Topic 6 Overview

Topic 6A: Heat & Temperature

1. Energy can exist in different forms – chemical, electrical, electromagnetic, thermal, mechanical, nuclear.

- ✓ Stored energy is referred to as potential energy.
- ✓ Energy of motion is kinetic energy.

2. The Law of Conservation of Energy states that energy can not be lost or destroyed, only changed from one form to another.

3. Heat is a transfer of energy (often but not always thermal energy) from a body of higher temperature to a body of lower temperature.

4. Temperature is a measure of the average kinetic energy of the particles in a sample. Temperature is NOT a form of energy and should not be confused with heat.

5. The concepts of kinetic and potential energy can be used to explain physical processes such as fusion (melting), solidification (freezing), vaporization (boiling, evaporation), condensation, sublimation, and deposition.

6. Processes that are exothermic give off heat energy. This typically causes the surrounding environment to become warmer.

7. Processes that are endothermic absorb energy. This typically causes the surrounding environment to become colder.

Topic 6A: Heat & Temperature Outline

1. Temperature is a "measure of the average kinetic energy of the particles in a sample of matter."

- ✓ Kinetic energy is energy due to motion. So as temperature increases, the particles move faster, on average.
- ✓ Temperature does NOT depend on the mass of the sample.

2. Temperature scales used by chemists are the Celsius and Kelvin scales.

- ✓ The freezing point of water is a reference point often used in science, and is referred to as "standard temperature." Its value is 0^oC or 273 K, and is noted on Table A.
- ✓ The boiling point of water is 100^oC or 373 K.
- ✓ Converting from C^o to K: $K = C^o + 273$ (on Table T)

3. Heat is a form of energy and IS NOT the same as temperature.

- ✓ Heat is dependent on mass. There is more heat in an iceberg that is at 0^0C than a cup full of boiling water.
- ✓ Heat can be transferred from one substance to another when their particles are in contact (when the objects touch). Heat will move from the object with more particle KE (higher temp) to the one with less.
- ✓ The amount of heat needed to cause a temperature change is dependent on the mass of the sample, its "specific heat" and the amount of temperature change: $q = m\ c\ \Delta T$ (Table T) When heat is absorbed to cause a temperature change, it is resulting in a change in KE of particles.
- ✓ The amount of heat needed to cause a phase change can be calculated using the $q = mHf$ (melting), or $q = mHv$ (boiling) (Table T). When heat is added to cause a phase change, it is causing a change in intermolecular forces between particles.
  - ✓ The values for water are on Table B.

4. Heat of fusion (H_f) is the energy needed to convert one gram of a substance from solid to liquid.

5. Heat of vaporization (H_v) is the energy needed to convert one gram of a substance from liquid to gas.

6. Specific heat (C) is the energy required to raise one gram of a substance 1 degree (Celcius or Kelvin).

- ✓ The specific heat of liquid water is 1 cal/g*J or 4.2 J/g*K.

7. The three phases of matter are solid, liquid and gas. Each has its own properties.

- ✓ Solids have a constant volume and shape. Particles are held in a rigid, crystalline structure.
- ✓ Liquids have a constant volume but a changing shape. Particles are mobile but still held together by strong attraction.
- ✓ Gases have no set volume or shape. They will completely fill any closed contained. Particles have largely broken free of the forces holding them together.
- ✓ The phase a substance is in is dependent on the temperature. Melting points and boiling points are on Table S (in Kelvin degrees).

8. Phase changes are a type of physical change. If they are changes that involve heat being absorbed, they are endothermic changes.

- ✓ Endothermic phase changes are melting, boiling, evaporating and subliming (s→l).
- ✓ Opposite type of phase changes (freezing, condensing, depositing) are exothermic.

9. A heating curve (or cooling curve) traces the changes in temperature of a substance as it changes from solid to liquid to gas (or gas to liquid to solid).

- ✓ When the substance undergoes a phase change, there is no change in temperature. The line "flattens" until the phase change is complete.
- ✓ When a phase change is occurring, the potential energy of the substance changes while kinetic energy remains the same.
- ✓ As temperature increases, kinetic energy increases.

10. The amount of heat involved in some chemical changes is shown on Table I, called "heat of reaction" or ΔH.

- ✓ If the value is negative, the reaction is exothermic.
- ✓ This can be expressed as a potential energy diagram.
- ✓ If the energy is written into the equation, and is on the reactants side, the reaction is endothermic.
- ✓ ↯H is the difference between the energy stored in the products (PE) and the potential energy of the reactants.

11. Breaking bonds is ALWAYS endothermic, and forming bonds is ALWAYS exothermic.

- ✓ I + I → I_2 Bond is forming, I atoms are become stable by bonding, so they release energy (Exo)
- ✓ H_2 → H + H Bond is breaking, requires energy in order to put atoms in unbonded state (endo)