HYDROGEN

1. The percentage of para hydrogen in ordinary hydrogen increases when:
   a) Temperature is lowered
   b) Temperature is increased
   c) Pressure is increased and temperature is decreased.
   d) None of the above
2. Manufacture of H_2 is made by:
   a) Lane's process b) Bosch process c) From natural gas d) All of these
3. H_2O_2 on treatment with chlorine gives:
   a) H_2 b) Oxygen c) Hypochlorous acid d) ClO_2
4. Radioactive isotope of hydrogen is
   a) Tritium b) Deuterium c) *Para* hydrogen d) *Ortho hydrogen*
5. K_a of H_2O_2 is of the order of
   a) 10^{-12} b) 10^{-14} c) 10^{-16} d) 10^{-10}
6. The hardness of water is estimated by
   a) EDTA method b) Titrimetic method c) Conductivity method d) Distillation method
7. The $H-O-O$ bond angle in H_2O_2 is
   a) 107.28° b) 97° c) 104.5° d) 109.28°
8. Hydrogen loses its electron to form H^+ion. In this respect it resembles to:
   a) Transition metals b) Alkali metals c) Halogens d) Noble gases
9. $TiH_{1.73}$ is an example of :
   a) Ionic hydride b) Covalent hydride c) Metallic hydride d) Polymeric hydride
10. The decomposition of H_2O_2 can be slowed down by the addition of small amount of phosphoric acid which acts as:
    a) Stopper b) Detainer c) Inhibitor d) promoter
11. The ortho and para hydrogen possess:
    a) Same physical properties but different chemical properties
    b) Different physical properties but same chemical properties
    c) Same chemical and physical properties
    d) Different, physical and chemical properties
12. The volume strength of 1.5 N H_2O_2 solution is
    a) 4.8 b) 8.4 c) 4.2 d) 2.4
13. Which of the following is correct about heavy water?
    a) Water at 4°C having maximum density is known as heavy water
    b) It is heavier than water(H_2O)
    c) It is formed by the combination of heavier isotope of hydrogen and oxygen
    d) None of the above
14. Which is not present in clear hard water?
    a) $Mg(HCO_3)_2$ b) $CaCl_2$ c) $MgSO_4$ d) $MgCO_3$
15. Which of the following is not correct regarding the electrolytic preparation of H_2O_2?
    a) Lead is used as cathode b) 50% H_2SO_4 is used
    c) Hydrogen is liberated at anode d) Sulphuric acid undergoes oxidation

16. Electrolysis of *X* gives *Y* at anode. Vacuum distillation of *Y* gives H_2O_2. The number of peroxy (O - O) bonds present in *X* and *Y* respectively are
a) 1.1 b) 1.2 c) Zero, 1 d) Zero, zero
17. When H_2O_2 is added to acidic ferrous sulphate solutions:
a) Electrons are gained by Fe^{2+}
b) Electrons are lost by Fe^{2+}
c) There is no loss or gain of electrons
d) Iron hydroxide precipitates
18. Which of the following reactions produces hydrogen?
a) $H_2S_4O_8 + H_2O$ b) $BaO + HCl$ c) $Mg + H_2O$ d) $Na_2O_2 + 2HCl$
19. H_2O_2 is formed by which of the following compounds?
a) Na_2O_2 b) NaOH c) Na_2O d) KO_2
20. Which of the following acts as both reducing and oxidising agents?
a) H_2SO_4 b) H_2O_2 c) KOH d) $KMnO_4$
21. The sum of protons, electrons and neutrons in the heaviest isotope of hydrogen is
a) 3 b) 5 c) 4 d) 6
22. On shaking H_2O_2 with acidified potassium dichromate and ether, ethereal layer becomes
a) Green b) Red c) Blue d) Brown
23. The acidified solution of $FeCl_3$ is reduced by passing:
a) ordinary H_2 b) O_2 c) nascent H d) H_2
24. Hydrogen does not combine with
a) Helium b) Bismuth c) Antimony d) Sodium
25. H_2 acts as an oxidant in its reaction with:
a) Br_2 b) Ca c) N_2 d) S
26. Of the two solvents H_2O and D_2O, NaCl dissolves:
a) Equally in both b) Only in H_2O c) More in D_2O d) More in H_2O
27. What is formed when calcium carbide react with heavy water?
a) C_2D_2 b) CaD_2 c) CaD_2O d) CD_2
28. When different metals like Zn, Sn, Fe are added to dilute sulphuric acid, same gas, which burns explosively in air, is evolved. The gas is:
a) O_2 b) N_2 c) Cl_2 d) H_2
29. Heavy water is represented as
a) $H_2\,{}^{18}O$ b) D_2O c) $D_2\,{}^{18}O$ d) H_2O at 4°C
30. Which is not a water softener?
a) Calgon b) Permutit c) Na_2CO_3 d) Na_2SO_4
31. The boiling point of heavy water is:
a) 100°C b) 101.4°C c) 104°C d) 102.5°C
32. The volume of oxygen liberated from 15mL of 20 volume H_2O_2 is
a) 250mL b) 300mL c) 150mL d) 200mL
33. Decomposition of H_2O_2 is prevented by
a) KOH b) MnO_2 c) Acetanilide d) Oxalic acid
34. The boiling point of water is high because
a) Water molecule is linear
b) Water molecule is not linear
c) Water molecules possess covalent bond between H and O
d) Water molecules associate due to H-bonding
35. The volume of '10 vol.' of H_2O_2 required to liberate 500 mL O_2 at NTP is:
a) 50 mL b) 25 mL c) 100 mL d) 125 mL
36. Which of the following pairs of ions make the water hard?
a) NH_4^+, Cl^- b) Ca^+, HCO_3^- c) Ca^{2+}, NO_3^- d) Na^+, SO_4^{2-}

37. Which of the following gas is insoluble in water?
a) SO_2 b) NH_3 c) H_2 d) CO_2

38. Which will produce hard water?
a) Saturation of water with $CaSO_4$
b) Addition of Na_2SO_4 to water
c) Saturation of water with $CaCO_3$
d) Saturation of water with $MgCO_3$

39. In Bosch's process which gas is utilised for the production of hydrogen gas?
a) Producer gas b) Water gas c) Coal gas d) None of these

40. Triple point of water is
a) 203 K b) 193 K c) 273 K d) 373 K

41. The hybridization of the orbitals of oxygen in H_2O_2 is:
a) sp^3d b) sp c) sp^2 d) sp^3

42. Which of the following pairs will not produce dihydrogen gas?
a) Cu + HCl (dil.) b) Fe + H_2SO_4 c) Mg + steam d) Na + alcohol

43. Calgon used as water softner is
a) $Na_2[Na_4(PO_3)_6]$ b) $Na_4[Na_2(PO_3)_6]$ c) $Na_2[Na_4(PO_4)_5]$ d) None of these

44. Permutit is:
a) Hydrated sodium aluminium silicate
b) Sodium hexa meta-phosphate
c) Sodium silicate
d) Sodium meta-aluminate

45. The rubber foam is produced by passing oxygen through rubber foaming material. This oxygen is released from:
a) Nitric oxide b) Hydrogen peroxide c) Water d) CO_2

46. Which is the poorest reducing agent?
a) Atomic hydrogen b) Nascent hydrogen
c) Dihydrogen d) All have same reducing strength

47. In context with the industrial preparation of hydrogen from water gas (CO + H_2) which of the following is the correct statement.
a) CO and H_2 are fractionally separated using differences in their densities
b) CO is removed by absorption in aqueous Cu_2Cl_2 solution
c) H_2 is removed through occlusion with Pd
d) CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali

48. The number of radioactive isotopes of hydrogen is:
a) 1 b) 2 c) 3 d) None of these

49. The oxidation number of oxygen in hydrogen peroxide is
a) + 1 b) - 1 c) + 2 d) - 2

50. The normality of 30 volume H_2O_2 is
a) 2.678 N b) 5.336 N c) 8.034 N d) 6.685 N

51. Acidified solution of chromic acid on treatment with H_2O_2 yields:
a) $CrO_3 + H_2O + O_2$ b) $Cr_2O_2 + H_2O + O_2$ c) $CrO_5 + H_2O + K_2SO_4$ d) $H_2Cr_2O_7 + H_2O + O_2$

52. The hair dyes available in the market generally contain two bottles, one containing the dye and the other hydrogen peroxide. Before applying the dye, the two solutions are mixed. The hydrogen peroxide.
a) Is added to dilute the solution of the dye
b) Oxidises the dye to give the desired colour
c) Reduces the dye to give the desired colour
d) Acidifies the solution of the dye

53. In periodic table tritium is placed in group:
a) I b) II c) III d) IV

54. The *ortho* and *para* hydrogen differ in respect of which of the following?
    a) In the molecular weight
    b) In the nature of spin of protons
    c) In the nature of spin of electrons
    d) In the number of protons
55. The bond energy of covalent O—H bond in water is:
    a) Equal to bond energy of hydrogen bond
    b) Greater than bond energy of hydrogen bond
    c) Lesser than bond energy of hydrogen bond
    d) None of the above
56. Water acts as excellent solvent due to:
    a) Hydrogen bonding
    b) Neutral nature
    c) High dielectric constant
    d) None of the above
57. $TiH_{1.73}$ is an example of which type of the hydride?
    a) Metallic b) Ionic c) Covalent d) Polymeric
58. An aqueous solution of hydrogen peroxide is
    a) Alkaline b) Neutral c) Strongly acidic d) Weakly acidic
59. The O—O bond length in H_2O_2 is:
    a) 1.54 Å b) 1.48 Å c) 1.34 Å d) 1.01 Å
60. Moist hydrogen peroxide cannot be dried over conc. H_2SO_4 because
    a) It can catch fire
    b) It is reduced by H_2SO_4
    c) It is oxidised by H_2SO_4
    d) It is decomposed by H_2SO_4
61. The strength in volumes of a solution containing 30.36g/L of H_2O_2 is
    a) 10 volume b) 20 volume c) 5 volume d) None of these
62. Tritium emits:
    a) α-particles b) β-particles c) γ-rays d) Neutrons
63. The ratio of electron, proton and neutron in tritium is:
    a) 1 : 1 : 1 b) 1 : 1 : 2 c) 2 : 1 : 1 d) 1 : 2 : 1
64. Hydrogen directly combines with
    a) Cu b) Au c) Ca d) Ni
65. In which of the following reactions, H_2O_2 is acting as a reducing agent?
    a) $SO_2 + H_2O_2 \rightarrow H_2SO_4$
    b) $2KI + H_2O_2 \rightarrow 2KOH + I_2$
    c) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$
    d) $AgO_2 + H_2O_2 \rightarrow 2Ag + H_2O + O_2$
66. Permutit is the technical name given to
    a) Aluminates of calcium and sodium
    b) Hydrated silicate of aluminium and sodium
    c) Silicates of calcium and magnesium
    d) Silicates of calcium and sodium
67. The best method to test whether a clear liquid is water, is to:
    a) Taste the liquid
    b) Smell the liquid
    c) Add litmus paper
    d) Add few drops on anhydrous copper sulphate and look for colour change
68. An inorganic compound liberates O_2 when heated, turns an acid solution of KI brown and reduces acidified $KMnO_4$. The substance is:
    a) H_2O_2 b) D_2O c) KNO_3 d) $Pb(NO_3)_2$
69. Heavy water is qualified as heavy because it is:
    a) A heavy liquid
    b) An oxide of a heavier isotope of oxygen
    c) An oxide of deuterium
    d) Denser than water
70. Permanent hardness can be removed by adding

a) Cl_2 b) Na_2CO_3 c) Ca (OCl) Cl d) K_2CO_3

71. The ionization energy of hydrogen is:
    a) Lower than alkali metals
    b) Lower than halogens
    c) Closer to alkali metals
    d) Closer to halogens
72. Which one of the following reactions represents the oxidising property of H_2O_2?
    a) $2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$
    b) $2K_3[Fe(CN)_6] + 2KOH + H_2O_2 \rightarrow 2K_4[Fe(CN)_6] + 2H_2O + O_2$
    c) $Pb_2 + H_2O_2 \rightarrow PbO + H_2O + O_2$
    d) $2KI + H_2SO_4 + H_2O_2 \rightarrow K_2SO_4 + I_2 + 2H_2O$
73. Hydrogen peroxide is prepared in the laboratory by
    a) Passing CO_2 into BaO_2 b) Adding MnO_2 to dil. H_2SO_4
    c) Adding Na_2O_2 to cold water d) Adding PbO_2 into $KMnO_4$
74. Heavy water is
    a) Water at 0°C
    b) Water containing Fe, Cr, Mn
    c) D_2O
    d) Water obtained after a number of distillations
75. *Ortho* and *para* hydrogen differ in
    a) Nuclear charge b) Nuclear reaction c) Electron spin d) Proton spin
76. Hydrogen peroxide is manufactured by the auto-oxidation of:
    a) 2-ethylanthraquinol b) Anthraquinone c) Naphthalene d) Anthracene
77. What is the product of the reaction of H_2O_2 WITH Cl_2?
    a) $O_2 + HOCl$ b) $HCl + O_2$ c) $H_2O + HCl$ d) $HCL + H_2$
78. One mole of calcium phosphide on reaction with excess water gives:
    a) One mole of phosphene
    b) Two moles of phosphoric acid
    c) Two moles of phosphine
    d) One mole of phosphorus pentaoxide
79. Hydrogen may be prepared by heating a solution of caustic soda with:
    a) Mg b) Zn c) Fe d) Ag
80. H_2O_2 is manufactured these days
    a) By the action of H_2O_2 on BaO_2 b) By the action of H_2SO_4 on Na_2O_2
    c) By electrolysis of 50% H_2SO_4 d) By burning hydrogen in excess of oxygen
81. On bubbling CO_2 through a solution of barium peroxide in water:
    a) O_2 is formed b) H_2CO_3 is formed c) H_2O_2 is formed d) H_2 is formed
82. The most reactive state of hydrogen is:
    a) Atomic hydrogen b) Heavy hydrogen c) Molecular hydrogen d) Nascent hydrogen
83. The number of protons, electrons and neutrons respectively in a molecule of heavy water is:
    a) 10, 10, 10 b) 8, 10, 11 c) 10, 11, 10 d) 11, 10, 10
84. Ordinary hydrogen is a mixture at:
    a) 75% ortho H_2 + 25% para H_2
    b) 25% ortho H_2 + 75% para H_2
    c) 50% ortho H_2 + 50% para H_2
    d) 99% para H_2 + 1%ortho H_2
85. Heavy water freezes at:
    a) -3.8° C b) 3.8° C c) 0° C d) 3.2° C
86. The electronic configuration of deuterium is:
    a) $1s^2$ b) $1s^1, 2s^2$ c) $1s^2, 2s^1$ d) $1s^1$

87. Smell of H_2O_2 resembles:
a) Alcohol b) Alkali c) Nitric acid d) Chloroform

88. Hydrogen produced in contact with substance which is to be reduced is:
a) Ortho H_2 b) Para H_2 c) Active H d) Nascent H

89. H_2O_2 acts as an oxidizing agent in:
a) Neutral medium
b) Acidic medium
c) Alkaline medium
d) acidic as well as in alkaline medium

90. The concentration of H_2O_2 solution of '10 volume' is
a) 30% b) 3% c) 1% d) 10%

91. Water possesses a high dielectric constant, therefore
a) It always contains ions b) It is universal solvent
c) Can dissolve covalent compounds d) Can conduct electricity

92. Tailing of mercury is a laboratory test for:
a) O_3 b) Hg c) Cl_2 d) O_2

93. Which method cannot be used to remove hardness of water?
a) Clark's method
b) By adding washing soda
c) Calgon process
d) Filtration

94. Which of the following could act as a propellant for rockets?
a) Liq. H_2 + Liq. O_2 b) Liq. N_2 + Liq. O_2 c) Liq. H_2 + Liq. N_2 d) Liq. O_2 + Liq. Ar

95. When electric current is passed through an ionic hydride in the molten state,
a) Hydrogen is liberated at the cathode
b) Hydrogen is liberated at the anode
c) Hydride ion migrates towards cathode
d) No reaction takes place

96. Deuterium was discovered by:
a) Urey b) Aston c) Rutherford d) Chadwick

97. The percentage by weight of hydrogen in H_2O_2 is:
a) 50 b) 25 c) 6.25 d) 5.88

98. Ortho and para-hydrogen differ in the:
a) Number of protons b) Molecular weight c) Nature of spins of protons d) Nature of spins of electrons

99. Decomposition of H_2O_2 is retarded by:
a) Acetanilide b) Alcohol c) H_3PO_4 d) All of these

100. Heavy water possesses:
a) Insoluble impurities like silica
b) Impurities like carbonates and bicarbonates of calcium and magnesium
c) High density and different physical properties than those of water
d) The capacity to expedite the rate of nuclear reactions

101. Which element forms maximum compound in chemistry?
a) O b) H c) Si d) C

102. The bleaching properties of H_2O_2 are due to its:
a) Reducing properties b) Oxidizing properties c) Unstable nature d) Acidic nature

103. Which one of the following is called amphoteric solvent?
a) Ammonium hydroxide b) Chloroform
c) Benzene d) Water

104. The colour of hydrogen is

a) Yellow b) Orange c) Black d) Colourless

105. The amount of H_2O_2 present in 1 L of 1.5 *N* H_2O_2 solution is:
a) 2.5 g b) 25.5 g c) 3.0 g d) 8.0 g

106. H_2O_2 is prepared in the laboratory when:
a) MnO_2 is added to dilute cold H_2SO_4
b) BaO_2 is added to CO_2 bubbling through cold water
c) PbO_2 is added to an acidified solution of $KMnO_4$
d) Na_2O_2 is added to boiling water

107. Decolourisation of acidified potassium permanganate occurs when H_2O_2 is added to it. This is due to:
a) Oxidation of $KMnO_4$
b) Reduction of $KMnO_4$
c) Both oxidation and reduction of $KMnO_4$
d) None of the above

108. Which hydride is neutral?
a) H_2S b) H_2O c) H_2Se d) H_2Te

109. Hydrogen burns with:
a) Smoky flame b) Yellow flame c) Blue flame d) Pale yellow flame

110. Zeolites are extensively used in:
a) Softening of water and catalyst b) Preparing heavy water c) Increasing the hardness of water d) Mond's process

111. Deuterium, an isotope of hydrogen is:
a) Radioactive b) Non-radioactive c) Heaviest d) Lightest

112. Which is the lightest gas?
a) Nitrogen b) Hydrogen c) Helium d) Oxygen

113. Temporary harness is caused due to the presence of:
a) $CaSO_4$ b) $CaCl_2$ c) $CaCO_3$ d) $Ca(HCO_3)_2$

114. H_2O_2 is:
a) Diamagnetic b) Paramagnetic c) Ferromagnetic d) None of these

115. Commercial 11.2 volume H_2O_2 solution has a molarity of
a) 1.0 b) 0.5 c) 11.2 d) 1.12

116. The life period of atomic hydrogen is:
a) Only five minute
b) Only one third of a second
c) Only two hour
d) 10 second

117. There is a sample of 20 volume of hydrogen peroxide solution. Calculate its strength
a) 6.07% b) 3.035% c) 2.509% d) 4.045%

118. When the same amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide, the ratio of volumes of hydrogen evolved is:
a) 1 : 1 b) 1 : 2 c) 2 : 1 d) 9 : 4

119. Atomic hydrogen is obtained by:
a) Electrolysis of heavy water
b) Reaction of water with heavy metals
c) Thermal decomposition of water
d) Passing silent electric discharge through hydrogen at low pressure

120. Which loses weight on exposure to the atmosphere?
a) Concentrated H_2SO_4
b) Solid NaOH
c) A saturated solution of CO_2
d) Anhydrous sodium carbonate

121. Which can adsorb large volumes of hydrogen gas?
a) Colloidal solution of palladium
b) Finely divided nickel
c) Colloidal ferric hydroxide
d) Finely divided platinum

122. In the hydrogen peroxide molecule:
a) Two hydrogen atoms are connected to one of the oxygen
b) All the four atoms are in the same plane
c) The four atoms are arranged in a non-linear and non-planar manner
d) O—H bonds are polar but molecule is non-polar

123. Fluorine reacts with water to form:
a) Fluorine water b) Oxygen c) Ozone d) Oxygen, ozone

124. The hardness of water sample containing 0.002 mole of magnesium sulphate dissolved in a litre of water is expressed as
a) 20ppm b) 200ppm c) 2000ppm d) 120ppm

125. Adsorbed hydrogen by palladium is known as
a) Nascent b) Atomic c) Heavy d) Occluded

126. When hydrogen peroxide is added to acidified potassium dichromate, a blue colour is produced due to formation of
a) CrO_3 b) Cr_2O_3 c) CrO_5 d) CrO_4^{2-}

127. Which is false about H_2O_2?
a) Act as both oxidising and reducing agent
b) Two OH bonds lie in the same plane
c) Pale blue liquid
d) Can be oxidised by ozone

128. The reaction of $H_2S + H_2O_2 \rightarrow S + 2H_2O$ manifests
a) Reducing action of H_2O_2
b) Oxidising nature of H_2O_2
c) Alkaline nature of H_2O_2
d) Acidic nature of H_2O_2

129. The reagent commonly used to determine hardness of water titrimetrically is
a) Oxalic acid
b) Sodium thiosulphate
c) Sodium citrate
d) Disodium salt of EDTA

130. Ordinary hydrogen has preponderance of:
a) Hydrogen atoms
b) Deuterium atoms
c) Tritium atoms
d) The above three are in equal proportions

131. Benzene is oxidized by H_2O_2 in presence of $FeSO_4$ to :
a) Phenol b) Cyclohexane c) Benzaldehyde d) Benzoic acid

132. Which of the following is an example of interstitial hydride?
a) NH_3 b) CH_4 c) ZnH_2 d) H_2O

133. If water is boiled for sometime it becomes free from:
a) Permanent hardness
b) Temporary hardness
c) Suspended matter
d) Temporary hardness and dissolved gases

134. Polyphosphates are used as water softening agents because they
a) Form soluble complexes with anionic species
b) Precipitate anionic species
c) Precipitate cationic species
d) Form soluble complexes with cationic species

135. When two ice cubes are pressed over each other they unite to form one cube. Which of the following forces are responsible to hold them together?
    a) Ionic interaction
    b) Van der Waals' forces
    c) Covalent interaction
    d) Hydrogen bond formation
136. The pH of a solution of H_2O_2 is 6.0. Some chloride gas is bubbled into this solution. Which of the following is correct?
    a) The pH of resultant solution becomes 8.0
    b) Hydrogen gas is liberated from resultant solution
    c) The pH of resultant solution becomes less than 6.0 and oxygen gas is liberated
    d) Cl_2O is formed in the resultant solution
137. Permanent hardness of water can be removed by adding Calgon $(NaPO_3)_n$. This is an example of:
    a) Adsorption b) Exchange of ion c) Precipitation d) None of these
138. Hydrogen molecules are:
    a) Monoatomic and form X_2^{2-} ions
    b) Diatomic and form X_2^{2-} ions
    c) Diatomic and form X^- ions
    d) Monoatomic and form X^- ions
139. Hydrogen reacts with ..... even in the dark.
    a) Br_2 b) F_2 c) I_2 d) Cl_2
140. 1000 g aqueous solution of $CaCO_3$ contains 10 g of calcium carbonate. Hardness of the solution is:
    a) 10 ppm b) 100 ppm c) 1000 ppm d) 10000 ppm
141. Metal which does not react with cold water but evolves H_2 with steam is:
    a) Na b) K c) Pt d) Fe
142. The pair that yields the same gaseous product on reaction with water:
    a) K and KO_2 b) Ca and CaH_2 c) Na and Na_2O_2 d) Ba and BaO_2
143. The heaviest among the following is:
    a) Deuterium b) Helium c) Tritium d) Hydrogen
144. The molarity of a 100 mL solution containing 5.1 g of hydrogen peroxide is:
    a) 0.15 *M* b) 1.5 *M* c) 3.0 *M* d) 50.0 *M*
145. The metal that does not displace hydrogen from an acid is:
    a) Hg b) Zn c) Al d) Ca
146. Deionised water is obtained by passing hard water through
    a) Anion exchanger b) Zeolite
    c) Cation exchanger d) Both anion and cation exchanger
147. The strength in volumes of a solution containing 30.36 g/L of H_2O_2 is
    a) 10 V b) 5 V c) 20 V d) None of these
148. Hydrogen was discovered by:
    a) Scheele b) Berzelius c) Cavendish d) Priestley
149. Hard water becomes free from ..... ions when passed through ion exchange resin containing *R*COOH groups.
    a) Cl^- b) SO_4^{2-} c) H_3O^+ d) Ca^{2+}
150. The sum of number of neutrons and protons in one of the isotopes of hydrogen is:
    a) 3 b) 4 c) 5 d) 6
151. Water contracts on heating:
    a) To 100°C b) From 0°C to 4°C c) To 273 K d) From 10°C to 20°C
152. Hydrogen combines directly with:
    a) Ca b) Cu c) Zn d) Fe
153. H_2O_2 restores the colour of old lead paintings, blackened by the action of H_2S gas, by:

a) Converting PbO_2 to Pb
b) Oxidising PbS to $PbSO_4$
c) Converting $PbCO_3$ to Pb
d) Oxidising $PbSO_3$ to $PbSO_4$

154. 10 volumes of H_2O_2 has a strength of approximately:
a) 3% b) 30% c) 10% d) 5%

155. Ammonium persulphate solution on heating under reduced pressure gives:
a) H_2O_2 b) O_2 c) H_2 d) $(NH_4)_2SO_4$

156. Which statement about zeolite is false?
a) They are used as cation exchanger
b) They have open structure which enables them to take up small molecules
c) Zeolites are alumino silicates having three dimensional network
d) Some of the SiO_4^{4-} units are replaced by AlO_4^{5-} and AlO_6^{9-} ions in zeolites

157. Which of the following metal evolves hydrogen on reacting with cold dilute HNO_3?
a) Fe b) Cu c) Al d) Mg

158. The reaction of water with sodium and potassium is
a) Endothermic b) Reversible
c) Exothermic d) Irreversible and endothermic

159. High boiling point of water is due to:
a) Its high specific heat
b) Hydrogen bonding
c) High dielectric constant
d) Low dissociation constant

160. Ozone reacts with H_2O_2 to give oxygen. One volume of ozone gives:
a) One volume of oxygen
b) Half volume of oxygen
c) 1.5 volume of oxygen
d) Two volumes of oxygen

161. Which of the following statements do not define the characteristic property of water "water is a universal solvent".?
a) It has high liquid range
b) It has very low dielectric constant
c) It can dissolve maximum number of compounds
d) None of the above

162. Sodium zeolite is:
a) $NaAlSi_2O_6$ b) $Na_2Al_2Si_2O_3$ c) $Na_2Al_2Si_2O_8$ d) $NaAl_2Si_2O_8$

163. Acidified $KMnO_4$ is decolourised by:
a) Oxygen b) Hydrogen c) Nitric oxide d) Nascent hydrogen

164. The oxidizing property of H_2O_2 is best explained by assuming that two oxygen atoms in its molecule are:
a) Bonded differently
b) Bonded similarly
c) Bonded covalently
d) Bonded by hydrogen bonds

165. H_2O_2 is stored in:
a) Iron container after addition of stabilizer
b) Glass container after addition of stabilizer
c) Plastic container after addition of stabilizer
d) None of the above

166. Hydrogen is not used for:
a) Manufacture of vegetable ghee

b) Production of high temperature
c) As rocket fuel with kerosene
d) As a reducing agent

167. H_2O_2 is concentrated by:
a) Steam distillation
b) Fractional distillation
c) Freezing in freezing mixture
d) Distillation under reduced pressure

168. Pure H_2 is obtained by the action of:
a) Al over KOH
b) NaH over H_2O
c) Electrolysis of warm solution of Ba(OH)2 using Ni electrodes
d) All of the above

169. Heavy water is manufactured in India at:
a) Delhi b) Trombay c) Bhilai d) None of these

170. What is formed when calcium carbide reacts with heavy water?
a) C_2D_2 b) CaD_2 c) Ca_2D_2O d) CD_2

171. The ionization of hydrogen atom gives:
a) Hydride ion b) Hydronium ion c) Proton d) Hydroxyl ion

172. Which is not true in case of H_2O_2?
a) It is more stable in basic solution
b) It acts as strong oxidizing agent in acid and basic solutions
c) It is decomposed by MnO_2
d) It behaves as reducing agent towards $KMnO_4$

173. Which one of the following is a true peroxide?
a) SO_2 b) MnO_2 c) NO_2 d) BaO_2

174. What is the volume of "20 volume H_2O_2" required to get 5000 cm^3 of oxygen at STP?
a) 250 cm^3 b) 20 cm^3 c) 100 cm^3 d) 125 cm^3

175. The melting points of most of the solid substances increase with an increase of pressure. However, ice melts at a temperature lower than its usual melting point when the pressure is increased. This is because:
a) Ice is less denser than water
b) Pressure generates heat
c) The chemical bonds break under pressure
d) Ice is not a true solid

176. Heavy water was discovered by:
a) Nernst b) Haber c) Urey and Washburn d) Aston

177. The maximum possible number of hydrogen bonds a water molecule can form is:
a) 1 b) 2 c) 3 d) 4

178. H_2O_2 acts as antiseptic due to its:
a) Reducing property b) Oxidizing property c) Bleaching property d) Acidic property

179. Hydrogen gas will not reduce:
a) Heated cupric oxide
b) Heated ferric oxide
c) Heated stannic oxide
d) Heated aluminium oxide

180. Which pair does not show hydrogen isotopes?
a) *Ortho* and *para* hydrogen b) Protium and deuterium
c) Deuterium and tritium d) Tritium and protium

181. The hardness of water is due to .... Metal ions.

a) $Ca^{2+}$and Na^{+} b) Mg^{2+} and K^{+} c) Ca^{2+} and Mg^{2+} d) Zn^{2+} and Ba^{2+}

182. Under what conditions of temperature and pressure, the formation of atomic hydrogen from molecular hydrogen will be favoured more?
   a) High temperature and low pressure
   b) Low temperature and low pressure
   c) High temperature and high pressure
   d) Low temperature and high pressure

183. Heavy hydrogen is used:
   a) In filling the balloons
   b) In studying reaction mechanism
   c) In calculating heat of formation
   d) Iron hydroxide precipitates

184. The reaction, $H_2S + H_2O_2 \longrightarrow S + 2H_2O$ manifests:
   a) Acidic nature of H_2O_2
   b) Alkaline nature of H_2O_2
   c) Oxidizing nature of H_2O_2
   d) Reducing nature of H_2O_2

185. Decomposition of H_2O_2 is accompanied by:
   a) Decrease in free energy
   b) Increase in free energy
   c) No change in free energy
   d) Evolution of heat

186. Which of the following statements is correct? Dielectric constant of H_2O_2
   a) Increases with dilution b) Decreases with dilution
   c) Is unaffected on dilution d) None of the above

187. Heavy water is not used for dinking because:
   a) It is poisonous
   b) It is costly
   c) Its physiological action is different from ordinary water
   d) Its chemical properties are different from ordinary water

188. Maximum density of heavy water is at:
   a) 0° C b) 4° C c) 11.6° C d) 3.8° C

189. The catalyst used in Bosch process of manufacture of H_2 is:
   a) Finely divided Ni b) V_2O_5 c) Pd d) $Fe_2O_3 + Cr_2O_3$

190. In which of the following reactions, H_2O_2 behaves as a reducing agent?
   a) $Na_2SO_3(aq) + H_2O_2(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$
   b) $PbO_2(s) + H_2O_2(aq) \rightarrow PbO(s) + H_2O(l) + O_2(g)$
   c) $2KI(aq) + H_2O_2(aq) \rightarrow 2KOH(aq) + I_2(s)$
   d) $KNO_2(aq) + H_2O_2(aq) \rightarrow KNO_3(aq) + H_2O(l)$

191. Among CaH_2, NH_3, NaH and B_2H_6, which are covalent hydride?
   a) $NH_3$and B_2H_6 b) NaH and CaH_2 c) NaH and NH_3 d) CaH_2 and B_2H_6

192. In which reaction hydrogen is not formed?
   a) Copper and hydrochloric acid
   b) Iron and sulphuric acid
   c) Magnesium and steam
   d) Sodium and alcohol

193. The adsorption of hydrogen by metals is called
   a) Adsorption b) Occlusion c) Hydrogenation d) Dehydrogenation

194. A molten ionic hydride on electrolysis gives:
   a) H^{+} ion moving towards the cathode

b) H^+ ion moving towards the anode
c) H_2 is liberated at anode
d) H_2 is liberated at cathode

195. Moist hydrogen cannot be dried over concentrated H_2SO_4 because:
a) It can catch fire
b) It is reduced by H_2SO_4
c) It is oxidized by H_2SO_4
d) It decomposes H_2SO_4

196. Both temporary and permanent hardness are removed on boiling water with:
a) $Ca(OH)_2$ b) Na_2CO_3 c) $CaCO_3$ d) CaO

197. The weight percentage of deuterium in heavy water is:
a) 22 b) 11.11 c) 4 d) 20

198. Very pure hydrogen(99.9%) can be made by which of the following processes?
a) Mixing natural hydrocarbons of high molecular weight
b) Electrolysis of water
c) Reaction of salt like hydrides with water
d) Reaction of methane with steam

199. Density of water is maximum at:
a) 0°C b) 100° C c) 4°C d) 0 K

200. The most reactive isotope of H is:
a) $_1H^1$
b) $_1H^2$
c) $_1H^3$
d) All the same reactivity

201. Heavy water is used in atomic reactor as
a) Moderator b) Coolant
c) Both moderator and coolant d) Neither coolant nor moderator

202. The exhausted Permutit is generally regenerated by percolating through it a solution of:
a) Sodium chloride b) Calcium chloride c) Magnesium chloride d) Potassium chloride

203. The best explanations for not placing hydrogen with the group of alkali metals or halogens is:
a) Hydrogen can form compounds with all other elements
b) Hydrogen is much lighter element than the alkali metals or the halogens
c) The ionization energy of hydrogen is too high for group of alkali metals but too low for halogen group
d) None of the above

204. Hydrogen molecule differs from chlorine molecule in the following respect.
a) Hydrogen molecule is non-polar but chlorine molecule is polar
b) Hydrogen molecule is polar while chlorine molecule is non-polar
c) Hydrogen molecule can form intermolecular hydrogen bonds but chlorine molecule does not
d) Hydrogen molecule cannot participate in coordinate bond formation but chlorine molecule can

205. The geometry of water molecule is same as that of:
a) CO_2 b) C_2H_4 c) Chlorine oxide d) Boron trifluoride

206. Hydrogen peroxide does not:
a) Liberate iodine from KI
b) Turn the titanium salt yellow
c) Give silver peroxide with moist silver oxide
d) Turn the mixture of aniline, $KClO_3$ and dil. H_2SO_4 violet

207. The most dangerous method of preparing hydrogen would be by the action of dil. HCl and:
a) Zn b) Fe c) K d) Al

208. When zeolite which is hydrated sodium aluminium silicate is treated with hard water, the sodium ions are exchanged with

a) H^+ ions b) Mg^{2+} ion c) Ca^{2+} ion d) both Ca^{2+} and Mg^{2+}

209. Hydrolysis of one mole of peroxodisulphuric acid produces:
a) Two moles of sulphuric acid
b) Two moles of peroxomonosulphuric acid
c) One mole of sulphuric acid and one mole of peroxomonosulphuric acid
d) One mole of sulphuric acid, one mole of peroxomonosulphuric acid and one mole of hydrogen peroxide

210. During hydrogenation of oil the catalyst commonly used is:
a) Pd on $CuCl_2$ b) Ni c) Fe d) V_2O_5

211. Oxygen and hydrogen react to form water. This discovery was made by:
a) Priestley b) Cavendish c) Scheele d) Newton

212. Which one of the following processes will produce hard water?
a) Saturation of water with $CaCO_3$ b) Saturation of water with $MgCO_3$
c) Saturation of water with $CaSO_4$ d) Addition of Na_2SO_4 to water

213. The oxygen atom of H_2O_2 used for oxidation is bound by:
a) Electrovalent bond b) Co-ordinate bond c) Covalent bond d) None of these

214. Which reaction shows oxidizing nature of H_2O_2?
a) $H_2O_2 + 2KI \longrightarrow 2KOH + I_2$
b) $Cl_2 + H_2O_2 \longrightarrow 2HCl + O_2$
c) $H_2O_2 + Ag_2O \longrightarrow 2Ag + H_2O + O_2$
d) $NaClO + H_2O_2 \longrightarrow NaCl + H_2O + O_2$

215. H_2O_2 is manufactured these days
a) By burning hydrogen in excess of oxygen
b) By the action of H_2O_2 on BaO_2
c) By the action of H_2SO_4 on Na_2O_2
d) By electrolysis of 50% H_2SO_4

216. MnO_2 liberates oxygen from a solution of H_2O_2 (the action being catalytic) only if the solution is:
a) Basic b) Acidic c) Neutral d) None of these

217. Ionic hydrides react with water to give
a) Hydride ions b) Acidic solutions c) Protons d) Basic solutions

218. Hydrogen is evolved by the action of cold dilute HNO_3 on:
a) Fe b) Mg or Mn c) Cu d) Al

219. Hydrogen peroxide for the first time was prepared by:
a) Priestley b) Thenard c) Gay-Lussac d) Bernard

220. Which pair does not show hydrogen isotopes?
a) *Ortho* hydrogen and *para* hydrogen b) Protium and deuterium
c) Deuterium and tritium d) Tritium and protium

221. The strength of 10 volume of H_2O_2 solution is
a) 10 b) 68 c) 60.70 d) 30.36

222. The conversion of atomic hydrogen into ordinary hydrogen is:
a) Exothermic change
b) Endothermic change
c) Nuclear change
d) Photochemical change

223. Para hydrogen is:
a) Less stable than ortho hydrogen
b) More stable than ortho hydrogen
c) As stable as ortho hydrogen
d) None of the above

224. Some statements about heavy water are given below:
(i) Heavy water is used as a moderator in nuclear reactors

(ii) Heavy water is more associated than ordinary water
(iii) Heavy water is more effective solvent than ordinary water
Which of the above statements are correct?
a) (i) and (ii) b) (i), (ii) and (iii) c) (ii) and (iii) d) (i) and (iii)

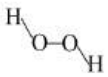
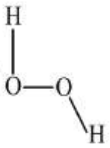
225. H_2O_2 acts as a reducing agent in its:
a) Reaction with a ferrous salt
b) Reaction with iodides
c) Reaction with lead sulphide
d) Reaction with $KMnO_4$ in acidic medium

226. When hydrolith is treated with water it yields:
a) H_2 b) H_2O_2 c) N_2 d) NaH

227. Atomic hydrogen produces formaldehyde when it reacts with:
a) CO_2 b) CO c) O_2 d) C_2H_2

228. K_a for H_2O_2 is of the order of:
a) 10^{-12} b) 10^{-14} c) 10^{-16} d) 10^{-10}

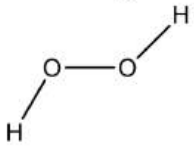
229. Which one of the following reaction does not form gaseous product?
a) $PbO_2 + H_2O_2 \rightarrow$ b) Acidified $KMnO_4 + H_2O_2 \rightarrow$
c) $PbS + H_2O_2 \rightarrow$ d) $Cl_2 + H_2O_2 \rightarrow$

230. The structure of H_2O_2 is:
a) 
b) 
c) H—O—O—H
d) 

231. Which cannot be oxidised by H_2O_2?
a) Na_2SO_3 b) PbS c) KI d) O_3

232. A mixture of hydrazine and 40 to 60 per cent of H_2O_2 solution is:
a) Antiseptic b) Rocket fuel c) Germicide d) Insecticide

233. Hydrogen peroxide is now generally prepared on industrial scale by the:
a) Action of H_2SO_4 on barium peroxide
b) Action of H_2SO_4 on sodium peroxide
c) Electrolysis of 50% H_2SO_4
d) Burning hydrogen in excess of oxygen

234. The equilibrium molecular structure of hydrogen peroxide is
Planar as given below b) Linear
a) 
c) Tetrahedral d) Non-planar

235. A given solution of H_2O_2 is 30 volume. Its concentration in terms of molarity is:
a) 9.1*M* b) 2.68 *M* c) 2.5 *M* d) 26.8 *M*

236. H_2O_2 turns an acidified solution of ..... to orange red.
a) BaO_2 b) PbO_2 c) Na_2O_2 d) TiO_2

237. Tritium is obtained by:
a) Nuclear reactions
b) Passing steam over heated C
c) Action of NaOH on Al
d) Action of H_2SO_4 on Zn

238. In the case of H_2O_2, the angle between the planes containing the hydrogen atom is:
a) 100° b) 90° c) 109° 28′ d) 180°

239. In laboratory, H_2O_2 is prepared by
a) Cold $H_2SO_4 + BaO_2$
b) $HCl + BaO_2$
c) conc $H_2SO_4 + Na_2O_2$
d) $H_2 + O_2$

240. The formula of heavy water is:
a) H_2O^{18} b) D_2O c) T_2O d) H_2O^{17}

241. Hydrogen resembles in many of its properties with:
a) Alkali metals b) Halogens c) Both (a) and (b) d) None of these

242. Hydrogen is not obtained when zinc reacts with
a) Cold water b) hot NaOH solution c) dil. H_2SO_4 d) dil. HCl

243. The H-O-H angle in water molecule is about
a) 105° b) 102° c) 180° d) 90°

244. Hydrogen adsorbed on palladium is known as:
a) Atomic H b) Nascent H c) Occluded H d) Heavy H

245. Hydrogen molecule differs from chlorine molecule in the following respect
a) Hydrogen molecule is non-polar but chlorine molecule is polar
b) Hydrogen molecule is polar while chlorine molecule is non-polar
c) Hydrogen molecule can form intermolecular hydrogen bonds but chlorine molecule does not
d) Hydrogen molecule cannot participate in coordination bond formation but chlorine molecule can

246. Decomposition of H_2O_2 is accelerated by:
a) Traces of acids b) Finely divided metals c) Acetanilide d) Alcohol

247. Which one of the following is used for reviving the exhausted 'permutit'?
a) HCl solution b) 10% $CaCl_2$ solution c) 10% $MgCl_2$ solution d) 10% NaCl solution

248. The volume strength of 1.5 N H_2O_2 solution is
a) 16.8 L b) 8.4 L c) 4.2 L d) 5.2 L

249. Nascent hydrogen consists of:
a) Hydrogen atoms with excess energy
b) Hydrogen molecules with excess energy
c) Hydrogen ions in excited state
d) Solvated protons

250. At absolute zero:
a) Only para hydrogen exists
b) Only ortho hydrogen exists
c) Both para and ortho hydrogen exist
d) None of the above

251. Hydrogen peroxide works as:
a) An oxidant only
b) A reductant only
c) An acid only
d) An oxidant, a reductant and an acid

252. Which of the following will not give H_2O_2 on hydrolysis?
a) $HClO_4$ b) $H_2S_2O_8$ c) H_2SO_5 d) HNO_4(pernitric acid)

253. The n/p ratio for $_1H^1$ is:
a) 1 b) 2 c) 3 d) Zero

254. The percentage by weight of hydrogen in H_2O_2 is:
a) 5.88 b) 6.25 c) 25 d) 50

255. Exhausted permutit does not contain .....ion.
a) Na^+ b) Mg^{2+} c) Al^{3+} d) Si^{4+}

256. The molarity of pure water at 4° C is:
a) 1 *M* b) 2.5 *M* c) 5 *M* d) 55.5 *M*

257. The gas used in the hydrogenation of oils in presence of nickel as a catalyst is:
a) Methane b) Ethane c) ozone d) Hydrogen

258. The volume of oxygen liberated from 0.68 g of H_2O_2 is
a) 112mL b) 224mL c) 56mL d) 336mL

259. Which hydride is an ionic hydride?
a) NH_3 b) H_2S c) $TiH_{1.73}$ d) NaH

260. H_2O_2 reduces $K_3Fe(CN)_6$ in:
a) Neutral solution b) Acidic solution c) Alkaline solution d) Non-polar medium

261. Point out the incorrect statement.
a) Hardness of water depends upon its soap consuming power
b) Temporary hardness is due to bicarbonates of calcium and magnesium
c) Permanent hardness is due to soluble sulphates, chlorides and nitrates of Ca and Mg
d) Permanent hardness can be removed by boiling water

262. H_2O_2 converts potassium ferrocyanide to ferricyanide. The change observed in the oxidation state of iron is:
a) $Fe^{2+} \longrightarrow Fe^{3+}$ b) $Fe \longrightarrow Fe^{2+}$ c) $Fe^{3+} \longrightarrow Fe^{2+}$ d) $Fe^{2+} \longrightarrow Fe^{+}$

263. Which of the following is correct about heavy water?
a) Water at 4°C having maximum density is known as heavy water
b) It is formed by the combination of heavier isotope of hydrogen and oxygen
c) It is heavier than water
d) None of the above

264. Hydrogen is prepared on large scale for industrial use
a) by $Zn + H_2SO_4$ b) by $Al + NaOH$ c) by $Na + C_2H_5OH$ d) From water gas

265. Hydrogen is obtained by the action of an alloy of silicon and iron with NaOH. The process is called:
a) Wood process b) Bosch process c) Haber process d) Silicol process

266. In transforming 0.01 mole of PbS to $PbSO_4$, the volume of 10 volume H_2O_2 required will be
a) 11.2mL b) 22.4mL c) 33.6mL d) 44.8mL

267. Hydrogen peroxide when added to a solution of potassium permanganate acidified with sulphuric acid
a) Forms water only
b) Acts as an oxidising agent
c) Acts as a reducing agent
d) Reduces sulphuric acid

268. Water is oxidised to oxygen by
a) ClO_2 b) $KMnO_4$ c) H_2O_2 d) Fluorine

269. The most abundant element in the universe is thought to be
a) Carbon b) Oxygen c) Hydrogen d) Nitrogen

270. In the preparation of hydrogenated oil the chemical reaction involving hydrogen is called:
a) Hydrogenation b) Reduction c) Dehydrogenation d) Oxidation

271. The most abundant isotope of hydrogen is:
a) Tritium b) Deuterium c) Protium d) Para-hydrogen

272. Which statement is not correct for hydrogen peroxide?
a) Pure H_2O_2 is fairly stable
b) It sometimes acts as a reducing agent
c) It acts as an oxidizing agent
d) Aqueous solution of H_2O_2 is weakly basic

273. Which one is correct for perhydrol?
a) It is 30% H_2O_2 or 100 vol. H_2O_2
b) Its molarity is 8.8 *M*

c) It is used as antiseptic and germicide
d) All of the above

274. Hydrogen has a tendency to gain one electron in order to acquire helium configuration. It thus, resembles:
a) Alkali metals b) Noble gases c) Halogens d) Alkaline earth metals

275. Calgon is an industrial name given to:
a) Normal sodium phosphate
b) Sodium meta-aluminate
c) Sodium hexa meta-phosphate
d) Hydrated sodium aluminium silicate

276. For the bleaching of hair, the substance used is:
a) SO_2 b) Bleaching powder c) H_2O_2 d) O_3

277. In solid hydrogen, the intermolecular bonding is:
a) Ionic b) Van der Waals' c) Metallic d) Covalent

278. The species that does not contains peroxide ions is:
a) PbO_2 b) H_2O_2 c) SrO_2 d) BaO_2

279. The critical temperature of water is higher than that of O_2 because H_2O molecule has:
a) Fewer electrons than oxygen
b) Two covalent bonds
c) V-shape
d) Dipole moment

280. Pure H_2O_2 is:
a) Colourless liquid
b) A gas
c) Blue syrupy liquid
d) Pale blue syrupy liquid

281. When silicon is boiled with caustic soda solution, the gas evolved is:
a) O_2 b) SiH_4 c) H_2 d) None of these

282. In which of the following reactions hydrogen peroxide is a reducing agent?
a) $H_2SO_3 + H_2O_2 \rightarrow H_2SO_4 + H_2O$
b) $2HI + H_2O_2 \rightarrow 2H_2O + I_2$
c) $2FeCl_2 + 2HCl + H_2O_2 \rightarrow 2FeCl_3 + 2H_2O$
d) $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$

283. Which does not react with cold water?
a) Mg_3N_2 b) CaC_2 c) $COCl_2$ d) SiC

284. Deuterium resembles hydrogen in chemical properties but reacts:
a) Slower the hydrogen
b) Faster than hydrogen
c) More vigorously than hydrogen
d) Just as hydrogen

HYDROGEN

: ANSWER KEY :

1)	a	2)	d	3)	b	4)	a	149)	d	150)	a	151)	b	152)	a
5)	a	6)	a	7)	b	8)	b	153)	b	154)	a	155)	a	156)	d
9)	c	10)	c	11)	b	12)	b	157)	d	158)	c	159)	b	160)	d
13)	c	14)	d	15)	c	16)	c	161)	b	162)	c	163)	d	164)	a
17)	b	18)	c	19)	a	20)	b	165)	c	166)	c	167)	d	168)	d
21)	c	22)	c	23)	c	24)	a	169)	b	170)	a	171)	c	172)	a
25)	b	26)	d	27)	a	28)	d	173)	d	174)	a	175)	a	176)	c
29)	b	30)	d	31)	b	32)	b	177)	d	178)	b	179)	d	180)	a
33)	c	34)	d	35)	a	36)	b	181)	c	182)	a	183)	b	184)	c
37)	c	38)	a	39)	b	40)	c	185)	a	186)	a	187)	c	188)	c
41)	d	42)	a	43)	a	44)	a	189)	d	190)	b	191)	a	192)	a
45)	b	46)	c	47)	d	48)	a	193)	b	194)	c	195)	c	196)	b
49)	b	50)	b	51)	c	52)	b	197)	d	198)	b	199)	c	200)	a
53)	a	54)	b	55)	b	56)	c	201)	c	202)	a	203)	c	204)	d
57)	a	58)	d	59)	b	60)	d	205)	c	206)	c	207)	c	208)	d
61)	a	62)	b	63)	b	64)	c	209)	c	210)	b	211)	b	212)	c
65)	d	66)	b	67)	d	68)	a	213)	c	214)	a	215)	d	216)	b
69)	c	70)	b	71)	d	72)	d	217)	d	218)	b	219)	b	220)	a
73)	a	74)	c	75)	d	76)	c	221)	d	222)	a	223)	a	224)	a
77)	b	78)	c	79)	b	80)	c	225)	d	226)	a	227)	b	228)	a
81)	c	82)	a	83)	a	84)	a	229)	c	230)	b	231)	d	232)	b
85)	b	86)	d	87)	c	88)	d	233)	c	234)	d	235)	b	236)	d
89)	d	90)	b	91)	b	92)	a	237)	a	238)	b	239)	a	240)	b
93)	d	94)	a	95)	b	96)	a	241)	c	242)	a	243)	a	244)	c
97)	d	98)	c	99)	d	100)	c	245)	d	246)	b	247)	d	248)	b
101)	b	102)	b	103)	d	104)	d	249)	a	250)	a	251)	d	252)	a
105)	b	106)	b	107)	b	108)	b	253)	d	254)	a	255)	a	256)	d
109)	c	110)	a	111)	b	112)	b	257)	d	258)	b	259)	d	260)	c
113)	d	114)	a	115)	a	116)	b	261)	d	262)	a	263)	b	264)	d
117)	a	118)	a	119)	d	120)	c	265)	d	266)	d	267)	c	268)	d
121)	a	122)	c	123)	d	124)	b	269)	c	270)	a	271)	c	272)	d
125)	d	126)	c	127)	b	128)	b	273)	d	274)	c	275)	c	276)	c
129)	d	130)	a	131)	a	132)	c	277)	b	278)	a	279)	d	280)	d
133)	b	134)	d	135)	d	136)	c	281)	c	282)	d	283)	d	284)	a
137)	b	138)	c	139)	b	140)	d								
141)	d	142)	b	143)	b	144)	b								
145)	a	146)	d	147)	a	148)	c								

HYDROGEN

: HINTS AND SOLUTIONS :

1 **(a)**
It is a fact.

2 **(d)**
$3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$ (Lane's process)

$CO + H_2 + H_2O \xrightarrow[\Delta]{Fe_2O_3} CO_2 + 2H_2$ (Bosch process)

$CH_4 + H_2O \xrightarrow{Ni-Cr} CO + 3H_2$

3 **(b)**
$Cl_2 + H_2O_2 \longrightarrow 2HCl + O_2$

4 **(a)**
The radioactive isotope of hydrogen is tritium. Its half-life is 12.16 yr. It shows β −disintegration.

$$^3_1H \rightarrow {}^3_2He + {}^0_{-1}e(\beta)$$

5 **(a)**
H_2O_2 (hydrogen peroxide) is a corrosive volatile liquid. It is slightly acidic in nature. Its pK_a value is approximately 10^{-12}.

6 **(a)**
Ethylene diaminetetraacetic acid (EDTA) when treated with water, forms stable complex with metal ions and hence, remove hardness of water.

8 **(b)**
Alkali metals also form H^+ ion by the loss of their

9 **(c)**
Transitions metals form metallic hydrides.

10 **(c)**
H_3PO_4 acts as negative catalyst for the decomposit

11 **(b)**
Ortho and para-hydrogen possess same electronic arrangement but different spin of nuclei.

12 **(b)**
Volume strength = 5.6 × normality

$$= 5.6 \times 1.5$$

$$= 8.4$$

13 **(c)**

D_2O had deuterium (heavier isotope of H) and O (t

.

14 **(d)**
$MgCO_3$ is insoluble in water.

15 **(c)**
H_2O_2 can be prepared by electrolysis of 50% H_2SO_4. In this method, hydrogen is liberated at cathode.

$$H_2SO_4 \rightleftharpoons 2H^+ + 2HSO_4^-$$

At anode : $2HSO_4 \rightarrow H_2S_2O_8 + 2e^-$

$$H_2S_2O_8 + 2H_2O \rightarrow 2H_2SO_4 + H_2O_2$$

At cathode : $2H^+ + 2e^- \rightarrow H_2 \uparrow$

16 **(c)**
A 30% solution of hydrogen peroxide can be obtained by the electrolysis of 50% sulphuric acid followed by vacuum distillation. The first product of electrolysis is perdisulphuric acid ($H_2S_2O_8$) which reacts with water during distillation to form H_2O_2.

$$2H_2SO_4 \rightarrow 2H^+ + 2HSO_4^-$$

$$2HSO_4^- \rightarrow H_2S_2O_8 + 2e^- \text{ (At anode)}$$

$$H_2S_2O_8 + 2H_2O \rightarrow 2H_2SO_4 + H_2O_2$$

'X' is H_2SO_4 and 'Y' is $H_2S_2O_8$. So, 'X' and 'Y' contains zero and one peroxy bond respectively.

17 **(b)**
$2FeSO_4 + H_2SO_4 + H_2O_2 \longrightarrow Fe_2(SO_4)_3 + 2H_2O$

18 **(c)**
$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2 \uparrow$

19 **(a)**
$Na_2O_2 + H_2SO_4 \xrightarrow{\text{Ice cold}} Na_2SO_4 + H_2O_2$

$\therefore H_2O_2$ is formed by reaction of Na_2O_2 on dil H_2SO_4

20 **(b)**

$O_2^{1-} + 2e \longrightarrow 2O^{2-}$ (As oxidant)

$O_2^{1-} \longrightarrow O_2^0 + 2e$ (As reductant)

21 **(c)**

$_1H^3$ has 3 nucleons (1 proton + 2 neutrons) and one electron, so sum of these is $3 + 1 = 4$

22 **(c)**

$$K_2Cr_2O_7 + H_2SO_4 \rightarrow K_2SO_4 + H_2Cr_2O_7$$

$$4[H_2O_2 \rightarrow H_2O + O]$$

$$H_2Cr_2O_7 + 4O \rightarrow 2CrO_5 + H_2O$$

$$K_2Cr_2O_7 + H_2SO_4 + 4H_2O_2 \rightarrow 2CrO_5 + K_2SO_4 + 5H_2O$$

Acidified $K_2Cr_2O_7$ is oxidised to blue peroxide of chromium (CrO_5) which is soluble in ether and produces blue coloured solution.

23 **(c)**

$FeCl_3 + [H] \longrightarrow FeCl_2 + HCl$

24 **(a)**

Helium is a noble gas and does not combine with hydrogen

25 **(b)**

$Ca(s) + H_2(g) \longrightarrow CaH_2$

26 **(d)**

D_2O has higher viscosity which is responsible for low solubility of NaCl inspite of high dielectric constant.

27 **(a)**

$Ca : C_2$

$$OD : D \xrightarrow{D_2O} C_2D_2 + Ca(OD)_2$$

$OD : D$

28 **(d)**

$Zn + \text{dil.}\ H_2SO_4 \longrightarrow ZnSO_4 + H_2$

$Fe + \text{dil.}\ H_2SO_4 \longrightarrow FeSO_4 + H_2$

$Sn + \text{dil.}\ H_2SO_4 \longrightarrow SnSO_4 + H_2$

29 **(b)**

Heavy water is the oxide of heavy hydrogen (deuterium), hence named heavy water. It is represented by D_2O. It is used in nuclear reactor as moderator.

30 **(d)**

Calgon, permutit and Na_2CO_3 are used for the rem

31 **(b)**

It is a fact.

32 **(b)**

Quantity of $H_2O_2 = 15$ mL and volume of $H_2O_2 = 20$

We know that 20 volume of H_2O_2 means 1 L of this solution will give 20 L of oxygen at NTP.

Since, oxygen liberated from 1000mL (1L) of

$H_2O_2 = 20$ L, therefore, oxygen liberated from 15mL of H_2O_2

$$= \frac{20}{1000} \times 15 = 0.3 \text{ L} = 300 \text{ mL}.$$

33 **(c)**

Pure hydrogen peroxide is an unstable liquid and decomposes into water and oxygen either upon standing or heating.

$2H_2O_2 \rightarrow 2H_2O + O_2; \qquad \Delta H = -196.0$ kJ

To prevent decomposition of H_2O_2, phosphoric acid, acetanilide or glycerol are added. These acts as negative catalyst.

35 **(a)**

10 vol. H_2O_2 means that 1 mL H_2O_2 gives 10 mL O_2; thus, 50 mL H_2O_2 will give 500 mL O_2.

38 **(a)**

$CaSO_4$ is soluble in water and provides Ca^{2+} ions to develop hardness. $CaCO_3$ and $MgCO_3$ are insoluble in water.

39 **(b)**

$$\underset{\text{Water gas}}{CO + H_2} + \underset{\text{Steam}}{H_2O} \xrightarrow{\text{Catalyst}} CO_2 + 2H_2$$

40 **(c)**

The triple point of any substance is that temperature and pressure at which the material can exist in all three phases (solid, liquid and gas) in equilibrium, specifically the triple point of water is 273. 16 K at 611.2 Pa

41 **(d)**

It is a fact.

42 **(a)**

Cu has E_{OP}^0 lesser than H.

43 **(a)**
Calgon is represented by sodium hexa metaphosphate, $(NaPO_3)_6$ or $Na_2[Na_4(PO_3)_6]$.

44 **(a)**
Permutit are complex inorganic salts like sodium alumino silicate $(Na_2Al_2SiO_3xH_2O)$ or zeolite (Na_2Z) where Z is $Al_2SiO_3xH_2O$.

45 **(b)**
It is a fact.

46 **(c)**
Because dihydrogen is less reactive

47 **(d)**
CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali.

$$CO + H_2 + H_2O \xrightarrow[\text{catalyst}]{\text{Steam}} CO_2 + 2H_2$$

$$\downarrow \text{KOH}$$

$$K_2CO_3$$

48 **(a)**
Only tritium is radioactive.

49 **(b)**
Oxidisation number of oxygen in hydrogen peroxide is -1.

$$H - O - O - H$$

$$\uparrow$$

peroxide linkage

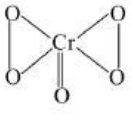
50 **(b)**
Volume strength = 5.6 × normality

$$30 = 5.6 \times N$$

$$\Rightarrow \quad N = \frac{30}{5.6} = 5.3$$

51 **(c)**
$K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + H_2Cr_2O_7$
$H_2Cr_2O_7 + 4H_2O_2 \longrightarrow 2CrO_5 + 5H_2O$
Chromic acid

CrO_5 is blue peroxide of Cr



52 **(b)**
It is the property of H_2O_2.

54 **(b)**
The *Ortho* and *Para* hydrogen differ in the nature of spin of protons. In *Ortho* hydrogen, the spin of proton are in the same direction, while in *para* hydrogen the spin of proton are in opposite direction.

55 **(b)**
Covalent bonding is stronger than H-bonding.

58 **(d)**
$H_2O_2 \rightleftharpoons H^+ + HO_2^-$

59 **(b)**
It is a fact.

60 **(d)**
Moist H_2O_2 cannot be dried over conc. H_2SO_4 because it is decomposed by H_2SO_4.

61 **(a)**
Strength of H_2O_2 in g/L $= \frac{68}{22.4} \times V$

Given strength of $H_2O_2 = 30.36$ g/L

Or $$V = \frac{30.36 \times 22.4}{68}$$

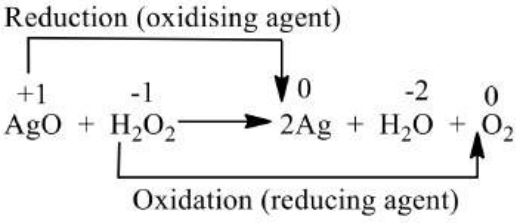
$$= 10 \text{ volumes}$$

62 **(b)**
$_1H^3 \longrightarrow {}_2He^3 + {}_{-1}e^0$

63 **(b)**
$1 : 1 : 2 :: e : p : n$

64 **(c)**
H_2 does not react with Au, Cu or Ni. with Ca, it gives CaH_2

65 **(d)**
H_2O_2 is acting as reducing agent in the reaction that involve increase in the oxidation state of oxygen H_2O_2 (*i.e.,* in which H_2O_2 is being oxidised).



66 **(b)**
It is $Na_2Al_2Si_2O_8 \,.\, xH_2O$

67 **(d)**
$CuSO_4 + H_2O \longrightarrow CuSO_4 \,.\, 5H_2O$
Anhydrous (White) — Hydrated (Blue)

68 **(a)**

These are the oxidizing and reducing properties of

69 **(c)**

Its (D_2O) molecular weight is 20 whereas mol. wt.

70 **(b)**

Permanent hardness is removed by precipitating carbonates of Ca^{2+} and Mg^{2+}.

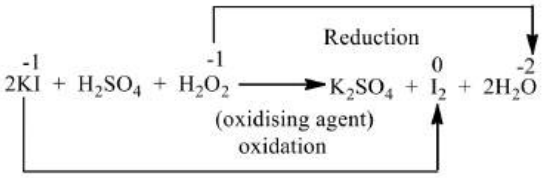
$$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 \downarrow + 2NaCl$$

71 **(d)**

IE of H = -13.6 eV ; IE of halogens = 13.0 for Cl; 17.4 for F.

72 **(d)**

The reaction in which H_2O_2 is reduced while the other reactant is oxidised, represents the oxidising property of H_2O_2.



73 **(a)**

Hydrogen peroxide is prepared by the action of CO_2 on barium peroxide peroxide (BaO_2).

$$BaO_2 + CO_2 + H_2O \rightarrow BaCO_3 + H_2O_2$$

barium peroxide — barium carbonate — hydrogen peroxide

76 **(c)**

Industrial preparation of H_2O_2:

(A) **By the electrolysis of 50 % H_2SO_4**: 50 % H_2SO_4 solution is electrolyzed at 0°C between Pt electodes. The perdisulphuric acid is formed.

$$H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$$

At Anode ; $2HSO_4^- \longrightarrow H_2S_2O_8 + 2e$

At Cathode ; $2H^+ + 2e \longrightarrow H_2$

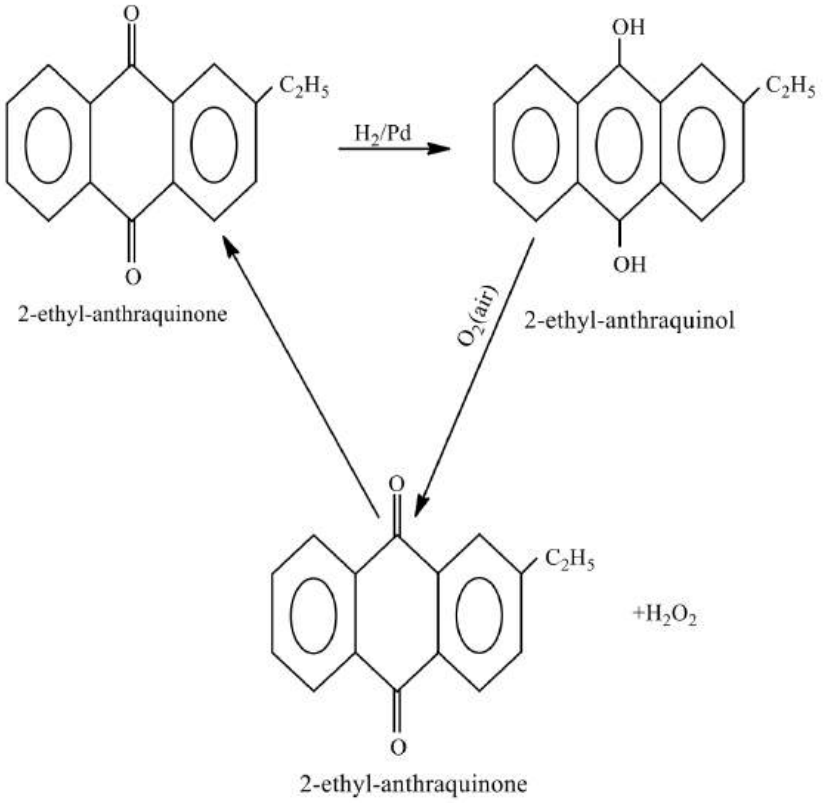
The obtained perdisulphuric acid gives H_2O_2 on hydrolysis.

$$H_2S_2O_8 + 2H_2O \rightleftharpoons H_2O_2 + 2H_2SO_4$$

This H_2O_2 is separated by distillation at reduced pressure and thus, 30 % solution of H_2O_2 is obtained.

(B) **By the auto-oxidation of 2-ethyl-anthraquinol (Modern method) :** Anthraquinol, in a mixture of benzene and *n*-heptanol on treatment with air gives H_2O_2 and 2-ethyl-anthraquinone. This 2-ethyl-anthraquinone on hydrogenation gives 2-ethyl-anthraquinol in presence of Pd catalyst.

It is a cyclic process and in it only H_2 is consumed, 2-ethyl-anthraquinone is reobtained during reaction.



78 **(c)**

$Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3$

79 **(b)**

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

80 **(c)**

Electrolysis of 50% sulphuric acid is the commercial method for the preparation of hydrogen peroxide.

$$H_2SO_4 = H^+ + HSO_4^-$$

At anode

$$2HSO_4^- \rightarrow H_2S_2O_8 + 2e^-$$

$$H_2S_2O_8 + 2H_2O \rightarrow 2H_2SO_4 + H_2O_2$$

At cathode

$$2H + 2e^- \rightarrow H_2$$

81 **(c)**

$BaO_2 + CO_2 + H_2O \longrightarrow BaCO_3 + H_2O_2$

82 **(a)**

It is a fact.

83 **(a)**

$(H^2)_2\ O^{16}$ or D_2O.

D has $1n$, 1p and $1e$

O has $8n$, $8p$ and $8e$

84 **(a)**

It is a fact.

85 **(b)**

It is a fact.

86 **(d)**

Electronic configuration of $_1H^1$ and $_1H^2$ is same.

87 **(c)**

It is a fact.

89 **(d)**

In acid : $H_2O_2 + 2H^+ + 2e \longrightarrow 2H_2O$ (slow)

In alkali : $H_2O_2 + 2e \longrightarrow 2OH^-$ (fast)

90 **(b)**

"10 volume H_2O_2" means 1mL of its solution on decomposition at NTP, give 10 mL oxygen gas. Volume of oxygen formed from 100 mL of solution at NTP = 1000 ML.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

2 moles 1 mole

2×34 g 22400 mL.

$\because$ 22400 mL O_2 formed at NTP by decomposition of 68 g H_2O_2.

$\therefore$ 1 mL O_2 formed at NTP from $\frac{68}{22400}$ of H_2O_2

$\therefore$ 1000 mL O_2 formed at NTP from

$$\frac{68 \times 1000}{22400}\ \text{g}\ H_2O_2 = 3.035\ \text{g}\ H_2O_2$$

So, concentration of "10 volume H_2O_2"

$= 3.0\%$ approximately

92 **(a)**
O_3 reacts with Hg to form Hg_2O which sticks on the walls of glass. This is called tailing of mercury, $O_3 + 2Hg \longrightarrow Hg_2O + O_2$. The tailing is removed by the action of H_2O_2 on Hg_2O. $H_2O_2 + Hg_2O \longrightarrow 2Hg + H_2O + O_2$

93 **(d)**
The ions responsible for hard water are soluble in water.

94 **(a)**
Liq. H_2 because of low atomic mass and high enthalpy of combustion and liq. O_2 a strong supporter for combustion.

95 **(b)**
$M^+H^- \rightarrow M^+ + \underset{\text{hydride ion}}{H^-}$

$H^- \rightarrow \frac{1}{2}H_2 + e^-$ (at anode)

96 **(a)**
It is a fact.

97 **(d)**
34 g H_2O_2 has 2 g H_2.

99 **(d)**
Acetanilide, alcohol, H_3PO_4 act as negative catalyst

100 **(c)**
D_2O has different properties than H_2O.

101 **(b)**
Hydrogen forms maximum number of compounds in chemistry (not carbon).

102 **(b)**
$H_2O_2 \longrightarrow H_2O + [O]$

103 **(d)**
Amphoteric solvent dissolves both acids and bases.

$\therefore$ H_2O_2 is amphoteric solvent because it dissolves both acids and bases.

105 **(b)**
Meq. of $H_2O_2 = 1000 \times 1.5$

$\therefore \quad \frac{w}{34/2} \times 1000 = 1000 \times 1.5 (E_{H_2O_2} = M/2)$

$\therefore \quad w = 25.5$ g

106 **(b)**
$BaO_2 + CO_2 + H_2O \longrightarrow H_2O_2 + BaCO_3$

107 **(b)**
$Mn^{7+} + 5e \longrightarrow Mn^{2+}$.

108 **(b)**
Its pH is 7.

109 **(c)**
A characteristic of hydrogen.

111 **(b)**
Deuterium ($_1H^2$) has stable nuclei, because the ratio of $\frac{n}{p} = 1$.

113 **(d)**
Bicarbonates of Ca and Mg are responsible for temporary hardness.

114 **(a)**
It does not have impaired electrons.

115 **(a)**
1mL H_2O_2 solution gives 11.2 mL O_2 at NTP

$\therefore$ 100 mL H_2O_2 solution gives $O_2 = 100 \times 11.2$

$= 1120.0$ mL O_2 at NTP

H_2O_2 decomposes as

$$2H_2O_2\ (l) \rightarrow 2H_2O\ (l) + O_2(g)$$

$\therefore$ 22400 mL O_2 at NTP is obtained from 68g H_2O_2

$\therefore$ 1 mL O_2 at NTP is obtined from

$$= \frac{68}{22400}\ \text{g}\ H_2O_2$$

$\therefore$ 1120 mL O_2 at NTP is obtained from

$$= \frac{68}{22400} \times 1120$$

$$= 34\ \text{g}$$

$$w = \frac{M \times m \times V}{1000}$$

$$M = 1.0$$

116 **(b)**
It is a fact.

117 **(a)**
$\left[H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2\right] \times 2$

$2H_2O_2 \rightarrow 2H_2O + \quad O_2$

68 g 22.4 L at NTP

$\because$ 22.4 L O_2 at NTP is obtained by 68 g of H_2O_2

$\therefore$ 20 L O_2 at NTP will be obtained by H_2O_2

$$= \frac{68}{22.4} \times 20 = 60.7 \text{ g/L}$$

$\therefore$ 1000 mL O_2 at NTP is obtained by H_2O_2
$= 60.7$ g

$$\therefore \text{Percentage strength} = \frac{60.7 \times 100}{1000} = 6.07 \text{ g}$$

118 **(a)**

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

119 **(d)**

Atomic hydrogen is obtained by passing ordinary hydrogen through an electric arc.

$$H_2 \xrightarrow[200^0C]{\text{Electric arc,}} 2H;\ \triangle H = 104.5 \text{ kcal mol}^{-1}$$

120 **(c)**

CO_2 escapes out slowly.

121 **(a)**

Colloidal Pd has larger surface area.

122 **(c)**

It is a fact.

123 **(d)**

$2F_2 + 2H_2O \longrightarrow 4HF + O_2$

$3F_2 + 6H_2O \longrightarrow 6HF + 2O_3$

124 **(b)**

The hardness of water sample containing 0.02 mole of $MgSO_4$ dissolved in 1 L of water.

Number of moles = mass/molecular mass

$$0.002 = \text{mass}/120$$

$$\text{mass} = 0.24 \text{ g}$$

0.24 g mass of $MgSO_4$ in 1 L of water.

$\therefore$ 10^3 g of H_2O contains = 0.24 g of $MgSO_4$

$$\because 10^6 \text{ g of } H_2O \text{ contains} = \frac{0.24 \times 10^6}{10^3} \text{ g of } MgSO_4$$

$$= 0.24 \times 10^3 \text{ g}$$
$$= 0.24 \text{ g of } MgSO_4$$

10^6 g of water contains = 240 g of $MgSO_4$

120 g $MgSO_4 \equiv$ 100 g of $CaCO_3$

$$240 \text{ g of } MgSO_4 = \frac{100 \times 240}{120}$$
$$= 200 \text{ g of } CaCO_3$$

Hence, hardness of H_2O = 200 ppm.

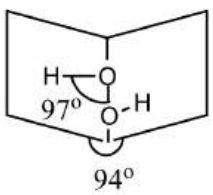
126 **(c)**

H_2O_2 oxidises the acidified potassium dichromate solution into blue peroxide of chromium, CrO_5.

$Cr_2O_7^{2-} + 2H^+ + 4H_2O_2 \rightarrow 2CrO_5 + 5H_2O$

127 **(b)**

H_2O_2 is pale blue liquid, it can be oxidised by ozone. H_2O_2 acts as both oxidising and reducing agent. The value of dipole moment of H_2O_2 is 2.1 D which suggests it cannot be planar. In fact it has open book like structure.



The two O- H bonds lie in different planes

129 **(d)**

It forms calcium and magnesium complex with EDTA salt

130 **(a)**

Ordinary hydrogen mainly contains Protium ($_1H^1$).

132 **(c)**

ZnH_2 is an example of interstitial hydride while NH_3, CH_4 and H_2O are the examples of covalent hydride.

133 **(b)**

It is a fact.

134 **(d)**

Polyphosphates like sodium hexametaphosphates, sodium tripolyphosphate or STPP) form soluble complexes with Ca^{2+}, Mg^{2+} present in hard water

136 **(c)**

$H_2O_2 + Cl_2 \rightarrow 2HCl + O_2$

HCl is formed by the reduction of chlorine by H_2O_2, hence pH further decreases.

137 **(b)**
It is a fact.

138 **(c)**
H_2 is diatomic and forms H^- and H^+ ions.

139 **(b)**
$H_2 + F_2 \xrightarrow{\text{Dark}} 2HF$

140 **(d)**
Hardness is expressed in g of $CaCO_3$ present in 10^6 g of H_2O.

141 **(d)**
$3Fe + 4H_2O(v) \underset{\text{Red hot}}{\longrightarrow} Fe_3O_4 + 4H_2$

142 **(b)**
$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$
$CaH_2 + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

143 **(b)**
Atomic mass of helium ($_2He^4$) is maximum.

144 **(b)**
$M = \frac{5.1 \times 1000}{34 \times 100} = 1.5$

145 **(a)**
Hg is placed below H in electrochemical series.

146 **(d)**
Deionised or demineralised water is obtained by passing hard water through both cation and anion exchangers one after the other

147 **(a)**
Eq. wt. of $H_2O_2 = 17$

$$N = \frac{30.36}{17} = 1.78\ N$$

Volume strength = 5.6 × normality

$$= 5.6 \times 1.78 = 10\ V$$

148 **(c)**
It is a fact.

149 **(d)**
Water becomes hard when it contains dissolved salts of calcium, Mg of Fe such as chloride, sulphates, bicarbonates and carbonates.

150 **(a)**
In tritium, it is three.

151 **(b)**
It is a fact.

152 **(a)**
Hydrogen reacts with active metals (like alkali and alkaline earth metals) form corresponding hydrides. $Ca(s) + H_2(g) \longrightarrow CaH_2$

153 **(b)**
$PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$

154 **(a)**
Per cent conc. of $H_2O_2 = \frac{17}{56} \times$ volume conc. of $H_2O_2 = \frac{17}{56} \times 10 = 3\%$ app.

156 **(d)**
First three choices are characteristics of zeolites.

159 **(b)**
Extra energy is required to break these hydrogen bonds.

160 **(d)**
$O_3 + H_2O_2 \longrightarrow 2O_2 + H_2O$

161 **(b)**
Water has high dielectric constant, *ie*, 82, high liquid range and can dissolve maximum number of compounds. That's why it is used as universal solvent

162 **(c)**
Sodium zeolite is used for softening of water having the formula $Na_2Al_2Si_2O_8$.

163 **(d)**
Nascent hydrogen, (i.e., hydrogen at the moment of generation) is more powerful reducing agent than ordinary H_2.

164 **(a)**
It is a fact.

165 **(c)**
H_2O_2 easily decomposes into water and oxygen and the decomposition speeds up in the presence of metallic impurities, or strong bases and on exposure to light. Hence, it is stored in plastic container after addition of stabilizer.

166 **(c)**
It is a fact.

167 **(d)**
It is a method to concentrate H_2O_2.

168 **(d)**
$2Al + 2KOH + 2H_2O \longrightarrow 2KAlO_2 + 3H_2$
(Uyeno's methods)
$NaH + H_2O \longrightarrow NaOH + H_2$ and electrolysis of $Ba(OH)_2$. These all are methods to prepared pure H_2.

169 **(b)**
It is a fact.

170 **(a)**
$CaC_2 + 2D_2O \longrightarrow Ca(OD)_2 + C_2D_2$

171 **(c)**
$H \longrightarrow H^+ + e$

172 **(a)**
H_2O_2 is di-basic acid and thus, less stable in basic medium.

174 **(a)**
'20 volume H_2O_2' means that 1mL of this H_2O_2 gives 20mL oxygen on decomposition at STP.

Hence, 5000 cm^3 O_2 will be obtained by $= \frac{5000}{20}$

$= 250\ cm^3$

175 **(a)**
Ice ⇌ Water; Also volume of ice >volume of water. Thus, an increase in pressure favours the forward reaction.

176 **(c)**
D_2O was discovered by Urey and Wash burn.

177 **(d)**
It is a fact.

178 **(b)**
An important property of H_2O_2.

179 **(d)**
Stannic and ferric oxides are reduced to stannous a

180 **(a)**
Ortho and *para* hydrogens are two forms of hydrogen which differ only in direction of spin of proton.

Protium (^1_1H), deuterium (^2_1D) and tritium (^3_1T) are three isotopes of hydrogen. All of them have one proton and electron each. Protium has no neutron, deuterium has one neutron and tritium has two neutrons.

181 **(c)**
Ca^{2+} and Mg^{2+} forms insoluble salts with soap.

182 **(a)**
$H_2 \rightarrow H + H, \Delta H = +ve$
The reaction is favoured by low pressure and high temperature

184 **(c)**
$S^{2-} \longrightarrow S^0 + 2e$

186 **(a)**
Dielectric constant of H_2O_2 increases with dilution. It is 93.7 for pure H_2O_2, 97 for 90% H_2O_2 and 120 for 65% H_2O_2.

187 **(c)**
It is a fact.

188 **(c)**
It is a fact (density of D_2O
$= 1.1073$ g/mL at 284.6 K).

189 **(d)**
It is a fact.

191 **(a)**
Hydrides are binary compounds of hydrogen. These can be classified in four groups *viz :*

(i) Ionic hydrides *e.g.,* NaH, CaH_2, LiH etc.

(ii) Covalent hydrides *e.g.,* B_2H_6, NH_3, SbH_3 etc.

(iii) Polynuclear hydrides *e.g.,* $LiAlH_4$, $NaBH_4$ etc.

(iv) Interstitial hydrides, in which hydrogen is trapped in the interstial spaces of transition metals.

194 **(c)**
Ionic hydride has H^- ion.

195 **(c)**
Moist hydrogen cannot be dried over concentrated H_2SO_4 because it is oxidized by H_2SO_4 and catches fire.
$H_2SO_4 + H_2 \longrightarrow 2H_2O + SO_2 \uparrow$

196 **(b)**
$Ca(HCO_3)_2 + \underset{\text{Insoluble}}{Na_2CO_3} \longrightarrow CaCO_3 + 2Na(HCO_3)$
$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaCl$
Ca^{2+} of Mg^{2+} ions are removed as insoluble carbo

197 **(d)**
20 g D_2O has 4 g deuterium.

198 **(b)**
Hydrogen of high purity is obtained by electrolyzing aqueous barium hydroxide in presence of Ni electrodes.
$2e + 2H_3O^+ \longrightarrow 2H_2O + \frac{1}{2} H_2$
$2OH^- \longrightarrow H_2O + \frac{1}{2} O_2 + 2e$

199 **(c)**
It is a fact.

200 **(a)**
Lighter isotopes are more reactive.

201 **(c)**
Heavy water is used as a moderator to slow down the speed of fast moving neutrons and as well as a coolant

202 **(a)**
$CaZ + \underset{\text{(Conc.)}}{2NaCl} \longrightarrow CaCl_2 + Na_2Z$

203 **(c)**
It is fact.

205 **(c)**
Both are V-shaped.

206 **(c)**
No such reaction exists.

207 **(c)**
Potassium reacts violently with acids.

209 **(c)**
$H_2S_2O_8 + H_2O \longrightarrow H_2SO_4 + H_2SO_5$

210 **(b)**
It is a fact.

211 **(b)**
It is a fact.

212 **(c)**
Alkaline earth metal salts are causing hardness :

Temporary hardness caused by soluble Ca and Mg hydrogen carbonates. Calcium and magnesium soluble sulphates and chlorides cause permanent hardness.

214 **(a)**
$2I^- \longrightarrow I_2^0 + 2e$
$2e + O_2^{1-} \longrightarrow 2O^{2-}$

215 **(d)**
Electrolysis of 50% sulphuric acid gives per disulphuric acid ($H_2S_2O_8$) which on distillation yields 30% solution of hydrogen peroxide

216 **(b)**
$MnO_2 + H_2SO_4 + H_2O_2 \longrightarrow MnSO_4 + 2H_2O + O_2$

217 **(d)**
Ionic hydrides give basic solution when reacts with water *e.g.,*

$LiH + H_2O \rightarrow LiOH + H_2 \uparrow$

218 **(b)**
Only Mg and Mn react with cold dil. HNO_3 to give H

219 **(b)**
Thenard obtained H_2O_2 for the first time.

220 **(a)**
Ortho and *para* hydrogen show different spin in a hydrogen molecule, hence, these are not the isotopes

221 **(d)**
10 volume =1 volume of H_2O_2 gives 10 volume of O_2 at NTP.

$2H_2O_2 \rightarrow 2H_2O + O_2$

$2(2 + 32) = 68$ g 22400 mL at NTP

At NTP

$\because$ 22400 mL of O_2 is obtained from

$= 68$ g H_2O_2

$\therefore$ 10 mL of O_2 is obtained from

$$= \frac{68 \times 10}{22400} = 0.03035 \text{ g } H_2O_2$$

1 mL of H_2O_2 solution contains

$= 0.03035$ g H_2O_2

100 mL of H_2O_2 solution contains

$= 0.03035 \times 100$

$= 3.035$ g H_2O_2

$\therefore$ Strength of 10 volume H_2O_2

$= 3.035 \times 10$

$= 30.35$ g/L

222 **(a)**
Bond formation is exothermic.

223 **(a)**
Ortho-hydrogen is more stable and para form always try to convert in ortho form.

224 **(a)**
These are facts.

225 **(d)**
$5e + Mn^{7+} \longrightarrow Mn^{2+}$
$O_2^{1-} \longrightarrow O_2^0 + 2e$

226 **(a)**
$CaH_2 + 2H_2O \longrightarrow Ca(OH)_2 + 2H_2$

227 **(b)**
$2H + CO \longrightarrow HCHO$

228 **(a)**
It is a fact.

229 **(c)**
Hydrogen peroxide oxidise lead sulphide into lead sulphate which is a solid.

$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

230 **(b)**
H_2O_2 has open book structure.

231 **(d)**
Na_2SO_3 is oxidised by H_2O_2 to Na_2SO_4

PbS is oxidised by H_2O_2 to $PbSO_4$

KI is oxidised by H_2O_2 to I_2

O_3 cannot be oxidised by H_2O_2 but it is reduced to O_2 by H_2O_2

$$H_2O_2 + O_3 \rightarrow H_2O + 2O_2$$

232 **(b)**

It is one of the uses of H_2O_2.

233 **(c)**

Industrial preparation of H_2O_2:

(A) **By the electrolysis of 50 % H_2SO_4**: 50 % H_2SO_4 solution is electrolyzed at 0°C between Pt electodes. The perdisulphuric acid is formed.

$$H_2SO_4 \rightleftharpoons H^+ + HSO_4^-$$

At Anode ; $2HSO_4^- \longrightarrow H_2S_2O_8 + 2e$

At Cathode ; $2H^+ + 2e \longrightarrow H_2$

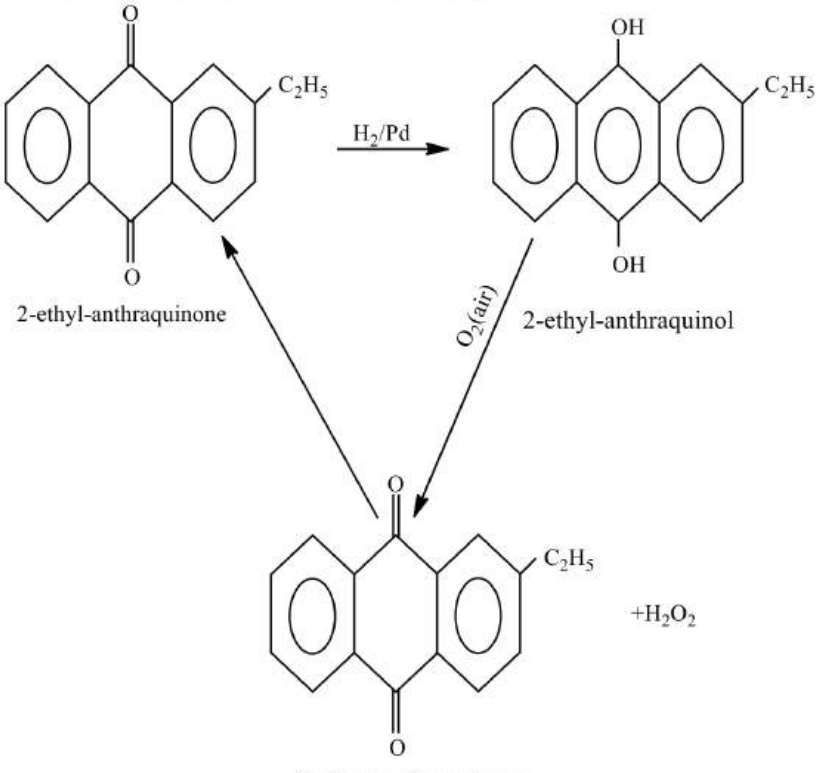
The obtained perdisulphuric acid gives H_2O_2 on hydrolysis.

$$H_2S_2O_8 + 2H_2O \rightleftharpoons H_2O_2 + 2H_2SO_4$$

This H_2O_2 is separated by distillation at reduced pressure and thus, 30 % solution of H_2O_2 is obtained.

(B) **By the auto-oxidation of 2-ethyl-anthraquinol (Modern method) :** Anthraquinol, in a mixture of benzene and *n*-heptanol on treatment with air gives H_2O_2 and 2-ethyl-anthraquinone. This 2-ethyl-anthraquinone on hydrogenation gives 2-ethyl-anthraquinol in presence of Pd catalyst.

It is a cyclic process and in it only H_2 is consumed, 2-ethyl-anthraquinone is reobtained



during reaction.

235 **(b)**

30 mL O_2 is obtained by $\frac{34\times30}{11200}$ g H_2O_2/mL

$\therefore \quad M = \frac{34\times30\times100}{11200\times34} = 2.68\ M$

236 **(d)**

$TiO_2 + H_2O_2 \longrightarrow H_2TiO_4$(orange)

237 **(a)**

Tritium ($_1H^3$) is a heavy isotope of hydrogen which is obtained by nuclear reactions.

238 **(b)**

It is a fact.

239 **(a)**

$H_2SO_4 + BaO_2 \rightarrow BaSO_4 + H_2O_2$

240 **(b)**

The formula of heavy water is D_2O.

241 **(c)**

It resemble with alkali metals as it forms H^+ ion by losing its outer electron and resemble with halogen as it forms H^- ion by gaining one electron.

242 **(a)**
Zinc, does not react with cold water.

$$Zn + H_2O \rightarrow ZnO + H_2O \uparrow$$

steam

$$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2 \uparrow$$

$$Zn + 2HCl\ (dil.) \rightarrow Zn\ Cl_2 + H_2 \uparrow$$

$$Zn + H_2SO_4\ (dil.) \rightarrow ZnSO_4 + H_2 \uparrow$$

243 **(a)**
The $H-O-H$ angle in water molecule is about $105°$ (due to two lone pairs of electrons)

244 **(c)**
Some transition metals such as Pt, Ni, Pd, Os, Cr, Mn, Fe, etc., adsorb relatively large amount of hydrogen gas, which is called occluded hydrogen.

245 **(d)**
Chlorine has lone pair which it can donate to form coordinate bond while hydrogen cannot

246 **(b)**
Metals in finely divided state possess larger surface area and are more reactive.

247 **(d)**
During the softening process the reaction takes place as :

$$Na_2Ze + Ca\ (HCO_3)_2 \rightarrow CaZe + 2NaHCO_3$$

$$Na_2Ze + Mg(HCO_3)_2 \rightarrow MgZe + 2NaHCO_3$$

After sometime, the zeolite is completely converted into calcium and magnesium zeolites. Eventually, the bed ceases to soften water *i.e.,* it gets exhausted. At this stage, the supply of hard water is stopped and the exhausted zeolite is reclaimed by treating the bed with a 10% NaCl solution (Brine soln.) when the following reaction takes place

$$CaZe \text{ or } Mgze + 2NaCl \rightarrow Na_2Ze + CaCl_2 \text{ or } MgCl_2$$

Reclaimed zeolite

248 **(b)**
Volume strength $= 5.6 \times$ normality

$$= 5.6 \times 1.5 = 8.4\ L$$

249 **(a)**
Follow reactive nature of nascent hydrogen.

250 **(a)**
It is a fact.

251 **(d)**
These are characteristic properties of H_2O_2.

252 **(a)**
$HClO_4$ does not give H_2O_2 on hydrolysis. Rest all contains O—O bond and gives H_2O_2 on heating.

253 **(d)**
$_1H^1$ has no neutron, $i.e., n = 0, p = 1, \frac{n}{p} = \frac{0}{1} = 0$

254 **(a)**
34 g H_2O_2 has 2 g H
$\therefore$ 100 g H_2O_2 has $\frac{2\times100}{34} = 5.88$ g H

255 **(a)**
Permutit or zeolite is the aluminosilicate of sodium. It is used to remove hardness of water. It converts insoluble salts of Ca^{2+} and Mg^{2+} into soluble zeolites. It exchange these ions with Na^+ and water becomes soft.

Thus, exhausted permutit does not contain Na^+ ions.

256 **(d)**
$M_{H_2O} = \frac{1000}{18\times1} = 55.6$

257 **(d)**

$$\underset{\substack{\text{More}\\\text{Unsaturated}}}{\text{Oil}} + H_2 \xrightarrow{Ni} \underset{\substack{\text{More}\\\text{Saturated}}}{\text{Margarine(Ghee)}}$$

258 **(b)**
$2H_2O_2 \rightarrow 2H_2O + O_2$

2×34 g 22400mL

$\because$ 68 g of H_2O_2 liberates 22400 mL O_2

$$\therefore 0.68 \text{ g of } H_2O_2 \text{ liberates} = \frac{0.68 \times 22400}{68}$$

$$= 224 \text{ mL } O_2$$

260 **(c)**
H_2O_2 reduces potassium ferricyanide (alk. Solution) $K_3Fe(CN)_6$ to potassiur ferrocyanide.

261 **(d)**

Permanent hardness in the name because this type of hardness is not removed by only boiling the water.

262 **(a)**

$Fe^{2+} \longrightarrow Fe^{3+} + e$

$O_2^{1-} + 2e \longrightarrow 2O^{2-}$

263 **(b)**

Heavy water is formed by the combination of heavier isotope ($_1H^2$ or D) with oxygen.

$2D_2 + O_2 \rightarrow \quad 2D_2O$

heavy water

264 **(d)**

Industrially, hydrogen is prepared from water gas which is a mixture of carbon monoxide and hydrogen, by removing carbon monoxide by Bosch process or by liquefaction.

$$CO + H_2O \rightarrow CO_2 + H_2$$

265 **(d)**

It is a fact.

266 **(d)**

$PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

from the above equation

$\because$ 1 mole of PbS required 4 moles of H_2O_2

0.01 moles of PbS required 0.04 mole of H_2O_2

Weight of 0.04 mole $H_2O_2 = 1.36$ g

10 volume of H_2O_2 means,

1mL of such solution of H_2O_2 on decomposition by heat produces 10mL of oxygen at NTP.

H_2O_2 decomposes as,

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

Thus 1mL of 10 volume H_2O_2 solution contains

$$= \frac{68}{22400} \times 10 \text{ g of } H_2O_2$$

$$= 0.030.35 \text{ g of } H_2O_2$$

$\because$ 0.03035 g of H_2O_2 is present in 1 mL of 10 volume H_2O_2.

$\therefore$ 1.36 g of H_2O_2 present in $\frac{1}{0.03035}$

$\times$ 1.36 mL of 10 volume of H_2O_2

$= 44.81$ mL

267 **(c)**

$$\overset{+7}{2K\,Mn}O_4 + 3H_2SO_4 + 5H_2O_2$$

$$\overset{+2}{\quad} \qquad \overset{0}{\quad}$$

$$\rightarrow 2MnSO_4 + 8H_2O + 5O_2$$

In this reaction hydrogen peroxide acts as a reducing agent and it reduces $KMnO_4$ to Mn^{2+} ions.

268 **(d)**

Water is oxidised to oxygen by fluorine as

$$2F_2 + 2H_2O \rightarrow O_2 + 4HF$$

269 **(c)**

Hydrogen forms about 75% of the mass (total amount) of the universe. It has been estimated that more than 90% of all atoms in the universe are H-atoms. While most of the remaining atoms are of He.

The order of abundance of given elements in the universe is

$$H > O > C > N$$

270 **(a)**

It is a fact.

271 **(c)**

Protium is $_1H^1$.

272 **(d)**

H_2O_2 is weak di-basic acid.

273 **(d)**

These are characteristics of perhydrol .

274 **(c)**

Both halogen (ns^2np^5) and hydrogen $1s^1$ have one electron short to attain configuration of nearest noble gas.

275 **(c)**

Calgon is sodium hexa meta

$-$ phosphate $(NaPO_3)_6$ or $Na_2[Na_4(PO_3)_6]$.

276 **(c)**

It is one of the uses of H_2O_2.

277 **(b)**

Covalent molecules occupy solid structure due to increasing van der Waals' forces.

278 **(a)**
PbO_2 dose not contain —O—O— bond. It is lead dioxide.

280 **(d)**
It is a fact.

281 **(c)**
$Si + 2NaOH + H_2O \longrightarrow Na_2SiO_3 + 2H_2$

282 **(d)**

$$\underbrace{\overset{0}{Cl_2} + \overset{-1}{H_2O_2} \longrightarrow 2\overset{-1}{HCl}}_{\text{1 unit decrease}} + \overset{0}{O_2}$$

In this reaction, H_2O_2 works as a reducing agent

283 **(d)**
SiC is a covalent compound.

284 **(a)**
The reactivity order of isotopes decreases with increase in mass no.

HYDROGEN

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 1 to 0. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

1

Statement 1: NaCl is less soluble in heavy water than in ordinary water.

Statement 2: Dielectric constant of ordinary water is more than that of heavy water.

2

Statement 1: Hard water is more suitable than soft water.

Statement 2: Hard water can be used in steam boilers.

3

Statement 1: Water has high boiling point.

Statement 2: Water shows hydrogen bonding.

4

Statement 1: Temporary hardness can be removed by boiling.

Statement 2: One boiling the soluble bicarbonates change to carbonates which being insoluble get precipitated.

5

Statement 1: Hydrogen shows resemblance with alkali metals as well as halogens.

Statement 2: Hydrogen exists in atomic form only at high temperature.

6

Statement 1: Hydrogen ahs only two isotopes namely protium and deuterium .

Statement 2: Protium is radio active in nature.

7

Statement 1: Saline hydrides are nonvolatiles noe conducting and crystalline solids.

Statement 2: Saline hydrides are compounds of hydrogen with most of the p block elements

HYDROGEN

: ANSWER KEY :

1)	a	2)	d	3)	a	4)	a
5)	b	6)	d	7)	c		

HYDROGEN

: HINTS AND SOLUTIONS :

1 **(a)**
NaCl is less soluble in heavy water than in ordinary water because dielectric constant of ordinary water (*i.e.*, 81) is more than that of heavy water (*i.e.,* 80).

2 **(d)**
Hard water is unsuitable for laundary washing and dying. By using hard water over a period of time, the inner surface of the boiler gets crusted with so called boiler scale. It reduces the efficiency of boiler and also damages it.

3 **(a)**
The high boiling point of H_2O is due to H-boiling which holds the water the water molecules together rather than leaving them free.

4 **(a)**
Temporary hardness is due to presence of bicarbonates of Ca and Mg.

$$M(HCO_3)_2 \rightleftharpoons MCO_3 \downarrow + CO_2 + H_2O$$

$(M = \text{Ca, Mg})$

5 **(b)**
Hydrogen can gain an electron form H^- ion with the stable noble gas configuration of helium. It can also lose its electron to give H^+ ion. Hydrogen therefore has resemblance to the halogens as well as to the alkali metals which gain or lose an electron respectively to form univalent negative and positive ions with noble gas configuration.

6 **(d)**
Hydrogen has three isotopes namely protium ($_1H^1$) deuterium($_1H^2$ or D) and tritium ($_1H^3$ or T). Tritium is radioactive and emits low energy β particles.

7 **(c)**
Saline or ionic hydrides are compounds of hydrogen with most of the *s*-block metals hydrogen forms molecular or covalent hydrides.

HYDROGEN

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

1. Match List I with List II. Choose the correct matching codes from the choices given.

Column-I	**Column- II**
(A) BeH_2	(1) Complex
(B) AsH_3	(2) Lewis acid
(C) B_2H_6	(3) Interstitial
(D) LaH_3	(4) Covalent
(E) $LiAlH_4$	(5) Intermediate
	(6) Ionic

CODES :

	A	**B**	**C**	**D**	**E**
a)	6	2	4	5	1
b)	6	2	4	3	1
c)	6	4	2	3	1
d)	6	4	2	3	1
e)	5	4	2	3	1

HYDROGEN

: ANSWER KEY :

1) d

HYDROGEN

: HINTS AND SOLUTIONS :

1 **(d)**

Complex compounds which do not give all their constituent ions when dissolved in water, individual identity of ions are lost, *e.g.*, $-[Cu(NH_3)_4]SO_4$, $LiAlH_4$.

Lewis acid electrons deficient species which gain electrons while forming a bond with Lewis bases. *E.g.*, B_2H_6.

Interstitial metal hydrides f −block hydrides are non-stoichiometric *e.g.*, LaH_n etc, where chemical composition is variable *e.g.*, $-LaH_{2.87}, X_bH_{2.5}$ etc.

Intermediate hydride polymeric in nature *e.g.*, BeH_2.

Covalent hydride bond forms by sharing of electron. *e.g.*, AsH_3.