Unit 7 – Energy & Particles

Essential Questions

What is heating?
How does the transfer of energy through heating affect the physical characteristics of matter?
What is temperature?
How is temperature related to particle motion in a substance?
How does phase change relate to particle motion and energy storage and transfer?

Instructional goals

By the end of this unit, you should be able to do the following:

1. Particle motion and energy
   Relate observations regarding the addition of energy by warming to increased particle motion.
   Explain, at the particle level, how a thermometer measures the temperature of the system.
   State the basic tenets of Kinetic Molecular Theory (KMT) as they relate to gases:
   Particles of a gas:
   - The speed of the particles is related to their temperature.
   - The pressure of a gas is related to the frequency and impact of the collisions of the gas particles with the sides of the container in which they are enclosed.

   Recognize energy as a conserved, substance-like quantity that is always involved when a system undergoes change.
2. Energy storage containers
   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.
3. Energy storage mechanisms
   Describe the ways that energy is transferred between the system and the surroundings. These are:
   - Heating – transfer of energy through the collisions of particles
   - Working – transfer of energy when macroscopic objects exert forces on each other
   - Radiating – transfer of energy by the emission or absorption of light
4. Heating and cooling curves
   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.
   Given a heating/cooling curve for a substance, identify which energy storage mode is changing for the various portions of the curve.
   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.

Sequence

1. Demo on thermal expansion of liquids, explanation of how a thermometer works,
2. Watch Eureka videos - Expansion and Contraction; Measuring Temperature. Discussion to define temperature
3. Exercise 1 – Temperature and motion of particles
4. Discussion of solution parts, solubility and reading curves
5. Exercise 2 – Reading solubility curves
6. Heat vs Temperature discussion, Eureka episode Heat vs Temperature. Predict the effect of the addition of energy to a system of particles in the solid or liquid state.
7. Activity 1 – Heat Transfer – Conduction, Convection and Radiation
8. Activity 2 - Icy Hot, collect data, plot graph of temperature vs. time
9. Activity 3 – Freezing Lauric Acid
10. Exercise 3 – Energy bar charts part 1
11. Exercise 4 – Energy bar charts part 2
12. Test