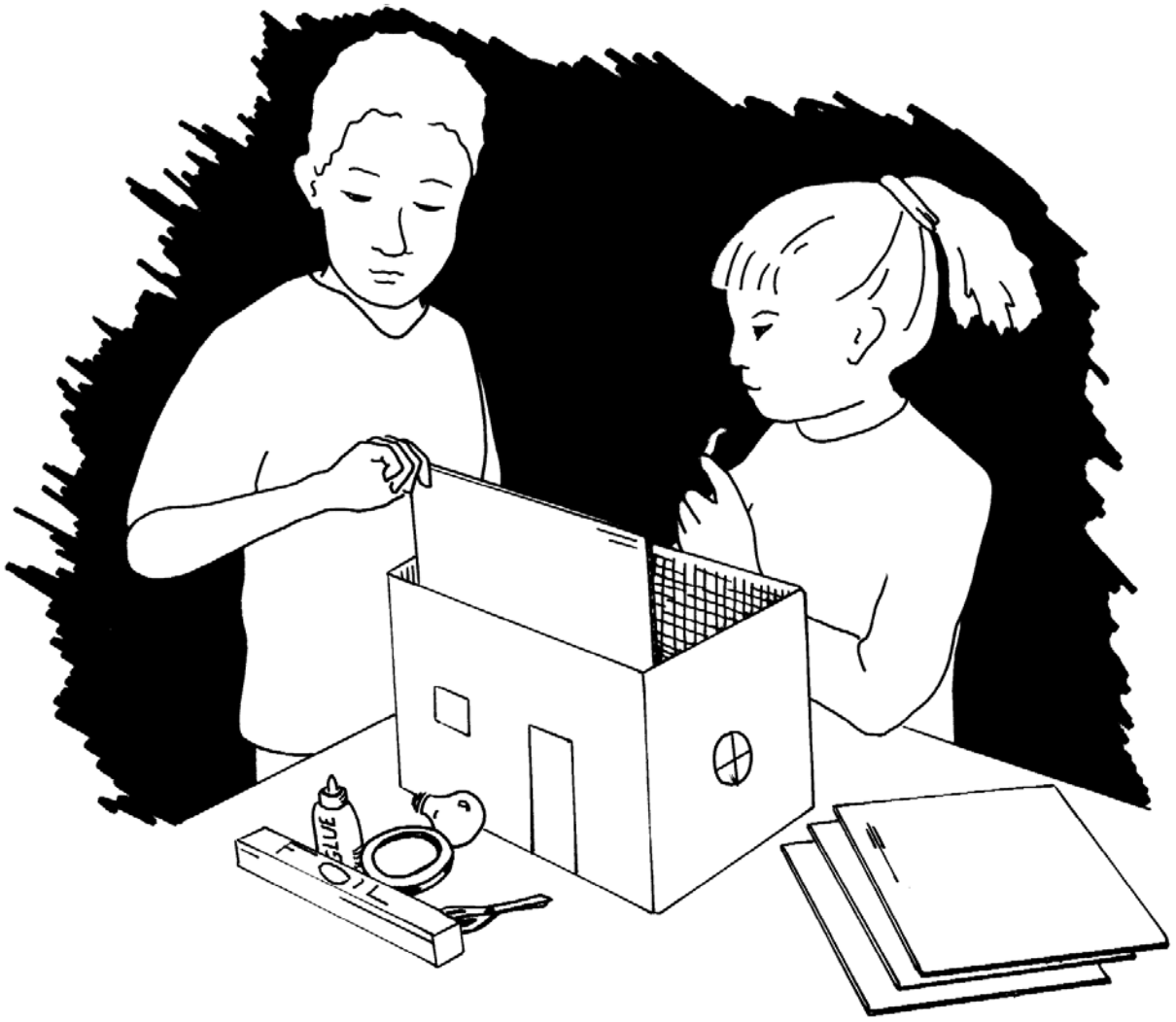
Explore It!

SCIENCE INVESTIGATIONS
IN OUT-OF-SCHOOL PROGRAMS



Heating a House and an Oven

EDC CENTER FOR Science Education

Heating a House and an Oven

READING TEMPERATURE

EXPLORATION 1

WHAT TO DO

PART 1 **Reading Temperature**

Discovery Question

How do you measure the temperature?

1. Discuss with your team where you think the warmest and coolest places are in the room you are in right now.
2. Use a thermometer (Figure 6) to find those places and to measure the hottest and coolest temperatures in the room.
3. Record your temperatures on the *Temperature Recording: Using the Thermometer* chart provided.
4. Feel some ice water with your finger. What do think the temperature is? Measure it.
5. CAREFULLY feel hot tap water with your finger. What do think the temperature is? Measure it.
6. Feel your own hand (palm side) and someone else's. Are they the same temperature? Measure them.

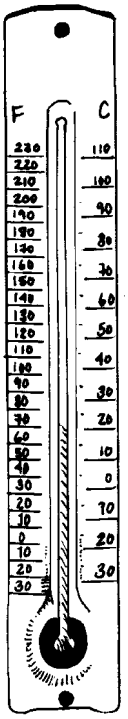


Figure 6
Liquid-filled thermometer.

PART 2 **Melting Ice**

Discovery Question

How fast does ice melt?

For each task below, record your times on the *Temperature Recording: Ice Melt* chart provided.

1. Measure how long it takes for an ice cube to melt in air while on a table.
2. Measure how long it takes for an ice cube to melt in hot water.
3. Measure how long it takes for an ice cube to melt in your hand.

READING TEMPERATURE

EXPLORATION 1

EXPLORERS' SHEET 1

WHAT TO THINK ABOUT

- Why do you think there are so many different temperatures in the same room?
- What's the temperature of ice water?
- Why do people have different hand temperatures?

TEMPERATURE RECORDING: USING THE THERMOMETER

Each team member should measure and write down each temperature. Then the team should try to agree on just one number between them.

	Team Member 1:	Team Member 2:	Team Member 3:	Team Decision
Hottest room temperature				
Coolest room temperature				
Ice water temperature				
Hot tap water temperature				
Hand temperature				

TEMPERATURE RECORDING: ICE MELT

Each team member should write down in the chart below how long each of his or her ice cubes survived.

	Team Member 1:			Team Member 2:			Team Member 3:		
Time	**Start**	**Finish**	**Melt Time**	**Start**	**Finish**	**Melt Time**	**Start**	**Finish**	**Melt - Time**
Ice on Table									
Ice in Hot Water									
Ice in Hand									

EXPLORERS' SHEET 1

READING TEMPERATURE
EXPLORATION 1

MATERIALS

For Each Child
- 3 small ice cubes (all same size)
- 2 paper coffee cups (6-ounce)
- 1 paper towel

For Each Team
- 3 liquid-filled (alcohol) thermometers*
- 2 paper coffee cups (6-ounce)
- 1 Explorers' Sheet, including the *Temperature Recording* charts.

Shared
- 1 bucket of ice water
- hot water from faucet
- extra ice cubes
- *optional*: 1 large thermos flask

For the Program Leader
- 1 spoon or ladle
- mini ice cube tray*

**Additional information is available under Special Notes About Materials (pages xv-xvi) for those materials noted with an asterisk.*

PREPARING FOR THE EXPLORATION

- Test the accuracy of all your thermometers by immersing them in a cup of ice water for a few minutes. Check the reading on each thermometer while it is still immersed in the ice water. If the reading on any thermometer is more than two degrees higher or lower than 32°F, do not use it for this project.
- Fill a bucket about half full with *cold* tap water and add ice until the bucket is nearly full. Let this stand somewhere cool (in a refrigerator or on a counter away from sunlight or other heat sources) until you need it later in this exploration. The water must stand for at least 5–10 minutes, so that the temperature settles down at 32° F. If all the ice has melted by the time you use it, add some more ice and let it stand for a few minutes again. Before using the water, stir it with a spoon or ladle. This will quickly equalize the temperature throughout the water.
- Make one copy of the Explorers' Sheet, including the *Temperature Recording* charts, for each team. However, wait to pass them out until after you have explained the task at hand.
- (Optional) Make one copy of the *Reading a Thermometer Accurately* worksheet for each team (found on page 71 in the Appendix). See Observing Progress in the Background section on how this worksheet can be used.

READING TEMPERATURE
EXPLORATION 1

INTRODUCING THE EXPLORATION

Tell the children that they are going to spend the next few weeks studying how to heat up a house and then an oven. Explain that they will be making a toy house out of a cardboard box and that they will have a chance to find out the best way to make it hot inside.[1]

Tell the children that before they begin working on their houses, they must become familiar with how to measure temperature. So the very first exploration will be about measuring the temperature of various things using a liquid-filled thermometer. Tell them that their first challenge will be to find out the temperature in their work space and then to compare that with the temperature of their hands, melting ice, and other things around the room.

Divide the group into teams of two or three, and have them decide who will take on the different team roles for this first session. Explain the duties of each role.

Pass out the Explorers' Sheets to each team, and have children look at and think about the Discovery Questions.

[1] Use your own best judgment as to whether to mention at this point that the project finale will be to turn the house into an oven in order to bake cookies (see Exploration 5). Knowing about the final exploration will probably get the children excited, but it may also make them impatient to skip over the earlier parts of the project to get to the end.

LEADING THE EXPLORATION

PART 1

Ask the children to see if they can detect with their hands where the warm and cool spots in the room are. Let them walk around the room for a very short time to try to answer this question and then call them back together and ask where the warm and cool spots are and how much difference in temperature they think there is between the two.

Give each team one thermometer. Tell them that the challenge is to find the hottest and the coolest spots in the room. Each child should write their temperature readings in their column on the *Temperature Recording: Using the Thermometer* chart. After all team members have taken their measurements, they should look at the results and decide what and where the hottest and coolest temperatures in the room are.[2]

When all the teams have finished taking their measurements, call the group together. On a sheet of chart paper, draw a sketch of the room from above. As the teams call out their hottest and coolest temperatures, mark these on the sketch.

[2] While the children are taking measurements, keep your eyes open for those children who are not confident in using the thermometer (or are perhaps letting someone else do the measuring). Do not intervene too much, but make a mental note to visit those children as they work on the project and help them figure out how to use the device accurately.

Scale Confusion—Choose Fahrenheit

As soon as the children begin calling out their temperatures, it may become apparent that they are not all using the same temperature scale on the thermometers. Children using these dual-scale thermometers may sometimes read the temperature from one scale and, at other times, from the other. This can produce the unlikely results that similar parts of the room have temperatures

such as 77° and 28°. If the children are thinking about their results, they should notice that this does not make a lot of sense. If they do not notice it for themselves, ask them if they think it makes sense and what could have caused such numbers to be reported. Fortunately, it is easy to convert the lower number—28° (presumably from the Celsius scale)—to a Fahrenheit reading. Simply find 28° C on the one scale of a thermometer and read the F number opposite it—no arithmetic is required to do the conversion.[3]

Problems Reading the Thermometers

Another common problem is that some children only know how to read the thermometer to the nearest multiple of 10. So, if the top of the liquid column is anywhere between 60° and 70° (even if it is at 69°), they will read the temperature as 60°. If this is happening a lot, make a large diagram of the thermometer scale on a sheet of chart paper and point out the minor graduations between the 10s. Then have children use this diagram to practice counting out the smaller graduations of temperature.

Hopefully, there will be agreement that some parts of the room are warmer (by a few degrees) than others. Ask the children to explain this. Perhaps there will be obvious reasons such as the presence of direct sunlight, an open door or window (with a cool draft), a radiator, a baseboard heater, or another heating device. See if the children can identify any of these reasons, but don't dwell on them too much. Just make sure children are aware of the various factors that could influence the temperature in a room and make sure they can read their thermometers accurately.[4]

Ice Water/Hot Water

Ask the children to put aside their thermometers while you hand out to each team a small cup of ice and water and another cup containing hot water from the faucet. Then, ask each child to feel the water in each cup and, without using a thermometer, to estimate the temperature of each.

Have the group share their guesses and make a note of the range of these guesses on a sheet of chart paper.

Then, let all the children take turns within their teams measuring the temperature of each cup of water and writing it down on their team's T*emperature Recording: Using a Thermometer* chart. Have all teams report their findings from this test and write these numbers on the chart paper. The interesting finding is that the temperature of ice water is always at or very near 32° F as long as there is still plenty of ice in the mixture.[5]

It is likely that the children will record very different temperature readings for the hot water. See sidebar 5 for one possible explanation (however, this time the bulb meets the relatively *cool* air of the room and the temperature reading moves *down*). An additional factor is *when* the children take their

3 This is a good opportunity to discuss which scale everyone should use and why there are different scales in the first place. In the United States, the Fahrenheit scale is still the most widely used temperature scale, even though most of the rest of the world has now switched to the Celsius scale. It is recommended that you stay with Fahrenheit throughout this project, because this is the scale most children are familiar with, and because it is hard to find candy thermometers (used in the final exploration) that use the Celsius scale.

4 You may find that different teams measure different temperatures in the same place. Possible reasons for these differences could be that some teams are not reading or using their thermometers properly, for instance, they might be holding the thermometer bulb in their hand when taking a measurement.

5 It is possible that children who are reading their thermometers carefully still arrive at different and inaccurate temperature readings for the melting ice. This *may* be because they lift the thermometer out of the cold water to see the numbers on the thermometer scale more easily. As soon as the bulb of the thermometer comes out of the water and into contact with the relatively warm air in the room, the thermometer will register a higher (false) temperature reading.

measurements. The hot water will begin to cool down from the moment you hand it out, so unless all the children measure this temperature at the same time, their hot water temperature readings may vary by as much as 5° or 10°.

Hand Temperature

Have the children grip the bulb of a thermometer in the palm of their left hand. They should hold it there for 2 minutes (have them watch the clock) and then write down the temperature on their chart. Normal blood temperature is 98.5° F, but there is some variation in this and there will certainly be differences in how children actually hold the thermometers, so children should not be surprised by the range of readings. Readings of more than 5° above or below 98.5° are suspect. Have the children re-measure—perhaps with a different thermometer (although that is probably not the problem).

PART 2

Part 2 of the exploration gives children the chance to see how long an ice cube can survive in three different environments—the air, hot water, and a human hand.

To complete this exploration, every child will need his or her own small drinking cup filled with hot water, another cup with three ice cubes, and a square of paper towel that should be placed flat on the table.

Have children sit in teams and make sure that each team has a *Temperature Recording: Ice Melt* chart and that every child has a pencil to record data. Tell them that on your signal, they should do the following:

1. Place one ice cube on their paper towel on the table.
2. Place another ice cube in their cup of hot water.
3. Grip the third ice cube firmly in their *non-writing* hand (so they can record information with the other hand while the ice cubes are melting).

Have the children guess how long the ice cubes will last in each instance.

Now pass out to each team the cups filled with three ice cubes and the empty cups for the hot water. At the last moment possible, fill each of the empty cups with the hottest water you can get from the faucet.

You should call out the starting time for this experiment, and everyone should write it down on the *Temperature Recording: Ice Melt* chart. Everyone should watch the clock to see how long their ice cubes last. As soon as any of their cubes melts completely, each child should write how long that cube lasted on the chart.[6]

[6] Some children might be reluctant to hold onto the ice until it melts; others will enjoy the challenge. Those who are able to hold the ice until it melts should add their data to the chart.

READING TEMPERATURE
EXPLORATION 1

Leading the Discussion

When you have worked through the activities described above, gather the children to discuss what they have learned about measuring temperature with this kind of thermometer. Much of this conversation may focus on the difficulty of reading the thermometers accurately and on the apparent inaccuracies of the thermometers themselves. If it appears that some of the thermometers themselves are the problem, replace them with others that are more accurate.

Discussion Questions

Use these questions to further children's thinking about the exploration. Answers are provided in the Background section.

1. Why do you think there are so many different temperatures in the same room?
2. What's the temperature of icy water?
3. Why do people have different hand temperatures?

READING TEMPERATURE

EXPLORATION 1

RATIONALE

Many children are unfamiliar with the difference between the two commonly used temperature scales—Fahrenheit and Celsius (also know as Centigrade). So, before they begin building their houses, the children should practice reading both temperature scales accurately.

SCIENCE/TECHNOLOGY BACKGROUND

It is very common for people to use the words "temperature" and "heat" as if they meant exactly the same thing. Actually they don't.

1. **Heat** is a form of energy. You can feel it, but you cannot actually see it with your own eyes (although some insects and animals can). When hot things glow, it is light energy, not the heat itself, that you are seeing.

   Heat is usually measured in "calories," but there is no simple device to make these measurements. To calculate the *amount* of heat in an object, you would have to know its temperature (see below) and its mass (weight).

   Contrary to many people's intuition, even things that we would say are very cold (icebergs, for instance) contain very large amounts of heat.

2. The **temperature** in an object or location is a measurement of the *concentration* or *intensity* (not the amount) of heat at that place. A cup of boiling water (212° F) contains far less heat energy (calories) than an iceberg at 32° F or less. Luckily, there is a simple device to measure temperature; it is called a **thermometer**.

ANSWERS TO DISCUSSION QUESTIONS

1. Why are there different temperatures in the same room?

It is very unusual for the temperature in a large room to be uniform. It is almost always warmer close to the heating units and furnaces, and if there are windows that let in sunlight or drafts, that area of the room may be warmer or cooler than the surrounding area. But even if none of those issues apply, there is still the fact that hot air rises. So unless there are fans to circulate the air, it will often be warmer near the ceiling than the floor.

2. What's the temperature of icy water?

If you have ever tried making ice cream with ice and salt, you will know that an ice-water-salt mixture can be as cold as 0° F (-20° C). But as long as there is nothing in the water except ice (no sugar, salt, or other impurities), and as long is there are about equal amounts of liquid water and solid ice, then the temperature of a mixture of ice and water will always be 32° F (or very close to it).

It takes quite a lot of energy to melt ice. If any heat energy enters the mixture from outside (even from a flame under the mixture), that energy will first be absorbed by the ice cubes before it can begin heating up the free water. Only when most of the ice has melted will the free water begin to warm up noticeably.

3. Why do people have different hand temperatures?

Everyone has a slightly different body temperature, and everyone's body temperature changes slightly all the time. Real differences, however, should not exceed one or two degrees either side of 98° F. Larger variances may be caused by inaccurate reading of the thermometers. Some children may take the thermometer away from their hand before reading it, so that the apparent temperature is lower than the actual. Medical thermometers avoid this problem by having a small kink in the tiny tube inside the thermometer where the liquid moves up and down. This stops the liquid moving back down the tube when it cools down in those first few seconds after you take your temperature. With those thermometers, once you have read the temperature, you shake it vigorously and the liquid goes back down the tube.

Observing Progress

During Manipulation of Materials

- Did the children pay attention to the smaller gradations between the 10°, 20°, 30°, 40°, etc., marks?
- Were they careful to read the thermometer while it was still immersed in the hot or cold water, rather than taking it out in order to read it?

During Discussion

- Did the children express their own ideas about temperature?
- Did they come up with explanations for why different teams had different readings?

Further Exploration

Reading a Thermometer Accurately

If you want the children to practice reading a thermometer accurately, you can pass out copies of the *Reading a Thermometer Accurately* worksheet (see page 71 in the Appendix). Use just one sheet per team and ask the children to decide, as a team, what temperature each thermometer is registering. They should write their answers in the box below each thermometer. Give the group about two or three minutes to complete this sheet, and then have them share their answers.