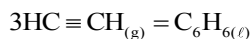


**THERMODYNAMICS**

1. Assuming ideal behaviour, the magnitude of log K for the following reaction at 25°C is  $x \times 10^{-1}$ . The value of x is \_\_\_\_\_.

(Integer answer)

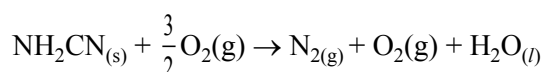


[Given:  $\Delta_f G^\circ(\text{HC} \equiv \text{CH}) = -2.04 \times 10^5 \text{ J mol}^{-1}$ ;

$\Delta_f G^\circ(\text{C}_6\text{H}_6) = -1.24 \times 10^5 \text{ J mol}^{-1}$ ;

$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ]

2. The reaction of cyanamide,  $\text{NH}_2\text{CN}_{(s)}$  with oxygen was run in a bomb calorimeter and  $\Delta U$  was found to be  $-742.24 \text{ kJ mol}^{-1}$ . The magnitude of  $\Delta H_{298}$  for the reaction



is \_\_\_\_\_ kJ. (Rounded off to the nearest integer)

[Assume ideal gases and  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ ]

3. For the reaction  $\text{A}(g) \rightleftharpoons \text{B}(g)$  at 495 K,  $\Delta_r G^\circ = -9.478 \text{ kJ mol}^{-1}$ .

If we start the reaction in a closed container at 495 K with 22 millimoles of A, the amount of B in the equilibrium mixture is \_\_\_\_\_ millimoles. (Round off to the Nearest Integer).

[ $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ ;  $\ln 10 = 2.303$ ]

4. At 25°C, 50 g of iron reacts with HCl to form  $\text{FeCl}_2$ . The evolved hydrogen gas expands against a constant pressure of 1 bar. The work done by the gas during this expansion is \_\_\_\_\_ J.

(Round off to the Nearest Integer)

[Given :  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$ . Assume, hydrogen is an ideal gas]

[Atomic mass of Fe is 55.85 u]

5. During which of the following processes, does entropy decrease ?

- (A) Freezing of water to ice at 0°C  
 (B) Freezing of water to ice at -10°C  
 (C)  $\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)$   
 (D) Adsorption of  $\text{CO}(g)$  and lead surface  
 (E) Dissolution of NaCl in water

(1) (A), (B), (C) and (D) only

(2) (B) and (C) only

(3) (A) and (E) only

(4) (A), (C) and (E) only

6. The gas phase reaction



at 400 K has  $\Delta G^\circ = + 25.2 \text{ kJ mol}^{-1}$ .

The equilibrium constant  $K_C$  for this reaction is \_\_\_\_\_  $\times 10^{-2}$ . (Round off to the Nearest integer)

[Use :  $R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$ ,  $\ln 10 = 2.3$

$\log_{10} 2 = 0.30$ , 1 atm = 1 bar]

[antilog (-0.3) = 0.501]

7. If the standard molar enthalpy change for combustion of graphite powder is  $-2.48 \times 10^2 \text{ kJ mol}^{-1}$ , the amount of heat generated on combustion of 1 g of graphite powder is \_\_\_\_\_ kJ. (Nearest integer)

8. At 298.2 K the relationship between enthalpy of bond dissociation (in  $\text{kJ mol}^{-1}$ ) for hydrogen ( $E_H$ ) and its isotope, deuterium ( $E_D$ ), is best described by :

(1)  $E_H = \frac{1}{2} E_D$                       (2)  $E_H = E_D$

(3)  $E_H \approx E_D - 7.5$                 (4)  $E_H = 2E_D$

9. At 298 K, the enthalpy of fusion of a solid (X) is  $2.8 \text{ kJ mol}^{-1}$  and the enthalpy of vaporisation of the liquid (X) is  $98.2 \text{ kJ mol}^{-1}$ . The enthalpy of sublimation of the substance (X) in  $\text{kJ mol}^{-1}$  is \_\_\_\_\_.

(in nearest integer)

10. A home owner uses  $4.00 \times 10^3 \text{ m}^3$  of methane ( $\text{CH}_4$ ) gas, (assume  $\text{CH}_4$  is an ideal gas) in a year to heat his home.

Under the pressure of 1.0 atm and 300 K, mass of gas used is  $x \times 10^5 \text{ g}$ . The value of  $x$  is \_\_\_\_\_ . (Nearest integer)

(Given  $R = 0.083 \text{ L atm K}^{-1} \text{ mol}^{-1}$ )

11. A system does 200 J of work and at the same time absorbs 150 J of heat. The magnitude of the change in internal energy is \_\_\_\_\_ J. (Nearest integer)

12. For water at  $100^\circ\text{C}$  and 1 bar,

$$\Delta_{\text{vap}} H - \Delta_{\text{vap}} U = \text{_____} \times 10^2 \text{ J mol}^{-1}.$$

(Round off to the Nearest Integer)

[Use :  $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$ ]

[Assume volume of  $\text{H}_2\text{O}(\text{l})$  is much smaller than volume of  $\text{H}_2\text{O}(\text{g})$ . Assume  $\text{H}_2\text{O}(\text{g})$  treated as an ideal gas]

13. An average person needs about 10000 kJ energy per day. The amount of glucose (molar mass =  $180.0 \text{ g mol}^{-1}$ ) needed to meet this energy requirement is \_\_\_\_\_ g.

(Use :  $\Delta_{\text{c}}H(\text{glucose}) = -2700 \text{ kJ mol}^{-1}$ )

**SOLUTION**

**1. Official Ans. by NTA (855)**

**Sol.**  $3\text{HC} \equiv \text{CH}_{(g)} \rightarrow \text{C}_6\text{H}_6(l); \Delta G^0 = -RT \ln k$

$$\Delta G_f^0 - 2.04 \times 10^5 \frac{\text{J}}{\text{mol}} - 1.24 \times 10^5 \text{J/mol}$$

$$\Rightarrow \Delta G^0 = \sum (\Delta G_f^0)_P - \sum (\Delta G_f^0)_R$$

$$\Rightarrow -RT \ln k = 1 \times (-124 \times 10^5) - (-3 \times 2.04 \times 10^5)$$

$$\Rightarrow -2.303 \times R \times T \log k = 4.88 \times 10^5$$

$$\Rightarrow \log k = -\frac{4.88 \times 10^5}{2.303 \times R \times T} = -\frac{488000}{5705.848} = -85.52$$

$$= 855 \times 10^{-1}$$

$$\Rightarrow x = 855$$

**2. Official Ans. by NTA (741)**

**Sol.**  $\Delta H = \Delta U + \Delta n_g RT$

$$= -742.24 + \frac{1}{2} \times \frac{8.314}{1000} \times 298$$

$$= -741 \text{ kJ/mol}$$

Hence answer is (741)

**3. Official Ans. by NTA (20)**

**Sol.**  $\Delta G^0 = -RT \ln K_{eq}$

Given  $\Delta G^0 = -9.478 \text{ KJ/mole}$

$T = 495\text{K}$   $R = 8.314 \text{ J mol}^{-1}$

$$\text{So } -9.478 \times 10^3 = -495 \times 8.314 \times \ln K_{eq}$$

$$\ln K_{eq} = 2.303$$

$$= \ln 10$$

$$\text{So } K_{eq} = 10$$

Now  $\text{A(g)} \rightleftharpoons \text{B(g)}$

$$t = 0 \quad 22 \quad 0$$

$$t = t \quad 22-x \quad x$$

$$K_{eq} = \frac{[\text{B}]}{[\text{C}]} = \frac{x}{22-x} = 10$$

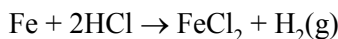
$$\text{or } x = 20$$

So millmoles of B = 20

**4. Official Ans. by NTA (2218)**

**Sol.**  $T = 298 \text{ K}, R = 8.314 \frac{\text{J}}{\text{molK}}$

→ Chemical reaction is



$$50\text{g} \qquad \qquad \qquad P = 1 \text{ bar}$$

$$= \frac{50}{55.85} \text{ mol} \qquad \qquad \frac{50}{55.85} \text{ mol}$$

→ Work done for 1 mol gas

$$= -P_{\text{ext}} \times \Delta V$$

$$= \Delta n_g RT$$

$$= -1 \times 8.314 \times 298 \text{ J}$$

→ Work done for  $\frac{50}{55.85}$  mol of gas

$$= -1.8314 \times 298 \times \frac{50}{55.85} \text{ J}$$

$$= -2218.059 \text{ J}$$

$$\approx -2218 \text{ J}$$

**5. Official Ans. by NTA (1)**

**Sol.** (A) Water  $\xrightarrow{0^\circ\text{C}}$  ice;  $\Delta S = -ve$

(B) Water  $\xrightarrow{-10^\circ\text{C}}$  ice;  $\Delta S = -ve$

(C)  $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g}); \Delta S = -ve$

(D) Adsorption;  $\Delta S = -ve$

(E)  $\text{NaCl}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}); \Delta S = +ve$

**6. Official Ans. by NTA (166)**

**Official Ans. by ALLEN (2)**

**Sol.** Using formula

$$\Delta_r G^0 = -RT \ln K_p$$

$$25200 = -2.3 \times 8.3 \times 400 \log(K_p)$$

$$K_p = 10^{-3.3} = 10^{-3} \times 0.501$$

$$= 5.01 \times 10^{-4} \text{ Bar}^{-1}$$

$$= 5.01 \times 10^{-9} \text{ Pa}^{-1}$$

$$= \frac{K_c}{8.3 \times 400}$$

$$K_c = 1.66 \times 10^{-5} \text{ m}^3/\text{mole}$$

$$= 1.66 \times 10^{-2} \text{ L/mol}$$

$$\text{Ans} = 2$$

## 7. Official Ans. by NTA (21)

Sol. 1 mol graphite = 12 gm C

$$\text{Ans.} = \frac{248}{12} = 20.67 \text{ kJ / gm heat evolved}$$

## 8. Official Ans. by NTA (3)

Sol. Enthalpy of bond dissociation (kJ/mole) at 298.2K

For , hydrogen = 435.88

For , Deuterium = 443.35

$$\therefore E_H \approx E_D - 7.5$$

## 9. Official Ans. by NTA (101)

Sol.  $\Delta H_{\text{sub}} = \Delta H_{\text{fus.}} + \Delta H_{\text{vap.}}$ 

$$= 2.8 + 98.2$$

$$= 101 \text{ kJ/mol}$$

## 10. Official Ans. by NTA (26)

Sol.  $n(\text{CH}_4) = \frac{PV}{RT}$ 

$$= \frac{1 \times 4 \times 10^3 \times 1000}{0.083 \times 300}$$

Weight of  $\text{CH}_4$ 

$$= \frac{40 \times 16 \times 10^5}{0.083 \times 300} \text{ gm}$$

$$= 25.7 \times 10^5 \text{ gm}$$

## 11. Official Ans. by NTA (50)

Sol.  $w = -200 \text{ J}$ ,  $q = +150$  :  $\Delta U = q + w$ 

$$\Delta U = 150 - 200 = -50 \text{ J : magnitude} = 50 \text{ J}$$

$$= |\Delta U|$$

## 12. Official Ans. by NTA (31)

Sol.  $\text{H}_2\text{O}_{(l)} \rightleftharpoons \text{H}_2\text{O}_{(v)}$ 

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

for 1 mole waters ;  $\Delta n_g = 1$ 

$$\therefore \Delta n_g RT = 1 \text{ mol} \times 8.31 \text{ J/mol-k} \times 373 \text{ K}$$

$$= 3099.63 \text{ J} \approx 31 \times 10^2 \text{ J}$$

## 13. Official Ans. by NTA (667)

Sol. 1 mole glucose give 2700 kJ energy

so mole of glucose needed for  $10^5$  kJ energy

$$= \frac{10000}{2700} = 370 \text{ moles}$$

$$\text{wt. of glucose} = 3.10 \times 180$$

$$= 666.666$$

$$\approx 667 \text{ gm}$$

$$\frac{Y_{\text{Benzene}}}{Y_{\text{M.B}}} = \frac{P_B^0 X_B}{P_{\text{MB}}^0 X_{\text{MB}}} = \frac{70 \times 1}{20 \times 1} = \frac{7}{2}$$

$$Y_{\text{Benzene}} = \frac{7}{9} = 77.77 \times 10^{-2}$$

$$= 78 \times 10^{-12}$$