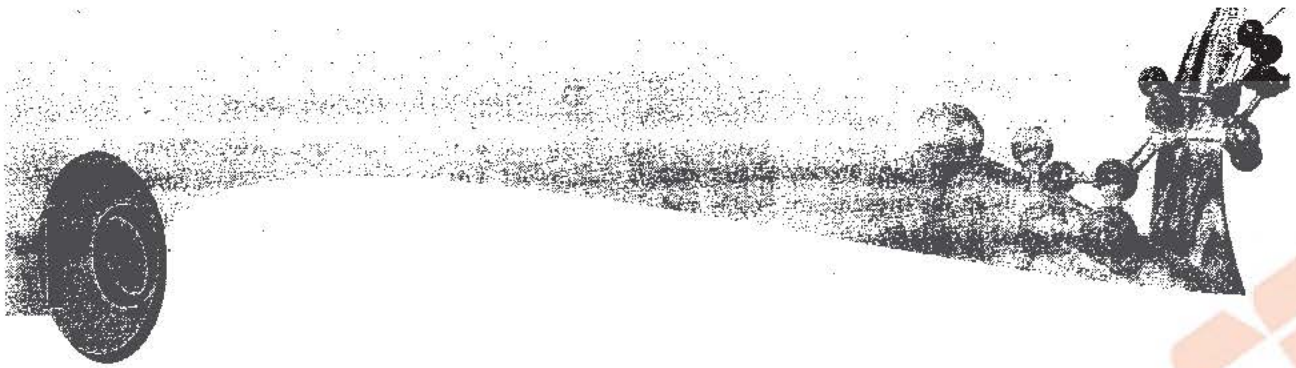

Hydrogen and Its Compounds

JEE (Main) Exercises

Single Correct Answer Type

1. Hydrogen burns in air with a:
   (a) Light bluish flame (b) Yellow flame
   (c) Green flame (d) None of these
2. 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
3. Hydrogen from HCl can be prepared by:
   (a) Mg (b) Cu
   (c) P (d) Pt
4. The color of hydrogen is:
   (a) Black (b) Yellow
   (c) Orange (d) Colorless
5. 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
6. The adsorption of hydrogen by metals is called:
   (a) Dehydrogenation (b) Hydrogenation
   (c) Occlusion (d) Absorption
7. Which of the following produces hydrolith with dihydrogen?
   (a) Mg (b) Al
   (c) Cu (d) Ca
8. The metal which displaces hydrogen from a boiling caustic soda solution is:
   (a) As (b) Zn
   (c) Mg (d) Fe
9. In context with the industrial preparation of hydrogen from water gas ($CO + H_2$), which of the following is the correct statement?
   (a) CO is removed by absorption in aqueous Cu_2Cl_2 solution
   (b) H_2 is removed through occlusion with Pd
   (c) CO is oxidized to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali
   (d) CO and H_2 are fractionally separated using differences in their densities
10. Which is poorest reducing agent?
    (a) Nascent hydrogen
    (b) Atomic hydrogen
    (c) Dihydrogen
    (d) All have same reducing strength
11. 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) Same in both
    (d) Smaller in simple water
12. Ortho-hydrogen and para-hydrogen resemble in which of the following properties?

(a) Thermal conductivity
(b) Magnetic properties
(c) Chemical properties
(d) Heat capacity

13. Hydrogen can be prepared by mixing steam and water gas at 673 K in the presence of Fe_2O_3 and Cr_2O_3. This process is called:
(a) Nelson's process (b) Serpeck's process
(c) Bosch's process (d) Parke's process

14. 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

15. Which of the following halogen has maximum affinity for hydrogen?
(a) F_2 (b) Cl_2
(c) Br_2 (d) I_2

16. Hydrogen is not obtained when zinc reacts with:
(a) Cold water (b) Hot NaOH solution
(c) Conc. H_2SO_4 (d) Dil. HCl

17. The oxidation states shown by hydrogen are:
(a) –1 only (b) Zero only
(c) +1, –1, 0 (d) +1 only

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

19. 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) Dideutero sulphuric acid

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

21. 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

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

23. Triatomic hydrogen is called:
(a) Deuterium (b) Hyzone
(c) Ortho form (d) Hydronium ion

24. $LiAlH_4$ is obtained by reacting an excess of .... with an ethereal solution of $AlCl_3$:
(a) LiCl (b) LiH
(c) Li (d) LiOH

25. 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?
(a) $CaCO_3$ (b) CaO
(c) $Ca(OH)_2$ (d) $Ca(HCO_3)_2$

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

27. The property of hydrogen which distinguish it from alkali metals is:
(a) Its electropositive character
(b) Its affinity for non-metal
(c) Its reducing character
(d) Its non-metallic character

28. Synthetic detergents are more effective in hard water than soaps because:
(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 the above

29. Which of the following pairs of ions makes the water hard?
(a) Na^+, SO_4^{2-} (b) K^+, HCO_3^-
(c) Ca^{2+}, NO_3^- (d) NH4 +, Cl^-

30. H_2O is hard if it contains:
(a) $NaHCO_3$ (b) $MgSO_4$
(c) KCl (d) NaCl

31. Hardness of water is due to presence of salts of:
(a) Na^+ and K^+ (b) Ca^{2+} and Mg^{2+}
(c) Ca^{2+} and K^+ (d) Ca^{2+} and Na^{2+}

32. Temporary hardness of water is due to the presence of:
(a) Magnesium bicarbonate

(b) Calcium chloride
(c) Magnesium sulphate
(d) Calcium carbonate

33. Which of the following acid is formed when SiF_4 react with water?
(a) SiF_4 (b) H_2SiF_4
(c) H_2SO_4 (d) H_2SiF_6

34. The low density of ice compared to water is due to:
(a) Induced dipole–induced dipole interactions
(b) Dipole-induced–dipole interaction
(c) Hydrogen bonding interactions
(d) Dipole–dipole interactions

35. 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 the above

36. Which of the following will cause pure demineralised water:
(a) Passing water through cation exchange resin followed by anion exchanger resin succesively
(b) Passing water through anion exchange resin
(c) Passing water through sand
(d) Passing water through alumina

37. Permutit is the 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

38. 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

39. The boiling point of water is exceptionally high because:
(a) There is covalent bond between H and O
(b) Water molecules are linear
(c) Water molecules associate due to hydrogen bonding
(d) Water molecules are not linear

40. Match List I with List II and select the correct answer using the codes given below the lists

List I	List II
(a) Heavy water	(p) Bicarbonates of Mg and Ca in water
(b) Temporary hard water	(q) No foreign ions in water
(c) Soft water	(r) D_2O
(d) Permanent hard water	(s) Sulphates and chlorides of Mg and Ca in water

Codes

	1	2	3	4
(a)	c	d	b	a
(b)	b	a	c	d
(c)	b	d	c	a
(d)	c	a	b	d

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

42. Metal which does not react with cold water but evolves H_2 with steam is:
(a) Na (b) K
(c) Pt (d) Fe

43. Why do calcium ions make water hard but sodium ions do not?
(a) Calcium forms insoluble compounds with stearate ions present in soap
(b) Sodium forms insoluble compounds with stearate ions present in soap
(c) Calcium forms soluble compounds with stearate ions present in soap
(d) Both calcium and sodium form insoluble compounds with stearate ions present in soap

44. Hydrogen has three isotopes protium, deuterium, and tritium, these isotopes differ from each other:
(a) These isotopes differ from one another in respect of the number of neutrons
(b) These isotopes differ from one another in respect of the number of proton
(c) These isotopes differ from one another in respect of the number of electrons
(d) None of these

45. Blackened oil painting can be restored into original form by the action of:

(a) Chlorine (b) BaO_2
(c) H_2O_2 (d) MnO_2

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

47. What is product of the reaction of H_2O_2 with Cl_2?
(a) $O_2 + HOCl$ (b) $HCl + O_2$
(c) $H_2O + HCl$ (d) $HCl + H_2$

48. H_2O_2 will oxidize:
(a) $KMnO_4$ (b) H_2S
(c) $K_2Cr_2O_7$ (d) $PbSO_4$

49. Fenton's reagent is
(a) $FeSO_4 + H_2O_2$ (b) Zn + HCl
(c) Sn + HCl (d) None of these

50. 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

51. Which is false about H_2O_2?
(a) Act as both oxidizing and reducing agents
(b) Two OH bonds lies in the same plane
(c) Very pale blue liquid
(d) It can be oxidized by ozone

52. The structure of H_2O_2 is:
(a) Half open book like (b) Linear
(c) Closed book (d) Pyramidal

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

54. Which one of the following undergoes reduction with hydrogen peroxide in an alkaline medium?
(a) Mn^{2+} (b) HOCl
(c) PbS (d) Fe^{2+}

55. 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

56. HCl is added to following oxides. Which one would give H_2O_2?
(a) MnO_2 (b) PbO_2
(c) BaO_2 (d) None of these

57. 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

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

59. Which of the following salts are responsible for hardness of water:
(a) Chloride of Ca and Mg
(b) Sulphates of Ca and Mg
(c) Bicarbonates of Ca and Mg
(d) All of these

60. Which of the following method(s) is/are used to removal of temporary hardness:
(a) By boiling (b) Clark's method
(c) Both (a) and (b) (d) None of these

61. Which of the following method(s) is/are used to removal of parmanent hardness:
(a) Calgon's method
(b) Ion-exchange method
(c) Synthetic resins method
(d) All of these

62. Metallic or non-stoichiometric (or interstitial) hydrides are formed by:
(a) Many *d*-block and *f*-block elements
(b) Many *s*-block elements
(c) Many *p*-block elements
(d) None of these

63. In which of the following hydrides, the law of constant composition does not hold good:
(a) Saline hydride (b) Metallic hydride
(c) Molecular hydride (d) All of these

64. Which of the following properties of water leads in comparison to H_2S and H_2Se due to H-bonding:

(a) Low freezing point
(b) Low boiling point
(c) Low heat of vaporization
(d) High heat of fuszion

65. Select the incorrect statements about ice:
(a) At atmospheric pressure ice crystallizes in the hexagonal form, but at very low temperature it condenses to cubic form
(b) Density of ice is less than that of water therefore, an ice cube floats on water
(c) In winter season ice formed on surface of a lake provides thermal insulation
(d) Volume of ice is less than that of water

66. Which of the following is the method for the manufacture of ammonia by the Haber process:
(a) $N_2 + O_2 \rightarrow NO$
(b) $N_2 + 3H_2 \xrightarrow[200\ atm., Fe]{673} 2NH_3$
(c) $NH_3 + O_2 \rightarrow NO$
(d) None of these

67. Which of the following statement is correct for ionic hydrides:
(a) The ionic hydrides are crystalline
(b) The ionic hydrides are non-volatile
(c) The ionic hydrides are non-conducting in solid state
(d) All are correct

68. $LiH + \underline{B}_2H_6 \rightarrow 2Li\underline{B}H_4$,
find the change in hybridization of underlined atom.
(a) $sp^2 \rightarrow sp^3$ (b) $sp^3 \rightarrow sp^2$
(c) $sp \rightarrow sp^3$ (d) None

69. Which of the following isotope is called as heavy hydrogen:
(a) Protium (b) Deuterium
(c) Tritium (d) All of these

70. Which of the following isotope of hydrogen is radioactive and emits low energy $\beta^{\ominus}$ particles ($t_{1/2}$, 12.33 years)
(a) Protium (b) Deuterium
(c) Tritium (d) All of these

71. Isotopes of hydrogen have same electronic configuration and they have almost the same chemical properties but the only difference is in their rates of reactions.
(a) Mainly due to their different enthalpy of bond dissociation
(b) Mainly due to their different size
(c) Mainly due to their same number of e^-
(d) Mainly due to their same number of proton

72. In physical properties isotopes of hydrogen differ considerably due to their:
(a) Large size difference
(b) Significant mass difference
(c) Large atomic number difference
(d) None of these

73. H_2 gas is usually prepared by the reaction of
(a) Zn + dil. HCl (b) Zn + dil. H_2SO_4
(c) Zn + NaOH (d) All of these

74. High purity (> 99.95 %) dihydrogen is obtained by:
(a) Electrolysis of acidified water using platinum electrodes
(b) Electrolyzing warm aqueous barium hydroxide solution between nickel electrodes
(c) Electrolysis of brine solution
(d) Reaction of steam on hydrocarbons or coke at high temperature in the presence of catalyst

75. The mixture of CO and H_2 is called:
(a) Water gas (b) Producer gas
(c) Coal gas (d) All of these

76. ($CO + H_2$) mixture is called:
(a) Synthesis gas (b) Syn gas
(c) Both (a) and (b) (d) None of these

77. Nowadays syn gas is produced from:
(a) Sewage
(b) Saw–dust
(c) Scrap wood and newspaper
(d) All of these

78. The process of producing syn gas from coal is called coal gasification, which of the following reaction is correct for coal gasification.
(a) $CO_{(g)} + 2H_{2(g)} \xrightarrow{Cobalt} CH_3OH_{(l)}$
(b) $3H_{2_{(g)}} + N_{2_{(g)}} \xrightarrow[Fe]{} 2NH_{3(g)}$
(c) $C_{(s)} + H_2O_{(g)} \xrightarrow{1270\ K} CO_{(g)} + H_{2(g)}$
(d) None of these

79. Which of the following reaction is called water gas shift / Bosch reaction
(a) $C_{(s)} + H_2O_{(g)} \xrightarrow{1270\ K} CO_{(g)} + H_{2(g)}$
(b) $CO_{(g)} + H_2O_{(g)} \xrightarrow[Fe_2O_3 - Cr_2O_3]{673\ K} CO_{2(g)} + H_{2(g)}$
(c) $H_2 + CO + RCH{=}CH_2 \rightarrow RCH_2CH_2CHO$
(d) None of these

80. Select the correct statement about dihydrogen:
(a) It is colorless, odorless, and tasteless
(b) It is combustible gas
(c) It is lighter than air and insoluble in water
(d) All of these

81. When H_2 reacts with halogen X_2 then order of reactivity is:
(a) $F_2 > Cl_2 > Br_2 > I_2$ (b) $Cl_2 > F_2 > Br_2 > I_2$
(c) $Br_2 > I_2 > Cl_2 > F_2$ (d) $I_2 > Br_2 > Cl_2 > F_2$

NCERT Exemplar Exercises

Single Correct Answer Type

1. Hydrogen resembles halogens in many respects for which several factors are responsible. Of the following factors which one is most important in this respect?
(a) Its tendency to lose an electron to form a cation
(b) Its tendency to gain a single electron in its valence shell to attain stable electronic configuration
(c) Its low negative electron gain enthalpy value.
(d) Its small size

2. Why does H^+ ion always get associated with other atoms or molecules?
(a) Ionization enthalpy of hydrogen resembles that of alkali metals
(b) Its reactivity is similar to halogens
(c) It resembles both alkali metals and halogens
(d) Loss of an electron from hydrogen atom results in a nucleus of very small size as compared to other atoms or ions. Due to small size it cannot exist free

3. Metal hydrides are ionic, covalent or molecular in nature. Among LiH, NaH, KH, RbH, CsH, the correct order of increasing ionic character is:
(a) LiH > NaH > CsH > KH > RbH
(b) LiH < NaH < KH < RbH < CsH
(c) RbH > CsH > NaH > KH > LiH
(d) NaH > CsH > RbH > LiH > KH

4. Which of the following hydride is electron precise hydride?
(a) B_2H_6 (b) NH_3
(c) H_2O (d) CH_4

5. Radioactive elements emit α, β, and γ rays and are characterized by their halflives. The radioactive isotope of hydrogen is:
(a) Protium (b) Deuterium
(c) Tritium (d) Hydronium

6. Consider the reactions
(i) $H_2O_2 + 2HI \rightarrow I_2 + 2H_2O$
(ii) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$
Which of the following statements is correct about H_2O_2 with reference to these reactions? Hydrogen perioxide is _____.
(a) An oxidizing agent in both (i) and (ii)
(b) An oxidizing agent in (i) and reducing agent in (ii)
(c) A reducing agent in (i) and oxidizing agent in (ii)
(d) A reducing agent in both (i) and (ii)

7. The compound that gives H_2O_2 on treatment with dilute H_2SO_4 is:
(a) PbO_2 (b) $BaO_2.8H_2O + O_2$
(c) MnO_2 (d) TiO_2

8. Which of the following equations depict the oxidizing nature of H_2O_2?
(a) $2MnO_4^- + 6H^+ 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$
(b) $2Fe^{3+} + 2H^+ + H_2O_2 \rightarrow 2Fe^{2+} + 2H_2O + O_3$
(c) $2I + 2H^+ + H_2O_2 \rightarrow I_2 + 2H_2O$
(d) $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$

9. Which of the following equation depicts reducing nature of H_2O_2?
(a) $2[Fe(CN)_6]^{4-} + 2H^+ + H_2O_2 \rightarrow 2[Fe(CN)_6]^{3-} + 2H_2O$
(b) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$
(c) $Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$
(d) $PbS + 4H_2O_2 \rightarrow PbSO_4 + 4H_2O$

10. Hydrogen peroxide is:
(a) An oxidizing agent
(b) A reducing agent
(c) Both an oxidizing and a reducing agent
(d) Neither oxidizing nor reducing agent

11. Which of the following reactions increases production of dihydrogen from synthesis gas?
(a) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270\ K} CO(g) + 3H_2(g)$
(b) $C(s) + H_2O(g) \xrightarrow{1270\ K} CO(g) + H_2(g)$

(c) $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{673\ K} CO_2(g) + H_2(g)$

(d) $C_2H_6 + 2H_2O \xrightarrow[Ni]{1270\ K} 2CO + 5H_2$

12. When sodium peroxide is treated with dilute sulphuric acid, we get:
    (a) Sodium sulphate and water
    (b) Sodium sulphate and oxygen
    (c) Sodium sulphate, hydrogen, and oxygen
    (d) Sodium sulphate and hydrogen peroxide

13. Hydrogen peroxide is obtained by the electrolysis of:
    (a) Water
    (b) Sulphuric acid
    (c) Hydrochloric acid
    (d) Fused sodium peroxide

14. Which of the following reactions is an example of use of water gas in the synthesis of other compounds?
    (a) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270\ N} CO(g) + H_2(g)$
    (b) $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{673\ K} CO_2(g) + H_2(g)$
    (c) $C_nH_{2n+2} + nH_2O(g) \xrightarrow[Ni]{1270\ K} nCO + (2n+1)H_2$
    (d) $CO(g) + 2H_2(g) \xrightarrow[\text{Catalyst}]{\text{Cobalt}} CH_3OH(\ell)$

15. Which of the following ions will cause hardness in water sample?
    (a) Ca^{2+} (b) Na^+
    (c) Cl (f) K^+

16. Which of the following compounds is used for water softening?
    (a) $Ca_3(PO_4)_2$ (b) Na_3PO_4
    (c) $Na_6P_6O_{18}$ (d) Na_2HPO_4

17. Elements of which of the following group(s) of periodic table do not form hydrides.
    (a) Groups 7, 8, 9 (b) Group 13
    (c) Groups 15, 16, 17 (d) Group 14

18. Only one element of which group forms hydride.
    (a) Group 6 (b) Group 7
    (c) Group 8 (d) Group 9

Multiple Correct Answers Type

In the following questions two or more options may be correct.

1. Which of the following statements are not true for hydrogen?
    (a) It exists as diatomic molecule
    (b) It has one electron in the outermost shell
    (c) It can lose an electron to form a cation which can freely exist
    (d) It forms a large number of ionic compounds by losing an electron

2. Dihydrogen can be prepared on commercial scale by different methods. In its preparation by the action of steam on hydrocarbons, a mixture of CO and H_2 gas is formed. It is known as:
    (a) Water gas (b) Syngas
    (c) Producer gas (d) Industrial gas

3. Which of the following statement(s) is/are correct in the case of heavy water?
    (a) Heavy water is used as a moderator in nuclear reactor
    (b) Heavy water is more effective as solvent than ordinary water
    (c) Heavy water is more associated than ordinary water
    (d) Heavy water has lower boiling point than ordinary water

4. Which of the following statements about hydrogen are correct?
    (a) Hydrogen has three isotopes of which protium is the most common
    (b) Hydrogen never acts as cation in ionic salts
    (c) Hydrogen ion H^+, exists freely in solution
    (d) Dihydrogen does not act as a reducing agent

5. Some of the properties of water are described below. Which of them is/are not correct?
    (a) Water is known to be a universal solvent
    (b) Hydrogen bonding is present to a large extent in liquid water
    (c) There is no hydrogen bonding in the frozen state of water
    (d) Frozen water is heavier than liquid water

6. Hardness of water may be temporary or permanent. Permanent hardness is due to the presence of:
    (a) Chlorides of Ca and Mg in water
    (b) Sulphates of Ca and Mg in water
    (c) Hydrogen carbonates of Ca and Mg in water
    (d) Carbonates of alkali metals in water

7. Which of the following statements is correct?
    (a) Elements of group 15 form electron deficient hydrides

(b) All elements of group 14 form electron precise hydrides

(c) Electron precise hydrides have tetrahedral geometries

(d) Electron-rich hydrides can act as Lewis acids

8. Which of the following statements is correct?
   (a) Hydrides of group 13 act as Lewis acids
   (b) Hydrides of group 14 are electron deficient hydrides
   (c) Hydrides of group 14 act as Lewis acids
   (d) Hydrides of group 15 act as Lewis bases
9. Which of the following statements is correct?
   (a) Metallic hydrides are deficient of hydrogen
   (b) Metallic hydrides conduct heat and electricity
   (c) Ionic hydrides do not conduct electricity in solid state
   (d) Ionic hydrides are very good conductors of electricity in solid state

Short Answer Type

1. How can production of hydrogen from water gas be increased by using water gas shift reaction?
2. What are metallic/interstitial hydrides? How do they differ from molecular hydrides?
3. Name the classes of hydrides to which H_2O, B_2H_6 and NaH belong.
4. If same mass of liquid water and a piece of ice is taken, then why is the density of ice less than that of liquid water?
5. Complete the following equations:
   (a) $PbS(s) + H_2O_2(aq) \rightarrow$
   (b) $CO(g) + 2H_2(g) \xrightarrow[\text{Catalyst}]{\text{Cobalt}}$
6. Give reasons:
   (a) Lakes freeze from top towards bottom.
   (b) Ice floats on water.
7. What do you understand by the term 'auto protolysis of water'? What is its significance?
8. Discuss briefly de-mineralization of water by ion exchange resin.
9. Molecular hydrides are classified as electron deficient, electron precise and electron-rich compounds. Explain each type with two examples.
10. How is heavy water prepared? Compare its physical properties with those of ordinary water.
11. Write one chemical reaction for the preparation of D_2O_2.
12. Calculate the strength of 5 volume H_2O_2 solution.
13. (a) Draw the gas phase and solid phase structure of H_2O_2.
    (b) H_2O_2 is a better oxidizing agent than water. Explain.
14. Melting point, enthalpy of vaporization and viscosity data of H_2O and D_2O is given below:

	H_2O	D_2O
Melting point / K	373.0	374.4
Enthalpy of vaporization at (373 K)/ kJ mol^{-1}	40.66	41.61
Viscosity/centipoise	0.8903	1.107

On the basis of these data, explain in which of these liquids intermolecular forces are stronger?

15. Dihydrogen reacts with dioxygen (O_2) to form water. Write the name and formula of the product when the isotope of hydrogen which has one proton and one neutron in its nucleus is treated with oxygen. Will the reactivity of both the isotopes be the same towards oxygen? Justify your answer.
16. Explain why HCl is a gas and HF is a liquid.
17. When the first element of the periodic table is treated with dioxygen, it gives a compound whose solid state floats on its liquid state. This compound has an ability to act as an acid as well as a base. What products will be formed when this compound undergoes autoionization?
18. Rohan heard that instructions were given to the laboratory attendent to store a particular chemical i.e., keep it in the dark room, add some urea in it, and keep it away from dust. This chemical acts as an oxidizing as well as a reducing agent in both acidic and alkaline media. This chemical is important for use in the pollution control treatment of domestic and industrial effluents.
    (a) Write the name of this compound.
    (b) Explain why such precautions are taken for storing this chemical.
19. Give reasons why hydrogen resembles alkali metals?
20. Hydrogen generally forms covalent compounds. Give reason.
21. Why is the ionization enthalpy of hydrogen higher than that of sodium?

22. Basic principle of hydrogen economy is transportation and storage of energy in the form of liquid or gaseous hydrogen. Which property of hydrogen may be useful for this purpose? Support your answer with the chemical equation if required.
23. What is the importance of heavy water?
24. Write the Lewis structure of hydrogen peroxide.
25. An acidic solution of hydrogen peroxide behaves as an oxidizing as well as reducing agent. Illustrate it with the help of a chemical equation.
26. With the help of suitable examples, explain the property of H_2O_2 that is responsible for its bleaching action?
27. Why is water molecule polar?
28. Why does water show high boiling point as compared to hydrogen sulphide? Give reasons for your answer.
29. Why can dilute solutions of hydrogen peroxide not be concentrated by heating. How can a concentrated solution of hydrogen peroxide be obtained?
30. Why is hydrogen peroxide stored in wax lined bottles?
31. Why does hard water not form lather with soap?
32. Phosphoric acid is preferred over sulphuric acid in preparing hydrogen peroxide from peroxides. Why?
33. How will you account for 104.5° bond angle in water?
34. Write redox reaction between fluorine and water.
35. Write two reactions to explain amphoteric nature of water.

Matching Column Type

1. Correlate the items listed in Column-I with those listed in Column-II. Find out as many correlations as you can.

Column-I	Column-II
(a) Synthesis gas	(p) $Na_2[Na_4(PO_3)_6]$
(b) Dihydrogen	(q) Oxidizing agent
(c) Heavy water	(r) Used in softening of water
(d) Calgon	(s) Reducing agent
(e) Hydrogen peroxide	(t) Stoichiometric compounds of *s*-block elements
(f) Salt-like hydrides	(u) Produced by prolonged electrolysis of water
	(v) Zn + NaOH
	(w) Zn + dil. H_2SO_4
	(x) Synthesis of methanol
	(y) Mixture of CO and H_2

2. Match Column-I with Column-II for the given properties/applications mentioned therein.

Column-I	Column-II
(a) H	(p) Used in the name of perhydrol
(b) H_2	(q) Can be reduced to dihydrogen by NaH
(c) H_2O	(r) Can be used in hydroformylation of olefin
(d) H_2O_2	(s) Can be used in cutting and welding

3. Match the terms in Column-I with the relevant item in Column-II.

Column-I	Column-II
(a) Electrolysis of water produces	(p) Atomic reactor
(b) Lithium aluminium hydride is used as	(q) Polar molecule
(c) Hydrogen chloride is a	(r) Combines on metal surface to generate high temperature
(d) Heavy water is used in	(s) Reducing agent
(e) Atomic hydrogen	(t) Hydrogen and oxygen

4. Match the items in Column-I with the relevant item in Column-II.

Column-I	Column-II
(a) Hydrogen peroxide is used as a	(p) Zeolite
(b) Used in Calgon method	(q) Perhydrol
(c) Permanent hardness of water is removed by	(r) Hexametaphosphate
	(s) Propellant

Assertion-Reasoning Type

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the options given below each question.

1. **Assertion (A):** Permanent hardness of water is removed by treatment with washing soda.

   Reason (R): Washing soda reacts with soluble magnesium and calcium sulphate to form insoluble carbonates.

   (a) Statements A and R both are correct and R is the correct explanation of A.

   (b) A is correct but R is not correct.

   (c) A and R both are correct but R is not the correct explanation of A.

   (d) A and R both are false.

2. **Assertion (A):** Some metals like platinum and palladium, can be used as storage media for hydrogen.

   Reason (R): Platinum and palladium can absorb large volumes of hydrogen.

   (a) Statements A and R both are correct and R is the correct explanation of A.

   (b) A is correct but R is not correct.

   (r) A and R both are correct but R is not the correct explanation of A.

   (d) A and R both are false.

Long Answer Type

1. Atomic hydrogen combines with almost all elements but molecular hydrogen does not. Explain.
2. How can D_2O be prepared from water? Mention the physical properties in which D_2O differs from H_2O. Give at least three reactions of D_2O showing the exchange of hydrogen with deuterium.
3. How will you concentrate H_2O_2? Show differences between structures of H_2O_2 and H_2O by drawing their spatial structures. Also mention three important uses of H_2O_2.
4. (a) Give a method for the manufacture of hydrogen peroxide and explain the reactions involved therein.

   (b) Illustrate oxidizing, reducing and acidic properties of hydrogen peroxide with equations.
5. What mass of hydrogen peroxide will be present in 2 litres of a 5 molar solution? Calculate the mass of oxygen which will be liberated by the decomposition of 200 mL of this solution.
6. A colorless liquid 'A' contains H and O elements only. It decomposes slowly on exposure to light. It is stabilized by mixing urea to store in the presence of light.

   (a) Suggest possible structure of A.

   (b) Write chemical equations for its decomposition reaction in light.
7. An ionic hydride of an alkali metal has significant covalent character and is almost unreactive towards oxygen and chlorine. This is used in the synthesis of other useful hydrides. Write the formula of this hydride. Write its reaction with Al_2Cl_6.
8. Sodium forms a crystalline ionic solid with dihydrogen. The solid is nonvolatile and non-conducting in nature. It reacts violently with water to produce dihydrogen gas. Write the formula of this compound and its reaction with water. What will happen on electrolysis of the melt of this solid.

Hints & Solutions

JEE (Main) Exercises

Single Correct Answer Type

1. (a) Hydrogen burns in air with light bluish flame.
2. (a) Ortho-hydrogen and para-hydrogen are nuclear isomers based on nuclear spin, isomers of hydrogen are protium, deuterium, and tritium.
3. (a) $Mg + HCl \rightarrow MgCl_2 + H_2$

   Cu, P, and Pt are weak reducing agent.
4. (d) Hydrogen is colorless.
5. (a) Ordinary hydrogen at room temperature is a mixture of 75% of ortho-hydrogen and 25% of para-hydrogen.
6. (c) Occlusion—The property of metal to absorb any gas is called occlusion.
7. (d) $Ca + H_2 \rightarrow CaH_2$ (Hydrolith)
8. (b) $Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2 \uparrow$
10. (c) Reacitivity order

    Atomic hydrogen > Nascent hydrogen > Molecular hydrogen