Unit 3 – Energy & States of Matter Standards to be Assessed

(3.01) I can describe what is happening at the particle level during temperature or phase changes using thermal energy, phase energy, motion and collisions
(3.02) I can represent and quantify energy storage and transfer during system changes using energy bar charts (LOL)
(3.03) I can relate changes in energy to the arrangement and motion of particles using particle diagrams
(3.04) I can draw heating curves for various situations,label solid, liquid, gas and determine how heating curves are affected by heat and mass changes.
(3.05) I can draw a heating curve given initial and final phases and temperatures (know the melting point and boiling point of water)
(3.06) I can relate the regions on a heating/cooling curve to a change in thermal energy and phase energy
(3.07) I can calculate using temperature, specific heat capacity, heat capacity
(3.08) I can calculate using heat of fusion, & heat of vaporization
(3.09) I can calculate a specific heat capacity using calorimetry data such as in the lab experiment with the coffee cup calorimeter.
(3.10) I can identify specific heat capacity using slope of Q vs. T, algebraically, and via experimental data.

Instructional goals

1. Relate observations regarding the addition of energy by warming to increased particle motion.
2. Describe the characteristics of solids, liquids and gases in terms of particles and their:
Arrangement: use particle diagrams to account for motion and density differences; describe the process of how the arrangement of matter particles changes during phase changes.
Attraction: infer the necessity of an attractive force between particles at close range from observations of differences in cohesiveness of the three phases;
Behavior: describe and contrast particle motion in the three phases singly, and during phase changes.
3. Recognize energy as a conserved, substance-like quantity that is involved when a system undergoes change.
4. Recognize that energy is stored in an object or system in several ways; for now we restrict our discussion to:
Thermal – due to the motion of the particles. The thermal energy depends on the mass and the velocity of the particles. The temperature of a system is a measure of its thermal energy.
Phase – due to the arrangement of the particles in solid, liquid and gaseous phases. Attractions lower the energy of a system; therefore, solids have the lowest phase energy because the particles are bound most tightly, liquids have greater energy because they have more freedom of motion, and gases have the greatest amount of energy because the particles have overcome the attractions that hold solids and liquids together.

5. Draw energy bar graphs to account for energy storage and transfer in all sorts of changes. Make up a sample situation and sketch the LOL bar graph.
6. Given a heating/cooling curve for a substance, identify what phase(s) is/are present in the various portions of the curve, and what the melting and freezing temperatures for the substance are.
7. Given a heating/cooling curve for a substance, identify which energy storage mode is changing for the various portions of the curve.
8. Given a situation in which a substance at a given temperature undergoes a change (in temperature, phase or both), sketch a heating/cooling curve that represents the situation.
9. State the physical meaning of the heat of fusion (Hf) and heat of vaporization (Hv) for a given substance and use these factors to relate the mass of a substance to the energy absorbed or released during a phase change (at the melting or boiling temperature).
10. State the physical meaning of the specific heat capacity (C) of a substance and use this factor to relate the mass and temperature changes to the energy absorbed or released during a change in temperature (with no phase change). Specific heat capacity is obtained via the slope of a temperature change relative to mass and heat supplied. $C = Q/(m \Delta T)$ and thus large specific heat capacities require more energy to raise the temperature.
11. Specific heat capacity is used to describe a material (per gram of material) where heat capacity is used to describe an object.
12. Conductors change temperature rapidly, insulators change temperature slowly. High heat capacity requires a lot of energy to change temperature by the same amount as something with a low heat capacity.