5. CHEMICAL EQUILIBRIUM

PREVIOUS EAMCET BITS

1. The equilibrium constant for the given reaction is 100? **(2009 E)**

$$N_{2(g)} + 2O_2(g) \rightleftharpoons 2NO_{2(g)}$$

What is the equilibrium constant for the reaction given below $2NO_{2(g)} \rightleftharpoons N_{2(g)} + 2O_{2(g)}$

1) 10 2) 1 3) 0.1 4) 0.01

Ans : 3

Sol: $\frac{[NO_2]^2}{[N_2][O_2]} = 100$

$\frac{[N_2]\,[O_2]^2}{[NO_2]} = \frac{1}{100}$

$\therefore \frac{[N_2]^{1/2}[O_2]}{[NO_2]} = \sqrt{\frac{1}{100}} = \frac{1}{10} = 0.1$

2. The equilibrium constant for the reaction $SO_{2(g)} + \frac{1}{2}O_2(g) \rightleftharpoons SO_{3(g)}$ is 5×10^{-6} atm^{-1}. The equilibrium constant of the reaction. $2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$ would be **(2009 E)**

1) 100 atm 2) 200 atm 3) 4×10^4 atm 4) 6.25×10^4 atm

Ans : 3

Sol: $SO_{2(g)} + \frac{1}{2}O_2(g) \rightleftharpoons SO_{3(g)}$

$K_p = \frac{P_{SO_3}}{P_{SO_2} \times (P_{O_2})^{1/2}} = 5\times10^{-3}$

Squaring

$\frac{P^2_{SO_3}}{P^2_{SO_2}.P_{O_2}} = 25\times10^{-6}$

$\frac{P^2_{SO_2}.P_{O_2}}{P_{SO_3}.} = \frac{1}{25\times10^{-6}}$

= 4×10^4 atm

$2SO_{3(g)} \rightleftharpoons 2SO_{2(g)} + O_{2(g)}$

$K_p = 4\times10^4$ atm

3. What is the equation for the equilibrium constant (K_C) for the following reaction ?

$\frac{1}{2}A_{(g)} + \frac{1}{3}B_{(g)} \xrightleftharpoons{T(K)} \frac{2}{3}C_{(g)}$ **(2006 M)**

1) $K_C = \frac{[A]^{1/2}[B]^{1/3}}{[C]^{3/2}}$ 2) $K_C = \frac{[C]^{3/2}}{[A]^2[B]^3}$

3) $K_C = \frac{[C]^{2/3}}{[A]^{1/2}[B]^{1/3}}$ 4) $K_C = \frac{[C]^{2/3}}{[A]^{1/2}+[B]^{1/3}}$

Ans : 3

Sol: $K_C = \frac{[C]^{2/3}}{[A]^{1/2}[B]^{1/3}}$

4. Which of the following is not a characteristic property of chemical equilibrium? **[2006 E]**

1. Rate of forward reaction is equal to rate of backward reaction at equilibrium
2. After reaching the chemical equilibrium, the concentrations of reactants and products remain unchanged with time
3. For $A(g) \rightleftharpoons B(g)$ is 10^{-2}. If this reaction is carried out in the presence of a catalyst, the value of Kc decreases.
4. After reaching the equilibrium, both forward and backward reactions continue to take place

Ans : 3

Sol: Addition of catalyst does not alter the equilibrium constant.

5. Observe the following reaction : $2A + B \rightarrow C$. The rate of formation of C is 2.2×10^{-4} mol. lit^{-1}. min^{-1}.What is the valur of $\frac{-d[A]}{dt}$ (in mol. lit^{-1}. min^{-1}) **[2005 E]**

1. 2.2×10^{-3} 2. 1.1×10^{-3} 3. 4.4×10^{-3} 4. 5.5×10^{-3}

Ans : 3

Sol: $2A + B \rightarrow C$

$$\frac{-1}{2}\frac{d[A]}{dt} = \frac{-d[B]}{dt} = \frac{+d[C]}{dt}$$

$$\therefore \frac{-d[A]}{dt} = 2 \times \frac{d[C]}{dt}$$

= $2 \times 2.2 \times 10^{-3}$ mol. lit^{-1}. min^{-1}

= 4.4×10^{-3} mol. lit^{-1}. min^{-1}

6. In Which of the following reactions, the concentration of reactant is equal to concentration of product at equilibrium (K = equilibrium constant) **(2004 E)**

1) $A \rightleftharpoons B;\ K = 0.01$ 2) $R \rightleftharpoons P;\ K = 1$

3) $X \rightleftharpoons Y;\ K = 10$ 4) $L \rightleftharpoons J;\ K = 0.025$

Ans : 2

Sol: If the concentration of reactant is equal to concentration of product equilibrium constant K = 1

7. In which of the following reactions, the concentration of reactant is equal to concentration of product at equilibrium (K = equilibrium constant) **(2004 M)**

1) $A \rightleftharpoons B;\ K = 0.001$ 2) $M \rightleftharpoons N;\ K = 10$

3) $X \rightleftharpoons Y;\ K = 0.005$ 4) $R \rightleftharpoons P;\ K = 0.01$

Ans : 2

Sol: Highest the K value mean concentration of product is high.

8. In the reaction $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$, the equilibrium concentration of PCl_5 and PCl_3 are 0.4 and 0.2 mole/litre respectively. If the value of K_c is 0.5. What is concentration of Cl_2 in moles/litre ? **(2003 M)**

1) 2.0 2) 1.3 3) 1.0 4) 0.5

Ans : 3

Sol: $K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$

$0.5 = \frac{0.2[Cl_2]}{0.4}$

$\therefore [Cl_2] = \frac{0.5 \times 0.4}{0.2} = 1$

9. Consider the following reaction equilibrium $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$. Initially, 1 mole of N_2 and 3 moles of H_2 are taken in a 2 litre flask. At equilibrium state if, the number of moles of N_2 is 0.6. What is the total number moles of all gases present in the flask ? **(2003 E)**

1) 0.8 2) 1.6 3) 3.2 4) 6.4

Ans : 3

Sol: $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

Initial mole 1mole 3 mole 0 mole

At. eq. 0.6 3-1.2 0.8 mole

= 1.8 mole

Total no of mole = 0.6 +1.8+0.8 = 3.2 moles

10. One mole of $A_{(g)}$ is heated to 200^0C in a one litre closed flask, till the following equilibrium is reached. A(g) $\rightleftharpoons$ B(g).

The rate of forward reaction at equilibrium is 0.02 mol-lit^{-1}-min^{-1}. What is the rate (in mol. Lit^{-1} min^{-1}) of the backward reaction at equilibrium ? **(2002 E)**

1) 0.04 2) 0.01 3) 0.02 4) 1

Ans : 3

Sol: At equilibrium rate of forward reaction in equal to rate of backward reaction.

11. Equilibrium constant for the reaction $H_2O_{(g)} + CO_{(g)} \rightleftharpoons H_{2(g)} + CO_{2(g)}$ is 81. If the velocity constant of the forward reaction is 162 lit. mol^{-1} sec^{-1}, what is the velocity constant (in lit. mole^{-1} sec^{-1}) for the backward reaction? **(2001 E)**

1) 13122 2) 2 3) 261 4) 243

Ans : 3

Sol: Eq. constant = $\frac{\text{velocity constant of forward reaction}(K_f)}{\text{velocity constant of backward reaction}(K_b)}$

$81 = \frac{162}{K_b}$

$\therefore K_b = \frac{162}{81} = 2$

12. 9.2 gm of N_2O_4 (g) is taken in a closed one litre vessel and heated till the following equilibrium is reached $N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$.

At equilibrium 50% of N_2O_4 (g) is dissociated. What is the equilibrium constant (in mole lit^{-1}) (Molecular wt. of N_2O_4 is 92) **(2001 M)**

1) 0.1 2) 0.2 3) 0.4 4) 2

Ans : 2

Sol: No of moles of N_2O_4 initially taken $\frac{9.2}{92} = 0.1$ mole

Volume of vessel = 1lit

At equilibrium 50% of N_2O_4 is dissociated

$$= \frac{0.1 \times 50}{100} = 0.05 \text{ mole}$$

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}.$$

Initial concentration $\frac{0.1}{1}$ mole lit^{-1}

At equilibrium $\frac{0.05}{1}$ mole lit^{-1}

$$\frac{2 \times 0.05}{1} = 0.1 \text{ mole } lit^{-1}$$

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{[0.1]^2}{0.05}$$

$$= \frac{0.1 \times 0.1}{0.05}$$

$= 0.2$ mole lit^{-1}

13. The equilibrium constant for the reaction $H_2(g)+I_2(g) \rightleftharpoons 2HI(g)$ is 64, at certain temperature. The equilibrium concentrations of H_2 and HI are 2 and 16 mol lit^{-1} respectively. What is the equilibrium concentration (in mol Lit^{-1}) of I_2? **(2000 E)**

1) 16 2) 4 3) 8 4) 2

Ans : 4

Sol: $H_2(g)+I_2(g) \rightleftharpoons 2HI(g)$

$$K_c = \frac{[HI]^2}{[H_2][I_2]}$$

$$64 = \frac{[16]^2}{2[I_2]}$$

$$[I_2] = \frac{256}{64 \times 2} = 2$$

14. 4 moles of HI is taken in a lit closed vessel and heated till equilibrium is reached. At equilibrium, the concentration of H_2 is one mol lit^{-1}. What is the equilibrium constant for dissociation of HI ?

(2000M)

1) 4 2) 0.5 3) 2 4) 0.25

Ans : 4

Sol: $2HI \rightleftharpoons H_2 + I_2$

Initial Mole 4 0 0

At. Eq. 2 1 1

$$K_c = \frac{[H_2][I_2]}{[HI]^2} = \frac{1 \times 1}{2^2} = \frac{1}{4} = 0.25$$

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