Measuring the Temperature of Water, Snow, and Ice

Equipment

- Alcohol or digital thermometer, about 8 inches long, that measures in both Celcius or Fahrenheit.
- Thermometer must be able to measure temperatures BELOW -40 degrees, and ABOVE 212 degrees Fahrenheit.

Pre-K and Kindergarten Activities:

- Young children can play with a thermometer to develop an understanding of what it does.
- Have them hold a thermometer in their hands to watch the temperature go up and down.
- Have them watch the thermometer when you let it sit indoors for a while.
- Have them watch the temperature go down when you take the thermometer outdoors in the winter.
- Have them watch what happens to the temperature when they put the thermometer in the snow.
- (Note: If the ground has been covered with snow for several weeks, the temperature of the ground underneath the snow may be warmer than the temperature of bare ground, due to the insulating properties of snow. The deeper and fluffier the snow, the warmer the ground will be at the bottom of the snow.)

Grades 1-3 Activities

- Children ESTIMATE the outside and indoors temperature daily (this can be a daily guessing game, before they record the temperature using a thermometer. With practice, they will eventually know the temperature, with a high degree of accuracy, without a thermometer).
- Children record the outside air temperature daily.
- Teacher helps them create a classroom bar graph showing the outside air temperatures over a period of several days, weeks, or months.
- Children measure the temperature of the ground in various locations (sunny, shady, concrete, asphalt, dirt, grass) on cold days and on warm days, throughout the year. This data can also be recorded on bar or line graphs.
- Children measure the temperature of snow, just above the top surface of the snow, and at the bottom of the snow. If you have snow on the ground for a long period of time, this data can also be recorded on bar or line graphs over a period of weeks or months.
- Children observe what happens to the temperature as we boil water, and record the temperature when the water starts to boil, and as it continues to boil. (Note: “Boil” means that the water is rolling, bubbling vigorously, and water vapor is rising. At high altitudes, such as in southwest Montana, water will boil at temperatures BELOW 212 degrees Fahrenheit, due to lower air pressure. At 5,000 feet altitude, water will boil at approximately 208 degrees Fahrenheit. Adding salt to the water will cause it to boil at a higher temperature, but you have to add quite

a bit of salt (try 2 tablespoons) for the difference to be noticeable. The children should notice that after water boils, the temperature does not continue to go up.)

- Children collect a container full of snow. They record the temperature when the snow melts.
- Children can compare different types of insulating materials (such as different boots), by placing various types of boots in the snow, each with a thermometer inside, cover each boot with some type of insulator (Styrofoam or wool cloth), and check the temperature inside the boot in about 10 minutes.
- Children can compare different types of insulating materials (such as gloves) by placing two different types of gloves, one on each hand, then placing the gloves inside baggies. Then place their baggie-covered hands inside a tub of water that has a lot of ice cubes in it. Have them decide which glove insulates.
- Teacher explains that ice/snow melts at 32^{o} Fahrenheit. At low altitudes, water boils at 212^{o} Fahrenheit. (The students may notice that when water freezes, the temperature may vary a bit.)

Grades 4-8

Temperature is a measure of the amount of heat, or kinetic energy (energy of motion), in an object (such as, air, water, ice, snow, or the ground).

Most of the above activities will also be useful for older children who have not had many experiences with temperature and thermometers.

Teacher explains that in the US, we typically refer to temperatures using the Fahrenheit scale. In almost all other countries of the world, however, people use the Celcius scale.

Scientists also use the Celsius scale or, when measuring extremely cold temperatures, they use the Kelvin scale.

When we measure time, we refer to minutes and hours. When we measure temperature, we refer to degrees. We use a symbol to represent "degrees."

In the Fahrenheit scale, ice melts at 32^{o} F. Water boils at 212^{o} F.
In the Celcius scale, ice melts at O^{o} C. Water boils at 100^{o} C.

In the Kelvin scale, ice melts at 273 Kelvin. Water boils at 373 K. (The term "degrees" is not used in the Kelvin scale. The value of one degree in the Celcius is the same as one "degree" change of temperature in Kelvin). Thus, Kelvin = degrees Celcius + 273.

On the Kelvin scale, the scale starts at Absolute Zero, the theoretically coldest possible temperature (the temperature at which molecules theoretically would stop moving).

Absolute Zero = 0 Kelvin = -273.15^{o} Celcius = $=459.7^{o}$ Fahrenheit

Activities:

- Children record the outside temperature daily, using both Fahrenheit and Celcius (Note: It is NOT important for students to memorize the conversion factors between Celcius and Fahrenheit. It is much more important for them to gain lots of practice measuring in BOTH Fahrenheit and Celcius. The more practice they have measuring in both systems, the more comfortable they will be with both.)
- Children create an on-going classroom graph, showing the daily temperatures (in both F & C) for several weeks or months (It is particularly important for children to have lots of opportunities to record negative numbers, when the temperature goes below freezing. This kind of hands-on work with negative numbers facilitates their understanding of negative numbers in mathematics problems (Notice that it is very easy to get to negative numbers when you use the Celcius scale).
- Pantomime: Children can pretend to be water molecules that are cold, by huddling close together and being fairly still. Then, as the "water molecules" get warmer, they can start to move around faster and faster. Eventually, they move so fast that they "boil" and water vapor floats away.
- Brain Teaser: Having observed the temperature in both Fahrenheit and Celcius for several days, the children may be able to discover the formula for converting from Fahrenheit to Celcius and vice versa. Teacher poses the following problem:
    - Using the following table, figure out the mathematical formula you would use if you know the temperature in degrees Celcius and want to know what it is in degrees Fahrenheit.
    - Hint: You have to use addition or subtraction, and multiplication or division, to convert between the two scales.
    - More specific hints: Converting Celcius to Fahrenheit – One way to do it is to multiply using a number less than 10, then divide using a number less than 10, & then add a number less than 50. Converting Fahrenheit to Celcius, one way to do it is to use subtraction, multiplication, & division.

Known temperatures

Degrees C	Degrees F
100	212
21.1	70
10.0	50
0	32

Use your formula to find the temperature in degrees Fahrenheit:

Degrees C	Degrees F
26.7	
4.4	
-6.7	

(One solution: To convert Celcius to Fahrenheit: Multiply degrees Celcius by 9; Divide by 5; Add 32)

To convert Fahrenheit to Celcius: Subtract 32 from degrees Fahrenheit; Multiply by 5; Divide by 9)

- Teacher poses the following questions:
    - There is a point when the temperature is the same in both Fahrenheit and Celcius scales. Can you figure out what that point will be? (Students work in pairs to solve this problem.) (Solution: -40 degrees.)
    - Measure the temperature of distilled water as it approaches freezing. What do you conclude about the freezing point of distilled water? (Note to teacher: The freezing temperature of highly purified distilled water is -42 degrees Celcius. Ask the students to predict the freezing point of distilled water before measuring the temperature. After they discover that the temperature is much lower than for tap water, have them create a hypothesis (explanation) of what causes this difference. Then let them look it up.
    - How would you design an experiment to determine the freezing point of salt water? (Note to teacher: Engage students in measuring the temperature of water that has salt added to it. The students will figure out that they need to test different amounts of salt. Place the salted water outdoors (or in a freezer) when the air temperature is well below 0 degrees Celcius. Note: Salt LOWERS the freezing point of water. Thus, with salt added, water will remain a liquid when it is well BELOW the normal freezing point of water. If the students keep adding more and more salt, eventually they will reach a point where adding more salt does not continue to lower the freezing point of water.)
    - Design an experiment to test this problem (during an extended period of cold weather): If you use rock salt to melt ice on your front steps, at what ground temperature will the salt no longer work? (Note that the special salts that are commonly sold in stores for this purpose have chemicals added to enable them to work at even lower temperatures. Students could compare rock salt with chemically-treated salts.)