

Ionic Equilibrium

1. Concepts of Acid & Base

Q 1. Which of the following is not an Arrhenius acid?

- (A) HCl (B) CH₃COOH
(C) H₂C₂O₄ (D) H₃BO₃

Q 2. Among the following, which is not a Lewis acid?

- (A) SnCl₂ (B) AlCl₃
(C) CCl₄ (D) SiCl₄

Q 3. Which of the following constitutes a set of amphoteric species?

- (A) H₃O⁺, H₂P₄⁻, HCO₃⁻
(B) H₂O, HPO₄²⁻, H₂PO₂⁻
(C) H₂O, H₂PO₃⁻, HPO₄²⁻
(D) HC₂O₄⁻, H₂PO₄⁻, SO₄²⁻

Q 4. The following equilibrium is established when HCl is dissolved in acetic acid



The set that characterizes the conjugate acid base pair is

- (A) (HCl, CH₃COOH) & (CH₃COOH₂⁺, Cl⁻)
(B) (HCl, CH₃COOH₂⁺) & (CH₃COOH, Cl⁻)
(C) (CH₃COOH₂⁺, HCl) & (Cl⁻, CH₃COOH)
(D) (HCl, Cl⁻) & (CH₃COOH₂⁺, CH₃COOH)

Q 5. The conjugate bases in the following reaction



- (A) H₂O, H₃O⁺ (B) HSO₄⁻, H₂O
(C) H₃O⁺, H₂SO₄ (D) H₂SO₄, HSO₄⁻

Q 6. Species acting as both Bronsted acid and base is

[IIT-JEE 1992]

- (A) HSO₄⁻ (B) Na₂CO₃
(C) NH₃ (D) OH⁻

Q 7. The conjugate base of H₂PO₄⁻ is [IIT-JEE 96]

- (A) H₃PO₄ (B) P₂O₅

- (C) PO₄³⁻ (D) HPO₄²⁻

Q 6.

In the following,



Species behaving as Bronsted-Lowry acids are

- (A) [Al(H₂O)₆]⁺³, H₂CO₃
(B) HCO₃⁻, [Al(H₂O)₅OH]⁺²
(C) HCO₃⁻, H₂CO₃
(D) [Al(H₂O)₆]⁺³, [Al(H₂O)₅OH]⁺²

Q 7. Glycine NH₂CH₂COOH behaves

- (A) as a Bronsted acid
(B) As a Bronsted base
(C) Both as an acid and a base
(D) Neither as an acid nor as a base

Q 10. The conjugate acid of NH₂ is

- (A) NH₄⁺ (B) NH₃
(C) NH₂OH (D) N₂H₄

Q 11. Identify acid-base conjugate pairs from

- (A) HONO, NO₂⁻ (B) H₃O⁺, OH⁻
(C) CH₃NH₃⁺, CH₃NH₂ (D) HS⁻, S²⁻

Q 12. The following equilibrium is established when hydrogen chloride is dissolved in acetic acid.



The set that characterizes the conjugate acid-base pairs is

[IIT-JEE 1992]

- (A) (HCl, CH₃COOH) & (CH₃COOH₂⁺, Cl⁻)
(B) (HCl, CH₃COOH₂⁺) & (CH₃COOH, Cl⁻)
(C) (CH₃COOH₂⁺, HCl) & (Cl⁻, CH₃COOH)
(D) (HCl, Cl⁻) & (CH₃COOH₂⁺, CH₃COOH)

2. K_a & K_b of acid & Base, K_w of H_2O

- Q 1. An example of non – electrolyte is
 (A) Fructose (B) Sodium acetate
 (C) NaCl (D) $FeSO_4$
- Q 2. Which of the following species is a strong electrolyte ?
 (A) HF (B) NH_4OH
 (C) NH_4Cl (D) All of these
- Q 3. Which of the following species is ionized to negligible extent when dissolved in H_2O ?
 (A) HCl (B) NaOH
 (C) NH_4OH (D) $Ca(OH)_2$
- Q 4. Which is correct representation of K_a (Acid dissociation constant) of H_2CO_3
 (A) $\frac{[H^+]^2[CO_3^{2-}]}{[H_2CO_3]}$ (B) $\frac{[H^+][CO_3^{2-}]}{[H_2CO_3]}$
 (C) $\frac{[H^+][CO_3^{2-}]}{[HCO_3^-]}$ (D) None of these
- Q 5. The correct representation of K_b (base dissociation constant) of NH_3 in H_2O is
 (A) $\frac{[NH_2^-][H^+]}{[NH_3]}$ (B) $\frac{[NH_4^+][OH^-]}{[NH_3]}$
 (C) $\frac{[NH_4^+][OH^-]}{[NH_3][H_2O]}$ (D) None of these
- Q 6. The dissociation constant of H_2O at $25^\circ C$ is
 (A) 1×10^{-14} (B) 1.8×10^{-16}
 (C) 10^{+14} (D) 1.8×10^{16}
- Q 7. The K_a value for the acid HA is 1.0×10^{-6} . What is the value of K for the reaction ?
 $A^- + H_3O^+ \rightleftharpoons HA + H_2O$
 (A) 1.0×10^6 (B) 1.0×10^8
 (C) 1.0×10^{-3} (D) 1.0×10^{-8}
- Q 8. Which of the following expressions is /are not true ?
 (A) $[H^+] = [OH^-] = \sqrt{K_w}$ for a neutral solution at all temperatures
 (B) $[H^+] > \sqrt{K_w}$ & $[OH^-] < \sqrt{K_w}$ for an acidic solution
 (C) $[H^+] < \sqrt{K_w}$ & $[OH^-] > \sqrt{K_w}$ for an alkaline solution
 (D) $[H^+] = [OH^-] = 10^{-7} M$ for a neutral solution at all temperatures
- Q 9. The degree of dissociation of pure H_2O at 25° is $1.9 \times 10^{-7} \%$ and density is 1.0 g/cc. The ionic constant for water is [IIT-JEE 1995]
 (A) 1.0×10^{-10} (B) 1.0×10^{-14}
 (C) 1.0×10^{-16} (D) 1.0×10^{-8}
- Q 10. The ratio of degree of dissociation of pure H_2O to its dissociation constant at $25^\circ C$ is.
 (A) 10^7 (B) 10^{-7}
 (C) 1.8×10^{-7} (D) 1.8×10^7
- Q 11. The ionic product of water is $1 \times 10^{-14} M^2$. The number of H^+ ions that present in one millionth part of 1 ml of pure water is
 (A) 66.9 million (B) 52.2 million
 (C) 48.3 million (D) 60.23 million
- Q 12. What is the value of K_w in 0.01 M NaOH at $25^\circ C$?
 (A) 1×10^{-15} (B) 1×10^{-13}
 (C) 1×10^{-16} (D) 1×10^{-14}
- Q 13. The K_w of $H_2O \rightleftharpoons H^+ + OH^-$ at $25^\circ C$ & $90^\circ C$ are 10^{-14} & 10^{-12} respectively. The value of ΔH for $H_2O(C) \rightleftharpoons H^+ + OH^-$ is
 (A) 63.73 kJ (B) 57.2 kJ
 (C) 98.2 kJ (D) None of these

3. pH & pOH, Acidic & Basic Solution

- Q 1. Calculate pH of the solution having
 $[H^+] = 3.75 \times 10^{-6} M$
 (A) 5.43 (B) 6.43
 (C) 5.57 (D) 6.57
- Q 2. For $pH = 3.68$, $[OH^-]$ in a solution is
 (A) 4.8×10^{-10} (B) 4.8×10^{-11}
 (C) 4.8×10^{-7} (D) 4.8×10^{-12}
- Q 3. At any temperature for a neutral solution
 (A) $pH > pOH$ (B) $pH = pOH = 7$
 (C) $pH = pOH$ (D) $pH < pOH$
- Q 4. The ionic product of water at $45^\circ C$ is 4×10^{-14} .
 What is pH of pure water at this temperature
 [Take: $\log 2 = 0.3$]
 (A) 6.7 (B) 7
 (C) 7.3 (D) 13.4
- Q 5. In a solution, $[H^+] = 10^{-6} M$ at a certain temp.
 The nature of solution may be
 (A) Acidic (B) basic
 (C) Neutral (D) All of these
- Q 6. If K_w of water at $50^\circ C$ is 5×10^{-14} , then the
 nature of solutions having $pH=7$, $pH = 6$ & $pH = 8.2$ is respectively
 (A) neutral, basic, acidic
 (B) neutral, acidic, basic
 (C) basic, acidic, basic
 (D) basic, acidic, neutral
- Q 7. At $50^\circ C$, $pH + pOH$ is
 (A) less than 14 (B) more than 14
 (C) equal to 14 (D) equal to 4
- Q 8. The ionic product of water at 100° is 55 times
 than that at $25^\circ C$. The value of pH of water at
 $100^\circ C$ is
 (A) 6.13 (B) 7.02
 (C) 6.63 (D) 7.12
- Q 9. At certain temperature K_w for water 4×10^{-14}
 which of the following is incorrect for pure water
 at the given temperature ? $\log 2 = 0.3$
 (A) $pH = 6.7$ and water is acidic

- (B) $pH = 6.7$ and water is neutral
 (C) $pOH = 6.7$ and water is neutral
 (D) $pH + pOH = 13.4$

- Q 10. Calculate the pH of a solution at $25^\circ C$ which is
 twice as alkaline as pure water
 (A) 6.7 (B) 7.3
 (C) 14 (D) 0
- Q 11. How many litre of water must be added to 1 lit of
 an aqs solution of HCl with a pH of 1 to create an
 aqs solution with pH of 2? [AIEEE 2006]
 (A) 0.1 lit (B) 0.9 lit
 (C) 2.0 lit (D) 9.0 lit
- Q 12. Calculate amount of water added to 1 litre
 solution of $pH = 2.1$. So that pH may get
 increased to 4 ($\log 2 = 0.3$)
 (A) 79 lit (B) 89 lit
 (C) 99 lit (D) 49 lit
- Q 13. At a temperature under high pressure
 $K_w(H_2O) = 1 \times 10^{-10}$
 A solution of pH 5.4 under these conditions is
 said to be
 (A) acidic (B) basic
 (C) neutral (D) amphoteric
- Q 14. When the pH changes from 4 to 2, the hydrogen
 ion concentration will increase by a factor
 (A) 2 (B) 1/2
 (C) 10^2 (D) $10^{0.5}$
- Q 15. Equal volume of three acid solutions of pH 3, 4 &
 5 are mixed in a vessel. What will be the H^+ ion
 concentration in the mixture? [CBSE PMT 2008]
 (A) $1.11 \times 10^{-4} M$ (B) $3.7 \times 10^{-4} M$
 (C) $3.7 \times 10^{-3} M$ (D) $1.11 \times 10^{-3} M$

4. pH of Strong Acid & Strong Base Solution

- Q 1. Calculate PH of 0.02M HBr solution at $25^\circ C$
 (A) 2.3 (B) 1.7
 (C) 7 (D) 2
- Q 2. Calculate PH of $10^{-7} M$ $HClO_4$ solution at
 $25^\circ C$
 (A) 7 (B) 6.8

- (C) 7.2 (D) None of these
- Q 3. Calculate the PH of 5×10^{-11} M HNO_3 solution at 25°C
 (A) 10.3 (B) 3.6
 (C) 7 (D) None of these
- Q 4. Calculate the PH of 0.01M KOH solution at 25°C
 (A) 2 (B) 10
 (C) 12 (D) None of these
- Q 5. Concentration of H^+ and OH^- ion in 10^{-8} M NaOH, is respectively
 (A) $1 \times 10^{-6}, 1 \times 10^{-8}$
 (B) $0.95 \times 10^{-6}, 1.05 \times 10^{-8}$
 (C) $0.95 \times 10^{-7}, 1.05 \times 10^{-7}$
 (D) $1.05 \times 10^{-7}, 0.95 \times 10^{-7}$
- Q 6. $[\text{H}^+]$ and $[\text{OH}^-]$ ion in a 8 litre solution containing 9.25 gm/l of $\text{Ca}(\text{OH})_2$ at 25°C , is
 (A) $[\text{OH}^-] = 0.25 \times 10^{-7}, [\text{H}^+] = 4 \times 10^{-7}$
 (B) $[\text{OH}^-] = 0.25, [\text{H}^+] = 4 \times 10^{-14}$
 (C) $[\text{OH}^-] = 1.25 \times 10^{-7}, [\text{H}^+] = 8 \times 10^{-8}$
 (D) $[\text{OH}^-] = 2.5, [\text{H}^+] = 4 \times 10^{-15}$
- Q 7. How much $\text{Ca}(\text{OH})_2$ must be added in 5 litre of water to change its pH by 3 units
 (A) 1.37 gm (B) 0.0185 gm
 (C) 0.037 gm (D) 1.85 gm
- Q 8. The pH of NaOH solution is 12. What is the amount in grams of NaOH present in one litre of a solution ?
 (A) 40 (B) 4
 (C) 0.4 (D) 20
- Q 9. Which of the following solution will have a pH exactly equal to 8?
 (A) 10^{-8} M HCl solution at 25°C
 (B) 10^{-8} M H^+ solution at 25°C
 (C) 2×10^{-6} M $\text{Ba}(\text{OH})_2$ solution at 25°C
 (D) 10^{-6} M NaOH solution at 50°C
- Q 10. 10 mL of 10^{-6} M HCl solution is mixed with 90 mL H_2O . pH will change approximately
 (A) by 1 unit (B) by 0.3 unit
 (C) 0.8 unit (D) 0.1 unit
- Q 11. 100 mL solution of pH = 6 is diluted to 1000 mL. Resulting solution has pH
 (A) 7.0 (B) 6.79
 (C) 7.3 (D) 6.40
- Q 12. Which of the following aqueous solutions, when added to 100 ml of 0.1 M HCl (aq) will cause no change in its pH ? Assume volumes to be additive
 (A) 100 ml distilled water
 (B) 100 ml of 0.1 M HNO_3
 (C) 50 ml of 0.2M HCl
 (D) 100 ml of 0.1 M AgNO_3
- Q 13. Which of the following solution will have pH close to 1.0 ?
 (A) 100 ml M/10 HCl + 100 ml of M/10 NaOH
 (B) 55 ml M/10 HCl + 45 ml of M/10 NaOH
 (C) 10 ml M/10 HCl + 90 ml of M/10 NaOH
 (D) 75 ml M/5 HCl + 25 ml of M/5 NaOH
- Q 14. The pH of a solution obtained by mixing 50 ml of 0.4 N HCl and 50 ml of 0.2 N NaOH is
 (A) $-\log 2$ (B) $-\log 0.2$
 (C) 1.0 (D) 2.0
- Q 15. The hydrogen ion concentration and pH of the solution made by mixing 100 mL of 1.0 M HNO_3 will 100 mL of 0.8 M KOH, are
 (A) $[\text{H}^+] = 0.1\text{M}, \text{pH} = 1$
 (B) $[\text{H}^+] = 0.01\text{M}, \text{pH} = 2$
 (C) $[\text{H}^+] = 1 \times 10^{-12}\text{M}, \text{pH} = 12$
 (D) $[\text{H}^+] = 1 \times 10^{-7}\text{M}, \text{pH} = 7$
- Q 16. 10 mL of 0.1 N HCl is added to 990 mL solution of NaCl. The pH of the resulting solution is
 (A) zero (B) 3
 (C) 7 (D) 10

5. pH of Weak Acid & Weak Base Solution, Mixture of Acid Solution

- Q 1. When 35 gm of NH_4OH is dissolved in 10 lit. of water, then its degree of dissociation will be ($K_b = 1.8 \times 10^{-5}$)
- (A) 1.34×10^{-3} (B) 1.34×10^{-2}
(C) 4.24×10^{-2} (D) 4.24×10^{-3}
- Q 2. The amount of CH_3NH_2 dissolved in 2 lit of water so that it produces concentration OH^- equal to $5 \times 10^{-4} \text{ M}$, is
[Given K_b of $\text{CH}_3\text{NH}_2 = 2 \times 10^{-6}$]
- (A) 5.6 gm (B) 3.88 gm
(C) 7.75 gm (D) 8.3 gm
- Q 3. The percentage of Pyridine ($\text{C}_5\text{H}_6\text{N}$) that forms Pyridinium ion ($\text{C}_5\text{H}_6\text{N}^+\text{H}$) in 0.10 aqs solution of pyridine ($K_b = 1.7 \times 10^{-9}$) solution is
[NEET 2016, phase II]
- (A) 0.0060 % (B) 0.013 %
(C) 0.77 % (D) 1.6 %
- Q 4. The ionization constant of an acid, K_a is the measure of strength of an acid. The K_a values of acetic acid, hypochlorous acid and formic acid are 1.74×10^{-5} , 3.0×10^{-8} and 1.8×10^{-4} respectively. Which of the following orders of pH of 0.1 mol/lit solutions of these acids is correct?
[NCERT Exemplar]
- (A) Acetic acid > hypochlorous acid > formic acid
(B) Hypochlorous acid > acetic acid > formic acid
(C) Formic acid > hypochlorous acid > acetic acid
(D) Formic acid > acetic acid > hypochlorous acid
- Q 5. **Assertion (A):** pH value of HCl solution is less than that of acetic acid of the same concentration.
Reason (R): In equimolar solution, the number of titrable protons present in HCl is less than that present in acetic acid.
[AIIMS 2014]
- (A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) Both A and R are false
- Q 6. In a 5 litre solution of acetic acid, having $\alpha = 1\%$ and $K_a = 1.8 \times 10^{-5}$. The amount of acetic acid present in the solution is
- (A) 54 gm (B) 27 gm
(C) 60 gm (D) 30 gm
- Q 7. How much water must be added in 900 ml of 0.1 M CH_3COOH solution to triple its degree of dissociation (Assume $\alpha < 5\%$ is negligible): ($K_a = 1.8 \times 10^{-5}$)
- (A) 7.2 L (B) 3.6 L
(C) 5.8 L (D) 2.4 L
- Q 8. Lemon juice normally has a pH of 2. If all the acid in the lemon juice is citric acid & there are no citrate salts present, then what will be the citric acid concentration [HCit] in the lemon juice? (Assume only first hydrogen of citric acid is important)
- $$\text{HCit} \rightleftharpoons \text{H}^+ + \text{Cit}^-, K_a = 8.4 \times 10^{-4} \text{ mol L}^{-1}$$
- (A) $8.4 \times 10^{-4} \text{ M}$ (B) $4.2 \times 10^{-4} \text{ M}$
(C) $1.68 \times 10^{-3} \text{ M}$ (D) 0.12 M
- Q 9. The ionization constant of HF is 3.2×10^{-4} . Calculate the degree of dissociation of HF in its 0.02 M solution. Calculate the conc. of all species present (H^+ , F^- , HF) in the solution & its pH.
[NCERT Solved]
- Q 10. The pH of 0.1 M monobasic acid is 4.50. Calculate the concentration of species H^+ , A^- and HA at equilibrium. Also, determine the value of K_a and $\text{p}K_a$ of the monobasic acid.
[NCERT Solved]
- Q 11. The pH of 0.004M hydrazine solution is 9.7. Calculate its ionization constant K_b & $\text{p}K_b$.
[NCERT Solved]
- Q 12. Calculate PH of a solution containing 0.1 mole per lit of HA ($K_a = 2 \times 10^{-13}$) at 25°C
- (A) $13 - \log_2$ (B) $7 - \frac{1}{2} \log_2$

- (C) $7 - \frac{1}{2} \log_3$ (D) None of these
- Q 13. Calculate PH of a solution containing 0.5 mole per lit of HB ($K_a = 10^{-18}$) at 25°C
 (A) 9 (B) 7
 (C) $7 - \frac{1}{2} \log 9$ (D) None of these
- Q 14. The pH of 0.1 molar solution of an acid HQ is 3. The value of acid dissociation constant K_a for the acid is [AIEEE 2006]
 (A) 3×10^{-1} (B) 1×10^{-3}
 (C) 1×10^{-5} (D) 1×10^{-7}
- Q 15. Concentration of H^+ ion and OH^- ion in a solution obtained by mixing 600 ml of $10^{-2} M H_2SO_4$, 800 ml of $10^{-3} M HNO_3$ and 1100 ml of $10^{-7} M HCl$, is
 (A) $3 \times 10^{-3}, 3.33 \times 10^{-11}$
 (B) $8 \times 10^{-3}, 0.125 \times 10^{-11}$
 (C) $4 \times 10^{-5}, 2.5 \times 10^{-9}$
 (D) $5.12 \times 10^{-3}, 0.19 \times 10^{-11}$
- Q 16. Calculate the pH of 0.10 M HCl dissolved in $10^{-3} M CH_3COOH$ solution ($K_a = 2 \times 10^{-5}$)
 (A) 1 (B) 3.1
 (C) 4 (D) None of these
- Q 17. Degree of dissociation of 1M CH_3COOH in presence of 2M $HClO_4$ + 0.1M HCl having $\alpha = 95\%$, is
 (A) 2.36×10^{-6} (B) 8.6×10^{-6}
 (C) 3.34×10^{-6} (D) 1.86×10^{-5}
- Q 18. A solution contains 0.09 M HCl, 0.09 M CCl_2HCOOH , and 0.1 M CH_3COOH . If total $[H^+] = 0.1M$ and K_a for $CH_3COOH = 10^{-5}$, K_a for CCl_2HCOOH is
 (A) 1.35×10^{-4} (B) 0.18×10^{-2}
 (C) 0.18×10^{-5} (D) 1.25×10^{-2}
- Q 19. Calculate the pH of solution by mixing equal volume of 0.02 M HCl ($K_a = 2 \times 10^{-4}$) & 0.2M CH_3COOH ($K_a = 2 \times 10^{-5}$)
 (A) 2.7 (B) 3.3
 (C) 5.7 (D) 5.3
- Q 20. Calculate the pH of a mixture of 0.1M HC ($K_a = 10^{-5}$) & 0.2M HD ($K_a = 10^{-9}$)
 (A) 5 (B) 3
 (C) 4 (D) None of these
- Q 21. When rain water is accompanied by a thunderstorm, the collected rain water will have pH value [IIT-JEE 1996]
 (A) slightly higher than that when the thunderstorm is not there
 (B) uninfluenced by occurrence of thunderstrom
 (C) which depends on the amount of dust in air
 (D) slightly lower than that of rain water without thunderstorm

6. pH of Polybasic Acid Solution

- Q 1. Calculate the PH of 0.1 M H_2S solution. ($K_{a1} = 10^{-7}$) & $K_{a2} = 10^{-14}$
 (A) 4 (B) 3
 (C) 11 (D) 7
- Q 2. Calculate the $[CO_3^{2-}]$ in 0.01 M solution of H_2CO_3 solution at PH = 4.18 ($K_{a1} = 4.45 \times 10^{-7}$ & $K_{a2} = 4.69 \times 10^{-11}$)
 (A) 4.78×10^{-6} (B) 4.78×10^{-11}
 (C) 4.78×10^{-5} (D) 6.61×10^{-5}
- Q 3. Which is the incorrect statement for 0.01 M $H_2C_2O_4$? ($K_1 = 5.6 \times 10^{-2}$, $K_2 = 5 \times 10^{-6}$)
 (A) It forms two types of acidic salt

- (B) Its maximum H^+ comes from second ionization and $[H^+] = 2.36 \times 10^{-2} M$
- (C) pH of $H_2C_2O_4$ solution is less the pH of $HC_2O_4^-$ solution
- (D) On addition of $KMnO_4$ pH increases sharply upto seven due to oxidation of $C_2O_4^{2-}$
- Q 4. Consider an aqueous solution, 0.1M each of HOCN, HCOOH, $(COOH)_2$ and H_3PO_4 , for HOCN, we can write $K_a(HOCN) = \frac{[H^+][OCN^-]}{[HOCN]}$, $[H^+]$ in this expression refers to
- (A) H^+ ions released by HOCN
- (B) Sum of H^+ ions released by all monoprotic acids
- (C) Sum of H^+ ions released for first dissociation of all the acids
- (D) Overall H^+ ion concentration in the solution
- Q 5. For $10^{-2} M H_3PO_3$ solution which of the following relation is correct ?
- (A) $[H_3PO_3] + [H_2PO_3^-] + [HPO_3^{2-}] + [PO_3^{3-}] = 10^{-2} M$
- (B) $[H_3PO_3] + [H_2PO_3^-] + [HPO_3^{2-}] = 10^{-2} M$
- (C) $[H_2PO_3^-] + [HPO_3^{2-}] + [PO_3^{3-}] = 10^{-2} M$
- (D) $[H_3PO_3] + [H_3PO_3^-] + 2[HPO_3^{2-}] = 10^{-2} M$
- Q 6. $[H_3O^+]$ in 0.1 M H_2SO_4 at two stages
- $H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$
- $HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$ are
- (A) 0.1 M, 0.1 M (B) 0.1 M, $> 0.01 M$
- (C) $> 0.1 M$, $> 0.1 M$ (D) 0.1 M, $< 0.1 M$
- Q 7. Calculate the PH of 1.0M H_2SO_4 solution ($K_{a1} = 10^2, K_{a2} = 1.2 \times 10^{-2}$)
- (A) 0 (B) $-\log_2$
- (C) 0.3 (D) 0.7
- Q 8. Calculate the PH of $10^{-3} M H_2SO_4$ solution ($K_{a1} = 10^2, K_{a2} = 1.2 \times 10^{-2}$)
- (A) 3 (B) 6
- (C) 2.7 (D) 3.3
- Q 9. Calculate the PH of 0.1 M H_2SO_4 solution ($K_{a1} = 10^2, K_{a2} = 1.2 \times 10^{-2}$)
- (A) 1 (B) 0.96
- (C) 0.7 (D) None of these
- Q 10. Calculate the $HC_2O_4^-$ concentration in 0.1 M solution of $H_2C_2O_4$ ($K_{a1} = 10^{-2} \& K_{a2} = 10^{-5}$)
- (A) 0.1 (B) 0.01
- (C) 0.027 M (D) 0.073 M
- Q 11. In an aqs solution of carbonic acid (H_2CO_3) the K_a values: $K_1 = 4.2 \times 10^{-7} \& K_2 = 4.8 \times 10^{-11}$. Select the correct statement for a 0.034 M saturated solution of H_2CO_3 . [AIEEE 2010]
- (A) the conc. of CO_3^{2-} is 0.034 M
- (B) conc. of CO_3^{2-} is greater than that of HCO_3^-
- (C) the conc. of H^+ & HCO_3^- are approx. equal
- (D) the conc. of H^+ is double that of CO_3^{2-}
- Q 12. The first ionization constant of H_2S is 9.1×10^{-8} . Calculate the concentration of HS^- ion in its 0.1M solution. How will this concentration be affected if the solution is 0.1 M in HCl also? If the second dissociation constant of H_2S is 1.2×10^{-13} , calculate the concentration of S^{2-} under both conditions. [NCERT]

7. Hydrolysis of Salt

- Q 1. The ionization constant of HF, HCOOH and HCN at 298 K are 6.8×10^{-4} , 1.8×10^{-4} and 4.8×10^{-9} respectively. Calculate the ionization constants of the corresponding conjugate base. [NCERT]
- Q 2. What is the percentage hydrolysis of NaCN in N/80 solution? When the dissociation constant for HCN is 1.3×10^{-9} and $K_w = 1 \times 10^{-14}$
- (A) 2.48 (B) 5.26
(C) 8.2 (D) 9.6
- Q 3. The dissociation constant for NH_4OH is 1.8×10^{-5} . The degree of hydrolysis of 0.2 M NH_4Cl solution is
- (A) 2.35×10^{-5} (B) 5.27×10^{-5}
(C) 3.62×10^{-5} (D) 4.85×10^{-5}
- Q 4. In the hydrolytic equation $\text{A}^- + \text{H}_2\text{O} \rightleftharpoons \text{HA} + \text{OH}^-$; $K_a = 1 \times 10^{-5}$. The degree of hydrolysis of 0.001 M solution of the salt is
- (A) 10^{-3} (B) 10^{-4}
(C) 10^{-5} (D) 10^{-6}
- Q 5. If we prepare an aqueous solution by mixing 100 ml of 0.2 M HCOOH with 100 ml of 0.2 M NaOH, then its degree of hydrolysis & hydrolysis constant will be [Given: $K_a(\text{HCOOH}) = 1.8 \times 10^{-5}$]
- (A) $K_h = 5.55 \times 10^{-10}$, $h = 1.04 \times 10^{-5}$
(B) $K_h = 55.5 \times 10^{-10}$, $h = 1.98 \times 10^{-5}$
(C) $K_h = 5.55 \times 10^{-11}$, $h = 2.36 \times 10^{-5}$
(D) $K_h = 55.5 \times 10^{-11}$, $h = 7.44 \times 10^{-5}$
- Q 6. If $\text{p}K_b$ for CN^- at 25°C is 4.7, the pH of 0.5 M aqueous NaCN solution is
- (A) 12 (B) 10
(C) 11.5 (D) 11
- Q 7. It is found that 0.1 M solution of three sodium salts NaX, NaY and NaZ gave pH 7.0, 9.0 and 11.0 respectively. The correct order of increasing strength of acid HX, HY, HZ is
- (A) $\text{HX} < \text{HY} < \text{HZ}$ (B) $\text{HY} < \text{HZ} < \text{HX}$
(C) $\text{HZ} < \text{HY} < \text{HX}$ (D) $\text{HZ} > \text{HY} < \text{HX}$
- Q 8. The pH of 0.1 M solution of the following salts increases in the order [IIT-JEE 1999]
- (A) $\text{NaCl} < \text{NH}_4\text{Cl} < \text{NaCN} < \text{HCl}$
(B) $\text{HCl} < \text{NH}_4\text{Cl} < \text{NaCl} < \text{NaCN}$
(C) $\text{NaCN} < \text{NH}_4\text{Cl} < \text{NaCl} < \text{HCl}$
(D) $\text{HCl} < \text{NaCl} < \text{NaCN} < \text{NH}_4\text{Cl}$
- Q 9. The degree of hydrolysis of a salt of weak acid and weak base in its 0.1 M solution is found to be 50%. If the molarity of the solution is 0.2 M, the percentage hydrolysis of the salt should be
- (A) 100% (B) 50%
(C) 25% (D) none of these
- Q 10. Which of the following does not undergo hydrolysis?
- (A) FeSO_4 (B) K_2CO_3
(C) $\text{CH}_3\text{COONH}_4$ (D) Na_2SO_4
- Q 11. The $\text{p}K_a$ of weak acid HA is 4.80 & $\text{p}K_b$ of a weak base BOH is 4.78. The pH of solution of corresponding salt BA will be? [AIEEE 2006]
- (A) 9.58 (B) 4.79 (C) 7.01 (D) 9.22
- Q 12. **Assertion (A):** Aqueous solution of ammonium carbonate is basic
Reason (R): Acidic / basic nature of a salt solution of a salt of weak acid and weak base depends on K_a and K_b value of the acid and the base forming it. [NCERT Exemplar]
- (A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) Both A and R are false
- Q 13. In an aqueous solution of NH_4Cl
- (i) Anionic Hydrolysis takes Place
(ii) PH of the solution is greater than 7
(iii) It turns red litmus to blue
(iv) $k_h = \frac{k_w}{k_a}$

- (A) I and iv are correct
 (B) All are correct
 (C) ii and iii are correct
 (D) All are wrong
- Q 14. The hydrolysis constant K_h of a salt of NaOH and a weak acid (HX) if the K_a of the acid is 2×10^{-6} is
 (A) 5×10^{-8} (B) 5×10^{-6}
 (C) 5×10^{-9} (D) 2.5×10^{-7}
- Q 15. If equilibrium constant for the reaction between BOH and HCl is 10^{12} , then pH of 10^{-2} M BCl solution is
 (A) 2.2 (B) 7
 (C) 12.3 (D) 2.8
- Q 16. If the equilibrium constant for reaction of HCN with NaOH is 10^{10} , then calculate pH of 10^{-3} M NaCN solution.
 (A) 6.5 (B) 7.5
 (C) 8.5 (D) None of these
- Q 17. Calculate pH of 10^{-2} M $\text{Ba}(\text{Lac})_2$, given that K_a of lactic acid = 10^{-4}
 (A) 8.15 (B) 8
 (C) 8.3 (D) None of these
- Q 18. Equal volume of 0.2 M NH_4OH (or ammonia) and 0.1 M H_2SO_4 are mixed calculate pH of final solution.
 Given: K_b of $\text{NH}_3 = 1.8 \times 10^{-5}$
 (A) 5.75 (B) 5.13
 (C) 5.00 (D) None of these
- Q 19. What is the correct relationship between the pH of isomolar solutions of sodium oxide (pH_1), sodium sulphide (pH_2), Sodium selenide (pH_3) and sodium telluride (pH_4)? [CBSE PMT 2005]
 (A) $\text{pH}_1 > \text{pH}_2 = \text{pH}_3 > \text{pH}_4$
 (B) $\text{pH}_1 < \text{pH}_2 < \text{pH}_3 < \text{pH}_4$
 (C) $\text{pH}_1 < \text{pH}_2 < \text{pH}_3 = \text{pH}_4$
 (D) $\text{pH}_1 > \text{pH}_2 > \text{pH}_3 > \text{pH}_4$
- Q 20. **Assertion (A):** Aqs solution of Ammonium carbonate is basic

Reason (R): Acidic/Basic nature of a solution of a salt of weak acid & weak base depends on K_a & K_b value of acid & base forming it.

[AIIMS 2010]

- (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false

8. pH of Salts Solution – Part II, Common Ion effect

- Q 1. Calculate the pH of 0.1 M K_3PO_4 solution (For $\text{H}_3\text{PO}_4 : K_{a1} = 1.8 \times 10^{-4}$, $K_{a2} = 2.5 \times 10^{-8}$, $K_{a3} = 1.5 \times 10^{-12}$)
 (A) 12.41 (B) 8.51
 (C) 9.6 (D) None of these
- Q 2. Calculate the PH of 0.01 M Na_2CO_3 solution ($\text{H}_2\text{CO}_3 : K_{a1} = 4.2 \times 10^{-7}$ $K_{a2} = 5.0 \times 10^{-11}$)
 (A) 9.1 (B) 11.15
 (C) 9.5 (D) None of these
- Q 3. Calculate the pH of resulting solution when 50 ml of 0.12 M H_3PO_4 mixed with 40 ml of 0.15 M NaOH. [Given for $\text{H}_3\text{PO}_4; K_1 = 7.5 \times 10^{-3}$; $K_2 = 6.2 \times 10^{-8}$; $K_3 = 1.0 \times 10^{-12}$]
 (A) 4.12 (B) 4.66
 (C) 9.3 (D) 1.23
- Q 4. Calculate the PH of 0.1 M NaHCO_3 solution ($\text{H}_2\text{CO}_3 : K_{a1} = 4.2 \times 10^{-7}$; $K_{a2} = 5.0 \times 10^{-11}$)
 (A) 8.34 (B) 11.15
 (C) 9 (D) None of these
- Q 5. Calculate PH of 0.5M Na_2HA solution ($\text{H}_3\text{A}; k_{a1} = 10^{-5}$, $k_{a2} = 10^{-9}$, $k_{a3} = 10^{-13}$)
 (A) 7 (B) 9
 (C) 11 (D) None of these

- Q 6. Calculate PH of 1.5M NaH_2A solution (use above K_a data)
 (A) 7 (B) 9
 (C) 11 (D) None of these

- Q 7. **List I** **List II**
 A. Weak acid & strong base 1. $\frac{1}{2} pK_w$
 B. Strong acid & weak base 2. $\frac{1}{2} (pK_w - pK_B + pK_A)$
 C. Weak acid & weak base 3. $\frac{1}{2} (pK_w - pK_B - \log C)$
 D. Strong acid & strong base 4. $\frac{1}{2} (pK_w + pK_A + \log C)$

- Q 8. The dissociation of HCN will be suppressed in
 (A) NaCN solution (B) HCl solution
 (C) both A & B (D) None of these

- Q 9. The dissociation of NH_4OH is suppressed is
 (A) KOH solution (B) HCl solution
 (C) NH_3 solution (D) None of these

- Q 10. **Assertion (A):** The ionization of hydrogen sulphide in water is low in the presence of hydrochloric acid. **[NCERT Exemplar]**

Reason (R): Hydrogen sulphide is a weak acid.

- (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false

- Q 11. The PK_a of acetylsalicylic acid (aspirin) is 3.5. the pH of gastric juice in human stomach is about 2-3 and the pH in the small intestine is about 8. Aspirin will be **[IIT-JEE 1988]**

- (A) Unionized in the small intestine and in the stomach.
 (B) Completely ionized in the small intestine and in the stomach.
 (C) Ionized in the stomach and almost unionized in the small intestine
 (D) Ionized in the small intestine and almost unionized in the stomach

- Q 12. The ionization constant of phenol is 1.0×10^{-10} . What is the concentration of phenolate ion in 0.05 M solution of phenol? What will be its degree of

ionization if the solution is also 0.01 M in sodium phenolate? **[NCERT]**

- Q 13. **Assertion (A):** On addition of NH_4Cl to NH_4OH solution, pH decreases but remains greater than 7

Reason (R): Addition of NH_4^+ ion decreases ionization of NH_4OH , thus $[\text{OH}^-]$ is decreased, hence pH decreases. **[AIIMS 2013]**

- (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false

9. pH of Buffer Solution

- Q 1. An acidic buffer solution can be prepared by mixing the solution of **[IIT-JEE 1981]**

- (A) ammonium acetate & acetic acid
 (B) ammonium chloride & ammonium Hydroxide
 (C) sulphuric acid & sodium sulphate
 (D) sodium chloride & sodium hydroxide

- Q 2. Which of the following will produce a buffer solution when mixed in equal volumes?

[NCERT Exemplar]

- (A) 0.1 M NH_4OH and 0.1 M HCl
 (B) 0.05 M NH_4OH and 0.1 M HCl
 (C) 0.1 M NH_4OH and 0.05 M HCl
 (D) 0.1 M CH_3COONa & 0.1 M NaOH

- Q 3. 20 mL of 0.2 M NaOH is added to 50 mL of 0.2 M CH_3COOH . Hence $(\text{pH} - \text{p}K_a)$ is

- (A) $\log \frac{3}{2}$ (B) $\log \frac{2}{3}$
 (C) $\log 2$ (D) $2 \log 2$

- Q 4. pH of mixture of HA and A^- buffer is 5. K_b of

$\text{A}^- = 10^{-10}$. Hence $[\text{HA}]/[\text{A}^-]$ will be

- (A) 1 (B) 10
 (C) 0.1 (D) 100

- Q 5. A certain buffer solution contains equal concentration of X^- and HX . The K_b for X^- is 10^{-10} . The pH of the buffer is [IIT-JEE 1984]
 (A) 4 (B) 7
 (C) 10 (D) 14
- Q 6. pH of the buffer containing 0.6 g of acetic acid and 8.2 g of sodium acetate in 1 litre of water is (pK_a of acetic acid = 4.5)
 (A) 7.5 (B) 4.5
 (C) 5.5 (D) 6.5
- Q 7. The pH of blood is 7.4. If the blood contains CO_2 and HCO_3^- , what is the ratio of conjugate base to acid (H_2CO_3) to maintain the pH of the blood equal to 7.4? [Given: pK_{a1} of $H_2CO_3 = 6.4$]
 (A) 10 (B) $\frac{1}{10}$
 (C) 100 (D) 8
- Q 8. On diluting a buffer solution, its pH
 (A) is increased
 (B) is decreased
 (C) remains constant
 (D) changes which can not be predicted unless dissociation constant of weak acid or weak base is provided.
- Q 9. Buffer solutions have constant acidity & alkalinity because [CBSE PMT 2012]
 (A) these give unionized acid or base on reaction with added acid or alkali
 (B) acids and alkalis in these solutions are shielded from attack by other ions
 (C) they have large excess of H^+ or OH^- ions
 (D) they have fixed value of pH
- Q 10. The pH value of blood does not change appreciably by a small addition of an acid or base because the blood [CBSE PMT 1995]
 (A) it is body fluid
 (B) can be easily coagulated
 (C) contains Fe as a part of the molecule
 (D) contains serum protein that act as buffer
- Q 11. **Assertion (A):** A solution containing a mixture of acetic acid and sodium acetate maintains a constant value of pH on addition of small amounts of acid or alkali
Reason (R): A solution containing a mixture of acetic acid and sodium acetate acts as buffer solution around pH 4.75. [NCERT Exemplar]
 (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false
- Q 12. In alkaline buffer solution containing NH_4OH and NH_4Cl , if some HCl is added its pH will
 (A) increase a little
 (B) decrease a little
 (C) remains constant
 (D) change but cannot be predicted
- Q 13. Fixed volume of 0.1 M benzoic acid ($pK_a = 4.2$) solution is added into 0.2M sodium benzoate solution and formed a 300 ml of resultant acidic buffer solution. If pH of this buffer solution is 4.5 then find added volume of benzoic acid
 (A) 100 ml (B) 150 ml
 (C) 200 ml (D) None of these
- Q 14. 40 ml of 0.1 M Ammonia solution is mixed with 20 ml of 0.1 M HCl. What is the pH of the mixture? ($pK_b = 4.74$ for NH_3) [AIIMS 2018]
 (A) 4.74 (B) 2.26
 (C) 9.26 (D) 5.00
- Q 15. In what volume ratio should you mix 1.0 M solution of NH_4Cl and NH_3 to produce a buffer solution of pH 9.80? [$pK_b(NH_3) = 4.74$]
 (A) $10^{-0.54}$ (B) $10^{0.54}$
 (C) $10^{5.4}$ (D) $10^{-5.4}$
- Q 16. To prepare a buffer of pH 8.26, amount of $(NH_4)_2SO_4$ to be added into 500 mL of 0.01 M NH_4OH solution [$pK_a(NH_4^+) = 9.26$]
 (A) 0.05 mol (B) 0.025 mol

- (C) 0.10 mol (D) 0.005 mol
- Q 17. pH of a mixture which is 0.1 M in CH_3COOH and 0.05 M in $(\text{CH}_3\text{COO})_2\text{Ba}$ is
 (A) 4.74 (B) 5.04
 (C) 4.44 (D) 7.00
- Q 18. $\text{pK}_a(\text{CH}_3\text{COOH})$ is 4.74. x mol of lead acetate and 0.1 mol of acetic acid in one L solution make a solution $\text{pH}=5.04$. Hence, x is
 (A) $10^{-0.7}$ (B) $10^{-0.7}$
 (C) $\left(\frac{10^{-0.7}}{2}\right)$ (D) $10^{\frac{0.7}{2}}$
- Q 19. Which buffer solution has maximum pH?
 (A) mixture which is 0.1 M in CH_3COOH and 0.1 M in CH_3COONa
 $[\text{pK}_a(\text{CH}_3\text{COOH}) = 4.74]$
 (B) mixture which is 0.2 M CH_3COOH and 0.2 M in CH_3COONa
 (C) mixture which is 0.1 M in NH_4Cl and 0.1M in NH_4OH $[\text{pK}_a(\text{NH}_4^+) = 9.26]$
 (D) all solution have equal pH which is 4.74
- Q 20. In order to prepare a buffer of $\text{pH} = 8.26$, the mole of $(\text{NH}_4)_2\text{SO}_4$ required to be mixed with one litre of 0.1M $\text{NH}_3(\text{aq})$, $\text{pK}_b = 4.74$ is
 (A) 1.0 mole (B) 10.0 mole
 (C) 0.50 mole (D) 5 mole
- Q 21. Calculate the pH of a 0.10 M ammonia solution. Calculate the pH after 50.0 mL of this solution is treated with 25.0 mL of 0.10 M HCl. The dissociation constant of ammonia, $\text{K}_b = 1.77 \times 10^{-5}$. [NCERT Solved]
- 10. Buffer Capacity of Buffer Solution**
- Q 1. **Assertion (A):** An aqueous solution of ammonium acetate can act as a buffer.
Reason (R): Acetic acid is a weak acid and NH_4OH is a weak base. [NCERT Exemplar]
 (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false
- Q 2. Which of the following buffer solution turns invalid on addition of 10 ml of 0.1 M HCl?
 [AIIMS 2010]
 (A) 100 ml having 0.15 M NH_3 and NH_4Cl each
 (B) 100 ml having 0.2 M NH_3 & NH_4Cl each
 (C) 100 ml having 0.2 M NH_3 & 0.1 M NH_4Cl
 (D) 100 ml having 0.05 NH_3 & NH_4Cl each
- Q 3. Which solution has maximum buffer capacity
 (A) 0.1 M HA & 0.2 MA^-
 (B) 1.0M HA & 2 MA^-
 (C) 0.01 M HA & 0.02 MA^-
 (D) All have equal buffer capacity
- Q 4. Which of the following solutions containing weak acid and salt of its conjugate base has maximum buffer capacity ?
 (A) $[\text{Salt}] = [\text{Acid}]$ (B) $[\text{Salt}] > [\text{Acid}]$
 (C) $[\text{Salt}] < [\text{Acid}]$ (D) $[\text{Salt}] + [\text{Acid}]$ is min
- Q 5. We have acidic buffer of CH_3COONa and CH_3COOH . One or more of the following operations will not change pH
 I: diluting the mixture ten times
 II: adding some HCl
 III: adding some NaOH
 IV: adding moles of CH_3COONa and CH_3COOH insame ratio (as solution have) into the buffer
 Select correct alternate:
 (A) I, II, III, IV (B) II, III
 (C) I, IV (D) II, IV
- Q 6. Buffer begins to lose its effectiveness when

- (A) $\frac{[\text{Salt}]}{[\text{weak electrolyte}]} \leq 0.1$
 (B) $\frac{[\text{Salt}]}{[\text{weak electrolyte}]} \geq 10$
 (C) both (A) and (B)
 (D) None of these
- Q 7. A physician wishes to prepare a buffer solution at $\text{pH} = 3.58$ that efficiently resist change in pH yet contains only small conc. of the buffering agents. Which one of the following weak acid together with its sodium salt would be best to use?

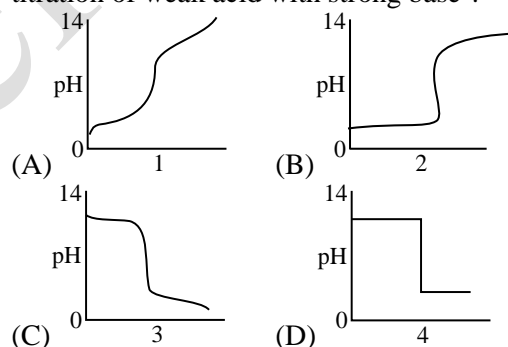
[CBSE PMT 1997]

- (A) m-chlorobenzoic acid ($\text{pK}_a = 3.98$)
 (B) p-chlorocinnamic acid ($\text{pK}_a = 4.41$)
 (C) 2,5-dihydroxy benzoic acid ($\text{pK}_a = 2.97$)
 (D) acetoacetic acid ($\text{pK}_a = 3.58$)
- Q 8. The buffer capacity of a given acid buffer solution is 100. To the solution if 0.5 moles of alkali is added, then
 (A) pH increase by 5 unit
 (B) pH increases by 0.5 unit
 (C) pH increases by 50 unit
 (D) pH increases by 5×10^{-3} unit
- Q 9. Calculate the buffer capacity of a solution if its pH changes from 4.745 to 4.832 on addition of 0.01 mole of NaOH to 250 ml of a solution
 (A) 0.087 (B) 0.04
 (C) 0.46 (D) 0.01
- Q 10. 0.1 M acetic acid solution is titrated against 0.1 M NaOH solution. What would be the difference in pH between $\frac{1}{4}$ and $\frac{3}{4}$ stages of neutralization of acid?
 (A) $2 \log \frac{3}{4}$ (B) $2 \log \frac{1}{4}$
 (C) $\log \frac{1}{3}$ (D) $2 \log 3$
- Q 11. Calculate the pH of resulting solution when 40ml of 0.12 M H_3PO_4 mixed with 40 ml of 0.18 M NaOH .
 [Given for H_3PO_4 : $\text{K}_1 = 7.5 \times 10^{-3}$;
 $\text{K}_2 = 6.2 \times 10^{-8}$; $\text{K}_3 = 1.0 \times 10^{-12}$]
 (A) 3.12 (B) 5.22
 (C) 7.2 (D) 8.5

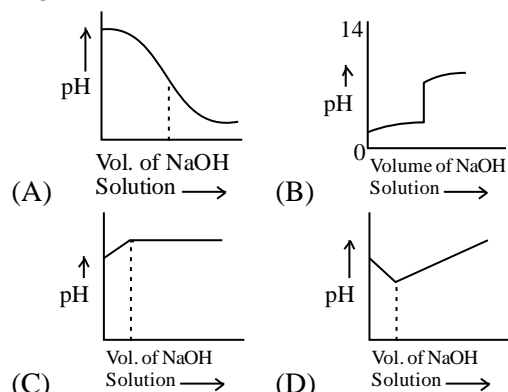
- Q 12. Calculate the pH of resulting solution when 40 ml of 0.10 M H_3PO_4 mixed with 40 ml of 0.25 M NaOH . [Use K_a for H_3PO_4 from previous Q]
 (A) 5.13 (B) 6.8
 (C) 8.6 (D) 12
- Q 13. Calculate the pH of resulting solution when 40 ml of 0.10 M H_3PO_4 is mixed with 40 ml of 0.10 M Na_3PO_4 . [Use K_a for H_3PO_4 from previous Q]
 (A) 6.3 (B) 11.8
 (C) 9.6 (D) 7.20

11. Titration & pH Curve

- Q 1. Which of the following curves best represents the titration of weak acid with strong base?



- Q 2. Which one of the following curves represents the graph of pH during the titration of NaOH and HCl



- Q 3. In which of the following acid-base titration, $\text{pH} > 8$ at equivalence point? [AIIMS 2003]
 (A) Acetic acid vs Ammonia

- (B) Acetic acid vs sodium hydroxide
 (C) Hydrochloric acid vs ammonia
 (D) Hydrochloric acid vs sodium hydroxide
- Q 4. Which is/are correct statements:
 0.1 M acetic acid solution is titrated against 0.1 M NaOH solution. The difference in pH between $\frac{1}{4}$ and $\frac{3}{4}$ stages of neutralization of acid will be $2 \log 3$.
 (A) a only (B) b only
 (C) a,b both (D) None is correct
- Q 5. When CH_3COOH ($K_a = 1.8 \times 10^{-5}$) of concentration 0.1 M is treated with NaOH, pH at half equivalence point is
 (A) 5.04 (B) 4.74
 (C) 4.34 (D) None of these
- Q 6. Calculate OH^- concentration at the equivalent point when a solution of 0.1 M acetic acid is titrated with a solution of 0.1 M NaOH. K_a for the acid = 1.9×10^{-5}
 (A) $5.12 \times 10^{-6} \text{ M}$ (B) $\frac{10^{-8}}{5.12} \text{ M}$
 (C) 5.12×10^{-8} (D) None of these
- Q 7. Calculate the hydronium ion concentration and the pH at the equivalence point in a titration of 50.0 mL of 0.40 M NH_3 with 0.40 M HCl . [$K_b = 1.8 \times 10^{-5}$]
 (A) 6.98 (B) 9.02
 (C) 4.98 (D) 7.02
- Q 8. 50 ml of 0.1 M H_3PO_4 is treated with 0.1 M NaOH solution. Find the pH of solution (Given for H_3PO_4 $\text{PK}_{a_1} = 3, \text{PK}_{a_2} = 7, \text{PK}_{a_3} = 11$)
- Q 9. 25 ml of NaOH is used
 (A) 7 (B) 4 (C) 3 (D) 5
- Q 10. 75 ml of NaOH is used
 (A) 7 (B) 9 (C) 5 (D) 11
- Q 11. 100 ml of NaOH is used
 (A) 7 (B) 9 (C) 5 (D) 11
- Q 12. Above titration has no. of equivalence point
 (A) 1 (B) 2 (C) 3 (D) 4
- Q 13. Which of the following statements about pH and H^+ ion concentration is incorrect?
 [CBSE PMT 2000]
 (A) Addition of one drop of conc. HCl in NH_4OH solution decreases the pH of the solution
 (B) A solution of the mixture of one equivalent of each of CH_3COOH & NaOH has a pH of 7
 (C) pH of pure neutral water is not zero
 (D) A cold & conc. H_2SO_4 has lower H^+ ion concentration than a dilute solution of H_2SO_4
- Q 14. A weak base (50.0 mL) was titrated with 0.1 M HCl. The pH of the solution after the addition of 10.0 mL and 25.0 mL were found to be 9.84 and 9.24, respectively. Calculate K_b of the base and pH at the equivalence point.

12. Acid – Base Indicator

- Q 1. Which of the following indicators is best suited in the titration of a weak acid versus strong base?
 (A) Phenolphthalein (8.3 – 10.0)
 (B) Methyl orange (3.1 – 4.4)
 (C) Methyl red (4.2 – 6.3)
 (D) Litmus (4.5 – 8.3)
- Q 2. Which of the following indicators is best suited in the titration of a weak base versus strong acid?
 (A) Phenolphthalein (8.3 – 10.0)
 (B) Phenol red (6.8 – 8.4)
 (C) Methyl orange (3.1 – 4.4)
 (D) Litmus (4.5 – 8.3)
- Q 3. **Assertion (A):** In an acid – base titration involving strong base & a weak Acid, methyl orange can be used as an indicator.
Reason (R): Methyl orange changes its Colour in pH range of 7 to 9. [AIIMS 2012]
 (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false
- Q 4. The pink colour of phenolphthalein in alkaline medium is due to

- (A) the acidic form of phenolphthalein
 (B) the anionic form of phenolphthalein
 (C) OH^- of the alkali
 (D) The non conjugated structure of phenolphthalein
- Q 5. The rapid change in pH near the stoichiometric point of an acid base titration is the basis of indicator detection. pH of the solution is related to ratio of the concentration of the conjugate acid (HIn) & base (In^-) forms of the indicator given by the expression [CBSE AIPMT 2004]
- (A) $\log \frac{[\text{In}^-]}{[\text{HIn}]} = \text{pK}_{\text{in}} - \text{pH}$
 (B) $\log \frac{[\text{HIn}]}{[\text{In}^-]} = \text{pK}_{\text{in}} - \text{pH}$
 (C) $\log \frac{[\text{HIn}]}{[\text{In}^-]} = \text{pH} - \text{pK}_{\text{in}}$
 (D) $\log \frac{[\text{In}^-]}{[\text{HIn}]} = \text{pH} - \text{pK}_{\text{in}}$
- Q 6. What fraction of an indicator HIn is in basic form at a pH of 6 if the pK_a of the indicator is 5?
- (A) $\frac{1}{2}$ (B) $\frac{1}{11}$
 (C) $\frac{10}{11}$ (D) $\frac{1}{10}$
- Q 7. Bromophenol blue is an indicator with a value of $\text{K}_a = 5.84 \times 10^{-5}$. Calculate the % of this indicator in its basic form at a pH of 4.84
- (A) 20% (B) 60%
 (C) 80% (D) 96%
- Q 8. An acid-base indicator which is a weak acid has a pK_a value = 5.5. At what concentration ratio of sodium acetate to acetic acid would the indicator show a colour half-way between those of its acid and conjugate base forms? pK_a of acetic acid = 4.75
- (A) 4.93 : 1 (B) 6.3 : 1
 (C) 5.62 : 1 (D) 2.37 : 1
- Q 9. K_b of conjugate base of an acid-base indicator HIn is 10^{-9} . The pH at which its 10^{-3} (M) solution shows the colour change
- (A) 9 (B) 7
 (C) 5 (D) 3
- Q 10. An indicator is a weak acid and pH range its colour is 3 to 5. If the neutral point of the indicator lies in the hydrogen ion concentration corresponding to the centre of given pH range. This indicator is suitable for titration having pH at equivalence point closest to
- (A) 3.3 (B) 4.0
 (C) 7.0 (D) 5.0
- Q 11. An acid base indicator has $\text{K}_a = 1.0 \times 10^{-5}$. The acid form of the indicator is red and the basic form is blue. Calculate the pH change required to change the colour of the indicator from 80% red to 80% blue
- (A) 1.20 (B) 0.80
 (C) 0.20 (D) 1.40
- Q 12. An acid type indicator, HIn differs in colour from its conjugate base (In^-). The human eye is sensitive to colour differences only when the ratio $\frac{[\text{In}^-]}{[\text{HIn}]}$ is greater than 10 or smaller than 0.1. What should be the minimum change in the pH of the solution to observe a complete change ($\text{K}_a = 1.0 \times 10^{-5}$)?
- (A) 1 (B) 2 (C) 3 (D) 4
- Q 13. An acid base indicator has $\text{K}_{\text{in}} = 3 \times 10^{-5}$. The acid form is red and basic form is blue. The change in $[\text{H}^+]$ required to change the indicator from 75% red to 75% blue is
- (A) 8×10^{-5} (B) 9×10^{-5}
 (C) 1×10^{-5} (D) 3×10^{-4}

13. Solubility Product

- Q 1. The K_w for $\text{Cr}(\text{OH})_3$ is 1.6×10^{-30} . The molar solubility of this compound in water is
[AIEEE 2008]
(A) $\sqrt[2]{1.6 \times 10^{-30}} \text{ M}$ (B) $\sqrt[4]{1.6 \times 10^{-30}} \text{ M}$
(C) $\sqrt[4]{1.6 \times 10^{-30}} / 27 \text{ M}$ (D) $1.6 \times 10^{-30} / 27 \text{ M}$
- Q 2. The solubility product of a salt having general formula MX_2 , in water is 4×10^{-12} . The concentration of M^{2+} ion in the aqueous solution of the salt is
[IIT - JEE 1998]
(A) $4.0 \times 10^{-10} \text{ M}$ (B) $1.6 \times 10^{-4} \text{ M}$
(C) $1.0 \times 10^{-4} \text{ M}$ (D) $2.0 \times 10^{-6} \text{ M}$
- Q 3. In a saturated solution of the sparingly soluble electrolyte AgIO_3 (molecular mass = 283) the equilibrium which sets in is $\text{AgIO}_3(\text{s}) \rightleftharpoons \text{Ag}^+(\text{aq}) + \text{IO}_3^-(\text{aq})$. If the solubility product constant K_{sp} of AgIO_3 at a given temperature is 1.0×10^{-8} , what is the mass of AgIO_3 contained in 100 ml of its saturated?
[IIT - JEE 2001]
(A) $1.0 \times 10^{-4} \text{ g}$ (B) $28.3 \times 10^{-2} \text{ g}$
(C) $2.83 \times 10^{-3} \text{ g}$ (D) $1.0 \times 10^{-7} \text{ g}$
- Q 4. If K_{sp} of AgI is 8.1×10^{-17} . The maximum amount of AgI which can be dissolved in 2500 ml of water will be
(A) $9.22 \times 10^{-9} \text{ gm}$ (B) $2.3 \times 10^8 \text{ gm}$
(C) $5.28 \times 10^{-6} \text{ gm}$ (D) $2.17 \times 10^{-5} \text{ gm}$
- Q 5. How many grams of CaC_2O_4 will dissolve in distilled water to make one litre of saturated solution of it?
(K_{sp} of $\text{CaC}_2\text{O}_4 = 2.5 \times 10^{-9} \text{ mol}^2 \text{ lit}^{-2}$)
(A) 0.0064 gm (B) 0.1028 gm
(C) 0.1280 gm (D) 0.2056 gm
- Q 6. At 20°C , the Ag^+ ion concentration in a saturated solution Ag_2CrO_4 is 1.5×10^{-4} mole/lit. At 20°C , the solubility product of Ag_2CrO_4 could be
(A) 3.37×10^{-12} (B) 1.68×10^{-10}
(C) 1.68×10^{-12} (D) 1.12×10^{-10}
- Q 7. The solubility of sparingly soluble electrolyte 1.12×10^{-10} in water given by the expression
(A) $s = \left[\frac{K_{sp}}{m^m a^a} \right]^{m+a}$ (B) $s = \left[\frac{K_{sp}}{m^m a^a} \right]^{1/(m+a)}$
(C) $s = \left[\frac{K_{sp}}{m^a a^m} \right]^{m+a}$ (D) $s = \left[\frac{K_{sp}}{m^a a^m} \right]^{1/(m+a)}$
- Q 8. Concentration of Ag^+ ion in a saturated solution of Ag_2CrO_4 is $5.4 \times 10^{-6} \text{ g/litre}$ when the salt is 50% dissociated. Then solubility product of Ag_2CrO_4 is
(A) 7.03×10^{-17} (B) 6.25×10^{-23}
(C) 1.72×10^{-23} (D) 2.15×10^{-24}
- Q 9. The solubility product of As_2O_3 is 10.8×10^{-9} . It is 50% dissociated in saturated solution. The solubility of salt is
[AIIMS 2007]
(A) 10^{-2} M (B) $2 \times 10^{-2} \text{ M}$
(C) $5 \times 10^{-3} \text{ M}$ (D) $5.4 \times 10^{-9} \text{ M}$
- Q 10. The K_{sp} of AgCl is 4×10^{-10} at 298 K. The solubility of AgCl in 0.04 M CaCl_2 will be
(A) $2 \times 10^{-5} \text{ M}$ (B) $1 \times 10^{-4} \text{ M}$
(C) $5 \times 10^{-9} \text{ M}$ (D) $2.2 \times 10^{-4} \text{ M}$
- Q 11. The molar solubility of PbI_2 in 0.2 M $\text{Pb}(\text{NO}_3)_2$ solution in terms of solubility product, K_{sp} of PbI_2 is
(A) $\left(\frac{K_{sp}}{0.2} \right)^{1/2}$ (B) $\left(\frac{K_{sp}}{0.8} \right)^{1/2}$

- (C) $\left(\frac{K_{sp}}{0.8}\right)^{1/3}$ (D) $\left(\frac{K_{sp}}{0.4}\right)^{1/2}$
- Q 12. Solubility of As_2S_3 in 0.3 M Al_2S_3 solution in terms of solubility product K_{sp} of As_2S_3 is
- (A) $\sqrt{\frac{K_{sp}}{2.916}}$ (B) $3\sqrt{\frac{K_{sp}}{2.916}}$
- (C) $\sqrt{\frac{K_{sp}}{1.2}}$ (D) $3\sqrt{\frac{K_{sp}}{1.2}}$
- Q 13. Calculate the molar solubility of $Ni(OH)_2$ in 0.10 M NaOH. The ionic product of $Ni(OH)_2$ is 2.0×10^{-15} . [AIIMS 2013] [NCERT Solved]
- Q 14. K_{sp} of $Zn(OH)_2$ is 4.5×10^{-17} then its solubility in a solution having pH = 10 will be
- (A) $4.5 \times 10^{-9} M$ (B) $1.4 \times 10^{-10} M$
- (C) $6.7 \times 10^{-10} M$ (D) $7.6 \times 10^{-10} M$
- Q 15. Solubility of $Mg(OH)_2$ with $K_{sp} 8.9 \times 10^{-13}$, in a solution containing 500 ml of 0.2 M NH_4OH and 500 ml of 0.4M $Ca(OH)_2$ is
- (A) $3.4 \times 10^{-19} M$ (B) $55.63 \times 10^{-13} M$
- (C) $2.34 \times 10^{-9} M$ (D) $8.34 \times 10^{-13} M$
- Q 16. $M(OH)_x$ has a K_{sp} of 4×10^{-9} and its solubility is $10^{-3} M$. The value of x is
- (A) 4 (B) 1
- (C) 3 (D) 2
- 14. Relative Solubility & Precipitation of Solid**
- Q 1. Solubility product (K_{sp}) of salts of types MX , MX_2 & M_3X at temperature T are 4×10^{-8} , 3.2×10^{-14} & 2.7×10^{-15} respectively. Solubility (in Molarity) of the salts at temperature is in order [IIT - JEE 2008]
- (A) $MX > MX_2 > M_3X$
- (B) $M_3X > MX_2 > MX$
- (C) $MX_2 > M_3X > MX$
- (D) $MX > M_3X > MX_2$
- Q 2. MY & NY_3 are two insoluble salts, have same K_{sp} value 6.2×10^{-13} at room temperature. Which statement would be true in regard to MY & NY_3 ? [NEET 2016, Phase 1]
- (A) the molar solubility of MY in water is less than that of NY_3
- (B) the salts MY & NY_3 are more soluble in 0.5 M KY than in pure water
- (C) the addition of salt of KY to solution of MY and NY_3 will have no effect on their solubilities
- (D) the molar solubilities of MY & NY_3 in water are identical.
- Q 3. The solubility product of salt M_2X_3 is 2.2×10^{-20} . If the solubility of another salt having formula M_2X is twice the molar solubility of M_2X_3 , then Solubility product of M_2X is [AIIMS 2009]
- (A) 3.0×10^{-12} (B) 9.16×10^{-5}
- (C) 4.58×10^{-5} (D) 2.76×10^{-18}
- Q 4. The values of K_{sp} of two sparingly soluble salts $Ni(OH)_2$ and $AgCN$ are 2.0×10^{-15} and 6×10^{-17} respectively. Which salt is more soluble? Explain. [NCERT Solved]
- Q 5. The solubility of $Sr(OH)_2$ at 298 K is 19.23 g/L of solution. Calculate the concentrations of strontium and hydroxyl ions and the pH of the solution. [NCERT]
- Q 6. The solubility product of $BaSO_4$ is 1.5×10^{-9} . The precipitation in a 0.01 M Ba^{2+} ions solution will start on adding H_2SO_4 of concentration
- (A) $10^{-9} M$ (B) $10^{-8} M$
- (C) $10^{-7} M$ (D) $10^{-6} M$
- Q 7. The solubility products of $Al(OH)_3$ and $Zn(OH)_2$ are 8.5×10^{-23} and 1.8×10^{-14} at room temperature. If the equal concentration of the ion first precipitated by adding NH_4OH is

- (A) Al^{3+} (B) Zn^{2+}
(C) both (D) none
- Q 8. Solubility product of silver bromide is 5.0×10^{-13} . The quantity of potassium bromide (molar mass taken as 120 g mol^{-1}) to be added to 1 litre of 0.05 M solution of silver nitrate to start the precipitation of AgBr is [AIEEE 2011]
(A) $1.2 \times 10^{-10} \text{ g}$ (B) $1.2 \times 10^{-9} \text{ g}$
(C) $6.2 \times 10^{-5} \text{ g}$ (D) $5.0 \times 10^{-8} \text{ g}$
- Q 9. At 25°C , the solubility product of $\text{Mg}(\text{OH})_2$ is 1.0×10^{-11} . At which pH, will 1.0×10^{-11} ions start precipitating in the form of $\text{Mg}(\text{OH})_2$ from a solution of 0.001M Mg^{2+} ions? [AIEEE 2012]
(A) 9 (B) 10
(C) 11 (D) 8
- Q 10. Solid $\text{Ba}(\text{NO}_3)_2$ is gradually dissolved in a $1.0 \times 10^{-4} \text{ M Na}_2\text{CO}_3$ solution. At what concentration of Na_2CO_3 will a precipitate begin to form? (K_{sp} for $\text{BaCO}_3 = 5.1 \times 10^{-9}$) [JEE Main 2014]
(A) $5.1 \times 10^{-5} \text{ M}$ (B) $8.1 \times 10^{-8} \text{ M}$
(C) $8.1 \times 10^{-7} \text{ M}$ (D) $4.1 \times 10^{-5} \text{ M}$
- Q 11. Equal volumes of 0.002M solutions of sodium iodate and cupric chlorate are mixed together. Will it lead to precipitation of copper iodate? (Cupric iodate: $K_{\text{sp}} = 7.4 \times 10^{-8}$) [NCERT]
- Q 12. The precipitate of CaF_2 ($K_{\text{sp}} = 1.7 \times 10^{-10}$) is obtained when equal volume of following are mixed
(A) $10^{-4} \text{ M Ca}^{2+} + 10^{-4} \text{ M F}^-$
(B) $10^{-2} \text{ M Ca}^{2+} + 10^{-3} \text{ M F}^-$
(C) $10^{-5} \text{ M Ca}^{2+} + 10^{-3} \text{ M F}^-$
(D) $10^{-3} \text{ M Ca}^{2+} + 10^{-5} \text{ M F}^-$
- Q 13. What is the maximum pH required to prevent the precipitation of ZnS in a solution i.e., 0.01M ZnCl_2 and saturated with 0.1 M MH_2S ?
 $K_{\text{sp}}(\text{ZnS}) = 10^{-21}, K_{\text{a}_1} \times K_{\text{a}_2}(\text{H}_2\text{S}) = 10^{-20}$
(A) 4 (B) 3
(C) 2 (D) 1
- Q 14. A solution containing $[\text{Cl}^-] = [\text{Br}^-] = [\text{I}^-] = 10^{-2} \text{ M}$ (initially) To this solution AgNO_3 is gradually added. What is the concentration ratio of $[\text{I}^-]$ & $[\text{Cl}^-]$ where AgBr starts precipitating?
(A) 10^{-2} (B) 10^{-6}
(C) 10^{-4} (D) 10^4
- Q 15. Solubility product of $\text{Ba}(\text{OH})_2$ and $\text{Al}(\text{OH})_3$ are 1.8×10^{-10} and 2.4×10^{-20} respectively. If equal concentration of both Al^{3+} and Ba^{+2} ions are present in a solution, which one will be precipitated on addition of ammonium hydroxide solution
(A) $\text{Ba}(\text{OH})_2$ (B) $\text{Al}(\text{OH})_3$
(C) Both are precipitated at same time
(D) Both are not precipitated

15. Complex Ion Equilibrium

- Q 1. In which of the following solvents is silver chloride most soluble? [NCERT Exemplar]
(A) $0.1 \text{ mol dm}^{-3} \text{ AgNO}_3$ solution
(B) $0.1 \text{ mol dm}^{-3} \text{ HCl}$ solution
(C) H_2O
(D) Aqueous ammonia
- Q 2. $\text{Ag}^+ + \text{NH}_3 \rightleftharpoons [\text{Ag}(\text{NH}_3)^+]$; $K_1 = 3.5 \times 10^{-3}$
 $[\text{Ag}(\text{NH}_3)^+] + \text{NH}_3 \rightleftharpoons [\text{Ag}(\text{NH}_3)_2^+]$
 $K_2 = 1.7 \times 10^{-3}$ [IIT JEE 2006]

Then formation constant of $[\text{Ag}(\text{NH}_3)_2]^+$ is

- (A) 6.08×10^{-6} (B) 6.08×10^6
 (C) 6.08×10^{-9} (D) None of these

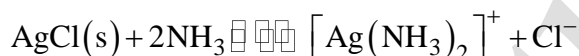
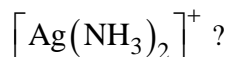
- Q3. Precipitated silver chloride dissolves in hydrochloric acid as a result of the formation of the AgCl_2^- ion. What is the molar solubility of silver chloride in 1.0 M $\text{HCl}(\text{aq})$?

$$K_{\text{sp}}(\text{AgCl}) = 1.6 \times 10^{-10},$$

$$K_f[\text{AgCl}_2^-] = 2.5 \times 10^5$$

- (A) $4 \times 10^{-5} \text{ M}$ (B) $4 \times 10^{-7} \text{ M}$
 (C) $4 \times 10^{-8} \text{ M}$ (D) $4.0 \times 10^{-6} \text{ M}$

- Q 4. What is the minimum mole of ammonia which must be added to 1.0 L of solution in order to dissolve 0.10 mol silver chloride by forming



$$K_{\text{sp}}(\text{AgCl}) = 10^{-9} \quad K_f[\text{Ag}(\text{NH}_3)_2]^+ = 10^8$$

- (A) 1.032 (B) 0.516
 (C) 0.258 (D) 2.64

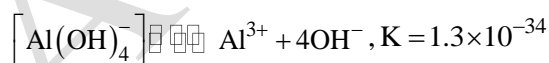
- Q 5. At what minimum pH will $1.0 \times 10^{-3} \text{ mol}$ of



- (A) 10.2 (B) 8.3
 (C) 12.4 (D) 9.41

- Q 6. At what maximum pH will $1.0 \times 10^{-3} \text{ mol}$ of $\text{Al}(\text{OH})_3$ go into 1L solution as Al^{3+} ?

$$\text{Give } K_{\text{sp}}[\text{Al}(\text{OH})_3] = 5.0 \times 10^{-33} \text{ and for}$$



- (A) 3.1 (B) 5.2
 (C) 4.23 (D) 6.4

- Q 7. H_2S gas when passed through solution of cations containing HCl precipitates the cations in second

group in qualitative analysis but not those belonging to the fourth group. It is because

[CBSE PMT 2005]

- (A) Presence of HCl decreases sulphide ion conc.
 (B) Presence of HCl increases sulphide ion conc.
 (C) Solubility product of Group II sulphides is more than that of Group IV sulphides.
 (D) Sulphides of Group IV cations are unstable in HCl

- Q 8. When H_2S is passed through the HCl containing aqs solution of CuCl_2 , HgCl_2 , BiCl_3 & CoCl_2 , it does not precipitate out [AIIMS 2007]

- (A) CuS (B) HgS
 (C) Bi_2S_3 (D) CoS

- Q 9. **Assertion (A):** Sb_2S_3 is not soluble in yellow ammonium sulphide.

Reason (R): The common ion effect due to S^{2-} ions reduces the solubility of Sb_2S_3 [AIIMS 2006]

- (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false

- Q 10. **Assertion (A):** $\text{Sb}(\text{III})$ is not precipitated as sulphide when in it alkaline solution H_2S is passed. [AIIMS 2004]

Reason (R): The concentration of S^{2-} ion in alkaline medium is inadequate for precipitation

- (A) Both A and R are true and R is the correct explanation of A
 (B) Both A and R are true but R is not the correct explanation of A
 (C) A is true but R is false
 (D) Both A and R are false

- Q 11. The ionization constant of benzoic acid is 6.46×10^{-5} and K_{sp} for silver benzoate is 2.5×10^{-13} . How many times is silver benzoate more soluble in a buffer of pH 3.19 compared to its solubility in pure water? [NCERT]

Answer Key

1. Concepts of Acid & Base

- (1). D (2). C (3). C
 (4). D (5). B (6). A
 (7). D (8). A (9). C
 (10). B (11). A,C,D (12). D

2. K_a & K_b of acid & Base, K_w of H_2O

- (1). A (2). C (3). C
 (4). A (5). B (6). B
 (7). A (8). D (9). B
 (10). A (11). D (12). D
 (13). A

3. pH & pOH, Acidic & Basic Solution

- (1). A (2). B (3). C
 (4). A (5). D (6). C
 (7). A (8). A (9). A
 (10). B (11). D (12). A
 (13). B (14). C (15). B

4. pH of Strong Acid & Strong Base Solution

- (1). B (2). B (3). C
 (4). C (5). C (6). B
 (7). B (8). C (9). B
 (10). C (11). B (12). B
 (13). D (14). C (15). A
 (16). B

5. pH of Weak Acid & Weak Base Solution,

Mixture of Acid Solution

- (1). B (2). C (3). B
 (4). D (5). C (6). A
 (7). A (8). D
 (9). $[H^+] = [F^-] = 2.4 \times 10^{-3} M$,
 $[HF] = 17.6 \times 10^{-3} M$, $\alpha = 0.12$, $pH = 2.52$
 (10). $K_a = 1.0 \times 10^{-8}$, $pK_a = 8$
 (11). $K_b = 8.96 \times 10^{-7}$, $pK_b = 6.04$

- (12). C (13). B (14). C
 (15). D (16). A (17). B
 (18). D (19). A (20). B
 (21). D

6. pH of Polybasic Acid Solution

- (1). A (2). B (3). C
 (4). D (5). B (6). B
 (7). A (8). C (9). B
 (10). C (11). C
 (12). $[HS^-] = 9.54 \times 10^{-5}$, 9.1×10^{-8}
 $[S^{2-}] = 6.5 \times 10^{-8}$, 1.09×10^{-19}

7. pH of Salts Solution – Part I

- (1). 1.5×10^{-11} , 5.6×10^{-11} , 2.08×10^{-6}
 (2). A (3). B
 (4). A (5). C (6). C
 (7). C (8). B (9). B
 (10). D (11). D (12). A
 (13). D (14). C (15). B
 (16). B (17). A (18). B
 (19). D (20). A

8. pH of Salts Solution – Part II,
Common Ion effect

- (1). A (2). B (3). B
 (4). A (5). C (6). A
 (7). A – 4, B – 3, C – 2, D – 1
 (8). C (9). A (10). B
 (11). D (12). 2.2×10^{-6} , 10^{-8}
 (13). A

9. pH of Buffer Solution

- (1). A (2). C (3). B
 (4). C (5). A (6). C
 (7). A (8). C (9). A
 (10). D (11). A (12). B
 (13). B (14). C (15). A

- (16). B (17). A (18). C
 (19). C (20). C
 (21). $\text{pH}_i = 11.12$, $\text{pH}_f = 9.24$

10. Buffer Capacity of Buffer Solution

- (1). C (2). D (3). B
 (4). A (5). C (6). C
 (7). D (8). D (9). C
 (10). D (11). C (12). D
 (13). D

11. Titration & pH Curve

- (1). A (2). B (3). B
 (4). C (5). B (6). A
 (7). C (8). C (9). D
 (10). A (11). B (12). C
 (13). B (14). B

12. Acid – Base Indicator

- (1). A (2). C (3). D
 (4). B (5). D (6). C
 (7). C (8). C (9). C
 (10). A (11). A (12). B
 (13). A

13. Solubility Product

- (1). C (2). C (3). C
 (4). C (5). A (6). C
 (7). B (8). B (9). B
 (10). C (11). B (12). A
 (13). $[\text{Ni}^{2+}] = 2.0 \times 10^{-13} \text{ M}$,
 (14). A (15). B (16). D

14. Relative Solubility & Precipitation of Solid

- (1). C (2). A (3). A
 (4). S $[\text{Ni}(\text{OH})_2] > \text{S} [\text{AgCN}]$
 (5). $[\text{Sr}^{2+}] = 0.16 \text{ M}$, $[\text{OH}^-] = 0.32$, $\text{pH} = 13.5$
 (6). D (7). A (8). B
 (9). B (10). A (11). Yes
 (12). B (13). D (14). C
 (15). B

15. Complex Ion Equilibrium

- (1). D (2). A (3). A
 (4). B (5). D (6). C
 (7). A (8). D (9). D
 (10). D (11). $\sqrt{11}$