KATTAR NEET (2026)

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Ionic Equilibrium

Q1 Conjugate acid of PO_4^{-3} is:

(A) H_3PO_4 (B) $H_2PO_4^-$

(C) HPO_4^{-2} (D) HPO_3^-

Q2 At infinite dilution, the percentage ionisation for both strong and weak electrolytes is;

(A) 1% (B) 20%

(C) 50% (D) 100%

Q3 The dissociation constants of HCN and HOCl are 5×10^{-10} and 2×10^{-4} respectively. The equilibrium constant for the reaction

$CN^- + HOCl \rightleftharpoons OCl^- + HCN$ is:

(A) 4×10^5

(B) 2.5×10^{-6}

(C) 4×10^{-5}

(D) 1×10^6

Q4 1 L of a solution of pH = 2 and 9 L of a solution of pH = 3 are mixed then pH of final solution is: (log 1.9 = 0.28)

(A) 0.72 (B) 1.72

(C) 2.72 (D) 3.72

Q5 The pH of 0.01 M of HCOOH is:

[K_a of HCOOH = 2×10^{-4}, log 1.41 = 0.15]

(A) 2 (B) 3.15

(C) 3.5 (D) 2.85

Q6 The solubility of CaF_2 is 2×10^{-4} moles/litre. its solubility product (K_{sp}) is;

(A) 2.0×10^{-4}

(B) 4.0×10^{-3}

(C) 8.0×10^{-12}

(D) 3.2×10^{-11}

Q7 10^{-6} M NaOH is diluted by 100 times. The pH of diluted base is:

(A) Between 6 and 7

(B) Between 10 and 11

(C) Between 7 and 8

(D) Between 5 and 6

Q8 K_a for hydrofluoric acid is 6.9×10^{-4}. What is the equilibrium constant K for the following reaction?

$F^-_{(aq.)} + H_2O_{(l)} \rightleftharpoons HF_{(aq.)} + OH^-_{(aq.)}$

(A) 6.9×10^{-11}

(B) 1.4×10^{-11}

(C) 2.6×10^{-9}

(D) 8.3×10^{-6}

Q9 Match the following

Column I (Sample)		Column II (pH)	
(A)	Basic Buffer	(I)	$pk_a + \log\frac{[salt]}{[acid]}$
(B)	Salt of strong acid and weak base	(II)	$\frac{pk_w + pk_a + \log C}{2}$
(C)	Salt of weak acid and strong base	(III)	$\frac{pk_w - pk_b - \log C}{2}$
(D)	Acid Buffer	(IV)	$14 - pk_b - \log\frac{[salt]}{base}$

Choose the **correct** answer from the options given below.

(A) A-III, B-I, C-IV, D-II

(B) A-IV, B-III, C-II, D-I

(C) A-III, B-IV, C-II, D-I

(D) A-IV, B-III, C-I, D-II

Q10 The precipitate of CaF_2 ($K_{sp} = 1.7 \times 10^{-10}$) is obtained by mixing equal volumes of which of the following?

(A) 10^{-4} M Ca^{2+} + 10^{-4} M F^-

(B) 10^{-2} M Ca^{2+} + 10^{-3} M F^-

(C) 10^{-5} M Ca^{2+} + 10^{-3} M F^-

(D) 10^{-3} M Ca^{2+} + 10^{-5} M F^-

Q11 If the degree of ionization of water be 1.8 $\times 10^{-9}$ at 298 K. Its ionization constant will be
(A) 1.8×10^{-16}
(B) 1×10^{-14}
(C) 1×10^{-16}
(D) 1.67×10^{-14}

Q12 When a solution of benzoic acid was titrated with NaOH, the pH of the solution when half the acid neutralized was 4.2. Dissociation constant of the acid is
(A) 6.31×10^{-5}
(B) 3.2×10^{-5}
(C) 8.7×10^{-8}
(D) 6.42×10^{-4}

Q13 10^{-2} mole of NaOH was added to 10 litre of water. The pH will change by
(A) 3 (B) 4
(C) 7 (D) 11

Q14 pH of $Ba(OH)_2$ solution is 12. Its solubility product is
(A) $10^{-6} M^3$
(B) $4 \times 10^{-6} M^3$
(C) $0.5 \times 10^{-7} M^3$
(D) $5 \times 10^{-7} M^3$

Q15 The hydrolysis constant for $ZnCl_2$ will be;
Where K_b is effective dissociation constant of base Zn^{2+}
(A) $K_h = \frac{K_w}{K_b}$ (B) $K_h = \frac{K_w^2}{K_b^2}$
(C) $K_h = \frac{K_w^2}{K_b}$ (D) $K_h = \frac{K_b}{K_w^2}$

Q16 The strongest Bronsted base in the following anion is
(A) ClO^- (B) ClO_2^-
(C) ClO_3^- (D) ClO_4^-

Q17 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A: $BaCO_3$ is more soluble in HNO_3 than in plain water.
Reason R: Carbonate is a weak base and reacts with the H^+ from the strong acid, casuing the barium salt to dissociate.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) A is true but R is false.
(B) A is false but R is true.
(C) Both A and R are true and R is the correct explanation of A.
(D) Both A and R are true but R is NOT the correct explanation of A.

Q18 Dissociation constant of a weak acid is 1×10^{-4}. Equilibrium constant of its reaction with strong base is
(A) 1×10^{-4}
(B) 1×10^{10}
(C) 1×10^{-10}
(D) 1×10^{14}

Q19 The pH value of 0.1 M HCl is approximately 1. What will be the approximate pH value of 0.05 M H_2SO_4?
(A) 0.05 (B) 0.5
(C) 1 (D) 2

Q20 Which one has pH = 12?
(A) 0.01M KOH (B) 1M KOH
(C) 1N NaOH (D) 1M $Ca(OH)_2$

Q21 At 90°C pure water has $[H_3O^+] = 10^{-6}$ M, the value of K_w at this temperature will be;
(A) 10^{-6} (B) 10^{-12}
(C) 10^{-14} (D) 10^{-8}

Q22 Any precipitate is formed when
(A) Solution becomes saturated
(B) The value of ionic product is less that than the value of solubility product
(C) The value of ionic product is equal to the value of solubility product
(D) The value of ionic product is greater than the value of solubility product

Q23 The solubility product of $BaSO_4$ is 1.5×10^{-9}. The precipitation in a 0.01 M Ba^{2+} solution will

start, on adding H_2SO_4 of concentration;
(A) $1.5 \times 10^{-9} M$
(B) $1.5 \times 10^{-8} M$
(C) $1.5 \times 10^{-7} M$
(D) $1.5 \times 10^{-10} M$

Q24 Ionic product of water increases, if
(A) Pressure is reduced
(B) H^+ is added
(C) OH^- is added
(D) Temperature increases

Q25 Which hydroxide will have lowest value of solubility product at normal temperature $(25^{\circ}C)$
(A) $Mg(OH)_2$ (B) $Ca(OH)_2$
(C) $Ba(OH)_2$ (D) $Be(OH)_2$

Q26 Which of the following salts undergoes hydrolysis?
(A) CH_3COONa (B) KNO_3
(C) NaCl (D) K_2SO_4

Q27 The pH of an aqueous solution of 0.1M solutionof a weak monoprotic acid which is 1% ionised is;
(A) 1 (B) 2
(C) 3 (D) 11

Q28 An example of a Lewis acid is
(A) NaCl (B) H_2O
(C) $AlCl_3$ (D) NH_3

Q29 Review the equilibrium and choose the **correct** statement
$$HClO_4 + H_2O \rightleftharpoons H_3O^+ + ClO_4^-$$
(A) $HClO_4$ is the conjugate acid of H_2O
(B) H_3O^+ is the conjugate base of H_2O
(C) H_3O is the conjugate acid of H_3O^+
(D) ClO_4^- is the conjugate base of $HClO_4$

Q30 If α is the degree of ionization, C the concentration of a weak electrolyte (HCN) and K_a the acid ionization constant, then the correct relationship between α, C and K_a is:
(A) $\alpha^2 = \sqrt{\frac{K_a}{C}}$ (B) $\alpha^2 = \sqrt{\frac{C}{K_a}}$
(C) $\alpha = \sqrt{\frac{K_a}{C}}$ (D) $\alpha = \sqrt{\frac{C}{K_a}}$

Q31 The pH of 0.01 M NH_4Cl solution will be [Given: K_b of $NH_4OH = 10^{-5}$]
(A) 8.5 (B) 6.5
(C) 5.5 (D) 11.5

Q32 Given below are two statements:
Statement I: In aqueous solution H^+ may exist as $H_5O_2^+$
Statement II: Autoprotolysis constant of water increases with increase in temperature.
In the light of the above statements, choose the most appropriate answer from the options given below:
(A) Statement I is correct but Statement II is incorrect.
(B) Statement I is incorrect but Statement II is correct.
(C) Both Statement I and Statement II are correct.
(D) Both Statement I and Statement II are incorrect.

Q33 If the solubility of $Ni(OH)_2$ in water is S $molL^{-1}$ then the expected solubility of $Ni(OH)_2$ in a buffer solution of pH = 13 will be
(A) 200 S^3 M (B) 50 S^3 M
(C) 100 S^3 M (D) 400 S^3 M

Q34 When equal volume of following solutions are mixed precipitation of AgCl ($K_{sp} = 1.8 \times 10^{-18}$) will occure in which option?
(A) 10^{-9} M Ag^+ and 10^{-9} M Cl^-
(B) 10^{-7} M Ag^+ and 10^{-7} M Cl^-
(C) 10^{-5} M Ag^+ and 10^{-5} M Cl^-
(D) 10^{-3} M Ag^+ and 10^{-3} M Cl^-

Q35 If dissociation constant (Ka) of 0.1 M HA is 4×10^{-6}, then the dissociation constant of A^- will be;
(A) 2.5×10^{-9}
(B) 5×10^{-8}
(C) 2.5×10^{-10}
(D) 5×10^{-9}

Q36 A certain weak acid has a dissociation constant 1×10^{-6}. The equilibrium constant for its reaction with a strong base is;

(A) 10^8 (B) 10^6

(C) 10^4 (D) 10^{12}

Q37 Solubility product (K_{sp}) of salts MX, MX_2, and M_3X are 4×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15} respectively. The solubility order of the salts is;

(A) $MX > MX_2 > M_3X$

(B) $MX > M_3X > MX_2$

(C) $M_3X > MX_2 > MX$

(D) $M_3X > MX > MX_2$

Q38 At T K, pure water has $[H_3O^+] = 10^{-8}$ M. The K_w of water at T K is;

(A) 10^{-14} M^2 (B) 10^{-8} M^2

(C) 10^{-16} M^2 (D) 10^{-12} M^2

Q39 Match List-I with List-II:

List-I (Solution)		List-II (pH)	
A.	0.5 M HF ($K_a = 2 \times 10^{-4}$)	I.	13
B.	0.5 M $Ba(OH)_2$	II.	12.3
C.	10^{-8} M HCl	III.	2
D.	0.02 M NaOH	IV.	6.95

Choose the **correct** answer from the options given below:

(A) A-III, B-II, C-I, D-IV

(B) A-III, B-I, C-IV, D-II

(C) A-II, B-III, C-IV, D-I

(D) C-II B-I C-III D-IV

Q40 How much water from 4 L of 10^{-3} M HCl should be evaporated to change its pH by 2 units?

(A) 3.96 L (B) 2.24 L

(C) 1.42 L (D) 0.84 L

Q41 Amongest the following, the total number of compounds whose aqueous solution turns blue litmus paper red is

Na_2SO_4, $Zn(NO_3)_2$, $FeCl_3$, K_2CO_3, KCl

(A) 5 (B) 4

(C) 3 (D) 2

Q42 Given below are two statements:

Statement I: $(CH_3)_3B$ behaves as an Lewis acid.

Statement II: NH_2^- can not exits in equeous solution.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct.

(D) Both Statement I and Statement II are incorrect.

Q43 The pH of a resulting solution obtained by mixing 400 ml of 0.1 M HCl and 100 ml of 0.3 M H_2SO_4 will be nealy;

(A) 2.3 (B) 0.7

(C) 0.3 (D) 1.3

Q44 pH of 0.01 M $(CH_3COO)_2Ca$ solution is; (given: pK_a of $CH_3COOH = 4.74$)

(A) 8.5 (B) 9.2

(C) 10.6 (D) 7.4

Q45 Which pair of electrolytes will show common ion effect?

(A) HCl + HNO_3 (B) NaOH + HCN

(C) CH_3COOH + HNO_3 (D) NaOH + KOH

Q46 Ostwald dilution Law is applicable for an aqueous solution of;

(A) NaOH (B) H_2SO_4

(C) HNO_3 (D) NH_4OH

Q47 Given below are two statements:

Statement I: The degree of hydrolysis of aqueous solution of NH_4CN does not depends on concentration of salt.

Statement II: Blood behave as buffer solution.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.
(C) Both Statement I and Statement II are correct.
(D) Both Statement I and Statement II are incorrect.

Q48 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A: $I^- + I_2 \rightarrow I_3^-$, is an example of Lewis acid- lewis base reaction.
Reason R: I^- can donate a pair of electron while I_2 can accept a pair of electron.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) A is true but R is false.
(B) A is false but R is true.
(C) Both A and R are true and R is the correct explanation of A.
(D) Both A and R are true but R is NOT the correct explanation of A.

Q49 10 mL of 0.1 M H_2SO_4 solution is added to 30 mL of 0.2 M NH_4OH solution. The pH of resultant solution will be: (Given: pK_b of NH_4OH = 4.7)
(A) 9.6 (B) 10.2
(C) 8.4 (D) 11.8

Q50 Concentration of S^{2-} in a solution containging 0.1 M HCl and 0.2 M H_2S will be; [Given: for H_2S, K_{a1} = 1.4×10^{-7} and $K_{a2} = 1 \times 10^{-14}$]
(A) 1×10^{-14} M
(B) 1.4×10^{-22} M
(C) 2.8×10^{-20} M
(D) 1.4×10^{-20} M

Q51 Which of the following solutions will have pH close to 1.0?
(A) 75 mL of 0.2 M HNO_3 + 25 mL of 0.2 M NaOH
(B) 10 mL of 0.1 M HNO_3 + 90 mL of 0.1 M NaOH
(C) 55 mL of 0.1 M HNO_3 + 45 mL of 0.1 M NaOH
(D) 100 mL of 0.1 M HNO_3 + 100 mL of 0.1 M NaOH

Q52 Identify conjugate acid-base pair among the following:
(A) HPO_3^{2-} and $H_2PO_2^-$
(B) $H_2PO_4^-$ and HPO_3^{2-}
(C) PO_4^{3-} and HPO_4^{2-}
(D) H_3PO_4 and $H_2PO_3^-$

Q53 Solubility of AgCl will be maximum is;
(A) pure H_2O (B) 0.1 M NaCl
(C) 0.1 M NH_3 (D) 0.2 M $AgNO_3$

Q54 The **correct** increasing order of pH for 0.1 M aq. solution of given electrolytes is;
(A) NaCl < HCl < NH_4Cl < NaCN < NaOH
(B) HCl < NH_4Cl < NaOH < NaCN < NaCl
(C) HCl < NH_4Cl < NaCl < NaCN < NaOH
(D) NH_4Cl < NaCN < NaCl < HCl < NaOH

Q55 The degree of dissociation of weak acid (HA) having pH = 3 of its 0.1 M aq. solution is;
(A) 1% (B) 0.1%
(C) 10% (D) 0.01%

Q56 If Hydronium ion concentration in an aq. solution of H_2SO_4 is 1×10^{-4} M at 25°C. The hydroxide ion concentration in the solution will be;
(A) zero
(B) 0.5×10^{-10} M
(C) 1×10^{-4} M
(D) 1×10^{-10} M

Q57 **Correct** order regarding acidic strenth is;
(A) HCl > HI
(B) $H_2O > H_2S$
(C) NH_3 > HF
(D) HBr > H_2O

Q58 Weakest base among the following is;
(A) H^- (B) HCO_3^-
(C) Cl^- (D) OH^-

Q59 What concentration of Ag^+ ion in aqueous solution will just fail to give a precipitate of Ag_2CrO_4 which contain 3×10^{-4} M CrO_4^{2-} ion? (Given: K_{sp} of $Ag_2CrO_4 = 1.2 \times 10^{-11}$)
(A) 2×10^{-4} M
(B) 1×10^{-4} M
(C) 2×10^{-3} M

(D) 1×10^{-2} M

Q60 pH of 0.1 M aq. H_2CO_3 solution is; [given: K_{a_1} = 4 $\times 10^{-3}$ and K_{a_2} = 9×10^{-6}]

(A) 1.7 (B) 2.7

(C) 1.3 (D) 2.1

Answer Key

Q1	(C)
Q2	(D)
Q3	(A)
Q4	(C)
Q5	(D)
Q6	(D)
Q7	(C)
Q8	(B)
Q9	(B)
Q10	(B)
Q11	(A)
Q12	(A)
Q13	(B)
Q14	(D)
Q15	(C)
Q16	(A)
Q17	(C)
Q18	(B)
Q19	(C)
Q20	(A)
Q21	(B)
Q22	(D)
Q23	(C)
Q24	(D)
Q25	(D)
Q26	(A)
Q27	(C)
Q28	(C)
Q29	(D)
Q30	(C)
Q31	(C)
Q32	(C)
Q33	(D)
Q34	(D)
Q35	(A)
Q36	(A)
Q37	(B)
Q38	(C)
Q39	(B)
Q40	(A)
Q41	(D)
Q42	(C)
Q43	(B)
Q44	(A)
Q45	(C)
Q46	(D)
Q47	(C)
Q48	(C)
Q49	(A)
Q50	(C)
Q51	(A)
Q52	(C)
Q53	(C)
Q54	(C)
Q55	(A)
Q56	(D)
Q57	(D)
Q58	(C)
Q59	(A)
Q60	(A)

Hints & Solutions

Q1 Text Solution:

$PO_4^{3-} + H^+ \rightarrow HPO_4^{2-}$

Q2 Text Solution:

At infinite dilution, even weak electrolytes ionize completely, so both strong and weak electrolytes show 100% ionization.

Q3 Text Solution:

$HCN \rightleftharpoons H^+ + CN^-, K_1 = 5 \times 10^{-10}$

$HOCl \rightleftharpoons H^+ + OCl^-, K_2 = 2 \times 10^{-4}$

$CN^- + HOCl \rightleftharpoons OCl^- + HCN,$

$K = \frac{K_2}{K_1} = 4 \times 10^5$

Q4 Text Solution:

$[H^+] = \frac{10^{-2}\times1+10^{-3}\times9}{10} = 1.9 \times 10^{-3}$

pH = 2.72

Q5 Text Solution:

$[H^+] = \sqrt{K_a C}$

$= \sqrt{2 \times 10^{-4} \times 0.01}$

$= \sqrt{2} \times 10^{-3}$

pH = – log[H⁺] = 3 – $\frac{1}{2} \times 0.3 = 2.85$

Q6 Text Solution:

Dissociation of CaF_2 in water:

$CaF_2 \leftrightarrow Ca^{2+} + 2F^-$

Let solubility S = 2×10^{-4}

$[Ca^{2+}] = S = 2 \times 10^{-4}$

$[F^-] = 2S = 4 \times 10^{-4}$

Now,

$K_{sp} = [Ca^{2+}] \cdot [F^-]2 = (2 \times 10^{-4}) \cdot (4 \times 10^{-4})^2$

$= 2 \times 10^{-4} \cdot 16 \times 10^{-8}$

$= 32 \times 10^{-12}$

$= 3.2 \times 10^{-11}$

Q7 Text Solution:

$NaOH \rightarrow Na^+ + OH^-$

$[OH^-]$ after dilution from NaOH,

$= \frac{10^{-6}}{100} = 10^{-6} \times 10^{-2} = 10^{-8} M$

$[\overline{O}H_{total}] = 10^{-8} + 10^{-7}$

pOH = -log[OH]

$= -\log[10^{-8} + 10^{-7}],$

$= -\log[10^{-8}(1 + 10^1)],$

$= -\log[10^{-8}(11)],$

$= -(\log 10^{-8} + \log 11)$

$= (-1)(-8)\log 10 - \log 11$

= 8 - log11

= 6.96

pH= 14 - 6.96

= 7.04

Q8 Text Solution:

$F^- + H_2O \rightleftharpoons HF + OH^-$

$K = \frac{[HF][OH^-]}{[F^-][H_2O]}$

$K = \frac{K_W}{Ka} = \frac{10^{-14}}{6.9\times10^{-4}}$

$K = 1.4 \times 10^{-11}$

Q9 Text Solution:

(A) Basic buffer : $pKb + \log\frac{[salt]}{[base]} = pOH$

$= pKb + \log\frac{[salt]}{[base]} = 14 - pH$

$pH = 14 - pKb - \log\frac{[salt]}{[base]}$

$A \rightarrow IV$

(B) Salt of S.A. + W.B.

$pH = \frac{pK_w}{2} - \frac{1}{2}pKb - \frac{1}{2}\log C$

$B \rightarrow III$

(C) Salt of W.A. + S.B.

$pH = \frac{pKw}{2} + \frac{1}{2}pKa + \frac{1}{2}\log C$

$C \rightarrow II$

(D) Acidic Buffer

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

$D \rightarrow I$

Q10 Text Solution:

Precipitation occurs only when ionic product exceeds the value of solubility product.

When equal volumes of solutions containing Ca^{2+} and F^- are mixed, $[Ca^{2+}]$ and $[F^-]$ will be halved.

(a) Ionic product = $[Ca^{2+}][F^-]^2$

$= \left(\frac{1}{2}\times 10^{-4}\right)\left(\frac{1}{2}\times 10^{-4}\right)^2 = \frac{1}{8}\times 10^{-12} < \underset{(K_{sp}=1.7\times 10^{-10})}{}$

K_{sp}; no precipitation.

(b) Ionic product $=\left(\frac{1}{2}\times 10^{-2}\right)\left(\frac{1}{2}\times 10^{-3}\right)^2$

$=\frac{1}{8}\times 10^{-8} > K_{sp}$; precipitation.

(c) Ionic product $=\left(\frac{1}{2}\times 10^{-5}\right)\left(\frac{1}{2}\times 10^{-3}\right)^2$

$=\frac{1}{8}\times 10^{-11} < K_{sp}$; precipitation.

(d) Ionic product = $\left(\frac{1}{2}\times 10^{-3}\right)\left(\frac{1}{2}\times 10^{-5}\right)^2$

$=\frac{1}{8}\times 10^{-13} < K_{sp}$; no precipitation.

Q11 Text Solution:

$K_a = \frac{K_w}{[H_2O]} = \frac{10^{-14}}{55.5} = 1.8 \times 10^{-16}$

Q12 Text Solution:

$C_6H_5COOH + NaOH \rightleftharpoons C_6H_5COONa + H_2O$

After neutralization 0.5 0.5

It is a buffer solution of weak acid and its salt

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

$pK_a = 4.2$

$K_a = 6.31\times 10^{-5}$

Q13 Text Solution:

Old pH = 7

New $[OH^-] = 10^{-2}\times\frac{1}{10} = 10^{-3}$ M

$\therefore\ pOH = -\log(10^{-3})$

$= 3$

New pH = 11

Change in pH = 4

Q14 Text Solution:

Since pH = 12 $\therefore$ pOH = 14 – 12 = 2

$\therefore [OH^-] = 10^{-2}$M

We know $Ba(OH)_2 \rightleftharpoons Ba^{2+} + 2OH^-$

$\therefore [Ba^{2+}] = \frac{10^{-2}}{2}$ M

$\therefore K_{SP} = [Ba^{2+}][OH^-]^2 = \left(\frac{10^{-2}}{2}\right)\times(10^{-2})^2$

$= 5\times 10^{-7}M^3$

Q15 Text Solution:

$Zn^{2+} + 2H_2O \rightleftharpoons Zn(OH)_2 + 2H^+$

$\therefore K_h = \frac{[Zn(OH)_2][H^+]^2}{[Zn^{2+}]}$ ... (1)

$Zn(OH)_2 \rightleftharpoons Zn^{2+} + 2OH^-$

$\therefore K_b = \frac{[Zn^{2+}][OH^-]^2}{[Zn(OH)_2]}$, $K_w = [H^+][OH^-]$

$\therefore \frac{K_w^2}{K_b} = K_h$

Q16 Text Solution:

HClO is the weakest acid. Its conjugate base ClO^- is the strongest base.

Q17 Text Solution:

Barium carbonate is more soluble in HNO_3 than in water become carbonate is a weak base and reacts with the H^+ ion of HNO_3 causing the barium salt to dissociate.

$BaCO_3 + HNO_3 \rightarrow Ba(NO_3)_2 + CO_2 + H_2O$

Q18 Text Solution:

$K_H = \frac{K_a}{K_w} = \frac{10^{-4}}{10^{-14}} = \frac{1}{10^{-10}} = 10^{10}$

Q19 Text Solution:

$[H^+] = 0.05\times 2\ M = 0.1\ M$

$\therefore\ pH = 1$

Q20 Text Solution:

A **pH of 12** means the solution is **basic.**

pH + pOH = 14, so **pOH = 2** $\rightarrow [OH^-] = 10^{-2}$ = 0.01 M

So, we are looking for the solution that gives an **OH^- concentration of 0.01 M.**

Option A: **0.01 M KOH**

KOH is a **strong base**, fully dissociates:

$KOH \rightarrow K^+ + OH^-$

$[OH^-]$ = 0.01 M $\Rightarrow$ pOH = 2 $\Rightarrow$ pH = 14 – 2 = 12

Q21 Text Solution:

For pure water $[H^+] = [OH^-]$,

$\therefore K_w = 10^{-12}$

Q22 Text Solution:

Solubility Product (Ksp):

The maximum product of the ion concentrations that can exist in a solution without forming a precipitate at a given temperature.

Ionic Product (IP):

The actual product of ion concentrations in a solution at any moment.

Q23 Text Solution:

K_{sp} of $\mathrm{BaSO_4} = 1.5 \times 10^{-9}$;

$[\mathrm{Ba^{2+}}] = 0.01\ \mathrm{M}$

$[\mathrm{SO_4^{2-}}] = \frac{1.5\times10^{-9}}{0.01} = 1.5 \times 10^{-7}\mathrm{M}$

Q24 Text Solution:

The ionic product of water (Kw) is:

$$\mathrm{H_2O} \rightleftharpoons \mathrm{H^+} + \mathrm{OH^-}$$

- The self-ionization of water is an endothermic process.
- According to Le Chatelier's Principle, if temperature increases, the equilibrium shifts to the right (more ionization).
- This increases the concentration of H^+ and OH^- ions, hence increasing Kw.

Q25 Text Solution:

$Be(OH)_2$ has lowest solubility and hence lowest solubility product.

Q26 Text Solution:

Salt hydrolysis occurs when a salt reacts with water to produce either an acidic or basic solution. This typically happens when the salt is formed from a weak acid or weak base.

Q27 Text Solution:

HA	$\rightleftharpoons$	H^+	+	A^-
0.1		0		0
$0.1\left(1-\frac{1}{100}\right)$		$\frac{1\times0.1}{100}$		$\frac{1\times0.1}{100}$

$[H^+] = 10^{-3}$ $\therefore$ pH = 3

Q28 Text Solution:

A Lewis acid is a substance that can accept a pair of electrons to form a coordinate covalent bond.

Q29 Text Solution:

$$\underbrace{HClO_4 + H_2O \rightleftharpoons H_3O^+ + ClO_4^-}_{\text{Conjugate acid and base pair}}$$

Q30 Text Solution:

According to the Ostwald's dilution formula $\alpha^2 = \frac{K(1-\alpha)}{C}$. But for weak electrolytes α is very small. So that (1-α) can be neglected. So that $\alpha = \sqrt{\frac{K_a}{C}}$

Q31 Text Solution:

$pH = \frac{1}{2}[pK_w - pK_b - \log c]$

$= \frac{1}{2}[14 + \log(10^{-5}) - \log(10^{-2})]$

$= \frac{1}{2}[14 - 5 + 2]$

$= 5.5$

Q32 Text Solution:

- $\mathrm{H^+} \xrightarrow{\mathrm{H_2O}} \mathrm{H_3O^+} \xrightarrow{\mathrm{H_2O}} \mathrm{H_5O_2^+}$
- K_w of H_2O increases with increase in temperature.

Q33 Text Solution:

$\mathrm{Ni(OH)_2} \rightleftharpoons \mathrm{Ni^{2+}} + 2\,\mathrm{OH^-}$

S 2S

$K_{sp} = (S)(2S)^2 = 4S^3$

for pH = 13, pOH = 14 – 13 = 1

$\therefore [OH^-] = 10^{-1}$ M

$\therefore K_{sp} = (S^1)(10^{-1})^2$

$4S^3 = S^1 \times 10^{-2}$

$S^1 = 400\ S^3$ mol L^{-1}

Q34 Text Solution:

- ppt take place when, IP > K_{sp}
- On mixing equal volume, concentration become half.

$$\mathrm{Ag^+} + \mathrm{Cl^-} \rightarrow \mathrm{AgCl}$$
$$\mathrm{IP} = [\mathrm{Ag^+}][\mathrm{Cl^-}]$$

- (A): $\mathrm{IP} = \frac{10^{-9}}{2} \times \frac{10^{-9}}{2} = 2.5 \times 10^{-19}$
- (B): $\mathrm{IP} = \frac{10^{-7}}{2} \times \frac{10^{-7}}{2} = 2.5 \times 10^{-15}$
- (C): $\mathrm{IP} = \frac{10^{-5}}{2} \times \frac{10^{-5}}{2} = 0.25 \times 10^{-10}$
- (D): $\mathrm{IP} = \frac{10^{-3}}{2} \times \frac{10^{-3}}{2} = 2.5 \times 10^{-7}$

Q35 Text Solution:

For conjugate acid-base pair;

$K_aK_b = K_w$

$4 \times 10^{-6} \times K_b = 10^{-14}$

$K_b = 2.5 \times 10^{-9}$

Q36 Text Solution:

Anionic hydrolysis;

$$X^- + H_2O \overset{K_h}{\rightleftharpoons} HX + OH^-$$

$$HX + OH^- \overset{K}{\rightleftharpoons} X^- + H_2O$$

$$K = \frac{1}{K_h} = \frac{1}{\left(\frac{Kw}{Ka}\right)} = \frac{K_a}{K_w} = \frac{10^{-6}}{10^{-14}} = 10^8$$

Q37 Text Solution:

- $\mathrm{MX} : \mathrm{S}_1 = \sqrt{4 \times 10^{-8}} = 2 \times 10^{-4}\ \mathrm{M}$
- $\mathrm{MX}_2 : S_2 = \left(\frac{3.2 \times 10^{-14}}{4}\right)^{1/3}$
  $= 2 \times 10^{-5}\ \mathrm{M}$
- $M_3X : S_3 = \left(\frac{2.7 \times 10^{-15}}{27}\right)^{1/4} = 10^{-4}\ \mathrm{M}$
- $S_1 > S_3 > S_2$

Q38 Text Solution:

$K_w = [H^+]\,[OH^-] = 10^{-8} \times 10^{-8} = 10^{-16}\ M^2$

Q39 Text Solution:

- $\mathrm{HF} : \left[\mathrm{H}^+\right] = \sqrt{\mathrm{K_a C}}$
  $= \sqrt{2 \times 10^{-4} \times 0.5} = 10^{-2}\mathrm{M}$
  $\mathrm{pH} = -\log\left[10^{-2}\right] = 2$
- $Ba(OH)_2$: $[OH^-] = 2 \times 0.05 = 0.1$ M

  pH = $-\log[10^{-1}] = 1$
  pOH = 14 – 1 = 13
- HCl: $[H^+] = (10^{-7} + 10^{-8})$ M $= 1.1 \times 10^{-7}$ M

  pH = $-\log(1.1 \times 10^{-7}) = 6.95$
- NaOH: $[OH^-] = 2 \times 10^{-2}$ M

  pOH = $-\log[2 \times 10^{-2}] = 1.7$
  pH = 14 – 1.7 = 12.3

Q40 Text Solution:

When H_2O is evaporated, conc. of HCl increases so pH decreases.

$M_1V_1 = M_2V_2$

$10^{-3} \times 4 = 10^{-1}\, V_2$

$V_2 = 0.04$ L

$\therefore$ H_2O evaporated = (4 – 0.04) L = 3.96 L

Q41 Text Solution:

- Blue litmus paper turns red in acidic solution
- $Zn(NO_3)_2$ and $FeCl_3$ are salt of weaks base and strong acid so their aqueous solution are acidic.
- Na_2SO_4 and KCl are salt of strong base and strong acid so their aqueous solution are neutral.
- K_2CO_3 is salt of strong base and weak acid so its solution is basic in nature.

Q42 Text Solution:

- In $(CH_3)_3$ B, there are only 6 valence electrons on B so behaves as an Lewis acid.
- $\mathrm{NH_2^-} \xrightarrow{\mathrm{H_2O}} \mathrm{NH_3} + \mathrm{OH^-}$

Q43 Text Solution:

For H^+: $M_1V_1 + M_2V_2 = M_3V_3$

$0.1 \times 400 + 0.3 \times 2 \times 100 = M_3 \times 500$

$M_3 = 0.2$ M

pH = $-\log(0.2) = -\log(2 \times 10^{-1})$

= 1 – 0.3 = 0.7

Q44 Text Solution:

$[CH_3COO^-] = 0.01 \times 2 = 2 \times 10^{-2}$ M

$\mathrm{pH} = \frac{1}{2}(\mathrm{pK_w} + \mathrm{pK_a} + \log\mathrm{C})$

$\mathrm{pH} = \frac{1}{2}\left[14 + 4.74 + \log\left(2 \times 10^{-2}\right)\right]$

$\mathrm{pH} = \frac{1}{2}[18.74 - 2 + 0.3010]$

$\mathrm{pH} = 8.5$

Q45 Text Solution:

Common ion effect is obseved for a mixture containing weak electrolyte (CH_3COOH) and strong electrolyte (HNO_3), having a common ion (H^+)

Q46 Text Solution:

Ostwald dilution Law is applicable for weak electrolytes.

Q47 Text Solution:

- For a salt solution of weak acid and weak base:

$$\mathrm{h} = \sqrt{\frac{\mathrm{K_w}}{\mathrm{K_aK_b}}}$$

- Blood is an acidic buffer solution of H_2CO_3 and $\mathrm{HCO_3^-}$.

Q48 Text Solution:

$I^- + I_2 \rightarrow I_3^-$

I^-: Lewis base (electron rich)

I_2: Lewis acid (Vacant d – orbitals)

Q49 Text Solution:

$H_2SO_4 + 2NH_4OH \rightarrow (NH_4)_2SO_4 + 2H_2O$

(i) 2 meq 6meq – –

(f) – 4meq 2 meq

resulting solution will behave as an basic buffer.

$$pOH = pK_b + \log_{10}\frac{[salt]}{[base]}$$
$$= 4.7 + \log_{10}\left(\frac{2}{4}\right)$$
$$= 4.7 - 0.3010$$

$\therefore$ pH = 14 – 4.4 = 9.6

Q50 Text Solution:

$$H_2S \overset{K_a}{\rightleftharpoons} 2H^+ + S^{2-}$$
$$K_a = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$$
$$1.4 \times 10^{-7} \times 1 \times 10^{-14} = \frac{(0.1)^2(S^{2-})}{0.2}$$
$$[S^{2-}] = 2.8 \times 10^{-20} M$$

Q51 Text Solution:

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

75 mL of 0.2 M $HNO_3 \Rightarrow$ 15 mmol HCl

25 mL of 0.2 M NaOH $\Rightarrow$ 5 mmol HCl

final, mmol of HCl = 15 – 5 = 10 mol

$$[H^+] = \frac{10}{75+25} = 0.1\ M$$

pH = –log [0.1] = 1

Q52 Text Solution:

Conjugate acid-base pair differ in one H^+.

Q53 Text Solution:

- More the common ion effect, lesser will be solubility.

  Solubility: H_2O > NaCl > $AgNO_3$

- Since Ag^+ form complex with NH_3 so solubility will be more than solubiity in H_2O.

$$AgCl + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]Cl$$

Q54 Text Solution:

- HCl: strong acid: pH <<< 7
- NH_4Cl: NH_4OH + HCl: pH < 7

  WB SA

- NaCl: NaOH + HCl: pH = 7

  SB SA

- NaCN: NaOH + HCl: pH > 7

  SB WA

- NaOH: Strong base: pH >>>7

Q55 Text Solution:

$[H^+] = 10^{-pH} = 10^{-3}$ M

$[H^+] = C\alpha$

$10^{-3} = 0.1 \times \alpha$

$$\alpha = 10^{-2}$$
$$\%\alpha = 10^{-2} \times 100 = 1\%$$

Q56 Text Solution:

$[H^+][OH^-] = K_w$

$1 \times 10^{-4} \times [OH^-] = 10^{-14}$

$[OH^-] = 10^{-10}$ M

Q57 Text Solution:

Acidic strength: HF << HCl < HBr < HI

: $CH_4 < NH_3 < H_2O < HF$

: $H_2O < H_2S$

Q58 Text Solution:

- Stronger the acid, weaker will be its conjugate base.
- Acidic Nature: HCl > H_2CO_3 > H_2O > H_2
- Basic Nature: Cl^- < HCO_3^- < HO^- > H^-

Q59 Text Solution:

$$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$$
$$1.2 \times 10^{-11} = [Ag^+]^2 \times 3 \times 10^{-4}$$
$$[Ag^+]^2 = 4 \times 10^{-8}$$
$$[Ag^+] = 2 \times 10^{-4} M$$

Q60 Text Solution:

for polyprotic weak acids:

$$\left[H^{+}\right] = \sqrt{K_{a_1}C} = \sqrt{4 \times 10^{-3} \times 0.1}$$

$$= 2 \times 10^{-2}$$

$$\therefore \ pH = -\log\left[2 \times 10^{-2}\right]$$

$$= 2 - 0.3$$

$$= 1.7$$