels in a repair shop, and for a wide variety of applications. Find as many uses for suction cups as you can and design a way to test their holding strength. Do certain applications use better suction cups? Are some brands better than others? And for all of them, what really is the force that holds them in place?

Teacher Information

When the plungers are pushed together, much of the air between them is forced out, creating a partial vacuum. The outside air pressure keeps them together. Plungers will not work on the moon, due to lack of air pressure. If there is a glass shop nearby, arrange for someone in the class to ask the shop owner about carrying large glass panels with suction cups.

Integrating

Math, social studies

Science Process Skills

Observing, inferring, measuring, identifying and controlling variables, experimenting

ACTIVITY 1.6

How Can Air Be Compressed?

(Take home and do with family and friends.)

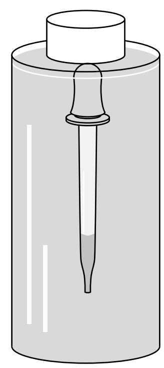
Materials Needed

- Clear, flexible plastic bottle filled with water
- Eyedropper with a small amount of water inside

Procedure

1. Observe the eyedropper in the capped bottle.
2. Gently squeeze the bottle.
3. What happened? Can you explain why?

Figure 1.6-1. Eyedropper in Plastic Bottle Full of Water



For Problem Solvers

With this activity you made a Cartesian diver. Can you make one that will go up and down by itself as the water temperature changes? What are the variables that you might want to change? Consider using a glass bottle, and be sure the lid will seal. What will happen if you begin with cold water and with the diver barely able to float, then put the bottle in the sunshine? What will happen if you begin with warm water and the diver barely able to float, then put the bottle in a refrigerator (not in a freezer)?

Try the same thing again, only using a plastic bag as the container. Be sure you seal the bag tightly and that you have no air trapped at the top of the bag above the water. Predict what will happen before you begin.

Teacher Information

This is called a Cartesian diver. Fill the plastic bottle with water. Put enough water in the eyedropper so it will just barely float in the bottle and place the dropper in the bottle, bulb end up. Put the cap on the bottle. When pressure is exerted on the bottle, water, which will not compress, is forced into the eyedropper, compressing the air and making the dropper heavier. It will sink lower in the bottle. When pressure on the bottle is released, the compressed air in the dropper will force some of the water out, and the dropper will float to the surface. If pressure on the bottle is varied, the dropper can be stopped in the middle or at any point desired.

Integrating

Language arts

Science Process Skills

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

ACTIVITY 1.7

What Is Another Way Air Can Be Compressed?

(Advance teacher preparation needed)

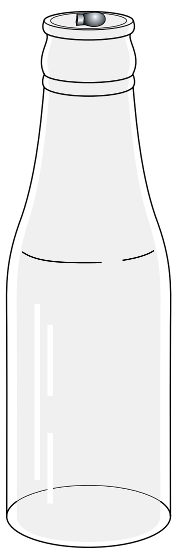
Materials Needed

- Clear glass soda bottle
- Head from wooden match
- Water

Procedure

1. Float a head from a wooden match in a soda bottle completely full of water.
2. Use your thumb to push down on the water in the mouth of the bottle. Your thumb should completely cover the bottle's mouth.
3. What happened? What can you say about this?

Figure 1.7-1. Match Head in Soda Bottle Full of Water



Teacher Information

This is another Cartesian diver. The wood in the match head is porous—full of air spaces—so it floats on top of the water. When you use your thumb to push on the surface, water is forced into the air spaces in the match head and it will sink. When the pressure is released, the match head will float to the surface again as the compressed air in the match head forces the water out.

Note: The thumb must cover the mouth of the bottle completely. This activity is not appropriate for young children except as a demonstration, because it requires a larger and stronger hand. You will need to remove the wood right up to the head of the match, until the match head barely floats.

Science Process Skills

Observing

ACTIVITY 1.8

What Can a Card Teach You About Air?

(Take home and do with friends, over the sink, please.)

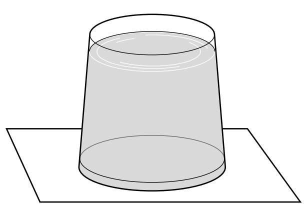
Materials Needed

- Plastic cup
- 4-inch by 6-inch index card
- Water and sink

Procedure

1. Working over a sink, fill the cup with water.
2. Put the index card over the mouth (open end) of the cup.
3. Hold the card in place with one hand, the cup in the other.
4. Turn the cup upside down and carefully remove your hand from the card.
5. Slowly turn the cup right-side up, but don't touch the card.
6. What happened?
7. What can you say about this? Discuss your ideas with your group.

Figure 1.8-1. Inverted Cup of Water Over Card



For Problem Solvers

Try this activity with cups of different sizes and find out whether size makes any difference. Try it with different materials in place of the index card. Predict what will happen with each material before you try it. Does a heavier card work as well? A sheet of paper? Try to find a very fine-mesh screen. Does that stay on the cup just the same as the card? Can you explain your results?

Teacher Information

Be sure to try this activity before using it with students. When the cup full of water is turned upside down and the hand is removed, the card will usually stay on the cup and the water will stay inside the cup. This is because the pressure of the air pushing on the card is great enough to hold the water in. When the cup is turned right-side up, the card will usually stay on the cup, showing that air pushes in all directions.

Tip: You might consider doing this activity over a bucket, a sink, or other appropriate container, just in case!

Integrating

Language arts

Science Process Skills

Observing, inferring, predicting, communicating

ACTIVITY 1.9

How Can You Crush a Gallon Can Without Touching It?

(Teacher demonstration)

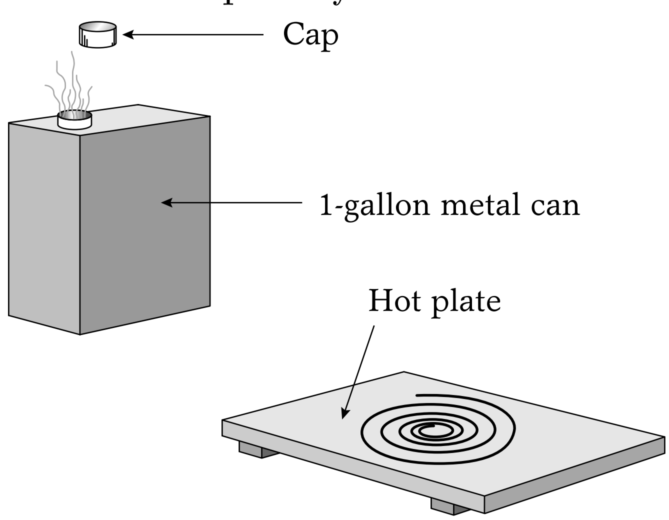
Materials Needed

- Gallon can with tight-fitting lid
- Hot plate
- Water
- Oven mitts

Procedure

1. Put a small amount of water ($\frac{1}{2}$ cup or so) in the can.
2. Put the can on the hot plate with the lid off and turn the hot plate on high.
3. When there is a good stream of steam coming out the spout, use oven mitts to remove the can from the hot plate.
4. Put the lid on tight, immediately after you remove the can from the hot plate. (See Figure 1.9–1.)

Figure 1.9–1. Gallon Can Being Removed from Hot Plate and Cap Ready to Be Put On



5. Have students predict what will happen to the can.
6. As students observe for a few minutes, discuss what is happening and why.

Teacher Information

Caution: There are two possible hazards with this activity. First, students could get burned. Second, the can should never be left on the hot plate with the lid on, as the can will likely explode. This activity should be done only by the teacher as a demonstration.

This is one of the more popular demonstrations of the great force of air pressure. For older students, it's an excellent time to apply math skills. Have them measure the dimensions of the can and compute the air pressure (about 14.7 pounds per square inch at sea level). Their figures will probably show that there are approximately 3,000 pounds of force on the can, and they will see the effect of that pressure as the can is crushed right before their eyes. To involve 3,000 pounds of force assumes that you were successful in driving out all of the air by water vapor, and that won't happen, but it will come close enough to provide students with a lasting memory about the force of air pressure.

The overabundant supply of gallon cans at school went out with the ditto machine. Gallon cans are sometimes available, however, at paint-supply stores. Businesses that mix paint usually even have new cans that they will sell at a reasonable price. Another possible source is your local auto-body shop. These shops get some of their reducers (thinners) in gallon cans, and they throw empties away. *CAUTION:* If you use cans that have had flammable material in them, be sure to *rinse them well* before putting them on a hot plate!

Integrating

Math, language arts

Science Process Skills

Observing, inferring, measuring, predicting, communicating

ACTIVITY 1.10

How Can You Crush a Soda Can with Air Pressure?

(Teacher demonstration)

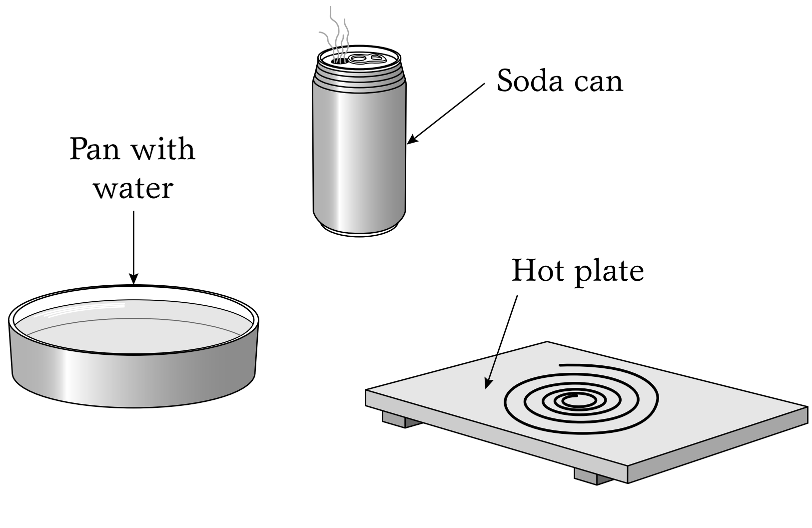
Materials Needed

- Empty soda can
- Hot plate
- Pan of water
- Oven mitts

Procedure

1. Put a small amount of water ($\frac{1}{8}$ cup or so) in the can.
2. Put the can on the hot plate and turn the hot plate on high.
3. When there is a good stream of steam coming out the spout, use oven mitts to remove the can from the hot plate.
4. Immediately turn the can upside down in the pan of water. Only the top of the can needs to enter the water. (See Figure 1.10–1.)
5. Have students hypothesize as to what happened to cause what they saw.

Figure 1.10–1. Soda Can Being Removed from Hot Plate with Pan of Water Ready



Teacher Information

Caution: Do this activity as a demonstration, to avoid the possibility of students getting burned.

This is an excellent substitute (or addition) for the gallon-can crusher to demonstrate the force of air pressure. For older students, math skills can still be applied by computing the amount of air pressure on the surface of the can. Many people recycle aluminum cans, and they usually stomp on the cans to minimize storage space. Here's a more exciting way to crush the cans!

Integrating

Math, language arts

Science Process Skills

Observing, inferring, measuring, predicting, communicating

ACTIVITY 1.11

How Can Air Pressure Make Things Stronger?

(Take home and do with family and friends.)

Materials Needed

- Paper straws
- Potato

Procedure

1. Hold a straw near one end and try to stick the other end in a potato. What happened?
2. Place your finger over the top of the straw and stick the other end into the potato (do it fast and hard). What happened?
3. What can you say about this? Discuss your ideas with your group.

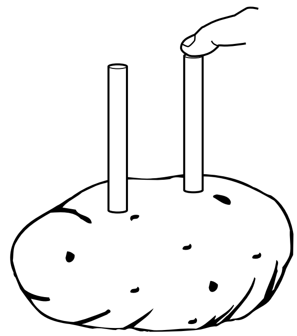
For Problem Solvers

Try this activity with a variety of straws—fat straws, skinny straws, plastic straws, and paper straws. Cut some of them shorter and try it. Can you penetrate the potato with all of the straws? If not, which ones work best? With which ones do you have to seal the opening with your finger in order to push them into the potato? Does this help you to see what difference it makes to seal the opening? Tell your teacher what you learned about straws, potatoes, and air pressure.

Teacher Information

When you try to stick the straw with both ends open in the potato, the straw will bend. When you place your finger over the upper end of the straw, the air is trapped inside and the column is strengthened. The straw will go into the potato. (Be sure to stab rapidly and hold the straw near the top during all parts of the activity.)

Figure 1.11-1. Potato with Straws Inserted



Integrating

Language arts

Science Process Skills

Observing, inferring, measuring, identifying and controlling variables, experimenting

ACTIVITY 1.12

How Can Air Help Us Drink?

Materials Needed

- Clear glass soda bottles filled with water
- Plastic or paper straws
- Modeling clay

Procedure

1. Drink some water through the straw.
2. Use clay to seal the top of the bottle all around the straw.
3. Drink some more water through the straw.
4. What happened? What can you say about this? Discuss your ideas with your group.

For Problem Solvers

Think about what really happens when you drink through a straw. You don't pull the liquid up the straw. Instead, you reduce the pressure inside the straw. See whether you can explain what really causes pressure inside the straw to be decreased. Then explain what causes the liquid to rise in the straw.

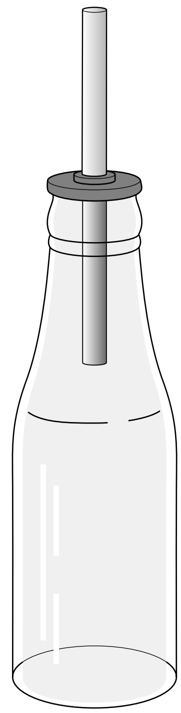
Teacher Information

In order to drink through a straw, you must have air pushing on the surface of the liquid. When the top of the bottle is sealed, any effort to get liquid to move up the straw reduces the pressure of the air above the surface of the liquid, more air cannot get in, and drinking is impossible. Soda cans have either two holes or one hole shaped in such a way that air can get in as the liquid pours out; narrow-necked bottles "gurgle" because they are not designed to let air flow in easily as liquid flows out.

Think about what you do physiologically as you drink through a straw. You seal your mouth over the straw with your mouth closed, and then open your mouth. This increases the size of the air space inside your mouth without allowing more air to come in, thus reducing the air pressure inside your mouth. Since the end of the straw is in your mouth, pressure of the air inside the straw is also reduced, and it is now less than atmospheric pressure. Atmospheric pressure on the surface of the liquid forces the liquid up the straw. You don't "suck" the liquid up the straw.

Suction is not a force; it is only a word that we use to imply a lack of air pressure. You simply reduce the pressure inside the straw. The force that moves the liquid up the straw is atmospheric pressure.

Figure 1.12-1. Soda Bottle with Straw Sealed to the Top



Integrating

Language arts

Science Process Skills

Observing, inferring, communicating

ACTIVITY 1.13

How Does Air Pressure Affect Water Flow?

(Do this over a sink or bucket.)

Materials Needed

- Gallon or quart metal can with tight-fitting lid and a hole punched into the side near the bottom
- Masking tape
- Water
- Sink or bucket

Procedure

1. There is a small hole near the bottom of the can. Find it and cover it with a piece of masking tape.
2. Fill the can with water.
3. Remove the masking tape and observe the stream of water.
4. Put the lid on the can tightly. Observe the stream of water. What happened?
5. Listen carefully as you loosen the lid. What happened?
6. What can you say about this?

For Problem Solvers

Do some research and find answers to the following questions:

1. Why is the hole in a pop-top can shaped the way it is?
2. Why do you punch a second hole in the solid lid of a juice can before you pour?
3. There are usually open plumbing pipes sticking out of the roof of your house or apartment. Why?

Teacher Information

Be sure the lid seals so the container is airtight. Without the lid, gravity will cause the water to flow in a stream from the hole. When the lid is on tight, the flow will gradually stop, even though water still remains in the can. When the lid is removed, gravity takes over and the water will flow from the hole again.

With the lid sealed, air cannot enter the can. Although the force of gravity still exerts a downward force on the water, the inside air pressure will be reduced enough that atmospheric pressure will hold the water in the can against the force of gravity, and the flow of water will stop.

Note: A rigid plastic bottle can be used in place of the metal can.

Your problem solvers will learn, through their research, that the hole in a pop-top can is designed to allow air to flow into the can while the liquid refreshment runs out, keeping the air pressure equalized. Two holes are needed in a juice can in order to allow air to flow into the can as liquid flows out, for the same reason. And a plumbing system is vented to the roof, also to allow equalization of pressure.

Integrating

Reading, language arts

Science Process Skills

Observing, inferring, researching

ACTIVITY 1.14

How Hard Can Air Push?

(Take home and do with family and friends.)

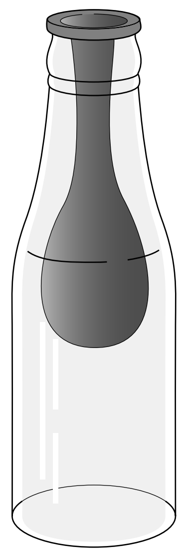
Materials Needed

- Clear glass soda bottle
- Balloon

Procedure

1. Put the balloon into the soda bottle, holding onto the balloon's open end.
2. Stretch the lip of the balloon over the mouth of the bottle.
3. Inflate the balloon inside the bottle.
4. What happened? Can you explain why?

Figure 1.14-1. Soda Bottle with Balloon Hanging Inside



For Problem Solvers

Try this activity with bottles of different sizes. Be sure all of them have small openings, so you can stretch the balloon over them. Can you blow the balloon up any further with some of the bottles than with others? What seems to make the difference? Try it with your friends and discuss your ideas about it.

Teacher Information

When the child blows into the balloon, the increased air pressure inside the balloon will push against the air trapped in the bottle. The pressure of the air in the bottle will increase and push harder on the balloon. The child will discover that the balloon cannot be inflated inside the bottle. Remember, the lip of the balloon must cover the mouth of the bottle and completely seal it.

Just for fun, make a small hole in the bottom of a *rigid* plastic bottle; then use this bottle for the above activity. Hold the bottle and seal the hole with your finger (students must not see this happen) as the student tries to blow up the balloon. Then carefully slide your finger from the hole and let the student try again. The student will now be able to blow up the balloon. Seal the hole again with your finger, just as the student stops blowing, and the balloon will remain inflated just from atmospheric pressure. Of course, the students still don't know about the hole in the bottom of the bottle. Let them puzzle over it and discover the hole. This is an excellent inquiry activity, and a lot of fun for all.

Integrating

Language arts

Science Process Skills

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

ACTIVITY 1.15

How Can You Put an Egg into a Bottle?

(Teacher demonstration or supervised activity)

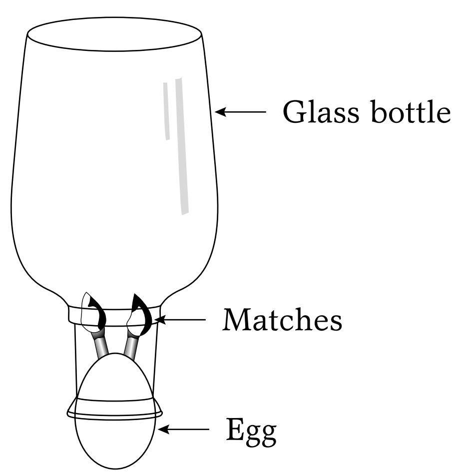
Materials Needed

- Hard-boiled egg, peeled
- Glass milk bottle or juice bottle, 1 liter (1 qt.) or larger
- Wooden matches

Procedure

1. Insert two wooden matches into the pointed end of the egg.
2. Holding the bottle upside down, light the matches and put the egg into the mouth of the bottle, pointed end first. Hold the egg lightly against the mouth of the bottle, but don't push! Keep the bottle upside down.
3. What happened? What can you say about this?

Figure 1.15-1. Bottle with Egg and Matches



Teacher Information

The mouth of the bottle should be somewhat smaller (5 mm or $\frac{1}{4}$in.) in diameter than the egg. If an old-style milk bottle is not available, you might find a juice bottle that will be about right if you use large eggs. Pullet eggs could be used with bottles having a smaller opening. (A pullet is a young hen, and it lays small eggs.)

The lit matches in the pointed end of the egg will heat the air inside the bottle, causing the air to expand. When this happens, warm air is forced out of the bottle (don't push the egg into the top of the bottle or the air can't get out). Soon the matches will go out and the air inside the bottle will cool and contract, leaving less pressure inside the bottle than outside the bottle. When this happens, the outside air pressure will force the egg into the bottle.

If the egg is not broken, you can get it out of the bottle by reversing the process. Hold the bottle above your head with the pointed end of the egg in the mouth of the bottle. Blow very hard into the bottle. The blowing will increase the air pressure inside the bottle and push the egg out. If the egg comes only partway out, try pouring warm water on the bottle. The air inside will expand and force the egg out.

Integrating

Math, language arts

Science Process Skills

Observing, inferring

ACTIVITY 1.16

How Can You Put a Water Balloon into a Bottle?

(Teacher demonstration)

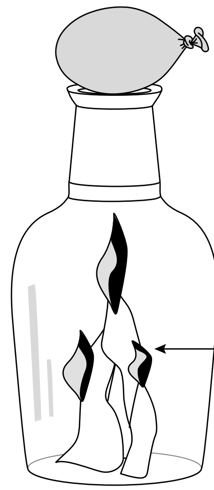
Materials Needed

- Large bottle (with an opening of at least 4 cm [$1\frac{1}{2}$ in.])
- Balloon
- Bowl of water
- Paper towel
- Match
- Aluminum foil (or other fireproof surface)

Procedure

1. Place a sheet of aluminum foil or other fireproof surface on the table and place the bottle and the bowl of water on the foil.
2. Put water in the balloon, making a water balloon that is a bit larger than the opening of the bottle.
3. Place the water balloon in the bowl of water, just to get it wet and provide lubrication.
4. Take half a sheet of paper towel (or other paper) and twist it lengthwise so that it fits easily into the opening of the bottle, but don't drop it into the bottle yet.
5. Hold the twisted paper above the spout of the bottle, light it with the match, and drop the burning paper into the bottle. (See Figure 1.16–1.)
6. Immediately place the water balloon on the bottle, while the paper is still burning, holding the balloon lightly by the neck.
7. Discuss what happened and why they think it did that.

Figure 1.16-1. Large Bottle with Water Balloon on Top and Paper Burning Inside



Teacher Information

Caution: This activity should be done only by the teacher as a demonstration, to avoid the possibility of students getting burned.

This is an excellent substitute (or addition) for the egg-in-the-bottle demonstration of air pressure, except that it doesn't provide breakfast. The water balloon has the advantage of flexible size, so most any bottle can be used.

Without disclosing conceptual information, you might want to describe the steps of the activity before lighting the paper afire and ask students to predict what will happen when you put fire in the bottle and place the water balloon on the top of the bottle.

After the balloon is in the bottle, have students hypothesize about what made the water balloon go into the bottle. Be sure they don't leave with the notion that a vacuum in the bottle "sucked" the balloon into the bottle. A vacuum is only a lack of pressure. Pressure is a force, and lack of force can't do work. The air expanded as it heated, and you probably noticed that the water balloon danced on the top of the bottle as the heating air escaped. As soon as the fire went out, the air began to cool and contract. With the water balloon sealing the spout and preventing air from reentering the bottle, air pressure inside the bottle decreased, resulting in less air pressure inside the bottle than outside the bottle. The balloon was pushed into the bottle by atmospheric pressure.

Have students hypothesize also about how you might get the water balloon out of the bottle. If you turn the bottle upside down, position the balloon over the opening to seal air from coming out of the bottle, then blow air into the bottle. The increased air pressure will force the balloon out of the bottle, just as air pressure pushed the balloon into the bottle.

Note: The operation of a vacuum cleaner is related to the process of getting the balloon into the bottle. The spinning of the fan creates reduced pressure immediately in front of the fan. Reduced pressure, however, cannot reach out and pull on the air in front of it. Rather, as the air pressure in front of the fan is reduced, more air is forced in by atmospheric pressure. This is also related to the movement of air outdoors. As the sun heats a large mass of air, the air expands. Pressure within the air mass is thereby reduced and surrounding air of greater pressure rushes in. We call it wind.

Integrating

Language arts

Science Process Skills

Observing, inferring, predicting, communicating

ACTIVITY 1.17

How Much Can You Lift by Blowing?

(Take home and do with family and friends.)

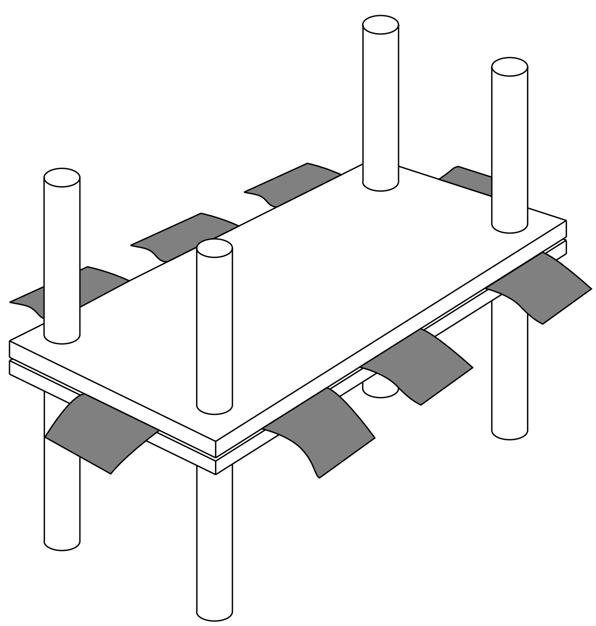
Materials Needed

- Small garbage bags, newspaper bags, or other plastic bags (at least six)
- Two tables (alike and medium sized)
- Chair

Procedure

1. Place a book on a bag and blow into the bag to see whether you can lift the book.
2. Do you think you can lift three books by blowing into the bag? Try it.
3. If you could lift three books, find something heavier and try lifting it the same way.
4. Turn one table upside down on top of the other.
5. Have several people circle the table, each one inserting his or her bag, open end out, between the two tables. (See Figure 1.17-1.)

Figure 1.17-1. Two Tables Ready to Use



6. Have everyone blow together in the bags, on signal and in unison. Did the table rise?
7. If you were successful in raising the table by blowing into the bags, place a chair on the upside-down table and repeat steps 5 and 6.
8. Finally, put a person on the chair and do it again.
9. Discuss everyone's ideas about why they were able to lift such a lot of weight by blowing.

For Problem Solvers

Talk to someone who works in a mechanic shop and find out how much air pressure is used to lift a car on a hydraulic hoist. How can air pressure lift a car?

Find out how much air pressure is in the tires of your family car, or ask someone about theirs. Find out how much the car weighs. Discuss your information with your teacher and other class members. How can that much air pressure hold up a car?

Teacher Information

Students will be amazed at how much weight they can lift by blowing into a bag. Talk about the fact that automobiles ride on a cushion of air. A two-thousand-pound car (or more) is held up by tires that have approximately 30 pounds of air in them. This means 30 pounds per square inch of surface area. If you blow into a bag through an opening of 1 square inch, the air pressure you force into the bag can be multiplied by the number of square inches of surface area of the bag.

The total force that can be applied by a small amount of air pressure is astounding.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, measuring, predicting, communicating, formulating hypotheses, researching

ACTIVITY 1.18

How Can Air Pressure Help Airplanes Fly?

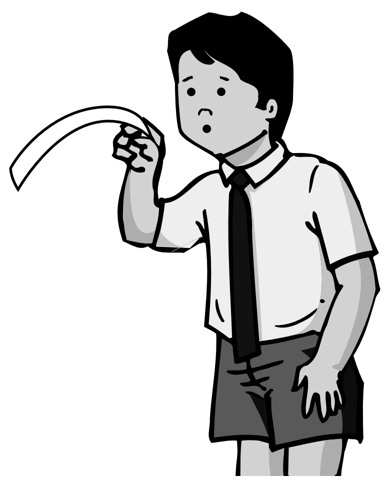
Materials Needed

- Sheets of standard-sized notebook paper

Procedure

1. Hold the sheet of paper by the corners just below your lower lip.
2. Permit the paper to hang down in front of you. (See Figure 1.18–1.)
3. Blow across the top of the paper.
4. What happened? What can you say about this? Discuss your ideas with your group.

Figure 1.18–1. Student Blowing Air Over Paper



For Problem Solvers

Place two textbooks flat on the table, side by side, leaving about 10 cm (4 in.) of space between them. Put a sheet of notebook paper on top of the books. Predict what will happen if you blow into the space beneath the paper between the books. Try it. What happened to the paper?

Repeat the activity, blowing through a soda straw. Which worked better for you?

Teacher Information

When a student blows across the top of the paper, it will rise. As air moves faster, its pressure is reduced and the greater air pressure below pushes the paper up. This is called Bernoulli's Principle, and airplane wings are shaped to take advantage of it. The same principle is applied to move chemicals out of the bottle of a garden-hose sprayer.

Your problem solvers will find that, as they blow beneath the paper that is supported by two books, air pressure under the paper is reduced, following Bernoulli's Principle, and air pressure above forces the paper down between the books.

Integrating

Language arts

Science Process Skills

Observing, inferring, predicting

ACTIVITY 1.19

What Is the Relationship Between Moving Air and Its Pressure?

(Take home and do with family and friends.)
(Advance teacher preparation needed)

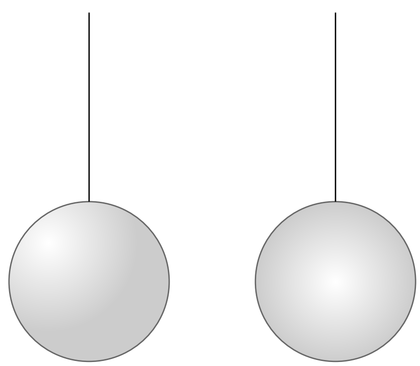
Materials Needed

- Two Ping-Pong balls with thread attached
- Paper and pencils
- Drinking straws

Procedure

1. Suspend two Ping-Pong balls from threads, leaving approximately 2 cm ($\frac{3}{4}$ in.) between them. (See Figure 1.19–1.)

Figure 1.19-1. Ping-Pong Balls Hanging from Thread



2. Predict what will happen if you blow between the balls with a drinking straw.
3. Write your prediction, then try it.
4. What happened? Was your prediction accurate? What can you say about this?

Teacher Information

Advance preparation: You will need to have a piece of thread (approximately 45 cm [18 inches]) already attached to each Ping-Pong ball. The easiest way is to thread a needle, then force the needle into one side of the ball and out the other, and tie a knot in the thread.

When air is blown between the Ping-Pong balls, they will come together because the molecules of air between the balls are moving faster, which reduces the pressure between the balls. The balls are pushed together by atmospheric pressure.

Integrating

Math, language arts

Science Process Skills

Observing, inferring, predicting

ACTIVITY 1.20

How Far Can You Blow a Ping-Pong Ball from a Funnel?

(Take home and do with family and friends.)

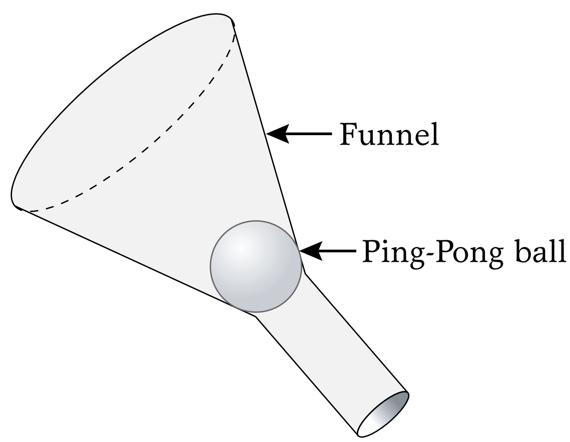
Materials Needed

- Standard kitchen funnels
- Ping-Pong balls

Procedure

1. Place a Ping-Pong ball in your funnel.
2. Hold your funnel at enough of an angle that the ball will stay in the funnel. (See Figure 1.20–1.)

Figure 1.20-1. Funnel at an Angle so Ball Will Stay in Place



3. Predict what will happen if you blow into the small end of the funnel. How far do you think you can blow the ball across the room?
4. Try it. How far did the ball go?
5. Can you explain what happened?
6. Discuss your ideas with others.

Teacher Information

If you get three (or more) funnels and Ping-Pong balls, you can have a contest with a group of students. Of course, it's important that they haven't already tried the activity, so they will earnestly compete as you give them the signal to blow. Ask the other students in the class to predict which of the "blowers" will be able to blow the ball the farthest across the room, and notice the surprised looks on the faces of all when the balls go nowhere.

This is an application of Bernoulli's Principle. As air rushes past the ball, pressure is reduced where the air is moving fastest. Atmospheric pressure pressing in on the center of the ball is then greater than the pressure around the perimeter of the ball, where the air is moving more rapidly. The harder you blow, the tighter the ball is held in the funnel.

Try it with the funnel upside down. Hold the ball in place, and then release it after you begin to blow hard. The ball will fall after you stop blowing.

Note: Be sure to wash the funnels with soap and water before using them with other students.

Integrating

Language arts

Science Process Skills

Observing, inferring, predicting, communicating, formulating hypotheses

ACTIVITY 1.21

Why Can't the Ball Escape the Air Stream?

(Take home and do with family and friends.)

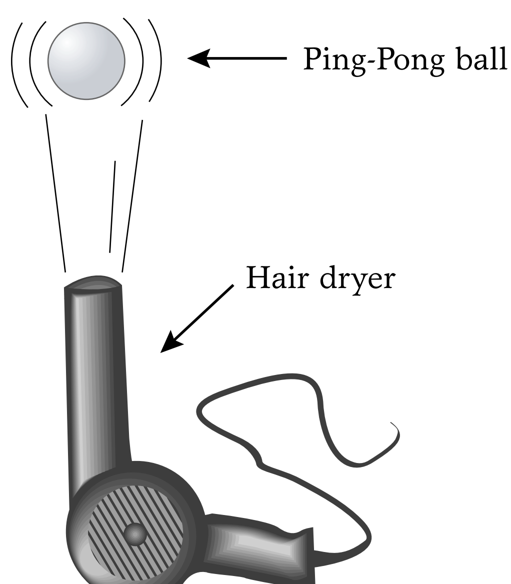
Materials Needed

- Hair dryer (with "no heat" setting)
- Ping-Pong ball

Procedure

1. Set the hair dryer on "no heat" and turn the fan on high speed.
2. With the air blowing upward, hold the ball in the air stream.
3. Carefully let go of the ball and move your hand away.
4. What happened?
5. Can you explain this?
6. With the ball still in the air stream, tilt the hair dryer back and forth slightly.
7. How can this happen? Discuss your ideas with your teacher and with your group.

Figure 1.21-1. Ping-Pong Ball Suspended in a Stream of Air



Teacher Information

This is another application of Bernoulli's Principle. As the ball moves to the side of the air stream due to the force of gravity, the air moving past the ball on the air stream side is moving faster than the air on the other side of the ball, reducing the pressure on the air stream side, and the ball is pushed back into the air stream by atmospheric pressure. As you direct the air stream vertically, you will see the ball waver back and forth, and as you tip it at a slight angle, atmospheric pressure will support the ball.

This activity also works fine with a tank-type vacuum as the blower. Plug the hose into the rear of the tank, so that air blows out through the hose.

Integrating

Language arts

Science Process Skills

Observing, inferring, communicating, formulating hypotheses

ACTIVITY 1.22

How Can You Make an Atomizer with a Drinking Straw?

(Take home and do with family and friends.)

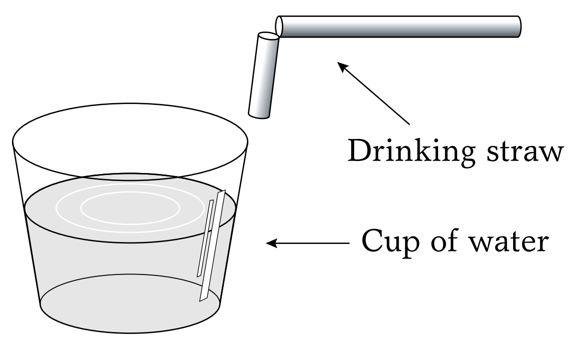
Materials Needed

- Drinking straw
- Small cup of water
- Scissors

Procedure

1. Cut the drinking straw almost through, with about one-third of the straw on one end of the cut and two-thirds of the straw on the other end. (See Figure 1.22–1)
2. Bend the straw at a right angle.

Figure 1.22-1. Straw Cut and Bent, Ready to Use in Cup of Water



3. Insert the short end of the straw into the water.
4. Predict what will happen if you blow on the other end of the straw.
5. Blow hard on the other end of the straw.
6. What happened? Was your prediction correct?
7. From what you have learned about Bernoulli's Principle, can you explain this?
8. Discuss your ideas with your group.

For Problem Solvers

Does the angle of the vertical straw change the way the atomizer works? Does the length of the vertical straw make any difference in how easy it is to use? Does the size of either straw matter, or the size of the cup? Think of ways to test these variables and answer them. What other variables do you wonder about? Test them, too, and share your information with your teacher and with other students.

Teacher Information

This is another application of Bernoulli's Principle. Air pressure is reduced in the vertical straw as air rushes over its opening. Atmospheric pressure is now greater than the pressure inside the straw, and the liquid is forced up the vertical tube by atmospheric pressure pushing down on the surface of the liquid in the cup.

Squeeze-bulb atomizers use this principle, as do paint sprayers and the type of weed sprayer that attaches to a garden hose. This principle has many other applications in life, including in the operation of a carburetor of a gasoline engine. Airplanes are supported in the air largely by atmospheric pressure, in another application of Bernoulli's Principle.

Incidentally, you might want to do this activity at the end of the day, or at least just before recess, because students will spray water everywhere—and they will always remember Bernoulli's Principle. Isn't that terrific! (And parents love you when you teach their children things like this!)

Integrating

Language arts, social studies

Science Process Skills

Observing, inferring, predicting, communicating, formulating hypotheses, experimenting

ACTIVITY 1.23

What Happens When Air Is Heated?

(Teacher demonstration)

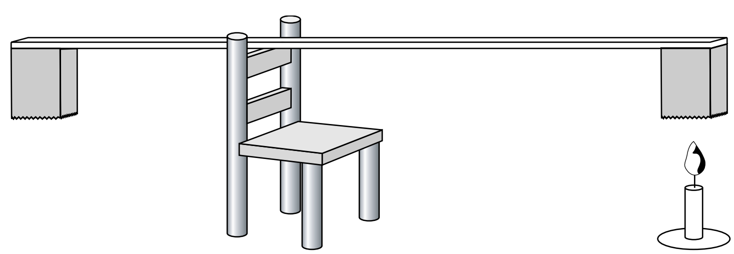
Materials Needed

- Masking tape
- Meter stick
- Candle
- Match
- Chair
- Two lunch-sized paper bags

Procedure

1. Use masking tape to attach a lunch-sized paper bag, open end down, to each end of the meter stick.
2. Balance the meter stick on the back of a chair.
3. What do you think will happen if you place a lighted candle under the open end of one of the paper bags?
4. Try it, being very careful to keep the candle a safe distance from the bag.
5. What happened?
6. What can you say about this?

Figure 1.23-1. Paper Bags Balanced on Chair



For Problem Solvers

Hot-air ballooning has become very popular. Flying safely requires a great deal of knowledge and skill, so balloon pilots must be licensed. What causes a hot-air balloon to rise into the air? Read about hot-air balloons and find out all you can about how they function. Observe the operation of one if you have the opportunity.

Teacher Information

Caution: Do this activity over a concrete surface, and take precautions that are appropriate in the use of an open flame.

As the air in the paper bag above the candle is heated, the rapid movement of air molecules causes the air to expand. As some of the air inside is forced out, the air in the bag becomes lighter and the paper bag will begin to rise. This is the same principle hot-air balloons use.

Integrating

Reading, language arts, social studies

Science Process Skills

Observing, predicting, researching

ACTIVITY 1.24

How Can You Tell That Warm Air Rises?

Materials Needed

- Lamp
- Compass
- Paper
- Thread
- Scissors

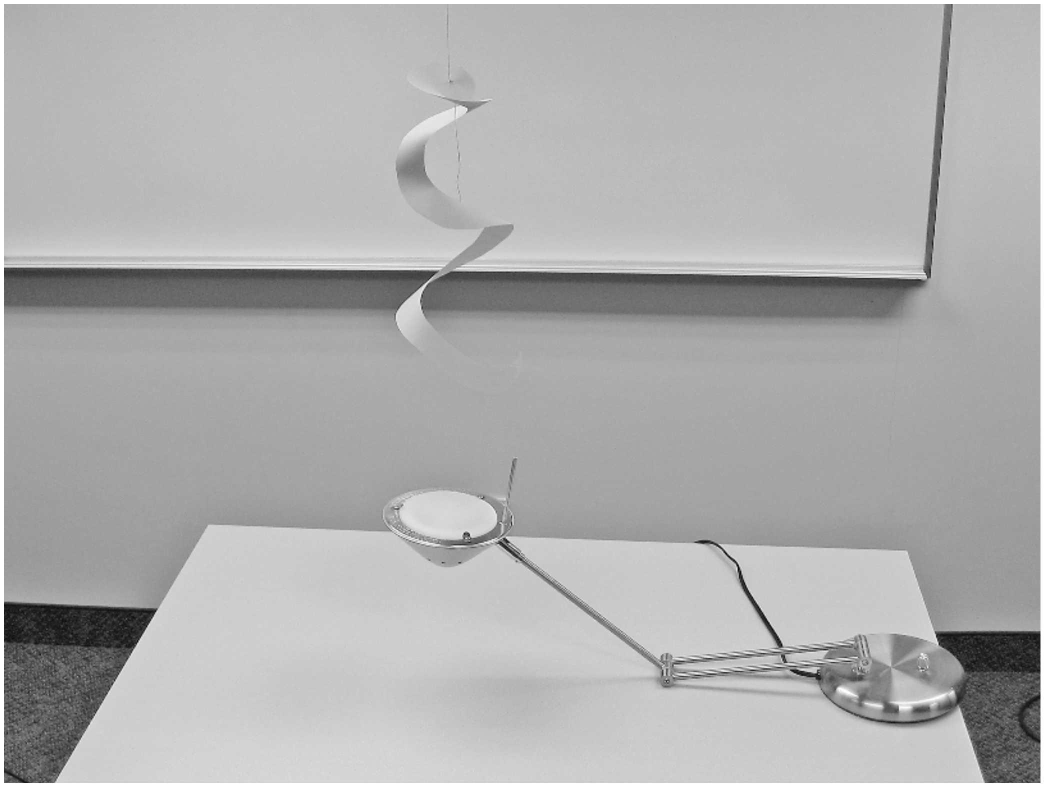
Procedure

1. With a compass, draw a circle with a 20-cm (8-in.) radius. Cut out the circle with scissors. Cut a spiral about 1 cm thick by starting on the outside of the circle and moving in to the center as you cut. Suspend your spiral by a thread attached in the center.
2. Hold the spiral over your head and blow gently. Did your spiral turn? Hold your spiral over a lamp that has been turned on. (See Figure 1.24–1.)
3. What does this tell you about warm air?

For Problem Solvers

Can you create other designs that would respond to moving air and show that warm air rises? Try it, and hang it over a lamp to see whether the lamp is heating the air.

Figure 1.24-1. Paper Spiral Held Over a Heat Lamp



Teacher Information

When you blow on the spiral, it will turn. When you hold the spiral over the lamp, it will turn in the same manner, demonstrating that the heated air above the lamp is rising or blowing upward.

Integrating

Art

Science Process Skills

Observing, inferring

ACTIVITY 1.25

What Happens When Air Gets Warmer?

(Teacher demonstration)

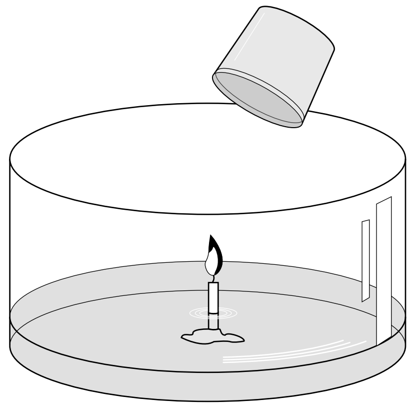
Materials Needed

- Bowl
- Drinking cup
- Birthday candles
- Plastic modeling clay
- Food coloring
- Rubber bands
- Matches
- Water

Procedure

1. Put about 3 cm (1 in.) of water into the bowl. Add a drop of food coloring to the water to help you see it more clearly.
2. Put a birthday candle in the clay and stand it up in the bowl.
3. Light the candle.
4. Put the mouth of the cup over the candle and into the water all the way to the bottom of the bowl.
5. What happened? What can you say about this?
6. Repeat the same activity using two, three, and four candles at a time. Use one rubber band around the cup to mark the water level each time you add a candle.
7. Can you predict what will happen if you use five candles? Try it.

Figure 1.25-1. Bowl Containing Water and Candle with Drinking Cup Above



Teacher Information

When the cup is placed over the burning candle, the air inside will be heated and forced out. The water will prevent more air from getting in. When the candle goes out, the air inside the cup will cool and contract. There will now be less air (and air pressure) inside the cup than outside. The outside air pressure will force water up into the cup. Increasing the number of candles will produce more heat, causing more air to be forced out, and the water will rise higher.

Integrating

Math

Science Process Skills

Observing, inferring, measuring, identifying and controlling variables

ACTIVITY 1.26

How Can We Watch Air Expand and Contract?

(Teacher-supervised activity)

Materials Needed

- Glass soda bottles or heat-resistant flask
- Balloons large enough to cover bottle mouth
- Bowls of very hot (not boiling) water
- Bowls of cold water

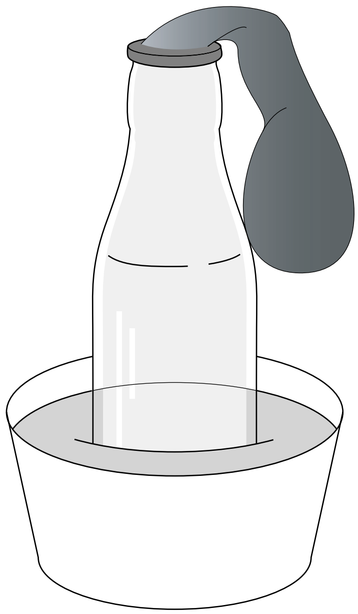
Procedure

1. Place the mouth of the balloon over the top of the bottle. Be sure no air can escape.
2. Put the bottle in very hot (not boiling) water for a few minutes.
3. What happened?
4. *Caution:* Remove the bottle from the hot water and wait several seconds before putting it in the cold water, to prevent possible cracking of the bottle. Now place the bottle in cold water for a few minutes.
5. What happened?
6. What can you say about this? Discuss your ideas with your group.

For Problem Solvers

Take a plastic bag that zips closed. Blow air into it until the bag is tight. Predict what will happen to the bag if you put it in a refrigerator. Seal the bag and place it in a refrigerator for a few minutes. Remove the bag and see whether your prediction was right. Now put it over a heat vent or in front of an electric heater for a few minutes. Predict what will happen, and then test your prediction.

Figure 1.26-1. Bottle in Bowl of Hot Water and Balloon on Top



Teacher Information

When the bottle is placed in hot water, the air inside will expand and cause the balloon to inflate slightly. When the bottle is placed in cold water, the air will contract and the balloon will deflate.

Integrating

Language arts

Science Process Skills

Observing, inferring, predicting

ACTIVITY 1.27

How Can Bubbles Show Us That Air Expands and Contracts?

(Take home and do with family and friends.)

Materials Needed

- Bubble solution in a bowl
- Soup can, empty with one end removed
- Warm water
- Ice water

Procedure

1. Dip the open end of the soup can into the bubble solution, then remove it and notice the bubble film across the opening of the can.
2. Predict what will happen to the soap film if you dip the closed end of the can in warm water. Write your prediction, then do it and watch the bubble.
3. What happened? Can you explain why? Was your prediction accurate?
4. Dip the closed end of the can in ice water and observe. Make your prediction first.
5. What happened? Explain why you think it did that.

For Problem Solvers

Try the same thing with larger and smaller cans. See which one you can get the largest bubble from. Figure out a way to measure how far the bubble dome extends out from the edge of the can.

Remove the other end from one of the cans and dip both ends into the bubble solution. Apply heat, then cold, by soaking a cloth in the water and wrapping it around the can.

With a small can that has both ends removed, dip one end in the bubble solution, remove it, and blow on the other end. Can you make large bubbles? Small bubbles?

Cut the neck off a balloon and stretch the balloon across one end of a can that has both ends removed, forming a diaphragm. Dip the open end of the can into the bubble solution, then pinch the center of the balloon and pull out, then push in. What happens?

What other ways can you make bubbles with a can?

Teacher Information

The bubble film across the end of the can will respond to the expansion and contraction of air inside the can as the air is heated and cooled, forming a concave surface when cooled and a convex surface when heated. Your problem solvers will have fun investigating in different ways with cans and bubbles.

Integrating

Math

Science Process Skills

Observing, measuring, predicting, communicating, comparing and contrasting, identifying and controlling variables

ACTIVITY 1.28

How Does Cold Air Behave?

(Teacher demonstration)

Materials Needed

- Hemp rope or incense
- Flashlight
- Refrigerator
- Match

Procedure

1. Light a hemp rope or use incense to make smoke. Observe how the smoke behaves.
2. Put the smoking object in the freezer compartment of a refrigerator.
3. Close the refrigerator door and darken the room.
4. Open the freezer compartment door and use a flashlight to observe the smoke.
5. What happened? What can you say about this?

Teacher Information

In air at room temperature, the smoke will rise. When it mixes with cold air in the freezer compartment, it will sink with the cold air when the door is opened. Cold air contains more molecules per cubic centimeter and therefore is heavier.

Note: Be sure to blow all the smoky air out of the refrigerator at the conclusion of the demonstration. (You could use an ice chest with ice as a substitute for the refrigerator if necessary.)

Integrating

Language arts

Science Process Skills

Observing

ACTIVITY 1.29

What Happens When Warm Air and Cold Air Mix?

(Teacher-supervised activity)

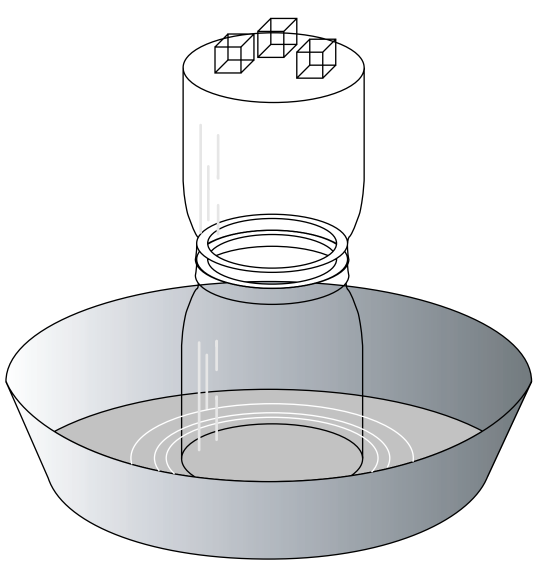
Materials Needed

- Two quart-sized clear jars
- Pan of hot water
- Hemp rope or incense
- Ice cubes
- Flashlight
- Match

Procedure

1. Put one jar upright in the pan of hot water.
2. Have your teacher put smoke in the two jars.
3. Then stand the second jar upside down on the first jar with the mouths together.
4. Put several ice cubes on top of the upper jar.
5. Darken the room. Use a flashlight to observe the smoke.
6. What happened? What can you say about this?

Figure 1.29-1. One Jar Inverted on Another. Lower Jar in Pan of Hot Water.



Teacher Information

The air in the bottom jar will be heated and rise. When it nears the top of the second bottle, it will cool and begin to sink. Air currents will swirl in the two jars.

When you open a window to cool a room, another window should be opened above or below the first, if possible, so the air can circulate.

Integrating

Language arts

Science Process Skills

Observing

ACTIVITY 1.30

How Can You Get Water Out of the Air?

Materials Needed

- Ice cubes
- Clear bottles with lids
- Sheets of white paper
- Food coloring
- Water

Procedure

1. Put several ice cubes in the bottle and fill the bottle with water.
2. Add a few (about 3 to 6) drops of food coloring to the water and stir. Then put the lid on the bottle.
3. Place the bottle on a piece of white paper and let it stand for 30 minutes or so, checking it occasionally.
4. What happened? What can you say about this?

For Problem Solvers

Have you noticed that your bathroom mirror is clean and shiny before you run water in the shower or bathtub, but that it gets foggy as warm water runs from the faucet or showerhead? 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 during cold weather. Where does the frost come from? Why does it form?

Teacher Information

As air cools it condenses and tends to give up moisture. As the bottle of ice water stands, the air around it will be cooled and moisture will condense on it unless the air is very dry. Food coloring and white paper are used to show that water is not passing through the bottle; if it did, the paper would become color-stained. The lid assures that the water collected on the outside of the bottle did not come over the top. The water formed on the outside will be clear.

We often use coasters under cold-drink glasses because of moisture that collects from condensation.

Integrating

Reading

Science Process Skills

Observing, inferring, communicating, using space-time relationships, identifying and controlling variables, experimenting

ACTIVITY 1.31

How Can a Balloon Remain Inflated with Its Mouth Open?

(Take home and do with family and friends.)

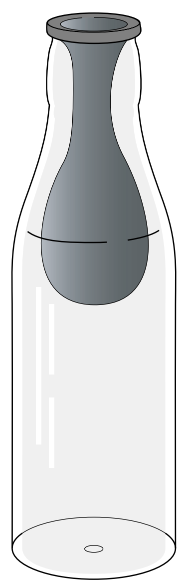
Materials Needed

- Balloon
- Rigid plastic bottle with small hole in bottom

Procedure

1. Tuck the balloon into the bottle, but hold onto the mouth of the balloon.
2. Stretch the mouth of the balloon over the mouth of the bottle, as shown in Figure 1.31–1.

Figure 1.31–1. Plastic Bottle with Balloon Hanging Inside



3. Put your finger over the hole in the bottom of the bottle, to seal the hole.
4. Try to blow up the balloon.
5. What happened? Explain why.

6. Now remove your finger from the hole in the bottom of the bottle and try again to blow up the balloon.
7. When the balloon is blown up and fills the bottle, seal the hole in the bottle again with your finger, and then remove the bottle from your mouth.
8. What happened to the balloon? Explain why it does this.

For Problem Solvers

You can have fun at home with this activity by holding the bottle for the person who is blowing up the balloon. You can hold your finger over the hole in the bottle the first time the other person tries, and he or she won't be able to blow up the balloon. The second time the person tries, secretly move your finger off the hole. Then after the balloon is blown up, quickly put your finger over the hole again and take the bottle away from the person's mouth. Let him or her wonder why the balloon is still blown up. Explain it to the person if he or she can't figure it out on his or her own.

Teacher Information

For this activity, you need a rigid plastic bottle. A small hole can be easily drilled in the bottom of the bottle with a drill or with a knife or other sharp instrument. Some juices are sold in rigid bottles, as are other materials. Two-liter soda bottles are flexible and will be crushed by atmospheric pressure, instead of the balloon remaining inflated. This still demonstrates the force of atmospheric pressure, but in a different way. With a rigid bottle, the balloon will remain inflated with the mouth of the balloon open to the atmosphere. This is a very impressive demonstration of the force of air pressure.

Integrating

Language arts

Science Process Skills

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

Name ______________________________ Date ______________

Can You Solve This Air Word Search?

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

air	space	displace
weight	pressure	vacuum
compress	push	atmosphere
suction	blow	expand
contract	exhale	inhale

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

Name ______________________________ Date ______________

Can You Create a New Air Word Search of Your Own?

Write your Air 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 Air Word Search

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

Name ______________________________ Date ______________

Do You Recall?

Section One: Air

1. Is air a form of matter?

2. Does air weigh anything at all?

3. If you press a suction cup onto a table and you can't pull it off, what holds the suction to the table?

4. Imagine that you place a card on a full cup of water, turn the cup upside down, and let go of the card. If the card stays in place, keeping the water in the cup, what is holding the card on the cup?

5. An airplane wing is rounded on top and flat on the bottom. How does this help to hold the plane in the air?

6. Why does a drop in temperature often bring rain?

Answer Key for Do You Recall?

Section One: Air

Answer	Related Activities
1. Yes	1.1, 1.2
2. Yes	1.3
3. The weight of air pressing against it	1.4, 1.5
4. Air pressure	1.8–1.17
5. Air pressure is reduced on top of the wing, resulting in a lifting force under the wing	1.18–1.22
6. Cold air cannot hold as much moisture as warm air can. If there is a lot of water in the air, and the air cools, it's like squeezing a wet sponge.	1.30