HYDROGEN

FACT/DEFINITION TYPE QUESTIONS

1. Following are some properties of hydrogen which of the following properties resemble with alkali metals and which with halogens
(i) Hydrogen lose one electron to form unipositive ions
(ii) Hydrogen gain one electron to form uninegative ions
(iii) Hydrogen forms oxides, halides and sulphides
(iv) Hydrogen has a very high ionization enthalpy
(v) Hydrogen forms a diatomic molecule, combines with elements to form hydrides and covalent compounds.
(a) Alkali metals resemble (i), (iii) and (iv) Halogens resemble (ii) and (v)
(b) Alkali metals resemble (i) and (iii) Halogens resemble (ii), (iii) and (v)
(c) Alkali metals resemble (i) and (iii) Halogens resemble (ii), (iv) and (v)
(d) Alkali metals resemble (i) only Halogens resemble (iv) and (v)

2. Hydrogen molecules 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

3. 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

4. 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

5. Hydrogen accepts an electron to form inert gas configuration. In this it resembles
(a) halogen (b) alkali metals
(c) chalcogens (d) alkaline earth metals

6. Which of the following statements is correct ?
(a) Hydrogen has same IP as alkali metals
(b) Hydrogen has same electronegativity as halogens
(c) It has oxidation number of –1 and +1
(d) It will not be liberated at anode

7. Why does H^+ ion always get associated with other atoms or molecules?
(a) Ionisation 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.

8. Which one of the following is not an isotope of hydrogen ?
(a) Deuterium (b) Tritium
(c) Ortho hydrogen (d) None of these

9. Number of neutrons in three isotopes of hydrogen, protium, deuterium and tritium respectively is
(a) 0, 1, 2 (b) 1, 1,1
(c) 2, 1, 0 (d) 2, 0, 1

10. Which isotope(s) of hydrogen is/are radioactive and emits low energy β^- particles?
(i) Protium (ii) Tritium
(iii) Deuterium
(a) (i) and (ii) (b) (iii) only
(c) (ii) only (d) (ii) and (iii)

11. Hydrogen bond energy is equal to :
(a) 3-7 cals (b) 30-70 cals
(c) 3-10 kcals (d) 30-70 kcals

12. Which of the following reaction(s) represents commercial method for production of dihydrogen?
(i) $CO(g) + H_2O(g) \xrightarrow[catalyst]{673K} CO_2(g) + H_2(g)$
(ii) $2H_2O(l) \xrightarrow[\text{traces of acid/base}]{\text{electrolysis}} 2H_2(g) + O_2(g)$
(iii) $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$
(iv) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + 3H_2(g)$
(a) (i), (ii) and (iii) (b) (iii) only
(c) (i), (ii) and (iv) (d) (ii), (iii) and (iv)

13. Which of the following is formed when zinc reacts with sodium hydroxide?
(a) Hydrogen gas (b) Sodium zincate
(c) Zinc oxide (d) Both (a) and (b)

14. Identify x and y in following reaction. What is the mixture of x and y called?

$$CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} x + y$$

(a) $x = CO_2$, $y = H_2O$, water gas
(b) $x = CO$, $y = H_2O$, syn gas
(c) $x = CO$, $y = H_2$, water gas
(d) $x = CO_2$, $y = H_2$, syn gas

15. Why is water gas (mixture of CO and H_2) also called 'syn gas'?
(a) Because it is synthesised from sewage, saw – dust, scrap wood etc.
(b) Because it is synthesised from methane gas
(c) Because it is used in the synthesis of methanol and a number of hydrocarbons.
(d) None of these

16. Which of the following statements is correct?
(a) Production of syngas from coal is called coal gasification.
(b) $CO(g) + H_2O\ (g) \xrightarrow[catalyst]{673K} CO_2(g) + H_2\ (g)$ represents water gas shift reaction.
(c) CO_2 formed in water gas shift reaction is removed by scrubbing with sodium zincate solution.
(d) Both (a) and (b)

17. Which one of the following pairs of substances on reaction will not evolve H_2 gas?
(a) Iron and H_2SO_4 (aqueous)
(b) Iron and steam
(c) Copper and HCl (aqueous)
(d) Sodium and ethyl alcohol

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

19. Hydrogen is evolved by the action of cold dil. HNO_3 on
(a) Fe (b) Mn
(c) Cu (d) Al

20. 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

21. Hydrogen is not obtained when zinc reacts with
(a) Cold water (b) dil. HCl
(c) dil. H_2SO_4 (d) Hot NaOH (20%)

22. Which one of the following pairs of substances will not produce hydrogen when reacted together?
(a) Copper and conc. nitric acid
(b) Ethanol and metallic sodium
(c) Magnesium and steam
(d) Phenol and metallic sodium

23. 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

24. Which of the following is formed on reaction of carbon monoxide gas with dihydrogen in presence of cobalt as a catalyst?
(a) Methanal (b) Methanol
(c) Methane (d) Formic acid

25. Which of the following is not a use of dihydrogen ?
(a) It used in fuel cells for generating electrical energy.
(b) Atomic hydrogen and oxy-hydrogen torches are used for cutting and welding purposes.
(c) It used in the synthesis of hydroquinone and tartaric acid.
(d) Both (b) and (c)

26. Elements of which of the following group do not form hydrides?
(a) Alkali metals (b) Halogens
(c) Alkaline earth metals (d) Noble gases

27. Which of the following statements is incorrect?
(a) Ionic hydrides are stoichiometric compounds of dihydrogen formed with most of s-block elements
(b) Ionic hydrides are crystalline, non-volatile and non-conducting in solid state.
(c) Melts of ionic hydrides conduct electricity and liberate dihydrogen gas at cathode.
(d) Both (a) and (c)

28. Saline hydrides react explosively with water, such fires can be extinguished by
(a) water (b) carbon dioxide
(c) sand (d) None of these

29. Choose the correct option for following hydrides.
B_2H_6, CH_4, NH_3 and HF
(a) Electron deficient hydride = B_2H_6 and HF
Electron precise hydride = CH_4
Electron rich hydride = NH_3
(b) Electron deficient hydride = B_2H_6
Electron precise hydride = CH_4
Electron rich hydride = NH_3 and HF
(c) Electron deficient hydride = CH_4
Electron precise hydride = B_2H_6
Electron rich hydride = NH_3 and HF
(d) Electron deficient hydride = CH_4 and HF
Electron precise = B_2H_6
Electron rich hydride = NH_3,

30. 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

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

32. Metal hydride on treatment with water gives
(a) H_2O_2 (b) H_2O
(c) Acid (d) Hydrogen

33. The polymeric hydride is
(a) CaH_2 (b) NaH
(c) BaH_2 (d) MgH_2

34. Ionic hydrides reacts with water to give
(a) acidic solutions (b) hydride ions
(c) basic solutions (d) electorns

35. Which of the following in incorrect statement?
(a) s-block elements, except Be and Mg, form ionic hydride
(b) BeH_4, MgH_2, CuH_2, ZnH_2, CaH_2 and HgH_2 are intermediate hydride
(c) p-block elements form covalent hydride
(d) d-and f-block elements form ionic hydride

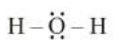
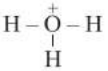
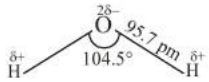
36. Metal hydrides are ionic, covalent or molecular in nature. Among LiH, NaH, KH, RbH, CsH, the correct order of increasing ionic character is
(a) LiH > NaH > CsH > KH > RbH
(b) LiH < NaH < KH < RbH < CsH
(c) RbH > CsH > NaH > KH > LiH
(d) NaH > CsH > RbH > LiH > KH

37. $LiAlH_4$ is used as :
(a) An oxidizing agent (b) A reducing agent
(c) A mordant (d) A water softener

38. Water is :
(a) more polar than H_2S
(b) more or less identical in polarity with H_2S
(c) less polar than H_2S
(d) None of these

39. In gas phase water is ___A___ molecule with a bond angle of ___B___ and O–H bond length of ___C___
(a) A = Bent, B = 100.5°, C = 95.7 pm
(b) A = Bent, B = 104.5°, C = 95.7 pm
(c) A = Bent, B = 109.5°,C = 99.7 pm
(d) A = Bent, B = 104.5°, C = 99.7 pm

40. The H–O–H angle in water molecule is about
(a) 90° (b) 180°
(c) 102.5° (d) 104.5°

41. Identify the structuer of water in the gaseous phase.
(a)  (b) 
(c)  (d) None of these

42. The unusual properties of water in the condensed phase (liquid and solid states) are due to the
(a) presence of hydrogen and covalent bonding between the water molecules
(b) presence of covalent bonding between the water molecules
(c) presence of extensive hydrogen bonding between water molecules
(d) presence of ionic bonding

43. The boiling point of water is exceptionally high because
(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

44. Water possesses a high dielectric constant, therefore :
(a) it always contains ions
(b) it is a universal solvent
(c) can dissolve covalent compounds
(d) can conduct electricity

45. At its melting point ice is lighter than water because
(a) H_2O molecules are more closely packed in solid state
(b) ice crystals have hollow hexagonal arrangement of H_2O molecules.
(c) on melting of ice the H_2O molecule shrinks in size
(d) ice froms mostly heavy water on first melting.

46. The low density of ice compared to water is due to
(a) hydrogen-bonding interactions
(b) dipole-dipole interactions
(c) dipole-induced dipole interactions
(d) induced dipole-induced dipole interactions

47. 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 ?
(a) Hydrogen bond formation
(b) Van der Waals forces
(c) Covalent attraction
(d) Ionic interaction

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

49. Which of the following metals reacts with H_2O at room temp?
(a) Ag (b) Fe
(c) Al (d) Na

50. 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

51. Which of the following groups of ions makes the water hard?
(a) Sodium and bicarbonate
(b) Magnesium and chloride
(c) Potassium and sulphate
(d) Ammonium and chloride.

52. The process used for the removal of hardness of water is
(a) Calgon (b) Baeyer
(c) Serpeck (d) Hoope

53. When zeolite (hydrated sodium aluminium silicate) is treated with hard water the sodium ions are exchanged with
(a) H^+ ions (b) Ca^{2+} ions
(c) SO_4^{2-} ions (d) OH^- ions

54. Calgon used as a water softener is
(a) $Na_2[Na_4(PO_3)_6]$ (b) $Na_4[Na_2(PO_3)_6]$
(c) $Na_4[Na_4(PO_4)_5]$ (d) $Na_4[Na_2(PO_4)_6]$

55. Polyphosphates are used as water softening agents because they
(a) form soluble complexes with anionic specise
(b) precipitate anionic species
(c) forms soluble complexes with cationic species
(d) precipitate cationic species

56. 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

57. Which one the following removes temporary hardness of water ?
(a) Slaked lime (b) Plaster of Paris
(c) Epsom (d) Hydrolith

58. Permanent hardness of water is due to the presence of
(a) bicarbonates of sodium and potassium
(b) chlorides and sulphates of sodium and potassium
(c) chlorides and sulphates of calcium and magnesium
(d) bicarbonates of calcium and magnesium

59. In lab 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) $H_2 + O_2$

60. HCl is added to following oxides. Which one would give H_2O_2
(a) MnO_2 (b) PbO_2
(c) BaO (d) None

61. The oxide that gives H_2O_2 on treatment with dilute H_2SO_4 is–
(a) PbO_2 (b) BaO_2
(c) MnO_2 (d) TiO_2

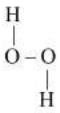
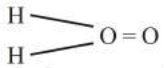
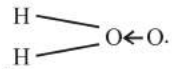
62. 30 volume hydrogen peroxide means
(a) 30% of H_2O_2 solution
(b) 30 cm^3 solution contains 1g of H_2O_2
(c) 1 cm^3 of solution liberates 30 cm^3 of O_2 at STP
(d) 30 cm^3 of solution contains 1 mole of H_2O_2

63. The volume strength of 1.5 N H_2O_2 solution is :
(a) 8.4 (b) 8.0
(c) 4.8 (d) 3.0

64. Commercial 10 volume H_2O_2 is a solution with a strength of approximately
(a) 15% (b) 3%
(c) 1% (d) 10%

65. The structure of H_2O_2 is
(a) planar (b) non planar
(c) spherical (d) linear

66. The O – O – H bond angle in H_2O_2 is
(a) 106° (b) 109°28'
(c) 120° (d) 94.8°

67. Which of the following is the true structure of H_2O_2 ?
(a) H–O–O–H (b) 
(c)  (d) 

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

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

70. When H_2O_2 is oxidised the product is
(a) OH^- (b) O_2
(c) O^{2-} (d) HO_2^-

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

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

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

74. 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) Oxidising action of H_2O_2
(d) Reducing action of H_2O_2.

75. 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

76. Consider the reactions

(A) $H_2O_2 + 2HI \rightarrow I_2 + 2H_2O$

(B) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

Which of the following statements is correct about H_2O_2 with reference to these reactions? Hydrogen peroxide is _____ .

(a) an oxidising agent in both (A) and (B)

(b) an oxidising agent in (A) and reducing agent in (B)

(c) a reducing agent in (A) and oxidising agent in (B)

(d) a reducing agent in both (A) and (B)

77. Which of the following equations depict the oxidising nature of H_2O_2?

(a) $2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$

(b) $2Fe^{3+} + 2H^+ + H_2O_2 \rightarrow 2Fe^{2+} + 2H_2O + O_2$

(c) $2I^- + 2H^+ + H_2O_2 \rightarrow I_2 + 2H_2O$

(d) $KIO_4 + H_2O_2 \rightarrow KIO_3 + H_2O + O_2$

78. Which one of the following undergoes reduction with hydrogen peroxide in an alkaline medium ?

(a) Mn^{2+} (b) HOCl

(c) PbS (d) I_2

79. Which of the following does not represent reducing action of H_2O_2?

(a) $PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$

(b) $HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$

(c) $2MnO_4^- + 3H_2O_2 \rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$

(d) $I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

80. Which of the following is not true for hydrogen peroxide?

(a) H_2O_2 decomposes slowly on exposure to light.

(b) It is kept away from dust because dust can induce explosive decomposition of the compound.

(c) H_2O_2 is used as bleaching agent for textiles, paper pulp etc.

(d) It is used as a moderator in nuclear reactor.

81. The decomposition of H_2O_2 is accelerated by –

(a) glycerine (b) alcohol

(c) phosphoric acid (d) Pt powder

82. 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 auto-oxidation on prolonged standing

(d) None of these

83. 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

84. 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

85. Heavy water is represented as

(a) $H_2{}^{18}O$ (b) D_2O

(c) $D_2{}^{18}O$ (d) H_2O at 4°C

86. What is formed when calcium carbide reacts with heavy water?

(a) C_2D_2 (b) CaD_2

(c) Ca_2D_2O (d) CD_2

87. D_2O is used in

(a) motor vehicles (b) nuclear reactor

(c) medicine (d) insecticide

88. Complete the following reaction.

$Al_4C_3 + D_2O \rightarrow x + y$

(a) $x = C_2D_2$ and $y = Al(OD)_3$

(b) $x = CD_4$ and $y = Al(OD)_3$

(c) $x = CO_2$ and $y = Al_2D_3$

(d) $x = CD_4$ and $y = Al_2D_3$

89. 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 with oxygen

(d) None of these

90. 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

91. The numbers of protons, electrons and neutrons in a molecule of heavy water are respectively :

(a) 8, 10, 11 (b) 10, 10, 10

(c) 10, 11, 10 (d) 11, 10, 10

92. Choose the incorrect statement

(a) Dihydrogen can release more energy than petrol.

(b) The only pollutant in combustion of dihydrogen is carbon dioxide.

(c) Hydrogen economy is based on the principle of transportation and storage of energy in the form of liquid or gaseous dihydrogen

(d) Hydrogen economy has advantage that energy is transmitted in the form of dihydrogen and not as electric power.

93. Which of the following fuel is used for runnning the automobiles first time in the history of India during October 2005?

(a) D_2O (b) H_2O_2

(c) D_2 (d) H_2

STATEMENT TYPE QUESTIONS

94. The storage tanks used for H_2 are made up of which metal alloy(s)

(i) $NaNi_5$ (ii) B_2H_6

(iii) $Ti–TiH_2$ (iv) $Mg–MgH_2$

(a) (iii) and (iv) (b) (i) and (ii)

(c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

95. Which of the following sequence of T and F is correct for given statements? Here T stands for true and F stands for false statement

(i) The H–H bond dissociation enthalpy is highest for a single bond between two atoms of any element

(ii) H_2 is relatively inert at room temperature.

(iii) Hydrogen combines with almost all the elements due to its incomplete orbital

(iv) The atomic hydrogen is produced at high temperature in an electric arc or under UV radiations.

(a) TTTT (b) FTFT

(c) FTTT (d) FTTF

96. Which of the following statement(s) is/are incorrect?

(i) Dihydrogen reduces copper (II) oxide to copper

(ii) Reaction of dihydrogen with sodium gives sodium hydride.

(iii) Hydroformylation of olefins yields aldehydes which further undergo reduction to give alcohols.

(iv) Hydrogenation of vegetable oils using iron as catalyst gives edible fats.

(a) (i), (ii) and (iii) (b) (i) and (iv)

(c) (iv) only (d) (iii) and (iv)

97. Choose the correct sequence of T and F for following statements. Here T stands for true and F stands for false statement.

(i) At atmospheric pressure ice crystallises in the hexagonal form, but at very low temperatures it condenses to cubic form.

(ii) Density of ice is less than that of water. Therefore, an ice cube floats on water.

(iii) In winter season ice formed on the surface of a lake makes survival of the aquatic life difficult.

(iv) Hydrogen bonding gives ice a open type structure with wide holes.

(a) TTFT (b) FTFT

(c) FTTT (d) TFTT

98. Which of the following statements are correct ?

(i) Hydrogen peroxide is industrially prepared by the auto-oxidation of 2-alkylanthraquinols

(ii) One millilitre of 30% H_2O_2 means that solution will give 100 V of oxygen at STP

(iii) Dihedral angle of H_2O_2 in gas phase is 90.2° and in solid phase dihedral angle is 111.5°

(a) (i), (ii) and (iii) (b) (i) and (iii)

(c) (ii) and (iii) (d) (i) and (ii)

99. 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 (iii) (b) (i) and (ii)

(c) (i), (ii) and (iii) (d) (ii) and (iii)

MATCHING TYPE QUESTIONS

100. Match the columns

	Column-I		**Column-II**
(A)	Ionic hydrides	(p)	$NiH_{0.6\text{-}0.7}$
(B)	Molecular hydrides	(q)	LiH
(C)	Metallic hydrides	(r)	HF

(a) A – (q), B – (r), C – (p)

(b) A – (r), B – (q), C – (p)

(c) A – (q), B – (p), C – (r)

(d) A – (r), B – (p), C – (q)

101. Match the columns

	Column - I (Chemical property of water)		**Column - II (Chemical equation)**
(A)	Basic nature	(p)	$2H_2O(l) + 2Na(s) \longrightarrow 2NaOH(aq) + H_2(g)$
(B)	Auto-protolysis	(q)	$H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$
(C)	Oxidising nature	(r)	$2F_2(g) + 2H_2O(l) \longrightarrow 4H^+(aq) + 4F^-(aq) + O_2(g)$
(D)	Reducing nature	(s)	$H_2O(l) + H_2S(aq) \rightleftharpoons H_3O^+(aq) + HS^-(aq)$

(a) A – (s), B – (q), C – (r), D – (p)

(b) A – (s), B – (q), C – (p), D – (r)

(c) A – (r), B – (q), C – (s), D – (p)

(d) A – (p), B – (q), C – (s), D – (r)

102. Match the columns

	Column-I		**Column-II**
(A)	Clark's method	(p)	$Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + Mg(OH)_2\downarrow + 2H_2O$
(B)	Calgon's method	(q)	$2NaZ(s) + M^{2+}(aq) \rightarrow MZ_2(s) + 2Na^+(aq)$
(C)	Boiling	(r)	$Ca(HCO_3)_2 \rightarrow CaCO_3\downarrow + H_2O + CO_2\uparrow$
(D)	Ion exchange method	(s)	$M^{2+} + Na_4P_6O_{18}^{2-} \rightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+$

(a) A – (s), B – (q), C – (r), D – (p)

(b) A – (q), B – (p), C – (r), D – (s)

(c) A – (p), B – (s), C – (r), D – (q)

(d) A – (r), B – (q), C – (p), D – (s)

103. Match the columns

	Column-I		**Column-II**
(A)	Coordinated water	(p)	$[Cu(H_2O)_4]^{4+}SO_4^{2-}.H_2O$
(B)	Interstitial water	(q)	$C_{17}H_{35}COONa$
(C)	Hydrogen-bonded water	(r)	$BaCl_2.2H_2O$
		(s)	$[Cr(H_2O)_6]^{3+}3Cl^-$

(a) A – (r), B – (s), C – (q)

(b) A – (q), B – (r), C – (s)

(c) A – (r), B – (q), C – (p)

(d) A – (s), B – (r), C – (p)

104. Match the columns

	Column-I		Column-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 & chlorides of Mg & Ca in water

(a) A – (r), B – (s), C – (q), D – (p)
(b) A – (q), B – (r), C – (s), D – (s)
(c) A – (q), B – (s), C – (r), D – (p)
(d) A – (r), B – (p), C – (q), D – (s)

105. Match the Column-I with Column-II and mark the appropriate choice.

	Column-I		Column-II
(A)	Syngas	(p)	$Na_6P_6O_{18}$
(B)	Calgon	(q)	$NaAlSiO_4$
(C)	Permutit	(r)	$CO + H_2$
(D)	Producer gas	(s)	$CO + N_2$

(a) (A) – (p), (B) – (q), (C) – (r), (D) – (s)
(b) (A) – (r), (B) – (p), (C) – (q), (D) – (s)
(c) (A) – (r), (B) – (q), (C) – (s), (D) – (p)
(d) (A) – (r), (B) – (q), (C) – (p), (D) – (s)

ASSERTION-REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
(c) Assertion is correct, reason is incorrect
(d) Assertion is incorrect, reason is correct.

106. **Assertion :** H^+ does not exist freely and is always associated with other atoms or molecules.
Reason : Loss of the electron from hydrogen atom results in nucleus (H^+) of ~ 1.5×10^{-3} pm size. This is extremely small as compared to normal atomic and ionic sizes of 50 to 200 pm.

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

108. **Assertion :** Temporary hardness can be removed by boiling.
Reason : On boiling the soluble bicarbonates change to carbonates which being insoluble, get precipitated.

109. **Assertion :** Calgon is used for removing permanent hardness of water.
Reason : Calgon forms precipitates with Ca^{2+} and Mg^{2+}.

110. **Assertion :** Hard water is not suitable for laundary.
Reason : Soap containing sodium stearate reacts with hard water to precipitate out as calcium or magnesium stearate.

111. **Assertion :** Decomposition of H_2O_2 is a disproportionation reaction.
Reason : H_2O_2 molecule simultaneously undergoes oxidation and reduction.

112. **Assertion :** H_2O_2 is not stored in glass bottles.
Reason : Alkali oxides present in glass catalyse the decomposition of H_2O_2

CRITICAL THINKING TYPE QUESTIONS

113. Hydrogen will not reduce
(a) heated cupric oxide (d) heated ferric oxide
(c) heated stannic oxide (d) heated aluminium oxide

114. 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

115. The sum of the number of neutrons and protons in all the three isotopes of hydrogen is
(a) 6 (b) 5
(c) 4 (d) 3

116. The hydride ion, H^-, is a stronger base than the hydroxide ion, OH^-. Which one of the following reactions will occur if sodium hydride (NaH) is dissolved in water?
(a) $H^-(aq) + H_2O(l) \rightarrow H_3O^-(aq)$
(b) $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + H_2(g)$
(c) $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + 2H^+(aq) + 2e$
(d) $H^-(aq) + H_2O(l) \rightarrow$ No reaction

117. 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) Oxidising nature of H_2O_2
(d) Reducing action of H_2O_2

118. Which of the following is not true?
(a) D_2O freezes at lower temperature than H_2O
(b) Reaction between H_2 and Cl_2 is much faster than D_2 and Cl_2
(c) Ordinary water gets electrolysed more rapidly than D_2O
(d) Bond dissociation energy of D_2 is greater than H_2

119. Heavy water reacts respectively with CO_2, SO_3, P_2O_5 and N_2O_5 to give the compounds :
(a) $D_2CO_3, D_2SO_4, D_3PO_2, DNO_2$
(b) $D_2CO_3, D_2SO_4, D_3PO_4, DNO_2$
(c) $D_2CO_3, D_2SO_3, D_3PO_4, DNO_2$
(d) $D_2CO_3, D_2SO_4, D_3PO_4, DNO_3$

120. Identify x and y in following reaction:

$$2HSO_4^-(aq) \xrightarrow{\text{electrolysis}} x \xrightarrow{\text{hydrolysis}} y + 2H^+(aq) + H_2O_2(aq)$$

(a) $x = H_2SO_4$ (aq), $y = 2HSO_4^-(aq)$
(b) $x = HO_3SOOSO_3H(aq)$, $y = 2HSO_4^-(aq)$
(c) $x = HO_3SOOSO_3H$ (aq), $y = H_2SO_4(aq)$
(d) $x = H_2SO_4(aq)$, $y = HO_3SOOSO_3H(aq)$

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. **(c)** (i) and (iii) are properties of hydrogen which shows its resemblance with alkali metals whereas (ii) , (iv) and (v) shows resemblance with halogens.

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

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

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

5. **(a)** $H + e^- \ (1s^1) \rightarrow H^- \ (1s^2 \text{ or [He]})$
$F + e^- ([He]2s^2 2p^5) \rightarrow F^- \ ([He]\ 2s^2\ 2p^6 \text{ or [Ne]})$

6. **(c)** In metal hydrides the O.S. of hydrogen –1 otherwise it is +1.

7. **(d)**

8. **(c)** (i) Protium, deuterium and tritium are isotopes of hydrogen.
(ii) Ortho and para hydrogens are allotropes of hydrogen. In ortho hydrogen, protons are spinning in same direction (parallel spin), while in para hydrogen, protons spin in opposite direction (antiparallel).

9. **(a)** Number of neutrons in protium, deuterium and tritium respectively is = 0, 1 and 2

10. **(c)** Tritium is radioactive and emits low energy β^- particles.

11. **(c)** Hydrogen bond is weak force of attraction existing between molecules. Its energy is equal to 3-10 k cal

12. **(c)** Except method given in statement (iii) all other are commercial methods for production of dihydrogen.

13. **(d)** $Zn + 2NaOH \longrightarrow \underset{\text{(Sodium zincate)}}{Na_2ZnO_2} + H_2$

14. **(c)** $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270\,K} CO + 3H_2$
Mixture of CO and H_2 is called water gas.

15. **(c)** Mixture of CO and H_2 is used in synthesis of methanol and a number of hydrocarbons due to this reason it is also called syn gas.

16. **(d)** Carbon dioxide formed in water gas shift reaction is removed by scrubbing with sodium arsenite solution.

17. **(c)** $Fe + \text{dil.}\, H_2SO_4 \rightarrow FeSO_4 + H_2 \uparrow$

$3Fe + \underset{\text{Steam}}{4H_2O} \rightarrow Fe_3O_4 + 4H_2 \uparrow$

$Cu + \text{dil. } HCl \rightarrow$ No reaction
Copper does not evolve H_2 from acid as it is below hydrogen in electrochemical series.

$2Na + 2C_2H_5OH \rightarrow 2C_2H_5ONa + H_2 \uparrow$

18. **(a)** $Mg + \text{dil. } HNO_3 \rightarrow Mg(NO_3)_2 + H_2$ (Mg and Mn give H_2 with dil HNO_3)

19. **(b)** $Mn + 2HNO_3\,(\text{dil.}) \rightarrow Mn(NO_3)_2 + H_2$

20. **(b)** $\underset{\text{water gas}}{CO + H_2} + H_2O \xrightarrow{\text{catalyst}} CO_2 + 2H_2$

21. **(a)** Zinc has no action on cold water.

22. **(a)** $Cu + 4HNO_3(\text{conc.}) \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

$C_2H_5OH + Na \longrightarrow C_2H_5O^-Na^+ + 1/2H_2 \uparrow$

$Mg + 2H_2O(\text{steam}) \longrightarrow Mg(OH)_2 + H_2 \uparrow$

$C_6H_5OH + Na \longrightarrow C_6H_5O^-Na^+ + 1/2H_2 \uparrow$

$NaH + H_2O \longrightarrow NaOH + H_2 \uparrow$

23. **(d)** Very pure hydrogen can be prepared by the action of water on sodium hydride.
$NaH + H_2O \longrightarrow NaOH + \underset{\text{(very pure Hydrogen)}}{H_2}$

24. **(b)** $CO(g) + 2H_2(g) \xrightarrow[\text{catalyst}]{\text{cobalt}} CH_3OH(l)$

25. **(c)** Hydrogen is not used in the synthesis of hydroquinone and tartaric acid.

26. **(d)** Almost all elements except noble gases, forms hydrides.

27. **(c)** Melts of ionic hydrides conduct electricity and liberate dihydrogen gas at anode.

28. **(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.

29. **(b)** Electron deficient hydride = B_2H_6
Electron precise = CH_4
Electron rich = NH_3 and HF

30. **(a)**

31. **(d)** All metal hydrides are ionic in nature.

32. **(d)** Metal hydride $+H_2O \rightarrow$ Metal hydroxide $+ H_2$

33. **(d)** Due to its covalent nature MgH_2 is Polymeric in nature.

34. **(c)** Ionic hydrides give the basic solution when it reacts with water, e.g.,
$LiH + H_2O \longrightarrow LiOH + H_2$

35. **(d)** d- and f-block elements form metallic hydride.
While p-block elements form covalent hydrides, s-block elements except Be and Mg form ionic hydrides. Hydrides of Be, Mg, Cu, Zn, Ca and Hg are intermediate hydride.

36. **(b)**

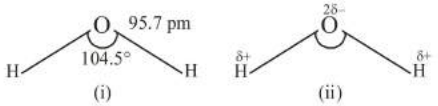
37. **(b)** $LiH + AlCl_3 \longrightarrow (AlH_3)_n \xrightarrow[LiH]{\text{excess}} Li[AlH_4]$
Lithuim aluminium hydride is a most useful organic reducing agent. It reduces functional groups but does not attack double bonds.

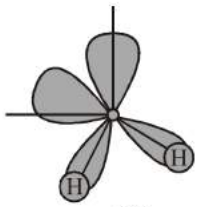
38. **(a)** Polarity of bond depends on difference in electronegativity of the two concerned atoms. H_2O is more polar than H_2S because oxygen (in O–H) is more electronegative than sulphur (in S–H).

39. **(b)** In gas phase water is a bent molecule with a bond angle of 104.5° and O–H bond length of 95.7 pm.

40. **(d)** The hybridisation in water is sp^3 and bond angle 104.5°

41. **(c)**





(iii)

42. **(c)** The unusual properties of water in the condensed phase (liquid an solid states) are due to the presence of extensive hydrogen bonding between the water molecules.

43. **(c)** The high boiling point of water is due to H-bonding.

44. **(b)** Due to high dielectric constant, water acts as a good solvent therefore it is also called a universal solvent.

45. **(b)** In the structure of ice each molecule of H_2O is surrounded by three H_2O molecules in hexagonal honey comb manner which results an open cage like structure. As a result there are a number of 'hole' or open spaces. In such a structure lesser number of molecules are packed per ml. When ice melts a large no. of hydrogen bonds are broken. The molecules therefore move into the holes or open spaces and come closer to each other than they were in solid state. This result sharp increase in the density. Therefore ice has lower density than water.

46. **(a)** We know that due to polar nature, water molecules are held together by intermolecular hydrogen bonds. The structure of ice is open with large number of vacant spaces, therfore the density of ice is less than water.

47. **(a)** Two ice cubes stick to each other due to H-bonding.

48. **(d)**

49. **(d)** Sodium is most electropositive element among those given.

$$2Na + 2H_2O \xrightarrow[\text{Room temp.}]{} 2NaOH + H_2$$

50. **(b)** Water has high dielectric constant i.e., 78.39 C^2/Nm^2, high liquid range and can dissolve maximum number of compounds. That is why it is used as universal solvent.

51. **(b)** Temporary hardness is due to presence of bicarbonates of calcium and magnesium and permanent hardness is due to the sulphates and chlorides of both of calcium and magnesium.

52. **(a)** Calgon process is used to remove permanent hardness of water

53. **(b)** Na zeolite + $CaCl_2 \rightarrow$ Ca zeolite + 2NaCl

54. **(a)** The complex salt of metaphosphoric acid sodium hexametaphosphate $(NaPO_3)_6$, is known as calgon. It is represented as $Na_2[Na_4(PO_3)_6]$

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

56. **(b)**

57. **(a)** This method is known as Clark's process. In this method temporary hardness is removed by adding lime water or milk of lime.

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

58. **(c)** Permanent hardness of water is due to chlorides and sulphates of calcium and magnesium.

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

60. **(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.

61. **(b)**

62. **(c)** 30 vol of H_2O_2 means one volume of H_2O_2 on decomposition will give 30 volume of oxygen.

63. **(a)** Normality of $H_2O_2 = \dfrac{\text{vol. strength}}{5.6}$

Volume of normal (1N) H_2O_2 solution = 5.6 volumes.

$\therefore$ Volume of strength of 1.5 N H_2O_2

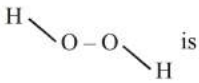
$= 1.5 \times 5.6 = 8.4$ volumes.

64. **(b)** Strength of 10V $H_2O_2 = \dfrac{68 \times 10}{22400} \times 100 = 3.035\%$

65. **(b)** Structure of H_2O_2 is nonplanar

66. **(d)** O – O – H bond angle in H_2O_2 is 94.8°.

67. **(b)**



is the true structure of H_2O_2.

68. **(b)**

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

70. **(b)** $H_2O_2 + [O] \xrightarrow{\text{Oxidation}} H_2O + O_2\uparrow$

71. **(b)** The value of dipole moment of H_2O_2 is 2.1 D, which suggest the structure of H_2O_2 cannot be planar.

An open-book structure is suggested for H_2O_2 in which O – H bonds lie in different plane.

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

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

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

74. **(c)** H_2S is oxidised to S by H_2O_2.

75. **(d)** H_2O_2 does not have basic properties.

76. **(b)** **77. (c)**

78. **(b,d)** $HOCl(aq) + H_2O_2(aq) \longrightarrow H_3O^+(aq) + Cl^-(aq) + O_2(g)$

$I_2(s) + H_2O_2(aq) + 2OH^-(aq) \longrightarrow 2I^-(aq) + 2H_2O(l) + O_2(g)$

79. **(a)** Option (a) represents oxidising action of H_2O_2 in acidic medium.

80. **(d)** H_2O_2 is not used as a moderator in nuclear reactors

81. **(d)** Decomposition of H_2O_2 can be accelerated by finely divided metals such as Ag, Au, Pt, Co, Fe etc.

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

83. **(d)** Although H_2O_2 is a better polar solvent than H_2O. However it cannot be used as such because of the strong auto-oxidation ability.

84. **(d)** H_2O_2 show all these properties.

85. **(b)** The formula of heavy water (deuterium oxide) is D_2O.

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

87. **(b)** D_2O is used in nuclear reactors as moderator.

88. **(b)** $Al_4C_3 + D_2O \rightarrow 3CD_4 + 4Al(OD)_3$

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

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

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

91. **(b)** Heavy water is D_2O hence
number of electrons = 2 + 8 = 10
number of protons = 10
Atomic mass of D_2O = 4 + 16 = 20
hence number of neutron
= Atomic mass – number of protons
= 20 – 10 = 10

92. **(b)** The only pollutant in combustion of dihydrogen is oxides of dinitrogen (due to the presence of dinitrogen as impurity with dihydrogen).

93. **(d)** It is for the first time in the history of India that a pilot project using dihydrogen as fuel was launched in October 2005 for running automobiles. Initially 5% H_2 has been mixed in CNG for use in four wheeler vehicles.

STATEMENT TYPE QUESTIONS

94. **(c)** Tanks of metal alloy like $NaNi_5$, $Ti - TiH_2$, $Mg - MgH_2$ etc are used for storage of dihydrogen in small quantities.

95. **(a)**

96. **(c)** Hydrogenation occurs in presence of nickel as a catalyst.

97. **(a)** In winter seasons ice formed on the surface of a lake provides thermal insulation which ensures the survival of the aquatic life.

98. **(d)** Dihedral angle of H_2O_2 in gas phase is 111.5° and in solid phase it is 90.2°

99. **(b)**

MATCHING TYPE QUESTIONS

100. **(a)** 101. **(b)** 102. **(c)**

103. **(d)** Many salts can be crystallised as hydrated salts from an aqueous solutions such an association of water is of different types viz.,
(i) Coordinated water e.g., $[Cr(H_2O)_6]^{3+}3Cl^-$
(ii) Interstitial water e.g., $BaCl_2 . 2H_2O$
(iii) Hydrogen-bonded water
e.g., $[Cu(H_2O)_4]^{4+}SO_4^{2-}.H_2O$ in $CuSO_4.5H_2O$

104. **(d)** Heavy water is D_2O (1 – C); Temporary hard water contains the bi-carbonates of Mg and Ca (2 – A); Soft water contains no foreign ions (3 – B); Permanent hard water contains the sulphates and chlorides of Mg and Ca (4 – D) therefore the answer is D.

105. **(b)**

ASSERTION-REASON TYPE QUESTIONS

106. **(a)** Due to extremely small size of H^+ as compared to normal atomic and ionic size H^+ does not exist freely.

107. **(a)** 108. **(a)**

109. **(c)** Both assertion is correct reason is not true.
Correct reason : Calgon forms soluble complexes with Ca^{2+} and Mg^{2+} in which properties of these ions are masked.

110. **(a)** $2C_{17}H_{35}COONa(aq) + M^{2+}(aq) \longrightarrow (C_{17}H_{35}COO)_2M\downarrow (M = Ca \text{ or } Mg) + 2Na^+(aq)$

111. **(a)** Both assertion and reason are true and reason is the correct explanation of assertion.

112. **(a)**

CRITICAL THINKING TYPE QUESTIONS

113. **(d)** H_2 will not reduce heated Al_2O_3. As Al is more electro-positive than hydrogen. therefore, its oxide will not be reduced by hydrogen.

114. **(d)** Heavy water is stable.

115. **(a)** $_1H^1$ $_1D^2$ $_1T^3$
no. of neutrons respectively are 0 , 1 , 2
no. of protons respectively are 1 , 1 , 1
Hence the sum of protons + neutrons = 1 + 2 + 3 = 6

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

In this reaction H^- acts as bronsted base as it accepts one proton (H^+) from H_2O and for H_2.

117. **(c)** $H_2\overset{-2}{S} + H_2O_2 \rightarrow \overset{0}{S} + 2H_2O$

In this reaction H_2O_2 shows oxidising nature.

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

119. **(d)**

120. **(b)** $2HSO_4^-(aq) \xrightarrow{\text{electrolysis}} HO_3SOOSO_3H(aq)$

$\xrightarrow{\text{Hydrolysis}} 2HSO_4^-(aq) + 2H^+(aq) + H_2O_2(aq)$