Thermodynamics
Lecture: 04 for Part I & Part II (Hons)

Internal energy (E): It is the sum of all the forms of energy and in an object, except Gravitational We represent internal energy by

$$E = E_p + E_K \quad - I$$

$$= E_p + E_V + E_R + E_e + \dots$$

In second equation E_V = energy of vibration, E_R = Rotational energy, E_e nic energy are actually the Kine Kinetic energy only.

- It can not be measured absol because it is the sum of diffe kind of energies whereas all th of energy can not be measur lutely at a time.
- It is state function because in in temperature internal energy object increases. $E \propto T$, so when $\Delta T = 0$
- It is extensive property because and kinetic

In Cyclic & isothermal condition Δ always zero.

Enthalpy : (H) :

Enthalpy is the sum of internal en and work done.

$$H = E + PV \quad \text{——————} \quad I$$

So $H_1 = E_1 + PV_1$

or $H_2 = E_2 + PV_2$

Change

$$(H_2 - H_1) = (E_2 - E_1) + P(V_2 - V_1)$$

$$\Delta H = \Delta E + P\Delta V \quad \text{——————} \quad II$$

Note : Most of the reaction take place at Consta & have not Consid for ideal gas

$$PV = nRT$$

or $$P\Delta V = \Delta n_g RT \quad \text{——————} \quad III$$

Now we put the value of PΔV from III to equation I we have

$$\Delta H = \Delta E + \Delta n_g RT \quad \text{——————} \quad IV$$

Where : Δn_g = Change in no. of mol

· Enthalpy is also state function.

· In previous cases we have solved for these reactions which take place pressure, but both P & V can change we can write the formula as fo

$$\Delta H = \Delta E + \Delta PV$$

or $$\Delta H = \Delta H + (P_2V_2 - P_1V_1)$$

· e.g of

Q A non ideal gas goes from ~~stage~~ stage 1 to stage (P = 3 atm, V = 5L, T = 300K) (P = 5

If the ΔE is 60 atm L, find out

Ans. $$\Delta H = \Delta E + (P_2V_2 - P_1V_1)$$

$$= 60 + (5 \times 8 - 3 \times 5)$$

$$= 60 + (40 - 15)$$

$$= 60 + 25$$

$$= 85 \text{ atm L.}$$

Q ΔH and ΔE for the reaction (

$Fe_2O_3(s) + 3H_2(g) \longrightarrow 2Fe(s) + H_2O(l)$

Q $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$, for the above rea
Correct statement is (Manipal
i) $\Delta H < \Delta E$ ii) $\Delta H = \Delta E$ iii) $\Delta H > \Delta E$ iv)

Ans. (I), Soln

$$\Delta n_g = 2 - 4 = -2$$

$$\Delta H = \Delta E - 2RT$$

So, $\Delta H < \Delta E$

Q. Calculate the difference between ΔE & the following reaction at 27°C (in K·Cal):

$C(\text{graphite}) + 2H_2(g) \longrightarrow CH_4(g)$

i) 0.6 ii) −1.2 iii) +0.6 iv) +1.2

Ans. (iii),

$$\Delta H = \Delta E + \Delta n_g RT$$

or $\Delta H - \Delta E = -\Delta n_g RT$

In the above reaction,

$$\Delta n_g = 1 - 2 = -1$$

$$\Delta H - \Delta E = -(-1) \times 2 \times 300$$

$$= 600 \text{ Cal} = 0.6 \text{ K. Cal.}$$

Q. If one mole of NH_3 and one mole of [illegible] mixed in a close container to form Chloride gas then

i) [illegible] ii) $\Delta H = \Delta E$ iii) $\Delta H < \Delta E$ iv)