Heating and Molecular Action

All matter is made up of atoms and molecules. Most matter exists in one of three physical states: solid, liquid, or gas. The particles that make up a solid are packed tightly together, usually in an orderly, rigid pattern. In a liquid, particles are close together, but the shape of a liquid is flexible. That's why your morning orange juice can come out of a square carton and still fit neatly into a round glass. The atoms or molecules in a gas are widely separated, and move about freely at high speeds. Because there is a lot of empty space between particles, gases will take on both the shape and volume of a container. For example, the air in your classroom fills up the whole room, not just one corner.

When you add enough heat energy to a solid, it will melt and become a liquid. Similarly, if you add enough heat energy to a liquid, it will evaporate and become a gas. But what happens between phases when you add heat energy, just not enough to cause a phase change?

When heat energy is transferred to molecules they become more agitated and move around more. The more they move around, the more space they take up. Think about how uncomfortable it feels to ride a crowded bus on a hot summer day—you just want to spread out from the people around you. Molecules "feel" the same way when they are heated up.

What You Need

- safety glasses
- beaker of water
- ring and ball set
- hot plate (or Bunsen burner)

The Experiment

1. Take the room temperature ball and slide it through the ring. You will see that the ball will slide easily through the ring.

2. Make a prediction. Based on what you know about the properties of matter, predict what you think will happen if you heat up the ball and then try to put it through the room temperature ring. Do you think the ball will pass easily through the ring, pass through the ring, but just barely fit, or will the ball no longer fit through the ring? Give a reason for your prediction.

I think the ball will _____.

Reason:

3. Use the hot plate or Bunsen burner to heat the metal ball (approximately 3 minutes). **CAUTION: The ball will get very hot! Use all the appropriate safety precautions**.

4. Remove the ball from the heat and try to slide it through the ring. Was your prediction supported? Describe what happened.

5. Dip both the ring and the ball in water to cool them down. Now try to slide the ball through the ring. What happened?

6. Predict what you think will happen if you heat the ring and try to pass a cool ball through it. Do you think the ball will fit through the ring or not? Give a reason for your prediction.

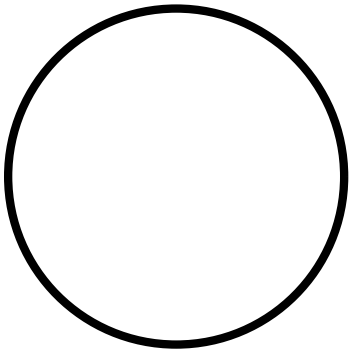
I think the ball will _____.

Reason:

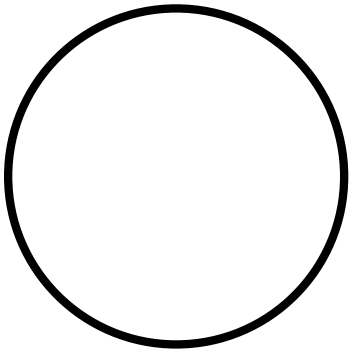
7. Heat the ring and try passing the ball through. What happens? Was your prediction met?

Analysis

Imagine that you have the power to see what is happening at the molecular level inside objects—you can actually see the individual molecules inside the metal ball. In the diagrams below, draw what you think the molecules inside the cool metal ball and the heated metal ball are doing.



Cool Ball



Heated Ball

1. When you heat the ball, are you adding energy, molecules, or both to the ball? Please explain your answer.

2. Describe what happened when you tried to pass the cool ball through the heated ring. Explain why you got a different result than you did when you tried to pass the heated ball through the cool ring. Draw a picture to support your answer.

Real Life Connections

Different materials expand and contract differently. Look at and make observations about the windows and doors in your classroom and around the school. How do they account for the expansion and contraction that is taking place?

In terms of expansion and contraction due to heating and cooling, what would be some differences between the windows and doors of an energy efficient building and an energy inefficient building? What are some steps you could take in your building to help make it more energy efficient?

Step 1:

Step 2:

Step 3:

Describe one or two examples from your own life when you were affected by the expansion or contraction of a material due to heating or cooling.

Connections to Capuano

Research how the Capuano Early Childhood Center controls the climate inside the school to help maintain the energy efficiency of the building and keep teachers and students comfortable.