Activity 2

1 Hot Leaks

See how the temperature of liquids changes the way they flow.

Safety: This experiment requires using the hot water tap and straight pins. Ask an adult to help you with this part of the experiment.

Materials

2 Styrofoam or paper cups

Paper cup

Straight pin

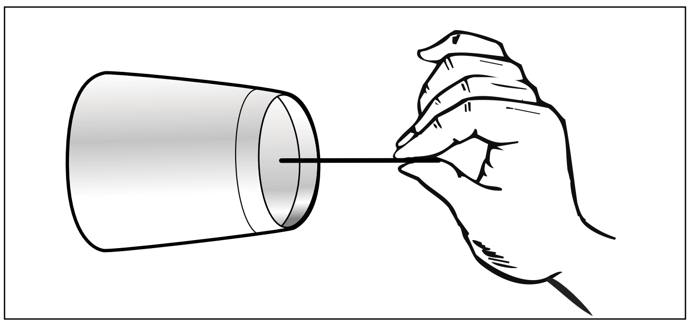
2 small clear cups

Hot water

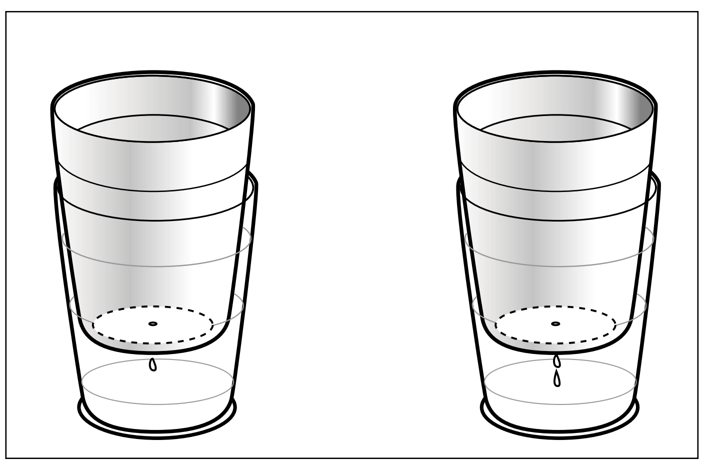
Cold water

Instructions

1. Fill the paper cup half full of cold water and then place it in a freezer for 45 minutes or until a thin icy layer forms along the surface.
2. Use the straight pin to poke a small hole in the bottom of each of the Styrofoam cups. Place each Styrofoam cup in one of the small clear cups.



3. After the 45 minutes are up, take the icy cold water out of the freezer and carefully pour the part that is still liquid into one of the Styrofoam cups making sure not to pour the part that has turned to ice in as well.
4. Turn on the hot water tap and let it run until the water is hot.
5. Place the second set of cups underneath the hot tap water and fill to same level as the cold water.
6. Set the cups side by side and observe what is taking place.



Discussion Questions

Which cup of water is dripping faster?

What is the difference between the two sets of cups?

Why might this cause a difference in how quickly the water drips out?

Activity 2

1 FOR THE TEACHER
Hot Leaks

Materials

2 Styrofoam or paper cups

Paper cup

Straight pin

2 small clear cups

Hot water

Cold water

Discussion

There is a direct relationship between the motion of molecules and their temperature. Molecules are constantly moving around, which means they have kinetic energy, and the temperature of a substance is the average kinetic energy of its molecules. Molecules with low kinetic energy move slowly and are at a low temperature. A high kinetic energy means the molecules move faster and have a higher temperature.

The hot water leaks faster than the cold water because the hot water molecules are more active and flow out of the hole at the bottom of the cup more often. The cold water molecules are moving more slowly and therefore do not flow out of the cup as fast as the hot water – or sometimes even at all!

Another way to help students understand the concept of molecule motion is to ask them to imagine themselves running around inside a room. They are just like the fast moving molecules and have a high kinetic energy. If the room had a small door, they would all be going through the door quickly. If they were moving slowly, with less kinetic energy, it would take them much longer to get out.

Suggested Resources

"Gas Molecule Motion":
http://id.mind.net/~zona/mstm/physics/mechanics/energy/heatAnd-Temperature/heatAndTemperature.html

Bibliography

Churchill, E. Richard, Loeschnig, Louis V., Mandell, Muriel, "730 Easy Science Experiments," Sterling Publishing Company, 1997.

Activity 2

2 Hot Air Balloon

Watch what happens as a balloon on a bottle is heated and cooled.

Safety: Ask an adult to help you with boiling water. Be careful not to burn yourself.

Materials

Small glass bottle

Stove top burner

Water

6 to 8 inch latex balloon

Small- to medium-sized stove pot

Potholder

Instructions

1. Pour water into the pot until it is about half full and place on burner.
2. Turn the burner on to medium-high heat.
3. Stretch the neck of the balloon and then place it over the bottle opening.

4. Once the balloon is secure and the water is boiling, carefully place the bottle in the pot with the water.
5. Observe what happens to the balloon for about the next two minutes.
6. Turn off the burner and use a potholder to remove the pot from the heat source.
7. Carefully remove the bottle from the pot or pour out most of the water.
8. Observe the balloon for about another two minutes.

Discussion Questions

What happened to the balloon when it was placed in the boiling water? Why?

What happened to the balloon when it was removed from the boiling water? Why?

What do you think would happen to the balloon if you put the bottle and balloon into the freezer? Why?

Using what you observed in this experiment, can you explain why hot air balloons seem more "full" when the flame is on at the bottom of the balloon?

Activity 2

2 FOR THE TEACHER
Hot Air Balloon

Discussion

When the balloon is placed on the opening of the bottle some air is sealed inside. During the experiment, air does not enter or exit the balloon and bottle system. As the bottle is heated in the boiling water, the temperature of the air inside the bottle increases. This temperature increase means that the molecules of warm air in the bottle move faster on average than they did at room temperature. Since the molecules are moving faster, they strike the sides of the balloon faster and more often, causing the balloon to expand.

After the pot is removed from the burner, the temperature of the air inside the bottle and balloon decreases. As the air molecules cool, they move more slowly. This makes the molecules hit the walls of the balloon less often and at lower speeds. When this happens there is less force holding the balloon in its expanded shape, and the balloon contracts back to its original size.

Students may propose that air is created inside of the bottle or that more air got into the bottle and that is what caused it to inflate. It is important to address this misconception and clarify that air neither enters nor is created in the bottle at any point in the experiment. The changes in the balloon are caused by the changing temperature of the air.

Materials

Small glass bottle

Stove top burner

Water

6 to 8 inch latex balloon

Small- to medium-sized stove pot

Potholder

Suggested Resources

Gas Molecule Motion:
http://id.mind.net/~zona/mstm/physics/mechanics/energy/heatAndTemperature/gasMoleculeMotion/gasMoleculeMotion.html

Bibliography

Churchill, E. Richard, Loeschnig, Louis V., Mandell, Muriel, "365 Simple Science Experiments with Everyday Materials," Sterling Publishing Company, 1997.

Activity 2

3 Molecular Motion

Make a model of the way molecules move in different states.

Safety: Ask an adult to help you when using the scissors.

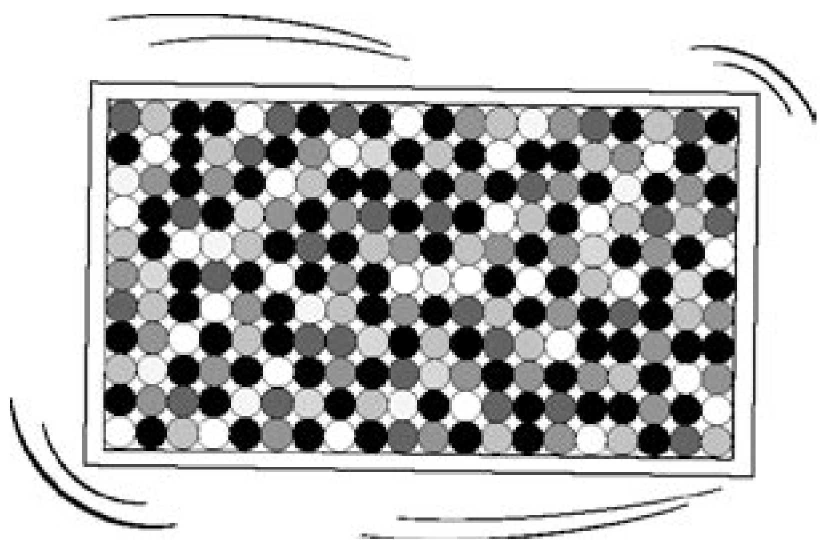
Materials

Box lid from a shoe box or something similar

Enough marbles to cover the box lid

Instructions

1. Place the marbles in the lid until they are packed tightly and cover the bottom.



2. Shake the lid back and forth. Observe how the marbles move.
3. Remove a handful of marbles and shake the lid again. Observe how the marbles move.
4. Remove all but about ten marbles and shake the lid again. Observe how the marbles move.

Discussion Questions

Which state of matter is best represented by the lid packed with marbles? (solid, liquid, or gas) Why?

Which state is best represented after some of the marbles have been removed and move around a little easier in the box lid? What about when you remove even more?

Can you think of any differences between this model of states of matter and the way molecules move in the real states of matter?

Activity 2

3 FOR THE TEACHER
Molecular Motion

Materials

Box lid from a shoe box or something similar

Enough marbles to cover the box lid

Discussion

This model is good for showing the differences in how molecules move in various states of matter. At first, when the box lid is completely covered with marbles, the students should notice that the “molecules” do not have the freedom to move very much. They can vibrate and rotate, but cannot change places with other molecules. This is similar to the motion of molecules in a solid, where each molecule has a location in a lattice or organized pattern, but may rotate or vibrate at that position.

After some “molecules” are removed the marbles can move about more freely. In this case they collide often and can vibrate, rotate, and move about the box lid. This part of the model is like a liquid, because the marbles are still close together, but can now move about the box. One difference between this model and a real liquid is that if the marbles were put into a bigger box lid they would still move about the whole lid, but a real liquid has a definite volume, and only takes up a finite amount of space.

The model represents a gas when most of the marbles are removed in the last step. Here the “molecules” are very spread out, and most of the lid is empty space. The molecules can still vibrate, rotate, and move about, but they run into each other far less often. One difference between the model and a real gas is that a real gas would not be confined to the box lid, but would instead take up the space around the lid as well unless contained on all sides.

Suggested Resources

States of Matter:
http://www.chem.purdue.edu/gchelp/atoms/states.html

States of Matter Plus Exotic States (states other than solid, liquid and gas):
http://en.wikipedia.org/wiki/List_of_states_of_matter

Activity 2

4 Float or Sink?

Watch water's strange behavior in a container with oil.

Materials

Water

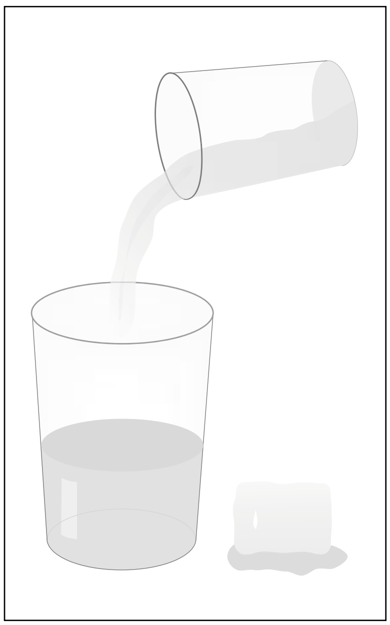
Ice cube

Vegetable Oil

Clear Plastic Container

Instructions

1. Pour oil into the container until there is enough to cover an ice cube.



2. Add about the same amount of water to the container.
3. Let the container sit for a few minutes and observe what happens.
4. Add an ice cube to the container. Observe how the ice cube's position differs from the water.

Discussion Questions

Is liquid water more or less dense (more or less heavy if you weighed the same volume of each one) than the cooking oil? How do you know?

Is the ice cube more or less dense than the cooking oil? How do you know?

If you could cool the oil enough to freeze it and form an "oil cube," where do you think it would settle in the container? Why?

Activity 2

4 FOR THE TEACHER
Float or Sink?

Materials

Water

Ice Cube

Vegetable Oil

Clear Plastic Container
(disposable cup, plastic graduated cylinder, or other small container large enough to hold an ice cube)

Discussion

Layering in fluids is controlled by the density of the fluids, just as the density of a solid determines whether it will sink or float in a liquid. Density is determined by the amount of mass a material has in a predetermined volume, usually by measuring the mass and dividing the result by an objects' volume. If two objects that take up the same amount of space (have the same volume) are compared, the object with a higher density will weigh more. In this experiment, students should see the cooking oil move to the top of the container as a layer above the water. This indicates that the oil is less dense, or weighs less than water when equal volumes of each liquid are compared.

The ice cube, however, will float in the oil. Students will probably be familiar with ice floating in water, which demonstrates that the ice formed has expanded to become less dense than liquid water. The result of this experiment shows that the ice is not only less dense than liquid water, but even less dense than oil. This property of water is actually quite unusual. Most liquids become denser when cooled and frozen. Water, on the other hand, becomes more dense (contracts) as it is cooled until it reaches about 4°C, but then expands until the water freezes near 0°C. The final discussion question, which asks where an "oil cube" might settle, can help introduce this unusual property of water. Oil, like most liquids, is denser when frozen and an "oil cube" would sink to at least the bottom of the oil layer, possibly to the bottom of the water as well. It is not possible to try this experiment because oil needs to be very very cold in order to freeze.

Tips: Students may notice the curved surface of the interface between the water and oil. This is called the meniscus, and is caused by water's tendency to be attracted to the sides of containers. See the "meniscus" resource below for more information.

You may wish to have the students predict what will happen both before the water is added and before the ice cube is added. Comparing the predictions with observation can lead to a lively discussion!

Suggested Resources

Density:
http://en.wikipedia.org/wiki/Density

Meniscus:
http://en.wikipedia.org/wiki/Meniscus

Freezing oil:
http://van.physics.uiuc.edu/qa/listing.php?id=1600
http://www.newton.dep.anl.gov/askasci/chem03/chem03265.htm