PHYSICAL CHEMISTRY

DPP

DAILY PRACTICE PROBLEMS

DPP No. 58

Total Marks : 60

Max. Time : 60 min.

Topic : Chemical Equilibrium

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.20	(3 marks, 3 min.)	[60, 60]

1. The equilibrium constant of the reaction $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ is $4 \times 10^{-3}\ atm^{-1/2}$. The equilibrium constant of the reaction $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ would be :
(A) 250 atm (B) 6.25×10^3 atm (C) 0.25×10^4 atm (D) 6.25×10^4 atm

2. $\log \frac{K_p}{K_c} + \log RT = 0$ is the relationship for the following gaseous phase reaction :
(A) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ (B) $2SO_2 + O_2 \rightleftharpoons 2SO_3$ (C) $H_2 + I_2 \rightleftharpoons 2HI$ (D) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

3. For the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$, the value of K_C does not depends upon :
(a) Initial concentration of the reactants (b) Pressure (c) Temperature (d) Catalyst
(A) Only c (B) Only a,b (C) Only a,b,d (D) Only b,d

4. When alcohol (C_2H_5OH) and acetic acid are mixed together in equimolar ratio at 27ºC, 33% is converted into ester. Then the K_C for the following equilibrium is :

$$C_2H_5OH(\ell) + CH_3COOH(\ell) \rightleftharpoons CH_3COOC_2H_5(\ell) + H_2O(\ell).$$

(A) 4 (B) 1/4 (C) 9 (D) 1/9

5. The equilibrium constant (K_p) for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is 16 atm. If the volume of the container is reduced to one half its original volume, the value of K_p for the reaction at the same temperature will be :
(A) 32 atm (B) 64 atm (C) 16 atm (D) 8 atm

6. 'a' moles of PCl_5 undergo thermal dissociation as : $PCl_5 \rightleftharpoons PCl_3 + Cl_2$. At equilibrium, the mole fraction of PCl_3 is 0.25 and the total pressure is 2 atm. The value of K_p in atm is :
(A) 0.25 (B) 1 (C) 0.5 (D) Data insufficient

7. A reaction mixture containing H_2, N_2 and NH_3 has their partial pressure 2 atm, 1 atm and 3 atm respectively at 725 K. If the value of K_P for the reaction : $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is $1.25\ atm^{-2}$ at 725 K, in which direction will the net reaction go :
(A) Forward (B) Backward
(C) No net reaction (D) Direction of reaction cannot be predicted

8. The extent of dissociation of PCl_5 at a certain temperature is 20 % at one atm equilibrium pressure. Calculate the equilibrium pressure in atm at which this substance is half dissociated at the same temperature :
(A) 0.125 (B) 0.1 (C) 2.5 (D) 0.25

9. Consider the following reactions :
(i) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(ii) $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$
The addition of an inert gas at constant volume :
(A) will increase the dissociation of PCl_5 as well as HI.
(B) will reduce the dissociation of PCl_5 and not affect the dissociation of HI.
(C) will increase the dissociation of PCl_5 and not affect the dissociation of HI.
(D) will not disturb the equilibrium of the reactions.

10. The vapour density of N_2O_4 at a certain temperature is 30. What is the percentage dissociation of N_2O_4 at this temperature ?
(A) 7.5% (B) 10% (C) 15% (D) 20%

11. $aA + bB \rightleftharpoons cC + dD$
In above gaseous phase reaction, low pressure and high temperature shift the equilibrium in backward direction. So correct set is :
(A) $(a + b) > (c + d), \Delta H > 0$ (B) $(a + b) < (c + d), \Delta H > 0$
(C) $(a + b) < (c + d), \Delta H < 0$ (D) $(a + b) > (c + d), \Delta H < 0$

12. On decomposition of NH_4HS, the following equilibrium is established :
$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$
If the total pressure is P atm, then the equilibrium constant K_P is equal to :
(A) P atm (B) P^2 atm^2 (C) $P^2 / 4$ atm^2 (D) $P^2 / 9$ atm^2

13. At room temperature, the equilibrium constant for the reaction $P + Q \rightleftharpoons R + S$ was calculated to be 4.32. At 425°C, the equilibrium constant became 1.24×10^{-2}. This indicates that the reaction :
(A) is exothermic (B) is endothermic
(C) could be exothermic or endothermic (D) is not possible

14. Consider the reaction :
$A(s) \rightleftharpoons 2B(g) + 3C(g)$
If the concentration of C at equilibrium is doubled, then after the equilibrium is re-established, the concentration of B will be :
(A) 4/3 times the original value (B) 3/4 times the original value
(C) $1 / 2\sqrt{2}$ times the original value (D) $2\sqrt{2}$ times the original value

15. **Statement-1 :** For $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, if more Cl_2 is added, the equilibrium will shift in backward direction and hence equilibrium constant will decrease.
Statement-2 : Addition of a product to the equilibrium mixture always cause the equilibrium to shift backward.
(A) Statement-1 is True, Statement-2 is True ; Statement -2 is a correct explanation for Statement-1
(B) Statement-1 is True, Statment-2 is True ; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True
(E) Statement-1 and Statement-2 both are False.

16. 500 ml vessel contains 1.5 moles each of A,B, C and D at equilibrium. If 0.5 mole each of C and D are taken out, the value of K_C for $A + B \rightleftharpoons C + D$ will be :
(A) 1 (B) 1/9 (C) 4/9 (D) 8/9

17. On adding 0.01 M HCl in some amount in aqueous solution of acetic acid :
(A) Equlibrium conc. of CH_3COOH decreases. (B) Equlibrium conc. of CH_3COO^- decreases.
(C) Equlibrium conc. of CH_3COO^- increases. (D) No change will occur.

18. 9.2 gram 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% N_2O_4 (g) is dissociated. What is the equilibrium constant (in mol lit^{-1}) :
(A) 0.1 (B) 0.2 (C) 0.4 (D) 2

19. A quantity of PCl_5 was heated in a 10 dm^3 vessel at 250°C : $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. At equilibrium, the vessel contains 0.1 mole of PCl_5 and 0.2 mole of Cl_2. The equilibrium constant of the reaction is :
(A) 0.04 mol/L (B) 0.4 mol/L (C) 4 mol/L (D) cannot be determined

20. For the equilibrium :
$H_2O(l) \rightleftharpoons H_2O(g)$,
what happens if pressure is applied :
(A) More water evaporates (B) The boiling point of water is increased
(C) No effect on boiling point (D) The boiling point of water is decreased

Answer Key

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1.	(D)	**2.**	(B)	**3.**	(C)	**4.**	(B)	**5.**	(C)
6.	(A)	**7.**	(A)	**8.**	(A)	**9.**	(D)	**10.**	(C)
11.	(D)	**12.**	(C)	**13.**	(A)	**14.**	(C)	**15.**	(E)
16.	(A)	**17.**	(B)	**18.**	(B)	**19.**	(A)	**20.**	(B)

Hints & Solutions

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1. $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ $\qquad K_p = 4\times10^{-3}$

$SO_3 \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$ $\qquad K^1{}_p = \frac{1}{Kp}$

$K^1{}_p = \left(\frac{1}{4\times10^{-3}}\right)$

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

$K^{II}{}_p = (K^I{}_p)^2 = \left[\frac{1}{4\times10^{-3}}\right]^2 = \left[\frac{1000}{4}\right]^2 = 6250 = 625\times10^2$ $\qquad$ **6.25×10^4 atm.**

2. $\log\frac{K_P}{K_C} + \log RT = 0$

$\log\left(\frac{K_P}{K_C}.RT\right) = 0$

$K_p = K_c\,(RT)^{-1}$

$\because K_p = K_c\,(RT)^{\Delta n}$ $\quad ; \quad$ $\Delta n = -1$

This is possible one for option (B).

3. Equilibrium const. is temp. dependent only.

4. $C_2H_5OH\,(\ell) + CH_3COOH\,(\ell) \rightleftharpoons CH_3COOC_2H_5\,(\ell) + H_2O\,(\ell)$.

a	a	0	0
a 0.33a	a – 0.33a	0.33a	0.33a

$$K_c = \frac{(0.33a)\times(0.33a)}{(0.67a)\times(0.67a)} = K_c = 1/4.$$

5. Since, K_p is temperature dependent only.

8. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

$\alpha = .2$, initially, $K_P = \frac{\alpha^2}{1-\alpha^2}P = \frac{(0.2)^2}{1-(.2)^2}\times 1 = \frac{.04}{.96} = .042$

If $\alpha = .5$, thus, $\frac{(.5)^2}{1-(.5)^2} \times P = .042$, $P = .126$

9. Since inert gas addition has no effect at const. volume.

12. $P_{NH_3} = P_{H_2S} = \frac{P}{2}$ Hence $K_p = P_{NH_3} \times P_{H_2S} = \frac{P}{2} \times \frac{P}{2} = \frac{P^2}{4}$

13. At room temperature, K = 4.32
and at 425°C, equilibrium constant become 1.24×10^{-4} i.e. it is decreases with increase in temperature. So, it is exothermic reaction.

14. $K = [B(g)]^2 [C(g)]^3 = x^2y^3$. If [C(g)] is doubled
i.e. = 2y. Suppose [B(g)] is z. Then

$K = z^2 (2y)^3 = x^2y^3$ or $z^2 = \frac{1}{8}x^2$ or $z = \frac{1}{\sqrt{8}}x = \frac{1}{2\sqrt{2}}x$.

17. On mixing some quantity of 0.01 MHCl in aqueous solution of CH_3COOH, equilibrium concentration of CH_3COO^- will be increase.

18. $N_2O_4(g) \rightleftharpoons 2\,NO_2(s)$

	$N_2O_4(g)$	$2\,NO_2(s)$
t = 0	0.1 mole	0
t = eq	0.05	0.1

$k = \frac{(0.1)^2}{0.05} = 0.2$

19. $PCl_5\,(g) \rightleftharpoons PCl_3(g) + Cl_2(s)$
at eq, mole of PCl_3 = mole of Cl_2

So $K = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{\left[\frac{0.2}{10}\right]\left[\frac{0.2}{10}\right]}{\frac{0.1}{[10]}} = 0.04$