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D. B. College (Jaynagar)
Akhilesh Kumar Singh
Chemistry Department
B. Sc. (II) subsidiary
Mob. no → 8750340927
G.mail → akhilsingh021@gmail.com

Thermodynamics

Enthalpy (H) :-

- Heat absorbed by system at constant pressure.
- It is state funᶜ.
- Extensive property

Molar Enthalpy : heat absorbed by one mole at constant P.
↳ intensive

$$H = E + PV$$

but we can't calculate absolute value of enthalpy.

So we calculate change in enthalpy

$$q_p \rightarrow \Delta H = \Delta E + \Delta(PV) \quad . \quad \Delta PV = \Delta P V + P\Delta V$$

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

P → Constant

$$\Delta PV = P\Delta V$$

$$P\Delta V = \Delta(nRT)$$

$$= \Delta nRT + nR\Delta T^{0}$$

↳ reaction takes place at Const T

$$P\Delta V = \Delta n_g RT$$

$$\boxed{\Delta H = \Delta E + \Delta n_g RT}$$

- Δn_g = Σ no. of moles of gaseous product − Σ no. moles of gaseous reactant

(2.)

1. $\Delta n_g = 0$ $\Delta H = \Delta E$
2. $\Delta n_g > 0$ $\Delta H > \Delta E$
3. $\Delta n_g < 0$ $\Delta H < \Delta E$

Ques: Assume each reacn is carried out in open container for which reacn

(i) $\Delta H = \Delta E$

(2) $\Delta H < \Delta E$

(i) $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$ $\Delta n_g = 0$ $\Delta H = \Delta E$

(ii) $C(s) + 2H_2O(g) \rightarrow 2H_2(g) + CO_2(g)$ $\Delta n_g = 3-2 = 1$
$\Delta n_g > \Delta H > E$

(iii) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$ $\Delta n_g = 1$
$\Delta n_g = 0$ $\Delta H > \Delta E$

(iv) $2CO(g) + O_2 \rightarrow 2CO_2(g)$ $\Delta n_g = 2-3 = -1$
$\Delta n_g < 0$

$\Delta H < \Delta E$

(a) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta n_g = 1-3 = -2$ $\Delta H < \Delta E$

(b) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ $\Delta n_g = 1$ $\Delta H > \Delta E$

(c) $H_2O(l) \rightarrow H_2(g) + \frac{1}{2}O_2(g)$ $\Delta n_g = \frac{3}{2}$ $\Delta H > \Delta E$

(d) $CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$

Ques:- for the reacn.

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ at const 27°C $\Delta H - \Delta E = ?$

(a) RT (b) 3RT (c) −3RT (d) −RT

$\Delta n_g = 3-6 = -3$

$\Delta H - \Delta E = \Delta n_g RT = -3RT$

(3) **Ques:** What is diff. b/w heat of reac^n at Const P & Const V for reac^n

$2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$

at 25°C in KJ

$\Delta n_g = 12 - 15$
$= -3$

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

$= -3RT$

$= -3 \times 8.3 \times 300$

$= 24.9 \times 300$
$= 249 \times 30 \simeq 7470 J$
$= 7.470 KJ$

Quest For Combustion of 1 mol of $C_6H_6(l)$ at 27°C the heat of reac^n at Const Pr is −780.9 K Cal then find heat of reac^n at const Vol.?

$C_6H_6(l) + \frac{15}{2} O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$

$\Delta H = q_p = -780.9 \text{ KCal} = -780.9 \times 10^3 \text{ Cal}$

$\Delta E = q_v = ?$

$\Delta n_g = 6 - \frac{15}{2} = \frac{12-15}{2} = \frac{-3}{2}$

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

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

$= -780.9 \times 10^3 - \left(\frac{-3}{2}\right) \times 2 \times 300$

$= -7809000 + 900$

$\Delta E = -78000$ Cal

Heat Capacity :- (C) It is heat required to ↑ Temp. of given amt. of substance by 1°C or 1K

$$C = \frac{q}{\Delta T}$$ $$q = C\Delta T$$

Unit JK⁻¹ or Cal K⁻¹

Molar Heat Capacity (Cm) :- It is heat req. to ↑ the Temp. of 1 mol. of substance 1°C or 1K

$$C = \frac{q}{n\Delta T}$$ $$q = nC_m\Delta T$$

Unit :- $J\,mol^{-1}\,K^{-1}$

Specific Heat Capacity (C) :- It is heat required to ↑ temp. of 1g substance by 1°C or 1K

$$C = \frac{q}{m\Delta T}$$ $$q = mc\Delta T$$

Unit :- $J\,gm^{-1}\,K^{-1}$

Extensive ← Heat capacity $\Delta H = C_P\Delta T$ $\Delta E = C_V\Delta T$

Intensive ← Molar Heat Capacity $\Delta H = n(C_m)_P\Delta T$ $\Delta E = n(C_m)_V\Delta T$

Intensive ← Sp. Heat Capacity $\Delta H = mC_P\Delta T$ $\Delta E = mC_V\Delta T$