

Internal energy (E): It is the sum of all the forms of energy available 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 = electronic energy are actually the kinetic energy only.

• It can not be measured absolute because it is the sum of different kind of energies whereas all the forms of energy can not be measured at a time.

• It is state function because with increase in temperature internal energy of object increases. $E \propto T$, so when $\Delta T = 0$

• It is extensive property because internal energy and kinetic

In Cyclic & isothermal conditions Δ always zero.

Enthalpy : (H):

Enthalpy is the sum of internal energy and work done.

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

So $H_1 = E_1 + PV_1$

or $H_2 = E_2 + PV_2$

Change

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

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

Note : Most of the reaction take place at constant pressure for ideal gas ~~is~~ ^{I have not consid}

$$PV = nRT$$

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

Now we put the value of $P\Delta V$ in equation II we have

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

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 at constant pressure, but both P & V can change. We can write the formula as follows:

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

$$\text{or } \Delta H = \Delta E + (P_2V_2 - P_1V_1)$$

e.g.
Q

A non ideal gas goes from ~~stage~~ stage 1 to stage 2
($P = 3 \text{ atm}$, $V = 5 \text{ L}$, $T = 300 \text{ K}$) ($P = 5$)
If the ΔE is 60 atm L , find out

Ans.

$$\begin{aligned}\Delta H &= \Delta E + (P_2V_2 - P_1V_1) \\ &= 60 + (5 \times 8 - 3 \times 5) \\ &= 60 + (40 - 15) \\ &= 60 + 25 \\ &= 85 \text{ atm L.}\end{aligned}$$

Q ΔH and ΔE for the reaction
 $\text{Fe}_2\text{O}_3 + 3\text{H}_2(\text{g}) \longrightarrow 2\text{Fe}(\text{s}) + 3\text{H}_2\text{O}(\text{l})$ (

Q. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, For the above reaction correct statement is (Manipal)

i) $\Delta H < \Delta E$ ii) $\Delta H = \Delta E$ iii) $\Delta H > \Delta E$ iv)

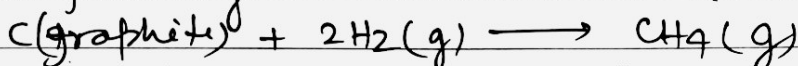
Ans. (I), Soln

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

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

$$\text{So, } \Delta H < \Delta E$$

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



i) -0.6 ii) -1.2 iii) +0.6 iv) +1.2

Ans. (iii),

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

$$\text{or } \Delta H - \Delta E = -\Delta n_g RT$$

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 H_2 mixed in a closed container to form Chloride gas then

i) $\Delta H < \Delta E$ ii) $\Delta H = \Delta E$ iii) $\Delta H > \Delta E$ iv)