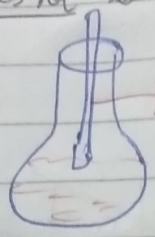
Internal Energy

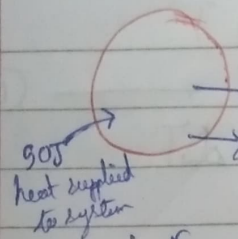
When we have an object and we measure how hot/cold that object is :-
On thermometer, it shows thermal energy
But it does not tell us the total energy of the system



→ Tells us about heat content and not total energy of system.

∴ Internal Energy (E) = Σ all energies

Eg:-

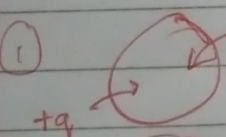


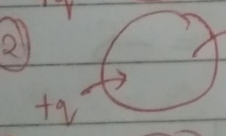
[E_1 & E_2 → internal energy before & after 90 J heat supplied]

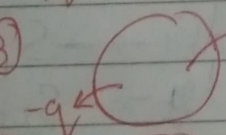
∴ $E_2 - E_1 = 90J$ ∴ $\Delta E = 90J$

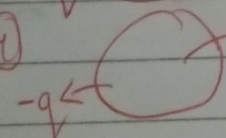
Hence, change in Internal energy can be determined

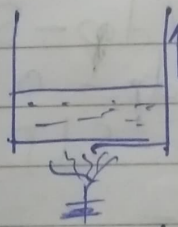
$$\Delta U = \text{Heat} + \text{Work done}$$
$$\downarrow q \qquad \downarrow W$$

Type ① 

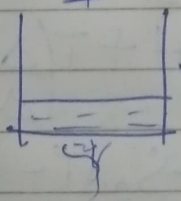
Type ② 

Type ③ 

Type ④ 



↑ Expands (+W)
Work done by system (-ve)



↓ Contracts (+W)
Work done on system (+ve)

Work done by system :- Energy expended by system to spread out their molecules (-W)
Work done on system :- Energy used on system itself to close the gaps in their molecules (+W)

Enthalpy :-

Heat supplied to a system (at constant pressure) → ΔH (Change in Enthalpy)

For Internal Energy :-

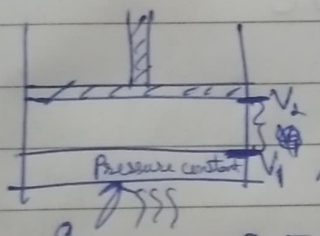
Consider a closed system, q J (heat) supplied to system
Part of this heat is used by system.

↙

To increase internal energy (ΔE) and rest of the heat is used for external work.

Heat(q_v) supplied to system is used to increase internal energy(ΔE) supplied to the system for doing external work (W)

$$\boxed{q_v = \Delta E + W}$$



Work done by the system :-

$W = P\Delta V \quad [\because \Delta P = 0]$

$q_v = \Delta E + P\Delta V$

$\Rightarrow \boxed{\Delta E = q_v - P\Delta V}$ → Internal energy formula at constant pressure

$\boxed{\Delta E = q_v - P\Delta V - V\Delta P}$ at normal conditions

$\Delta E = q_p - P\Delta V$ [heat supplied at const pressure]

For Enthalpy :-

$\boxed{H = E + PV}$

Enthalpy of system → State function

At constant pressure :-

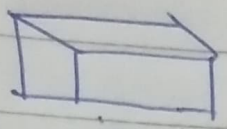
$$\begin{aligned} q_v &= \Delta E + P\Delta V \\ &= (E_2 - E_1) + P(V_2 - V_1) \\ &= (E_2 + PV_2) - (E_1 + PV_1) \\ &= H_2 - H_1 \end{aligned}$$

$\Rightarrow \boxed{q_v = \Delta H}$

$\therefore \Delta H$ → change in enthalpy where change in heat is accompanied at constant pressure

Types of Enthalpy :- 1 mole, Isothermal, Constant pressure

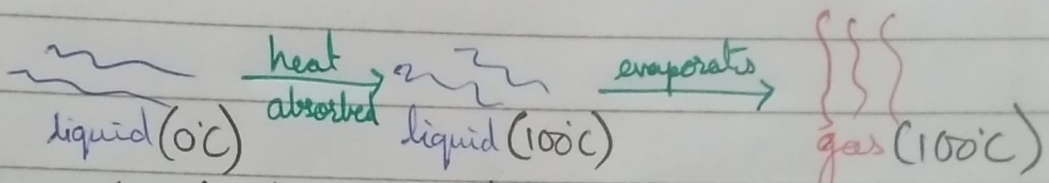
1) Enthalpy of fusion :-



$q = -W$
↳ work done by system to melt ice

It is the amount of heat required to melt 1 mole of solid ice to liquid such that there is no change in temperature

2) Enthalpy of vaporisation :-



It is the amount of heat required to evaporate 1 mole of liquid to gas such that there is no change in temperature

3) Enthalpy of combustion :-

It is the amount of heat required to completely burn 1 mole of substance in excess of O_2 !

4) Enthalpy of formation :-

It is the change in ~~ethe~~ enthalpy required for formation of a compound from its elements

Eg :- $2H_2 + O_2 \rightarrow 2H_2O$