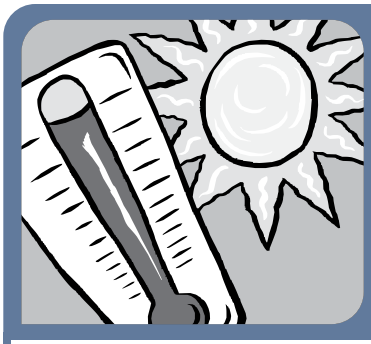

Taking Temperatures

Students use a thermometer to investigate how shading, coloring, and other factors affect temperature.

Grade Level: K–4

Subject Areas: English Language Arts, Health, Mathematics, Science

Setting: Classroom and outside on a sunny day

Time:
Preparation: 30 minutes
Activity: Two 30-minute periods

Vocabulary: Celsius, Centigrade, Degree, Fahrenheit, Heat (thermal) energy, Kinetic energy, Molecule, Temperature, Thermometer

Major Concept Areas:

- Natural laws that govern energy
- Energy flow in nonliving systems

Objectives

Students will be able to:

- use a thermometer to measure and record the temperature in a variety of locations; and
- describe how heat energy affects temperature.

Rationale

Understanding temperature gives students greater insight into the properties of thermal energy.

Materials

- Trade books about weather (optional)
- Pan of boiling water and pan of cold water (optional)
- Thermometer Diagram
- Copies of the following pages:
  - ***Reading a Thermometer*** (optional)
  - ***Taking Temperatures: Part 1***
  - ***Taking Temperatures: Part 2***
- Blue and red food dye (optional)
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Getting Ready: It may help students to dye the hot water red and the cold blue. The day before this activity, ask students to listen to the weather report or to ask a family member what the temperature for the day is expected to be. **Caution: Use thermometers with red alcohol filling (not mercury [silver], which is a toxic substance).** If possible, obtain thermometers with plastic frames, large numbers, and easy-to-read scales. All thermometers should have the same scale, either Celsius (Centigrade) or Fahrenheit. Shake down the thermometers once prior to handing them to students. A possible source for thermometers is your local high school science department.

Each group of students will need the following:

- A thermometer (see **Getting Ready**)
- A container of hot water
- A container of cold water

Background

What if you asked someone if it was hot outside, and they responded, "The air molecules are moving around faster than they were yesterday!" How would this help you know what the weather is like? Temperature is actually a measurement of how fast molecules move back and forth. Molecules move faster when they have more energy. The faster molecules move around, the higher the temperature. So if air molecules are moving

around faster today than yesterday, today's temperature is higher.

A thermometer is a tool for measuring temperature. A thermometer is usually composed of a glass clear tube that contains liquid mercury or some other material, such as alcohol colored with red dye. The base of the thermometer, where the liquid settles, is called the bulb. Air molecules hitting against the bulb cause molecules of the liquid to move faster. This is similar to when one ball strikes another, causing the second to move (energy of motion—kinetic energy—is transferred from the first ball to the second). Faster moving molecules need more space than slower moving ones, so the liquid will climb up the tube as it expands. NOTE: The thermometer measures molecular movement, but it does not measure the total amount of heat energy there is in a substance (see ***Temperature, Thermal Energy, and Heat***).

To provide consistent measurements of temperature, scientists developed a scale. The scale is like a ruler that divides temperature into equal increments. Instead of inches or centimeters, the increments for thermometers are called degrees. The symbol for degree is °. The temperature most commonly used around the world and by scientists is the Celsius or Centigrade scale (C). To develop this scale, the freezing point of water was given a temperature of zero degrees Celsius (0 °C), and the temperature of boiling water was recorded as 100 degrees Celsius (100 °C). Then the scale was divided into even increments between zero and 100. In the United States, a scale called Fahrenheit (F) is used. On this scale, freezing is 32 degrees F and boiling water is 212 degrees F.

One of the reasons people want to know the temperature of substances such as the air is so they can make

Temperature, Thermal Energy, and Heat

Thermometers measure temperature; they measure the level or degree of thermal energy in a substance. In other words, they measure how fast the molecules that make up the substance are moving. The molecules move faster in hot objects than they do in cooler materials. So, a thermometer helps us understand how hot or cold something is by letting us know how fast (the degree to which) its molecules are moving. The unit of measurement in a thermometer is degrees.

To measure the total amount of thermal energy in a substance, a different instrument is needed. A calorimeter determines the total quantity of energy contained in all the moving molecules within a substance. The measurement unit for thermal energy is calories.

For example, let's say you put a large pot of stew on the dinner table. If you remove one ladleful of the stew, the temperature of the stew in the pot and in the ladle will be the same because the molecules in both are moving at the same rate. The large pot of stew has more thermal energy, though. This difference in thermal energy is simply because there is more stew in the pot—the more stew, the more moving molecules, the more thermal energy. Proof of this is seen after some time has passed. The ladle of stew (with less thermal energy) cools off more quickly. The pot of stew will stay warm longer because it has more thermal energy.

Both stews will eventually cool down, of course. This is because of heat energy moving from the hot stew to the cooler surrounding air. Heat is the transfer or flow of energy from one object to another (such as from the hot soup to your tongue or from a radiator to the surrounding air). When something is "heated" this means energy flowed into it. You can measure the change in temperature by using a thermometer to record how fast the molecules are moving now compared to before the heat transfer. It is incorrect, however, to say a thermometer measures heat.

decisions. For instance, knowing air temperature helps people decide what clothes to wear. Therefore, when you hear that the air molecules are moving faster today than they were yesterday, you know that today is a warmer day than it was yesterday. So you'd better dress appropriately!

Procedure

Orientation

The day before this activity, ask students to listen to the weather report or to ask a family member what the temperature for the day is expected to be.

Discuss different types of weather with students. If available, read trade books about weather. Note if students use the term "temperature." Hold up a thermometer and ask students if they know what it is and what it is used for. Emphasize that the purpose of the thermometer is to measure temperature (or how hot or cold something is).

To help students get a basic understanding of temperature, show or ask students to think of a pan of cold water and one that is boiling. Without being able to feel the water, how would they describe the difference between the two pans of water? Students should note that they can see more movement in the pan of boiling water. Remind students that movement is evidence of energy.

Water is actually made up of tiny particles called molecules. Molecules are moving very fast when water boils. Explain that although we can't see them, the air contains tiny particles (molecules) that move around too. Ask students to imagine how the molecules in warm air would move compared to the ones in cold air. They should say that molecules in warm air move faster because the molecules contain more energy. NOTE: Stress that the molecules are moving randomly back and forth around the students and that warm air is not necessarily windy air; wind is a mass of air molecules moving primarily in the same direction.

Tell students that a thermometer measures how fast molecules are moving. The molecules can be in water, air, or our bodies. When the moving molecules hit the bulb of the thermometer, it makes the molecules of the liquid inside move faster. The moving molecules need more room, so the liquid flows up the tube.

Have students stand up and pretend they are air molecules. Air is a gas so the molecules move around the room. Tell students the air is cold. How should they move? Very slowly. Now tell students the air is heating up. The molecules move faster. Students may notice they need more room to move around quickly than when they moved slowly. Announce that the air is cold again and have students return to their seats.

Steps

1. Show students the ***Thermometer Diagram*** or draw a large picture of a thermometer on the whiteboard and tell students the basic parts of the instrument. These include the glass tube, scale (degrees Celsius or Fahrenheit), bulb, and the red liquid inside the tube.

2. Ask students if they know what the lines and numbers represent. Introduce the term "degree" and explain the degree scale. In other words, explain what the space between two lines represents (one degree, two degrees, five degrees). NOTE: You may want to introduce terms "Centigrade," "Celsius," and "Fahrenheit," and the symbol for degree (°).

3. Draw a line across the tube of the ***Thermometer Diagram*** and tell students what temperature this represents. Draw lines at other locations within the thermometer and have students report what temperature the line represents. Students can also complete ***Reading a Thermometer***.

4. Demonstrate how to properly use a thermometer:
   - The bulb should only touch what is being measured (if the bulb is not touching anything it is measuring air temperature)
   - Each time you are measuring something, hold the thermometer in place for at least one minute or until the red material stops moving
   - Allow the thermometer to return to room temperature before each new measurement is taken (you are waiting for the red material to move back down the tube)
   - Keep your hands away from the bulb, otherwise you will be measuring the temperature of your hand rather than what is intended

5. Provide students with the following safety tips:
   - Handle the thermometers carefully; they are made of glass and can break
   - Only students responsible for getting materials should walk with the thermometer
   - When walking with the thermometer, hold it down by your side and not in front of you. **Caution: Emphasize that they should walk carefully, not run, with thermometers.**

6. Divide students into groups of two or three. One student can be responsible for collecting materials, another for using the equipment, and a third for recording information. However, each student should practice using the thermometer at some time during the activity. NOTE: For younger students, especially those in kindergarten, you may want to divide the class into thirds and work with one third while the other two groups are occupied with another quiet activity, then rotate the groups. In addition, it may be best to provide the groups with materials rather than having the students retrieve them as described in **Step 7**. Model how to use the thermometer a few times prior to letting students practice. Younger students will also need assistance completing activity sheets, with you or a teaching assistant filling in the temperature readings.

7. Students responsible for collecting materials should get a copy of ***Taking Temperatures: Part 1*** and a thermometer. Then have them obtain containers of hot and cold water for their group.

8. Instruct students to hold the thermometer about six inches (15 cm) in front of their eyes while seated. They should wait a minute and record the temperature in the correct location on ***Taking Temperatures: Part 1*** (air inside the classroom). Check around the room to see if temperatures are being read correctly. Tell students that this is room temperature and their thermometer should be near this temperature before they measure anything else. NOTE: Students may notice that temperatures vary throughout the room. Ask students what this means about the movement of the air molecules around the room. (It varies throughout the room).

9. Provide students with the following directions: Place your thermometer in the container of cold water and observe what happens to the red liquid. Hold the thermometer in the water (not touching the sides of the container) until the red material stops moving. Record the temperature in the correct location on ***Taking Temperatures: Part 1***. Allow the red liquid to return to room temperature and repeat the activity using hot water.

10. Collect the containers of water and thermometers and take the class outside. Discuss what the air outside feels like. Encourage students to note how the sun warms their skin and casts shadows. **Caution: Students should never look directly at the sun.**

11. Hand out copies of ***Taking Temperatures: Part 2***. Ask students to guess what they think the temperature is. Instruct them to record this guess on their activity sheet ("Guesstimate" column). NOTE: You may want to skip this step with very young children. Younger students may have difficulty making realistic guesses and become concerned when their guesses are incorrect. Explain that scientists use guesses to guide their investigations and their guesses are often wrong.

12. Take the temperature of the air outside (preferably while standing in the sunshine), and instruct students to put this measurement on their ***Taking Temperatures: Part 2*** in the "Actual Temperature" column. Tell students this is the control, or first, air temperature measurement.

13. Tell each group to find a location where they think the air will be warmer than the control, or first, air temperature measurement. This location may be near the ground, by a tree, close to a window, above the pavement, etc. When they think they have found a spot, they should draw or describe the spot on their activity sheet and explain why they think the air will be warmer here. They should consider shading, coloring, moisture, etc. Also tell them to write down a guesstimate of what they think the temperature will be. NOTE: For younger students, ask them to point out locations where they think it will be warmer and cooler. Students can dictate their reasoning to you or an assistant to write on their activity sheet. You, a teaching assistant, or a responsible student can take and record the temperature and discuss the results.

14. When all groups have found a location, have students responsible for collecting materials get a thermometer for their group. Instruct the groups to take the temperature and record the measurement. Make sure students measure the temperature of the air and do not put the thermometer directly on a surface. Provide students with a standard distance such as one inch (2.5 cm) away from the surface they are measuring. If they are not considering a surface, the standard can be six inches (15 cm) in front of their eyes.

15. Collect the thermometers and repeat Steps 13 and 14, this time having students locate a spot where they think the air will be cooler.

Closure

After the measurements are complete, return to the classroom and discuss results. Have students compare

sets of measurements. Discuss what contributes to differences or similarities in measurements. Surfaces that are receiving direct sunlight may be warmer. Students may notice that the air near dark-colored surfaces is warmer than a surface that has a light color. Students should find that shaded areas are cooler than locations in direct sunlight. Throughout the discussion, emphasize how the heat from the sun makes the molecules in air move faster.

Assessment

Formative

- Can students read a thermometer properly? (Students can also complete ***Reading a Thermometer***)
- Did students use the thermometer correctly?
- Are students able to describe how heat energy affects the movement of molecules?

Summative

Conduct an ice cube melting contest. Have groups identify a spot where they think an ice cube will melt the fastest. They should develop a statement such as "Our ice cube will melt the fastest because..." They should not touch or put anything around the ice cube. An alternative is to provide groups with paper cups filled with warm, dissolved gelatin. Tell groups to place the mixture where they think it will remain warm and not solidify. After 15 minutes or so, have students bring their cups back to their desks and discuss the results. This activity can be done inside or outside. An extra challenge is to do this activity on a cold day.

Extensions

Have students maintain a weekly Temperature Chart. Individual students can be designated "weather person" for a week and be assigned to complete the chart. In the example on the next page, Monday's temperature was 77 degrees F (25 °C) and Tuesday's was 89.6 degrees F (32 °C).

Encourage students to use metric measurements for temperature in their daily lives. Help students to associate particular temperatures with familiar activities or objects. For example, have students state in Celsius which temperature they would prefer the water in a lake to be before swimming. Ask students to identify a temperature that is appropriate for baking cookies. Explain that students their age in other parts of the world use only metric measurements. Show students different types of thermometers, such as candy, meat, and freezer thermometers.

Related KEEP Activities

There are many opportunities throughout the school year for students to continue their temperature measuring skills. One avenue is through studying seasonal changes. K–5 Energy Sparks for Theme II: "Sunvestigations" describes teaching ideas for investigating how the sun's position in the sky changes throughout the year. Students can also monitor these changes through temperature readings. Build a solar cooker and have Students compare temperatures inside and outside the box (see "Shoebox Solar Cooker"). The activity "Exploring Heat" lists several suggestions for learning more about heat. Make sure students understand the difference between heat and temperature (see Temperature, Thermal Energy, and Heat).

The Wisconsin K-12 Energy Education Program is supported through funding from

Wisconsin K-12 Energy Education Program (KEEP)
College of Natural Resources
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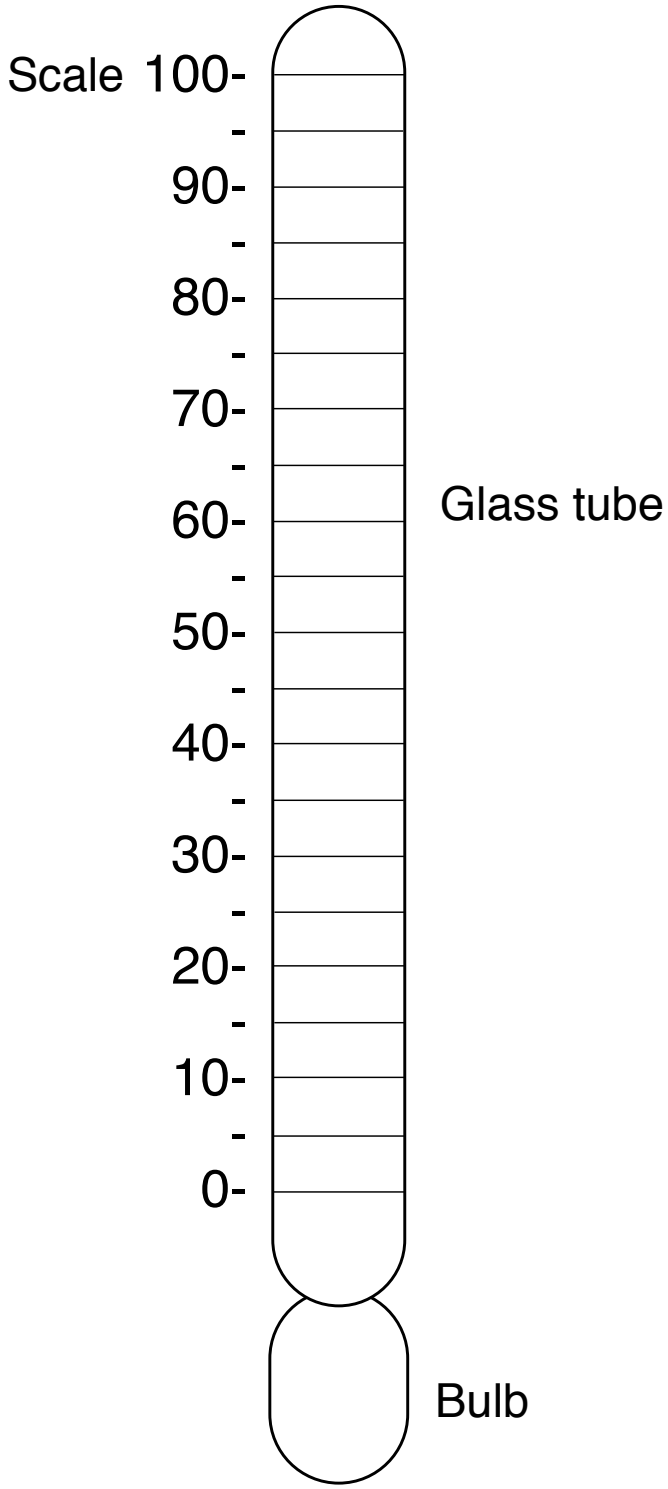
Temperature Chart

Temperature (Celsius)	Day of the Week				
	Monday	Tuesday	Wednesday	Thursday	Friday
50°					
40°					
30°		X			
20°	X				
10°					
0°					
-10°					
-20°					

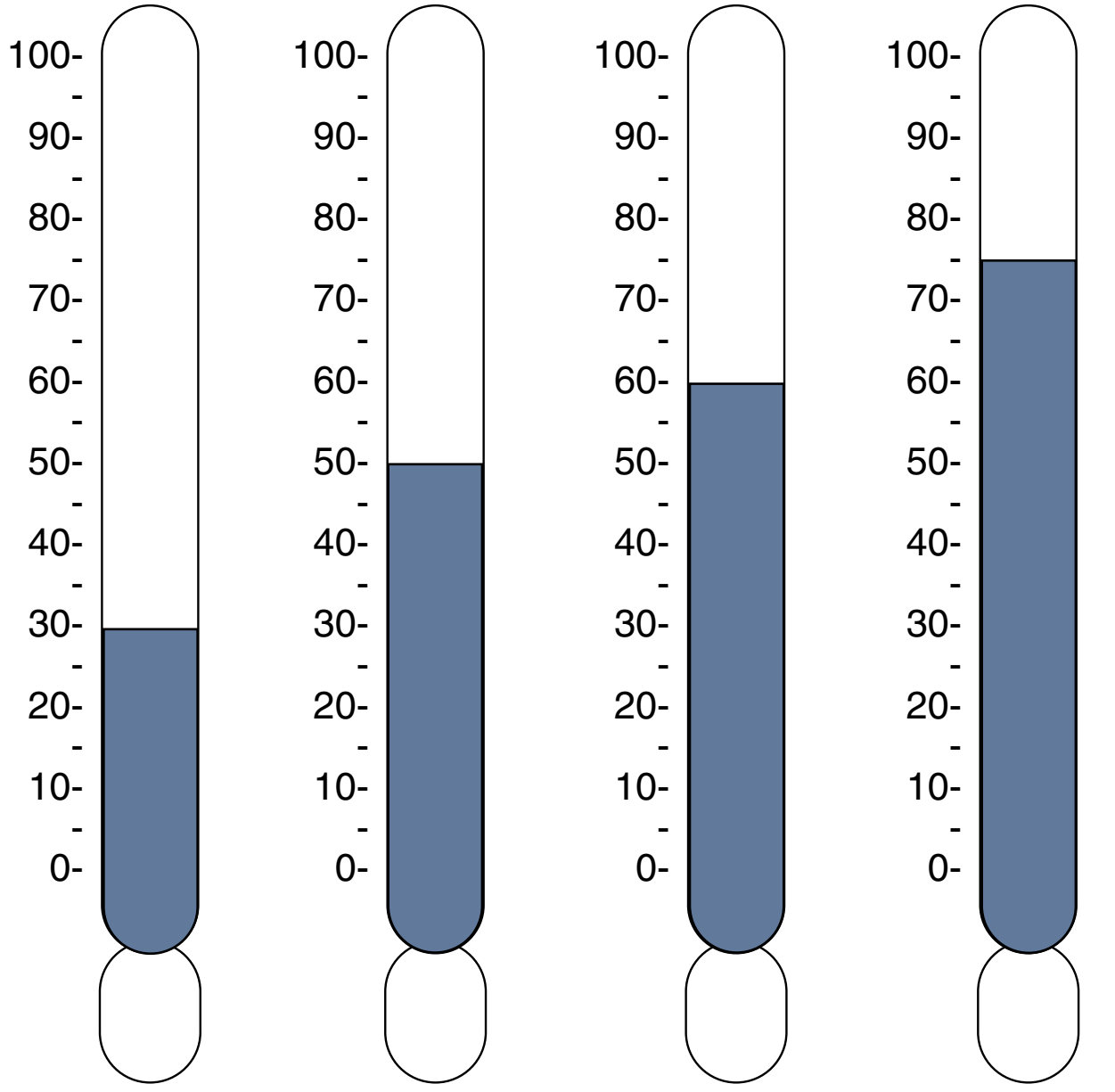
Thermometer Diagram



Reading a Thermometer

Name _____

Instructions: Circle the correct temperature.

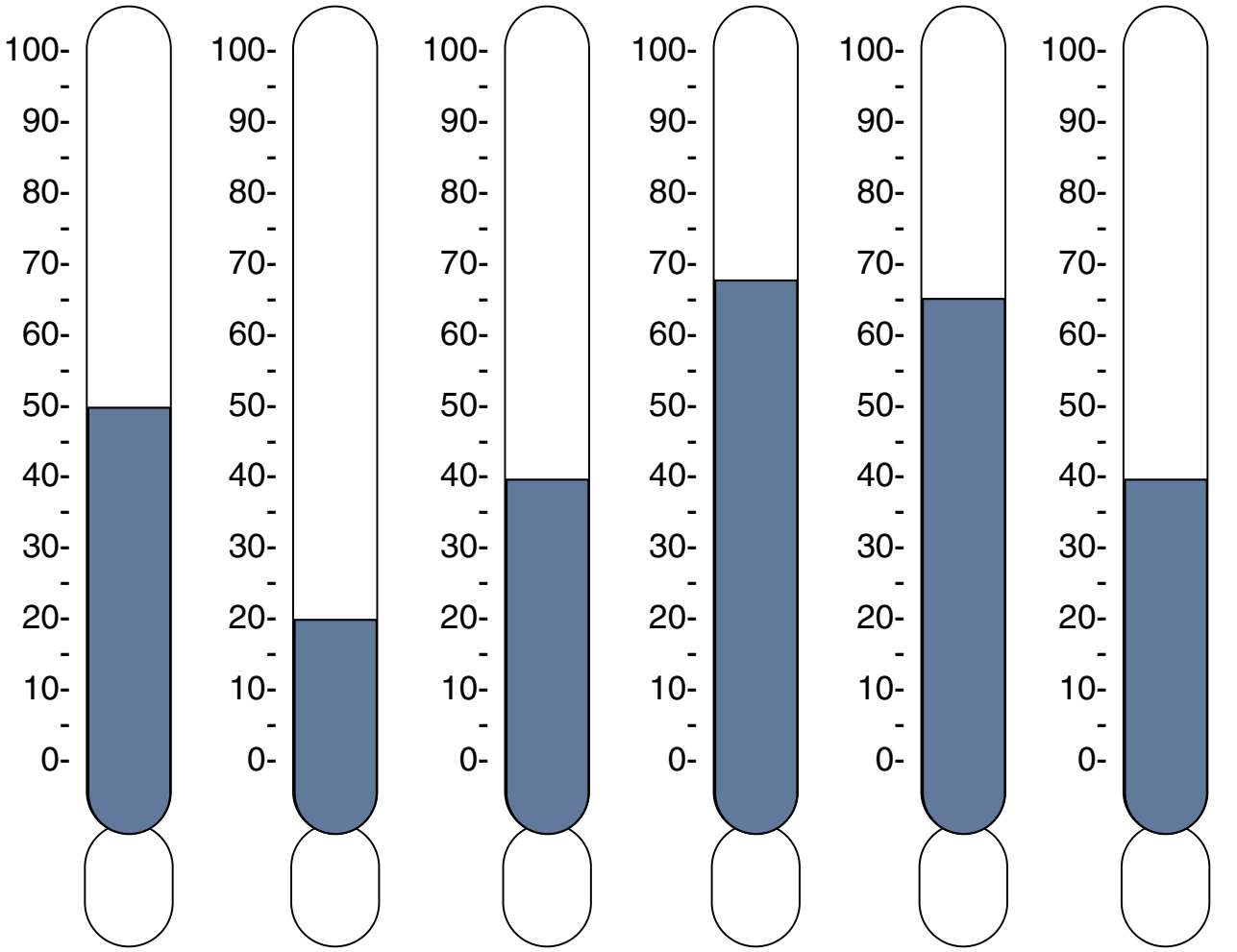


40° or 30° **50° or 40°** **60° or 70°** **70° or 75°**

Reading a Thermometer

Name _____

Instructions: Circle or write the correct temperature.

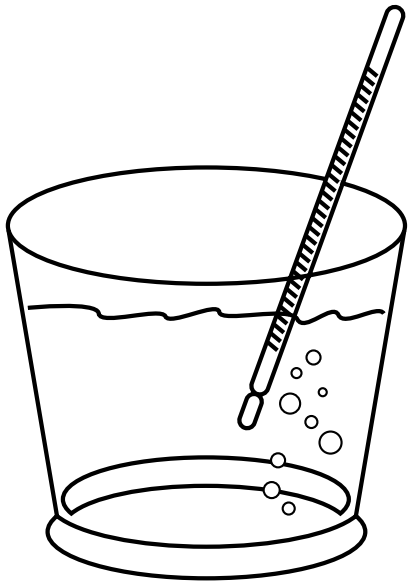


50° or 60° **20° or 30°** **38° or 40°** **68° or 64°** _____ _____

Taking Temperatures: Part 1

Name _____ Date _____

Measurements Taken Indoors	
Place	**Temperature**
Air inside the classroom	
Container of cold water	
Container of hot water	



Taking Temperatures: Part 2

Name _____ Date _____

Measurements Taken Outdoors

Place	Guesstimate Temperature	Actual Temperature
Air outside the classroom (control)		
Draw or describe a place you think will have a temperature warmer than the control (outside air temperature):		
Why do you think this place will have a warm temperature?		
Draw or describe a place you think will have a temperature cooler than the control (outside air temperature):		
Why do you think this place will have a cool temperature?		