Chapter: 08

Chemical Equilibrium

Objective

1. The term pH was introduced by:
   (A) Le-chattilier (B) Sorenson (C) Millikan (D) Henderson
2. The pH of Milk of Magnisia is:
   (A) 10.5 (B) 11.1 (C) 8.5 (D) 3.5
3. Which one affects the value of K_C?
   (A) catalyst (B) pressure (C) concentration (D) temperature
4. Which one of the following salts dissolves in water to form a solution with a pH greater than 7?
   (A) $CuSO_4$ (B) NH_4CI (C) Na_2CO_3 (D) NaCl
5. When ionic product of a solution is greater than the solubility product at a particular temperature then the solution is said to be:
   (A) super saturated (B) saturated (C) unsaturated (D) very dilute
6. Approximate pH of apple is:
   (A) 3.1 (B) 4.2 (C) 4.5 (D) 5.2
7. The pH of a solution is 9, the solution is:
   (A) Strongly acidic (B) strongly basic (C) Weakly acidic (D) Weakly basic
8. The reaction which proceeds in both forward and backward directions is called:
   (A) Spontaneous reaction (B) Irreversible reaction
   (C) Spontaneous reaction (D) Reversible reaction
9. The value of pK_w at 25 °C for water is:
   (A) 10^{-14} (B) 10^{-7} (C) 14 (D) 7
10. pH value of vinegar is:
    (A) 3.5 (B) 2.8 (C) 2.2 (D) 1.5
11. pH of 10^{-4} mol dm^{-3} of HCl is:
    (A) 4 (B) 3 (C) 2 (D) 1
12. The rate of Reaction:
    (A) Remain the same as the reaction procee (B) Increase as reaction proceed
    (C) None of these (D) Decrease as reaction proceed
13. For which system, does the equilibrium constant has no units:
    (A) $2HF \rightleftharpoons H_2 + F_2$ (B) $2NO_2 \rightleftharpoons N_2O_4$
    (C) $H_2 + I_2 \rightleftharpoons 2HI$ (D) $N_2 + 3H_2 \rightleftharpoons 2NH_3$
14. The solution having zero pH will be:
    (A) neutral (B) basic (C) acidic (D) Highly acidic
15. pH value for 1.0 M HCI solution is:

Ⓐ 0.8 Ⓑ 0.7 **Ⓒ 0.0** Ⓓ 0.5

16. Equilibrium constant for the reaction at 2000 °C $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$ is:

Ⓐ 10^{-5} **Ⓑ 10^{-13}** Ⓒ 10^{-9} Ⓓ 10^{-7}

17. A solution which resists to change its pH is called as:

Ⓐ Buffer solution Ⓑ Standard solution Ⓒ Basic solution Ⓓ Acid solution

18. Catalyst used in conversion of SO_2 into SO_3 in contact process is:

Ⓐ SiO_2 **Ⓑ V_2O_5** Ⓒ Al_2O_3 Ⓓ MgO

19. The value of pH of pure water at 25°C is:

Ⓐ 7 Ⓑ 14 Ⓒ 1×10^{14} Ⓓ 1×10^{-14}

20. Mixture of NH_4OH and NH_4Cl makes a buffer whose pH is:

Ⓐ 4 **Ⓑ more than seven** Ⓒ less than seven Ⓓ 7

21. PH of the soft drink is:

Ⓐ 3.0 Ⓑ 4.6 Ⓒ 5.6 Ⓓ 2.0

22. Dilution increases the degree of dissociation, is the statement of which of the following law or principle:

Ⓐ Law of mass action Ⓑ Hess's law
Ⓒ Ostwald dilution Ⓓ Le-Chatelier principle

23. The pH of tomato is:

Ⓐ 9.2 **Ⓑ 4.2** Ⓒ 7.2 Ⓓ 10

24. The reaction for synthesis of NH_3 the value of Δn is: $N_2 + 3H_2 \rightleftharpoons 2NH_3$

Ⓐ -2 Ⓑ +2 Ⓒ +4 Ⓓ +1

25. For an Exothermic Reversible reaction, increase in temperature will favour which:

Ⓐ Reverse Direction Ⓑ Initially in forward direction, then in reverse direction
Ⓒ Forward Direction Ⓓ Equilibrium will not disturbed

26. The law of mass action was given by Guldberg and P.Waage in:

Ⓐ 1909 Ⓑ 1946 Ⓒ 1846 **Ⓓ 1864**

27. The law of mass action was given by:

Ⓐ Bodentein Ⓑ Vant Hoff **Ⓒ Gulderg and Waage** Ⓓ Berthelot

28. The units of K_C for reaction $N_2 + O_2 \rightleftharpoons 2NO$ will be:

Ⓐ $moles^{-2}\ dm^{+6}$ **Ⓑ No unit** Ⓒ $moles^{-1}\ dm^{-3}$ Ⓓ $moles\ dm^{-3}$

29. The unit of equilibrium constant (K_C) for the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$ will be:

Ⓐ $Mol^{-2}\ dm^{+6}$ Ⓑ $Mol^{+2}\ dm^{-6}$ Ⓒ $Mol\ dm^{-3}$ Ⓓ Having no unit

30. The relationship between K_p and K_c is given by:

Ⓐ $K_c = K_p(\frac{P}{N})^{\Delta n}$ Ⓑ $K_c = K_p(P)^{\Delta n}$ Ⓒ $K_p = K_c(RT)^{-\Delta n}$ **Ⓓ $K_p = K_c(RT)^{\Delta n}$**

31. Acid having Ka > 1 will be:

Ⓐ Very weak Ⓑ weak **Ⓒ strong** Ⓓ moderate

32. Which statement about the following equilibrium is correct? $2SO_2 + O_2 \rightleftharpoons 2SO_3$
   (A) The value of K_p falls with increase in pressure.
   (B) The value of K_p falls with rise in temperature.
   (C) The value of K_p is equal to K_c.
   (D) Adding V_2O_5 catalyst increases the equilibrium yield of SO_3.

33. For the reaction $2SO_2 + O_2 \rightleftharpoons 2SO_3$:
   (A) $K_c = K_x$ **(B) $K_c > K_p$** (C) $K_c < K_p$ (D) $K_c = K_p$

34. The units for K_w of H_2O are:
   (A) $Mol^{+2}\ dm^{-6}$ (B) $Mol^{-2}\ dm^{+6}$ (C) $Mol^{-2}\ dm^{-3}$ (D) $Mol\ dm^{-3}$

35. Reaction of $BiCl_3$ with H_2O gives while ppt. of BiOCl and HCl is formed. The white ppt. disappears by:
   (A) Adding HCI (B) Adding $BiCl_3$
   (C) Decreasing temperature (D) Increase temperature

36. The value of K_w at 25°C is:
   (A) 0.30×10^{-14} (B) 3×10^{-14} (C) 0.11×10^{-14} **(D) 1×10^{-14}**

37. The optimum temperature for the synthesis of NH_3 by Haber's process is:
   (A) 500 °C (B) 300 °C **(C) 400 °C** (D) 200 °C

38. Catalyst used in preparation of NH_3 from N_2 and H_2 is:
   (A) V_2O_5 **(B) Fe** (C) Ni (D) Pt

39. In synthesis of ammonia by Haber's process, the optimum condition for pressure is:
   (A) 200-300atm (B) 300-350atm (C) 150-170 atm (D) 180-200 atm

40. When KCI is added to a saturated solution of $KClO_3$ the equilibrium is shifted to the:
   (A) Forward Direction (B) Not affected (C) Both A & B **(D) Backward Direction**

41. For which system does the equilibrium constant K_C has the Unit $(\text{concentration})^{-1}$:
   (A) $2HF \rightleftharpoons H_2 + F_2$ (B) $H_2 + I_2 \rightleftharpoons 2HI$
   (C) $2NO_2 \rightleftharpoons N_2O_4$ (D) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

42. An aqueous solution of ethanol in water may have vapour pressure:
   (A) Less than that of water **(B) More than that of water**
   (C) Equal to that of water (D) Equal to that of ethanol

43. The increase in dilution of solution:
   (A) Decreases the degree of dissociation (B) Depends upon the degree of the solute
   (C) Increase the degree of dissociation (D) Does not affect the degree of dissociation

44. A solution with pH = 0 indicates molar concentration of H^+ ions:
   (A) 10^{+7} (B) 10^{-7} **(C) 1.0** (D) 10^{-14}

45. Molarity of pure water is:
   (A) 6 **(B) 55.5** (C) 10 (D) 18

46. The nature of milk is:
   (A) Acidic (B) Normal (C) Basic (D) Neutral

47. Sum of pK_a and pK_b is equal to:

Ⓐ 0 Ⓑ 1 Ⓒ 7 Ⓓ 14

48. The pH of 10^{-4} moles dm^{-3} of $Ba(OH)_2$ is:
Ⓐ 6.4 Ⓑ 7.5 Ⓒ 10.3 Ⓓ 4.5

49. The pH of 10^{-3} moles dm^{-3} of an aqueous solution of H_2SO_4 is:
Ⓐ 3.0 Ⓑ 2.7 Ⓒ 2.0 Ⓓ 1.5

50. PH of buffer can be calculated by using:
Ⓐ Bohrs equation Ⓑ Henderson's equation
Ⓒ Moseley's equation Ⓓ De-Broglie's equation

51. The pH of the gastric juice is:
Ⓐ 2.0 Ⓑ 2.5 Ⓒ 3 Ⓓ 5.5

52. Which aqueous solution has highest pH?
Ⓐ 0.1M HCI Ⓑ 0.2M HNO_3 Ⓒ 0.1M H_2SO_4 Ⓓ 0.1M NaOH

53. The pH of buffer of CH_3COONa and CH_3COOH is:
Ⓐ 1 Ⓑ 7 Ⓒ < 7 Ⓓ > 7

54. The term pH was introduced by:
Ⓐ Thomson Ⓑ Sorenson Ⓒ Goldstein Ⓓ Henderson

55. The pH of human blood is:
Ⓐ 7.35 Ⓑ 8.0 Ⓒ 7.63 Ⓓ 7.53

56. The solubility of $KCIO_3$ in water is suppressed by adding:
Ⓐ $KMnO_4$ Ⓑ $NaClO_3$ Ⓒ NaCl Ⓓ KCI

57. In the presence of common ion, the ionization of an electrolyte will:
Ⓐ Moderate change Ⓑ no affect Ⓒ decrease Ⓓ Increase

58. The HCl is added to aqueous solution of H_2S the solubility will be:
Ⓐ Decreases Ⓑ Increase
Ⓒ First decreases then increases Ⓓ Remain constant

59. When HCI is added to H_2SO_4 aqueous solution, its ionization:
Ⓐ First increases then decreases Ⓑ Remain constant
Ⓒ Increases Ⓓ Decreases

60. An excess of aqueous silver nitrate is added to aqueous barium chloride and precipitate is removed by filtration. What are the main ions in the filtrate?
Ⓐ Ag^+ and NO only Ⓑ Ba^{2+} and NO_3^{-1} and Cl^-
Ⓒ Ag^+ and Ba^{2+} NO_3^{-1} Ⓓ Ba^{2+} and NO_3^{-1} only

61. The solubility product of AgCl is $2.0 \times 10^{-10} mol^2 dm^{-3}$. The maximum concentration of Ag^+ ions in the solution is:
Ⓐ 1.0×10^{-10} moldm^{-3} Ⓑ 2.0×10^{-10} moldm^{-3}
Ⓒ 4.0×10^{-2} moldm^{-3} Ⓓ 1.4×10^{-5} moldm^{-3}

Fill in the blanks

Q1: Law of mass action states that the .... at which a reaction proceeds, is directly proportional to the product of the active masses of the ....

Q2: In an exothermic reversible reaction .... temperature will shift the equilibrium towards the forward direction.

Q3: The equilibrium constant for the reaction $2O_3 \rightleftharpoons 3O_2$ is 10^{55} at 25°C, it tells that ozone is .... at room temperature.

Q4: In a gas phase reaction, if the number of moles of reactants are equal to the number of moles of the products, K_C of the reaction is .... to the K_P.

Q5: Buffer solution is prepared by mixing together a weak base and its salt with .... or a weak acid and its salt with ....

Answers

1.	rate, reactants	2.	decrease	3.	unstable	4.	equal
5.	Strong acid, strong base						

Chapter : 08 Chemical Equilibrium

Subjective

Q1: ***Define State of Dynamic Equilibrium.***

Ans: *Dynamic Equilibrium:*

When the forward and reverse reactions are taking place exactly at the same rate the equilibrium established is called dynamic equilibrium.

Q2: ***Difference between reversible and irreversible reactions.***

Ans: *The difference between reversible and irreversible reactions is:*

Reversible reaction	***Irreversible reaction***
The reaction which can precede both in forward as well as backward direction is called reversible reaction. $N_2 + 3H_2 \rightleftharpoons 2NH_3$	*The reaction which takes place only in one direction is called irreversible reaction.* $2Na + 2H_2O \longrightarrow 2NaOH + H_2$

Q3: ***The direction of reaction is determined by K_C.*** **OR**
How K_C predict the direction of a reaction.

Ans: *For this purpose K_C is compared with ratio of [Product]/ [reactants]:*

- *If ratio is equal to K_C it means reaction is at equilibrium.*
- *If ratio is less than K_C the reaction will proceed in forward direction.*
- *If ratio is greater than K_C the reaction will proceed in backward direction.*

Q4: ***State law of mass action.***

Ans: *Law of mass action:*

The rate at which substances react is directly proportional to their active masses.

Q5: ***Using Law of Mass action, how can you derive following expression for***

$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$ $K_C = \frac{4x^2}{(a-x)V}$ ***(Indicate what a, x,V stands for).***

Ans: $N_2O_{4(g)}$*, the expression of* K_C *involves the factor of volume.*

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

$$N_2O_4 \rightleftharpoons 2NO_2$$

at t = 0sec 'a' moles   0 moles

at t = t_{eq} *'a-x' moles   2x moles*

$$\frac{a-x}{v} \qquad \frac{2x}{v}$$

$$K_C = \frac{[NO_2]^2}{[N_2O_4]}$$

$$K_C = \frac{[\frac{2x}{v}]^2}{[\frac{a-x}{v}]} = \frac{\frac{4x^2}{V^2}}{\frac{a-x}{v}}$$

$$K_C = \frac{4x^2}{(a-x)v}$$

'a' is the initial number of moles of N_2O_4*, 'x' is number of moles of* N_2O_4 *decomposed and* V *is total volume of* N_2O_4 *and* NO_2 *at equilibrium stage.*

Q6: ***Give equilibrium constant*** K_C ***expression for***

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Ans:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

a moles	b moles	0 moles
a−x	b−3x	2x
$\frac{a-x}{v}$	$\frac{b-3x}{v}$	$\frac{2x}{v}$

So,

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K_C = \frac{[\frac{2x}{v}]^2}{[\frac{a-x}{v}][\frac{b-3x}{v}]^3} = \frac{(\frac{4x^2}{v^2})}{(\frac{a-x}{v})[\frac{(b-3x)^3}{v^3}]}$$

$$K_C = \frac{4x^2v^2}{(a-x)(b-3x)^3}$$

Q7: ***State law of Mass Action. Give equilibrium constant expression*** K_c ***for the following reaction.***

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Ans: *Law of mass action:*

The rate at which substance reacts is directly proportional to its active mass and the rate of reaction is directly proportional to the product of active masses of the reactants.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

Q8: ***Write two applications of equilibrium constant.***

Ans: *There are following applications of equilibrium constant:*

- *Prediction of direction of reaction.*
- *Extent of a chemical reaction.*
- *Effect of various factors on chemical equilibrium.*

Q9: ***Why the equilibrium constant value has its units for some of the reversible reactions but has not units for some other reactions?***

Ans: *Units of* K_C *depend upon the number of moles of reactants and products involved in the reaction.*

- *If number of moles of reactant and products are same it has no unit.*
- *If number of moles of reactants is different from products then* K_C *has units, related to the concentration or pressure.*

Q10: ***Reversible reaction attains the position of equilibrium which is dynamic in nature and not static. Explain it.***

Ans: *At equilibrium state the reaction is not stopped. Only the rate of forward reaction becomes equal to reverse reaction. Since reaction is in progress in both the directions. Therefore equilibrium is dynamics in nature not static.*

Q11: ***The change of temperature disturbs both the equilibrium position and equilibrium constant of a reaction. Explain with reason?***

Ans: *According to Le-Chateliers principle an increase in temperature will favour the endothermic reaction and decrease in temperature will favour the exothermic reaction. Therefore, change of temperature will disturb equilibrium position. The equilibrium constant is temperature dependent therefore with the change of temperature a new equilibrium position will be established.*

Q12: ***How*** K_C ***predicts the extent of chemical reaction?***

Ans: *The value of* K_C *also helps us to predict extent of chemical reaction.*

There are three possibilities:

Large K_C *value:*

If K_C *value is large it means reaction is almost completed.*

Small K_C *value:*

If K_C *value is small it means reaction does not proceed appreciably in forward direction. Small amount of products will be formed.*

K_C *is in fractions:*

If K_C *is in fractions. It means little forward reaction.*

Q13: ***What happen to the direction of reaction of a reversible reaction?*** ***OR***
When the ratio of concentration is less than actual K_c***?***

Ans: *In reversible reaction, when the ratio of concentration is less than* K_C*, it indicates that more of the product is required to attain the equilibrium; therefore, the reaction will proceed in forward direction.*

$$Qc < Kc$$

Q14: ***Define*** K_f ***and*** K_b ***for reversible reactions.***

Ans: K_f *and* K_b*:*

K_f is rate constant for forward reaction and K_b is rate constant for reverse or backward reaction. At equilibrium, rate of forward reaction becomes equal to reverse reaction.

Q15: Give the physical significance of K_f and K_b.

Ans: The rate of forward and reverse reaction tells us the condition on which a reaction will depend. It also tells about:

- Extent of a reaction.
- Direction of a reaction.

Q16: Why do rates of forward reactions slow down when the reversible reaction approaches the equilibrium stage?

Ans: The rate of forward reaction is directly proportional to molar conc. of reactants. Near the equilibrium stage, the concentration of reactant becomes small. Therefore, the rates of forward reaction slow down due to decrease in concentration.

Q17: Derive value of K_C for the reaction

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2?$$

Ans:

$$PCl_5 \rightleftharpoons PCl_3 + Cl_2:$$

$$K_C = \frac{[PCl_3]3[Cl_2]}{[PCl_5]}$$

Q18: Increasing pressure increase the oxidation of SO_2 to SO_3. Explain why?

Ans:

$$SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$$

The number of moles of products are smaller than number of moles of reactants. Hence according to Le-Chatelier's principle, an increase in pressure will favour the forward reaction. During this process the pressure is kept at one atmosphere. Hence by increasing the pressure the conc. of Oxygen increases, which results in greater yield of SO_3.

Q19: What are K_C and K_p and how these are related?

Ans: **K_C:** When the concentrations of reactants or products are expressed in moles dm^{-3} the equilibrium expression called K_C.

K_p: When the reactants or products are gases then the conc. terms may be replaced by partial pressure called K_p.

$$K_p = K_C (RT)^{\Delta n}$$

Where R = Universal gas constant.

Δn = Number of moles of products - number of moles of reactants.

Q20: State Le-Chatelier's Principle. Discuss the effect of change in pressure on equilibrium position.

Ans: If a stress is applied to a system at equilibrium, the system acts in such a way so as to nullify, as far as possible, the effect of that stress.

The change in pressure or volume is important only for the reversible gaseous reactions where the number of moles of reactants and products are not equal Le-Chatelier's principle plays an important role, to predict the position and direction of the reaction.

Take the example of formation of SO_3 gas from SO_2 gas and O_2 gas.

Q21: How some reactions are effected by change in pressure?

Ans: The change in pressure or volume is important only for the reversible gaseous reaction where number of moles of reactants and products are not equal.

Le-Chatelier's principle plays an important role, to predict the position and direction of reaction,

For example:

$$2SO_2 + O_2 \rightleftharpoons 2SO_3 \qquad \Delta H = -194\ KJmol^{-1}$$

$$N_2 + 3H_2 \rightleftharpoons 2NH_3 \qquad \Delta H = -92.46\ KJmol^{-1}$$

In both reactions, numbers of moles of reactants are greater so increase in pressure will favor the reaction in forward direction.

Q22: *Why during the synthesis of NH_3 temperature is kept low?*

Ans:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

This is an exothermic reaction. Hence decrease in temperature will favour the forward reaction. That's why during NH_3 preparation temperature kept low. Actually optimum temperature is 400 to 450°C.

This graph is just for your information.

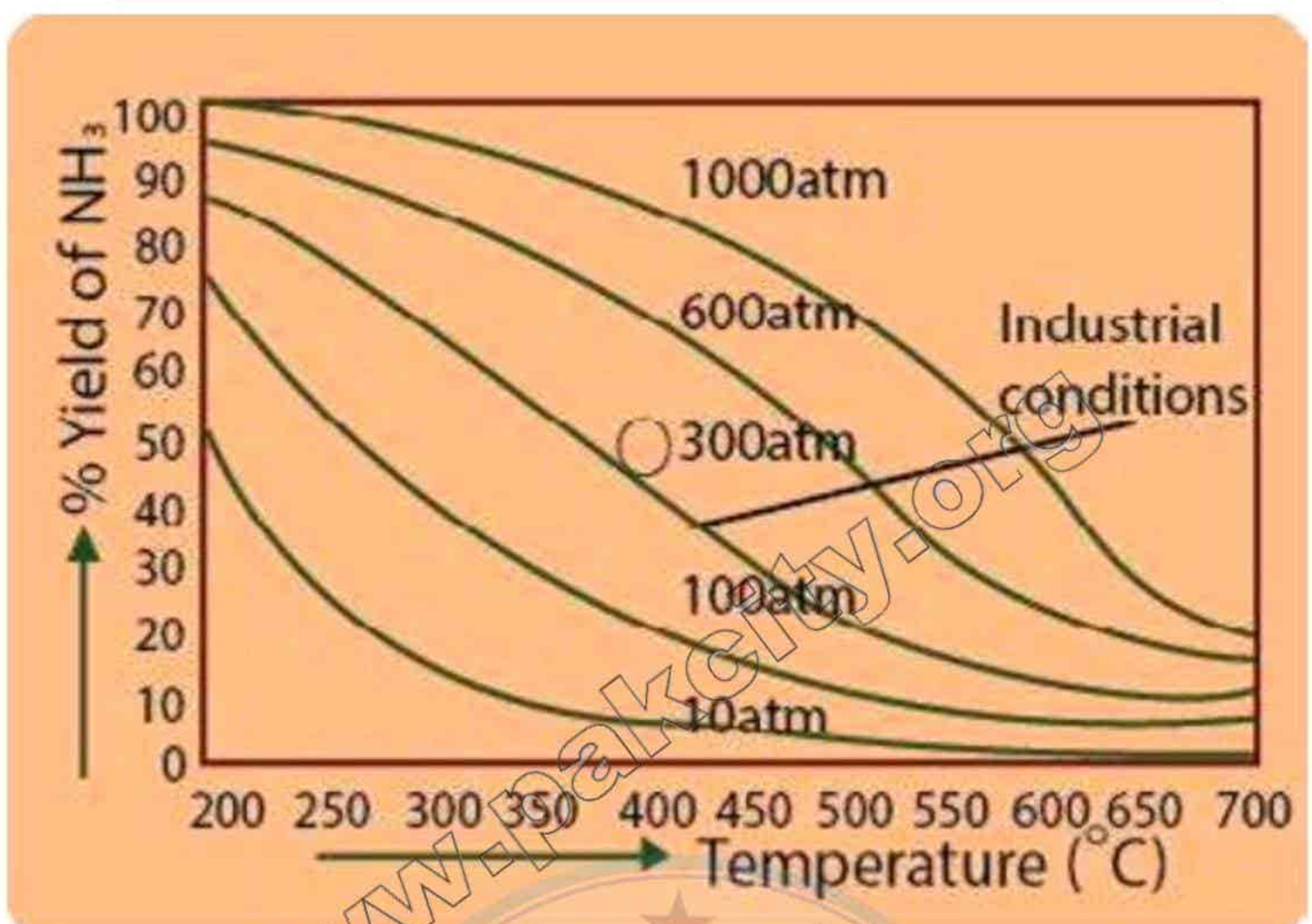

Fig Graphical representation of temperature and pressure for NH_3 synthesis.

Q23: *How does the change of pressure shift the equilibrium position in the synthesis of ammonia?*

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

Ans: When we increase or decrease the pressure of a gaseous system the equilibrium position is disturbed. If moles of products and reactants are same in reaction no disturbance in equilibrium position takes place. If moles of products and reactants are unequal, then reaction will move toward less number of moles by increasing pressure. In the formation of NH_3 more products is formed by increasing pressure.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Q24: *What are optimum conditions for the synthesis of NH_3?* ***OR***

What are favourable and what are condition to maximize yield of NH_3?

Ans: At high pressure, low temperature and continuous removal of NH_3 will give best yield of NH_3.

The optimum conditions are:

- 200-300 *atm pressure.*
- 400°C *temperature*
- *Piece of iron as catalyst embaded in fused mixture of* MgO, Al_2O_3 *and* SiO_2.

Q25: *What will be the effect of increase of pressure and temperature on the following reactions?*

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Ans: $$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

In this case number of moles of products is smaller than reactant. Therefore by increase in pressure will favour the forward reaction. Hence, NH_3 *concentration will increase. But as we know that it is an exothermic reaction. So, by increasing temperature yield of* NH_3 *become lower.*

Q26: ***What is the effect of temperature change on the direction of the reaction?***

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

Ans: According to Le- Chatelier's principle "Decreasing the temperature will shift it to the forward direction".

Q27: ***What will be the effect of volume change on the following system at equilibrium state?***

(A) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ (B) $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

Ans: $$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

The change in volume will affect the equilibrium position only. When volume is decreased reaction moves in backward direction to establish equilibrium again. But equilibrium constant is not affected.

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

When we decrease in volume for this reaction equilibrium position will shift in forward direction.

Q28: ***Why change of volume disturbs the equilibrium position for some of the gaseous phase reactions but not the equilibrium constant?***

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

This gas phase reaction proceeds with the decrease in the number of moles and hence decreases in volume at equilibrium stage. When the reaction approaches the equilibrium stage, the volume of the equilibrium mixture is less than the volume of reactants taken initially.

If one decrease the volume further at equilibrium state, the reaction is established a new equilibrium position while K_C *remains constant. The reverse happens when the volume is increased or pressure is decreased at equilibrium stage.*

Q29: ***What is the effect of catalyst of equilibrium constant?***

Ans: A catalyst does not change the equilibrium position. A catalyst only increases the rate of forward and reverse reaction and attains equilibrium earlier.

Q30: ***Why catalyst does not affect the equilibrium position?*** ***OR***

A catalyst does not affect the equilibrium position and K_c ***of a reversible reaction. Explain.***

Ans: In most of the reversible reactions, the equilibrium is not always reached within a suitable short time. So, an appropriate catalyst is added. A catalyst does not affect the equilibrium position of the reaction. It increases the rates of both forward and backward reactions and it reduces the time to attain the state of equilibrium. Actually a catalyst lowers the energy of activation of both forward and reverse steps by giving new path to the reaction.

Q31: ***What is the effect of increase in temperature on the yield of the product for the reaction?***

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

Ans: $$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} + \text{Heat}$$

It is an exothermic reaction in the forward direction. It means that by increasing temperature, the reaction at equilibrium will shift the reaction to the backward direction by decreasing the yield of product.

Q32: ***What will be the effect of increase of pressure on the decomposition of PCl_5?***

Ans: $$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

Since the number of moles of reactant are smaller than products. Therefore by increasing pressure equilibrium will shift towards left side and more amount of PCl_5 will produce.

Q33: ***Define pK_a and pK_b.***

Ans: *The values of K_a and K_b for weak acids and bases are small numbers usually expressed in exponential form. It is convenient to convert them into whole numbers by taking their negative log. Thus we obtain pK_a and pk_b Values of acids and bases.*

$$pK_a = - \log K_a$$

$$pK_b = - \log K_b$$

Q34: ***Prove that $pK_a + pK_b = 14$ at 25 °C.***

Ans: *For an acid $K_a \times K_b = K_W$ at 25 °C the value of K_W is 1×10^{-14}. By taking the log of above - equation we get*

$$\log K_a + \log K_b = \log K_w$$

Multiply above equation by -1, we get

$$-\log K_a + (-1)\log K_b = -\log K_w$$

$$pK_a + pK_b = pK_w$$

So, $$pK_a + pK_b = 14 \qquad \{pK_w = -\log(1 \times 10^{-14}) = 14\}$$

Q35: ***What is the justification for the increase of ionic product of water with temperature?***

Ans: $$H_2O \rightleftharpoons H^+ + OH^-$$

Water is a very weak electrolyte. The ionization of H_2O is an endothermic process which is increased with the rise in temperature.

Q36: ***Is it true that value of K_w increases 75 times when temperature is increased from 0 °C to 100 °C?***

Ans: *Ionic product of water is increase with rise in temperature because at high temperature ionization becomes easy.*

For example:

K_W *at* 0 °C *is* 0.10×10^{-14}. *At* 100 °C 7.5×10^{-14}

Thus the value from 0 °C-100 °C *is:*

$$\frac{7.5 \times 10^{-14}}{0.10 \times 10^{-14}} = 75 \text{ times}$$

Q37: ***What is ionic product of water?*** ***OR***
How does this value change by change in temperature?

Ans: *Water undergoes self-ionization as follows and reaction is reversible:*

$$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$$

$$H_2O \rightleftharpoons H^+ + OH^-$$

$$K_C = \frac{[H^+][OH^-]}{[H_2O]}$$

$$K_C = 1.8\times 10^{-16} \text{ moles dm}^{-3}$$

Since the water is present in very large excess and very few of its molecules undergo ionization, so its concentration remains effectively constant. Constant concentration of water is taken on L.H.S. and multiplied with K_C *to get another constant* K_w.

$$1.8\times 10^{-16} \times 55.5 = 1.01 \times 10^{-14} = [H^+][OH^-]$$

This 1.01×10^{-14} *is called* K_w *of water at* 25 °C

$$K_C[H_2O] = [H^+][OH^-]$$

$$K_w = [H^+][OH^-] = 10^{-14} \text{ at } 25\ °C$$

K_w *is called ionic product of water.*

The value of K_w *increases almost* 75 *times when temperature is increased from* 0 °C *to* 100 °C. *Anyhow, the increase in* K_w *is not regular.*

Q38: ***Is it true that the sum of*** pK_a ***and*** pK_b ***is always equal to 14 at all temperature for any acid?***

Ans: *It is not true because* pK_a *and* pK_b *values are temperature dependent. The degree of ionization of any acid increase as the temperature increases. Hence the value of* pK_a *and* pK_b *change with change in temperature.*

Q39: ***What will be nature of solution when: (a) pH = 3.0 (b) pH = 8.0?***

Ans: *The value of pH varies between* 0-14. *A solution having* pH *value* 0-7 *are acidic in nature while a solution having* pH *value* 7-14 *are basic in nature.*

- pH = 3 *This solution is acidic.*
- pH = 8 *This solution is basic.*

Q40: ***Define pH and pOH. Give its equation.***

Ans: pH: *The negative logarithm of* H^+ *ions concentration is called* pH.

$$pH = -\log(H^+)$$

pOH: *The negative logarithm of* OH^- *ions concentration is called* pOH.

$$pOH = -\log(OH^-)$$

Just for information and important for MCQs

Table Relationship of $[H_3O^+]$, $[OH^-]$, pH and pOH

More basic ↑ / More acidic ↓

	$[H_3O^+]$	pH	$[OH^-]$	pOH
Basic	1×10^{-14}	14.0	1×10	0.0
	1×10^{-13}	13.0	1×10^{-1}	1.0
	1×10^{-12}	12.0	1×10^{-2}	2.0
	1×10^{-11}	11.0	1×10^{-3}	3.0
	1×10^{-10}	10.0	1×10^{-4}	4.0
	1×10^{-9}	9.0	1×10^{-5}	5.0
	1×10^{-8}	8.0	1×10^{-6}	6.0
Neutral	1×10^{-7}	7.0	1×10^{-7}	7.0
Acidic	1×10^{-6}	6.0	1×10^{-8}	8.0
	1×10^{-5}	5.0	1×10^{-9}	9.0
	1×10^{-4}	4.0	1×10^{-10}	10.0
	1×10^{-3}	3.0	1×10^{-11}	11.0
	1×10^{-2}	2.0	1×10^{-12}	12.0
	1×10^{-1}	1.0	1×10^{-13}	13.0
	1×10^{-0}	0.0	1×10^{-14}	14.0

Approximate pH and pOH of some common materials at 25°C

Material	pH	pOH	Material	pH	pOH
1.0 M HCl	0.1	13.9	bread	5.5	8.5
0.1 M HCl	1.1	12.9	potatoes	5.8	8.2
0.1 M CH_3COOH	2.9	11.10	rainwater	6.2	7.8
gastric juice	2.0	12.00	milk	6.5	7.5
lemons	2.3	11.7	saliva	6.5-6.9	7.5-7.1
vinegar	2.8	11.2	pure water	7.0	7.00
soft drinks	3.0	11.00	eggs	7.8	6.2
apples	3.1	10.9	0.1 M $NaHCO_3$	8.4	5.6
grapefruit	3.1	10.9	seawater	8.5	5.5
oranges	3.5	10.5	milkofmagnesia	10.5	3.5
tomatoes	4.2	9.8	0.1 M NH_3	11.1	2.9
cherries	3.6	10.4	0.05 M Na_2CO_3	11.6	2.4
bananas	4.6	9.4	0.1 M NaOH	13.0	1.00

Q41: *What will be nature of solution when (a) pH is more than 7 (b) pH is smaller than 7?*

Ans: *pH scale generally ranges from 0 to 14. When pH is less than 7 the solution has acidic nature. When pH is greater than 7 then solution is basic.*

Q42: *Define pH and pOH. How are they related with pK_w.*

$$pK_w = pH + pOH$$

Ans: *Relation of pH and pOH with pK_w:*

We know that

$$K_w = (H^+)(OH^-)$$

Taking -ve log on both sides

$$-\log K_w = [-\log(H^+)] + [-\log(OH^-)]$$

Negative log of K_w is called pK_w. So,

$$pK_w = pH + pOH$$

Q43: *Why aqueous solution of CH_3COONa is basic in nature?*

Ans: *When salt CH_3COONa is dissolved in water, it produces NaOH and CH_3COON. NaOH is a strong base while CH_3COON is a weak acid. So, the solution becomes basic in nature.*

Q44: *Write down Henderson equation for acidic and basic buffers.*

Ans: *Henderson's equation:*

Consider a reaction:

$$NA \rightleftharpoons H^+ + A^-$$

$$NaA \rightleftharpoons Na^+ + A^-$$

The ionization constt. for acid.

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$[H^+] = \frac{K_a[HA]}{[A^-]}$$

Taking -ve log on both sides

$$-\log[H^+] = -\log.\frac{K_a[HA]}{[A^-]}$$

$$-\log[H^+] = -\log K_a - \log\frac{[HA]}{[A^-]}$$

$$pH = pK_a - \log\frac{[HA]}{[A^-]}$$

$$pH = pK_a - \log\frac{[acid]}{[salt]}$$

$$pH = pK_a + \log\frac{[salt]}{[acid]}$$

For basic buffers,

$$pOH = pK_b + \log\frac{[salt]}{[base]}$$

Q45: ***What is the ionization constant of acids?***

Ans: K_a *Ionization constant of acid:*

It is ionization constant of acid. Its value is quantitative measure of the strength of acid.

$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$

Equilibrium expression:

$$K_C = \frac{[H_3O^+][A^-]}{[HA][H_2O]}$$

Water being large in excess its concentration remain constant.

$$K_C[H_2O] = \frac{[H_3O^+][A^-]}{[HA]}$$

K_C *is equilibrium constant and* H_2O *concentration almost remains constant. So,* H_2O *is also constant. Thus, these constants are replaced by* K_a.

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

Greater the value of K_a *stronger will be the acid.*

These tables are just for information and imp for MCQs

Table Dissociation constants of some acids at 25°C and their relative strength

Acid	Dissociation	K_a	Relative strength
HCl	HCl □ $H^+ + Cl^-$	very large(10^{+7})	Very strong
HNO_3	HNO_3 □ $H^+ + NO_3^-$	very large(10^{+3})	Very strong
H_2SO_4	H_2SO_4 □ $H^+ + HSO_4^-$	Large(10^{+2})	Very strong
HSO^-_4	HSO^-_4 □ $H^+ + SO_4^{2-}$	1.3×10^{-4}	Strong
HF	HF □ $H^+ + F^-$	6.7×10^{-5}	Weak
CH_3COOH	CH_3COOH □ $H^+ + CH_3COOH^-$	1.85×10^{-5}	Weak
H_2CO_3	H_2CO_3 □ $H^+ + HCO_3^-$	4.4×10^{-7}	Weak
H_2S	H_2S □ $H^+ + HS^-$	1.0×10^{-7}	Weak
NH_4^+	NH_4 □ $H^+ + NH_3$	5.7×10^{-10}	Weak
HCO_3^-	HCO_3^- □ $H^+ + CO_3^{2-}$	4.7×10^{-11}	Weak
H_2O	H_2O □ $H^+ + OH^-$	1.8×10^{-16}	Very weak

Table K_b of some important bases

Base	Dissociation	K_b	Relative strength
$NaOH$	$NaOH$ □ $Na^+ + OH^-$	Very high	Very strong
KOH	KOH □ $K^+ + OH^-$	Very high	Very strong
$Ca(OH)_2$	$Ca(OH)_2$ □ $Ca^{2+} + 2OH$	High	Very strong
NH_4OH	NH_4OH □ $NH_4^+ + OH^-$	1.81×10^{-5}	Weak
CH_3NH_2 (Mathyl amine)	$CH_3NH_2 + H_2O$ □ $CH_3NH_3^+ + OH^-$	4.38×10^{-4}	Weak
$C_6H_5NH_2$ (Aniline)	$C_6H_5NH_2 + H_2O$ □ $C_6H_5NH_3^+ + OH^-$	4.7×10^{-10}	Very weak

Q46: ***Calculate pH of 10^{-4} mol dm^{-3} of $Ba(OH)_2$.***

Ans:
$$Ba(OH)_2 \rightleftharpoons Ba^{2+} + 2OH^-$$
$$10^{-4} \qquad\qquad 2\times10^{-4}$$
$$pOH = -\log[OH^-]$$
$$pOH = -[\log(2\times10^{-4})]$$
$$pOH = 3.69$$
$$pH + pOH = 14$$
$$pH + 3.69 = 14$$
$$pH = 14 - 3.69$$
$$pH = 10.31$$

Q47: ***Calculate pH of 10^{-4} mol dm^{-3} of HCl solution.***

Ans:
$$HCl \xrightleftharpoons{H_2O} H^+ + Cl^-$$
$$10^{-4} \qquad\qquad 2\times10^{-4}$$
$$pH = -\log[H^+]$$
$$[H^+] = 10^{-4} \text{ mol dm}^{-3}$$
$$pH = -\log[10^{-4}]$$
$$pH = -(-4)\log 10$$
$$pH = +4(1)$$
$$pH = +4$$

Q48: ***Define acid and base by Lowry-Bronsted concept.***

Ans: *Acid:*

An acid is a substance which has ability to donate proton.

Base:

The base is a substance which has ability to accept proton.

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$
Base Acid

Q49: ***Why aqueous solution of $CuSO_4$ is acidic in nature?***

Ans: *When $CuSO_4$ is dissolved in water it produce H_2SO_4 which is an acid, so aqueous Solution of $CuSO_4$ is acidic in nature as shown by following reaction:*

$$CuSO_4 + H_2O \rightleftharpoons Cu(OH)_2 + H_2SO_4$$

Q50: ***Why Aqueous Solution of NH_4Cl is acidic in Nature?***

Ans: *When NH_4Cl is dissolved in water it produces HCl. As HCl is strong acid and NH_4OH is weak base. So aqueous Solution of NH_4Cl is acidic in nature as shown by following reaction:*

$$NH_4Cl + H_2O \rightleftharpoons NH_4OH + HCl$$

Q51: ***Aqueous solution of Na_2CO_3 is alkaline in nature, Why?***

Ans: *When Na_2CO_3 is dissolved in water it produces weak acid and a strong base. So, aqueous solution of Na_2CO_3 is alkaline in nature as given by following chemical reaction:*

$$Na_2CO_3 + H_2O \rightleftharpoons NaOH + H_2CO_3$$

Q52: ***Explain the terms buffer and buffer capacity.*** ***OR***

Define buffer solutions.

Ans: *Buffer:*

The solutions which resist the change in pH *by the addition of small amount of an acid or base is called buffer.*

Buffer capacity:

The capacity of a buffer to maintain definite pH is called buffer capacity.

Q53: What happens to the acidic and basic properties of aqueous solutions when pH varies from zero to 14?

Ans: *Properties of solutions when* pH *changes from* 0 *to* 14.

pH = 7 — *Solution is neutral*

pH = 0 to 6.9 — *Solution is acidic*

pH = 7.1 to 14 — *Solution is basic*

Q54: What will be the nature of solution having pH equal to 12?

Ans: *The value of* pH *varies between* 0-14. *A solution having* pH *value* 0-7 *are acidic in nature while a solution having* pH *value* 7-14 *are basic in nature.*

pH = 12 — *This Solution is basic*

Q55: How does a buffer act? Explain with an example.

Ans: *Let us take the example of an acidic buffer consisting of* CH_3COOH *and* CH_3COONa. *Common ion effect helps us to understand how the buffer will work.* CH_3COOH *being a weak electrolyte undergoes very little dissociation.*

$$CH_3COOH + H_2O \rightleftharpoons H_3COO^- + H_3O^+$$

$$CH_3COONa \rightleftharpoons CH_3COO^- + Na^+$$

Actually a buffer mentioned above is a large reservoir of CH_3COOH *and* CH_3COO^- *components. When an acid or* H_3O^+ *ions are added to this buffer, they will react with* CH_3COO *to give back acetic acid and hence the* pH *of the solution will almost remain unchanged.*

Q56: Write two uses of buffer solution.

Ans: *The uses of buffer solution are:*

- *Buffers are used in many industrial processes like electroplating, dyes etc.*
- *The* pH *of human blood is maintained at* 7.35 *with the help of buffers. A higher or lower value than this may prove fatal.*

Q57: Give preparation of acidic buffer solutions. OR

Justify mixture of sodium acetate and acetic acid gives us the acidic buffer.

Ans: *Acidic buffer solutions are prepared by mixing a weak acid and its salt with strong base.*

For example:

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$CH_3COONa^+ \rightleftharpoons CH_3COO^- + Na^+$$

$$CH_3COOH / CH_3COONa$$

Q58: A mixture of NH_4OH and NH_4Cl gives a basic buffer. Justify the statement. OR

What is Basic Buffer, give example?

Ans: *A buffer which consists of a weak base and its salt with strong acid is called basic buffer. Since* NH_4OH *is a weak base and* NH_4CI *is its salt with strong acid. Therefore it is basic buffer.*

Q59: Why we need buffer solution? OR

Buffers are important in many area of chemistry.

Ans: *Buffers are the substances which resist the change in* pH. *Buffers are very important in many areas of chemistry. Buffers are needed in chemical analysis, pharmaceuticals, electroplating etc.*

Q60: ***What are buffer solutions?*** ***OR***
How a basic buffer can be prepared?

Ans: *Buffer solution:*

The solution that resists in pH *changes when small amount of an acid or a base is added to it is called buffer solution.*

Basic buffers are formed by mixing a weak base and its salt with strong acid. Such solution will give basic buffers with pH more than 7. Mixing of NH_4OH *and* NH_4Cl *is one of the best examples of such a basic buffer.*

Q61: ***Differentiate between acidic and basic buffers.***

Ans: *The difference between acidic and basic buffers is:*

Acidic buffers	Basic buffers
➢ The buffer which is prepared by mixing a weak acid and a salt of it with a strong base is known as acidic buffer. ➢ Such solutions give acidic buffers with pH less than 7, Mixture of acetic acid and sodium acetate is one of the best examples of such a buffer.	➢ The buffer which is prepared by mixing a weak base and a salt of it with a strong acid is known as basic buffer. ➢ Such solutions give basic buffers with pH more than 7. Mixture of NH_4OH and NH_4Cl is one of the best examples of basic buffer.

Q62: ***What is the formula to calculate the percentage ionization of weak acid?***

Ans: *We can calculate the percentage ionization of weak acids and the formula is as follows:*

$$\%\ \text{ionization} = \frac{\text{Amount of acid ionized}}{\text{Amount of acid initially available}} \times 100$$

Q63: ***What are applications of buffer in daily life?***

Ans: *Buffers are important in many areas of chemistry and allied sciences like molecular biology microbiology, cell biology, soil sciences, nutrition and the clinical analysis.*

Q64: ***What is common ion effect? Give an example.***

Ans: *Common ion effect:*

The decrease in degree of ionization of a weak electrolyte by the addition of another electrolyte having a common ion is called common ion effect.

For example:

$$NaCl \rightleftharpoons Na^+ + Cl^-$$

$$HCl \rightleftharpoons H^+ + Cl^-$$

Cl^- *is a common ion.*

Q65: ***Why solid*** NH_4Cl ***is added in qualitative analysis of 3rd group basic radical before adding*** NH_4OH***?***

Ans:

$$NH_3OH \rightleftharpoons NH_4^+ + OH^-$$

To provide low concentration of OH^- *ion* NH_4Cl *is added which is more soluble.*

$$NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$$

NH_4Cl *decrease the* OH^- *ion conc. by suppressing ionization of* NH_3OH *due to common ion. That's why a mixture of* $NH_4Cl + NH_3OH$ *is used as reagent for third group analysis.*

Q66: *Define conjugate acid with an example.*

Ans: *Conjugate acid is a substance which is formed by accepting a proton* (H^+) *by a base.*

$$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$

Acid Base conj.acid conj.base

Q67: *How NaCl can be purified by common ion effect?* OR
Give applications of common ion effect.

Ans: *The impurities like* $CaCl_2$, $MgCl_2$, Na_2SO_4, *can be removed by the use of common ion effect.* HCI *gas is passed through saturated solution of* NaCl.

$$NaCl \rightleftharpoons Na^+_{(aq)} + Cl^-_{(aq)}$$

$$HCl \rightleftharpoons H^+_{(aq)} + Cl^-_{(aq)}$$

Concentration of Cl^- *ions increase by passing* HCI. *According to Le-Chateliers principle the reaction will move in reverse direction to keep the value of* K_C *const. Hence* NaCl *will precipitated out.*

Q68: *What is the effect of common ion on solubility?*

Ans: *The solubility of a partially soluble electrolyte is decreased by the addition of a more soluble electrolyte having common ion.*

For example:

Precipitation of $KClO_3$

$$KClO_3 \rightleftharpoons K^+ + ClO_3^-$$

$$KCl \rightleftharpoons K^+ + Cl^-$$

Q69: *Solubility of glucose increase in water by heating. Give reason.*

Ans: *Formation of solution of glucose in* H_2O *is an endothermic process. The solution becomes cold. Therefore, according to Le-Chateliers principle an increase in temperature will favour the formation of glucose solution.*
Thus by increasing temperature more quantity of glucose will dissolve in water.

Q70: *Define solubility and solubility product.*

Ans: *Solubility:*
The concentration of the solute in the solution when it is in equilibrium with the solid substance at a particular temperature.

Solubility product:

The solubility product is the product of the concentration of ion raised to exponent equal to coefficient of the balanced equation.
It is denoted by K_{sp}.

Example:

$$PbSO_4 \rightleftharpoons Pb^{2+} + SO_4^{2-}$$

$$K_C = \frac{[Pb^{2+}][SO_4^{2-}]}{[PbSO_4]}$$

Since $PbSO_4$ *is sparingly soluble therefore its concentration will remain constant.*

$$K_C\,[PbSO_4] = [Pb^{2+}][SO_4^{2-}]$$

$$K_{sp} = [Pb^{2+}][SO_4^{2-}]$$

Q71: *Define solubility product and write down its applications.*

Ans: *Solubility product:*

The solubility product is the product of the concentration of ion raised to exponent equal to coefficient of the balanced equation.

It is denoted by K_{sp}.

Applications of K_{sp}:

- *Determination of solubility from* K_{sp}.
- *Determination of* K_{sp} *from solubility.*

Q72: ***Define solubility product. Derive solubility product expression for*** Ag_2CrO_4 ***and*** $PbCl_4$.

Ans: *Solubility product:*

The solubility product is the product of the concentration of ion raised to exponent equal to coefficient of the balanced equation.

It is denoted by K_{sp}.

$PbCl_4$:

$$PbCl_4 \rightleftharpoons Pb^{2+} + 4Cl^-$$

$$K_C = \frac{[Pb^{2+}][Cl^-]^4}{[PbCl_4]}$$

$$K_C\,[PbCl_4] = [Pb^{2+}][Cl^-]^4$$

$$K_{sp} = [Pb^{2+}][Cl^-]^4$$

$$K_C\,[PbCl_4] = K_{sp}$$

Ag_2CrO_4:

$$Ag_2CrO_4 \rightleftharpoons 2Ag^+ + CrO_4^{2-}$$

$$K_C = \frac{[Ag^+]^2[CrO_4^{-2}]}{[Ag_2CrO_4]}$$

$$K_C\,[Ag_2CrO_4] = [Ag^+]^2[CrO_4^{-2}]$$

So, $$K_{sp} = [Ag^+]^2[CrO_4^{-2}]$$

This table is just for information and imp for MCQs

Table K_{sp} values for some ionic compounds (compounds are arranged alphabetically).

Salt	Ion Product	K_{sp}	Salt	Ion Product	K_{sp}
AgBr	$[Ag^+][Br^-]$	5.0×10^{-13}	CuS	$[Cu^{2+}][S^{2-}]$	8×10^{-34}
Ag_2CO_3	$[Ag^+]^2[CO_3^{2-}]$	8.1×10^{-12}	FeS	$[Fe^{2+}][S^{2-}]$	6.3×10^{-18}
AgCl	$[Ag^+][Cl^-]$	1.8×10^{-10}	Fe_2S_3	$[Fe^{3+}][S^{2-}]^3$	1.4×10^{-85}
AgI	$[Ag^+][I^-]$	8.3×10^{-17}	$Fe(OH)_3$	$[Fe^{3+}][OH^-]^3$	1.6×10^{-39}
Ag_2S	$[Ag^+]^2[S^{2-}]$	8×10^{-48}	HgS	$[Hg^{2+}][S^{2-}]$	2×10^{-50}
$Al(OH)_3$	$[Al^{3+}][OH^-]^3$	3×10^{-34}	$MgCO_3$	$[Mg^{2+}][CO_3^{2-}]$	3.5×10^{-8}
$BaCO_3$	$[Ba^{2+}][CO_3^{2-}]$	2×10^{-9}	$Mg(OH)_2$	$[Mg^{2+}][OH^-]^2$	6.3×10^{-10}
$BaSO_4$	$[Ba^{2+}][SO_4^{2-}]$	1.1×10^{-10}	MnS	$[Mn^{2+}][S^{2-}]$	3×10^{-11}
CdS	$[Cd^{2+}][S^{2-}]$	8.0×10^{-27}	$PbCl_2$	$[Pb^{2+}][Cl^-]^2$	1.6×10^{-5}
$CaCO_3$	$[Ca^{2+}][CO_3^{2-}]$	3.3×10^{-9}	$PbCrO_4$	$[Pb^{2+}][CrO_4^{2-}]$	2.3×10^{-13}
CaF_2	$[Ca^{2+}][F^-]^2$	3.2×10^{-11}	$PbSO_4$	$[Pb^{2+}][SO_4^{2-}]$	1.6×10^{-8}
$Ca(OH)_2$	$[Ca^{2+}][OH^-]^2$	6.5×10^{-6}	PbS	$[Pb^{2+}][S^{2-}]$	8.0×10^{-28}

Chapter : 08 Chemical Equilibrium

Long Questions

Q1: The following reaction was allowed to reach the state of equilibrium

$$2A_{(aq)} + B_{(aq)} \rightleftharpoons C_{(aq)}?$$ OR

Q2: Define law of mass action & derive equilibrium constant for a general chemical reaction.

Q3: $N_{2(g)}$ *and* $H_{2(g)}$ *Combine to give* $NH_{3(g)}$. *The value of* K_C *in this reaction at* 500°C *is* 6.0×10^{-2} *Calculate the value of* K_P *for this reaction.* *(V.Imp)*

Q4: When 1.00 *Mole of steam and* 1.00 *mole of Carbon Monoxide are allowed to reach equilibrium* 33.3% *of the equilibrium mixture is Hydrogen. Calculate the value of* K_p. *State the units of* K_p.

Q5: What is the percentage ionization of acetic acid in the solution in which 0.1 *moles of it has been dissolved per* dm^3 *of the solution?* *(V.Imp)*

Q6: Write a note on synthesis of ammonia gas by Haber's process keeping in mind the applications of chemical equilibrium in industry.

Q7: The equilibrium constant for the reaction between acetic acid and ethyl alcohol is 4.0. *A mixture of* 3 *moles of acetic acid and one mole* C_2H_5OH *is allowed to come to equilibrium. Calculate the amount of ethyl acetate at equilibrium state in no of moles and grams. Also calculate mass of reactants left behind.*

Q8: Define common ion effect. Give its two applications.

Q9: Calculate the pH of a buffer solution in which 0.11 molar CH_3COONa *and* 0.09 molar *acetic acid solutions are present.* K_a *for* CH_3COONa *is* 1.85×10^{-5}. *(V.Imp)*

Q10: The solubility of PbF_2 *at* 25°C *is* 0.64g dm^{-3} *Calculate* K_{sp} *Of* PbF_2. (Molecular mass of PbF_2 = 245.2g mol^{-1}) *(V.Imp)*

Q11: $Ca(OH)_2$ *is a sparingly soluble compound. Its solubility product is* 6.5×10^{-6}. *Calculate the solubility of* $Ca(OH)_2$?

Q12: The Solubility of CaF_2 *in water at* 25°C *is found to be* 2.05×10^{-4} mol dm^{-3}. *What is the value of* K_{sp} *at this temperature?* *(V.Imp)*

Q13: A buffer solution is pre pared by mixing 0.2 M CH_3COONa *and* 0.5 M CH_3COOH *in* $1dm^3$ *of solution. Calculate pH of solution.* pk_a *of acid is* 4.74.

Q14: Define Le. Chaterlieri's principle. Discuss effect of

- *Change in volume*
- *Change in temperature on the formation of ammonia.*