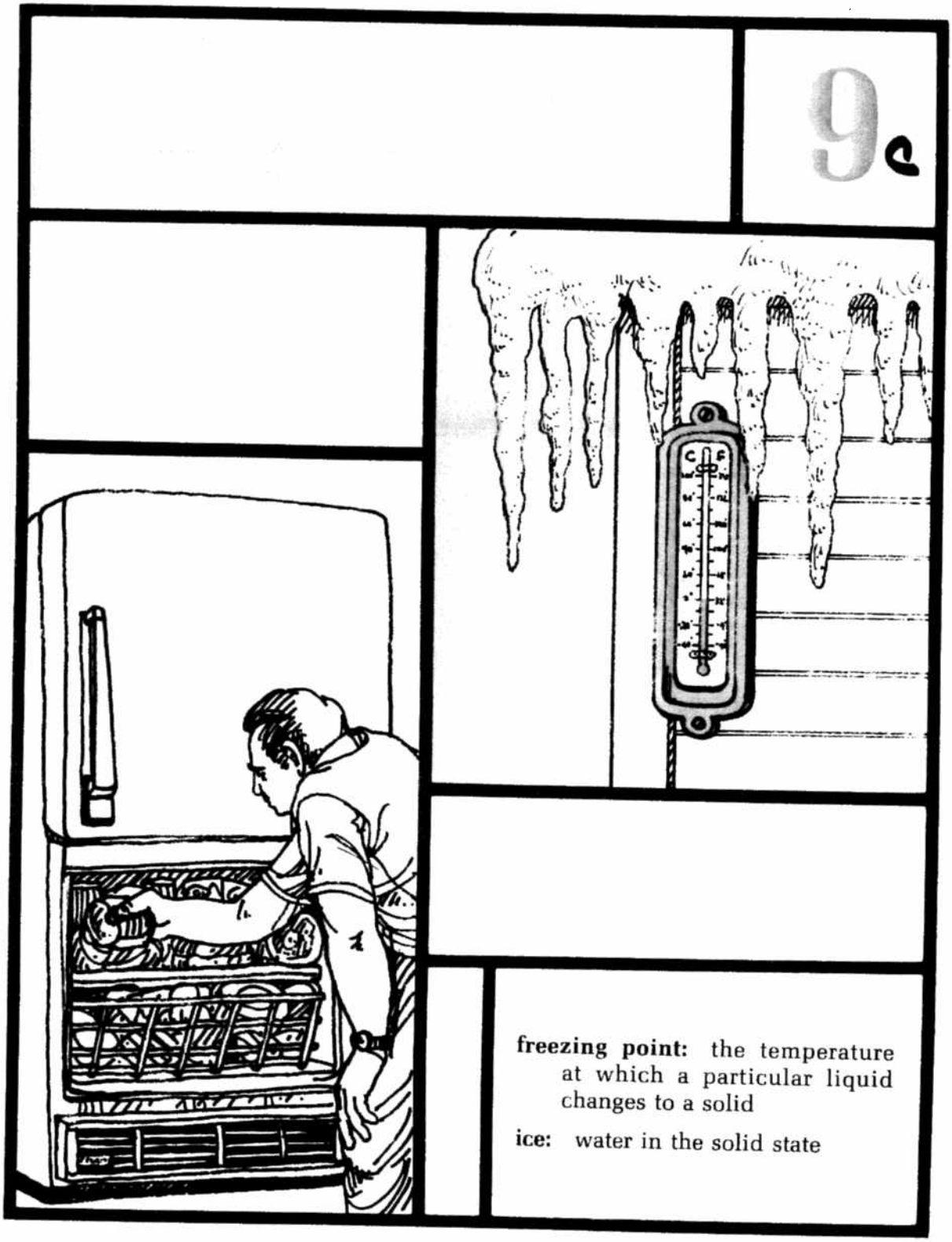
WHAT HAPPENS TO WATER WHEN IT COOLS?



AIM 9 What happens to water when it cools?

Can you walk on water? Sure you can! Just step onto ice. Ice is water. It is water in the solid state. But it is still water—H_2O.

Water can be a liquid, or a solid, or a gas. It all depends on the temperature.

You have already learned that water changes to a gas when it *takes in* enough heat.

What happens when water *loses* heat?

When water loses heat, its temperature drops. It becomes colder and colder. When the water loses enough heat, it changes to a solid called ice. We say it *freezes*.

Plain water freezes at 0° C (32° F). This is its *freezing point*. Other liquids freeze at different temperatures. When water temperature falls to 0°C, it stays liquid for a short time. *Then* it changes to a solid—a bit at a time.

The temperature of ice keeps dropping as the air temperature around it becomes colder. This means that some ice is colder than other ice.

DOES ICE HAVE HEAT?

Yes, ice *does* have heat!

All matter has heat. Some matter just has more heat than other matter.

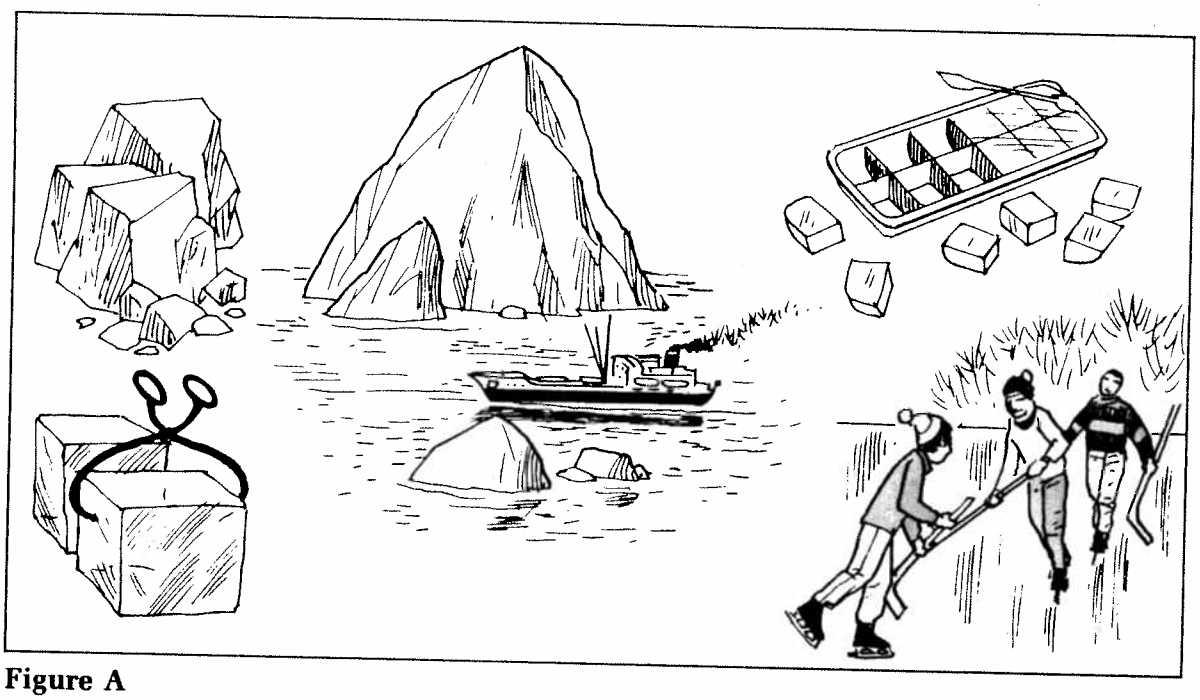


Figure A

Heat moves from one place to another.

Heat that is lost in one place goes somewhere else.

As matter becomes warmer, it *gains* heat.

As matter becomes cooler, it *loses* heat.

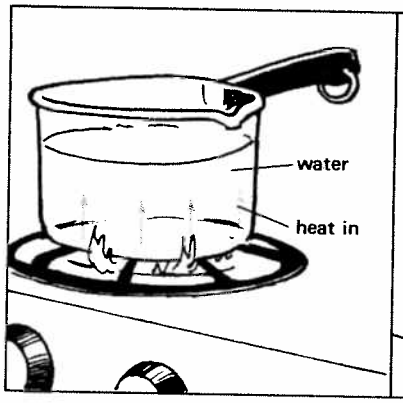


Figure B

When liquid water becomes warmer, it gains heat.

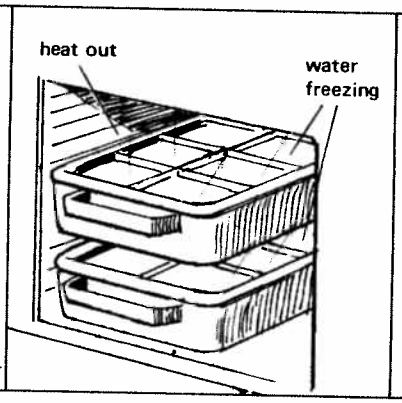


Figure C

When liquid water freezes, it loses heat.

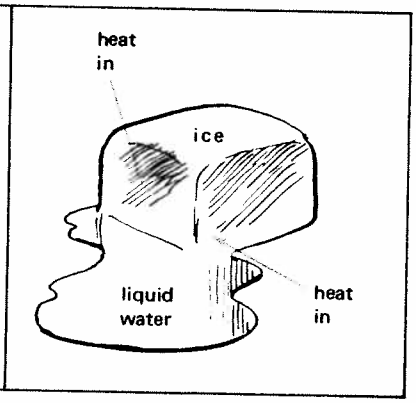


Figure D

When ice changes to liquid water, it gains heat.

WHEN WATER FREEZES

This experiment can be done at home.

Purpose: To *find the freezing temperature of water*

What You Need small plastic cup half full with water
thermometer that goes below 0° C (32° F)
refrigerator freezer

Figure E

What To Do

1. Check the water's temperature *before* placing it in the freezer. Write it down on the chart below.
2. Keep the thermometer in the cup. Place the cup into your freezer.
3. Check the temperature every 15 minutes. Write down the temperature each time. Do this until all the water changes to ice.
4. Check the temperature in the morning. Write it down on the chart.

	Time	Temperature	State of the Water. (Liquid, Part Liquid/ Part Solid, All Solid)
Outside the Freezer	Start		All Liquid
Inside the Freezer	15 min.		
	30 min.		
	45 min.		
	1 hour		
	1 hr., 15 min.		
	1 hr., 30 min.		
	2 hrs.		
	2 hrs., 30 min.		
	next morning		

What You Saw and Learned

1. While the water was in the freezer, the temperature went _____ (up, down).

2. When the temperature *just* reached 0° C (32° F), the water _____ (was still a liquid, changed to ice).

3. The water then changed to ice _____ (all at once, a little at a time).

4. What was the temperature of the water as it was changing to ice? _____

5. What was the temperature when all the water changed to ice? _____

6. **a)** What was the temperature of the ice in the morning? _____

   b) What does this show about the temperature of water? _____

   _____

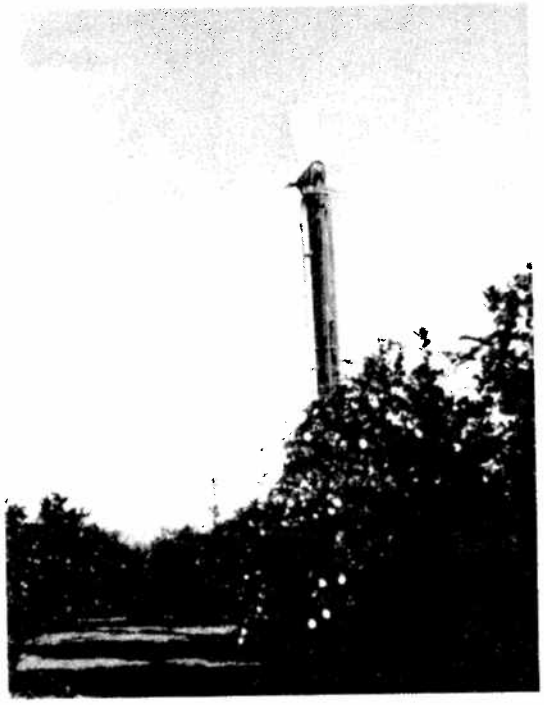
7. When water freezes, it _____ (takes in, gives off) heat.

TRUE OR FALSE

Write T on the line next to the number if the sentence is true.
Write F if the sentence is false.

1. _____ Everything has heat.
2. _____ Heat can be taken in and given off.
3. _____ Something that takes in heat gets colder.
4. _____ Heat that is given off by one thing is taken in by something else.
5. _____ Water is always a liquid.
6. _____ Water can be a gas.
7. _____ Water can be a solid.
8. _____ Water vapor is water in the solid state.
9. _____ Water freezes at 0° C.
10. _____ 0° C and 32° F stand for the same temperature.

KEEPING UP WITH SCIENCE



FROST BUGS BEWARE!

Citrus fruit, like grapefruit and oranges, grow in warm climates. Most of our nation's juice oranges grow in southern Florida. The temperature there usually stays above freezing—even during the winter months. However, sometimes, a cold spell may drop the temperature to below freezing. Frost can damage or destroy citrus crops. The loss can run to many millions of dollars. In the end, the consumer pays for it in higher prices.

Only a small number of grove owners try to protect their fruit from freezing. Some use huge propellers. The whirling blades blow warm Air that had risen from the ground onto the trees. Other grove owners use oil-burning smudge pots. But oil is expensive and polluting.

Steve Lindow of California, is a specialist in plant disorders. He is trying to develop an easy and inexpensive way to prevent frost damage.

Lindow has studied the process of freezing. Water, you know, freezes at 0°C (32°F). However, for water to freeze at this temperature, the water must have a "starter"—a right kind of speck of matter. Ice forms around this speck. If there is no speck, the water will freeze at a temperature *lower* than 0°C.

Dew will freeze on most kinds of plants at 0°C. Lindow discovered that on evergreens, dew freezes at a *lower* temperature. Why the difference? Research led to the discovery of the *frost bugs*.

On most plants, ice-forming specks are two kinds of bacteria, *P. syringia*, and *E. herbicola*. These bacteria do *not* live on evergreens.

Lindow saw a way of protecting crops from freezing down to at least −5°C. How? Get rid of the frost bugs! But how?

Farmers already use bacteriacides (bacteria-killing chemicals) to control plant diseases. Why not use them to kill the frost bugs and thus prevent frost? Nationwide testing of Lindow's approach is underway.

Lindow advises growers to use bacteriacides well in advance of cold weather. It seems that ice crystals form around *dead* bacteria as well as live ones. If treatment starts early enough, wind and rain will remove the dead bacteria.

Lindow says this approach will not permit citrus and other warm-climate crops to grow in the colder northern states. But it *can* save crops in areas that are generally warm, but that sometimes experiences frost.