ACTIVITY 6.1

CANDY IN HOT AND COLD WATER

TEACHING SUGGESTIONS:

Introduce this activity by having the students read the first paragraph and stressing that in a fair test or controlled experiment everything should be the same in the two cups except temperature. Use identical pieces of candy in the two cups. Different candies dissolve at different rates. Differences in speed of dissolving will be more apparent if the candy is broken into small pieces.

STUDENT RESPONSES:

1. Student predictions will vary, but may include:

   a. The candy dissolves in both cups. Wavy lines will be in both cups.

   b. The candy will dissolve faster in the cup with the hot water. There will be more wavy lines in the cup with the hot water.

   c. Hard candy in hot water should dissolve faster than in cold because the molecules of hot water are moving faster and hit the candy more often and harder than in cold. That makes the water molecules knock the molecules of the pieces of candy off faster. (Many students think that the candy "melts" in hot water. You may want to explain that the candy needs a much higher temperature to melt.)

2. Student answers should include the points listed under question number 1 on the previous page.

3. Molecules of water hit molecules of candy and knock them off of the pieces of candy. The separated molecules of candy mix together with the molecules of water.

4. The cup with the hot water. Students may make several suggestions about the difference in the molecules of hot and cold water, but the only difference is that molecules of hot water are moving faster than molecules of cold water. The faster the molecules of water are moving, the more often they knock off candy (sugar) molecules.

Use Transparency 10 here:

TRANSPARENCY 10: WHY DOES THE SUGAR DISSOLVE FASTER IN HOT WATER?

BOTTOM LAYER:

Students often answer this question by saying, "heat causes faster dissolving" or "molecules get hotter and so they move faster and dissolve faster." These are elements of the explanation but not an adequate explanation.

OVERLAY:

Heating a system does make the process of dissolving speed up, but that is not really an answer to the question. The important part of the question is that dissolving is faster in hot water. It is not because molecules heat up (molecules are neither hot or cold), but because they move faster, and are thus able to break off sugar molecules faster.

Use poster 2 here:

ACTIVITY 6.2

HEATING AND COOLING SOLIDS

1. When solids are heated they expand because their molecules move faster, push each other farther apart, and the empty spaces between the molecules become larger.

   When solids are cooled they contract because their molecules move slower, move closer together, and the empty spaces between the molecules become smaller.

   (Some students say that molecules become hot when solids are heated, which is not true--only the substance becomes hot. Students may also say that molecules expand, but molecules only move farther apart--the substance expands. This naive conception is held by "Barry" in question #2 on this page.)

2. Terry. When solids are heated the molecules themselves do not get larger and the number of molecules do not increase. The molecules move faster and push each other farther apart. (Since heat is not a substance, there are no heat molecules.)

3. The hot water heats the jar lid and makes it expand. This causes the lid to expand away from the jar. It does this because the molecules move faster and push each other farther apart when the jar lid is heated.

   (The process actually is a little more complicated than the above explanation implies. The jar is also heated and expands, but not as much as the lid because metal expands more than glass with a given rise in temperature.)

4. In summer the sidewalks get hot and expand compared to the winter. When the sidewalk is heated the molecules move faster, push each other farther apart and the empty spaces between the molecules become larger. Each section of sidewalk is a little larger in the summer than in the winter. The cracks between the sidewalk sections are smaller in the summer than in the winter.

ACTIVITY 6.3

THE THERMOMETER

STUDENT RESPONSES:

1. Most of the colored liquid is in the bulb. (The colored liquid is probably alcohol colored with dye.)

2. The position of the thermometer should not affect the temperature reading.

3. a. When the liquid is heated the molecules move faster, bump into each other harder, and push each other farther apart.

   b. This causes the colored liquid to expand up through the thermometer tube which give a higher temperature reading.

4. No. If you turn the thermometer upside down and heat the bulb, the liquid still expands, but it goes down, not up.

   (The idea that "heat rises" is familiar to students, so they often use it to explain something that "gets higher" when it is warmed. This naive conception may come up again in Lesson 6.4, where warm hands are used to expand air in a bottle and force some of the air out of the bottle's top.)

   In situations where hot substances (not "heat") rise (like ocean currents and weather fronts), it would be more accurate to say "hot liquids and gases are pushed up." Heated fluids (liquids or gases) expand, become less dense than the cooler fluid around them, so that hot fluids are buoyed up by the surrounding cooler fluid. This process is known as convection, and is not included in this unit.)

5. The colored liquid gets smaller or contracts. When the liquid is cooled it contracts because the molecules slow down and move closer together. This gives a lower temperature reading.

   Some students may remember from the Miracle of Water that water is an exception to this general rule between 0 degrees Celsius and 4 degrees Celsius.

After you have finished reading in the Science Book, you may want to have students go back to questions in the Activity Book and change their answers to make them more complete.

ACTIVITY 6.4

THE DANCING DIME

TEACHING SUGGESTIONS:

This activity will work only if the dime forms a tight seal at the top of the bottle. It needs to be wet around the edges to do this.

STUDENT RESPONSES:

1. Air
   Cold

2. The dime jumped or danced.

3. When the air inside the bottle is heated it expands because the molecules of air move faster and hit each other harder. This pushes the molecules farther apart. The expanding air pushes on the dime and forces its way out of the bottle. This makes the dime jump or dance.

   Note: A good optional activity is to place a balloon on a large, cold soda bottle. As it warms up the balloon will inflate. Challenge the students to explain this change by using the kinetic molecular theory.

4. a. The balloon would get larger or expand.

   b. When the air inside the bottle was heated it expanded because the molecules of air moved faster, hit each other harder, and moved farther apart.

      (Some students explain what happens by saying that "heat rises." But the air in the bottle does not move upwards, it only expands and a small amount of air moves out of the opening. Those students who say that "heat rises" will probably be surprised if they tried this activity with the bottle upside down.)

   c. No. The molecules move in all directions, not just up. The molecules throughout the bottle and balloon moved faster, hit each other harder, and moved farther apart.

QUESTION SET 6.4

LESSON CLUSTER REVIEW

STUDENT RESPONSES:

1. a. When substances are heated they expand because their molecules move faster, hit each other more often and push each other farther apart. The empty space between the molecules becomes larger, causing the substances to expand.

   b. When substances are cooled they contract because their molecules slow down, hit each other less often and move closer together. The empty spaces between the molecules become smaller, causing the substances to contract.

2. When you heat the ring it expands and the hole in the ring becomes larger, allowing the ball to go through. The ring expands because when it is heated its molecules move faster, hit each other more often, and push each other farther apart.

3. No. The molecules themselves do not expand or contract. They only move faster or slower.

4. Hot water. The molecules of the hot water are moving faster than the molecules of cold water. The faster the molecules move the more often they will hit the substance and the faster they will knock off molecules of the substance. The hot water will, therefore, dissolve a substance faster than cold water.