B.Sc. I (H+S), Paper–IA

Heat capacity

Heat capacity is defined as the amount of heat required to change the temperature of system by one degree is called heat capacity of the system.

If q heat is absorbed to ~~raise~~ rise the temperature of system from T_1 to T_2 then

$$\text{Heat capacity} = C = \frac{q}{T_2 - T_1} = \frac{q}{\Delta T}$$

For infinitesimale change ~~of heat~~ it can be written as

$$C = \frac{\partial q}{dT} \quad \text{—— (I)}$$

As q is not a state function, hence heat capacity is also not a state function.

According to first law of thermodynamics

$$dq = dE + PdV \quad \text{—— (II)}$$

At constant volume $dV = 0$

$$dq = [dE]_V$$

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$$\therefore \quad C_V = \left(\frac{dE}{dE}\right)_V \quad \text{------} \quad (iii)$$

C_V is called heat capacity at constant ~~tem~~ volume

Thus heat capacity at constant volume is defined as the rate of change of ~~en~~ internal energy of system with temperature.

From definition of heat constant or enthalpy

$$H = E + PV \quad \text{------} \quad (iv)$$

differentiate it w.r.to temperature at constant pressure

$$\left(\frac{dH}{dT}\right)_P = \left(\frac{dE}{dT}\right)_P + P\left(\frac{dV}{dT}\right)_P \quad \text{------} \quad (V)$$

According to definition of Heat capacity.

$$\left(\frac{dH}{dT}\right)_P = C_P \quad \text{------} \quad (VI)$$

Hence equation (V) will be.

$$\boxed{C_P = \left(\frac{dE}{dT}\right)_P + P\left(\frac{dV}{dT}\right)_P}$$

$$= \left(\frac{dH}{dT}\right)_P$$

Hence Heat capacity at constant pressure is the rate of change of enthalpy of system with temperature at constant pressure.

Relation between C_v and C_p -

From definition

$$C_p = \left(\frac{dH}{dT}\right)_P \text{ and } C_V = \left(\frac{dE}{dT}\right)_V$$

From Enthalpy definition

$$H = E + PV$$

or $$H = E + RT \quad (\text{For 1 mole } PV = RT)$$

Differentiate with respect to T

$$\frac{dH}{dT} = \frac{dE}{dT} + R$$

or $$\frac{dH}{dT} - \frac{dE}{dT} = R$$

or $$\boxed{C_p - C_V = R}$$

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