HEAT--Hide & Seek

PRE-LAB DISCUSSION

Some textbooks use the term ***latent*** to describe the energy evolved in the change of state of a pure substance. The term latent means "hidden".

Heat energy is usually measured in calories. A kilocalorie is one thousand calories and is often written as simply Calorie [with a capital C] to describe the energy value of foods. The amount of energy needed to raise the temperature of one gram of water one degree Celsius is a calorie.

A thermometer actually measures the average speed of the motion of the atoms and molecules. It does not account for the freedom of motion of the particles. It normally takes more energy for the particles to increase the randomness of their motion [higher entropy].

OBJECTIVE: To learn the difference between heat and temperature.

CHEMICALS/EQUIPMENT: Moth crystals [either paradichlorobenzene (preferred) or naphtha], 150 mm test tube, 400 ml beaker, Bunsen burner, test tube clamp, ring, screen, ring stand, thermometer.

PART I

PROCEDURE:

1. Fill the beaker 3/4 full of water and place it on the ring and screen with the Bunsen burner under it.

2. Place 20-25 grams of moth crystals in the test tube and clamp the tube so that the bottom half of the tube is in the water. Put the thermometer into the moth crystals.

3. In your lab notebook, set up a full sheet of paper with the following three columns:
   1. Observation Number
   2. Temperature
   3. Observations of paradichlorobenzene

4. Heat the water to boiling. Continue heating until the moth flakes form a clear liquid that is the same temperature as the boiling water. Record this temperature for observation number " 1".

5. Turn off the burner and remove the test tube from the water. Clamp it on the ring stand on the opposite side from the beaker of water. Record the temperature and observations of the paradichlorobenzene every two minutes until the substance cools to below 30º Celsius.

PART II

PROCEDURE:

1. Heat the beaker of water to boiling again.

2. Set up another page in your notebook with the same three columns.

3. Record the temperature of the moth crystals. Record this temperature for observation # " 1".

4. Turn off the burner and allow the water to cool for 2 minutes.

5. Clamp the test tube so that the bottom half of the tube is in the hot water. Make and record observations and temperature every 20 seconds until the temperature reaches 75º Celsius.

DATA AND OBSERVATIONS

1. Set up a graph with the temperature on the vertical axis and the observation numbers on the horizontal axis. Graph the points for Part I and connect them with a smooth line.

2. Make another graph for the data from Part II.

THINKING SCIENTIFICALLY

1. Describe the differences between the two graphs.

2. Describe the similarities between the two graphs.

3. At the point on both graphs where the temperature did not change for several observations, what was happening to the material in the test tube?

4. Give an *operational definition* of calorie.

5. Give an *operational definition* of temperature.

6. Give an *operational definition* of "heat of crystallization."

7. There was a period of time when the temperature was about 52º and remained constant for several observation time periods although heat was going into or out of the material. Review the observations of the paradichlorobenzene and the operational definitions above. Write a paragraph or more explaining how the heat content of the material could be changing while the temperature did not change.

POST LAB DISCUSSION

This lab experience highlights the importance of clear, concise operational definitions. *Conceptual* definitions of heat and temperature would not permit a clear explanation of the observations made in this lab.

If we could take the operational definition of temperature to an even more precise level, we could make some very interesting mathematical projections. If we could actually measure the speed of the molecules at each temperature, then we could calculate the reduction in speed for each degree change. We could plot a graph of the *reduction* in speed per change in temperature until "zero" speed is reached. This point is called "absolute zero". Logic will tell us that it is not possible to go slower that "stop". If something is moving any direction, it has a speed. It is not possible to have a negative speed. [you may need to review the difference between speed and velocity] It is also not possible to have a temperature below "absolute zero" which is -273º Celsius.