THERMODYNAMICS and the FIRST LAW OF THERMODYNAMICS

Thermodynamics is the study of the changes in heat energy associated with both chemical and physical changes. (thermo = heat, dynamic = change)

Potential Energy (energy of position) Includes:
- gravitational potential
- elastic potential
- electrical potential
- nuclear potential
- chemical potential energy

Kinetic Energy (energy of motion) Includes:
- motion (big motion – in the gross sense i.e buses and trains)
- heat (small motion)
- (light energy – difficult as usual)

Law of Conservation of Energy: energy cannot be created nor destroyed, it can only be change from one form to another.

$$\Delta H = -Q$$

Derivation of $\Delta H = -Q$, The **First Law of Thermodynamics**

- the total energy (E_t) of any system will be the sum of all potential energies (E_p) and all kinetic energies (E_k)

$$E_t = E_p + E_k$$

- it follows that any change in potential or kinetic should be reflected in the total energy

$$\Delta E_t = \Delta E_p + \Delta E_k$$

- however, due to the law of conservation of energy, the total energy of a system cannot change and therefore:

$$\Delta E_t = 0$$

- therefore:

$$0 = \Delta E_p + \Delta E_k$$

$$\Delta E_p = -\Delta E_k$$

- therefore any change in potential energy will cause an opposite change in the amount of kinetic energy – a direct consequence of the law of conservation of energy

- chemical potential energy is called **enthalpy** (nice special name to make it more confusing). It has a symbol H.

- chemical potential energy cannot be measured directly (impossible due to the size of atoms), unlike physics where potential energy can be deduced from direct measurements (i.e. a rock on a cliff)

- only changes in potential energy can be measured (and then only indirectly), hence **H** is always shown as **ΔH,**

- absolute enthalpy, **H,** cannot be measured hence the symbol **H** is never seen (absolute measurements must have a zero point that is really zero: eg temperature in K, mass in any unit, distance, time)

- therefore ΔE_p is the same as **ΔH**

- kinetic energy is heat (i.e motion of particles)

- heat energy has the symbol of **Q**

- Q represents a positive quantity of heat energy

- if the value for Q is positive, it means that heat energy is increasing or being added

- if the value of Q is negative, it means that heat energy is consumed or being removed

- therefore ΔE_k is the same as **Q**

- finally:

$$\Delta E_p = -\Delta E_k$$

becomes

$$\Delta H = -Q$$

This Is the Law of Conservation of Energy for Chemistry
The First Law of Thermodynamics

- Since potential energies cannot be measured directly, the **only way to find potential differences** is to measure changes in heat. Hence Q can be measured and then using $\Delta H = -Q$, potential energy changes can be found.