2. IONIC EQUILIBRIUM- MCQS

Acid-Base Concepts

1. An acid is a compound that gives H^+ in water, and a base is a compound that gives OH^- in water. This concept was proposed by
   a. Svante August Arrhenius b. J.N. Bronsted & Thomas Lowry c. G.N. Lewis d. Sorensen
2. Which of the following would not have been classified as a base by Arrhenius?
   a. CH_3OH b. KOH c. LiOH d. $Mg(OH)_2$
3. Which of the following is a limitation of Arrhenius' concept of acid and base?
   a. The concept is limited to water b. H^+ and OH^- do not exist in a free state
   c. There is a base which does not have OH^- d. All of the above
4. The protonic concept of acid and base is given by
   a. Bronsted and Lowry b. Lewis c. Arrhenius d. Ostwald
5. Proton donors are called:
   a. Lewis bases b. Lewis acids c. Bronsted acids d. Bronsted bases
6. Which of the following statements is in agreement with the Brønsted–Lowry concept?
   a) A base is an electron-pair donor.
   b) Acids and bases are proton donors and acceptors, respectively.
   c) Acids and bases are substances that increase H^+ and OH^- concentrations in water.
   d) Acids and bases are proton acceptors and proton donors, respectively.
7. Which of the following does not act as a Brønsted-Lowry acid?
   a. CH_3COO^- b. HCO_3^- c. NH_4^+ d. HSO_3^-
8. Which of the following is a Brønsted acid?
   a) Cl^- b) HCO_3^- c) $HCOO^-$ d) CH_3COO^-
9. Which of the following is a Brønsted–Lowry base?
   a) HCl b) NH_3 c) H_2SO_4 d) CH_3COOH
10. Which of the following can act both as a Bronsted-Lowry acid and a Brønsted- Lowry base?
    a. CO_3^{-2} b. HSO_4^- c. BF_3 d. H_3O^+
11. Which of the following substances can act only as a proton donor?
    a) HSO_4^- b) H_2O c) NH_4^+ d) HCO_3^-
12. In the reaction $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$, which of the following constitutes a conjugate acid-base pair?
    a. NH_3 and H_2O b. NH_4^+ and OH^- c. H_2O and OH^- d. NH_3 and OH^-
13. The two chemical species that differ by one H^+ are
    a. conjugate acid b. conjugate base c. conjugate acid base pair d. amphoteric substances
14. In the equilibrium reaction shown below, which species are a conjugate acid-base pair?
    $CH_3CH_2CH_2COOH + H_2O \rightleftharpoons CH_3CH_2CH_2COO^- + H_3O^+$
    A. $CH_3CH_2CH_2COOH$ and H_2O **B**. H_2O and H_3O^+
    C. H_2O and $CH_3CH_2CH_2COO^-$ **D**. $CH_3CH_2CH_2COO^-$ and H_2O
15. In which reaction is water behaving as a Brønsted–Lowry base?
    A $H_2O + Na \rightarrow NaOH + 1/2H_2$ **B** $H_2O + H_3PO_4 \rightarrow H_3O^+ + H_2PO_4$
    C $H_2O + CaO \rightarrow Ca(OH)_2$ **D** $NH_3 + [Cu(H_2O)_6]^{2+} \rightarrow NH_4^+ + [Cu(H_2O)_5(OH)]^+$
16. The conjugate base of $H_2PO_4^-$ is:
    a) H_3PO_4 b) HPO_4^{2-} c) PO_4^{3-} d) $H_4PO_4^+$
17. The conjugate acid of HPO_4^{2-} is
    a. H_3PO_4 b. $H_2PO_4^-$ c. PO_4^{3-} d. H_3O^+
18. The conjugate acid of NH_3 is:
    a) NH_2^- b) NH_4^+ c) NH_2^+ d) OH^-
19. The conjugate acid of NH_2^- is
    a. NH_3 b. NH_4^+ c. NH_2OH d. N_2H_4
20. The conjugate base of HSO_4^- is:
    a) SO_4^{2-} b) H_2SO_4 c) SO_3^{2-} d) HSO_3^-
21. In $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$, Cl^- is:
    a) Conjugate base to HCl b) Conjugate acid to HCl c) Conjugate base to H_2O d) Conjugate acid to H_2O
22. In the system $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$ the conjugate pairs are
    a. NH_4^+/NH_3 & H_2O/H_3O^+ b. NH_4^+/H_3O^+ & H_2O/NH_3 c. NH_4^+/H_2O &NH_3/H_3O^+ d. Only NH_4^+ and H_3O^+
23. The conjugate acid of a strong base is a
    a. Strong acid b. Weak acid c. Strong base d. Weak base

24. The relative strength of an acid is affected by various factors. Which of the following best explains acid strength?
    a) Its pH value. b) The stability of its conjugate base.
    c) The amount of water it can dissolve in. d) Both a and b.
25. Which of the following is the strongest conjugate base
    a. Cl- b. CH_3COO- c. SO_4^{--} d. NO_3-
26. In the Lewis system, a base is defined as
    a. An electron-pair acceptor b. An electron-pair donor c. A proton donor d. A proton acceptor
27. According to the Lewis concept, an acid is a substance that
    a. Accepts a proton b. Donates a proton
    c. Accepts a lone pair of electrons d. Donates a lone pair of electrons
28. All nucleophiles are
    a. Arrhenius acid b. Bronsted base b. Lewis base d. Lewis acid
29. A Lewis base must have:
    a) An unshared pair of electrons. b) A proton-donor capability.
    c) A hydroxide group. d) None of these.
30. Find out the false statement among the following;
    a. HCl is both an Arrhenius and a Bronsted acid.
    b. NH_3 is both a Bronsted base and a Lewis base.
    c. Lewis acids are electron pair acceptors, and Lewis bases are electron pair donors.
    d. Bronsted acids produce H^+ ions, and Bronsted bases give OH^- ions.
31. NH_3 is a base and BF_3 is an acid according to
    a. Arrhenius concept b. Bronsted-Lowry concept c. Lewis concept d. Ivanovic concept
32. An example of a Lewis base is
    (a) BF_3 (b) $AlCl_3$ (c) $FeCl_3$ d) NH_3
33. Which of the following can act as a base according to the Lewis concept?
    a. Cl^- b. Na^+ c. H^+ d. K
34. Which of the following is a Lewis acid?
    a) NH_3 b) H_2O c) BF_3 d) OH^-
35. A Lewis acid is a lone-pair acceptor. Which of the following is not a Lewis acid?
    a) BF_3 b) $AlCl_3$ c) NH_3 d) H^+
36. H^+ can be regarded as an acid according to which concept?
    a. Arrhenius concept b. Bronsted-Lowry concept c. Lewis concept d. H_3O^+ concept

Ionisation of Electrolytes and Ostwald's Law

37. NaCl conducts electricity due to the presence of
    a. free electrons b. free ions c. free molecules d. atoms of Na and Cl
38. Which of the following is a non-electrolyte?
    a) NaOH b) HCl c) Glucose d) NH_4Cl
39. An aqueous solution of acetic acid contains
    a. CH_3COO^- and H^+ b. CH_3COO^-, H_3O^+ and CH_3COOH c. CH_3COO^- and H_3O^+ d. CH_3COOH, CH_3COO^- and H^+
40. Acetic acid is a weak acid because
    a. It is unstable b. It is an organic aliphatic acid c. It is slightly ionised d. None of these
41. Strong acid:
    A) HCl B) NH_4OH C) NaOH D) CH_4
42. Which acid is the weakest among the following?
    a) HCl b) HNO_3 c) H_2SO_4 d) CH_3COOH
43. Ostwald's dilution law applies to the ionisation of
    a. HCl b. NH_4OH c. CH_3COONa d. NaOH
44. Ostwald's dilution law applies to
    a. HNO_3 b. HNO_2 c. HCl d. HNO_2 + HCl
45. The degree of ionisation of a weak electrolyte
    a. Increases with dilution c. decreases with dilution
    b. May increase or decrease with dilution d. Is not affected by dilution
46. If the concentration of a weak acid solution is doubled, its degree of ionisation will:
    a) Increase b) Decrease c) Remain unchanged d) Become 100%
47. According to Ostwald's dilution law, the degree of ionisation is proportional to:
    a) √C b) 1/C c) 1/√C d) C^2

48. According to Ostwald's dilution law, which of the following is true about the degree of ionisation of a weak electrolyte?
    a) It is inversely proportional to its concentration. b) It is directly proportional to its concentration.
    c) It is independent of its concentration. d) It is inversely proportional to temperature.
49. The fraction of total molecules ionised in a solution is called
    A. Dissociation constant B. Mole fraction C. Degree of ionisation D. None
50. The degree of ionisation of an electrolyte does not depend upon
    a. temperature b. nature of the solute c. colour of the solution d. concentration of the solution
51. If a 0.01 M solution of acetic acid is 0.01% ionised, what will be the dissociation constant of acetic acid?
    a. 1×10^{-3} c. 1×10^{-6} b. 1×10^{-8} d. 1×10^{-10}
52. The degree of ionisation of 0.2 M formic acid is 3.2%, its ionisation constant is
    a. 9.6×10^{-3} b. 2.0×10^{-4} c. 1.25×10^{-6} d. 4.8×10^{-5}

pH

53. The ionic product of water (Kw) at 25°C is:
    a) 1×10^{-14} b) 1×10^{-7} c) 7×10^{-7} d) 14
54. The value of the ionic product of water at 393 K is
    a. Less than 1×10^{-14} c. greater than 1×10^{-14} b. Equal to 1×10^{-15} d. equal to 1×10^{-7}
55. An aqueous solution having a pH = 0 is
    a. Neutral b. acidic c. basic d. amphoteric
56. The pH of pure water at 25°C is:
    a) 0 b) 1 c) 7 d) 14
57. The sum of the pH and pOH of a solution at 25 °C is
    a. 0 b. 7 c. 14 d. 1
58. Which one has the lowest pH value
    a. 1 M HCl b. 1 M HNO_3 c. 1 M H_2SO_4 d. 1 M NaOH
59. The pH of a 0.10 M acetic acid solution is
    a. 7 b. Greater than 1.0 c. 1.0 d. Less than 1.0
60. Which of the following solutions contains the largest concentration of OH^- ions?
    a) pH = 2 b) pH = 5 c) pH = 7 d) pH = 11
61. The pOH of a solution having pH = 5 is:
    a) 5 b) 7 c) 9 d) 14
62. The pH of a solution is zero. The solution is
    a. Neutral b. 1.0 N acid c. 1.0 N alkali d. Strongly alkaline
63. The pH of a solution is 4. The $[OH^-]$ of the solution is
    a. 10^{-4} M b. 10^{-10} M c. 10^{-11} M d. 10^{-12} M
64. The pH of a 0.01 M HCl solution is:
    a) 1 b) 2 c) 12 d) 13
65. The pH of a 0.63% HNO_3 solution is:
    a) 0 b) 1 c) 1.5 d) 2.5
66. A pH higher than 7 means a hydronium ion concentration
    A. $< 10^{-7}$ M B. $= 10^{-7}$ M C. $> 10^{-7}$ M D. $\geq 10^{-7}$ M
67. The $[H^+]$ in pure water is 10^{-7} M. An aqueous solution will be acidic if $[H^+]$ is
    a. 10^{-9} M b. 10^{-7} M c. 10^{-3} M d. None
68. 20 mL of 0.1 N HCl is mixed with 20 mL of 0.1 N KOH. The pH of the solution is
    A. 2 B. 7 C. 9 D. 0
69. The pH of a solution is 4. The $[H^+]$ is:
    a. 10^{-4} M b. 10^{-10} M c. 10^{-11} M d. 10^{-12} M
70. The pH of a 10^{-8} M aqueous solution of HCl is
    a. Less than 7 c. 7 b. 8 d. More than 8
71. A 10^{-5} M HCl solution is diluted 100 times. Its pH is:
    a. 6 b. 8 c. 6.95 d. 9.5
72. The pH of a solution is 5. Its H^+ ion concentration is reduced by a factor of 100. The solution becomes
    a) acidic b) basic c) neutral d) amphoteric
73. When an acidic solution of pH = 5 is diluted with water, it becomes:
    a) More acidic b) Less acidic c) Neutral d) Basic

74. The pH of 0.015 N NaOH is
a. 1.82 b. 8.23 c. 12.18 d. 10.57
75. The pH of 0.01N NaOH is
a. 1.82 b. 8.23 c. 12.18 d. 10.57
76. A solution contains 2×10^{-3} moles of OH^- ions in 2 litres of water. Its pH is:
a) pH = 3 b) pH = 3 – log 2 c) pH = 11 d) Cannot be determined
77. Which of the following has the highest pH?
a) 0.1 M HCl b) 0.01 M HCl c) 0.1 M NaOH d) Pure water
78. Which solution has the highest pH value?
a) 10^{-2} M HCl b) 10^{-3} M NaOH c) Pure water d) 10^{-2} M NH_4OH
79. When a strong acid solution having a pH of 5 is diluted 100-fold, the resultant pH of the diluted solution is
b. Less than 7 b. More than 7 c. Equal to 7 d. Always constant at 5
80. In a solution at equilibrium, what happens to the concentration of H+ ions if the concentration of OH- ions is increased?
a. The concentration of H+ ions increases. C. The concentration of H+ ions decreases.
b. The concentration of H+ ions stays the same d. It depends on the initial concentration of H+ ions
81. At 25°C, pKw is
a. 7 b. 14 c. 10^{-4} d. 10^{-7}
82. The acid dissociation constant (Ka) of a strong acid is:
a) Very small b) Zero c) Very large d) Equal to one
83. Which statement is true for a strong acid?
a) It has a small Ka value. b) It is only partially ionised.
c) Its conjugate base is very weak. d) Its pH is always zero
84. Which acid has the highest pKa value?
a) HCl b) HF c) HNO_2 d) CH_3COOH
85. A strong acid is characterised by
a. high $[H^+]$, high K_a, & low pK_a b. low $[H^+]$, low K_a, & high pK_a
c. high $[H^+]$, high K_a & high pK_a d. low $[H^+]$, low K_a, & low pK_a
86. The pH of rainwater is often slightly below 7, mainly because of dissolved:
a) Oxygen b) Nitrogen c) Carbon dioxide d) Hydrogen

Solubility Product and Solubility Product Principle

87. The solubility product (Ksp) applies to:
a) Highly soluble salts b) Sparingly soluble salts c) Strong acids d) Strong bases
88. Ksp is equal to the ionic product in ...
a. dilute solution b. saturated solution c. unsaturated solution d.supersaturated solution
89. Which condition indicates a saturated solution of a sparingly soluble salt?
a) Ionic product < Ksp b) Ionic product > Ksp c) Ionic product = Ksp d) Solubility = 0
90. For the precipitation of a substance
a. I P = Ksp b. I P > Ksp c. I P < Ksp d. both b or c
91. The expression for the solubility product for the system $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$ is
a. $[Pb^{2+}]^2[Cl^-]^2$ b. $[Pb^{2+}][Cl^-]^2$ c. $[Pb^{2+}]^2[Cl^-]$ d. $[Pb^{3+}][Cl^-]$
92. The solubility product of CaF_2 is:
A. $[Ca^{2+}][F^-]^2$ B. $[Ca^{2+}][2F^-]$ C. $[Ca^{2+}]2 \times [F^-]$ D. $[Ca^{2+}][F^-]$
93. For Ag_2S, the relation between Ksp and solubility s:
a) $Ksp = 4s^2$ b) $Ksp = 4s^3$ c) $Ksp = 108s^5$ d) $Ksp = s^2$
94. The solubility product of a sparingly soluble salt A_2B is 4.0×10^{-12} at 298 K. Its molar solubility is ...
a. 4.0×10^{-3} b. 4.0×10^{-4} c. 1.0×10^{-6} d. 1.0×10^{-4}
95. If the solubility of Bi_2S_3 is s,
$Bi_2S_3 \rightleftharpoons 2Bi^{3+} + 3S^{2-}$
Its solubility product will be
a. $8s^2$ b. $27s^3$ c. 108s d. $108s^5$
96. Equal volumes of two solutions containing Ba^2 and SO_4^2 ions separately are mixed. Which will give a precipitate of $BaSO_4$? (Ksp for $BaSO_4 = 1.5 \times 10^{-9}$)
a. 10^{-5} M Ba^{2+} and 10^{-5} M SO_4^{2-} b. 10^{-6} M Ba^{2+} and 10^{-6} M SO_4^{2-}
c. 10^{-7} M Ba^{2+} and 10^{-7} M SO_4^{2-} d. 10^{-3} M Ba^{2+} and 10^{-3} M SO_4^{2-}

Common Ion Effect

97. The common ion effect decreases:
    a) Solubility of a sparingly soluble salt b) Temperature
    c) Degree of ionisation of a strong electrolyte d) Ionic product of water
98. When HCl gas is passed through a saturated solution of NaCl, the solubility of NaCl
    a. Increases b. Decreases c. Does not change d. NaCl is decomposed
99. What happens when sodium acetate is added to acetic acid?
    a) Ionisation of acetic acid increases b) Ionisation of acetic acid decreases
    c) No effect on ionisation d) Acetic acid becomes completely ionised
100. Pure solid NaCl is prepared by passing HCl gas into a saturated NaCl solution. This is based on the principle of
    a. Henry's Principle b. Displacement law c. Common-ion effect d. Fractional crystallization
101. The addition of HCl will not decrease the ionisation of
    a. CH_3COOH b. C_6H_5COOH c. H_2S d. H_2SO_4
102. In which of the following combinations can the common ion effect not be observed?
    a. $HCl + CH_3COOH$ c. $CH_3COOH + NH_4OH$ b. $NH_4OH + KOH$ d. $NaOH + NH_4OH$
103. Which of the following solutions has the lowest solubility for AgCl?
    a) Distilled water b) 0.01 M NaCl c) 0.10 M NaCl d) 0.001 M NaCl

Buffer solution and its application

104. The pH of a solution remains almost unaffected on the addition of a few drops of an acid, alkali, or water; such a solution is known as
    a. Neutral solution b. Colloidal solution c. Buffer solution d. Saturated solution
105. A buffer solution resists changes in:
    a) Temperature b) Pressure c) pH d) Volume
106. When 1.0 mL of dilute HCl is added to 100 mL of a buffer solution of pH 4.0, the pH of the solution
    a. Becomes 7.0 b. Does not change c. Becomes 2.0 d. Becomes 10.0
107. An acidic buffer solution can be prepared by mixing the solutions.
    a. NaCl and NaOH b. H_2SO_4 and Na_2SO_4 c. CH_3COOH and CH_3COONa d. NH_4Cl and NH_4OH
108. Which of the following is an acidic buffer?
    a) $NH_4OH + NH_4Cl$ b) HCl + NaCl c) $CH_3COOH + CH_3COONa$ d) NaOH + NaCl
109. Which of the following cannot act as a buffer solution?
    a) $CH_3COOH + CH_3COONa$ b) $NH_3 + NH_4Cl$ c) $HCl + NH_4Cl$ d) $H_2CO_3 + NaHCO_3$
110. Which of the following is not a buffer solution
    a. $CH_3COOH + CH_3COONa$ b. HCl + NaCl c. $NH_4OH + NH_4Cl$ d. $C_6H_5COOH + C_6H_5COONa$
111. Which of the following pairs can resist a change in pH even after the addition of two drops of NaOH solution?
    a) HCl and NaOH b) CH_3COOH and CH_3COONa c) NaCl and NaOH d) HNO_3 and NH_4OH
112. A chemical factory requires the use of CH_3COOH in its processes, but it needs to maintain a slightly higher, constant pH in the acidic range. Which compound should they add?
    a. NaOH b. NH_4OH c. HCl d. CH_3COONa
113. A mixture of a weak acid (e.g., acetic acid) and its salt with a strong base (e.g., sodium acetate) acts as a buffer solution. Which of the following pairs has similar properties
    a. HCl and NaOH b. NaOH and $NaNO_3$ c. KOH and KCl d. NH_4OH and NH_4Cl

Selection of Indicators in Acid-Base Titration and pH Curve

114. Acid turns blue litmus:
    A) blue B) red C) green D) yellow
115. Methyl orange gives red colour in
    A. Sodium carbonate solution B. Sodium chloride solution
    C. Hydrochloric acid solution D. Potassium hydroxide solution
116. Acid-base indicators are
    a. weak organic acid b. weak organic acid or base c. weak organic base d. inorganic acid or base
117. Colour changing pH range of methyl orange is
    a. 3.2 - 3.8 b. 3.8 - 4.4 c. 3.1 - 4.5 d. 8.2 - 10
118. The proper indicator for a strong base and weak acid titration is
    a. Phenolphthalein c. Methyl orange b. Methyl red d. Methyl yellow
119. Which indicator is used to titrate a strong acid against a weak base?
    a) Phenolphthalein b) Litmus solution c) Methyl orange d) Universal indicator

120. Phenolphthalein is suitable for titrations involving:
a) Strong acid and strong base. b) Weak acid and weak base.
c) Weak acid and strong base. d) Both a and c.

121. Phenolphthalein is not suitable for the titration of
A. NaOH and oxalic acid B. HCl and K_2CO_3 C. HCl and KOH D. KOH and H_2SO_4

122. Phenolphthalein cannot be used as an indicator for the titration between:
a. NaOH against oxalic acid c. Ferrous sulphate against KMnO4
b. NaOH against HCl d. NaOH against H_2SO_4

123. In the titration of dil. HCl versus standard Na_2CO_3 solution, which of the following is a suitable indicator?
A) Methyl yellow B) Methyl orange C) Phenolphthalein D) Litmus

124. For the titration of Na_2CO_3 and H_2SO_4, the suitable indicator is
a. phenolphthalein b. methyl orange c. thymol blue d. none

Types of salts

125. Which of the following is a double salt?
a) $K_4[Fe(CN)_6]$ b) $[Cu(NH_3)_4]SO_4$ c) $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$ d) $Na_2[Zn(OH)_4]$

126. Which of the following acts as a complex ion?
a) Na^+ b) Cl^- c) $[Cu(NH_3)_4]^{2+}$ d) H^+

127. A complex salt contains:
a) Two cations or two anions. b) A metal atom surrounded by ligands.
c) Simple ions only. d) Both a and b.

128. $KHSO_4$ is
a. acid b. base c. acid salt d. normal salt

129. Phosphoric acid can form how many different sodium salts upon partial or complete neutralisation?
a. 1 b. 2 c. 3 d. 4

130. Which of the following salts is obtained by partial neutralisation of a polybasic acid?
a) Na_2SO_4 b) KNO_3 c) $NaHSO_4$ d) NaCl

Hydrolysis of Salts

131. When a pinch of NaCl is added to water, its pH
a. increases b. remains the same c. decreases d. none of the above

132. An aqueous solution of KCN is
a. amphoteric c. acidic b. basic d. neutral

133. Which of the following will have the highest pH in a water solution?
a. NaCl b. Na_2CO_3 c. KCl d. $CuSO_4$

134. An aqueous solution of aluminium sulphate would show
a. An acidic reaction b. a neutral reaction c. A basic reaction d. both basic and acidic reactions

135. What is the nature of an aqueous solution of $CuSO_4$?
A) Alkaline B) Neutral C) Acidic D) Depends on concentration

136. Hydrolysis of a salt can result in an acidic, basic, or neutral solution. Which of the following solutions will be acidic due to hydrolysis?
a) NaCl b) NH_4Cl c) KNO_3 d) Na_2SO_4

137. The pH of a solution of NH_4Cl is expected to be:
a) Less than 7 b) Equal to 7 c) Greater than 7 d) 14

138. Which salt will produce a neutral solution on hydrolysis?
a) NH_4NO_3 b) Na_2CO_3 c) KCl d) CH_3COONa

139. $FeCl_3$ solution is
a. Acidic b. Basic c. Neutral d. Amphoteric

140. The compound whose 0.10 M solution is basic is
a. Ammonium acetate b. Ammonium chloride c. Ammonium sulphate d. Sodium acetate

141. An aqueous solution of sodium acetate is
a. Neutral b. Weakly acidic c. Strongly acidic d. Alkaline

142. Which of the following will not be hydrolysed?
a. KCl b. $CuNO_3$ c. K_2CO_3 d. KCN

*** ... ***