

## TOPIC : CHEMICAL EQUILIBRIUM

1. Which of the following statements is correct about the equilibrium constant ?
  - (a) Its value increase by increase in temperature
  - (b) Its value decrease by decrease in temperature
  - (c) Its value may increase or decrease with increase in temperature
  - (d) Its value is constant at all temperature
  
2. Pure ammonia is placed in a vessel at a temperature when its dissociation is appreciable. At equilibrium
  - (a)  $\alpha$  does not change with pressure
  - (b) concentration of ammonia does not change with pressure
  - (c) concentration of hydrogen is less than that of nitrogen
  - (d)  $K_p$  does not change significantly with pressure.
  
3. In which of the following equilibria will  $K_c$  and  $K_p$  have the same value ?
  - (a)  $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$
  - (b)  $2\text{CO} + \text{O}_2 \rightleftharpoons \text{CO}_2$
  - (c)  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$
  - (d)  $\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}$
  
4. In which of the following gaseous equilibria, the equilibrium will shift to the right if total pressure is increased.
  - (a)  $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$
  - (b)  $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$
  - (c)  $\text{H}_2 + \text{Cl}_2 \rightleftharpoons 2\text{HCl}$
  - (d)  $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$
  
5. Which of the following is not favourable for the formation of  $\text{SO}_2$  ?
 
$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) ; \Delta H = -188 \text{ kJ}$$
  - (a) High pressure
  - (b) High temperature
  - (c) Decreasing  $[\text{SO}_3]$
  - (d) Increasing  $[\text{SO}_2]$
  
6. For the gas phase reaction
 
$$\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}; \Delta H = +180 \text{ kJ mol}^{-1}$$
 which of the following is true ?
  - (a) The value of  $K$  changes with change in pressure
  - (b) The value of  $K$  changes with introduction of  $\text{NO}$
  - (c) The value of  $K$  changes with change in concentration of  $\text{N}_2$
  - (d) The value of  $K$  changes with change in temperature
  
7. At  $90^\circ\text{C}$ , pure water has  $[\text{H}_3\text{O}^+] = 10^{-6} \text{ mol L}^{-1}$ . What is the value of  $K_w$  at  $90^\circ\text{C}$  ?
  - (a)  $10^{-6}$
  - (b)  $10^{12}$
  - (c)  $10^{-14}$
  - (d)  $10^{-12}$
  
8. Which one is the strongest Bronsted-Lowry base out of the following ?
  - (a)  $\text{ClO}^-$
  - (b)  $\text{ClO}_2^-$
  - (c)  $\text{ClO}_2^-$
  - (d)  $\text{ClO}_4^-$
  
9. Which of the following is not a Lewis base ?
  - (a)  $\text{CH}_3^-$
  - (b)  $\text{AlCl}_3$
  - (c)  $\text{R}-\text{OH}$
  - (d)  $\text{RNH}_2$
  
10. Which one of the following is not amphoteric ?
  - (a)  $\text{HSO}_4^-$
  - (b)  $\text{HCO}_3^-$
  - (c)  $\text{H}_2\text{PO}_4^-$
  - (d)  $\text{HCOO}^-$
  
11. The pH of 0.1 M acetic acid is
  - (a) 1
  - (b) zero
  - (c) less than 1
  - (d) more than 1
  
12. In the reaction,  $\text{AlCl}_3 + \text{Cl}^- \rightarrow \text{AlCl}_4^-$ ,  $\text{AlCl}_3$  acts as a
  - (a) Salt
  - (b) Lewis acid
  - (c) Lewis base
  - (d) Bronsted base
  
13. The weakest base among the following is
  - (a)  $\text{H}^-$
  - (b)  $\text{CH}_3^-$
  - (c)  $\text{CH}_3\text{O}^-$
  - (d)  $\text{Cl}^-$
  
14. Which of the following equimolar solutions can act as an acidic buffer ?
  - (a)  $\text{NH}_4\text{Cl}$  and  $\text{NH}_4\text{OH}$
  - (b)  $\text{HCl}$  and  $\text{NaCl}$
  - (c)  $\text{HCOOH}$  and  $\text{HCOONa}$
  - (d)  $\text{HNO}_3$  and  $\text{NH}_4\text{NO}_3$

15. In which of the following does the reaction go almost to completion ?  
 (a)  $K = 10^6$  (b)  $K = 10^2$   
 (c)  $K = 10^{-6}$  (d)  $K = 10^{-12}$
16. Which of the following expression is not correct ?  
 (a)  $\Delta G^\circ = -RT \ln K$   
 (b)  $[H_3O^+] = 10^{-pH}$   
 (c)  $K_c = K_p (RT)^{\Delta H}$   
 (d)  $pH = pK_a + \log \frac{[Salt]}{[Acid]}$
17. The following equilibrium is established when hydrogen chloride is dissolved in acetic acid  
 $HCl + CH_3COOH \rightleftharpoons Cl^- + CH_3COOH_2^+$   
 The set that characterizes the conjugate acid-base pairs is  
 (a)  $(HCl, CH_3COH)$  and  $(CH_3COOH_2^+, Cl^-)$   
 (b)  $(HCl, CH_3COOH_2^+)$  and  $(CH_3COOH, Cl^-)$   
 (c)  $(CH_3COOH_2^+, HCl)$  and  $(Cl^-, CH_3COOH)$   
 (d)  $(HCl, Cl^-)$  and  $(CH_3COOH_2^+, CH_3COOH)$
18.  $Cu^{2+}$  and  $Pb^{2+}$  ions are both present in aqueous solution. To precipitate one of the ions and leave the other in the solution add  
 (a)  $H_2S(aq)$  (b)  $HNO_3(aq)$   
 (c)  $NH_4NO_3(aq)$  (d)  $H_2SO_4(aq)$
19. Which of the following sulphide has the largest value of  $K_{sp}$  ?  
 (a)  $CuS$  (b)  $CdS$   
 (c)  $PbS$  (d)  $ZnS$
20. The number of moles of  $H_3O^+$  ion in 200 mL of 0.005 M  $H_2SO_4$  is  
 (a) 0.005 (b) 0.01  
 (c) 0.002 (d) 0.001
21. According to Le Chatelier's principle adding heat to a solid and liquid in equilibrium will cause the  
 (a) amount of solid to decrease  
 (b) amount of liquid to decrease  
 (c) temperature of rise  
 (d) temperature to fall
22. 0.1 M solution of which of the substance will behave basic ?  
 (a) sodium borate (b) ammonium chloride  
 (c) calcium nitrate (d) sodium sulphate
23. In what manner will increase of pressure affects the following equilibrium ?  
 $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$   
 (a) Shift in the forward direction  
 (b) Shift in the reverse direction  
 (c) Increases in the yield of hydrogen  
 (d) No effect.
24. For the chemical reaction  $3X(g) + Y(g) \rightleftharpoons X_3Y(g)$  the amount of  $X_3Y$  at equilibrium is affected by  
 (a) temperature and pressure  
 (b) temperature only  
 (c) pressure only  
 (d) temperature, pressure and catalyst
25. For a gaseous reaction,  
 $pA + qB \rightleftharpoons qC + pD$   
 which of the following relationship is true ?  
 (a)  $K_p = K_c$  (b)  $K_p = K_c (RT)^{p+q}$   
 (c)  $K_p = K_c (RT)^{p-q}$  (d)  $K_p = K_c = (RT)^{1/p+q}$
26. Which has the highest degree of ionization ?  
 (a) 1 M  $NH_3$  (b) 0.001 M  $NH_3$   
 (c) 0.1 M  $NH_3$  (d) 0.0001 M  $NH_3$
27. For the equilibrium,  
 $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$   
 the total pressure at equilibrium is P and degree of dissociation of  $PCl_5$  is x. Which of the following is the partial pressure of  $PCl_3$  ?  
 (a)  $\frac{x}{x-1} \times P$  (b)  $\frac{x}{1-x} \times P$   
 (c)  $\frac{x}{x+1} \times P$  (d)  $\frac{2x}{1-x} \times P$
28. The dissociation constants of two weak acids are  $K_1$  and  $K_2$ . The relative strength of the two acids is given by  
 (a)  $K_1/K_2$  (b)  $(K_1/K_2)^{1/2}$   
 (c)  $(K_1/K_2)^{3/2}$  (d)  $K_1 - K_2$

29. A quantity of  $\text{PCl}_5$  was heated in a 10 L vessel at 525 K.
- $$\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$$
- At equilibrium the vessel contains 0.10 mole of  $\text{PCl}_5$ , 0.20 mole of  $\text{PCl}_3$  and 0.20 mole of  $\text{Cl}_2$ . The equilibrium constant for the reaction is
- (a) 0.04 (b) 0.4  
(c) 0.02 (d) 0.05
30. Consider the two gaseous equilibria involving  $\text{SO}_2$  and the corresponding equilibrium constants at 298 K
- $$\text{SO}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g}) \quad \dots K_1$$
- $$2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \quad \dots K_2$$
- The values of equilibrium constants are related as :
- (a)  $2K_1 = K_2^2$  (b)  $K_2^2 = \frac{1}{K_1}$   
(c)  $K_1^2 = \frac{1}{K_2}$  (d)  $K_2 = \frac{3}{K_1^2}$
31. The value of  $\Delta G^\circ$  for a reaction having  $K = 1$  would be
- (a)  $-RT$  (b)  $-1$   
(c) 0 (d)  $+RT$
32. pH of an aqueous solution is 5.5. The hydroxyl ion conc. in the solution would be
- (a)  $-5.5$  (b)  $-8.5$   
(c)  $10^{-8.5}$  (d)  $10^{8.5}$
33. When 100 mL of N/10 NaOH are added to 50 mL of N/5 HCl. The pH of the resulting solution would be
- (a) 7 (b)  $> 7$   
(c)  $< 7$  (d) Zero
34. Given,  $\text{HF} + \text{H}_2\text{O} \xrightarrow{K_a} \text{H}_3\text{O}^+ + \text{F}^-$   
 $\text{F}^- + \text{H}_2\text{O} \xrightarrow{K_b} \text{HF} + \text{OH}^-$
- Which one of the following relations is correct ?
- (a)  $K_a = \frac{1}{K_b}$  (b)  $K_a \times K_b = K_w$   
(c)  $\frac{K_a}{K_b} = K_w$  (d)  $\frac{K_b}{K_a} = K_w$
35. The solubility of  $\text{Fe}(\text{OH})_3$  is  $x \text{ mol L}^{-1}$ . Its  $K_{sp}$  would be
- (a)  $9x^3$  (b)  $3x^4$   
(c)  $27x^4$  (d)  $9x^4$
36. The solubility product  $K_{sp}$  of the sparingly soluble salt  $\text{Ag}_2\text{CrO}_4$  is  $4 \times 10^{-12}$ . The solubility of the salt is
- (a)  $1 \times 10^{-12} \text{ mol L}^{-1}$   
(b)  $2 \times 10^{-6} \text{ mol L}^{-1}$   
(c)  $10^{-6} \text{ mol L}^{-1}$   
(d)  $10^{-4} \text{ mol L}^{-1}$
37.  $\text{Ba}(\text{OH})_2$  is a strong base. The pH of its 0.005 M solution would be
- (a) 11.31 (b) 11.7  
(c) 12 (d) None of these
38. Hydrogen ion concentration of a solution of a weak base of dissociation constant  $K_b$  and concentration C is
- (a)  $\frac{K_w}{\sqrt{K_b \times C}}$  (b)  $K_w \times K_b$   
(c)  $\frac{K_w}{K_b}$  (d)  $K_w \times \sqrt{K_b \times C}$
39. The pH of mixture of containing 70 ml of 0.1 M HCl and 30 ml of 0.1 M NaOH solution will be
- (a) 0.7 (b) 1.4  
(c) 0.8 (d) 0.5
40. If  $\alpha$  is the fraction of HI dissociated at equilibrium in the reaction,  $2\text{HI}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ , starting with 2 moles of HI, the total number of moles of reactants and products at equilibrium are
- (a)  $1 + \alpha$  (b)  $2 + 2\alpha$   
(c) 2 (d)  $2 - \alpha$
41. In the reaction  $\text{A} + \text{B} \rightarrow \text{C}$ , if we start with equal concentration of A and B, at equilibrium we find that the moles of C is two times of A. What is the equilibrium constant of the reaction ?
- (a) 4 (b) 2  
(c)  $\frac{1}{4}$  (d)  $\frac{1}{2}$

42. When two reactants, A and B are mixed to give products C and D, the reaction quotient, Q, at the initial stages of the reaction
- is zero
  - decreases with time
  - is independent of time
  - increases with time
43. For an equilibrium  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$  the total pressure at equilibrium is P and degree of dissociation of  $\text{N}_2\text{O}_4$  is x. Which one of the following is the partial pressure of  $\text{NO}_2$  ?
- $\frac{2x}{(1+x)} P$
  - $2 \times P$
  - $\frac{2}{(1-x)} P$
  - $\frac{2}{3} \times P$
44. One mole of  $\text{SO}_3$  was placed in a litre vessel at a certain temperature. When equilibrium is established in the reaction,
- $$2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$$
- the vessel was found to contain 0.4 moles of  $\text{SO}_3$ . The value of equilibrium constant is
- 0.13
  - 0.36
  - 0.68
  - 0.45
45. When 4 gm of NaOH is dissolved in 10 litre of solution, the pH is
- 6
  - 12
  - 18
  - 24
46. The decomposition of  $\text{N}_2\text{O}_4$  to  $\text{NO}_2$  is carried out at  $280^\circ$  in chloroform. When equilibrium is reached, 0.2 mol of  $\text{N}_2\text{O}_4$  and  $2 \times 10^{-3}$  mol of  $\text{NO}_2$  are present in a 2L solution, the equilibrium constant for the reaction  $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$  is
- $1 \times 10^{-2}$
  - $2 \times 10^{-3}$
  - $1 \times 10^{-5}$
  - $2 \times 10^{-5}$
47. In the system
- $$\text{Fe}(\text{OH})_3(\text{s}) \rightleftharpoons \text{Fe}^{3+}(\text{aq}) + 3\text{OH}^{-}(\text{aq}),$$
- decreasing the conc. of  $\text{OH}^{-}$  ions 1/3 times will cause the equilibrium conc. of  $\text{Fe}^{3+}$  to increase.... times.
- 3
  - 9
  - 18
  - 27
48. What is the decreasing order of strength of bases ( $\text{OH}^{-}$ ,  $\text{NH}_2^{-}$ ,  $\text{H}-\text{C} \equiv \text{C}^{-}$ ,  $\text{CH}_3\text{CH}_2^{-}$ )
- $\text{CH}_3\text{CH}_2^{-} > \text{NH}_2^{-} > \text{H}-\text{C} \equiv \text{C}^{-} > \text{OH}^{-}$
  - $\text{H}-\text{C} \equiv \text{C}^{-} > \text{CH}_3\text{CH}_2^{-} > \text{NH}_2^{-} > \text{OH}^{-}$
  - $\text{H}-\text{C} \equiv \text{C}^{-} > \text{CH}_3\text{CH}_2^{-} > \text{OH}^{-} > \text{NH}_2^{-}$
  - $\text{NH}_2^{-} > \text{H}-\text{C} \equiv \text{C}^{-} > \text{OH}^{-} > \text{CH}_3\text{CH}_2^{-}$
49. One mole of  $\text{SO}_3$  was placed in a litre reaction vessel at a certain temperature. The following equilibrium was established
- $$2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$$
- At equilibrium, 0.6 moles of  $\text{SO}_2$  were formed. The equilibrium constant of the reaction will be
- 0.35
  - 0.45
  - 0.54
  - 0.675
50. 4.5 moles each of hydrogen and iodine are heated in a sealed ten litre vessel. At equilibrium 3 moles of HI were found. The equilibrium constant for
- $$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$$
- is
- 1
  - 10
  - 5
  - 0.33

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ANSWERS KEY

1	C	11	D	21	A	31	C	41	A
2	D	12	B	22	A	32	C	42	D
3	D	13	D	23	B	33	A	43	A
4	A	14	C	24	A	34	B	44	C
5	A	15	A	25	A	35	C	45	B
6	D	16	C	26	D	36	D	46	C
7	D	17	D	27	C	37	C	47	D
8	A	18	D	28	B	38	A	48	A
9	B	19	D	29	A	39	B	49	D
10	D	20	C	30	C	40	C	50	A