EXERCISE – O

SINGLE CORRECT TYPE QUESTIONS

Acid Base Theory

1. The conjugate acid of $O^{2\ominus}$ ions is :

(A) $O_2^{\oplus}$ (B) $H^{\oplus}$ (C) $H_3O^{\oplus}$ (D) $OH^{\ominus}$

CIE099

2. Which ion does not show acidic behaviour :

(A) $[Al(H_2O)_6]^{3\oplus}$ (B) $[Fe(H_2O)_6]^{3\oplus}$ (C) $HPO_4^{2\ominus}$ (D) $ClO_3^{\ominus}$

CIE100

3. In the reaction $NH_3 + H_2O \rightleftharpoons NH_4^{\oplus} + OH^{\ominus}$, water behave as :

(A) Acid (B) Base (C) Neutral (D) Both acid & Base

CIE101

4. The conjugate base of $(CH_3)_2\overset{\oplus}{N}H_2$ is :

(A) CH_3NH_2 (B) $(CH_3)_2N^{\oplus}$ (C) $(CH_3)_2N$ (D) $(CH_3)_2NH$

CIE102

5. Weakest Bronsted Lowry base is :

(A) $H^{\ominus}$ (B) $OH^{\ominus}$ (C) $Cl^{\ominus}$ (D) $HCO_3^{\ominus}$

CIE103

6. Conjugate base of hydrazoic acid is :

(A) $HN_3^{\ominus}$ (B) $N_3^{\ominus}$ (C) $N^{3\ominus}$ (D) $N_2^{\ominus}$

CIE104

7. In the reaction $HNO_3 + H_2O \rightleftharpoons H_3O^{\oplus} + NO_3^{\ominus}$, the conjugate base of HNO_3 is :

(A) H_2O (B) $H_3O^{\oplus}$ (C) $NO_3^{\ominus}$ (D) $H_3O^{\oplus}$ and $NO_3^{\ominus}$

CIE105

8. For the reaction $NH_4^{\oplus} + S^{2\ominus} \rightleftharpoons NH_3 + HS^{\ominus}$, NH_3 and $S^{2\ominus}$ are a group of :

(A) Acids (B) Bases (C) Acid-base pair (D) None of these

CIE106

9. The conjugate acid of $NH_2^{\ominus}$ is

(A) NH_3 (B) NH_2OH (C) $NH_4^{\oplus}$ (D) N_2H_4

CIE107

10. Which of the following pair is Lewis acid & Lewis base & Product of these is also Lewis base

(A) BF_3, NH_3 (B) $SiCl_4$, $2Cl^{\ominus}$ (C) $CH_3^{\oplus}$, $^{\ominus}OC_2H_5$ (D) All of these

CIE108

Properties of water and pH scale

11. Ionic product of water will increase, if we :

(A) Decrease the pressure (B) Add $H^{\oplus}$

(C) Add $OH^{\ominus}$ (D) Increase the temperature

CIE109

12. At 25°C, the dissociation constant for pure water is given by :

(A) $(55.4\times10^{14})^{-1}$ (B) 1×10^{-14} (C) $\frac{1\times10^{-14}}{18}$ (D) None of these

CIE110

13. Choose the correct relation at T = 25°C

(A) $\frac{pH+pOH}{14}=7$ (B) pH + pOH = 14 (C) pOH = 14 + pH (D) pH = 14 + pOH

CIE111

14. The pH of H_2O at its boiling point :

(A) < 7 (B) > 7 (C) 7 (D) 0

CIE112

15. At 90°C, pure water has $[H_3O^{\oplus}] = 10^{-6.7}$ mol L^{-1} what is the value of K_w at 90°C:

(A) 10^{-6} (B) 10^{-12} (C) 10^{-67} (D) $10^{-13.4}$

CIE113

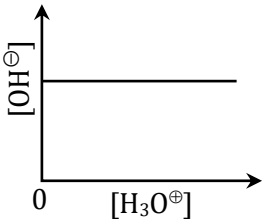
16. pH value of a solution, whose hydronium ion concentration is 6.2×10^{-9} mol/ℓ, is :-

(A) 6.21 (B) 7.21 (C) 7.75 (D) 8.21

CIE114

17. Which of the following graphs describes the relationship between $[H_3O^{\oplus}]$ and $[OH^{\ominus}]$ in an aqueous solution at a constant temperature ?

(A)



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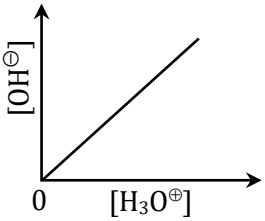
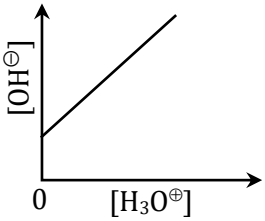
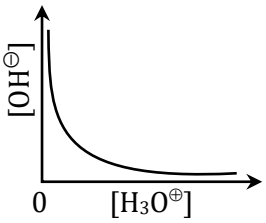


(C)



(D)



CIE115

18. In water, the bases NaOH, KOH, RbOH, CsOH and $Ba(OH)_2$ exhibit the same strength as they are completely ionised in water (an acid). This is called ..... of the solvent water.

(A) Strength (B) Capacity (C) Buffer effect (D) Levelling effect

CIE116

19. The pH of solution is increased from 3 to 6. Its $H^{\oplus}$ ion conc. will be :-

(A) Reduced to half (B) Doubled

(C) Reduced by 1000 times (D) Increased by 1000 times

CIE117

20. pOH of $[\frac{1}{200}]$ mol/m^3 H_2SO_4 (aq.) solution at 25°C is-

(A) 2 (B) 5 (C) 9 (D) 12 **CIE118**

21. What is the quantity of NaOH present in 250 cc of the solution, so that it gives a pH = 13 :-
(A) 10^{-13} g (B) 10^{-1} g (C) 1.0 g (D) 4.0 g

CIE126

22. Which one of the following has highest pH:-
(A) Distilled water (B) 1 M NH_3
(C) 1 M NaOH (D) Water saturated with chlorine

CIE127

23. 8 gm NaOH and 4.9 gm H_2SO_4 are present in one litre of the solution. What is its pH
(A) 1 (B) 13 (C) 12 (D) 2

CIE128

24. 10 ml of $\frac{M}{200}$ H_2SO_4 is mixed with 40 ml of $\frac{M}{200}$ H_2SO_4. The pH of the resulting solution is
(A) 1 (B) 2 (C) 2.3 (D) none of these

CIE134

25. Which of the following solution will have pH close to 1.0?
(A) 100 ml of M/100 HCl + 100 ml of M/10 NaOH
(B) 55 ml of M/10 HCl + 45 ml of M/10 NaOH
(C) 10 ml of M/10 HCl + 90 ml of M/10 NaOH
(D) 75 ml of M/5 HCl + 25 ml of M/5 NaOH

CIE135

26. Boric acid is a weak monoprotic acid. It ionizes in water as
$B(OH)_3 + H_2O \rightleftharpoons B(OH)_4^{\ominus} + H^{\oplus}$; $K_a = 5.9 \times 10^{-10}$
Calculate pH of 0.3 M boric acid is :
(A) 5.23 (B) 4.87 (C) 4.05 (D) 6.50

CIE183

Ostwald dilution Law and calculation of pH work acid or weak Base

27. Ostwald's dilution law is not applicable for strong electrolytes because:
(A) Strong electrolytes are completely ionised
(B) Strong electrolytes are volatile
(C) Strong electrolytes are unstable
(D) Strong electrolytes often contain metal ions

CIE119

28. The degree of ionisation of a compound depends upon :
(A) Size of the solute molecules (B) Nature of the solute molecules
(C) Nature of the container taken (D) The amount of current passed

CIE120

29. The pH of 0.15 M solution of HOCl ($K_a = 9.6 \times 10^{-6}$) is:
(A) 4.42 (B) 2.92 (C) 3.42 (D) None

CIE121

30. The molarity of nitrous acid at which its pH becomes 2. ($K_a = 4.5 \times 10^{-4}$) :
(A) 0.3333 (B) 0.4444
(C) 0.6666 (D) 0.2222

CIE122

31. Degree of dissociation of 0.1 N CH_3COOH is :- (Dissociation constant = 1×10^{-5})

(A) 10^{-5} (B) 10^{-4} (C) 10^{-3} (D) 10^{-2}

CIE123

32. The pH of a 0.02 M ammonia solution which is 5% ionised will be :-

(A) 2 (B) 11 (C) 5 (D) 7

CIE124

33. The concentration of $[H^{\oplus}]$ and concentration of $[OH^{\ominus}]$ of a 0.1 M aqueous solution of 2% ionised weak acid is [ionic product of water $=1 \times 10^{-14}$]

(A) 0.02×10^{-3} M and 5×10^{-11} M (B) 1×10^{-3} M and 3×10^{-11} M

(C) 2×10^{-3} M and 5×10^{-12} M (D) 3×10^{-2} M and 4×10^{-13} M

CIE125

Salt Hydrolysis

34. Hydroxyl ion concentration $[OH^{\ominus}]$ in the case of sodium acetate can be expressed as (where K_a is dissociation constant of CH_3COOH and C is the concentration of sodium acetate):

(A) $[OH^{\ominus}] = (CK_w.K_a)^{1/2}$ (B) $[OH^{\ominus}] = C.K_w\sqrt{K_a}$

(C) $[OH^{\ominus}] = \left(\frac{C.K_w}{K_a}\right)^{1/2}$ (D) $[OH^{\ominus}] = C.K_a.K_w$

CIE129

35. The highest pH value is of :

(A) 0.1 M NaCl (B) 0.1 M NH_4Cl

(C) 0.1 M CH_3COONa (D) 0.1 M CH_3COONH_4

CIE130

36. What will be the pH of 1.0 M ammonium formate solution. If $K_a = 1 \times 10^{-4}$, $K_b = 1 \times 10^{-5}$:

(A) 6.5 (B) 7.5 (C) 8.0 (D) 9.0

CIE131

37. At 90° C, the pH of 0.1M NaCl aqueous solution is :

(A) < 7 (B) > 7 (C) 7 (D) 0.1

CIE132

38. Which salt will not undergo hydrolysis :

(A) KCl (B) Na_2SO_4

(C) NaCl (D) All

CIE133

39. What is the percentage hydrolysis of NaCN in N/80 solution when the dissociation constant for HCN is 2×10^{-9} and $K_w = 1.0 \times 10^{-14}$

(A) 2 (B) 5.26 (C) 8.2 (D) 9.6

CIE136

40. The compound whose 0.1 M solution is basic is

(A) Ammonium acetate (B) Ammonium chloride

(C) Ammonium sulphate (D) Sodium acetate

CIE137

41. The pK_a of a weak acid, HA, is 4.80. The pK_b of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be :

(A) 8.58 (B) 4.79 (C) 7.01 (D) 9.22

CIE138

Buffer Solution

42. Henderson equation pH – pK_a = 1 will be applicable to an acidic buffer when :

(A) [Acid] = [Conjugate base] (B) [Acid] × 10 = [Conjugate base]

(C) [Acid] = [Conjugate base] × 10 (D) None of these

CIE146

43. When 0.02 moles of NaOH are added to a litre of buffer solution, its pH changes from 5.75 to 5.80. What is its buffer capacity :

(A) 0.4 (B) 0.05 (C) – 0.05 (D) 2.5

CIE147

44. Which of the following solutions does not act as buffer :–

(A) $H_3PO_4 + NaH_2PO_4$ (B) $NaHCO_3 + H_2CO_3$

(C) $NH_4Cl + HCl$ (D) $CH_3COOH + CH_3COONa$

CIE148

45. The pH of blood is maintained by CO_2 and H_2CO_3 in the body and chemical constituents of blood. This phenomenon is called :

(A) Colloidal (B) Buffer action (C) Acidity (D) Salt balance

CIE149

46. The buffer solution play an important role in :

(A) Increasing the pH value (B) Decreasing the pH value

(C) Keeping the pH constant (D) Solution will be neutral

CIE150

47. If equal volume of 0.05 M ammonium hydroxide solution is dissolved in 0.001 M ammonium chloride solution. What will be the $OH^{\ominus}$ ion concentration of this solution :

$K_b(NH_4OH) = 1.8 \times 10^{-5}$

(A) 3.0×10^{-3} (B) 4.6×10^{-4} (C) 9.0×10^{-3} (D) 9.0×10^{-4}

CIE151

48. Calculate the pH of a buffer prepared by mixing 600 cc of 0.6 M NH_3 and 400 cc of 0.5 M NH_4Cl. K_b for $NH_3 = 1.8 \times 10^{-5}$, (log 1.8 = 0.26)

(A) 11.3 (B) 9.0 (C) 9.52 (D) 5

CIE152

49. pK_b for NH_4OH at certain temperature is 4.74. The pH of basic buffer containing equimolar concentration of NH_4OH and NH_4Cl will be:-

(A) 7.74 (B) 4.74 (C) 2.37 (D) 9.26

CIE153

50. In a buffer solution the ratio of concentration of NH_4Cl and NH_4OH is 1 : 1. When it changes in 2 : 1, what will be the value of pH of buffer ?

(A) Increase (B) Decrease (C) No effect (D) None

CIE154

51. The total number of different kind of acidic buffers obtained during the titration of H_3PO_4 with NaOH are :

(A) 3 (B) 1 (C) 2 (D) 0

CIE155

Indicator and Titration

52. The rapid change of 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 concentrations of the conjugate acid (HIn) and base ($In^{\ominus}$) forms of the indicator by the expression :

(A) $\log\frac{[HIn]}{[In^{\ominus}]} = pK_{In} - pH$ (B) $\log\frac{[HIn]}{[In^{\ominus}]} = pH - pK_{In}$

(C) $\log\frac{[HIn]}{[In^{\ominus}]} = pH + pK_{In}$ (D) $\log\frac{[HIn]}{[In^{\ominus}]} = pK_{In} - pH$

CIE156

53. Calculate the pH range in which an acid indicator with K_{acid} (indicator) = 1.0×10^{-5} changes colour when the concentration of the indicator is 1×10^{-3} M.

(A) 5 ± 1 (B) 11 ± 1 (C) 3 ± 1 (D) 8 ± 1

CIE157

54. In what pH range will a 1×10^{-4} M solution of an indicator will K_b (indicator) = 1×10^{-11} change colour?

(A) 7.0 ± 1 (B) 3.0 ± 1 (C) 5.5 ± 1 (D) 11.0 ± 1

CIE158

55. Indicator which is used in the titration of CH_3COOH & NaOH :

(A) Methyl orange (B) Methyl red (C) Phenolphthalein (D) Litmus

CIE159

56. Phenolphthalein is a :

(A) Strong acid (B) Strong base (C) Weak base (D) Weak acid

CIE160

57. pH-range of Methyl red indicator is :

(A) 4·2–6·2 (B) 6·8–10·8 (C) 8 – 9·6 (D) 6·8 – 8·2

CIE161

58. At what pH does an indicator change colour if the indicator is a weak acid with $K_{ind} = 4 \times 10^{-4}$. For which one(s) of the following neutralizations would the indicator not be useful

(A) $NaOH + CH_3COOH$ (B) $HCl + NH_3$

(C) HCl + NaOH (D) None of the above

CIE162

59. In the volumetric estimation of HCl, if we make use of phenolphthalein as an indicator, which base is unsuitable for the titration :-

(A) NaOH (B) RbOH (C) KOH (D) NH_4OH

CIE163

60. Phenolphthalein does not act as an indicator for the titration between :-

(A) KOH and H_2SO_4 (B) NaOH and CH_3COOH

(C) Oxalic acid and $KMnO_4$ (D) $Ba(OH)_2$ and HCl

CIE164

61. For weak acid and strong base titration, the indicator used is :-

(A) Potassium di-chromate (B) Methyl orange

(C) Litmus (D) Phenolphthalein

CIE165

Solubility and solubility product

62. The values of K_{sp} for the slightly soluble salts MX and QX_2 are each equal to 4.0×10^{-18}. Which is the correct option.

(A) $S_1 > S_2$ (B) $S_1 < S_2$

(C) $S_1 = S_2$ (D) None of the above

CIE166

63. If the solubility of $PbBr_2$ is 'S' g molecules per litre, considering 100% ionisation its solubility product is :

(A) $2S^3$ (B) $4S^2$ (C) $4S^3$ (D) $2S^4$

CIE167

64. How many mole CuI ($K_{sp} = 5 \times 10^{-12}$) will dissolve in 1.0 L of 0.10 M NaI solution

(A) 6×10^{-11} (B) 5×10^{-11} (C) 8×10^{-11} (D) 7×10^{-11}

CIE168

65. A saturated solution of CaF_2 is found to contain 4×10^{-4} M fluoride ion. Calculate the K_{sp} of CaF_2. Neglect hydrolysis.

(A) 3.2×10^{-11} (B) 32×10^{-11}

(C) 6.4×10^{-11} (D) 64×10^{-12}

CIE169

66. The solubility of A_2X_3 is y mol dm^{-3}. Its solubility product is

(A) $6\ y^2$ (B) $64\ y^4$ (C) $36\ y^5$ (D) $108\ y^5$

CIE170

67. If the solubility of AgCl (formula mass=143) in water at 25°C is 1.43×10^{-4} gm/100 ml of solution then the value of K_{sp} will be :–

(A) 1×10^{-5} (B) 2×10^{-5} (C) 1×10^{-10} (D) 2×10^{-10}

CIE171

68. One litre of saturated solution of $CaCO_3$ is evaporated to dryness, 7.0 g of residue is left. The solubility product for $CaCO_3$ is:-

(A) 4.9×10^{-3} (B) 4.9×10^{-5} (C) 4.9×10^{-9} (D) 4.9×10^{-7}

CIE172

69. A_3B_2 is a sparingly soluble salt of molar mass M (g mol^{-1}) and solubility x g lit^{-1}. The ratio of the molar concentration of $B^{3\ominus}$ to the solubility product of the salt is

(A) $108\ \frac{x^5}{M^5}$ (B) $\frac{1}{108}\frac{M^4}{x^4}$ (C) $\frac{1}{54}\frac{M^4}{x^4}$ (D) None

CIE173

70. Solubility of Ag_2CrO_4 ($K_{sp} = 4 \times 10^{-13}$) in 0.1 M K_2CrO_4 solution will be :–

(A) 10^{-3} M (B) 10^{-6} M (C) 4×10^{-6} M (D) 5×10^{-7} M

CIE174

71. At 30°C, In which of the one litre solution, the solubility of Ag_2CO_3 (solubility product = 8×10^{-12}) will be maximum :-

(A) 0.05 M Na_2CO_3 (B) Pure water

(C) 0.05 M $AgNO_3$ (D) 0.05 M NH_3

CIE175

72. For the reaction : $[Ag(CN)_2]^{\ominus}(aq) \rightleftharpoons Ag^{\oplus}(aq) + 2CN^{\ominus}(aq)$, K_C at 25ºC is 4×10^{-19}. Calculate $[Ag^{\oplus}]$ in solution which was originally 0.1 M in KCN and 0.03 M in $AgNO_3$.

(A) 1.5×10^{-17} M

(B) 7.5×10^{-18} M

(C) 4.6875×10^{-19} M

(D) Value cannot be determined due to mathematical complications.

CIE176

73. The solubility product values of AgCl and AgCNS are 1.8×10^{-10} and 1.6×10^{-11} respectively. When a solution is saturated with both solids, calculate the ratio $[Cl^{\ominus}]/[CNS^{\ominus}]$ and also $[Ag^{\oplus}]$ in the solution : Assume no reaction of cation/anion.

(A) 1.125, 4×10^{-6} M (B) 11.25, 1.4×10^{-5} M

(C) 1.25, 4×10^{-5} M (D) 1.25, 4×10^{-6} M

CIE177

74. 2M solution of Na_2CO_3 is boiled in a closed container with excess of CaF_2. Very little amount of $CaCO_3$ and NaF are formed. If the solubility product (K_{sp}) of $CaCO_3$ is x and molar solubility of CaF_2 is y, find the molar concentration of $F^{\ominus}$ in resulting solution after equilibrium is attained.

(A) $\sqrt{\frac{8y^3}{x}}$ (B) $\sqrt{\frac{y^3}{x}}$ (C) $\sqrt{8y^3}$ (D) $\sqrt{\frac{8y^2}{x}}$

CIE178

75. Na_3PO_4 which should be added in 10 L of 1.0×10^{-5} M - $BaCl_2$ solution without any precipitation of $Ba_3(PO_4)_2$ is [Ksp of $Ba_3(PO_4)_2$] = 4×10^{-23}

(A) 2×10^{-4} gm (B) 0.328 gm (C) 0.164 gm (D) 0.82 gm

CIE184

MULTIPLE CORRECT TYPE QUESTIONS

Properties of water and pH scale

76. Which of the following solutions will have pH close to 1.0?

(A) 100 ml of $(\frac{M}{10})$ HCl + 100 ml of $(\frac{M}{10})$ NaOH.

(B) 55 ml of $(\frac{M}{10})$ HCl + 45 ml of $(\frac{M}{10})$ NaOH.

(C) 10 ml of $(\frac{M}{10})$ HCl + 90 ml of $(\frac{M}{10})$ NaOH.

(D) 75 ml of $(\frac{M}{5})$ HCl + 25 ml of $(\frac{M}{5})$ NaOH.

CIE186

77. Which would decrease the pH of 25 ml of a 0.01 M solution of hydrochloric acid? The addition of
(A) magnesium metal
(B) 25 ml 0.02 M of HCl
(C) 25 ml 0.005 M of HCl
(D) 50 ml wate

CIE187

78. Which of the following result(s) is/ are correct for the equilibrium state in a solution originally having 0.1 M-CH_3COOH and 0.1 M-HCl?
The value of Ka for $CH_3COOH = 1.8 \times 10^{-5}$.
(A) $[H^+] = 0.1$ M
(B) $[CH_3COO^-] = 1.8 \times 10^{-5}$ M
(C) Degree of dissociation of acetic acid $= 1.8 \times 10^{-4}$
(D) $[H^+]$ from water $= 10^{-13}$ M

CIE188

79. Which of the following statement(s) is/are correct?
(A) The pH of 10^{-8} M-HCl solution is 8.
(B) The conjugate base of $H_2PO_4^-$ is HPO_4^{2-}.
(C) Autoprotolysis constant of water increases with the increase in temperature.
(D) When a solution of a weak monoprotic acid is titrated against a strong base, at half neutralization point, pH = $\frac{pK_a}{2}$.

CIE189

Ostwald dilution Law and calculation of pH work acid or weak Base

80. Which of the following expression(s) for the degree of dissociation of weak monobasic acid in aqueous solution is/ are incorrect?
(A) $\sqrt{\frac{K_a}{c}}$
(B) $\frac{K_a}{K_a+[H^+]}$
(C) $\frac{[H^+]}{K_a+[H^+]}$
(D) $\frac{1}{1+10^{(pK_a-pH)}}$

CIE190

81. Which of the following will occur if a 0.1 M solution of a weak acid is diluted to 0.01 M at constant temperature?
(A) $[H^+]$ will decrease.
(B) pH will increase.
(C) Percentage ionization will increase.
(D) K_a will increase.

CIE191

82. The relation $pK_a = 14 - pK_b$ is true for which of the following pair(s)?
(a) $MeNH_3^+$, CH_3NH_2
(b) CH_3COOH, CH_3COO^-
(c) H_3O^+ , OH^-
(d) Na+ , NaOH

CIE192

83. If K_1 and K_2 are the first and second ionization constants of H_2CO_3 and $K_1 >> K_2$, then the incorrect relation(s) is/are
(A) $[H^+] = [HCO_3^-]$
(B) $[H^+] = \sqrt{K_1 \cdot [H_2CO_3]}$
(C) $K_2 = [CO_3^{2-}]$
(D) $[H^+] = 2.[CO_3^{2-}]$

CIE193

Salt Hydrolysis

84. The equilibrium constant for the ionization of $RNH_2(g)$ in water as

$RNH_2(g) + H_2O(l) \rightleftharpoons RNH_3^+(aq) + OH^-(aq)$

is 10^{-6} at 25o C. Which of the following is/ are correct?

(A) pH of the solution is 11.0 at partial pressure of $RNH_2(g)$ = 1 bar.

(B) Forward reaction is favoured by the addition of HCl(aq).

(C) Forward reaction is favoured by the addition of $H_2O(l)$.

(D) Forward reaction is favoured by the addition of $RNH_2(g)$.

CIE194

85. Which of the following processes will increase $[OH^-]$ in NH_4OH solution?

(A) Addition of HCl solution. (B) Addition of water.

(C) Addition of NH_4Cl solution. (D) Addition of solid NH_4OH.

CIE195

Buffer Solution

86. Which of the following may act as buffer in aqueous solution?

(A) $NH_4Cl + NH_4OH$ (B) $CH_3COOH + CH_3COONa$

(C) $CH_3COONa + NaCl$ (D) Borax + Boric acid

CIE196

87. A buffer solution can be prepared from a mixture of

(A) NH_4Cl and NaOH in 2 : 1 mole ratio. (B) CH_3COONa and HCl in 1 : 1 mole ratio.

(C) CH_3COONa and HCl in 2 : 1 mole ratio. (D) CH_3COONa and HCl in 1 : 2 mole ratio

CIE197

88. Which of the following statements is/are correct?

(A) A buffer solution may contain a weak acid and its conjugate base.

(B) A buffer solution shows little change in pH on the addition of a small amount of acid or base.

(C) A buffer solution can be prepared by mixing a solution of ammonium acetate and acetic acid.

(D) The addition of solid potassium cyanide to water increases the pH of water.

CIE198

Indicator and Titration

89. A 2.5 g impure sample containing weak monoacidic base (Molecular weight = 45) is dissolved in 100 ml water and titrated with 0.5-M HCl at 25° C. When 1/5th of the base was neutralized, the pH was found to be 9 and at equivalent point, the pH of solution is 4.5 (log 2 = 0.3).

(A) Kb of base is less than 10^{-6}.

(B) Concentration of salt at equivalent point is 0.25 M.

(C) Volume of HCl used at equivalent point is 100 ml.

(D) Mass percentage of base in given sample is 80%.

CIE199

90. A certain indicator (an organic dye) has $pK_a = 5$.

For which of the following titrations may it be suitable?

(A) Acetic acid against NaOH. (B) Aniline hydrochloride against NaOH.

(C) Sodium acetate against HCl. (D) Barium hydroxide against oxalic acid.

CIE200

Solubility and solubility product

91. An aqueous solution contains 0.02 M-$FeCl_2$ and 0.05 M-$FeCl_3$. The solubility products are 8×10^{-16} for $Fe(OH)_2$ and 4×10^{-28} for $Fe(OH)_3$. Identify the correct option(s) among the following regarding the precipitation of metal hydroxides.

(A) At pH = 9.0, neither $Fe(OH)_2$ nor $Fe(OH)_3$ will precipitate.

(B) At pH = 6.0, neither $Fe(OH)_2$ nor $Fe(OH)_3$ will precipitate.

(C) If pH of the solution is in between 5.3 and 7.3, only $Fe(OH)_3$ will precipitate but not $Fe(OH)_2$.

(D) If pOH of the solution is in between 6.7 and 8.7, only $Fe(OH)_2$ will precipitate but not $Fe(OH)_3$.

CIE201

Miscellaneous

92. H_2CO_3 ionizes as follows.

$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$; $K_1 = 4.0 \times 10^{-6}$

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$; $K_2 = 5.0 \times 10^{-11}$

Which of the following information is correctly related to 0.5 M – Na_2CO_3 solution?

(A) The degree of hydrolysis of Na_2CO_3 is 0.02.

(B) The pH of solution is 2.0.

(C) The pOH of solution is 2.0.

(D) $[H_2CO_3] = 2.5 \times 10^{-9}$ M

CIE202

93. The amino acid glycine (NH_2CH_2COOH) is basic because of its $-NH_2$ group and acidic because of its –COOH group. By a process equivalent to base dissociation, glycine can acquire an additional proton to form $\overset{\oplus}{N}H_3\,CH_2COOH$. The resulting cation may be considered to be a diprotic acid, since one proton from the –COOH group and one from the $-\overset{\oplus}{N}H_3$ group may be lost. The pK_a values for these processes are 2.22 and 9.78, respectively. For a 0.01 M solution of neutral glycine (log 1.7 = 0.22, log 6 = 0.78),

(A) the pH is 6.0.

(B) percentage of the glycine in the cationic form is 0.017%.

(C) the pOH is 6.0.

(D) percentage of the glycine in the anionic form is 0.017%.

CIE203

COMPREHENSION TYPE QUESTIONS

Ostwald dilution Law and calculation of pH work acid or weak Base

Paragraph for Question No. 94 to 95

The dissociation constant of acetic acid is 2.0×10^{-5}. An aqueous solution of acetic acid is prepared by dissolving 0.7 millimole acetic acid in sufficient water to get 10 m^3 of solution at 25°C.

94. What is the pH of the solution? (log 2 = 0.3, log 7 = 0.85, log 17 = 1.23, $\sqrt{4.49} = 2.1$)

(A) 7.15 (B) 6.77 (C) 6.85 (D) 7.0

CIE204

95. What is the concentration of unionized acetic acid in the solution?
(A) 0 (B) 4.9×10^{-10} M (C) 7×10^{-8} M (D) 2.45×10^{-10} M

CIE205

Buffer Solution

Paragraph for Question No. 96 to 98

A buffer solution contains 0.8 M-NH_4OH and 0.2 M-NH_4Cl. The value of K_a fo $NH_4^+ = 5.0 \times 10^{-10}$ (log 2 = 0.3, log 3 = 0.48).

96. The pH of the solution is
(A) 9.9 (B) 8.7 (C) 9.6 (D) 4.1

CIE206

97. The pH of the resulting solution on adding 0.15 mole HCl in 500 ml of the buffer solution is
(A) 9.3 (B) 0.48 (C) 0.52 (D) 9.9

CIE207

98. The pH of the resulting solution on adding 0.5 mole HCl in 500 ml of the buffer solution is
(A) 9.3 (B) 0.30 (C) 0.70 (D) 9.9

CIE208

Indicator

Paragraph for Question No. 99 to 101

A volume of 100 ml of 0.1 M-H_3PO_4 solution is titrated with 0.5 M-NaOH solution till the second equivalence point. Then 10 ml of 0.5 M-HCl solution is mixed in the resulting solution. The dissociation constants of H_3PO_4 are 10^{-3}, 10^{-8} and 10^{-13}.

99. pH at the second equivalence point is
(A) 13.0 (B) 8.0 (C) 5.5 (D) 10.5

CIE209

100. pH of the solution after adding HCl is
(A) 8.0 (B) 1.0 (C) 6.0 (D) 10.5

CIE210

101. The solubility product of base $A(OH)_2$ is 4.0×10^{-30}. Its solubility in the final solution is
(A) 10^{-10} M (B) 4.0×10^{-16} M (C) 4.0×10^{-18} M (D) 4.0×10^{-22} M

CIE211

Paragraph for Question No. 102 to 104

Human blood has a narrow pH range of 7.3 – 7.4, which must be maintained for metabolic processes to function properly. To keep the pH in this range, it requires a delicate balance between the concentrations of the conjugate acid–base pairs, making up to the buffer system. The main buffer is a carbonic acid-hydrogen carbonate system, which involves the following equilibria.

$$CO_2(g) \rightleftharpoons CO_2(aq.)$$

$$CO_2(aq.) + H_2O(l) \rightleftharpoons H_2CO_3(aq.)$$

$$H_2CO_3(aq.) + H_2O(l) \rightleftharpoons HCO_3^-(aq.) + H_3O^+(aq.)$$

At the body temperature, the pK_a for carbonic acid is 6.40. However, the normal concentration of $CO_2(g)$ in the lungs maintains a ratio of $HCO_3^-(aq.)$ and $H_2CO_3(aq.)$ in blood plasma at about 8 : 1. The H_2CO_3 concentration in blood is largely controlled by breathing and respiration and HCO_3^- concentration is largely controlled by excretion in urine. If blood pH rises above 7.4, then a potentially life-threatening condition called alkalosis can result. It normally occurs in climbers suffering from oxygen deficiency at high altitude or in patients who are hyperventilating from severe anxiety (log 2 = 0.3).

102. The pH of blood at body temperature is
(A) 6.4 (B) 7.4 (C) 7.3 (D) 7.2

CIE212

103. The maximum permissible value of $\frac{H_2CO_3}{HCO_3^-}$ in human blood to just prevent alkalosis is
(A) 0.1 (B) 10 (C) 8.0 (D) 0.125

CIE213

104. Which of the following statement is correct?
(A) One way to treat alkalosis can be to get the patient to breathe more quickly so that the amount of CO_2 exhaled increases and the blood becomes deficient in CO_2.
(B) One way to treat alkalosis is to get the patient breathe into a bag so that the exhaled CO_2 is re-inhaled.
(C) The pH of blood is independent of the concentration of CO_2.
(D) Alkalosis cannot be controlled by breathing and respiration.

CIE214

Solubility and solubility product

Paragraph for Question No. 105 to 107

The solubility product of AgCN is 1.0×10^{-16} and the formation constant of $Ag(CN)_2^-$ is 1.5×10^{17}.

105. The solubility of AgCN in 0.02 M-KCN solution, assuming no complex formation, is
(A) 1.0×10^{-8} M (B) 5.0×10^{-15} M (C) 0.02 M (D) 5.0×10^{-14} M

CIE215

106. The solubility of AgCN in 0.02 M-KCN solution, assuming complex formation, is
(A) 0.3 M (B) 0.02 M (C) 1.33×10^{-19} M (D) 1.87×10^{-2} M

CIE216

107. At what $[CN^-]$ in the solution, the solubility of AgCN will be minimum?
(A) 3.65×10^{-9} M (B) 1.33×10^{-17} M (C) 2.58×10^{-9} M (D) 5.48×10^{-8} M

CIE217

Miscellaneous

Paragraph for Question No. 108 to 109

Amino acid glycine (NH_2–CH_2–COOH) exists as a zwitterion in aqueous solution. The K_a and K_b values of glycine are 1.6×10^{-10} ($pK_a = 9.8$) and 2.5×10^{-12} ($pK_b = 11.6$), respectively. The K_a and K_b values are for zwitterion of amino acid with the following structure [$\overset{+}{N}H_3$ CH_2 – COO^-].

108. What is the value of K_b for –NH_2 group in glycine?
(A) 4×10^{-3} (B) 1.6×10^{-10} (C) 6.25×10^{-5} (D) 2.5×10^{-12}

CIE218

109. An aqueous solution of glycine has pH
(A) nearly 7 (B) nearly 7.9 (C) nearly 6.1 (D) nearly 11.5

CIE219

Paragraph for Question No. 110 to 113

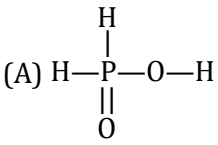
Phosphoric acid is of great importance in fertilizer production. Besides, phosphoric acid and its various salts have a number of applications in metal treatment, food, detergent and toothpaste industries.

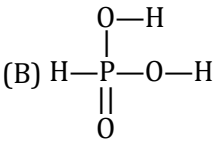
$$pK_{a_1} = 2.12,\ pK_{a_2} = 7.21,\ pK_{a_3} = 12.32,$$

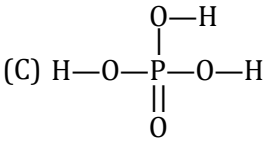
Small quantities of phosphoric acid are extensively used to impart the sour or tart taste to many soft drinks such as colas and root beers, in which a density of 1.00 g $mL^{\ominus 1}$ contains 0.05% by weight of phosphoric acid.

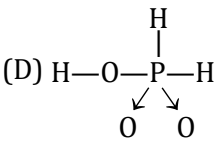
Phosphoric acid is used as a fertiliser for agriculture and in aqueous soil digesting. 1.00×10^{-3} M phosphoric acid is found to have pH = 7. Zinc is an essential micronutrient for plant growth. Plants can absorb zinc in water soluble from only. In the given soil, zinc phosphate is only the source of zinc and phosphate ions, K_{sp} (zinc phosphate) = 9.1×10^{-33}.

110. Phosphoric acid is a tribasic acid with three-step ionisation constants. Thus, its structure is :

(A)


(B)


(C)


(D)


CIE179

111. What is the pH of the cola assuming that the acidity of the cola arises only from phosphoric acid and second and third ionisation constants are of no importance ?

(A) 2.2 (B) 3.3

(C) 4.4 (D) 1.8

CIE180

112. Molar concentration of phosphate ion in the soil with pH 7 is :

(A) 1.2×10^{-4} M (B) 2.2×10^{-4} M

(C) 1×10^{-3} M (D) 1.1×10^{-10} M

CIE181

113. Concentration of $[Zn^{2\oplus}]$ in the soil is :

(A) 9.1×10^{-5} M (B) 5.7×10^{-9} M

(C) 4.0×10^{-10} M (D) 3.0×10^{-6} M

CIE182

MATRIX MATCH TYPE QUESTION

114. Match the columns.

Column-I (pH value)		**Column-II (Solution)**	
(A)	5.0	(P)	pH at which $Mg(OH)_2$ just start precipitating from 2.0×10^{-3} M-Mg^{2+} solution (K_{sp} of $Mg(OH)_2 = 2 \times 10^{-6}\ M^3$).
(B)	9.0	(Q)	Maximum pH at which 0.1 mole of $Al(OH)_3$ dissolves completely as Al^{3+} in 1 L solution (K_{sp} of $Al(OH)_3 = 1 \times 10^{-28}\ M^4$).
(C)	12.5	(R)	pH at which 0.1-M-CH_3COOH dissociates 1000/11% (K_a of CH_3COOH-= 1.0×10^{-5} M).
(D)	6.0	(S)	pH of 0.001 M-HA (weak acid) solution (pK_a of HA = pK_b of A^-).
		(T)	pH of 3×10^{-5} M-CaA_2 solution (CaA_2 dissociates completely in water; K_a of HA = 5×10^{-9}).

(A) A → P, S; B → T; C → S; D → R

(B) A → Q, S; B → R; C → P; D → R

(C) A → Q, S; B → T; C → P; D → R

(D) A → P, S; B → R; C → S; D → R

CIE220

115. Match the columns.

Column-I		**Column-II**	
(A)	NaCl	(P)	Cationic hydrolysis
(B)	Na_2CO_3	(Q)	Anionic hydrolysis
(C)	NH_4Cl	(R)	pH = 7.0 at 25 °C
(D)	CH_3COONH_4	(S)	pH < 7.0 at 25 °C
		(T)	pH > 7.0 at 25 °C

(A) A → P; B → Q, R; C → S, T; D → P, Q, S

(B) A → R; B → Q, T; C → P, S; D → P, Q, R

(C) A → S; B → P, Q; C → S, Q; D → P, Q, T

(D) A → R; B → S, T; C → Q, S; D → P, Q, S

CIE221

116. For a tribasic acid, H_3A, $K_{a1} = 10^{-4}$, $K_{a2} = 10^{-8}$ and $K_{a3} = 10^{-12}$. Match the pH (Column II) of the resulting solution (Column I) at 25 °C.

Column-I		Column-II	
(A)	Equimolar mixture of H_3A and NaH_2A.	(P)	12.0
(B)	Equimolar mixture of NaH_2A and Na_2HA.	(Q)	8.0
(C)	Equimolar mixture of Na_2HA and Na_3A.	(R)	4.0
(D)	Equimolar mixture of H_3A and NaOH.	(S)	6.0
(E)	Equimolar mixture of NaH_2A and NaOH.	(T)	10.0

(A) A → R; B → Q; C → P; D → S; E → T

(B) A → P; B → Q; C → R; D → S; E → T

(C) A → Q; B → S; C → R; D → P; E → T

(D) A → R; B → S; C → Q; D → P; E → T

CIE222

117. Match the columns.

Column-I		Column-II	
(A)	$\frac{pK_{a,H_2O} + pK_{b,H_2O}}{2}$ at 25oC (d_{water} = 1.0 g/ml)	(P)	$\frac{pK_w}{2}$
(B)	pH of CH_3COONH_4(aq) ($K_{a,CH_3COOH} = K_{b,NH_4OH}$)	(Q)	16 – log 1.8
(C)	pH of pure water at 320 K.	(R)	$-\log K_{a,H_2O}$
		(S)	< 7.0

(A) A → P, R; B → Q; C → P, S

(B) A → Q, R; B → P; C → P, S

(C) A → R, S; B → Q; C → R, S

(D) A → Q, R; B → S; C → P, Q

CIE223

EXERCISE - S

Properties of water and pH scale

1. What are the concentrations of H^+, HSO_4^-;SO_4^{2-} and H_2SO_4 in a 0.20 M solution of sulphuric acid?

Given : $H_2SO_4 \longrightarrow H^+ + HSO_4^-$; strong

$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$; $K_2 = 10^{-2}$ M

CIE224

2. Determine the $[S^{2-}]$ in a saturated (0.1M) H_2S solution to which enough HCl has been added to produce a $[H^+]$ of 2×10^{-4} . $K_1 = 10^{-7}$, $K_2 = 10^{-14}$.

CIE227

3. A weak base (50.0mL) 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. [log2 = 0.3]

CIE233

4. 10 ml of 0.1M weak acid HA($k_a = 10^{-5}$) is mixed with 10 ml 0.2M HCl and 10 ml 0.1M NaOH. Find the value of $[A^-]$ in the resulting solution.

CIE234

Ostwald dilution Law and calculation of pH work acid or weak Base

5. Calculate the pH of a 0.1M solution of $H_2NCH_2CH_2NH_2$; ethylenediamine (en).
Determine the en H_2^{2+} concentration in the solution. K_{b_1} and K_{b_2} values of ethylenediamine are 9×10^{-5} and 7.1×10^{-8} respectively.

CIE225

6. Nicotine, $C_{10}H_{14}N_2$, has two basic nitrogen atoms and both can react with water to give a basic solution

Nic (aq) + $H_2O \rightleftharpoons$ $NicH^+$ (aq) + OH^- (aq)

$NicH^+$ (aq) + $H_2O \rightleftharpoons$ $NicH_2^{2+}$ (aq) + OH^- (aq)

K_{b_1} is 8×10^{-7} and K_{b_2} is 10^{-10}. Calculate the approximate pH of a 0.20 M solution.

CIE226

7. An aqueous solution contains 0.01 M RNH_2 ($K_b = 2 \times 10^{-6}$) & 10^{-4} M NaOH.
The concentration of OH^- is nearly :

CIE228

8. Calculate the pH of 1.0×10^{-3} M sodium phenoxide, $NaOC_6H_5$. K_a for HOC_6H_5 is 0.6×10^{-10}.

CIE229

9. Calculate the OH^- concentration and the H_3PO_4 concentration of a solution prepared by dissolving 0.1 mol of Na_3PO_4 in sufficient water to make 1L of solution. $K_1 = 7.1 \times 10^{-3}$, $K_2 = 6.3 \times 10^{-8}$, $K_3 = 4.5 \times 10^{-13}$.

CIE230

10. Calculate the pH of 0.1 M solution of (i) $NaHCO_3$, (ii) Na_2HPO_4 and (iii) NaH_2PO_4. Given that:

$CO_2 + H_2O \rightleftharpoons H^+ + HCO_3^-$; $K_1 = 4.2 \times 10^{-7}$ M

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$; $K_2 = 4.8 \times 10^{-11}$ M

$H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$; $K_1 = 7.5 \times 10^{-3}$ M

$H_2PO_4^- \rightleftharpoons H^+ + HPO_4^{2-}$; $K_2 = 6.2 \times 10^{-8}$ M

$HPO_4^{2-} \rightleftharpoons H^+ + PO_4^{3-}$; $K_3 = 1.0 \times 10^{-12}$ M

(log 4.2 = 0.62, log 4.8 = 6.8, log 6.2 = 0.80, log 7.5 = 0.88)

CIE231

11. 150 ml of 0.5 M HCN ($K_a = 3.75 \times 10^{-9}$) was reacted with 1.5 M KOH for complete neutralisation. What will be molarity of HCN at equilibrium.

CIE235

12. The pH of 0.1M $NaHCO_3$ is x, then the value of 10x is
($K_1 = 5 \times 10^{-7}$, $K_2 = 5 \times 10^{-11}$ for carbonic acids).

CIE141

13. The pH of 0.05M potassium hydrogen phthalate, $KHC_8H_4O_4$ is 'x', then the value of 100x is

$H_2C_8H_4O_4 + H_2O \rightleftharpoons H_3O^{\oplus} + HC_8H_4O_4^{\ominus}$; $pK_1 = 2.94$

$HC_8H_4O_4^{\ominus} + H_2O \rightleftharpoons H_3O^{\oplus} + C_8H_4O_4^{2\ominus}$; $pK_2 = 5.44$

CIE142

14. The acid ionization (hydrolysis) constant of $Zn^{2\oplus}$ is 1.0×10^{-9} then the pH of a 0.001 M solution of $ZnCl_2$ is

CIE143

15. The pH of 0.1 M solution of (i) $NaHCO_3$, (ii) Na_2HPO_4 and (iii) NaH_2PO_4 is x, y and z, then the value of (y + z – x) is
(Roundoff your answer to the nearest integer)
Given that:

$H_2CO_3 + H_2O \rightleftharpoons H^{\oplus} + HCO_3^{\ominus}$; $K_1 = 4.2 \times 10^{-7}$ M

$HCO_3^{\ominus} \rightleftharpoons H^{\oplus} + CO_3^{2\ominus}$; $K_2 = 4.8 \times 10^{-11}$ M

$H_3PO_4 \rightleftharpoons H^{\oplus} + H_2PO_4^{\ominus}$; $K_1 = 7.5 \times 10^{-3}$ M

$H_2PO_4^{\ominus} \rightleftharpoons H^{\oplus} + HPO_4^{2\ominus}$; $K_2 = 6.2 \times 10^{-8}$ M

$HPO_4^{2\ominus} \rightleftharpoons H^{\oplus} + PO_4^{3\ominus}$; $K_3 = 1.0 \times 10^{-12}$ M

(log 4.2 = 0.62, log 4.8 = 0681, log 6.2 = 0.80, log 7.5 = 0.88)

CIE144

Salt Hydrolysis

16. The extent of hydrolysis of 0.005 M K_2CrO_4 is x%, the value of 100x is the first ionization is essentially strong. [$K_2 = 3.2 \times 10^{-7}$ for H_2CrO_4]

CIE139

17. A 0.010 M solution of $PuO_2(NO_3)_2$ was found to have a pH of 4.0. The hydrolysis constant, K_h, for $PuO_2^{2\oplus}$ is 10^{-a} and K_b for $PuO_2OH^{\oplus}$ is 10^{-b}, then the value of a × b is

CIE140

18. Calculate the pH of a 2.0 M solution of NH_4Cl. [K_b (NH_3) = 2×10^{-5}]

CIE145

Buffer Solution Topic -5

19. An ammonia-ammonium chloride buffer has a pH value of 9 with [NH_3] = 0.25. What will be the new pH if 500 ml 0.1 M KOH is added to 200 ml buffer solution ($K_b = 2 \times 10^{-5}$)
[log 2 = 0.3]

CIE232

Indicator and Titration Topic -6

20. The indicator phenol red is half in the ionic form when pH is 7.2. If the ratio of the undissociated form to the ionic form is 1 : 5, find the pH of the solution. With the same pH for solution, if indicator is altered such that the ratio of undissociated form to dissociated form becomes 1 : 4, find the pH when 50 % of the new indicator is in ionic form. [log2 = 0.3]

CIE236

Solubility and solubility product Topic -7

21. How much AgBr could dissolve in 1.0 L of 0.40 M NH_3 ? Assume that $Ag(NH_3)_2^+$ is the only complex formed. [K_f ($Ag(NH_3)_2^+$) = 1×10^8 ; K_{sp} (AgBr) = 5×10^{-13}] $\left[\sqrt{50} \simeq 7\right]$

CIE237

22. Calculate solubility of PbI_2 ($K_{sp} = 1.4 \times 10^{-8}$) in water at 25°, which is 90% dissociated.

$$\left(\frac{1.4}{(0.81)(3.6)}\right)^{1/3} = 0.78$$

CIE238

23. A recent investigation of the complexation of SCN^- with Fe^{3+} led to 130, 16, and 1.0 for K_1, K_2, and K_3, respectively. What is the overall formation constant of $Fe(SCN)_3$ from its component ions, and what is the dissociation constant of $Fe(SCN)_3$ into its simplest ions on the basis of these data ?

CIE239

24. Calculate the minimum mass of Na_2SO_4 needed to just start precipitation of $BaSO_4$ from 500 ml of 2×10^{-5}M - $BaCl_2$ solution. K_{sp} of $BaSO_4 = 8 \times 10^{-8}$.

CIE185

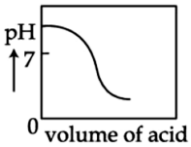
EXERCISE - JEE (Main) PYQ

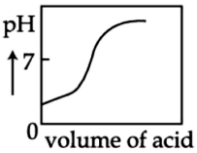
1. Class XII students were asked to prepare one litre of buffer solution of pH 8.26 by their chemistry teacher. The amount of ammonium chloride to be dissolved by the student in 0.2 M ammonia solution to make one litre of the buffer is (Given pK_b (NH_3) = 4.74; Molar mass of NH_3 = 17 g mol^{-1}; Molar mass of NH_4Cl = 53.5 g mol^{-1}) **[JEE (Main)-2022]**

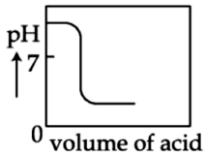
(1) 53.5 g (2) 72.3 g (3) 107.0 g (4) 126.0 g

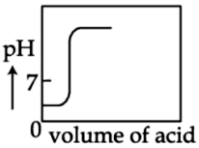
CIE240

2. The Plot of pH-metric titration of weak base NH_4OH vs strong acid HCl looks like: **[JEE (Main)-2022]**

(1) 

(2) 

(3) 

(4) 

CIE241

3. 20 mL of 0.1 M NH_4OH is mixed with 40 mL of 0.05 M HCl. The pH of the mixture is nearest to : (Given : $K_b(NH_4OH) = 1 \times 10^{-5}$, log 2 = 0.30, log 3 = 0.48, log 5 = 0.69, log 7 = 0.84, log 11 =1.04) **[JEE (Main)-2022]**

(1) 3.2 (2) 4.2 (3) 5.2 (4) 6.2

CIE242

4. 50 mL of 0.1 M CH_3COOH is being titrated against 0.1 M NaOH. When 25 mL of NaOH has been added, the pH of the solution will be _____ $\times 10^{-2}$. (Nearest integer) **[JEE (Main)-2022]**
(Given : pK_a (CH_3COOH) = 4.76)
log 2 = 0.30
log 3 = 0.48
log 5 = 0.69
log 7 = 0.84
log 11 = 1.04

CIE243

5. K_a for butyric acid (C_3H_7COOH) is 2×10^{-5}. The pH of 0.2 M solution of butyric acid is __ $\times 10^{-1}$. (Nearest integer) [Given log 2 = 0.30] **[JEE (Main)-2022]**

CIE244

6. The dissociation constant of acetic is x $\times 10^{-5}$. When 25 mL of 0.2 M CH_3COONa solution is mixed with 25 mL of 0.02 M CH_3COOH solution, the pH of the resultant solution is found to be equal to 5. The value of x is _____. **[JEE (Main) 2023]**

CIE245

7. If the pKa of lactic acid is 5, then the pH of 0.005 M calcium lactate solution at 25° C is _____ $\times 10^{-1}$ (Nearest integer) **[JEE (Main) 2023]**

Lactic acid $CH_3 - \underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}} - COOH$

CIE246

8. A litre of buffer solution contains 0.1 mole of each of NH_3 and NH_4Cl. On the addition of 0.02 mole of HCl by dissolving gaseous HCl, the pH of the solution is found to be _____× 10^{-3} (Nearest integer)

[**Given** : $pK_b(NH_3)$ = 4.745; log 2 = 0.301; log 3 = 0.477; T = 298 K] **[JEE (Main) 2023]**

CIE247

9. When the hydrogen ion concentration [H^+] changes by a factor of 1000, the value of pH of the solution _____. **[JEE (Main) 2023]**

(1) increases by 1000 units (2) decreases by 3 units

(3) decreases by 2 units (4) increases by 2 units

CIE248

10. Millimoles of calcium hydroxide required to produce 100 mL of the aqueous solution of pH 12 is $x \times 10^{-1}$. The value of x is _____ (Nearest integer).

Assume complete dissociation. **[JEE (Main) 2023]**

CIE249

11. 600 mL of 0.01M HCl is mixed with 400 mL of 0.01 M H_2SO_4. The pH of the mixture is_____ × 10^{-2}. (Nearest integer)

[Given log 2 = 0.30, log 3 = 0.48, log 5 = 0.69, log 7 = 0.84, log 11 = 1.04] **[JEE (Main) 2023]**

CIE250

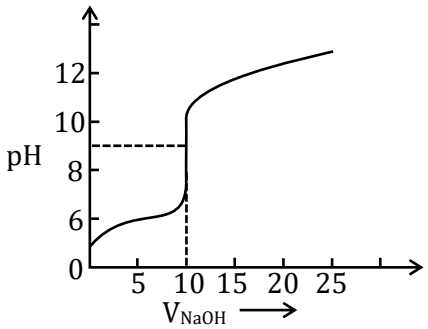
12. At 298 K, the solubility of silver chloride in water is $1.434\times10^{-3}\ g\ L^{-1}$. The value of $-\log K_{sp}$ for silver chloride is _____.

(Given mass of Ag is 107.9 $g\ mol^{-1}$ and mass of Cl is $35.5\ g\ mol^{-1}$) **[JEE (Main) 2023]**

CIE251

13. The titration curve of weak acid vs. strong base with phenolphthalein as indictor) is shown below. The $K_{phenolphthalein} = 4 \times 10^{-10}$.

Given: log2 = 0.3



The number of following statements which is/are correct about phenolphthalein is_____

A. It can be used as an indicator for the titration of weak acid with weak base.

B. It begins to change colour at pH = 8.4

C. It is a weak organic base

D. It is colourless in acidic medium **[JEE (Main) 2023]**

CIE252

14. Given below are two statements :
Statement I :- Methyl orange is a weak acid.
Statement II :- The benzenoid form of methyl orange is more intense/deeply coloured than the quinonoid form.
In the light of the above statement, choose the most appropriate answer from the options given below : **[JEE (Main) 2023]**
(1) Statement I is correct but Statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both Statement I and Statement II are incorrect.
(4) Both statement I and Statement II are correct.

CIE253

15. The solubility product of $BaSO_4$ is 1×10^{-10} at 298K. The solubility of $BaSO_4$ in 0.1 M K_2SO_4(aq) solution is _____ $\times 10^{-9}$ g L^{-1} (nearest integer). Given : Molar mass of $BaSO_4$ is 233 g mol^{-1} **[JEE (Main) 2023]**

CIE254

16. An analyst wants to convert. 1L HCl of pH = l to a solution of HCl of pH 2. The volume of water needed to do this dilution is _____ mL. (Nearest Integer) **[JEE (Main) 2023]**

CIE255

17. 25.0 mL of 0.050 M $Ba(NO_3)_2$ is mixed with 25.0 mL of 0.020 M NaF. K_{sp} of BaF_2 is 0.5×10^{-6} at 298 K. The ratio of $\left[Ba^{2+}\right]\left[F^-\right]^2$ and K_{sp} is _____ (Nearest integer) **[JEE (Main) 2023]**

CIE256

18. 20 mL of 0.1 M NaOH is added to 50 mL of 0.1 M acetic acid solution. The pH of the resulting solution is _____ $\times 10^{-2}$ (Nearest integer)
Given : pKa (CH_3COOH) = 4.76, log 2 = 0.30, log 3 = 0.48 **[JEE (Main) 2023]**

CIE257

19. Which of the following statement(s) is/are correct?
(A) The pH of 1×10^{-8} M HCl solution is 8.
(B) The conjugate base $H_2PO_4^-$ is HPO_4^{2-}.
(C) K_w increases with increase in temperature.
(D) When a solution of weak monoprotic acid is titrated against a strong base at half neutralisation point, $pH = \frac{1}{2}pK_a$
Choose the correct answer from the option given below. **[JEE (Main) 2023]**
(1) (B), (C), (D) (2) (A), (D) (3) (A), (B), (C) (4) (B), (C)

CIE258

20. Incorrect statement for the use of indicators in acid-base titration is : **[JEE (Main) 2023]**
(1) Methyl orange may be used for a weak acid vs weak base titration.
(2) Methyl orange is a suitable indicator for a strong acid vs weak base titration
(3) Phenolphthalein is a suitable indicator for a weak acid vs strong base titration
(4) Phenolphthalein may be used for a strong acid vs strong base titration.

CIE259

EXERCISE - JEE (Advanced) PYQ

1. In 1 L saturated solution of AgCl [$K_{sp}(AgCl) = 1.6 \times 10^{-10}$], 0.1 mol of CuCl [$K_{sp}(CuCl) = 1.0 \times 10^{-6}$] is added. The resultant concentration of $Ag^{\oplus}$ in the solution is 1.6×10^{-x}. The value of 'x' is. **[JEE (Advanced) 2011]**

CIE087

2. The initial rate of hydrolysis of methyl acetate (1M) by a weak acid (HA, 1M) is $1/100^{th}$ of that of a strong acid (HX, 1M), at 25°C. The K_a of HA is **[JEE (Advanced) 2013]**

(A) 1×10^{-4} (B) 1×10^{-5}

(C) 1×10^{-6} (D) 1×10^{-3}

CIE088

3. The K_{sp} of Ag_2CrO_4 is 1.1×10^{-12} at 298 K. The solubility (in mol/L) of Ag_2CrO_4 in a 0.1 M $AgNO_3$ solution is **[JEE (Advanced) 2013]**

(A) 1.1×10^{-11} (B) 1.1×10^{-10}

(C) 1.1×10^{-12} (D) 1.1×10^{-9}

CIE089

Paragraph For Questions 4 and 5

When 100 mL of 1.0 M HCl was mixed with 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temperature increases of 5.7°C was measured for the beaker and its content. **(Expt-1).** Because the enthalpy of neutralisation of a strong acid with a strong base is a constant (– 57.0 $kJmol^{-1}$), this experiment could be used to measure the calorimeter constant. In a second experiment **(Expt-2)**, 100 mL of 2.0 M acetic acid ($K_a = 2.0 \times 10^{-5}$) was mixed with 100 mL of 1.0M NaOH (under identical conditions to **(Expt-1))** where a temperature rise of 5.6°C was measured. (Consider heat capacity of all solutions as 4.2 $Jg^{-1}K^{-1}$ and density of all solutions as 1.0 g mL^{-1})

4. Enthalpy of dissociation (in kJ mol^{-1}) of acetic acid obtained from the **Expt-2** is **[JEE (Advanced) 2015]**

(A) 1.0 (B) 10.0

(C) 24.5 (D) 51.4

CIE090

5. The pH of the solution after **Expt-2** **[JEE (Advanced) 2015]**

(A) 2.8 (B) 4.7

(C) 5.0 (D) 7.0

CIE091

6. The solubility of a salt of weak acid(AB) at pH=3 is $Y \times 10^{-3}$ mol L^{-1}. The value of Y is___. (Given that the value of Solubility and Solubility Product of AB (K_{sp}) $= 2 \times 10^{-10}$ and the value of ionization constant of HB(K_a) $= 1 \times 10^{-8}$) **[JEE (Advanced) 2018]**

CIE092

7. Dilution process of different aqueous solutions; with water, are given in LIST-I. The effects of dilution of the solutions on $[H^{\oplus}]$ are given in LIST-II.

(Note : Degree of dissociation (α) of weak acid and weak base is << 1; degree of hydrolysis of salt <<1; $[H^{\oplus}]$ represents the concentration of $H^{\oplus}$ ions)

LIST-I		List-II	
P.	(10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	1	the value of $[H^{\oplus}]$ does not change on dilution
Q.	(20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	2	the value of $[H^{\oplus}]$ change to half of its initial value on dilution
R.	(20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	3	the value of $[H^{\oplus}]$ changes to two times of its initial value on dilution
S.	10 mL saturated solution of $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after dilution).	4	the value of $[H^{\oplus}]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution
		5	the value of $[H^{\oplus}]$ changes to $\sqrt{2}$ times of its initial value on dilution

Match each process given in LIST-I with one or more effect(s) in LIST-II. The correct option is

[JEE (Advanced) 2018]

(A) P $\rightarrow$ 4; Q $\rightarrow$ 2; R $\rightarrow$ 3; S $\rightarrow$ 1 (B) P $\rightarrow$ 4; Q $\rightarrow$ 3; R $\rightarrow$ 2; S $\rightarrow$ 3

(C) P $\rightarrow$ 1; Q $\rightarrow$ 4; R $\rightarrow$ 5; S $\rightarrow$ 3 (D) P $\rightarrow$ 1; Q $\rightarrow$ 5; R $\rightarrow$ 4; S $\rightarrow$ 1

CIE093

8. 5.00 mL of 0.10 M oxalic acid solution taken in a conical flask is titrated against NaOH from a burette using phenolphthalein indicator. The volume of NaOH required for the appearance of permanent faint pink color is tabulated below for five experiments. What is the concentration, in molarity, of the NaOH solution ? **[JEE (Advanced) 2020]**

Exp. No.	Vol. of NaOH (mL)
1	12.5
2	10.5
3	9.0
4	9.0
5	9.0

CIE094

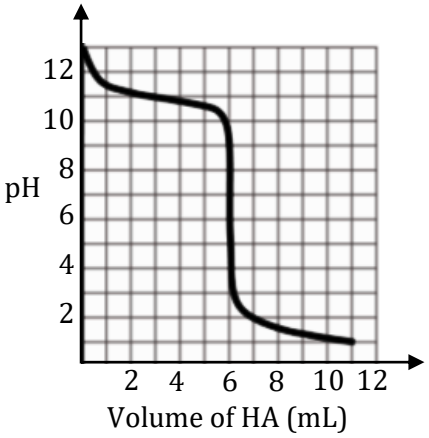
9. An acidified solution of 0.05 M $Zn^{2\oplus}$ is saturated with 0.1 M H_2S. What is the minimum molar concentration (M) of $H^{\oplus}$ required to prevent the precipitation of ZnS ?

Use K_{sp} (ZnS) = 1.25×10^{-22} and overall dissociation constant of H_2S,

$K_{NET} = K_1K_2 = 1 \times 10^{-21}$ **[JEE (Advanced) 2020]**

CIE095

10. A solution of 0.1 M weak base (B) is titrated with 0.1 M of a strong acid (HA). The variation of pH of the solution with the volume of HA added is shown in the figure below. What is the pK_b of the base? The neutralization reaction is given by $B + HA \rightarrow BH^{\oplus} + A^{\ominus}$. **[JEE (Advanced) 2020]**



CIE096

11. A solution is prepared by mixing 0.01 mol each of H_2CO_3, $NaHCO_3$, Na_2CO_3, and NaOH in 100 mL of water. pH of the resulting solution is _____.
[Given : pK_{a1} and pK_{a2} of H_2CO_3 are 6.37 and 10.32, respectively ; log 2 = 0.30]
[JEE (Advanced) 2022]

CIE097

12. Concentration of H_2SO_4 and Na_2SO_4 in a solution is 1 M and 1.8×10^{-2} M, respectively. Molar solubility of $PbSO_4$ in the same solution is $X \times 10^{-Y}$ M (expressed in scientific notation). The value of Y is _____.
[Given: Solubility and Solubility Product of $PbSO_4$ (K_{sp}) = 1.6×10^{-8}. For H_2SO_4, K_{a_1} is very large and $K_{a_2} = 1.2 \times 10^{-2}$]
[JEE (Advanced) 2022]

CIE098

13. On decreasing the *p*H from 7 to 2, the solubility of a sparingly soluble salt (MX) of a weak acid (HX) increased from 10^{-4} mol L^{-1} to 10^{-3} mol L^{-1}. The pK_a of HX is:
(A) 3 (B) 4 (C) 5 (D) 2
[JEE (Advanced) 2023]

CIE260

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases

1. Which of the following is not a Bronsted acid:-

(1) $CH_3NH_4^{\oplus}$ (2) $CH_3COO^{\ominus}$ (3) H_2O (4) $HSO_4^{\ominus}$

CIE001

2. Out of the following, amphiprotic species in aqueous medium are

I. $HPO_3^{2\ominus}$ II. $OH^{\ominus}$ III. $H_2PO_4^{\ominus}$ IV. $HCO_3^{\ominus}$

(1) I, III, IV (2) I and III (3) III and IV (4) All

CIE002

3. When ammonia is added to water, it decreases the concentration of which of the following ion

(1) $OH^{\ominus}$ (2) $H_3O^{\oplus}$ (3) $NH_4^{\oplus}$ (4) $NH_4^{\oplus}$ & $OH^{\ominus}$

CIE003

4. The pH of a solution obtained by mixing 50 mL of 0.4 N HCl and 50 mL of 0.2 N NaOH is-

(1) – log 2 (2) – log 0.2 (3) 1.0 (4) 2.0

CIE004

5. The dissociation constants of two acids HA_1 and HA_2 are 3.0×10^{-4} and 1.8×10^{-5} respectively. The relative strengths of the acids will be approximately-

(1) 1 : 4 (2) 4 : 1 (3) 1 : 16 (4) 16 : 1

CIE005

6. Liquid NH_3 ionises to a slight extent. At a certain temperature its self-ionization constant $K_{SIC(NH_3)} = 10^{-30}$. The number of $NH_4^{\oplus}$ ions present per 100 cm^3 of pure liquid are

(1) 10^{-15} (2) 6.022×10^8 (3) 6.022×10^7 (4) None

CIE006

7. The sodium salt of a certain weak monobasic organic acid is hydrolysed to an extent of 3% in its 0.1 M solution at 25 °C. Given that the ionic product of water is 10^{-14} at this temperature, what is the dissociation constant of the acid ?

(1) $\approx 1 \times 10^{-10}$ (2) $\approx 1 \times 10^{-9}$ (3) 3.33×10^{-9} (4) 3.33×10^{-10}

CIE007

8. The moles of $H^{\oplus}$ from H_2O in a 1*l*, $\sqrt{5} \times 10^{-7}$ M HCl solution at 25°C, is
$(\sqrt{5} = 2.23)$
(1) 10^{-7} (2) 6.85×10^{-8} (3) 3.85×10^{-8} (4) 10^{-8}

CIE008

9. K_a for HCN is 5×10^{-10} at 25 °C. For maintaining a constant pH of 9, the volume of 5 M KCN solution required to be added to 10 mL of 2M HCN solution is-
(1) 4 mL (2) 7.95 mL (3) 2 mL (4) 9.3 mL

CIE009

10. If pK_b for fluoride ion at 25° C is 10.4, the ionisation constant of hydrofluoric acid in water at this temperature is :
(1) 4×10^{-11} (2) 3×10^{-3} (3) 2.5×10^{-4} (4) 2×10^{-2}

CIE010

11. If equilibrium constant of
$CH_3COOH + H_2O \rightleftharpoons CH_3COO^{\ominus} + H_3O^{\oplus}$
is 1.8×10^{-5}, equilibrium constant for
$CH_3COOH + OH^{\ominus} \rightleftharpoons CH_3COO^{\ominus} + H_2O$ is
(1) 1.8×10^{-9} (2) 1.8×10^{9} (3) 5.55×10^{-9} (4) 5.55×10^{10}

CIE011

12. When NaCl is added to the reaction mixture of an oil and caustic soda, the soap is separated out because-
(1) NaCl is an ionic compound
(2) soap is insoluble in the presence of chloride ions
(3) the Solubility and Solubility Product of NaCl decreases in the presence of soap
(4) the Solubility and Solubility Product of the soap is exceeded due to the increased concentration of $Na^{\oplus}$ ions.

CIE012

13. Degree of Hydrolysis of $\frac{N}{100}$ solution of KCN is (Given Ka = 1.6×10^{-9})
(1) 2.5×10^{-3} (2) 2.5×10^{-2} (3) 2.5×10^{-4} (4) 2.5×10^{-5}

CIE013

14. Which can act as buffer :-
(1) NH_4OH + NaOH (2) HCOOH + HCl
(3) 40 ml. of 0.1 M NaCN + 20 ml. of 0.1 M HCl (4) All of them

CIE014

15. The solubility of Ag_2CO_3 in water at 25 °C is 1×10^{-4} mole/litre. What is its solubility in 0.1 M Na_2CO_3 solution ? Assume no hydrolysis of $CO_3^{2\ominus}$ ion.
(1) 6.323×10^{-6} mole/litre (2) 4.74×10^{-5} mole/litre
(3) 3.16×10^{-6} mole/litre (4) 5.51×10^{-5} mole/litre

CIE015

16. The solubility of CaF_2 ($K_{sp} = 3.4 \times 10^{-11}$) in 0.1 M solution of NaF would be-
(1) 3.4×10^{-12} M (2) 3.4×10^{-10} M (3) 3.4×10^{-9} M (4) 3.4×10^{-13} M

CIE016

17. The Solubility Product of $Mg(OH)_2$ in water at 25 °C is 8.9×10^{-13} (mole $dm^{-3})^3$ while that of $Al(OH)_3$ is 5×10^{-33} (mol $dm^{-3})^4$. If S_1 and S_2 are the solubilities of $Mg(OH)_2$ and $Al(OH)_3$ in water in mol dm^{-3} at 25 °C, what is the order of magnitude of the ratio, S_1/S_2 ?

(1) 10^5 (2) 10^4 (3) 10^6 (4) 10^3

CIE017

18. What will happen if the pH of the solution of 0.001 M $Mg(NO_3)_2$ solution is adjusted to pH = 9 (K_{sp} of $Mg(OH)_2 = 8.9 \times 10^{-12}$)

(1) ppt will take place (2) ppt will not take place

(3) Solution will be saturated (4) None of these

CIE018

19. What volume of 0.2 M NH_4Cl solution should be added to 100 ml of 0.1 M NH_4OH solution to produce a buffer solution of pH = 8.7?

Given : pK_b of $NH_4OH = 4.7$; log 2 = 0.3

(1) 50 ml (2) 100 ml (3) 200 ml (4) None of these

CIE019

20. What is the pK_b of a weak base whose 0.1 M solution has pH = 9.5 ?

(1) 7.5 (2) 8 (3) 9 (4) 10

CIE020

SECTION-B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

  Full Marks : +4, if only correct answer is given.

  Zero Marks : 0, if no answer is given.

  Negative Marks : -1 for incorrect answer

---

1. Calculate the number of $H^{\oplus}$ present in one ml of solution whose pH is 13. If the number of $H^{\oplus}$ ions is $x \times 10^7$ then the value of x is

CIE021

2. The pH of the solution produced when an aqueous solution of strong acid pH 5 is mixed with equal volume of an aqueous solution of strong acid of pH 4 is :-

CIE022

3. What is the $OH^{\ominus}$ concentration of a 0.18 M solution of CH_3COONa. [$K_a(CH_3COOH) = 1.8 \times 10^{-5}$], if the $OH^{\ominus}$ concentration is 1×10^{-y}, then y is

CIE023

4. Calculate pH of : 10^{-1} M CH_3COOH

Take $K_a = 2 \times 10^{-5}$

CIE024

5. How many grams of NH_4Cl should be dissolved per litre of solution to have a pH of 5.13 ? (K_b for NH_3 is 1.8×10^{-5}).

CIE025

6. Calculate the pH after the addition of 100 mL of 0.1 N NaOH to 100 mL, 0.1 N CH_3COOH. (Given pK_a for CH_3COOH = 4.74)

CIE026

7. What is the maximum volume of water required to dissolve 1 g of calcium sulphate at 25°C. For calcium sulphate, $K_{sp} = 9.0 \times 10^{-6}$.

CIE027

8. Calculate the solubility of AgCN in a buffer solution at pH = 3.0
Given : K_{sp} of AgCN = 8×10^{-10} , K_a of HCN = 5×10^{-10}. If the solubility of AgCN is $x \times 10^{-2}$ M, then x is

CIE028

9. Calculate pH of mixture of (400 mL, $\frac{1}{200}$ M $Ba(OH)_2$) + (400 mL, $\frac{1}{50}$ M HCl) + (200 mL of water).

CIE029

10. Calculate pH of 10^{-7} M of NaOH solution

CIE030

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **NINE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1, in all other cases

1. The pH of the solution produced when an aqueous solution of strong acid pH 5 is mixed with equal volume of an aqueous solution of strong acid of pH 3 is :-

(A) 3.3 (B) 3.5 (C) 4.5 (D) 4.0

CIE051

2. How many moles of HCl must be removed from 1 litre of aqueous HCl solution to change its pH from 2 to 3 :-

(A) 1 (B) 0.02 (C) 0.009 (D) 0.01

CIE052

3. 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 $H^{\oplus}$ solution at 25°

(C) 2×10^{-6} M $Ba(OH)_2$ solution at 25° C (D) NaOH solution at 50° C

CIE053

4. 50% neutralization of a solution of formic acid ($K_a = 2 \times 10^{-4}$) with NaOH would result in a solution having a hydrogen ion concentration of-

(A) 2×10^{-4} (B) 3.7 (C) 2.7 (D) 1.85

CIE054

5. Which of the following solution would have same pH ?

(A) 100 mL of 0.2 M HCl + 100 mL of 0.4 M NH_3

(B) 50 mL of 0.1 M HCl + 50 mL of 0.2 M NH_3

(C) 100 mL of 0.3 M HCl + 100 mL of 0.6 M NH_3

(D) All will have same pH

CIE055

6. At 25°C, the Solubility and Solubility Product values of AgCl and AgCNS are 1.7×10^{-10} and 1.0×10^{-12} respectively. When water is saturated with both solids, calculate the ratio $[Cl^{\ominus}]/[CNS^{\ominus}]$ and also $[Ag^{\oplus}]$ in the solution.

(A) 1.3×10^{2}, 1.7×10^{-5} M (B) 1.7×10^{2}, 1.308×10^{-5} M

(C) 1.3×10^{4}, 1.308×10^{-4} M (D) 1.7×10^{3}, 1.67×10^{-6} M

CIE056

7. pH of solution at first $1/4^{th}$ equivalence point of Na_2CO_3 when titrated with HCl will be (for H_2CO_3 $K_{a_1} = 10^{-7}$; $K_{a_2} = 10^{-11}$)

(A) 7 + log 3 (B) 7 – log3 (C) 11 + log3 (D) 11 – log3

CIE057

8. An acid indicator has a K_a of 3×10^{-5}. The acid form of the indicator is red & the basic form is blue. By how much must the pH change in order to change the indicator form 75% red to 75 % blue? [log 3 = 0.4771], (Roundoff your answer to nearest integer)

(A) 2 (B) 3 (C) 1 (D) 0

CIE058

9. The solubility of $Fe(OH)_3$ would be maximum in-

(A) 0.1 M NaOH (B) 0.1 M HCl (C) 0.1 M KOH (D) 0.1 M H_2SO_4

CIE059

SECTION-II

- This section contains **FIVE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4, if only (all) the correct option(s) is (are) chosen.
Partial Marks : +3, if all the four options are correct but ONLY three options are chosen.
Partial Marks : +2, if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1, if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0, if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –2 in all other cases.

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10. A 2.5 gm impure sample containing weak monoacidic base (Mol. wt. = 45) is dissolved in 100 ml water and titrated with 0.5 M HCl when $\left(\frac{1}{5}\right)^{th}$ of the base was neutralised the pH was found to be 9 and at equivalent point pH of solution is 4.5. Given: All data at 25°C & log 2 = 0.3.
Select correct statement(s).

(A) K_b of base is less than 10^{-6}
(B) Concentration of salt (C) at equivalent point is 0.25 M
(C) Volume of HCl used at equivalent point is 100 ml
(D) Weight percentage of base in given sample is 80%

CIE060

11. Select incorrect statement(s).

(A) Phenolphthalein is suitable indicator for the titration of HCl(aq) with NH_4OH (aq).
(B) An acid-base indicator in a buffer solution of pH = pK_{In} + 1 is ionized to the extent of 90%.
(C) In the titration of a monoacidic weak base with a strong acid, the pH at the equivalent point is always calculated by $pH = \frac{1}{2}[pK_w - pK_b - \log C]$
(D) When Na_3PO_4 (aq) is titrated with HCl (aq), the pH of solution at second equivalent point is calculated by $\frac{1}{2}[pK_{a_1} + pK_{a_2}]$

CIE061

12. Which of the following is correct for 0.1 M BOH solution ($K_b = 10^{-5}$)

(A) pH of solution is 11

(B) $OH^{\ominus}$ concentration is 10^{-3} mol/L

(C) it's salt with HCl (i.e. BCl) form the acidic solution in water

(D) Phenolphthalein indicator can be used during the titration of BOH with HCl

CIE062

13. Select correct statement for 50ml 0.1M H_2A(aq.) solution ; $K_{a_1} = 10^{-5}$; $K_{a_2} = 10^{-8}$

(A) $[H^{\oplus}] = 2[A^{2\ominus}]$

(B) pH of 0.1M H_2A solution is 3

(C) In above H_2A solution when 5 milimoles of NaHA are added then pH increases by 2 units

(D) 50 ml of 0.1M NaOH required to neutralised completely 50 ml of 0.1M H_2A solution

CIE063

14. How many moles NH_3 must be added to 2.0 litre of 0.80 M $AgNO_3$ in order to reduce the $Ag^{\oplus}$ concentration to 5×10^{-8} M. K_f of $[Ag(NH_3)_2]^{\oplus} = 10^8$

(A) 0.4 (B) 2

(C) 3.52 (D) 4

CIE064

SECTION–III

- This section contains **TWO** questions.
- **Each question has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.

Zero Marks : 0, if none of the bubbles is darkened.

Negative Marks : –1 in all other cases

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15. Match the effect of addition of 1 M NaOH to 100 mL 1 M CH_3COOH (in Column I) with pH (in Column II) :

Column-I	**Column-II**
(A) 25 mL of NaOH	(p) pK_a
(B) 50 mL of NaOH	(q) $pK_a + \log 3$
(C) 75 mL of NaOH	(r) $pK_a - \log 3$
(D) 100 mL of NaOH	(s) $\frac{1}{2}[pK_w + pK_a - \log 2]$

(A) A - (s), B - (p), C - (q), D - (r)

(B) A - (p), B - (q), C - (r), D - (s)

(C) A - (r), B - (p), C - (q), D - (s)

(D) A - (q), B - (p), C - (r), D - (s)

CIE065

16. Match the column-

Column I (pH of resultant solution)	**Column II** (Exist between Colour transition range of an indicator)
(A) 200 ml of H_2SO_4 solution (specific gravity 1.225 containing 25% H_2SO_4 by weight) + 800 ml of 0.525 M strong triacidic base X $(OH)_3$	(p) Phenol Red (6.8 to 8.4)
(B) 50 ml of 0.1 M $HCO_3^{\ominus}$ + 50 ml of 0.8 M $CO_3^{2\ominus}$ (H_2CO_3 : $K_{a_1} = 4\times10^{-7}$, $K_{a_2} = 2\times10^{-11}$)	(q) Propyl red (4.6 to 6.4)
(C) 50 ml of 0.2 M HA (aq) ($K_a = 10^{-5}$) +50ml of 0.1 M HCl (aq) + 100 ml of 0.13 M NaOH (aq)	(r) Phenolphthalein (8.3 to 10.1)
	(s) Malachite green (11.4 to 13)

(A) A - (s), B - (s), C - (q)
(B) A - (r), B - (s), C - (q)
(C) A - (q), B - (s), C - (r)
(D) A - (q), B - (r), C - (s)

CIE066

SECTION–IV

- This section contains **TWO** questions.
- **Each question has Assertion & Reason.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE is correct**
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases

These questions contains, Statement I (assertion) and Statement II (reason).
(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.
(B) Statement-I is true, Statement-II is true; Statement-II is NOT a correct explanation for statement-I
(C) Statement-I is true, Statement-II is false
(D) Statement-I is false, Statement-II is true

17. **Statement-I :** On dilution of a concentrated solution of CH_3COOH, the concentration of $[H^{\oplus}]$ decreases
Statement-II : Because increase in the volume is more than the increase in degree of ionisation

CIE067

18. **Statement-I :** In general phenolphthalein is used as an indicator for the titration of weak acid (HA) against strong base (NaOH)
Because
Statement-II : At equivalent point solution is basic.

CIE068

SECTION–V

- This section contains **TWO** questions.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct).
- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +3, if ONLY the correct numerical value is entered as answer.
  Zero Marks : 0 in all other cases.

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19. Calculate the ratio of degree of dissociation (α_2/α_1) when 1 M acetic acid solution is diluted to $\frac{1}{100}$ times. (Given $K_{a_1} = 1.8 \times 10^{-5}$)

CIE069

20. Determine the $[S^{2\ominus}]$ in a saturated (0.1M) H_2S solution to which enough HCl has been added to produce a $[H^{\oplus}]$ of 2×10^{-4}. $K_1 = 10^{-7}$, $K_2 = 10^{-14}$. If $[S^{2\ominus}]$ is $x \times 10^{-15}$ M than x is

CIE070

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	A	D	C	B	C	B	A	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	A	B	A	D	D	D	D	C	C
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	C	C	B	B	D	B	A	B	B	D
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	D	B	C	C	C	A	A	D	A	D
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	C	B	A	C	B	C	B	C	D	B
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	A	A	A	B	C	D	A	A	D	C
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	D	B	C	B	A	D	C	A	C	B
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	D	B	B	A	B	D	B	ABCD	BC	C
Que.	81	82	83	84	85	86	87	88	89	90
Ans.	ABC	AB	D	ABCD	D	ABD	AC	ABCD	BC	C
Que.	91	92	93	94	95	96	97	98	99	100
Ans.	C	ACD	ABD	C	B	A	A	C	D	A
Que.	101	102	103	104	105	106	107	108	109	110
Ans.	C	C	A	B	B	D	C	C	C	C
Que.	111	112	113	114	115	116	117			
Ans.	A	B	B	C	B	A	B			

EXERCISE - S

1. 0.209 M, 0.191 M, 9.13×10^{-3} M, 0

2. $[S^{2-}] = 2.5 \times 10^{-15}$M

3. $K_b \simeq 1.73 \times 10^{-5}$, 5.27

4. 10^{-5}M

5. pH = 11.48 , $[enH_2^{2+}] = 7.1 \times 10^{-8}$ M

6. 10.6

7. 2×10^{-4}M

8. pH = 10.52

9. $[OH^-] = 3.73 \times 10^{-2}$M, $[H_3PO_4] = 6 \times 10^{-18}$M

10. 8.35, 9.60, 4.66

11. 10^{-3}M

12. 83

13. 419

14. 6

15. 6

16. 25

17. 48

18. 4.5

19. 9.6

20. pH = 7.9 , pH = 7.3

21. 2.8×10^{-3} mole

22. 1.6×10^{-3}

23. $K_d = 1/K_f = 4.8 \times 10^{-4}$

24. 0.284

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	1	3	476	27	10	85	9079	2	5
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	186	10	2	3	233	9000	5	458	4	1

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	7	A	B	A	B	4.47	D	0.11	0.20	2.30 to 3.00
Que.	11	12	13							
Ans.	10.02	6	B							

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	2	3	2	3	2	3	1	3	3	3
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	2	4	2	3	3	3	2	2	3	2
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	6	3	5	3	5	9	2	4	2	7

JEE (Advanced) Practice Paper

Section-I	Q.	1	2	3	4	5	6	7	8	9
	A.	A	C	B	A	D	B	C	C	D
Section-II	Q.	10	11	12	13	14				
	A.	B,C	A,B,C	A,B,C	B,C	D				
Section-III	Q.	15	16							
	A.	C	A							
Section-IV	Q.	17	18							
	A.	A	B							
Section-V	Q.	19	20							
	A.	10.00	2.50							

Important Notes