Experiment 7: Heat

Phase Changes

Matter has 4 *phases* or *states*: solid, liquid, gas, and plasma. This lab looks at the phase transitions from solid to liquid to gas.

1. Obtain the following materials: 600mL beaker of ice, thermometer, hot plate, timer.

2. Add a very small amount of water to the ice so that air doesn't reach the thermometer bulb.

3. Set the temperature to "Medium" or a little above.

4. Heat the ice/water, stirring regularly (*especially when it is both ice and water*, and just before a temperature reading.)

5. Take temperature readings once a minute, even if nothing seems to be happening. Be sure to keep the thermometer *off the bottom of the beaker* when reading temps. Read question #9 as you take data so you can answer it later. Note the following events in your observations:

    a. All ice is melted.

    b. Visual distortions form in the water due to thermal currents and density changes.

    c. First noticeable steam appears.

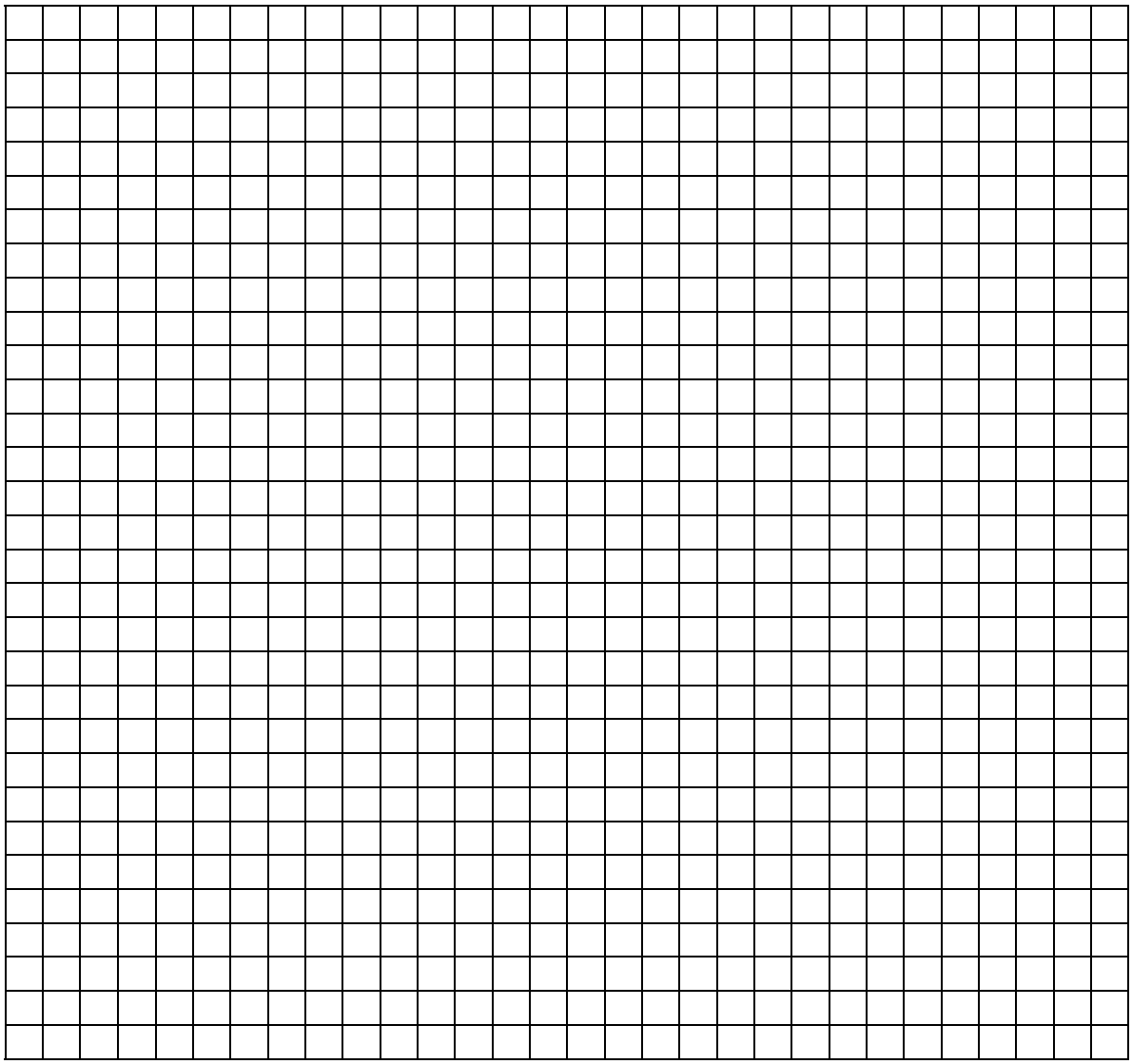
    d. Bubbles start. (Well before boiling you will notice very small bubbles on the side of the beaker. These are actually air, not steam, released from the water in which they were dissolved. You can ignore these.)

    e. Bubbles form from the center of the water

6. Keep taking data for at least 3 minutes after a full boil is reached.

Time (min)	Temp (°C)	Observations	Time (min)	Temp (°C)	Observations

7. Graph the data.



8. a) Now note on the graph the points where:

   - All the ice is just melted,

   - Bubbles form from the center of the water (full boil)

9. As the water first starts to boil, what happens to the bubbles? Explain.

10. There should be two "flat spots" in the graph, where the temperature is steady even though the burner is supplying heat to the ice/water. In each of these flat spots, where does this heat go?

11. After the ice melts, what effect does the heat have on the system?

Calorimetry

The *temperature* of something is a measure of the average kinetic energy of the atoms or molecules that make it up. From a practical standpoint, temperature is "what a thermometer measures."

Scientifically, *heat* is energy transferred between two bodies when their temperatures are different, such as the hot plate and the water. Once the temperatures are the same, heat no longer flows between them even though they may be very hot, such as when the burner is turned off at the end. The units of heat are joules, calories, or kilocalories (the kilocalorie is just called the "calorie" when referring to food).

1. It takes 1 calorie of heat energy to raise the temperature of 1 gram of water by 1°C. Thus the *specific heat* of water is (1cal/gm)/°C. How many calories would it take to raise the temperature of 100 grams of water from 60°C to 61°C? _____
   from 40°C to 50°C? _____

2. In general you can find the energy needed for a temperature change by $Q=mc\Delta T$, where Q is in calories, m is in grams, c is the specific heat of the substance, and ΔT is the temperature change (final minus initial).

3. Obtain 2 styrofoam cups (one large and one small), a plastic cup, a graduated cylinder, and 2 thermometers.

4. Fill the large Styrofoam cup with hot water, and the plastic cup with cold water. These are the "supply" cups. Keep a thermometer in both cups.

5. Record the temperature of the cold water and then measure and add 100g to the small Styrofoam cup (the "mixing" cup).

6. Record the temp of the hot water and then measure and add 20g to the mixing cup.

7. Stir gently with the thermometer. Record the highest temperature reached for the mixture. When the waters mix, the hot water gives up its heat to the cold water: the hot water goes down in temp (to the mixed temp) and the cold water goes up in temp (to the mixed temp). Dispose of the mixed water after recording its temp.

8. Repeat this procedure (steps 5-7) for additions of 40, 60, 80, and 100 grams of hot water. **Use 100g of new cold water each time.** Refill the supply cups as needed.

9. Do the calculations to complete your table. As alluded to in step 7, it might be helpful to think of the cold water and hot water as separate entities, even though they are mixed.

Initial temp of 100-g cold water (°C)	Final temp of hot-cold water mixture (°C)	Temp change of cold water (°C)	*Calculated calories gained by 100-g cold water*	Mass of hot water (g)	Initial temp of hot water (°C)	Final temp of hot-cold water mixture (°C)	Temp change of hot water (°C)	*Calculated calories lost by hot water*
				20				
				40				
				60				
				80				
				100				

10. Compare the *calories gained by the cold water* to the *calories lost by the hot water*, and explain.