7. Among the following, identify the compound which cannot act as both oxidising and reducing agents **[AMU 2002]**

(a) H_2O_2 (b) H_2

(c) SO_2 (d) Cl_2

8. Which of the following reaction produces hydrogen **[AIIMS 2002]**

(a) $Mg + H_2O$ (b) $BaO_2 + HCl$

(c) $H_2S_4O_8 + H_2O$ (d) $Na_2O_2 + 2HCl$

9. Hydrogen resembles in many of its properties **[MH CET 2001]**

(a) Halogen (b) Alkali metals

(c) Both (a) and (b) (d) None of these

10. Ortho and para hydrogen differ in **[AFMC 2001]**

(a) Proton spin (b) Electron spin

(c) Nuclear charge (d) Nuclear reaction

11. Action of water or dilute mineral acids on metals can give **[Kerala (Med.) 2002]**

(a) Monohydrogen (b) Tritium

(c) Dihydrogen (d) Trihydrogen

12. Hydrogen from *HCl* can be prepared by **[Pb. CET 1997]**

(a) *Mg* (b) *Cu*

(c) *P* (d) *Pt*.

13. Which of the following can adsorb largest volume of hydrogen gas

(a) Finely divided platinum (b) Finely divided nickel

(c) Colloidal palladium (d) Colloidal platinum

14. The nuclei of tritium (H^3) atom would contain neutrons

(a) 1 (b) 2

(c) 3 (d) 4

15. The colour of hydrogen is **[MP PET 2004]**

(a) Black (b) Yellow

(c) Orange (d) Colourless

16. Ordinary hydrogen at room temperature is a mixture of

(a) 75% of *o*-Hydrogen + 25% of *p*-Hydrogen

(b) 25% of *o*-Hydrogen + 75% of *p*-Hydrogen

(c) 50% of *o*-Hydrogen + 50% of *p*-Hydrogen

(d) 1% of *o*-Hydrogen + 99% of *p*-Hydrogen

17. Hydrogen cannot reduce

(a) Hot *CuO* (b) Fe_2O_3

(c) Hot SnO_2 (d) Hot Al_2O_3

18. Hydrogen does not combine with

(a) Antimony (b) Sodium

(c) Bismuth (d) Helium

19. The adsorption of hydrogen by metals is called **[EAMCET 1999; Manipal PMT 1999]**

(a) Dehydrogenation (b) Hydrogenation

(c) Occlusion (d) Adsorption

20. Which of the following produces hydrolith with dihydrogen

(a) *Mg* (b) *Al*

(c) *Cu* (d) *Ca*

21. The metal which displaces hydrogen from a boiling caustic soda solution is

(a) *As* (b) *Zn*

(c) *Mg* (d) *Fe*

22. Metals like platinum and palladium can absorb large volumes of hydrogen under special conditions. Such adsorbed hydrogen by the metal is known as

(a) Adsorbed hydrogen (b) Occluded hydrogen

(c) Reactive hydrogen (d) Atomic hydrogen

23. Which is poorest reducing agent

(a) Nascent hydrogen

(b) Atomic hydrogen

(c) Dihydrogen

(d) All have same reducing strength

24. The sum of protons, electrons and neutrons in the heaviest isotope of hydrogen is

(a) 6 (b) 5

(c) 4 (d) 3

25. Number of nucleons in D_2 molecule is

(a) 1 (b) 2

(c) 3 (d) 4

26. An ionic compound is dissolved simultaneously in heavy water and simple water. Its solubility is

(a) Larger in heavy water (b) Smaller in heavy water

(c) Solubility is same in both (d)

27. Ortho-hydrogen and para-hydrogen resembles in which of the following property

(a) Thermal conductivity (b) Magnetic properties

(c) Chemical properties (d) Heat capacity

28. The difference between heat of adsorption of ortho and para hydrogen is

(a) 0.4 $kJ\ mol^{-1}$ (b) 0.8 $kJ\ mol^{-1}$

(c) Zero (d) None of these

29. Hydrogen ion H^- is isoelectronic with

(a) *Li* (b) *He*

(c) H^+ (d) Li^-

30. Hydrogen can be fused to form helium at **[AFMC 2005]**

(a) High temperature and high pressure

(b) High temperature and low pressure

(c) Low temperature and high pressure

(d) Low temperature and low pressure

31. Hydrogen can be prepared by mixing steam, and water gas at 500°*C* in the presence of Fe_3O_4 and Cr_2O_3. This process is called

(a) Nelson process (b) Serpeck's process

(c) Bosch process (d) Parke's process

32. Which of the following metal do not liberate hydrogen from dilute hydrochloric acid

(a) Zn (b) Mg

(c) Fe (d) Au

33. An element reacts with hydrogen to form a compound A which on treatment with water liberates hydrogen gas. The element can be

(a) Nitrogen (b) Chlorine

(c) Selenium (d) Calcium

34. Hydrogen combines with other elements by

(a) Losing an electron

(b) Gaining an electron

(c) Sharing an electron

(d) Losing, gaining or sharing electron

35. Which of the following explanation is best for not placing hydrogen with alkali metals or halogen

(a) The ionization energy of hydrogen is high for group of alkali metals or halogen

(b) Hydrogen can form compounds

(c) Hydrogen is a much lighter element than the alkali metals or halogens

(d) Hydrogen atom does not contain any neutron

36. Which of the following terms is not correct for hydrogen

(a) Its molecule is diatomic

(b) It exists both as H^+ and H^- in different chemical compounds

(c) It is the only species which has no neutrons in the nucleus

(d) Heavy water is unstable because hydrogen is substituted by its isotope deuterium

37. When electric current is passed through an ionic hydride in the molten state

(a) Hydrogen is liberated at the anode

(b) Hydrogen is liberated at the cathode

(c) No reaction takes place

(d) Hydride ion migrates towards cathode

38. Which of the halogen has maximum affinity for hydrogen

(a) F_2 (b) Cl_2

(c) Br_2 (d) I_2

39. Which of the following statements is most applicable to hydrogen

(a) It can act as a reducing agent

(b) It can act as an oxidising agent

(c) It can act both as oxidising and reducing agent

(d) It can neither act as oxidising nor as a reducing agent

40. Hydrogen is

(a) Electropositive

(b) Electronegative

(c) Both electropositive as well as electronegative

(d) Neither electropositive nor electronegative

41. Ionization energy of hydrogen is

(a) Equal to that of chlorine

(b) Lesser than that of chlorine

(c) Slightly higher than that of chlorine

(d) Much higher than that of chlorine

42. Hydrogen acts as a reducing agent and thus resembles

(a) Halogen (b) Noble gas

(c) Radioactive elements (d) Alkali metals

43. Which position for hydrogen explain all its properties

(a) At the top of halogen

(b) At the top of alkali metals

(c) At the top of carbon family

(d) None of these

44. Hydrogen readily combines with non-metals and thus it shows its

(a) Electronegativity character

(b) Electropositive character

(c) Both (a) and (b)

(d) None of these

45. The oxidation states shown by hydrogen are

(a) –1 only (b) Zero only

(c) +1, –1, 0 (d) +1 only

46. Hydrogen readily combines with metals and thus shows its

(a) Electropositive character (b) Electronegative character

(c) Both (a) and (b) (d) None of these

47. Electrolysis of fused sodium hydride liberate hydrogen at the

(a) Anode

(b) Cathode

(c) Cathode and anode both

(d) None of these

48. Protonic acid is

(a) A compound that form solvated hydrogen ion in polar solvent

(b) An acid which accepts the proton

(c) A compound that forms hydride ion in polar solvent

(d) An acid which donates the proton

49. In all its properties, hydrogen resembles

(a) Alkali metals only

(b) Halogen only

(c) Both alkali metals and halogens

(d) Neither alkali metals nor halogens

50. 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

51. Which of the following statements concerning protium, deuterium and tritium is not true

(a) They are isotopes of each other

(b) They have similar electronic configurations

(c) They exist in the nature in the ratio of 1 : 2 : 3

(d) Their mass numbers are in the ratio of 1 : 2 : 3

52. When SO_3 is treated with heavy water the product is/are

(a) Deuterium and sulphuric acid

(b) Deuterium and sulphurous acid

(c) Only deuterium

(d) Dideuterosulphuric acid

53. Hydrogen has three isotopes, the number of possible diatomic molecules will be

(a) 2 (b) 6

(c) 9 (d) 12

54. In which of the compounds does hydrogen have an oxidation state of –1

(a) CH_4 (b) NH_3

(c) HCl (d) CaH_2

55. Pure hydrogen is obtained by carrying electrolysis of

(a) Water containing H_2SO_4

(b) Water containing $NaOH$

(c) $Ba(OH)_2$ solution

(d) KOH solution

56. 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

57. Deuterium differs from hydrogen in

(a) Chemical properties

(b) Physical properties

(c) Both physical and chemical properties

(d) Radioactive properties

58. Tritium undergoes radioactive decay giving

(a) α-particles (b) β-particles

(c) Neutrons (d) γ-rays

59. The gas used in the hydrogenation of vegetable oils in the presence of nickel as catalyst is

(a) Methane (b) Ethane

(c) Ozone (d) Hydrogen

60. The conversion of atomic hydrogen into ordinary hydrogen is

(a) Exothermic change

(b) Endothermic change

(c) Nuclear change

(d) Photochemical change

61. The name hydrogen was given by

(a) Cavendish (b) Lavoisier

(c) Urey (d) None of these

62. The ratio C_p / C_v for H_2 is

(a) 1.40 (b) 1.67

(c) 1.33 (d) None of these

63. Triatomic hydrogen is called

(a) Deuterium (b) Hyzone

(c) Ortho form (d) Hydronium ion

64. $LiAlH_4$ is obtained by reacting an excess of .... With an ethereal solution of $AlCl_3$

(a) $LiCl$ (b) LiH

(c) Li (d) $LiOH$

65. Alkali metal hydrides react with water to give

(a) Acidic solution (b) Basic solution

(c) Neutral solution (d) Hydride ion

66. Ionic hydrides are usually

(a) Good electrically conductors when solid

(b) Easily reduced

(c) Good reducing agents

(d) Liquid at room temperature

67. When $NaBH_4$ is dissolved in water

(a) It decomposes with the evolution of H_2

(b) Na^+ and BH_4^- are formed which are stable

(c) BH_4^- ions formed initially decompose to produce OH^- ions, which prevent further decomposition

(d) NaH and B_2H_6 are produced

68. Systematic name of H_2O (oxide of hydrogen) is

(a) Water (b) Hydrogen oxide

(c) Oxidane (d) None of these

69. Group 2 hydrides with significant covalent character is/are

(a) BeH_2 (b) MgH_2

(c) Both (a) and (b) (d) None of these

70. Limiting compositions of *f*-block hydrides are

(a) MH_2 and MH_3 (b) MH_3 and MH_5

(c) MH_2 and MH_8 (d) MH_2 and MH_6

71. Hydrogen directly combines with **[Roorkee Entrance 1990]**

(a) Au (b) Cu

(c) Ni (d) Ca

72. Chemical A is used for water softening to remove temporary hardness. A reacts with sodium carbonate to generate caustic soda. When CO_2 is bubbled through a solution of A, it turns cloudy. What is the chemical formula of A

[Pb. CET 1990; AIIMS 1999]

(a) $CaCO_3$ (b) CaO

(c) $Ca(OH)_2$ (d) $Ca(HCO_3)_2$

73. When same amount of zinc is treated separately with excess of sulphuric acid and excess of sodium hydroxide solution the ratio of volumes of hydrogen evolved is **[CPMT 1991]**

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) 9 : 4

74. Which one of the following substances is used in the laboratory for a fast drying of neutral gases **[CBSE PMT 1992]**

(a) Phosphorus pentoxide

(b) Active charcoal

(c) Anhydrous calcium chloride

(d) Na_3PO_4

75. Which is the lightest gas **[CPMT 1993]**

(a) Nitrogen (b) Helium

(c) Oxygen (d) Hydrogen

76. The composition of tritium is **[UGET Manipal 1995]**

(a) 1 electron, 1 proton, 1 neutron

(b) 1 electron, 2 protons, 1 neutron

(c) 1 electron, 1 proton, 2 neutrons

(d) 1 electron, 1 proton, 3 neutrons

77. The property of hydrogen which distinguishes it from alkali metals is

(a) Its electropositive character

(b) Its affinity for non metal

(c) Its reducing character

(d) Its non-metallic character

78. The hydride ion H^- is a stronger base than its hydroxide ion OH^-. Which of the following reactions will occur if sodium hydride (NaH) is dissolved in water **[CBSE PMT 1997]**

(a) $H^-(aq) + H_2O \rightarrow H_3O^-(aq)$

(b) $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + H_2(g)$

(c) $H^-(aq) + H_2O(l) \rightarrow$ No reaction

(d) None of these

79. Hydrogen accepts an electron to form inert gas configuration. In this it resembles **[Pb. PMT 1997]**

(a) Halogen (b) Alkali metals

(c) Chalcogens (d) Alkaline earth metals

80. Which of the following is correct for hydrogen **[AFMC 1997; BHU 1997]**

(a) It can form bonds in +1 as well as –1 oxidation state

(b) It is always collected at cathode

(c) It has a very high ionization potential

(d) It has same electronegativity as halogens

81. Which of the following will not displace hydrogen **[Pb. PMT 1999]**

(a) Ba (b) Pb

(c) Hg (d) Sn

82. Which of the following gas is insoluble in water **[Pb. CET 2003]**

(a) SO_2 (b) NH_3

(c) H_2 (d) CO_2

83. Which element forms maximum compound in chemistry **[Pb. CET 2004]**

(a) O (b) H

(c) Si (d) C

84. Hydrogen is not obtained when zinc reacts with **[J & K 2005]**

(a) Cold water (b) Hot $NaOH$ solution

(c) Conc. sulphuric acid (d) dilute HCl

Water or hydride of oxygen

1. Synthetic detergents are more effective in hard water than soaps because **[AMU 2002]**

(a) They are highly soluble in water

(b) Their Ca^{++} and Mg^{++} salts are water soluble

(c) Their Ca^{++} and Mg^{++} salts are insoluble in water

(d) None of these

2. D_2O is used more in **[BHU 1997; CPMT 1997]**

(a) Chemical industry

(b) Nuclear reactor

(c) Pharmaceutical preparations

(d) Insecticide preparation

3. Heavy water (D_2O) is **[RPET/PMT 2000; CPMT 2000]**

(a) A product of oxygen and hydrogen

(b) Water of mineral springs

(c) Water obtained by repeated distillation and condensation

(d) Ordinary water containing dissolved salts heavy metals

4. Temporary hardness may be removed from water by adding **[Pb. PMT 2002]**

(a) $CaCO_3$ (b) $Ca(OH)_2$

(c) $CaSO_4$ (d) HCl

5. Heavy water is **[AFMC 1997; UPSEAT 2003 MH CET 2003; Pb. CET 2001]**

(a) Water containing Fe, Cr, Mn

(b) Water at $0°C$

(c) D_2O

(d) Water obtained after a number of distillations

6. Heavy water is compound of **[DPMT 2001; DCE 2002]**

(a) Oxygen and heavier isotopes of hydrogen

(b) Hydrogen and heavier isotopes of oxygen

(c) Heavier isotopes of oxygen and hydrogen

(d) None of these

7. Which of the following pair of ions makes the water hard **[AMU 2002]**

(a) Na^+, SO_4^{2-} (b) K^+, HCO_3^-

(c) Ca^{2+}, NO_3^- (d) NH_4^+, Cl^-

8. Temporary hardness of water can be removed by **[Pb. PMT 2001]**

(a) Addition of potassium permagenate

(b) Boiling

(c) Filtration

(d) Addition of chlorine

9. When zeolite (Hydrated sodium aluminium silicate) is treated with hard water the sodium ions are exchanged with **[DPMT 2000]**

(a) OH^- ions (b) SO_4^{2-} ions

(c) Ca^{2+} ions (d) H^+ ions

10. Which of the following statements do not define the characteristic property of water "Water is a universal solvent"

(a) It can dissolve maximum number of compounds

(b) It has very low dielectric constant

(c) It has high liquid range

(d) None of these

11. The velocity of neutrons in nuclear reactor is slowed down by

(a) Heavy water (D_2O) (b) Ordinary water (H_2O)

(c) Zinc rod (d) Fused caustic soda

12. Temporary hardness of water is due to the presence of

(a) Magnesium bicarbonate (b) Calcium chloride

(c) Magnesium sulphate (d) Calcium carbonate

13. Which of the following is not true

(a) Hardness of water depends on its behaviour towards soap

(b) The temporary hardness is due to the presence of *Ca* and *Mg* bicarbonates

(c) Permanent hardness is due to the presence of soluble *Ca* and *Mg* sulphates, chlorides and nitrates

(d) Permanent hardness can be removed by boiling the water

14. The molarity of pure water at $4°C$ is

(a) 1 M (b) 2.5 M

(c) 5 M (d) 55.5 M

15. Which of the following is not a hard water

(a) Water containing $CaCl_2$

(b) Water containing dil. HCl

(c) Water containing $MgSO_4$

(d) None of these

16. Heavy water is used in atomic reactor as

(a) Coolant

(b) Moderator

(c) Both moderator and coolant

(d) Neither coolant nor moderator

17. Heavy water freezes at

(a) $0°C$ (b) $3.8°C$

(c) $38°C$ (d) $-0.38°C$

18. The pH of D_2O and H_2O at 298 K is

(a) 7.0, 7.0 (b) 7.35, 7.0

(c) 7.0, 6.85 (d) 6.85, 7.35

19. Which of the following is not true

(a) Ordinary water is electrolysed more rapidly than D_2O

(b) Reaction between H_2 and Cl_2 is much faster than D_2 and Cl_2

(c) D_2O freezes at lower temperature than H_2O

(d) Bond dissociation energy for D_2 is greater than H_2

20. Which of the following will determine whether the given colourless liquid is water or not

(a) Melting

(b) Tasting

(c) Phosphthalein

(d) Adding a pinch of anhydrous $CuSO_4$

21. Lead pipes are not used for carrying drinking water because

(a) They are covered with a coating of lead carbonate

(b) They are corroded by air and moisture

(c) Water containing dissolved air attacks lead forming soluble hydroxide

(d) None of these

22. Which one of the following removes temporary hardness of water

(a) Slaked lime (b) Plaster of Paris

(c) Cuprous (d) Hydrolith

23. Which of the following will cause softening of hard water

(a) Passing it through cation exchange resin

(b) Passing it through anion exchange resin

(c) Passing it through sand

(d) Passing it through alumina

24. which of the following process permanent hardness of water can be removed, by adding **[AFMC 2005]**

(a) Sodalime (b) Sodiumbicarbonate

(c) Washing soda (d) Sodium chloride

25. Permutit is technical name given to

(a) Aluminates of calcium and sodium

(b) Silicates of calcium and sodium

(c) Hydrated silicates of aluminium and sodium

(d) Silicates of calcium and magnesium

26. The approximate mass of tritium oxide molecule is

(a) 18 *amu* (b) 20 *amu*

(c) 22 *amu* (d) 24 *amu*

27. Molecular weight of heavy water is

(a) 19 (b) 18

(c) 17 (d) 20

28. Water is said to be permanently hard when it contains

(a) Sulphates of *Mg* and *Ca*

(b) Bicarbonates of *Mg* and *Ca*

(c) Sulphates of *Cu* and *Hg*

(d) Carbonates and bicarbonates of *Mg* and *Ca*

29. Sodium sulphate is soluble in water but barium sulphate is insoluble because **[Pb. PMT 1995]**

(a) The hydration energy of Na_2SO_4 is more than its lattice energy

(b) The lattice energy of $BaSO_4$ is more than its hydration energy

(c) The lattice energy has no role to play in solubility

(d) The hydration energy of Na_2SO_4 is less than its lattice energy

(e) Both (a) and (b)

30. The alum used for purifying water is **[EAMCET 1999]**

(a) Ferric alum (b) Chrome alum

(c) Potash alum (d) Ammonium alum

31. Which of the following metal will not reduce H_2O **[CPMT 1999]**

(a) *Ca* (b) *Fe*

(c) *Cu* (d) *Li*

32. Which of the following is correct about heavy water **[DCE 2002]**

(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 these

33. The boiling point of water is exceptionally high because **[KCET 2001]**

(a) There is covalent bond between *H* and *O*

(b) Water molecule is linear

(c) Water molecules associate due to hydrogen bonding

(d) Water molecule is not linear

34. Match list I with list II and select the correct answer using the codes given below the lists **[SCRA 2001]**

	List I	List II
1.	Heavy water	(a) Bicarbonates of *Mg* and *Ca* in water
2.	Temporary hard water	(b) No foreign ions in water
3.	Soft water	(c) D_2O
4.	Permanent hard water	(d) Sulphates and chlorides of *Mg* and *Ca* in water

Codes

(a) 1-*c*, 2-*d*, 3-*b*, 4-*a* (b) 1-*b*, 2-*a*, 3-*c*, 4-*d*

(c) 1-*b*, 2-*d*, 3-*c*, 4-*a* (d) 1-*c*, 2-*a*, 3-*b*, 4-*d*

35. The $H-O-H$ angle in water molecule is about **[AFMC 2001]**

(a) 90° (b) 180°

(c) 102° (d) 105°

36. When two ice cubes are pressed over each other, they unite to form one cube. Which of the following forces is responsible to hold them together **[AFMC 2001]**

(a) Hydrogen bond formation

(b) Van der Waals forces

(c) Covalent attraction

(d) Ionic interaction

37. What is formed when calcium carbide reacts with heavy water **[Manipal PMT 2001; Pb. CET 2000]**

(a) C_2D_2 (b) CaD_2

(c) Ca_2D_2O (d) CD_2

38. Pure water can be obtained from sea water by **[CBSE PMT 2001]**

(a) Centrifugation (b) Plasmolysis

(c) Reverse osmosis (d) Sedimentation

39. Action of water or dilute mineral acids on metals can give **[Kerala PMT 2002]**

(a) Monohydrogen (b) Tritium

(c) Dihydrogen (d) Trihydrogen

(e) D_2

40. Metal which does not react with cold water but evolves H_2 with steam is **[DCE 2002]**

(a) *Na* (b) *K*

(c) *Pt* (d) *Fe*

41. *pH* of neutral water at room temperature nearly

(a) 0 (b) 14
(c) 7 (d) 10^{-7}

42. Maximum number of hydrogen bonding in H_2O is **[DCE 2004; MP PET 2004; MP PMT 2004; BHU 2004]**
(a) 1 (b) 2
(c) 3 (d) 4

43. The low density of ice compared to water is due to **[Pb. CET 2004]**
(a) Induced dipole-induced dipole interactions
(b) Dipole-induced dipole interaction
(c) Hydrogen bonding interactions
(d) Dipole-dipole interactions

44. Which of the following acid is formed when SiF_4 reacts with water **[BHU 2004]**
(a) SiF_4 (b) H_2SiF_4
(c) H_2SO_4 (d) H_2SiF_6

45. Triple point of water is **[AFMC 2004]**
(a) $273\,K$ (b) $373\,K$
(c) $203\,K$ (d) $193\,K$

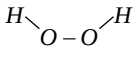
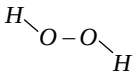
46. Hardness of water is due to presence of salts of **[BHU 2005]**
(a) Na^+ and K^+ (b) Ca^{2+} and Mg^{2+}
(c) Ca^{2+} and K^+ (d) Ca^{2+} and Na^+

Hydrogen peroxide

1. In which of the following reaction hydrogen peroxide is a reducing agent **[BHU 1995]**
(a) $2FeCl_2 + 2HCl + H_2O_2 \rightarrow 2FeCl_3 + 2H_2O$
(b) $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$
(c) $2HI + H_2O_2 \rightarrow 2H_2O + I_2$
(d) $H_2SO_3 + H_2O_2 \rightarrow H_2SO_4 + H_2O$

2. There is a sample of 10 volume of hydrogen peroxide solution. Calculate its strength **[UPSEAT 2001]**
(a) 3.00% (b) 4.045%
(c) 2.509% (d) 3.035%

3. In lab H_2O_2 is prepared by **[CPMT 2002; MH CET 2003; Pb. PMT 2004; BCECE 2005]**
(a) Cold $H_2SO_4 + BaO_2$ (b) $HCl + BaO_2$
(c) Conc. $H_2SO_4 + Na_2O_2$ (d) $H_2 + O_2$

4. The structure of H_2O_2 is **[UPSEAT 2001]**
(a)  (b) 
(c) $H-O-O-H$ (d) 

5. HCl is added to the following oxides which one would give H_2O_2 **[Kurukshetra CEE 1998]**
(a) MnO_2 (b) PbO_2
(c) BaO_2 (d) None of these

6. The oxide that gives hydrogen peroxide (H_2O_2) on the treatment with a dilute acid (H_2SO_4) is **[Pb. PMT 1999]**
(a) MnO_2 (b) PbO_2
(c) Na_2O_2 (d) TiO_2

7. Hydrogen peroxide is reduced by **[CPMT 2000; CBSE PMT 2000; KCET 2002]**
(a) Ozone
(b) Barium peroxide
(c) Acidic solution of $KMnO_4$
(d) Lead sulphide suspension

8. The reaction of $H_2S + H_2O_2 \rightarrow S + 2H_2O$ manifests **[UPSEAT 2000]**
(a) Acidic nature of H_2O_2
(b) Alkaline nature of H_2O_2
(c) Oxidising nature of H_2O_2
(d) Reducing action of H_2O_2

9. What is the product of the reaction of H_2O_2 with Cl_2 **[RPET 2003]**
(a) $O_2 + HOCl$ (b) $HCl + O_2$
(c) $H_2O + HCl$ (d) $HCl + H_2$

10. H_2O_2 will oxidise **[Roorkee 1995]**
(a) $KMnO_4$ (b) PbS
(c) MnO_2 (d) H_2S

11. Fenton's reagent is **[MP PET 2000; RPET 2000]**
(a) $FeSO_4 + H_2O_2$ (b) $Zn + HCl$
(c) $Sn + HCl$ (d) None of these

12. The structure of H_2O_2 is **[CBSE 1999; AFMC 2004]**
(a) Planar (b) Linear
(c) Spherical (d) Non-planar

13. The volume strength of 1.5 N H_2O_2 solution is **[BHU 2004; Pb. CET 2004]**
(a) 8.4 *litres* (b) 4.2 *litres*
(c) 16.8 *litres* (d) 5.2 *litres*

14. The volume of oxygen liberated from 15 *ml* of 20 volume H_2O_2 is **[MH CET 2003]**
(a) 250 *ml* (b) 300 *ml*
(c) 150 *ml* (d) 200 *ml*

15. The strength in volumes of a solution containing 30.36 *g/litre* of H_2O_2 is **[UPSEAT 2004]**
(a) 10 volume (b) 20 volume
(c) 5 volume (d) None of these

16. Hydrogen peroxide is used as
(a) Oxidising agent
(b) Reducing agent

(c) Both as oxidising and reducing agent
(d) Drying agent

17. Equivalent weight of H_2O_2 is
(a) 17 (b) 34
(c) 68 (d) 18

18. 20 volume H_2O_2 solution has a strength of about
(a) 30% (b) 6%
(c) 3% (d) 10%

19. H_2O_2 is manufactured these days **[DCE 2004]**
(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

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

21. 1 *ml* of H_2O_2 solution gives 10 *ml* of O_2 at NTP. It is
(a) 10 vol. H_2O_2 (b) 20 vol. H_2O_2
(c) 30 vol. H_2O_2 (d) 40 vol. H_2O_2

22. Which substance does not speed up decomposition of H_2O_2
(a) Glycerol (b) *Pt*
(c) Gold (d) MnO_2

23. Which of the following cannot be oxidised by H_2O_2
(a) O_3 (b) KI/HCl
(c) PbS (d) Na_2SO_3

24. Which substance cannot be reduced by H_2O_2
(a) $KMnO_4/H_2SO_4$ (b) $K_2Cr_2O_7/H_2SO_4$
(c) Ag_2O (d) Fe^{3+}

25. Which of the following statements is incorrect
(a) H_2O_2 can act as an oxidising agent
(b) H_2O_2 can act as a reducing agent
(c) H_2O_2 has acidic properties
(d) H_2O_2 has basic properties

26. H_2O_2 is
(a) Poor polar solvent than water
(b) Better polar solvent than H_2O
(c) Both have equal polarity
(d) Better polar solvent but its strong auto oxidising ability limits its use as such

27. H_2O_2 used in rockets has the concentration
(a) 50% (b) 70%
(c) 30% (d) 90%

28. H_2O_2 is a
(a) Weak acid (b) Weak base
(c) Neutral (d) None of these

29. Nitrates of all metals are
(a) Soluble in water (b) Insoluble
(c) Coloured (d) Unstable

30. Decomposition of H_2O_2 is prevented by
(a) $NaOH$ (b) MnO_2
(c) Acetanilide (d) Oxalic acid

31. H_2O_2 is always stored in black bottles because
(a) It is highly unstable
(b) Its enthalpy of decomposition is high
(c) It undergo autooxidation on prolonged standing
(d) None of these

32. H_2O_2 on reacting with ethene gives
(a) Ethane (b) Ethanal
(c) Ethylene glycol (d) Ethanol

33. Which of the following is wrong about H_2O_2? It is used
(a) As aerating agent in production of spong rubber
(b) As an antichlor
(c) For restoring white colour of blackened lead painting
(d) None of these

34. $H_2O_2 \rightarrow 2H^+ + O_2 + 2e^-$; $E^\circ = -0.68\ V$. This equation represents which of the following behaviour of H_2O_2
(a) Reducing (b) Oxidising
(c) Acidic (d) Catalytic

35. The structure of H_2O_2 is
(a) Open book like (b) Linear
(c) Closed book (d) Pyramidal

36. On shaking H_2O_2 with acidified potassium dichromate and ether, ethereal layer becomes
(a) Green (b) Red
(c) Blue (d) Black

37. K_a of H_2O_2 is of the order of **[MP PMT 1994]**
(a) 10^{-12} (b) 10^{-14}
(c) 10^{-16} (d) 10^{-10}

38. In which of the following reactions, H_2O_2 acts as a reducing agent **[EAMCET 2001]**
(a) $PbO_2(s) + H_2O_2(aq) \rightarrow PbO(s) + H_2O(l) + O_2(g)$
(b) $Na_2SO_3(aq) + H_2O_2(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$
(c) $2KI(aq) + H_2O_2(aq) \rightarrow 2KOH(aq) + I_2(s)$

(d) $KNO_2(aq)+H_2O_2(aq)\rightarrow KNO_3(aq)+H_2O(l)$

39. H_2O_2 acts as an oxidising agent in **[Kerala PMT 2004]**

(a) Neutral medium
(b) Acidic medium
(c) Alkaline medium
(d) Alkaline and neutral medium
(e) Acidic and alkaline medium

40. The $H-O-O$ bond angle in H_2O_2 is **[Kerala PMT 2004]**

(a) 107.28^o (b) 109.28^o
(c) 104.5^o (d) 106^o
(e) 97^o

41. The volume of oxygen liberated from $0.68\,gm$ of H_2O_2 is **[Pb. PMT 2004]**

(a) $112\ ml$ (b) $224\ ml$
(c) $56\ ml$ (d) $336\ ml$

Critical Thinking

Objective Questions

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

2. The critical temperature of water is higher than that of O_2 because H_2O molecule has **[IIT 1997]**
(a) Fewer electrons than oxygen
(b) Two covalent bonds
(c) V-shape
(d) Dipole moment

3. One mole of calcium phosphide on reaction with excess water gives **[IIT 1999]**
(a) One mole of phosphene
(b) Two moles of phosphoric acid
(c) Two moles of phosphene
(d) One mole of phosphorus pentaoxide

4. When zeolite, which is hydrated sodium aluminium silicate, is treated with hard water the sodium ions are exchanged with
(a) H^+ ions (b) Ca^{2+} ions
(c) Mg^{2+} ions (d) Both Ca^{2+} and Mg^{2+}

5. Hydrogen peroxide is
(a) A stronger acid than water
(b) A weaker acid than water
(c) An oxidising agent
(d) A reducing agent

6. Hydrogen can be obtained from water by
(a) Reaction with metal oxides
(b) Reaction with non-metal oxides
(c) Reaction with metals
(d) Reaction with metal hydrides

7. Which of the following is/are hard water(s)
(a) Water containing some potash alum
(b) Water containing a few drops of HCl
(c) Water containing common salt
(d) Water containing calcium nitrate

8. Pick the odd one out
(a) Sodium borohydride reacts very slowly with cold water
(b) Sodium borohydride reacts very violently with cold water to produce H_2
(c) Solubility of sodium borohydride in water at 25°C is 10.05 g/mL
(d) Melting point of sodium borohydride is 500°C

9. Hydrogen can be obtained from water, by the action of water on
(a) Calcium carbide (b) Calcium hydride
(c) Calcium oxide (d) Calcium

10. What is true about ice
(a) Its density is more than water
(b) It is a good conductor of heat **[IIT JEE (Screening) 2002]**
(c) It is a thermal insulator
(d) Its density is less than water

11. Hydrogen will not reduce **[IIT 1985]**
(a) Heated cupric oxide (b) Heated ferric oxide
(c) Heated stannic oxide (d) Heated aluminium oxide

12. HCl is added to following oxides. Which one would give H_2O_2 **[IIT 1980]**
(a) MnO_2 (b) PbO_2
(c) BaO (d) None of these

13. Which of the following pair will not produce dihydrogen gas **[IIT 1994]**
(a) $Cu+HCl(dil.)$ (b) $Fe+H_2SO_4$
(c) $Mg+\text{steam}$ (d) $Na+\text{alcohol}$

14. The amount of H_2O_2 present in 1 L of 1.5 N H_2O_2 solution is **[IIT 1990]**
(a) 2.5 g (b) 25.5 g
(c) 3.0 g (d) 8.0 g

15. Hydrogen is evolved by the action of cold dil. HNO_3 on **[IIT 1998]**
(a) Fe (b) Mn

(c) Cu (d) Al

16. Hydrogen can behave as a metal
(a) At very high temperature (b) At very low temperature
(c) At very high pressure (d) At very low pressure

17. D_2O is preferred to H_2O, as a moderator, in nuclear reactors because
(a) D_2O slows down fast neutrons better
(b) D_2O has high specific heat
(c) D_2O is cheaper
(d) None of these

18. Out of the two allotropic forms of dihydrogen, the form with lesser molecular energy is
(a) Ortho (b) Meta
(c) Para (d) All have same energy

19. Saline hydrides react explosively with water, such fires can be extinguished by
(a) Water (b) Carbon dioxide
(c) Sand (d) None of these

20. Metals of groups 7, 8 and 9 do not form metallic hydrides. This is termed as
(a) Hydride gap (b) Hydride shift
(c) Anhydride (d) Dehydride

21. When temporary hard water containing $Mg(HCO_3)_2$ is boiled the ppt. formed is of
(a) $MgCO_3$ (b) MgO
(c) $Mg(OH)_2$ (d) None of these

22. Permanent hardness due to Mg^{2+} ions is best removed by
(a) $Ca(OH)_2$ (b) Na_2CO_3
(c) $Na_2CO_3 + Ca(OH)_2$ (d) None of these

23. The most abundant element in the universe is
(a) Carbon (b) Silicon
(c) Hydrogen (d) Helium

24. Pick out the correct statement
(a) By decreasing the temperature pure para-hydrogen can be obtained
(b) By increasing the temperature pure ortho-hydrogen can be obtained
(c) By decreasing the temperature pure ortho-hydrogen can be obtained
(d) By increasing the temperature pure para-hydrogen can be obtained

25. Hydrogen can be produced by heating
(a) Cu with H_2SO_4 (b) Sodium formate
(c) Sodium oxalate (d) None of these

26. Plumbosolvency is a health hazard in the transportation of
(a) Hard water only
(b) Soft water only
(c) Both (a) and (b)
(d) Water containing plum juice

27. A sample of water contains sodium chloride. It is
(a) Hard water (b) Soft water
(c) Moderately hard (d) None of these

28. Hardness producing salt, whose solubility in water decreases with rise of temperature is
(a) $CaCl_2$ (b) $CaSO_4$
(c) $Ca(HCO_3)_2$ (d) $MgSO_4$

29. A sample of water containing some dissolved table sugar and common salt is passed through organic ion exchange resins. The resulting water will be
(a) Tasteless (b) Sweet
(c) Salty (d) None of these

30. Water obtained by purification with organic ion exchange resins is
(a) Pure water
(b) Free from only Ca^{2+}, Mg^{2+} ions
(c) Free from HCO_3^-, SO_4^{2-} and Cl^- ions only
(d) None of these

31. Which of the following can effectively remove all types of hardness of water
(a) Soap (b) Washing soda
(c) Slaked lime (d) None of these

32. A commercial sample of hydrogen peroxide is labelled as 10 volume. Its percentage strength is nearly **[KCET 2005]**
(a) 1% (b) 3%
(c) 10% (d) 90%

A R Assertion & Reason
For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : Hydrogen combines with other elements by losing, gaining or sharing of electrons.
Reason : Hydrogen forms electrovalent and covalent bonds with other elements.

2. Assertion : Calgon is used for removing Ca^{2+} and Mg^{2+} ions from hard water.

Reason : Calgon forms precipitates with Ca^{2+} and Mg^{2+}.

3. Assertion : Decomposition of H_2O_2 is a disproportionation reaction.
   Reason : H_2O_2 molecule simultaneously undergoes oxidation and reduction.
4. Assertion : H_2O_2 has higher boiling point than water.
   Reason : H_2O_2 has stronger dipole-dipole interactions than water.
5. Assertion : H_2O_2 is not stored in glass bottles.
   Reason : Alkali oxides present in glass catalyse the decomposition of H_2O_2.
6. Assertion : H_2O_2 reduces Cl_2 to HCl.
   Reason : H_2O_2 is called antichlor.
7. Assertion : In acidic medium, H_2O_2 reacts with MnO_2 to give O_2.
   Reason : H_2O_2 is a strong oxidising agent.
8. Assertion : In alkaline solution, H_2O_2 reacts with potassium ferricyanide.
   Reason : H_2O_2 is a strong reducing agent.
9. Assertion : Acidulated water is an example of hard water.
   Reason : In the presence of an acid, soap is converted into insoluble free fatty acids.
10. Assertion : Hydrogen peroxide forms only one series of salts called peroxides.
    Reason : Hydrogen peroxide molecule has only one replaceable hydrogen atom.

Answers

Hydrogen

1	a	2	d	3	a	4	a	5	d
6	d	7	b	8	a	9	c	10	a
11	c	12	a	13	c	14	b	15	d
16	a	17	d	18	d	19	c	20	d
21	b	22	b	23	c	24	c	25	d
26	b	27	c	28	a	29	b	30	a
31	c	32	d	33	d	34	d	35	c
36	d	37	a	38	a	39	c	40	c
41	c	42	d	43	d	44	b	45	c
46	b	47	a	48	a	49	c	50	d
51	c	52	d	53	b	54	d	55	c
56	b	57	b	58	b	59	d	60	a
61	b	62	a	63	b	64	b	65	b
66	c	67	c	68	c	69	c	70	a
71	d	72	c	73	a	74	c	75	d
76	c	77	d	78	b	79	a	80	a
81	c	82	c	83	b	84	c		

Water or hydride of oxygen

1	b	2	b	3	c	4	b	5	c
6	a	7	b	8	b	9	c	10	b
11	a	12	a	13	d	14	d	15	d
16	c	17	b	18	b	19	c	20	d
21	c	22	a	23	a	24	c	25	c
26	c	27	d	28	a	29	e	30	c
31	c	32	c	33	c	34	d	35	d
36	a	37	a	38	c	39	c	40	d
41	c	42	d	43	c	44	b	45	a
46.	b								

Hydrogen peroxide

1	B	2	d	3	a	4	b	5	c
6	c	7	d	8	c	9	b	10	b
11	a	12	d	13	a	14	b	15	a
16	c	17	a	18	b	19	c	20	c
21	a	22	a	23	a	24	d	25	d
26	d	27	d	28	a	29	a	30	c
31	c	32	c	33	d	34	a	35	a
36	c	37	a	38	a	39	e	40	e
41	b								

Critical Thinking Questions

1	c	2	d	3	c	4	d	5	acd
6	cd	7	abd	8	b	9	bd	10	cd
11	d	12	d	13	a	14	b	15	b
16	c	17	d	18	c	19	c	20	a
21	c	22	c	23	c	24	b	25	b
26	b	27	b	28	b	29	b	30	d
31	a	32	b						

Assertion & Reason

1	a	2	d	3	a	4	c	5	a
6	a	7	b	8	a	9	a	10	d

Answers and Solutions

Hydrogen and its preparation

1. (a) $NaH + H_2O \rightarrow NaOH + H_2 \uparrow$

2. (d) $KH + H_2O \rightarrow KOH + H_2 \uparrow$

3. (a) Hydrogen burns in air with a light bluish flame.

4. (a) Ortho and para hydrogen show different spin in a hydrogen molecule it does not show hydrogen isotopes.

5. (d) Boiling point of liquid hydrogen is lowest of given substances so it is distilled first.

6. (d) $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2 \uparrow$

8. (a) $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2 \uparrow$

10. (a) Ortho and para hydrogen differ in proton spin.

11. (c) $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2 \uparrow$

12. (a) $Mg + 2HCl \rightarrow MgCl_2 + H_2 \uparrow$

13. (c) Order of adsorption of H_2 (occlusion) is

Colloidal Palladium > Palladium > Platinum > Gold > Nickel

14. (b) Number of neutrons = Mass number – Atomic number

= 3 – 1 = 2

17. (d) Because *Al* has more affinity for oxygen than hydrogen.

18. (d) Helium is a noble gas and does not combine with hydrogen.

19. (c) Occlusion is the phenomenon of adsorption of hydrogen by metal.

20. (d) CaH_2 is known as hydrolith.

21. (b) *Zn* displaces hydrogen from the boiling solution of *NaOH*.

$Zn + 2NaOH + 2H_2O \rightarrow Na_2[Zn(OH)_4] + H_2 \uparrow$

22. (b) Occluded hydrogen is the hydrogen absorbed by the metal.

23. (c) Because dihydrogen is less reactive.

24. (c) ${}_1H^3$ has 3 nucleons (1 proton + 2 neutrons) and one electron so sum of these is 3 + 1 = 4.

25. (d) ${}^2_1D_2$ = (2 neutrons + 2 protons) = 4 nucleons.

26. (b) Solubility of ionic compound is lower in heavy water.

27. (c) These allotropic forms have similar chemical properties.

28. (a) It is 0.4 *kJ/mol*.

29. (b) $H^- = 1s^2; He = 1s^2$

30. (a) A fusion reaction is difficult to occur because positively charged nuclei repel each-other. At very high temperatures of the order of 10^6 to $10^7 K$, the nuclei may have sufficient energy to overcome the repulsive forces and fuse. It is for this reason, fusion reactions are also called thermonuclear reactions. Hence, hydrogen can be fused to form helium at high temperature and high pressure.

31. (c) It is Bosch process.

32. (d) Gold is a noble metal.

33. (d) $Ca + H_2 \rightarrow CaH_2 \xrightarrow{2H_2O} Ca(OH)_2 + 2H_2$

34. (d) Hydrogen can loose one electron (*e.g. HF*). It can gain one electron (*e.g. NaH*), Hydrogen can also share one electron (*e.g. H – H*).

35. (c) Hydrogen is a much lighter element than alkali metals or halogen.

36. (d) Heavy water is not unstable.

37. (a) $M^+H^- \rightarrow M^+ + \underset{\text{Hydride ion}}{H^-}$

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

38. (a) F_2 has maximum tendency to react with hydrogen. the decreasing order of reactivity is $F_2 > Cl_2 > Br_2 > I_2$.

39. (c) It acts both as a reducing agent and oxidising agent.

40. (c) $H \rightarrow H^+ + e^-$

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

41. (c) IE of *H* is 1312 *kJ/mole*.

IE of *Cl* is 1255 *kJ/mole*.

42. (d) Alkali metals are good reducing agents because of low ionization energy and hydrogen also shows same character.

43. (d) Position of hydrogen in the periodic table is not fully justified.

44. (b) $H_2 + Cl_2 \rightarrow H^+Cl^-$. In this hydrogen has positive oxidation state.

45. (c) For example $\underset{+}{HF}, \underset{-}{NaH}, \underset{(0)}{H_2}$

46. (b) $2Na + H_2 \rightarrow 2Na^+H^-$

Hydrogen has –*ve* (–1) oxidation state.

47. (a) $NaH \rightleftharpoons Na^+ + H^-$

At anode : $H^- \rightarrow H + e^-$

$H + H \rightarrow H_2$

48. (a) For example *HCl* is a protonic acid

$HCl + H_2O \rightleftharpoons [H_3O]^+ + Cl^-$

49. (c) Hydrogen resembles both alkali metals and halogens.

50. (d) Chlorine has lone pair which it can donate to form co-ordinate bond while hydrogen cannot.

51. (c) Actually these exist in the ratio.

Protium	:	Deuterium	:	Tritium
1	:	1.56×10^{-2}	:	1×10^{-17}

52. (d) $SO_3 + D_2O \rightarrow D_2SO_4$ dideutero-sulphuric acid.

53. (b) $H^1H^1, H^1H^2, H^2H^2, H^3H^3, H^2H^3$

54. (d) $\overset{+2}{Ca}\,\overset{x}{H}_2$ *i.e.*, $2 + 2x = 0$, $x = -1$

$2x = -2$ or $x = \frac{-2}{2} = -1$

55. (c) Pure hydrogen is obtained by the electrolysis of $Ba(OH)_2$ solution in a *U*-tube using nickel electrode. The gas is liberated at the cathode and is passed over heated platinum gauze to remove oxygen if present as impurity.

56. (b) $\underbrace{CO + H_2}_{\text{water gas}} + H_2O \xrightarrow{\text{catalyst}} CO_2 + 2H_2$

57. (b) Deuterium ($_1^2H$) and hydrogen ($_1^1H$) both have same atomic number but different mass number so they have similar chemical but different physical properties.

58. (b) $_1^3H \rightarrow {}_2^3He + {}_{-1}^0e$

59. (d) $V.oil + H_2 \xrightarrow[\Delta]{Ni} Fat$

60. (a) $2H \rightleftharpoons H_2$; $\Delta H = -104.5\,kcal$

61. (b) Lavoisier give the name hydrogen which means water maker.

62. (a) For diatomic gases (*e.g.* H_2) $r = C_p / C_v = 1.40$

For monoatomic gases $r = 1.66$

For triatomic gases $r = 1.33$

63. (b) H_3 is also called Hyzone.

64. (b) $4LiH + AlCl_3 \xrightarrow{\text{Ether}} LiAlH_4 + 3LiCl$

65. (b) Alkali metal hydrides react with water to give metal hydroxide and H_2 *e.g.*,

$NaH + H_2O \rightarrow NaOH + H_2$

Alkali metal hydroxides are strongly basic in nature.

66. (c) Ionic hydrides are good reducing agents.

68. (c) Systematic name of water is oxidane.

69. (c) BeH_2 and MgH_2 have significant covalent character.

70. (a) Limiting composition of *f* block hydrides are MH_2 and MH_3.

71. (d) H_2 does not react with *Au*, *Cu* or *Ni* with *Ca* it gives CaH_2. $Ca + H_2 \rightarrow CaH_2$

72. (c) $Ca(OH)_2$ is used for the softening of temporary hard water.

$Ca(OH)_2(aq) + CO_2(g) \rightarrow \underset{\text{cloudiness}}{CaCO_3(s)} + H_2O(l)$

73. (a) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

$\therefore$ Ratio of volumes of H_2 evolved is 1 : 1.

74. (c) Anhydrous $CaCl_2$ is used for fast drying of neutral gases.

75. (d) Hydrogen is the lightest gas.

76. (c) An atom of tritium contains 1 proton, 1 electron and 2 neutrons.

77. (d) Hydrogen is a non-metal while all other members of group 1 (alkali metals) are metals.

78. (b) $\underset{\text{base 1}}{H^-(aq)} + \underset{\text{acid 2}}{H_2O(l)} \rightarrow \underset{\text{base 2}}{OH^-(aq)} + \underset{\text{acid 1}}{H_2(g)}$

79. (a) $\underset{1s^1}{H} + e^- \rightarrow \underset{1s^2 \text{ or } [He]^2}{H^-}$

$\underset{[He]^2\,2s^2\,2p^5}{F} + e^- \rightarrow \underset{[He]^2\,2s^2\,2p^6 \text{ or } [Ne]^{10}}{F^-}$

80. (a) Hydrogen from bonds in +1 and –1 oxidation state.

81. (c) Mercury (*Hg*) will not displace hydrogen.

82. (c) Hydrogen is the lightest gas. It is insoluble in water.

83. (b) Hydrogen forms maximum number of compounds in chemistry comparison than carbon.

84. (c) $Zn + H_2O \rightarrow ZnO + H_2$

$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

$Zn + 2H_2SO_4 \rightarrow ZnSO_4 + SO_2 + 2H_2O$.

Water or hydride of oxygen

4. (b) $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow \underset{\text{ppt.}}{2CaCO_3\downarrow} + 4H_2O$

5. (c) D_2O in which $D = {}_1H^2$

7. (b) HCO_3^- is main reason of temporary hardness of water.

8. (b) By boiling temporary hardness of water can be removed.

$Ca(HCO_3)_2 \xrightarrow{\text{Boil}} \underset{\text{(insoluble)}}{CaCO_3} + H_2O + CO_2$

9. (c) $\underset{\text{Zeolite}}{Na_2Al_2Si_2O_8 .xH_2O} + Ca^{+2} \rightarrow$

$$CaAl_2Si_2O_8.xH_2O + 2Na^+$$

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

11. (a) Heavy water *i.e.*, D_2O slows down the speed of neutrons in nuclear reactors..

12. (a) Chlorides and sulphates of *Mg* and *Ca* produces permanent hardness and bicarbonates of *Mg* and *Ca* produces temporary hardness.

13. (d) Permanent hardness cannot be removed by boiling of water but temporary hardness can be removed.

14. (d) The density of water is $1\,g\,cm^{-3}$ at $4°C$

so molarity $= \frac{1000}{18} = 55.5\,M$.

15. (d) Water containing Ca^{+2}, Mg^{+2} and $H^+(>10^{-7}m)$ is a hard water.

$$H^+(aq) + CH_3COONa(aq) \rightleftharpoons CH_3COOH(s) + Na^+(aq)$$

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

17. (b) Heavy water freezes at a slightly higher temperature than water.

18. (b) *pH* of heavy water is slightly more than seven.

19. (c) D_2O actually has higher freezing point (3.8°*C*) than water H_2O (0°*C*).

20. (d) Colourless anhydrous $CuSO_4$ becomes blue on reaction with water.

21. (c) Due to plumbosolvancy, lead dissolves in water to a small extent to form soluble hydroxide which is poisonous so lead pipe is not used for carrying drinking water.

22. (a) Slaked lime removes temporary hardness of water.

$$\underset{\text{From hard water}}{Ca(OH)_2 + Ca(HCO_3)_2} \rightarrow 2CaCO_3 \downarrow + 2H_2O$$

23. (a) In cation exchange resin Mg^{+2} and Ca^{+2} (cations) are replaced by Na^+ ions.

24. (c) Washing soda removes both the temporary and permanent hardness by converting soluble calcium and magnesium compounds into insoluble carbonates.

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

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$

$$Ca(HCO_3)_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaHCO_3.$$

25. (c) It is $Na_2Al_2Si_2O_8.xH_2O$

26. (c) ${}_1H_2^3O = 16 + 2 \times 3 = 22\,amu$

27. (d) $H_2O(H = {}_1H^2)$

$16 + 2 \times 2 = 20\,amu$

30. (c) $K_2SO_4.Al_2(SO_4)_3.24H_2O$

Potash alum is generally used for purifying water.

31. (c) Copper will not reduce H_2O to H_2 because of low reducing power of copper comparison than hydrogen.

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

$$2D_2 + O_2 \rightarrow \underset{\text{Heavy water}}{2D_2O}$$

33. (c) Water molecule associate due to inter molecular hydrogen bonding.

34. (d) Heavy water is D_2O (1 – c)

Temporary hard water contains bicarbonates of Ca^{2+} and $Mg^{2+}(2-a)$

Soft water may have no foreign ions $(3-b)$.

Permanent hard water contains sulphates and chlorides of Ca^{+2} and $Mg^{2+}(4-d)$

35. (d) The $H-O-H$ angle in water molecule is about 105° (due to two lone pair of electron).

36. (a) Two ice cubes when pressed over each other unite due to hydrogen bond formation.

37. (a) $CaC_2 + 2D_2O \rightarrow C_2D_2 + Ca(OD)_2$

38. (c) Pure water can be obtained from sea water by reverse osmosis.

39. (c) Action of water on dil. Mineral acids (HCl, H_2SO_4) can give dihydrogen.

40. (d) Iron (*Fe*) does not react with cold water to give H_2. However, iron reacts with steam to give H_2.

41. (c) *pH* of neutral water at room temperature is seven.

43. (c) The low density of ice compared to water is due to hydrogen bonding interactions.

44. (b) Silicon tetra fluoride on hydrolysis furnish ortho silicic acid and hydrogen silicofluoride.

$$\underset{\text{(Silicontetra Fluoride)}}{3SiF_4} + \underset{\text{(Water)}}{4H_2O} \longrightarrow \underset{\text{(Ortho Silicicacid)}}{H_2SiO_4} + \underset{\text{(Hydrogen Silico Fluoride)}}{2H_2SiF_4}$$

45. (a) 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 $611.2\,Pa$.

46. (b) Hardness of water is due to the presence of bicarbonates, chlorides and sulphates of *Ca*

and Mg on it. These Ca^{2+} and Mg^{2+} ions react with the anions of fatty acids present in soaps to form curdy white precipitates. As a result, hard water does not produce lather with soap immediately.

Hydrogen peroxide

1. (b) $\underset{0}{Cl_2} + H_2O_2 \rightarrow 2\underset{-1}{HCl} + O_2$

In this reaction H_2O_2 works as reducing agent

2. (d) $[H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2] \times 2$

$\underset{68\,g}{2H_2O_2} \rightarrow 2H_2O + O_2$ 22.4 *litre* at N.T.P.

$\because$ 22.4 *litre* O_2 at N.T.P. obtained by 68 *gm* of H_2O_2

$\therefore$ 10 *litre* O_2 at N.T.P. obtained by

$\frac{68}{22.4} \times 10 = 30.35\ gm/litre$

$\therefore$ 1000 *ml* O_2 at N.T.P. obtained by = 30.35 *gm*

$\therefore$ 100 *ml* O_2 at N.T.P. obtained by

$= \frac{30.35}{1000} \times 100 = 3.035\%$

3. (a) $H_2SO_4 + BaO_2 \rightarrow BaSO_4 + H_2O_2$

5. (c) $BaO_2 + 2HCl \rightarrow BaCl_2 + H_2O_2$

6. (c) $Na_2O_2 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O_2$

7. (d) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

8. (c) $\underset{-2}{H_2S} + H_2O_2 \rightarrow \underset{0}{S} + 2H_2O$

In this reaction H_2O_2 shows oxidising nature.

9. (b) $H_2O_2 + Cl_2 \rightarrow 2HCl + O_2$

13. (a) Volume strength $= 5.6 \times$ Normality

$= 5.6 \times 1.5 = 8.4\ litre$

14. (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 *litre* of this solution will give 20 *litre* of oxygen at N.T.P.

Since, oxygen liberated from 1000 *ml* (1 *litre*) of $H_2O_2 = 20\ litre$, therefore oxygen liberate from 15 *ml* of H_2O_2

$= \frac{20}{1000} \times 15 = 0.3\ litre = 300\ ml$

15. (a) E.W. of $H_2O_2 = 17$

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

Volume strength $= 5.6 \times$ Normality

$= 5.6 \times 1.78 = 10\ litre$

17. (a) Equivalent weight of H_2O_2 is 17.

18. (b) $\because$ 22.4 *litre* O_2 at N.T.P. obtained by 68 *gm* of H_2O_2

$\therefore$ 1 *litre* O_2 at N.T.P. obtained by $\frac{68}{22.4}$ *gm* of H_2O_2

$\therefore$ 20 *litre* O_2 at N.T.P. obtained by

$\frac{68}{22.4} \times 20\ gm$ of $H_2O_2 = 60.71\ gm$ of H_2O_2

$\therefore$ 1000 *ml* O_2 at N.T.P. obtained by = 60.71 *gm* of H_2O_2

$\therefore$ 100 *ml* O_2 at N.T.P. obtained by

$= \frac{60.71}{1000} \times 100 = 6.71\%$

19. (c) Electrolysis of 50% sulphuric acid gives per disulphuric acid ($H_2S_2O_8$) which on distillation yields 30% solution of hydrogen peroxide.

20. (c) Due to $O-O$ bond.

21. (a) 10 volume of H_2O_2 means 10 *ml* of O_2 is obtained from 1 *ml* of H_2O_2.

22. (a) Glycerol, phosphoric acid or acetanilide is added to H_2O_2 to check its decomposition.

23. (a) H_2O_2 reduces O_3 to O_2

$O_3 + H_2O_2 \rightarrow H_2O + 2O_2$

24. (d) Fe^{+3} cannot be reduced by H_2O_2 while all other get reduced.

25. (d) Hydrogen peroxide does not show basic properties.

26. (d) Although H_2O_2 is a better polar solvent than H_2O. However it cannot be used as such because of the strong autooxidation ability.

27. (d) H_2O_2 is used as an oxidant for rocket fuel and has 90% concentration to be used in rockets.

28. (a) $\underset{\text{weak acid}}{H_2O_2} \rightarrow H_2O + [O]$

29. (a) Lattice energy of all metal nitrate are less than that of their solvation energy so nitrates of metals soluble in water.

31. (c) H_2O_2 is unstable liquid and decomposes into water and oxygen either on standing or on heating.

32. (c) $\underset{\|}{CH_2}{}_{CH_2} + H_2O_2 \rightarrow \overset{CH_2OH}{\underset{CH_2OH}{|}}$

33. (d) H_2O_2 show all these properties.

34. (a) As H_2O_2 is loosing electrons so it is acting as reducing agent.

36. (c) This is due to the formation of CrO_5.

$$K_2Cr_2O_7 + H_2SO_4 + 4H_2O_2 \rightarrow K_2SO_4 + \underset{\text{Blue}}{2CrO_5} + 5H_2O$$

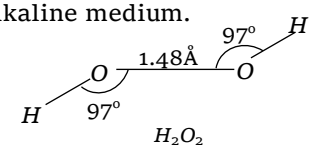
37. (a) K_a of $H_2O_2 = 1.55 \times 10^{-12}$

38. (a) In the following reaction H_2O_2 acts as a reducing agent.

$$PbO_2(s) + H_2O_2(aq) \rightarrow PbO(s) + H_2O(l) + O_2(g)$$

39. (e) H_2O_2 acts as an oxidising agent in acidic and alkaline medium.

40. (e)



H_2O_2

41. (b) We know that

$2H_2O_2 \longrightarrow 2H_2O + O_2$

$2 \times 34\ g \qquad 22400\ ml$

$\because\ 2 \times 34\ gm = 68\ gm$ of H_2O_2 liberates

$22400\ ml\ O_2$ at STP

$\therefore\ .68\ gm$ of H_2O_2 liberates

$$= \frac{.68 \times 22400}{68} = 224\ ml$$

Critical Thinking Questions

1. (c) Polyphosphates (sodium hexametaphosphates, sodium tripolyphosphate or STPP) from soluble complexes with Ca^{+2}, Mg^{+2} present in hard water.

2. (d) Critical temperature of water is more than O_2 due to its dipole moment (Dipole moment of water = 1.84 D; Dipole moment of O_2 = zero D).

3. (c) $\underset{\text{(Cal. phosphide) 1 mole}}{Ca_3P_2} + 6H_2O \rightarrow \underset{\text{(2 moles)}}{2PH_3} + 3Ca(OH)_2$

4. (d) Zeolite when treated with hard water exchange Cu^{+2} and Mg^{+2} ions (present in hard water) with Na^+ ions.

6. (c,d) $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2 \uparrow$

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

7. (a,b,d) Water containing any cation other than NH_4^+ and alkali metal is a hard water.

8. (b) Reaction of $NaBH_4$ with cold water is very slow. All other statements except (b) are correct.

9. (b,d) $CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2 \uparrow$

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2 \uparrow$

10. (c,d) Ice is a poor conductor of heat (a good thermal insulator) and its density is less than water.

11. (d) H_2 will not reduce heated Al_2O_3.

12. (d) MnO_2, PbO_2 and BaO will not give H_2O_2 with HCl. MnO_2 and PbO_2 will give Cl_2 and BaO will react with HCl to give $BaCl_2$ and water.

13. (a) Cu and dil. HCl will not produce H_2.

14. (b) Strength = Normality × Eq. mass

$= 1.5 \times 17$ (eq. mass of H_2O_2)

$= 25.5\ gL^{-1}$

15. (b) $Mn + 2HNO_3(dil.) \rightarrow Mn(NO_3)_2 + H_2$

16. (c) Hydrogen behaves as a metal at very high pressure.

17. (d) H_2O absorbs neutrons more than D_2O and this decreases the number of neutrons for the fission process.

18. (c) The para form of H_2 has lesser energy than the ortho form.

19. (c) Fire due to action of water on saline hydrides cannot be extinguished with water or CO_2. These hydrides can reduce CO_2 at high temperature to produce O_2.

21. (c) $Mg(OH)_2$ is less soluble than $MgCO_3$. On boiling temporary hard water containing Mg^{+2} ions, the ppt. obtained is of $Mg(OH)_2$ are not that of $MgCO_3$.

22. (c) $Ca(OH)_2$ removes the permanent hardness due to Mg^{2+} ion, but it produces Ca^{2+} ions which are removed by Na_2CO_3.

$Mg^{2+} + Ca(OH)_2 \rightarrow Mg(OH)_2 \downarrow + Ca^{2+}$

$Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3 \downarrow + 2Na^+$

$Ca(OH)_2$ or Na_2CO_3 alone cannot remove the permanent hardness.

25. (b) $\underset{\text{Sod. formate}}{2HCOONa(s)} \xrightarrow{\Delta} H_2(g) \uparrow + \underset{\text{Sod. oxalate}}{\overset{COONa}{\underset{COONa}{|}}}(s)$

26. (b) Presence of CO_3^{2-} and SO_4^{2-} ions in water reduced the tendency of dissolution of Pb in water as $Pb(OH)_2$.

27. (b) $NaCl$ does not make water hard.

28. (b) Solubility of $CaSO_4$ in water decreases with increase in temperature.

29. (b) Organic ion exchange resins can remove only ionic impurities.

30. (d) Water obtained from organic ion-exchange resins is free from all ionic impurities.

31. (a) Soap can remove all types of hardness of water as it converts the hardness producing cations into insoluble ppt.

32. (b) 10 volume solution of H_2O_2 is 3.035% solution

i.e., 3.035 g of H_2O_2 is present in $100ml$ of the solution.

Assertion & Reason

2. (d) Both assertion (A) and reason (R) are not true.

Correct Assertion : Calgon mask the properties of Ca^{2+} and Mg^{2+} ions present in water without removing them as ppt.

Correct Reason : Calgon forms soluble complexes with Ca^{2+} and Mg^{2+} in which properties of these ions are masked.

3. (a) Both assertion (A) and reason (R) are true and R is the correct explanation of A.

Correct Reason : H_2O_2 is a strong reducing agent.

4. (c) Assertion (A) is correct but reason (R) is not the correct explanation of A.

10. (d) Both assertion (A) and reason (R) are not true.

Correct Assertion : Hydrogen peroxide forms two series of salts called hydroperoxides and peroxides.

Correct Reason : Hydrogen peroxide molecule has two replaceable hydrogen atoms.