Name ______________________

# The Heat Lab

## Warming by Freezing?

In this experiment you are going to cause a liquid (actually a supersaturated solution) to rapidly change into a solid. This is a good demonstration of what happens to every liquid as it changes to a solid.

Take both fingers and bend the metal disk back and forth until you see a solid material forming in the packet. What results? Why is the energy change reasonable considering the phase change?

From an energy point of view what would you have to do to change the solid back into a liquid?

How do we accomplish this?

## Flexible or Brittle - Heat Treatment of Iron

Some elements go into different crystalline forms at different temperatures. Iron is such an element. At normal temperatures it has one arrangement of atoms, but at elevated temperatures it goes into another arrangement. You will discover the importance below.

1. Take three bobby pins. Bend each one until you have straight pieces of metal. Heat two in the middle until they turn red. Quickly cool one in water. Let the other cool slowly in the air (about 5 minutes).
2. Attempt to flex each pin in the middle several times. Report your results.

3. Attempt to explain your results in terms of crystalline structure. Do not attempt to make guesses about the type of crystalline structure but comment on the obvious properties of the high temp and low temp structures.

4. Think of and list uses for each type of material.

Flexible iron-

Brittle iron-

## Taking the Heat

1. Add tap water to some crushed ice in a 400 mL beaker so that you have a slurry of ice water. Then pour about 120 g of the cold water with a few ice chips into a 250 mL beaker. Use a thermometer to quickly get the temperature of the cold water. It should be very close to 0˚C. Stir until the ice chips have almost disappeared. Put the beaker immediately on an iron ring with wire gauze and heat using a "cool" Bunsen burner flame underneath. Take the temperature every 30 seconds until you get to 30˚C. Stir slightly with your thermometer but do not let it touch the bottom. Make a data table on another piece of paper. Do not record your data here.

2. Put about 120 g of crushed ice into a 250 mL beaker. Use a thermometer to get the temperature of the ice. It should be very close to 0˚C after careful tapping with your thermometer to remove air pockets. Then put the beaker on an iron ring with wire gauze and heat with a "cool" Bunsen burner flame underneath. Take the temperature every 30 seconds until you get to 30˚C. Tap the ice and stir slightly with your thermometer but do not let the thermometer touch the bottom. Note when all the ice appears to have changed into liquid water. Make a data table on another piece of paper. Do not record your data here.

3. Graph temperature versus time for both runs. Use graph paper or a graphing program such as *Graphical Analysis*. What is the difference in the two graphs?

What is happening to the heat energy added to the ice for the first few minutes of heating? What type of energy is being changed?

## Specific Heat Capacity

The amount of heat that it takes to raise the temperature of 1 g of a substance by 1C˚ is called the specific heat capacity. This value is different for every material and has a great influence on the thermal properties of matter.

1. Weigh the bundle of iron nails and measure out a equal mass of water into a styrofoam cup. Take the temperature of the water in the cup. Mass of nails ________________ Mass of water ______________
Temp of water _______________

2. Put the bundle of iron nails into a beaker of boiling water and leave for 5 minutes. Use a "hot" Bunsen burner flame. Make sure the tip of the inner blue cone touches the bottom of the wire gauze. Take the temperature of the boiling water. Temp of boiling water _________________

3. Place the styrofoam cup with water into another styrofoam cup. This helps to insulate the first cup. A device such as this used to determine thermal properties of matter is called a calorimeter.

4. Quickly move the bundle of iron nails from the boiling water into the calorimeter. Move the bundle up and down a few times to help the heat transfer. Insert the thermometer and read the maximum temperature of the water after it rises. Max temp of water and nails ______________________

Questions - What is the temperature of the iron after it has been in the boiling water?

_______________

We used equal masses of water and iron. Is the final temperature halfway between the temperature of the nails and the water? What is it closer to? _______________________

What does this answer mean about the relative specific heat capacity values of water and iron?

Determine mathematically what the specific heat capacity of iron is in calorie units assuming that liquid water has a heat capacity of 1.00 calorie/g C˚.

## Expand your knowledge

Notice how easily the metal ball goes through the metal ring. Then heat the ball in a "hot" Bunsen burner flame. Now try putting it through the ring. What happens? Why?

Immediately heat the metal ring as well. Now can you put the ball through the ring? Why?

Bimetallic strips are used in thermostats. They have 2 different metals that are "glued" back to back to make the strip. This means that different metals are on different sides of the strip.
Take the bimetallic strip and heat it gently in the flame. What happens to the strip? What property must be different for the 2 strips for it to do this?