

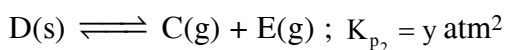
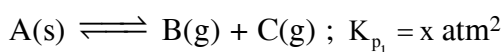
CHEMICAL EQUILIBRIUM

1. 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) 16 (2) 4

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

2. Two solids dissociate as follows

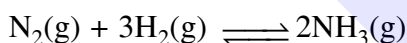


The total pressure when both the solids dissociate simultaneously is :-

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

(3) $2(\sqrt{x+y}) \text{ atm}$ (4) $\sqrt{x+y} \text{ atm}$

3. Consider the reaction,

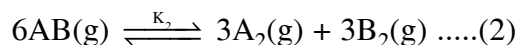
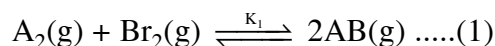


The equilibrium constant of the above reaction is K_p . If pure ammonia is left to dissociate, the partial pressure of ammonia at equilibrium is given by (Assume that $P_{NH_3} \ll P_{\text{total}}$ at equilibrium)

(1) $\frac{3^{\frac{3}{2}} K_p^{\frac{1}{2}} P^2}{4}$ (2) $\frac{3^{\frac{3}{2}} K_p^{\frac{1}{2}} P^2}{16}$

(3) $\frac{K_p^{\frac{1}{2}} P^2}{16}$ (4) $\frac{K_p^{\frac{1}{2}} P^2}{4}$

4. Consider the following reversible chemical reactions :



The relation between K_1 and K_2 is :

(1) $K_2 = K_1^3$ (2) $K_2 = K_1^{-3}$

(3) $K_1 K_2 = 3$ (4) $K_1 K_2 = \frac{1}{3}$

5. 5.1g 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

($R = 0.082 \text{ L atm mol}^{-1}\text{K}^{-1}$, Molar mass of S = 32 g mol^{-1} , molar mass of N = 14 g mol^{-1})

(1) $1 \times 10^{-4} \text{ atm}^2$

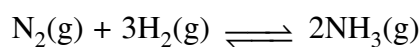
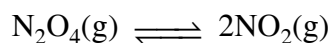
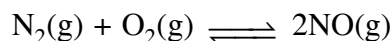
(2) $4.9 \times 10^{-3} \text{ atm}^2$

(3) 0.242 atm^2

(4) $0.242 \times 10^{-4} \text{ atm}^2$

6. The value of K_p/K_C for the following reactions at 300K are, respectively :

(At 300K, $RT = 24.62 \text{ dm}^3\text{atm mol}^{-1}$)



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

(2) 1, $4.1 \times 10^{-2} \text{ dm}^{-3}\text{atm}^{-1} \text{ mol}^{-1}$,
 $606.0 \text{ dm}^6 \text{ atm}^2 \text{ mol}^{-2}$

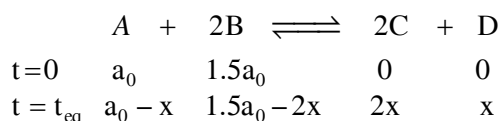
(3) $606.0 \text{ dm}^6\text{atm}^2\text{mol}^{-2}$,
 $1.65 \times 10^{-3} \text{ dm}^3\text{atm}^{-2} \text{ mol}^{-1}$

(4) 1, $24.62 \text{ dm}^3\text{atm mol}^{-1}$,
 $1.65 \times 10^{-3} \text{ dm}^{-6}\text{atm}^{-2} \text{ mol}^2$

7. For the following reactions, equilibrium constants are given :
- $$\text{S(s)} + \text{O}_2(\text{g}) \rightleftharpoons \text{SO}_2(\text{g}); K_1 = 10^{52}$$
- $$2\text{S(s)} + 3\text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}); K_2 = 10^{129}$$
- The equilibrium constant for the reaction,
 $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ is :
- (1) 10^{181} (2) 10^{154}
(3) 10^{25} (4) 10^{77}
8. For the reaction,
 $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$,
 $\Delta H = -57.2 \text{ kJ mol}^{-1}$ 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 increase.
- (3) The equilibrium constant decreases as the temperature increases.
- (4) The addition of inert gas at constant volume will not affect the equilibrium constant.
9. In which one of the following equilibria, $K_p \neq K_c$?
- (1) $\text{NO}_2(\text{g}) + \text{SO}_2(\text{g}) \rightleftharpoons \text{NO}(\text{g}) + \text{SO}_3(\text{g})$
(2) $2 \text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$
(3) $2\text{NO}(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + \text{O}_2(\text{g})$
(4) $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{CO}(\text{g})$

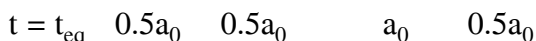
SOLUTION

1. Ans.(2)



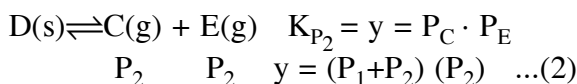
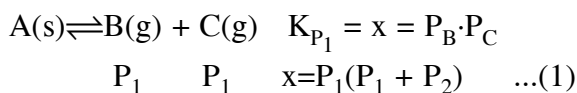
At equilibrium $[A] = [B]$

$$a_0 - x = 1.5a_0 - 2x \Rightarrow x = 0.5a_0$$



$$K_C = \frac{[C]^2 [D]}{[A][B]^2} = \frac{(a_0)^2 (0.5a_0)}{(0.5a_0)(0.5a_0)^2} = 4$$

2. Ans. (3)



Adding (1) and (2)

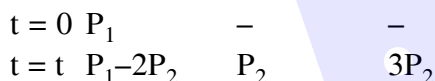
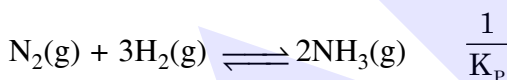
$$x + y = (P_1 + P_2)^2$$

Now total pressure

$$\begin{aligned}
 P_T &= P_C + P_B + P_E \\
 &= (P_1 + P_2) + P_1 + P_2 = 2(P_1 + P_2)
 \end{aligned}$$

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

3. Ans. (2)



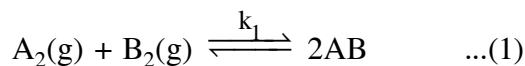
$$(P_1 - 2P_2) + P_2 + 3P_2 = P$$

$$\text{As } (P_1 - 2P_2) \ll P$$

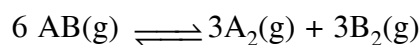
$$P_2 = \frac{P}{4}$$

$$\frac{1}{K_P} = \frac{(P/4)(3P/4)^3}{P_{NH_3}^2}$$

4. Ans. (2)

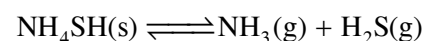


\Rightarrow eq. (1) $\times 3$



$$\Rightarrow \left(\frac{1}{k_1}\right)^3 = k_2 \Rightarrow k_2 = (k_1)^{-3}$$

5. Ans. (3)



$$n = \frac{5.1}{51} = 0.1 \text{ mole} \quad 0 \quad 0$$

$$0.1(1 - \alpha) \quad 0.1\alpha \quad 0.1\alpha$$

$$\alpha = 30\% = .3$$

so number of moles at equilibrium

$$\begin{array}{ccc}
 .1(1 - .3) & .1 \times .3 & .1 \times .3 \\
 = & .07 & =.03 & =.03
 \end{array}$$

Now use $PV = nRT$ at equilibrium

$$P_{total} \times 3 \text{ lit} = (.03 + .03) \times .082 \times 600$$

$$P_{total} = .984 \text{ atm}$$

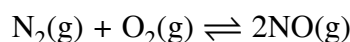
At equilibrium

$$P_{NH_3} = P_{H_2S} = \frac{P_{total}}{2} = .492$$

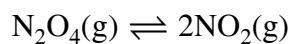
$$\text{So } k_p = P_{NH_3} \cdot P_{H_2S} = (.492)(.492)$$

$$k_p = 0.242 \text{ atm}^2$$

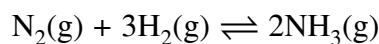
6. Ans. (4)



$$\frac{k_p}{k_c} = (RT)^{\Delta n_g} = (RT)^0 = 1$$

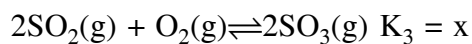


$$\frac{k_p}{k_c} = (RT)^1 = 24.62$$



$$\frac{k_p}{k_c} = (RT)^{-2} = \frac{1}{(RT)^2} = 1.65 \times 10^{-3}$$

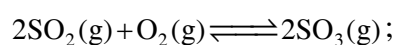
7. **Ans. (3)**



multiplying equation (1) by 2;



\Rightarrow Subtracting (3) from (2); we get



8. **Ans. (1)**

Sol. In option (2)- Δn_g is -ve therefore increase in pressure will bring reaction in forward direction.

In option (3)- as the reaction is exothermic therefore increase in temperature will decrease the equilibrium constant.

In option (4)- Equilibrium constant changes only with temperature.

Hence, option (2), (3) and (4) are correct therefore option (1) is incorrect choice.

9. **Ans. (4)**

Sol. if $\Delta n_g \neq 0$

$$K_p \neq K_c$$