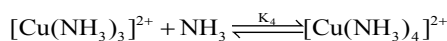
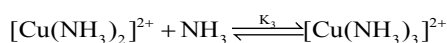
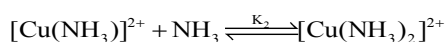
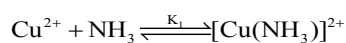


CHEMICAL EQUILIBRIUM

1. At 1990 K and 1 atm pressure, there are equal number of Cl_2 molecules and Cl atoms in the reaction mixture. The value K_p for the reaction $\text{Cl}_{2(g)} \rightleftharpoons 2\text{Cl}_{(g)}$ under the above conditions is $x \times 10^{-1}$. The value of x is _____. (Rounded off to the nearest integer)

2. The stepwise formation of $[\text{Cu}(\text{NH}_3)_4]^{2+}$ is given below



The value of stability constants K_1 , K_2 , K_3 and K_4 are 10^4 , 1.58×10^3 , 5×10^2 and 10^2 respectively. The overall equilibrium constants for dissociation of $[\text{Cu}(\text{NH}_3)_4]^{2+}$ is $x \times 10^{-12}$. The value of x is _____. (Rounded off to the nearest integer)

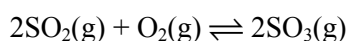
3. A homogeneous ideal gaseous reaction $\text{AB}_{2(g)} \rightleftharpoons \text{A}_{(g)} + 2\text{B}_{(g)}$ is carried out in a 25 litre flask at 27°C . The initial amount of AB_2 was 1 mole and the equilibrium pressure was 1.9 atm. The value of K_p is $x \times 10^{-2}$. The value of x is _____. (Integer answer)

4. Consider the reaction $\text{N}_2\text{O}_4(g) \rightleftharpoons 2\text{NO}_2(g)$. The temperature at which $K_C = 20.4$ and $K_p = 600.1$, is ____ K. (Round off to the Nearest Integer).

[Assume all gases are ideal and $R = 0.0831$ L bar $\text{K}^{-1} \text{mol}^{-1}$]

5. $2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)$

In an equilibrium mixture, the partial pressures are $P_{\text{SO}_3} = 43$ kPa ; $P_{\text{O}_2} = 530$ Pa and $P_{\text{SO}_2} = 45$ kPa. The equilibrium constant $K_p = _____ \times 10^{-2}$. (Nearest integer)

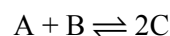


6. Value of K_p for the equilibrium reaction

$\text{N}_2\text{O}_4(g) \rightleftharpoons 2\text{NO}_2(g)$ at 288 K is 47.9. The K_C for this reaction at same temperature is _____. (Nearest integer)

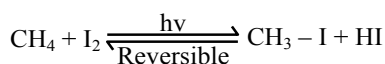
($R = 0.083$ L bar $\text{K}^{-1} \text{mol}^{-1}$)

7. For the reaction



the value of equilibrium constant is 100 at 298 K. If the initial concentration of all the three species is 1 M each, then the equilibrium concentration of C is $x \times 10^{-1}$ M. The value of x is _____. (Nearest integer)

8. Presence of which reagent will affect the reversibility of the following reaction, and change it to a irreversible reaction :



(1) HOCl

(2) dilute HNO_2

(3) Liquid NH_3

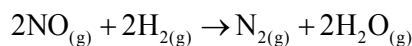
(4) Concentrated HIO_3

9. $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$; $K_c = 1.844$

3.0 moles of PCl_5 is introduced in a 1 L closed reaction vessel at 380 K. The number of moles of PCl_5 at equilibrium is $____ \times 10^{-3}$. (Round off to the Nearest Integer)

10. The equilibrium constant for the reaction
- $$A(s) \rightleftharpoons M(s) + \frac{1}{2}O_2(g)$$
- is $K_p = 4$. At equilibrium, the partial pressure of O_2 is ___ atm. (Round off to the nearest integer)

11. The following data was obtained for chemical reaction given below at 975 K.

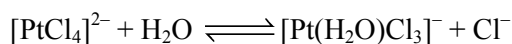


[NO]	[H ₂]	Rate
mol L ⁻¹	mol L ⁻¹	mol L ⁻¹ s ⁻¹
(A) 8×10^{-5}	8×10^{-5}	7×10^{-9}
(B) 24×10^{-5}	8×10^{-5}	2.1×10^{-8}
(C) 24×10^{-5}	32×10^{-5}	8.4×10^{-8}

The order of the reaction with respect to NO is _____. [Integer answer]

12. The equilibrium constant K_c at 298 K for the reaction $A + B \rightleftharpoons C + D$ is 100. Starting with an equimolar solution with concentrations of A, B, C and D all equal to 1M, the equilibrium concentration of D is _____ $\times 10^{-2}$ M. (Nearest integer)

13. The reaction rate for the reaction



was measured as a function of concentrations of different species. It was observed that

$$\frac{-d[[PtCl_4]^{2-}]}{dt} = 4.8 \times 10^{-5} [[PtCl_4]^{2-}] - 2.4 \times 10^{-3} [[Pt(H_2O)Cl_3]^-] [Cl^-].$$

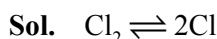
where square brackets are used to denote molar concentrations. The equilibrium constant $K_c =$ _____. (Nearest integer)

14. When 5.1 g of solid NH_4HS is introduced into a two litre evacuated flask at $27^\circ C$, 20% of the solid decomposes into gaseous ammonia and hydrogen sulphide. The K_p for the reaction at $27^\circ C$ is $x \times 10^{-2}$. The value of x is _____. (Integer answer)

$$[\text{Given } R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}]$$

SOLUTION

1. Official Ans. by NTA (5)



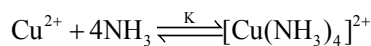
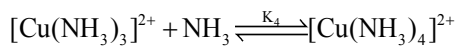
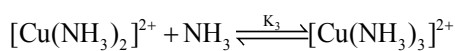
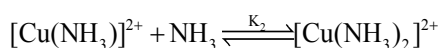
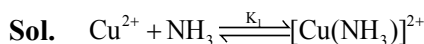
Let mol of both of Cl_2 and Cl is x

$$P_{\text{Cl}} = \frac{x}{2x} \times 1 = \frac{1}{2}$$

$$P_{\text{Cl}_2} = \frac{x}{2x} \times 1 = \frac{1}{2}$$

$$K_p = \frac{\left(\frac{1}{2}\right)^2}{\frac{1}{2}} = \frac{1}{2} = 0.5 \Rightarrow 5 \times 10^{-1}$$

2. Official Ans. by NTA (1)



So

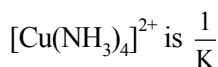
$$K = K_1 \times K_2 \times K_3 \times K_4$$

$$= 10^4 \times 1.58 \times 10^3 \times 5 \times 10^2 \times 10^2$$

$$K = 7.9 \times 10^{11}$$

Where $K \rightarrow$ Equilibrium constant for formation of $[\text{Cu}(\text{NH}_3)_4]^{2+}$

So equilibrium constant (K') for dissociation of



$$K' = \frac{1}{K}$$

$$K' = \frac{1}{7.9 \times 10^{11}}$$

$$= 1.26 \times 10^{-12} = (x \times 10^{-12})$$

So the value of $x = 1.26$

OMR Ans = 1 (After rounded off to the nearest integer)

3. Official Ans. by NTA (73)



$$\begin{array}{ccc} 1 & - & - \\ 1-\alpha & \alpha & 2\alpha \end{array}$$

$$= 0.535 \quad 0.465 \quad 0.93$$

$$1.9 \times 25 = n_T \times 0.08206 \times 300$$

$$n_T = 1.93 = 1 + 2\alpha$$

$$\alpha = 0.465$$

$$K_p = \frac{\left(\frac{0.465}{1.93} \times 19\right) \left(\frac{0.93}{1.93} \times 1.9\right)^2}{\left(\frac{0.535}{1.93} \times 1.9\right)}$$

$$\approx 73 \times 10^{-2} \text{ atm}^2$$

4. Official Ans. by NTA (354)

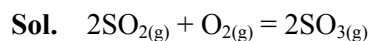


$$\text{Now, } K_p = K_c \cdot (\text{RT})^{\Delta n_g}$$

$$\text{or, } 600.1 = 20.4 \times (0.0831 \times T)^1$$

$$\therefore T = 353.99 \text{ K} = 354\text{K}$$

5. Official Ans. by NTA (172)



$$K_p = \frac{(\text{pSO}_3(\text{g}))^2}{\text{pSO}_2(\text{g})} \times \text{pO}_2(\text{g})$$

$$= \frac{43 \times 43}{45 \times 45} \times 530 \text{ Pa}^{-1}$$

$$= 172.28 \times 10^{-5} \text{ Pa}^{-1}$$

$$= 172.28 \text{ atm}$$

$$= 17228 \times 10^{-2} \text{ atm}$$

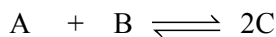
Ans is 17228

6. Official Ans. by NTA (2)

$$K_c = \frac{K_p}{RT} = \frac{47.9}{0.083 \times 288} = 2$$

7. Official Ans. by NTA (25)

Sol.



$$\begin{array}{ccc} 1 & 1 & 1 \\ -x & -x & 2x \end{array}$$

$$\begin{array}{ccc} 1-x & 1-x & 1+2x \end{array}$$

$$K = \frac{[C]_{\text{eq}}^2}{[A]_{\text{eq}}[B]_{\text{eq}}} = \frac{(1+2x)^2}{(1-x)(1-x)}$$

$$100 = \left(\frac{1+2x}{1-x} \right)^2$$

$$\left(\frac{1+2x}{1-x} \right) = 10$$

$$x = \frac{3}{4}$$

$$[C]_{\text{eq}} = 1 + 2x$$

$$= 1 + 2 \left(\frac{3}{4} \right)$$

$$= 2.5 \text{ M}$$

$$25 \times 10^{-1} \text{ M}$$

8. Official Ans. by NTA (4)

Sol. Iodination of alkane is reversible reaction.

It can be irreversible in the presence of strong oxidising agent like conc. HNO_3 or conc. HIO_3

9. Official Ans. by NTA (1396)

Sol. $\text{PCl}_{5(g)} \rightleftharpoons \text{PCl}_{3(g)} + \text{Cl}_{2(g)} \quad K_2 = 1.844$

$$t = 0 \quad 3 \text{ moles}$$

$$t = \infty \quad x \quad x$$

$$\Rightarrow \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]} = \frac{x^2}{3-x} = 1.844$$

$$\Rightarrow x^2 + 1.844 - 5.532 = 0$$

$$\Rightarrow x = \frac{-1.844 + \sqrt{(1.844)^2 + 4 \times 5.532}}{2}$$

$$\cong 1.604$$

$$\Rightarrow \text{Moles of } \text{PCl}_5 = 3 - 1.604 \cong 1.396$$

10. Official Ans. by NTA (16)

$$\text{Sol. } k_p = \text{Po}_2^{1/2} = 4$$

$$\therefore \text{Po}_2 = 16 \text{ bar} = 16 \text{ atm}$$

11. Official Ans. by NTA (1)

$$\text{Sol. } 7 \times 10^{-9} = K \times (8 \times 10^{-5})^x (8 \times 10^{-5})^y \quad \dots(1)$$

$$2.1 \times 10^{-8} = K \times (24 \times 10^{-5})^x (8 \times 10^{-5})^y \quad \dots(2)$$

$$\frac{1}{3} = \left(\frac{1}{3} \right)^x \Rightarrow x = 1$$

12. Official Ans. by NTA (182)

Sol. $A + B \rightleftharpoons C + D : K_{\text{eq}} = 100$

$$1\text{M} \quad 1\text{M} \quad 1\text{M} \quad 1\text{M}$$

First check direction of reversible reaction.

$$\text{Since } Q_c = \frac{[C][D]}{[A][B]} = 1 < K_{\text{eq}} \Rightarrow \text{reaction will}$$

move in forward direction to attain equilibrium state.

$$\Rightarrow A + B \rightleftharpoons C + D : K_{\text{eq}} = 100$$

$$\text{to } 1 \quad 1 \quad 1 \quad 1$$

$$t_{\text{eq.}} \quad 1-x \quad 1-x \quad 1+x \quad 1+x$$

$$\text{Now : } K_{\text{eq}} = 100 = \frac{(1+x)(1+x)}{(1-x)(1-x)}$$

$$\Rightarrow 100 = \left(\frac{1+x}{1-x} \right)^2$$

$$(i) \quad 10 = \left(\frac{1+x}{1-x} \right)$$

$$\Rightarrow 10 - 10x = 1+x \quad \Rightarrow 11x = 9$$

$$\Rightarrow x = \frac{9}{11}$$

$$(ii) \quad -10 = \frac{1+x}{1-x}$$

$$\Rightarrow -10 + 10x = 1+x \quad \Rightarrow -9x = -11$$

$$\Rightarrow x = \frac{11}{9}$$

→ 'x' cannot be more than one, therefore not valid.

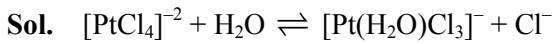
therefore equation concretion of (D) = 1 + x

$$= 1 + \frac{9}{11} = \frac{20}{11}$$

$$= 1.8181 = 181.81 \times 10^{-2}$$

$$\cong 182 \times 10^{-2}$$

13. Official Ans. by NTA (50)



$$\frac{-d[\text{PtCl}_4]^{-2}}{dt} = 4.8 \times 10^{-5} [\text{PtCl}_4^{-2}] - 2.4 \times 10^{-3}$$

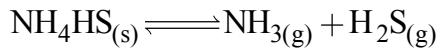


$$\Rightarrow K_{\text{eq}} = \frac{k_f}{k_b} = \frac{4.8 \times 10^{-5}}{2.4 \times 10^{-3}} = 0.02$$

14. Official Ans. by NTA (6)

Sol. moles of NH_4HS initially taken = $\frac{5.1\text{g}}{51\text{g/mol}}$
 $= 0.1\text{ mol}$

volume of vessel = 2ℓ



$t = 0$ 0.1 mol

$t = \infty$ $0.1(1-0.2)$ 0.1×0.2 0.1×0.2

\Rightarrow partial pressure of each component

$$P = \frac{nRT}{V} = \frac{0.1 \times 0.2 \times 0.082 \times 300}{2}$$

$= 0.246\text{ atm}$

$$\Rightarrow k_P = P_{\text{NH}_3} \times P_{\text{H}_2\text{S}} = (0.246)^2 = 0.060516$$

$= 6.05 \times 10^{-2} \quad \Rightarrow 6$