CHAPTER 5 – THERMOCHEMISTRY OVERVIEW OF CONCEPTS

Energy and Energy Transfer

Energy = Kinetic + Potential Energy

Kinetic Energy: Energy an object has when it is moving

K.E. = 1/2 mv^2 (m=mass (kg) v=meters/second)

For any object the average kinetic energy of its atomic-sized particles is directly proportional to the absolute temperature (Kelvin)

As temperature increases - KE increases

Potential Energy: Stored Energy

If an object feels no attractive or repulsive forces then it has NO potential energy.

When objects that attract are:

- **pulled apart, PE increases**
- **pushed together, PE decreases**

When objects that repel are:

- **pulled apart, PE decreases**
- **pushed together, PE increases**

Note: Think of the increase or decrease in force

Can also be referred to as Chemical Energy. When chemicals react, the changes in their bonds and atomic repulsions and attractions cause changes in Potential Energy (i.e. Chemical Energy)

Conservation of Energy

Major physical law

Energy can be neither created nor destroyed. It can only be transformed from one kind to another.

Heat Energy

This is really the Kinetic Energy of atoms and molecules

When something gets hot the average KE is large (more heat)

When something gets cold the average KE is small (less heat)

Heat flows from a hot object to a cold object (or to a less hot object)

Energy Changes in Chemical Reactions

Exothermic change

Temperature rises (KE increases) and Potential Energy decreases

Endothermic change

Temperature decreases (KE decreases) and Potential Energy increases

Measuring Energy in Chemical Reactions

SI Unit for Energy is a Joule (another unit for energy= erg)

1 J = 1 kg m^2/s^2

1 calorie = 4.184 J

1 Calorie = 1000 calories

Heat Capacity

The amount of heat needed to raise something by 1°C

Units: J/°C or cal/°C

Heat Capacity depends on the size of the sample

To Calculate:

Specific heat x mass = heat capacity

Specific Heat

The amount of heat needed to raise 1 gram of a substance by 1°C.

Units: J/g°C or cal/g°C

Specific heat of water = 4.184 J/g°C

To calculate the energy needed to raise the temperature of a substance:

Specific heat x mass x ΔT = Energy (J)

$\Delta T = (T_{final} - T_{initial})$

***note: When computing Final Temperature calculations utilizing equations set equal (heat loss = heat gained) remember that ΔT must be set up to be a positive number.**

Calorimetry: measuring energy changes in chemical reactions

Heat of Reaction ΔH = energy change in a chemical reaction

Calorimeter

Bomb Calorimeter

Heats of Reaction and Thermochemistry

Thermochemistry = The study of heats of reaction

System + Surroundings = Universe

Adiabatic Change

No heat can flow between the system and the surroundings (insulated)

If temperature of the system increases = exothermic

If temperature of the system decreases = endothermic

Isothermal Change

Heat can flow between the system and the surroundings therefore the system can maintain a relatively constant temperature

A good example would be to think of your body constantly exchanging energy with the surroundings to maintain a constant body temperature.

Enthalpy and Enthalpy Changes ΔH

Enthalpy = heat of reaction at constant pressure = ΔH

Endothermic = +ΔH

Exothermic = -ΔH

State Functions

A quantity whose value depends only on its current state regardless of the path (history)

Enthalpy, temperature, pressure, altitude, latitude, etc. are state functions

Hess's Law of Heat Summation

"It is possible to look at some overall change as the net result of a sequence of steps and the net value of ΔH for the overall process is merely the sum of all the enthalpy changes that take place along the way."

Simply a restatement of the Law of Conservation of Energy

Utilizes thermochemical equations to compute ΔH of an overall reaction.

Manipulating Thermochemical Equations

Identify the position of the desired reactants and products in the given thermochemical equations

If needed, reverse an equation, however don't forget to reverse the sign of ΔH.

ΔH are molar quantities so if there are coefficients, divide the entire equation to eliminate, however don't forget to divide the ΔH too.

Heats of Formation

ΔH_f = Formation of one mole of a substance from its elements

Standard States

Standard State = 25°C and 1 atmosphere of pressure

ΔH^0 = standard heat of reaction

ΔH_f^0 = standard heat of formation

NOTE: For any element in its standard state, $\Delta H_f^0 = 0$

Phase Changes – Heating and Cooling Curves

Phase Change Diagrams and Terminology of Phase Changes

Melting-Freezing, Vaporization-Condensation, Sublimation-Deposition

Calculating Heating and Cooling with Phase Changes

ΔH_{fus} ΔH_{vap} Q= ΔH n n=moles (units in kilojoules)

Q=m $C_{(choose\ appropriate\ state)}$ ΔT (units in Joules)