JEE Mains 2019 Chapter wise Question Bank

Chemical Equilibrium - Questions

Q1

Consider the following reversible chemical reactions:

$$A_2(g) + B_2(g) \xrightleftharpoons{K_1} 2AB(g) ......(1)$$

$$6AB(g) \xrightleftharpoons{K_2} 3A_2(g) + 3B_2(g) .....(2)$$

The relation between K_1 and K_2 is:

(1) $K_1K_2 = \frac{1}{3}$ (2) $K_2 = K_1^{3}$

(3) $K_2 = K_1^{-3}$ (4) $K_1K_2 = 3$

9 Jan Evening

Q2

The values of K_p/K_c for the following reactions at 300 K are, respectively: (At 300 K, RT = 24.62 dm^3 atm mol^{-1})

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

(1) 1, 24.62 dm^3 atm mol^{-1}, 606.0 dm^6 atm^2 mol^{-2}

(2) 1, 24.62 dm^3 atm mol^{-1}, 1.65×10^{-3} dm^{-6} atm^{-2} mol^2

(3) 1, 4.1×10^{-2} dm^{-3} atm^{-1} mol, 606 dm^6 atm^2 mol^{-2}

(4) 24.62 dm^3 atm mol^{-1}, 606.0 dm^6 atm^2 mol^{-2}, 1.65×10^{-3} dm^{-6} atm^{-2} mol^2

10 Jan Morning

Q3

5.1 g NH_4SH is introduced in 3.0 L evacuated flask at 327°C, 30% of the solid NH_4SH decomposed to NH_3 and H_2S as gases. The K_p of the reaction at 327°C is (R = 0.082 L atm mol^{-1} K^{-1}, molar mass of S = 32 g mol^{-1}, molar mass of N = 14 g mol^{-1})

(1) 0.242×10^{-4} atm^2 (2) 1×10^{-4} atm^2

(3) 4.9×10^{-3} atm^2 (4) 0.242 atm^2

10 Jan Evening

Q4

Consider the reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The equilibrium constant of the above reaction is K_P. If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by (Assume that $P_{NH_3} << P_{total}$ at equilibrium)

(1) $\frac{3^{3/2}K_P^{1/2}P^2}{16}$ (2) $\frac{K_P^{1/2}P^2}{16}$

(3) $\frac{K_P^{1/2}P^2}{4}$ (4) $\frac{3^{3/2}K_P^{1/2}P^2}{4}$

11 Jan Morning

Q5

In a chemical reaction, $A + 2B \xrightleftharpoons{K} 2C + D$, the initial concentration of B was 1.5 times of the concentration of A, but the equilibrium concentrations of A and B were found to be equal. The equilibrium constant (K) for the aforesaid chemical reaction is:

(1) 4 (2) 16

(3) $\frac{1}{4}$ (4) 1

12 Jan Morning

Q6

Two solids dissociate as follows

$A(s) \rightarrow B(g) + C(g); K_{P_1} = x \text{ atm}^2$

$D(s) \rightarrow C(g) + E(g); K_{P_2} = y \text{ atm}^2$

The total pressure when both the solids dissociate simultaneously is:

(1) $\sqrt{x+y}$ atm (2) $2(\sqrt{x+y})$ atm

(3) $(x+y)$ atm (4) $x^2 + y^2$ atm

12 Jan Morning

Q7

For the following reactions, equilibrium constants are given :

$S(s) + O_2(g) \rightleftharpoons SO_2(g); K_1 = 10^{52}$

$2S(s) + 3O_2(g) \rightleftharpoons 2SO_3(g); K_2 = 10^{129}$

The equilibrium constant for the reaction,

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is :

(1) 10^{154} (2) 10^{181} (3) 10^{25} (4) 10^{77}

8 April Evening

Q8

For the reaction,

$2SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$,

$\Delta H = -57.2$ kJ mol^{-1} and $K_c = 1.7 \times 10^{16}$

Which of the following statement is INCORRECT ?

(1) The equilibrium constant is large suggestive of reaction going to completion and so no catalyst is required.

(2) The equilibrium will shift in forward direction as the pressure increases.

(3) The equilibrium constant decreases as the temperature increases.

(4) The addition of inert gas at constant volume will not affect the equilibrium constant.

10 April Evening

Q9

In which one of the following equilibria, $K_p \neq K_c$?

(1) $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$

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

(3) $NO_2(g) + SO_2(g) \rightleftharpoons NO(g) + SO_3(g)$

(4) $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$

12 April Evening

JEE Mains 2019 Chapter wise Question Bank

Chemical Equilibrium - Answers

Q1

(3) Given: $A_2 + B_2 \xrightleftharpoons{K_1} 2AB$

$\Rightarrow \quad 2AB \rightleftharpoons A_2 + B_2;\ K = \frac{1}{K_1}$

$6AB \xrightleftharpoons{K_1} 3A_2 + 3B_2;\ K_2 = \left(\frac{1}{K_1}\right)^3$

The relation between K_1 and K_2 is $K_2 = K_1^{-3}$

9 Jan Evening

Q2

(2) $K_p = K_c\ (RT)^{\Delta n_g}$

Δn_g = No. of gaseous moles of products – No. of gaseous moles of reactants

$$\frac{K_p}{K_c} = (RT)^{\Delta n_g}$$

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g),\ \Delta n_g = 0$

$$= (24.62\ dm^3\ atm\ mol^{-1})^0 = 1$$

$N_2O_4(g) \rightleftharpoons 2NO_2(g),\ \Delta n_g = 1$

$$\frac{K_p}{K_c} = 24.62\ dm^3\ atm\ mol^{-1}$$

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g),\ \Delta n_g = -2$

$$\frac{K_p}{K_c} = (24.62\ dm^{-6}\ atm^{-2}\ mol^{-2})^{-2}$$

$$= \frac{1}{(24.62\ dm^2 atm\ mol^{-1})^2}$$

$$= 1.65 \times 10^{-3}\ dm^{-6}\ atm^{-2}\ mol^{-2}$$

10 Jan Morning

Q3

(4) Concerned reaction:

$$NH_4SH \longrightarrow NH_3(g) + H_2S(g)$$

Initial moles $= \frac{5.1}{51} = 0.1$ mol

Moles at equillibrium

NH_4SH	$\longrightarrow$	$NH_3(g)$	+	$H_2S(g)$
$0.1(1-0.3)$		0.1×0.3		0.1×0.3

$\therefore \quad K_c = [NH_3][H_2S] = \left(\frac{0.03}{3}\right)^2 = 10^{-4}$

$K_p = K_c(RT)^{\Delta n_g}$

$= 10^{-4} \times (0.082 \times 600)^2 = 0.242\ atm^2$

10 Jan Evening

Q4

(1) $\underset{P_{NH_3}}{2NH_3(g)} \rightleftharpoons \underset{P_{N_2}}{N_2(g)} + \underset{P_{H_2}}{3H_2(g)},\ K = \frac{1}{K_P}$

$\therefore\ K = \frac{1}{K_P} = \frac{P_{N_2}(P_{H_2})^3}{(P_{NH_3})^2}$ ... (i)

$\Rightarrow P_{Total}(P) = P_{N_2} + P_{H_2} + P_{NH_3}$

$\approx P_{N_2} + P_{H_2}\ (\because P_{NH_3} << P_T)$

Now,

Partial pressure of $N_2 = \frac{1}{4}P$; Partial pressure of $H_2 = \frac{3}{4}P$

From eq (1), $\frac{1}{K_P} = \frac{\left(\frac{1}{4}P\right)\left(\frac{3}{4}P\right)^3}{(P_{NH_3})^2}$

$$P_{NH_3} = \frac{3^{3/2}.P^2.K_P^{3/2}}{16}$$

11 Jan Morning

Q5

(1)

	A	+	2B	$\rightleftharpoons$	2C	+	D
$t = 0$	2		3		0		0
t_{eq}	$2 - x$		$3 - 2x$		$2x$		x

Given, $3 - 2x = 2 - x$

$\Rightarrow x = 1$

$\therefore$ [C] = 2, [D] = 1, [A] = 1, [B] = 1

$\therefore K_c = \left\{\frac{2^2 \times 1}{1^2 \times 1}\right\} = 4$

12 Jan Morning

Q6

(2) $A(s) \longrightarrow \underset{P_1}{B(g)} + \underset{P_1+P_2}{C(g)}$

$K_{P_1} = P_B \times P_C$

$P_1(P_1 + P_2) = x$ ...(i)

$D(s) \longrightarrow \underset{P_1+P_2}{C(g)} + \underset{P_2}{E(g)}$

$K_{P_2} = P_C \times P_E$

$(P_1 + P_2)\, P_2 = y$ ...(ii)

Adding (i) and (ii)

$\therefore P_1(P_1 + P_2) + P_2(P_1 + P_2) = x + y$

$P_1^2 + P_1P_2 + P_2P_1 + P_2^2 = x + y$

$P_1^2 + P_2^2 + 2P_1P_2 = x + y$

$\Rightarrow (P_1 + P_2)^2 = x + y$

$\Rightarrow P_1 + P_2 = \sqrt{x+y}$

$\therefore$ Total pressure $(P_T) = P_C + P_B + P_E$

$(P_1 + P_2) + P_1 + P_2 = 2\,(P_1 + P_2)$

$P_T = 2\,(\sqrt{x+y})$

12 Jan Morning

Q7

(3) Given, $S + O_2 \rightleftharpoons SO_2$ ... (i) ; $K_1 = 10^{52}$

$2S + 3O_2 \rightleftharpoons 2SO_3$ ... (ii) ; $K_2 = 10^{129}$

$2SO_2 + O_2 \rightleftharpoons 2SO_3$ ... (iii) ; K = ?

To get equation (iii) follow (ii) – 2 (i),

$2S + 3O_2 \rightarrow 2SO_3$ $K = 10^{129}$

$-(2S + 2O_2 \rightarrow 2SO_2$ $K = 10^{104})$

$O_2 \rightarrow 2SO_3 - 2SO_2$ $K = 10^{25}$

or $2SO_2 + O_2 \rightarrow 2SO_3$ $K = 10^{25}$

8 April Evening

Q8

(1) Equilibrium constant has no relation with catalyst. Catalyst only affects the rate of the reaction. Catalyst V_2O_5 in the given reaction, is used to speed up the reaction.

10 April Evening

Q9

(1) We know that, $K_p = K_c.(RT)^{\Delta n_g}$

$\therefore$ If $\Delta n_g \neq 0$ then $K_p \neq K_c$

Now, $2C(s) + O_2(g) \rightleftharpoons 2CO(g)$

$\Delta n_g = +1$

$\Rightarrow K_p = K_c(RT)^1$

Hence, $K_p \neq K_c$

12 April Evening