Heat and Temperature - Anatomy of a Phase Change

Name ____ Date ___________ Time ___________

Purpose: To create a heating curve for a sample of water, initially in the solid phase which ends in the vapor phase at experiment conclusion. In addition, a detailed individual analysis of the resulting curve will be submitted

Apparatus/Supplies per class/group: Data Studio temperature probe, 1 L glass beaker, ice, stir bar, heating/stirring plate, ring stand, hot mitts

Equations: $Q = mc\Delta T$ (c_{ice} or c_{water}), $Q_f = mL_f$ (L_f: latent heat of fusion, 80.0 cal/g) , $Q_v = mL_v$ (L_V: latent heat of vaporization, 540.0 cal/g)

Background: The enthalpy of fusion, also known as the heat of fusion or specific melting heat, is the change in enthalpy resulting from the addition or removal of heat from 1 mole of a substance to change its state from a solid to a liquid (melting) or the reverse processes of freezing. It is also called the latent heat of fusion, and the temperature at which it occurs is called the melting point.

When thermal energy is withdrawn from a liquid or solid, the temperature falls. When thermal energy is added to a liquid or solid, the temperature rises. However, at the transition point between solid and liquid (the melting point), extra energy is required (the heat of fusion).

In going from liquid to solid (freezing), the molecules of a substance become arranged in a more ordered state. For them to attain the order of a solid, slightly less heat is withdrawn at the point of crystallization. That not withdrawn heat is stored in the form of primarily potential energy to build the solid lattice. In going from solid to liquid (melting), the molecules of a substance become arranged in a less ordered state. To create the relative disorder from the solid crystal to liquid, slightly more heat is added at the point of decrystallization. That energy from heat is utilized to break the solid lattice. This heat does not result in a temperature change, and is called a *latent* (or hidden) heat.

The heat of fusion can be observed by measuring the temperature of water as it freezes. If a closed container of room temperature water is plunged into a very cold environment (say −20 °C), the temperature will fall steadily until it drops just below the freezing point (0 °C). The temperature then will rebound and hold steady while the water crystallizes. Once the water is completely frozen, its temperature will fall steadily again.

http://en.wikipedia.org/wiki/Enthalpy_of_fusion

heat of fusion - heat absorbed by a unit mass of a solid at its melting point in order to convert the solid into a liquid at the same temperature; "the heat of fusion is equal to the heat of solidification"

heat of transformation, latent heat - heat absorbed or radiated during a change of phase at a constant temperature and pressure http://www.thefreedictionary.com/heat+of+fusion

heat of vaporization - The amount of heat required to convert a unit mass of a liquid at its boiling point into vapor without an increase in temperature. http://www.thefreedictionary.com/heat+of+vaporization

Procedure: Turn the heating element to ~7-8. Place the stir bar in the beaker and fill with crushed ice. Turn the stirring function on. Place the temperature probe in the beaker, yet not resting on the beaker bottom or impeding the stirring motion. Start recording temperature. Stop recording after a short plateau at 100^0 is reached.

Assignment: Individually, write a report on what is happening in area 1, 2, and 3, discussing the heat (Q), temperature and phase in each one. **Label each occurrence when it happens on the graph** - condensation appearing/disappearing, stir bar starting/stopping, bubbles forming, but not breaking the surface, first sign of steam, etc. **Include the temperature and time for the occurrence**. There are three states of matter and we see each in our experiment. The heat input never varied, yet the temperature varied according to the distinct region of the heating and cooling curve. Discuss heat in each region. Why does the experimental graph have curves and bumps, not distinct angles as the textbook temperature changes? Two graphs are provided to help justify your reported explanations. Use your lecture text book to help you construct an intelligent, informed analysis of the graph.

Submit individually, electronically to Blackboard by one week from your class time. You must have a labeled graph embedded in your document. Label areas 1, 2, and 3.