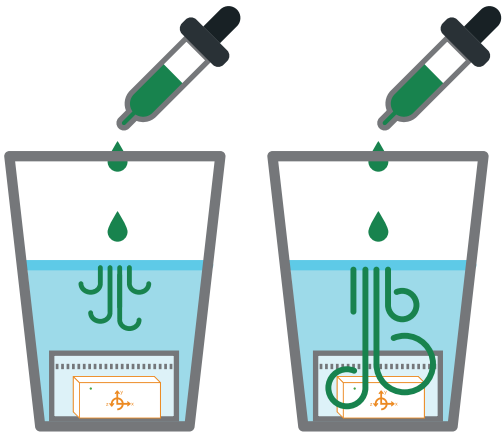
What is Temperature?

Exploration

What does it mean to change temperature? What is temperature? We know what it means to be hot or cold, but what does it mean when you measure the temperature of an item?

Materials

- PocketLab
- One cup of warm water
- One cup of ice cold water
- Small sealable plastic bag
- Food coloring



Objective

In this experiment, students will:

1. Understand how the temperature of the water is related to the movement (kinetic energy) of the water molecules.
2. Use observations to describe the principle of thermal expansion.

Method

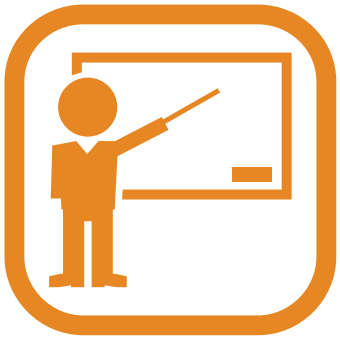
1. Place the PocketLab in the sealable plastic bag. Ensure the bag is sealed.
2. Place the plastic bag (with PocketLab sealed inside) into the cup of warm water. Do not use boiling water. Room temperature water will do.
3. Note the temperature reading – this will take some time for the reading to settle on the correct temperature.
4. Place the plastic bag (with PocketLab sealed inside) into the cup of ice cold water.
5. Note the temperature reading.
6. Now place a drop of food coloring into each cup.

Predictions

- How do you think the movement of the food coloring will relate to the temperature of the water? Explain your answer.
- What does the movement of the food coloring have to do with the temperature of the water? How does it help us visualize what the water molecules are doing?

Observations/Conclusions

- Describe the relationship observed between the temperature of the water and the movement of the food coloring.
- Use your observations to describe the relationship between temperature and the movement/kinetic energy of the matter in the substance being measured.
- Rub your hands together quickly for 30 seconds. How does the temperature of your hands change? How is this related to your answer from the previous question?
- Describe what temperature is really measuring. Use the data and observations you collected to support your answer.
- Using your observations, describe what would happen to a balloon filled with gas if it was left out in the sun to heat up. What would happen to the volume of the balloon? What would happen to the volume of the balloon if it were brought into a cold environment, like the inside of a refrigerator?
- Use the answer to the previous question, as well as all your observations to explain the principle of thermal expansion.



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TEACHER GUIDE

Make sure the bag is completely sealed. Check every bag before you allow students to place the PocketLab into the water. You can add tape to the ziplock seal to make sure it doesn't come open. If the bag opens, water could get into the PocketLab and it could be damaged. Be very careful. Make sure the cups for water are clear so students can observe the food coloring.

Students should note the difference in temperature between the cold and warm water. Make sure they record plenty of readings. When the food coloring is dropped in the water, make sure there is still a significant difference in the temperatures. The food coloring in the cold water should not spread through the cup nearly as quickly as the warm water. The warmer the water, the faster and more expansive the spread of the food coloring will be. Push students to relate this to what is happening at a molecular level. Students can relate this to states of matter.

When students rub their hands together and feel them increase in temperature, relate this to the moving molecules in the water. Kinetic energy from their hands is translating into thermal energy. The molecules in the warmer water have greater kinetic energy and therefore greater thermal energy. The additional energy "stimulates" the molecules, causing them to move around more. Temperature is really a measurement of this movement.

When having the students think about the balloon, they should draw the conclusion that the balloon will expand in the heat and contract in the cold. The balloon doesn't gain or lose a significant amount of gas molecules, but as the balloon heats those air molecules become more stimulated and move about more quickly, expanding the volume they occupy. The opposite is true when the balloon is colder in the refrigerator.