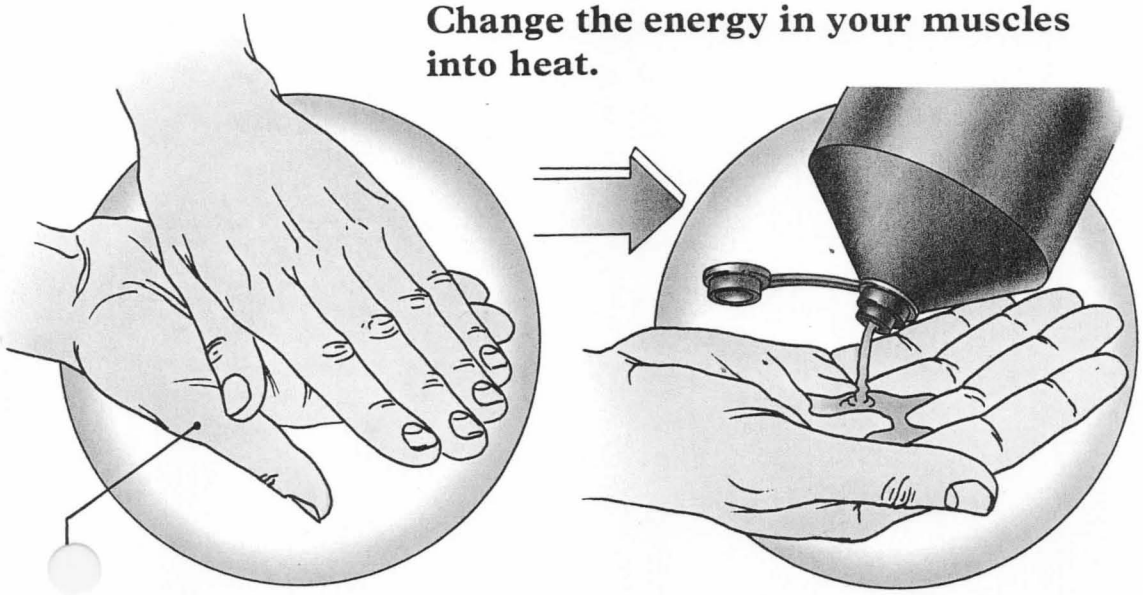
Making heat

Change the energy in your muscles into heat.



Make sure your hands are dry.

△ Rubbing to make heat in this way is called friction. It happens because the skin on your hands is slightly rough. Rubbing harder needs more effort and produces more friction, turning more of your muscle energy into heat. Liquid detergent or soap makes your skin smooth and there is very little friction, so slippery hands do not get hot.

Heat is energy

Rub your hands together lightly. Feel that your hands are beginning to get warm. Rub them more strongly and your hands get really hot. Try this again, but spread a little liquid detergent or soap on your hands. Add a few drops of water to make them slippery. Now your hands stay cool.

Heat is a form of energy and it is always made from another form of energy. You change some of the energy in your arm muscles into heat if you rub your hands together when they are dry, but not if they are slippery.

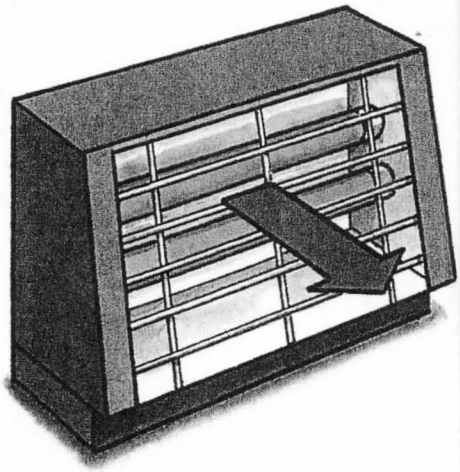
HEAT

Heat transfers energy from one place to another. Heat always transfers energy from a warmer place to somewhere cooler. For example, the heat energy in a hot drink moves from the drink to the cooler air surrounding it.

Heat can travel in three different ways. When land warms the air above it, the air rises and this upward movement forces cooler air to take its place. Heat is being transferred from one place to another by moving air. This type of heat transfer, which takes place in both gases and liquids, is called "convection." In a solid, heat is transferred from the hottest point, along the solid, to the coolest point. This is called "conduction." Heat from the sun reaches us by traveling across space by "radiation." Radiation is the only form of heat transfer that can occur across a vacuum.

Convection
Water at the bottom of the pan gets hot first and rises. The arrows show how the water forms a "convection current."

Conduction
If heat is transferred to one part of a knife from a source, it will spread out along the metal blade in both directions.



Radiation
Heat is transferred from an electric heater by radiation. Energy travels as a "ray" that spreads out in all directions.

Episode Guide

Heat

Nifty Questions in This Episode	Awesome Answers
Which has more heat energy—a lighted match or an ice sculpture?	The ice has more heat energy, because it has a greater mass of molecules.
What are three forms of heat energy?	The three forms of heat energy are conduction, convection, and radiation.
What is heat?	Heat is energy that affects molecules.

Experiments shown on the video:

SUGAR CUBE RACE

Objective: To see whether wood, plastic, or metal is the best conductor of heat.

- Place a Popsicle stick, a plastic knife, and a metal knife with one end in a bowl of hot water.
- Place a pat of butter, then a sugar cube on top of the stick and the knives.
- Observe to see which sugar cube falls off first.

DO THE TWIST

Objective: To identify the indications that heat rises.

- Cut out a paper spiral.
- Tape the center of the spiral to a 2-liter bottle cap.
- Tape a pencil to a popsicle stick (on the counter) so the eraser stands up; stick a pin in the eraser.
- Place the bottle cap on the eraser.
- Hold over a hot toaster and observe twisting spiral.

More interesting stuff to do:

RUNNING A TEMPERATURE

Objective: To determine if melting ice gives off heat energy.

- Place a small thermometer with a stiff backing (available from a science supply house) or a regular science thermometer in a 2-ounce cup; add 50 milliliters water.
- Gently squeeze the top of the cup closed; secure with paper clips.
- Freeze overnight; peel the paper away and record the temperature shown by the thermometer.
- Have your teacher hold the ice portion of thermometer over a lighted candle or match. Wear safety goggles and don't allow the flame to touch the thermometer.
- Record the temperature six times before the ice has melted halfway.

Glossary

Heat

Fold and cut to use as flashcards.

Bill Nye the Science Guy

HEAT

Heat

Heat is a form of energy that is transferred by a difference in temperature.

Bill Nye the Science Guy

CONDUCTION

Conduction

The transmission of heat from one body to another when they are in contact is called conduction.

Bill Nye the Science Guy

CONVECTION

Convection

Convection is the transfer of heat through a fluid (liquid or gas) caused by molecular motion. It also refers to the vertical movement of heat or other properties by massive motion within the atmosphere.

Bill Nye the Science Guy

RADIATION

Radiation

The physical phenomenon of radiating energy in the form of waves or particles is called radiation.

Name _____ Date _____

Quiz
Heat

True or False? Circle T or F

1. Only things that feel warm have heat. T or F
2. The more molecules an object contains, the more heat energy it has. T or F
3. Our eyes can see the thermal radiation that our bodies radiate. T or F
4. In a thermos bottle, the vacuum between two glass bottles prevents heat being conducted between the bottles. T or F
5. Radiating heat travels in waves moving at about 300,000 km/sec. T or F
6. We wear layers of coats, jackets, and sweaters on a winter day to keep the cold air away from our bodies. T or F
7. A heat pump is used to move heat into or out of a building. T or F

Multiple Choice: Circle the letter of the best answer

8. Heat is energy that can do which of the following? Heat can:
   A. Keep things warm
   B. Do work
   C. Make engines run
   D. All of the above

9. Which of the following is not a way by which heat can be transferred?
   A. Conduction
   B. Conservation
   C. Radiation
   D. Convection

10. Which of the following describes the formation of air convection currents?
    A. Molecules in cooler air move faster and farther apart than those in warmer air.
    B. Cooler air moves in over the warm air and pushes it down.
    C. The sun warms the land, which heats the air above it.
    D. All of the above

Answer Key

Heat

1. F	4. T	7. T	9. B
2. T	5. T	8. D	10. C
3. F	6. F		

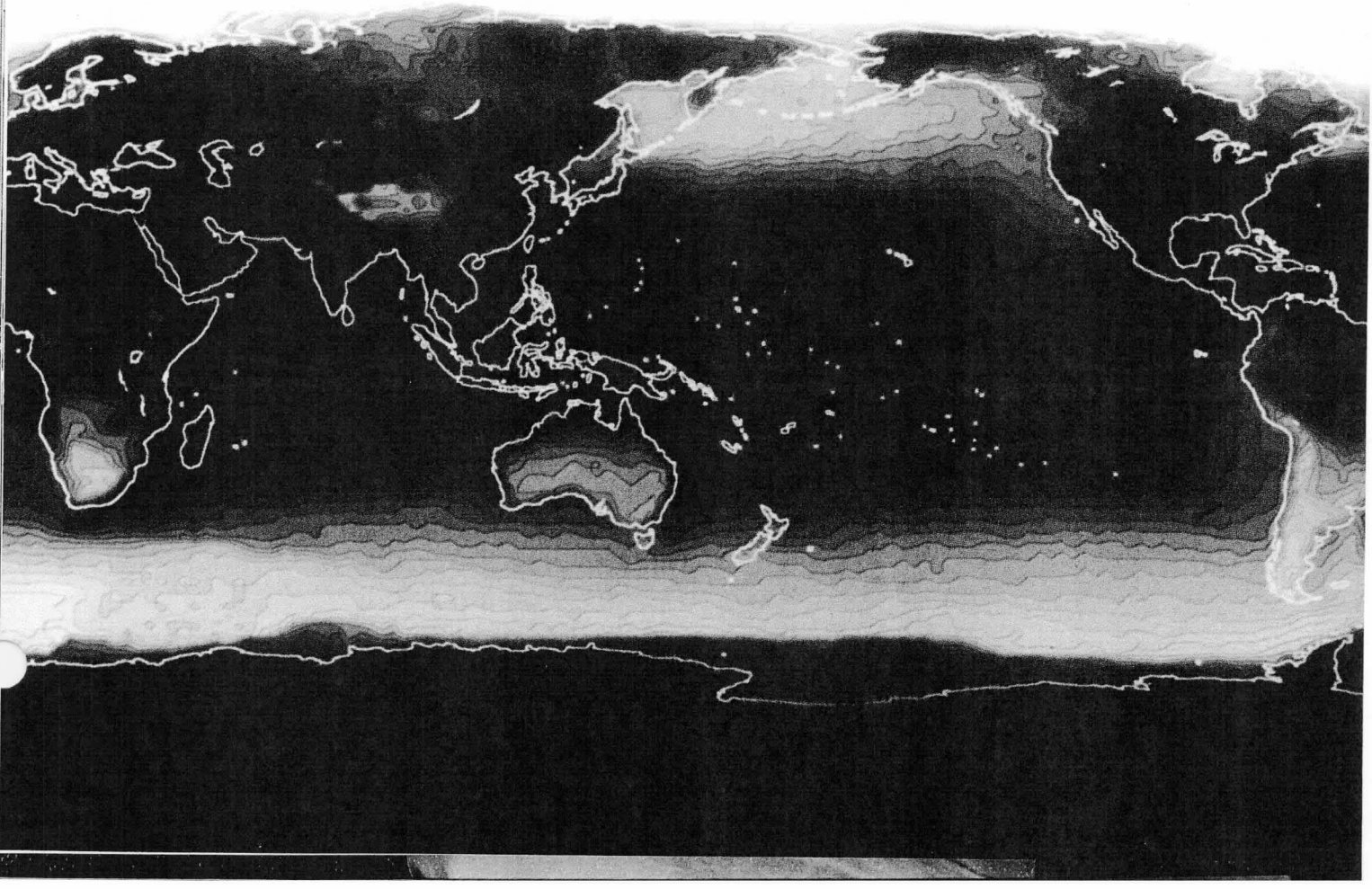
CONVECTION

Circles of air and water!

Why did the paper spiral twirl over the hot toaster oven? The answer is convection. Convection happens when heat is transferred in a gas or liquid by the circulation of currents. Hot air rises and travels and is replaced by cooler air in a circular motion. This circulation is called a convection current. When the air around the toaster oven warmed up, it expanded. The lighter warm air rose, and the heavier cool air sank.

The same thing happened in the *Water Volcano* experiment. When the bottle of warm water was on top, the colored water did not flow into the bottle of cold water. This is because the warm water was lighter than the cold water. When the bottles were reversed, the lighter warm water rose, and the heavier cold water sank. This created a water current, which was shown by the movement of the food coloring.

Warm water has a different **density** than cold water. This causes warm ocean water (red) and cold ocean water (blue) to move around the world. The movement of ocean water disperses heat around the Earth. It also churns up nutrients from the sea floor to feed marine life.

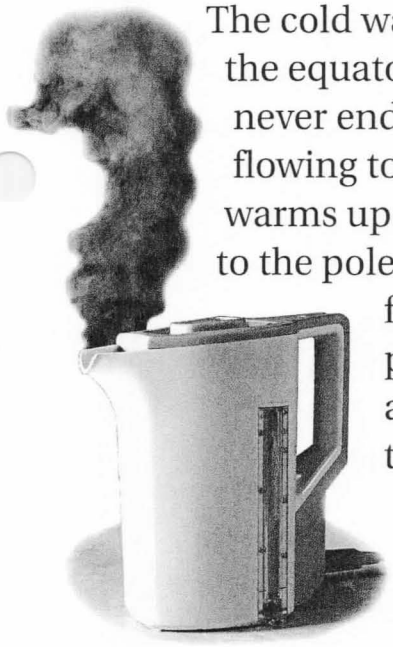


Convection in the sky...

Convection in the Earth's atmosphere creates air currents that affect the weather. When a large body of warm air rises, cool air moves in to take its place. This creates a breeze. When warm air rises, it cools and condenses. This forms clouds of water droplets, which fall as rain.

... and in the sea

Ocean waters are constantly moving. The sun heats the waters in the tropics. The warm water flows toward the poles. It displaces cold water from the poles. The cold water flows toward the equator. This cycle never ends. The cold water flowing to the equator warms up and flows back to the poles. Warm water flowing to the poles cools down and flows back to the equator.

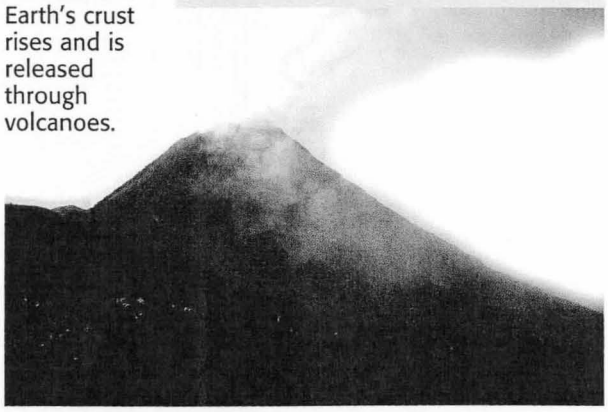


Water boils in a kettle through the circulation of hot and cold water.

QUIZTIME

How does all the water in a kettle get heated, when the heat source is only at the bottom?

Answer: By convection. Warm water around the heating element in the kettle rises and displaces cool water at the surface. The cool water sinks to the bottom, gets heated by the element, and rises. It is then replaced by more cool water. Eventually, there will be no more cool water in the kettle. When all the water in the kettle has reached the same temperature and density, convection stops.



Liquid rock beneath the Earth's crust rises and is released through volcanoes.

Did you know?

Convection takes place even on the sun! The sun transfers heat from its interior to its surface by convection. The core of the sun, the hottest part, sends columns of hot gases rising to the surface. At the surface, the gases release their heat into space and then sink to the core to be reheated.

CONVECTION DEEP UNDERGROUND!

Convection also occurs in the molten rock beneath the Earth's crust. Molten rock closest to the Earth's core is the hottest and lightest. It rises toward the crust. Molten rock closest to the crust is cooler. It is heavier and sinks. This exchange of material between crust and core creates convection currents, which move huge pieces of the Earth's crust known as tectonic plates. The tectonic plates move closer together or farther apart, forming mountains and trenches.

A heat wave!

Heat energy moves through gases in the form of waves. Heat waves travel by radiation and are absorbed differently by different objects to varying degrees. Try this experiment to find out which surfaces absorb more heat energy than others!

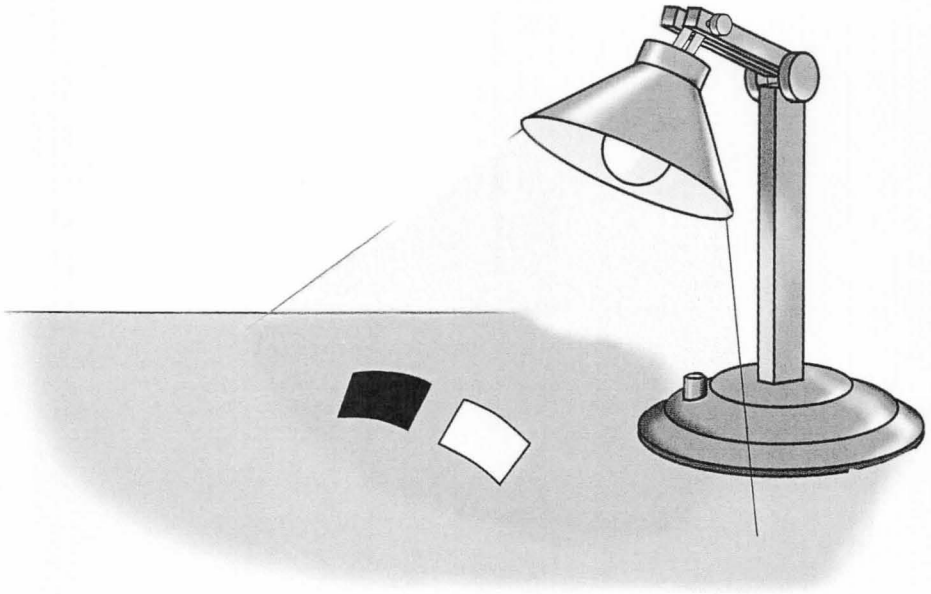
You will need:

- Aluminum foil
- Matte (non-glossy) black paint
- A small paintbrush
- A desk lamp with a 60 watt light bulb

Hot and hotter!

WATCH OUT!
Ask an adult to help you with this experiment. Light bulbs can get very hot.

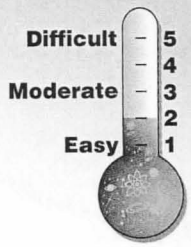
1 Tear two pieces of aluminum foil so that both pieces are equal in size. Paint one side of one piece of foil with black paint.



2 After the paint is dry, place both pieces of foil directly under the lamp. Turn the lamp on.

3 Turn the lamp off after about one minute. Carefully touch each of the pieces of foil. Which one is hotter?

ow, we know how the sun's heat reaches us. It travels through space by radiation. This experiment will show you how hot the sun's rays can be!



You will need:

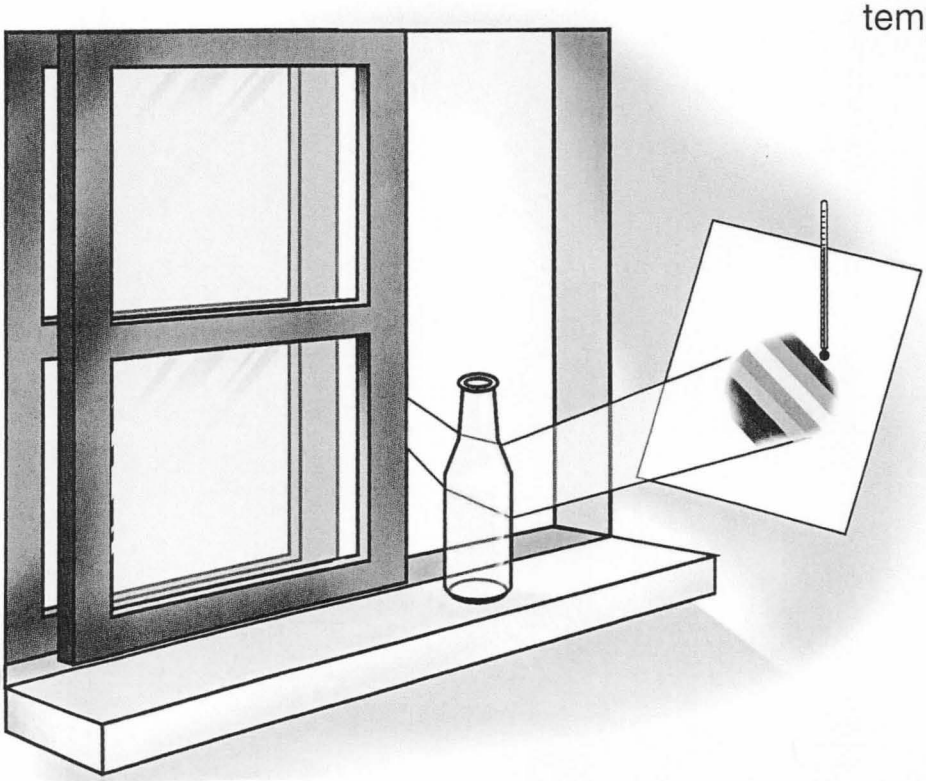
- A glass bottle
- An open window
- A piece of white paper
- A thermometer

Red hot!

1 On a sunny day, place the glass bottle near the window so that sunlight passes through it.

2 Hold up the piece of white paper behind the bottle so that sunlight shines through the bottle and onto the paper. Adjust the distance between the paper and the bottle, until a spectrum of seven colors appears on the paper.

3 Place the bulb of the thermometer near the red side of the rainbow. Watch the temperature rise!



4 Note the temperature of the red strip. Now, take the temperature of the other colors. Which is the hottest color of the rainbow?

What Is Heat?

Like light, sound, and electricity, heat is a type of **energy**. To understand what happens when we heat something, we need to imagine what it is like inside that substance.

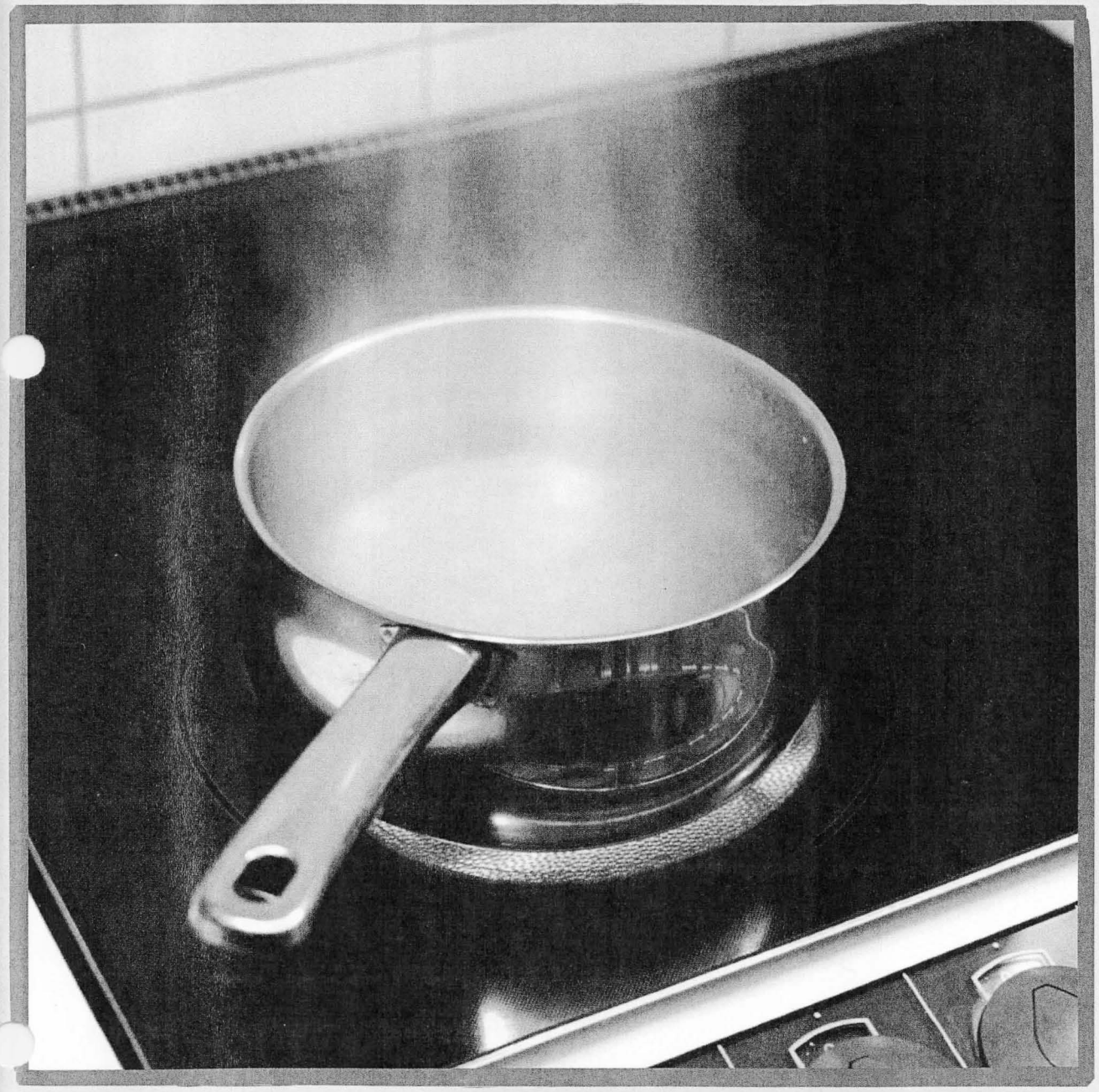
Tiny Particles

Everything is made of tiny **particles** that are much too small to see. The tiny particles are moving all the time. Sometimes they move a little, sometimes they move a lot.

◀ *Everything is made of tiny particles that move. When you play with a hula-hoop, you get tired and have to rest. The tiny particles that make up everything never stop moving.*

Adding Heat

Adding heat makes particles move faster. A metal saucepan of water sits on a stove. Heat energy from the stove makes the metal particles move faster and faster. The saucepan gets very hot. The water inside the saucepan also gets hot and it begins to bubble and **steam.**



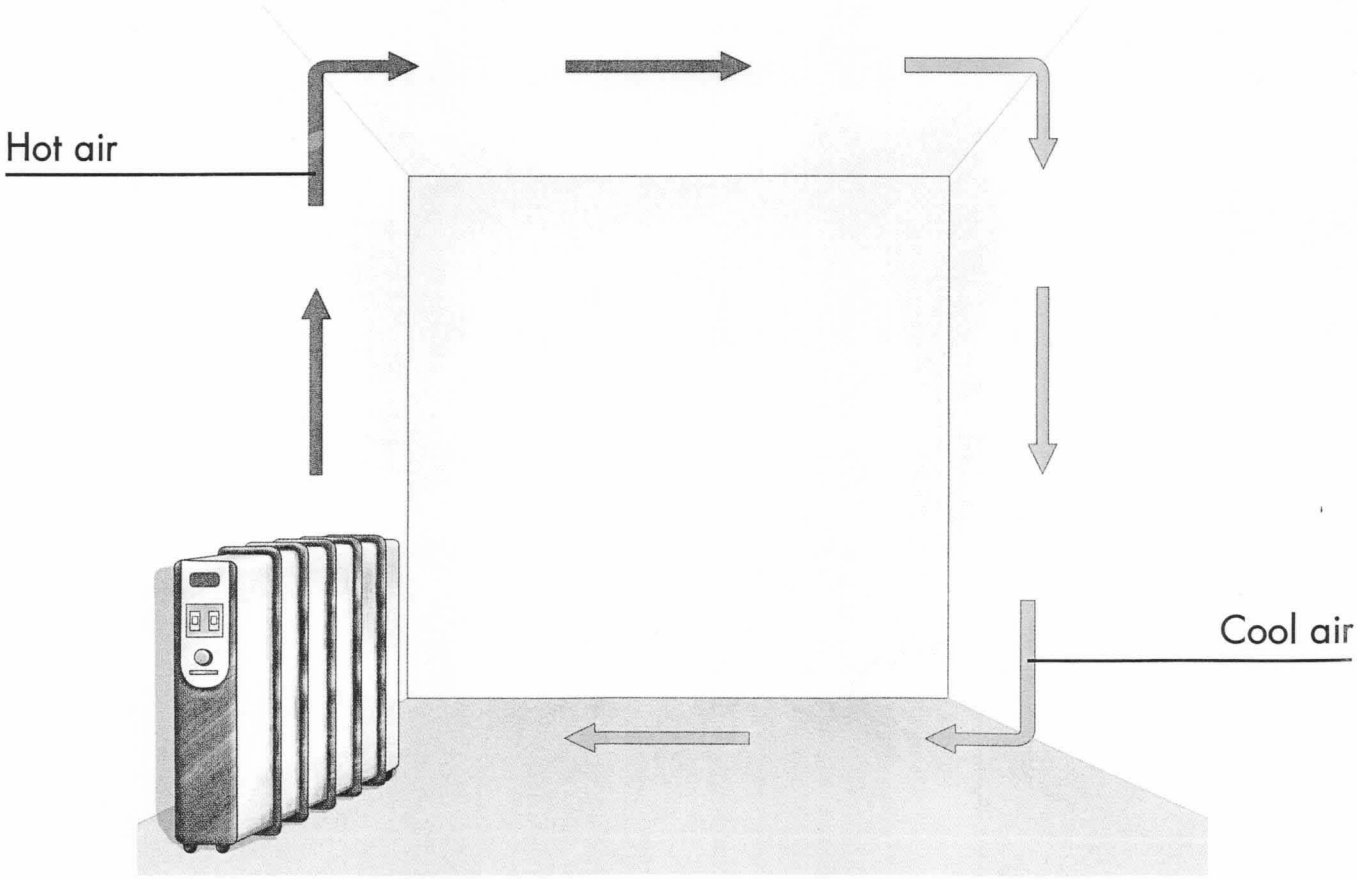
▲ *The hotter something is, the faster its particles move.*

Heat on the Move

Heat can move from one place to another in different ways. It can even move through empty space.

Convection

The hot air above a radiator rises. Near the ceiling the air cools. It becomes heavier and sinks to the floor. This movement of air around a room is called **convection.**

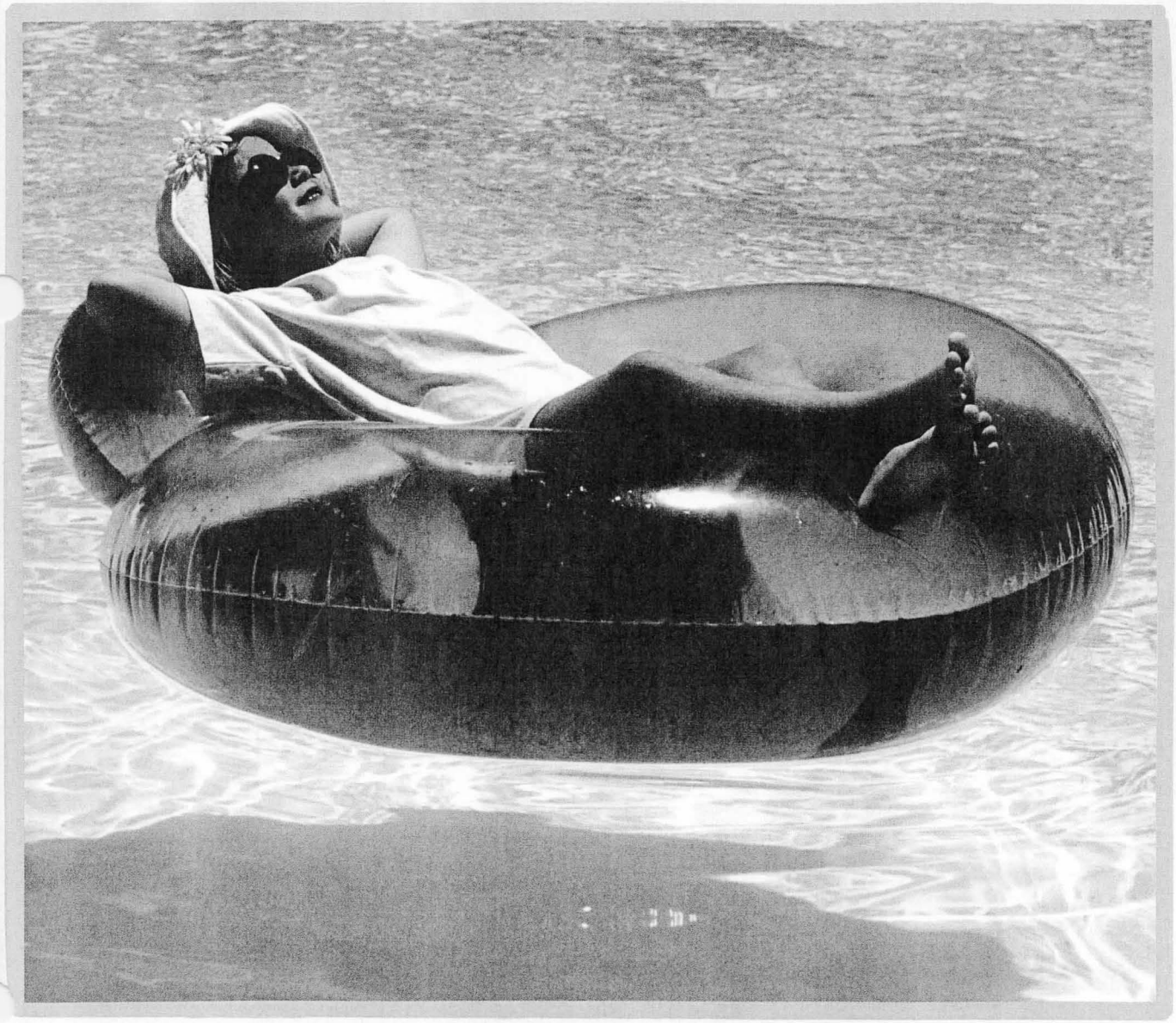


▲ *The convection current around a room. You can feel hot air rising if you put your hand above a hot radiator.*

Conduction

A metal spoon becomes hot when it is put in hot soup. The particles in the spoon move faster as they are heated. The particles bump into each other. This movement of heat is called **conduction.**

▼ *Heat from the sun travels to you as rays. When heat travels in this way, it is called* ***radiation.***



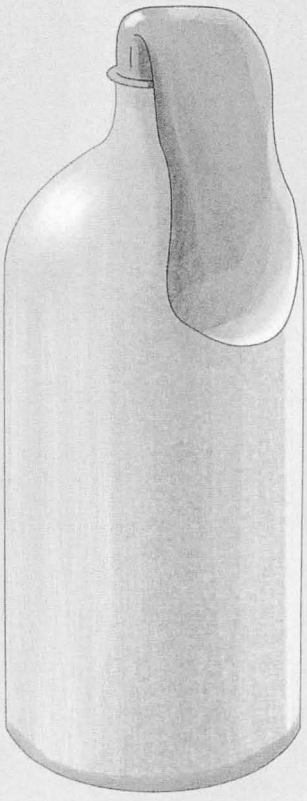
Try This...

Hot and Cold Air

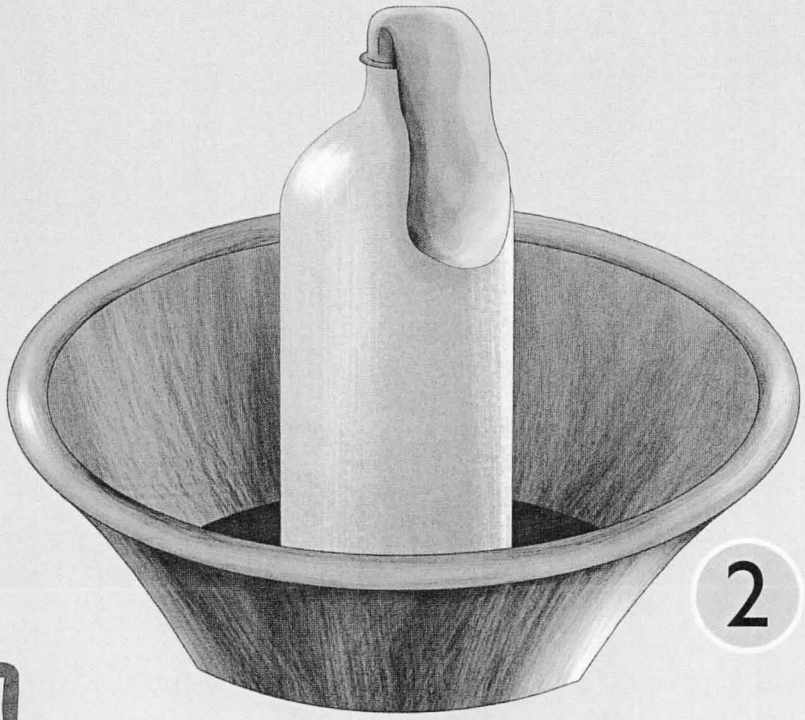
See what happens to air when it is heated.

You Will Need

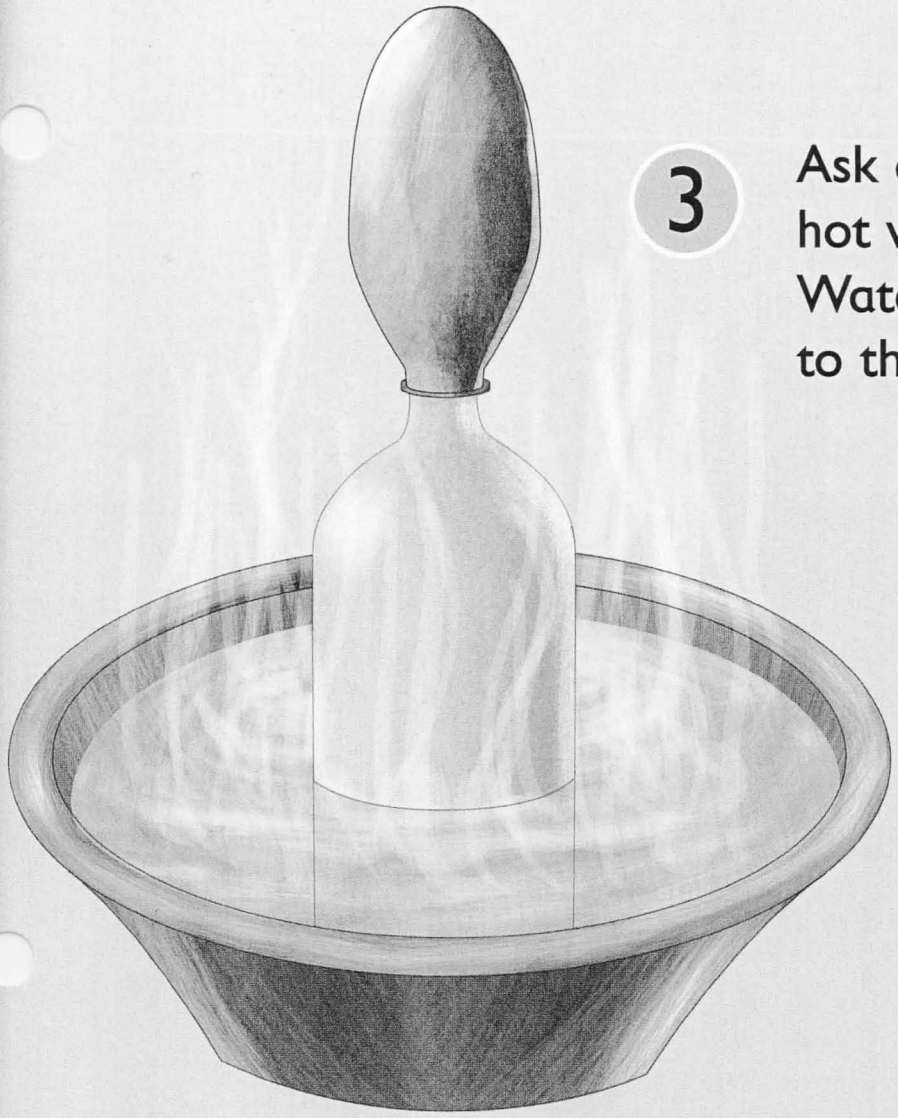
• a balloon • a small plastic bottle • a dish • hot water



1 Fit the end of the balloon over the opening of the bottle. The balloon must completely cover the opening.



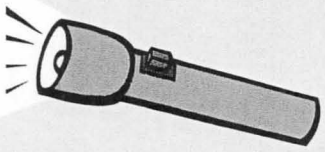
2 Put the bottle with the balloon on it in a dish.



3 Ask an adult to add hot water to the dish. Watch what happens to the balloon.

What happened?

Heat moves from the water into the plastic and into the air inside the bottle. The air particles move faster and faster. They move farther apart. The air becomes lighter and starts to rise. The only place that the air particles in the bottle can go is into the balloon. The balloon starts to blow up.



Heat trap

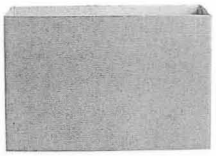
Heat travels from the sun to the earth in waves. Build a trap that can catch these heat waves and warm things up.

You will need:


Glass of water


Aluminum foil


Ruler

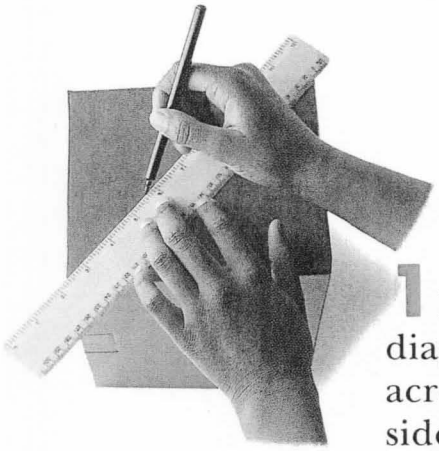

Large cardboard box


Scissors

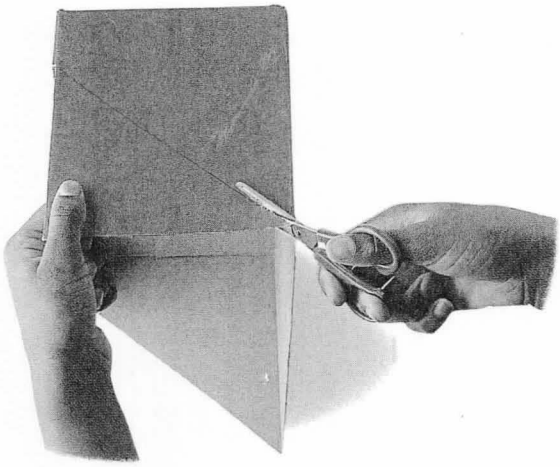

Plastic wrap


Tape

Pen

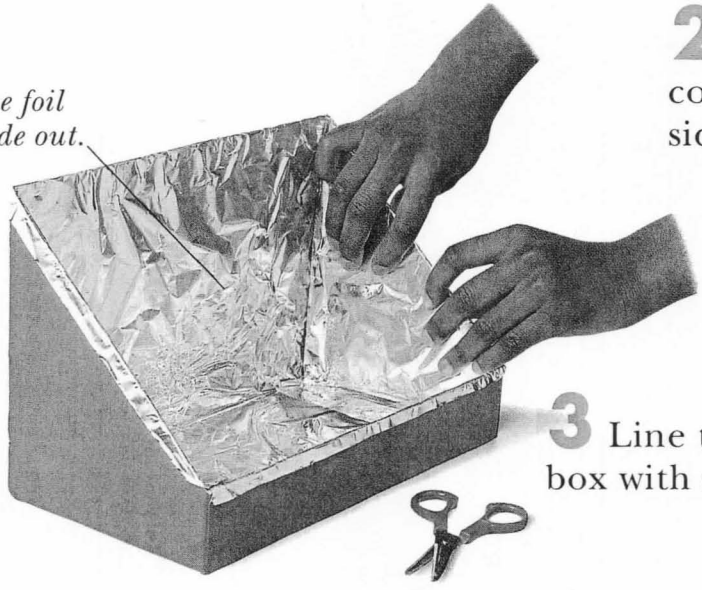


1 Draw matching diagonal lines across the short sides of the box.

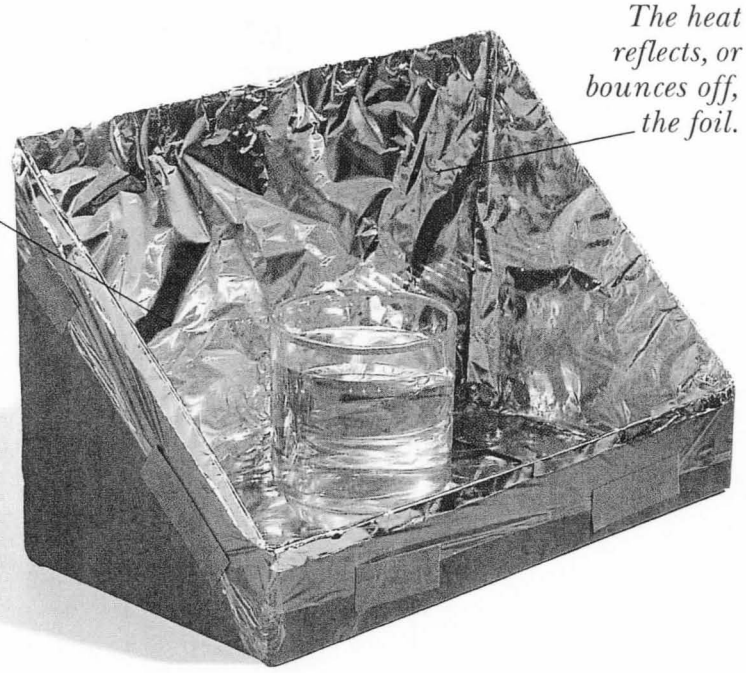


2 Carefully cut the corners and most of one side off the box.

Place the foil shiny side out.



3 Line the inside of the box with aluminum foil.

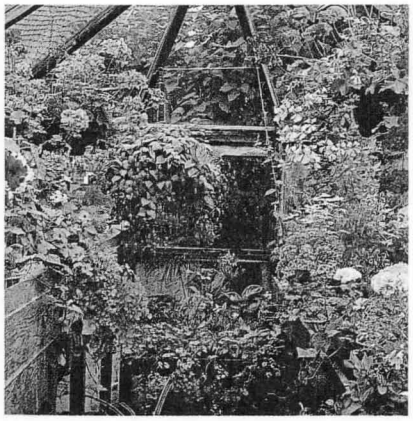


4 Place the box somewhere sunny and set the glass of water inside it. Cover the box with plastic wrap.

5 ⚠ After 30 minutes, carefully test the water with your finger. It is warm.

Growing under glass

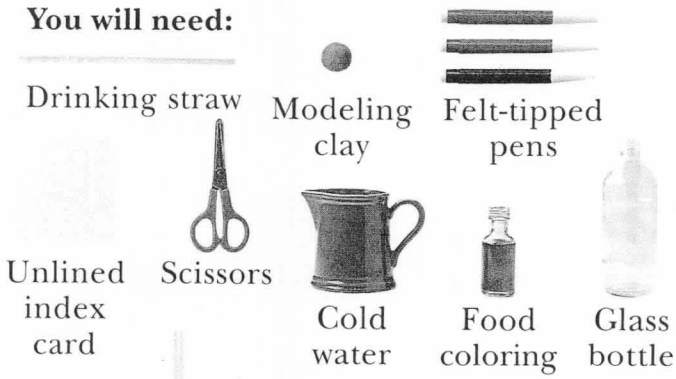
Flowers grow well in a greenhouse. Heat passes through the glass walls and roof and is trapped inside, warming the air in the greenhouse, even on cold days.

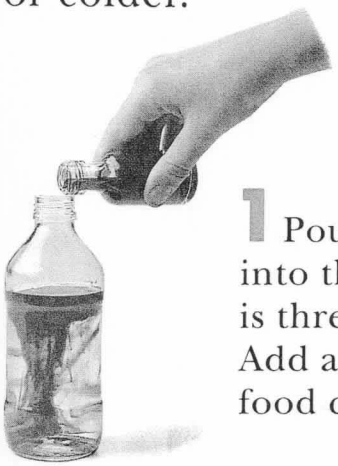


Heat tester

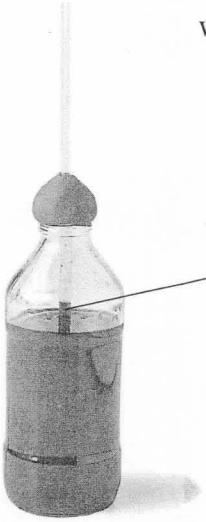
You can build a simple thermometer to show how hot or cold things are. A thermometer measures temperature, which goes up or down as things get hotter or colder.

You will need:





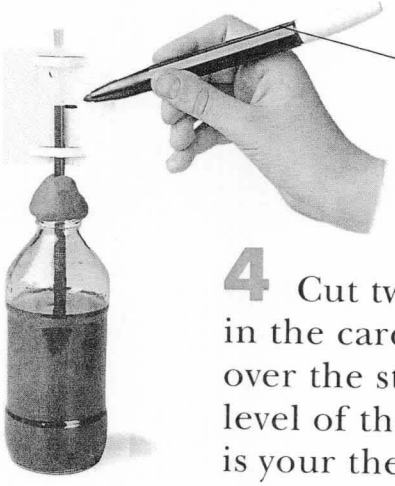
1 Pour cold water into the bottle until it is three-quarters full. Add a few drops of food coloring.



The straw must dip into the water.

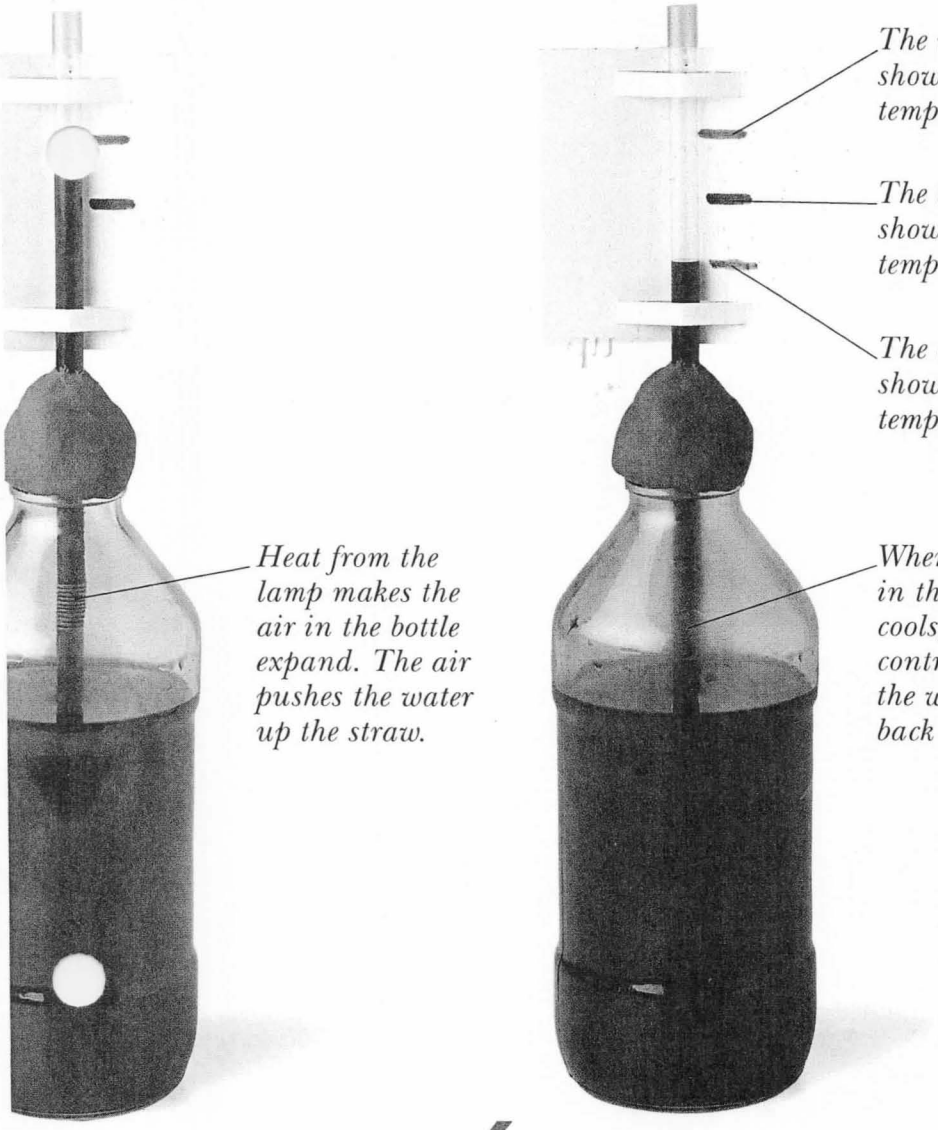
2 Put the straw into the bottle and seal it firmly in place with some clay.

3 Blow gently into the bottle until the water rises halfway up the straw.



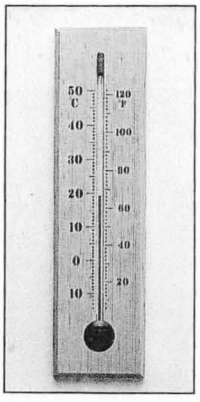
Use a black pen to mark the level.

4 Cut two sets of slits in the card and slide it over the straw. Mark the level of the water. This is your thermometer.



e thermometer in a
:e, such as under a
: water level rises.
th a red pen.

6 Put the thermometer in the refrigerator for 10 minutes. The water level falls. Mark it in blue.



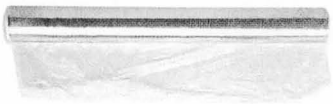
s

ube on this thermometer contains a red liquid that
or down a scale to indicate the temperature. It uses
rature scales: Celsius (C) and Fahrenheit (F).

Clean up

:an clean some water, just by ng it up and cooling it down. changes a liquid an invisible :. When you cool apor, it changes into a liquid.

You will need:


Plastic wrap

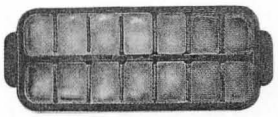

Small glass


Large bowl


Spoon

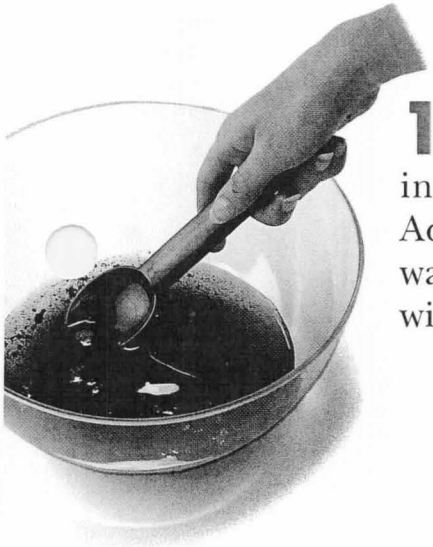

Scissors


Tape

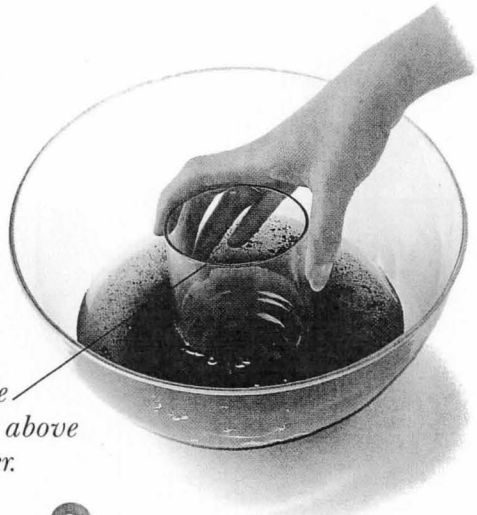

Ice cubes


Soil

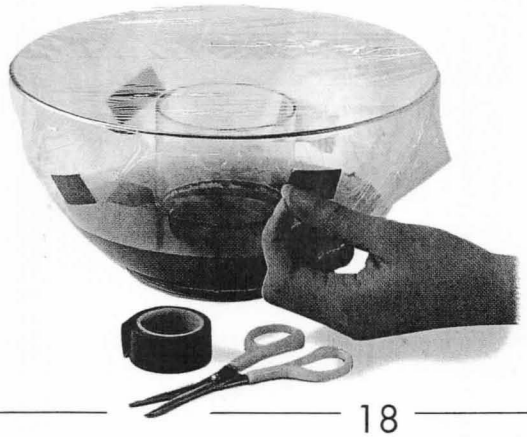

Warm water



1 Put the soil in the bowl. Add the warm water and stir with the spoon.

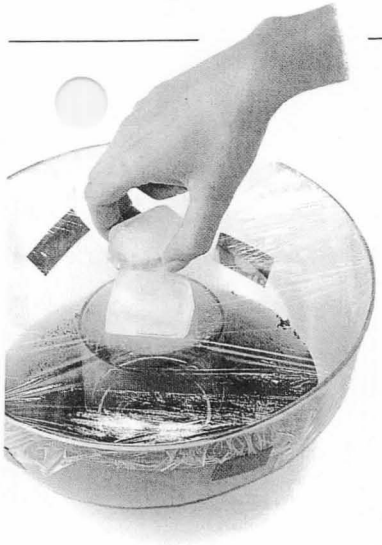


The rim of the glass must be above the dirty water.



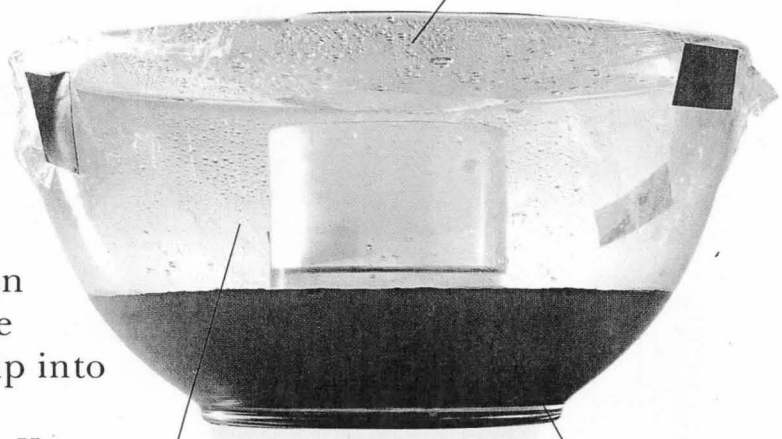
2 Place the glass in the center of the bowl.

3 Cover the dish with plastic wrap and tape it in place.



4 Place the ice cubes in the center of the plastic wrap.

When the water vapor comes into contact with the cool plastic wrap, it changes back into liquid water.



5 Leave the bowl alone for an hour. Water drops form on the underside of the plastic wrap and drip into the glass.

Heat causes some of the water to change into vapor, which rises into the air.

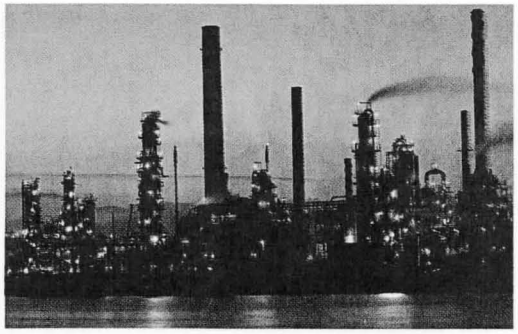
Try increasing the heat by placing the bowl in direct sunlight.

6 Take out the glass. The water in it is clean!

The dirt does not turn to vapor, so the water in the glass is not dirty.

f oil

e oil is made up of gasoline and many liquids. In an oil refinery, the liquids parated by heating the oil. All the ls change into vapors. Each kind of is then cooled separately to form a liquid, such as gasoline for cars.



Heat store

ɪt things soon lose their
at if they are not insulated.
insulator is something
ıt does not let heat pass
ough it easily. You can
ep some water warm by
king an insulated
ıtainer.

You will need:


Large jar with lid


Small jar with lid


Small glass


Warm water

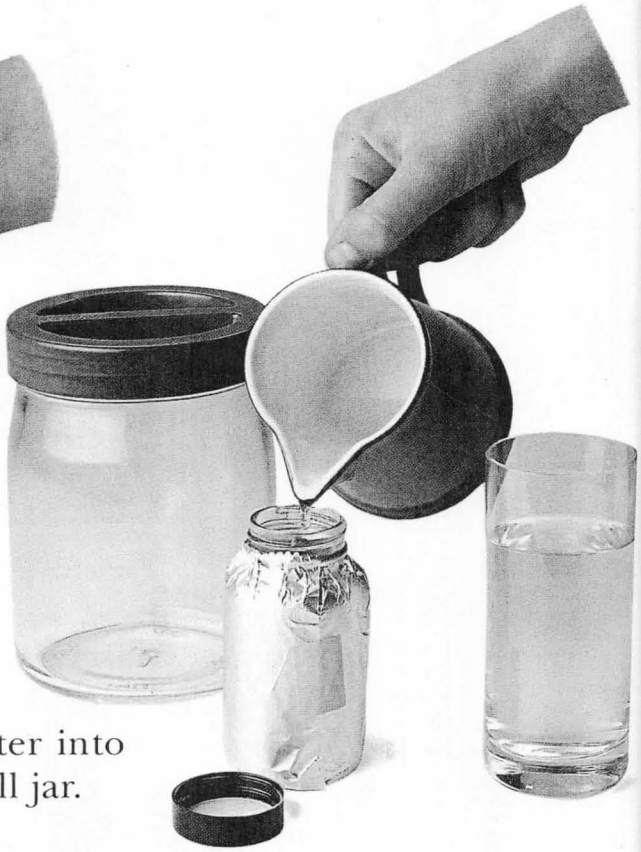

Tape


Wide cork


Scissors

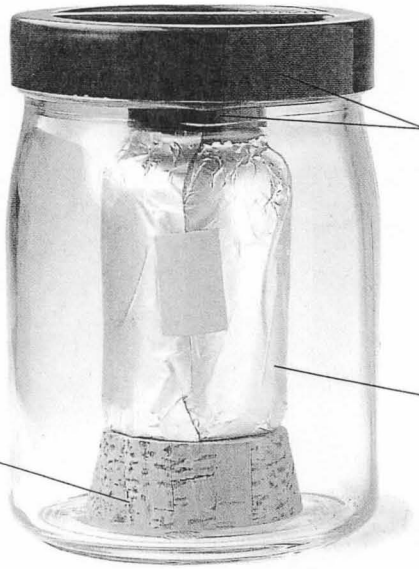

Aluminum foil

1 Wrap two layers of aluminum foil around the small jar. Tape them in place.



2 ⚠ Pour warm water into the glass and the small jar. Put the lid on the jar.

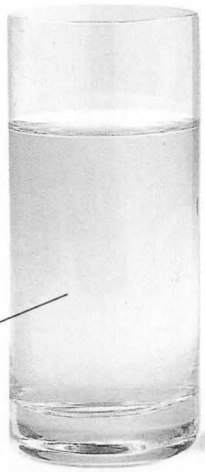
ıce the cork in
ıter of the large
l set the small jar
of it. Then put
on the large jar.
your insulated
ıer.



The lids of the jars help keep heat from escaping upward.

The shiny layers of foil help keep the heat in.

'eat cannot travel ell through the cork · the layer of air 'ound the bottle.

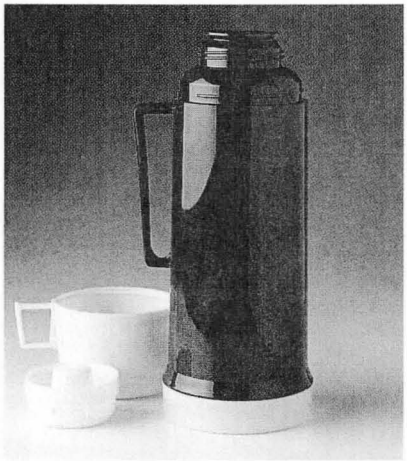


Heat easily leaves the glass, so the water cools.

4 Wait for 5 to 10 minutes. Take the jar out and dip a finger in the water. It is still warm, unlike the water in the glass, which has cooled.

ıg hot—and cold

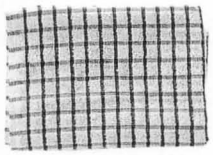
stay hot in a thermos. It has a shiny and tight seals that don't allow much ı escape. The thermos also keeps cold cold, because heat cannot get in, either.



Easy freeze

How can you freeze things without a freezer? Find out how ice and salt can make things very cold—and end up with some tasty ice cream!

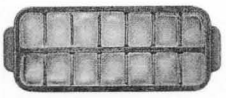
You will need:


Dish towel


Chocolate-drink mix


Salt


Large bowl


Ice cubes

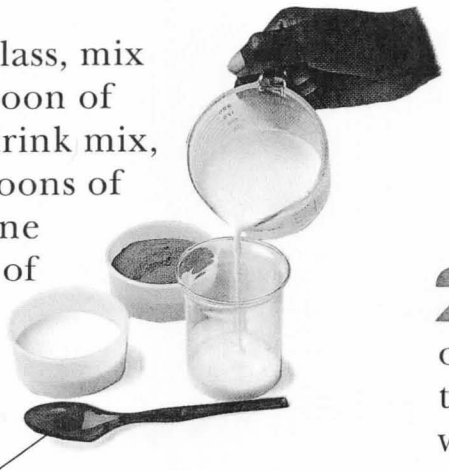

Glass


Milk


Cream

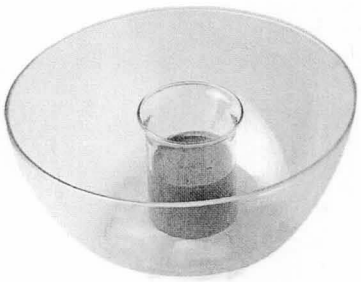

Tablespoon

1 In the glass, mix one tablespoon of chocolate-drink mix, two tablespoons of milk, and one tablespoon of cream.



Use the spoon to mix the ingredients well.

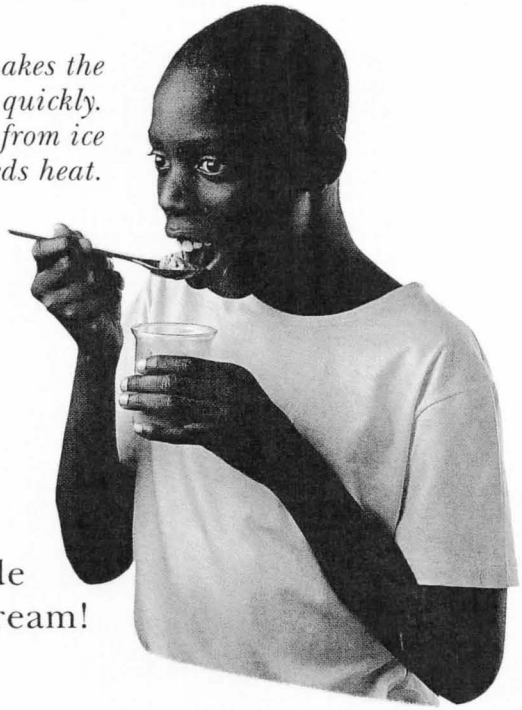
2 Put a layer of ice cubes into the bowl. Sprinkle with a lot of salt.



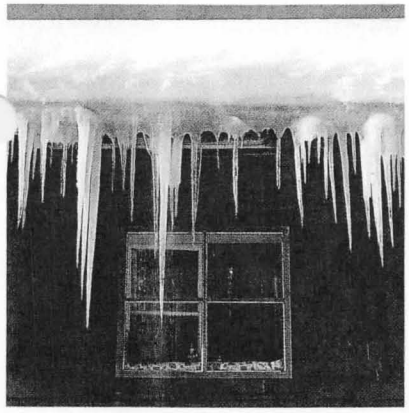
5 Cover the bowl with the dish towel. Leave the mixture in the bowl for about an hour, stirring it every few minutes.

The salt makes the ice melt quickly. The change from ice to water needs heat.

Heat is drawn from the mixture in the glass, and the mixture gets very cold and freezes.



6 Have a taste of your homemade chocolate ice cream!



Growing ice

An icicle forms as water drips over the edge of a cold surface. Heat leaves the water, which turns to ice. The icicle grows as more water runs down the cold icicle and freezes.

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Science consultant Jack Challoner

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