

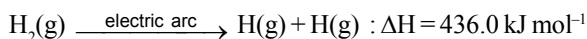
SOLVED EXAMPLES

Ex. 1 Discuss the consequences of high enthalpy of H–H in terms of chemical reactivity.

Sol. Due to high bond enthalpy of H–H bond, dihydrogen molecule (H_2) is quite unreactive at room temperature. However, at high temperature or in presence of catalysts, it combines with many metals and non-metals to form respectively hydrides.

Ex. 2 How does the atomic hydrogen or oxy-hydrogen torch function for cutting and welding purposes ? Explain.

Sol. Atomic hydrogen is produced when molecular hydrogen is passed through an electric arc struck between tungsten electrodes (3773–4273 K).



The life span of atomic hydrogen is about 0.3 sec and therefore, it immediately gets converted into the molecular hydrogen (H_2) liberating a large amount of energy which is used for cutting and welding purposes in the form of atomic hydrogen torch.

Ex. 3 What do you understand by the term " non-stoichiometric hydrides" ? Do you expect this type of hydrides to be formed by alkali metals ? Justify your answer.

Sol. These are hydrides which have low hydrogen content. In these hydrides the ratio of the metal to hydrogen atoms is fractional and they are called non-stoichiometric hydrides. Furthermore, even this fractional ratio of atoms is not fixed but varies with the temperature and the pressure conditions. This type of hydrides are formed by d- and f-block elements. In these hydrides, the hydrogen atoms occupy holes in the metal lattice. Usually some holes always remain unoccupied and hence these metals form non-stoichiometric hydrides.

Alkali metals are highly reducing as they transfer their lone electron to the H atom, thereby, forming H^- ions. In other words, alkali metals hydrides are ionic in nature. Since such hydrides are formed by complete transfer of an electron, therefore, the ratio of metal to hydrogen is always fixed. Therefore, alkali metals form only stoichiometric hydrides. They do not form non-stoichiometric hydrides at all.

Ex. 4 What do you understand by (i) electron-deficient, (ii) electron-precise, and (iii) electron rich compounds of hydrogen ? Provide justification with suitable examples.

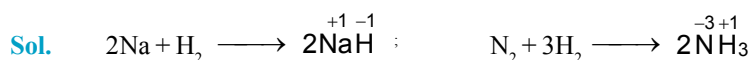
Sol. (i) Hydrides of elements of group-13 such as BH_3 , AlH_3 , etc., do not have sufficient number of electrons to form normal covalent bond and hence are called electron-deficient hydrides. To make up this deficiency, they generally exist in polymeric forms such as B_2H_6 , B_4H_{10} , $(AlH_3)_n$, etc.

(ii) Hydrides of elements of group-14 like CH_4 , SiH_4 , GeH_4 , etc. have exact number of electrons to form covalent bonds and hence are called electron-precise hydrides. All these hydrides have tetrahedral shapes.

(iii) Hydrides of elements of group 15, 16 and 17, like NH_3 , PH_3 , H_2O , H_2S , HF , HCl , etc. have more electrons than required to form normal covalent bonds and hence are called electron-rich hydrides. The excess electron in these hydrides are present as lone pairs of electrons.

Ex. 5 Which of the following is correct for hydrogen ?

- (1) It is always collected at cathode.
- (2) Its ionization energy is very low in comparison with alkali metals.
- (3) It can form bonds in +1 as well as in –1 oxidation states.
- (4) Its oxide is not stable.



Ans.(3)

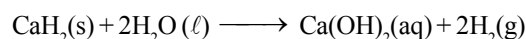
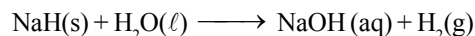
Ex. 6 Metal which does not react with cold water but evolves H_2 with steam is :

- (1) Na (2) K (3) Pt (4) Fe

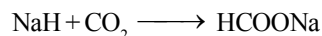
Sol. $4H_2O(g) + 3Fe(s) \xrightarrow{1000K} Fe_3O_4 + 4H_2 \uparrow$ **Ans. (4)**

Ex. 7 Saline hydride are known to react with water violently producing fire, Can, CO_2 , a well known fire extinguisher, be used in this case ? Explain.

Sol. Saline hydride (Such as NaH, CaH_2 , etc), react with water violently to form the corresponding metal hydroxides with the evolution of dihydrogen. The dihydrogen gas so liberated undergoes spontaneous combustion causing fire. This is because of exothermic nature of combustion reactions.



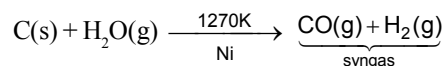
The fire so produced cannot be extinguished by CO_2 because it reacts with the hot metal hydride and forms formate ions



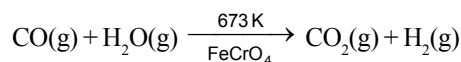
However, sand (because of its stable nature) is more effective fire extinguisher in such a case.

Ex. 8 How can the production of dihydrogen, obtained from coal gasification, be increased ?

Sol. Coal gasification is the process of producing 'syngas' from coal and steam



The production of hydrogen can be increased by the reaction carbon monoxide of syngas with steam in presence of iron chromate as catalyst at 673 K when it is oxidised to CO_2 .



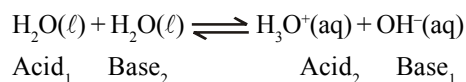
The CO_2 thus produced is removed by scrubbing with a solution of sodium arsenite.

Ex. 9 Among NH_3 , H_2O and HF which would you expect to have highest magnitude of hydrogen bonding and why?

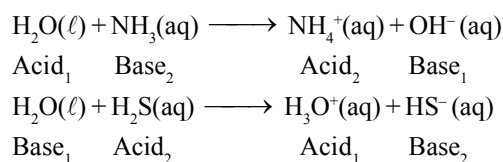
Sol. Strength of H–hydrogen depends upon the atomic size and electronegativity of the other atom to which H–atom is covalently bonded. Smaller size and higher electronegativity favour H-bonding. Now among N, F, O atoms, atomic size of F is lowest and its electronegativity is highest. Hence H–F will have highest magnitude of H–bonding.

Ex. 10 What do you understand by the term 'auto-protolysis' of water. What is its significance ?

Sol. Auto-protolysis refers to self ionization of water. It may be represented as :



Due to auto-protolysis, water acts as amphoteric substance i.e., it reacts with both acids and bases. It acts as a base towards acids stronger than itself and as an acid towards bases stronger than itself. For example,



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Ex. 11 Match list-I with list-II and select the correct answer :

Column-I

- (A) Heavy water
 (B) Temporary hard water
 (C) Soft water
 (D) Permanent hard water

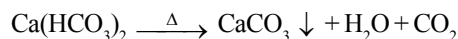
Column-II

- (p) Bicarbonates of Mg and Ca in water
 (q) Distilled water
 (r) Deuterium oxide
 (s) Sulphates and chlorides of Mg and Ca in water.

Ans. (A - r); (B - p); (C - q); (D - s)

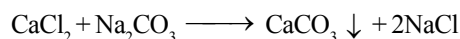
Sol. (A) Chemically heavy water is D₂O, i.e. deuterium oxide.

(B) Temporary hardness of water is due to the presence of bicarbonates of calcium and magnesium and can be removed by simple boiling.



(C) Water which produces lather with soap solution readily, is called soft water e.g., distilled water, rain water and demineralised water. It contains no foreign ions.

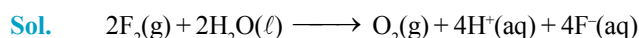
(D) Permanent hardness of water is due to the presence of sulphates and chlorides of calcium and magnesium and can be removed by chemical methods.



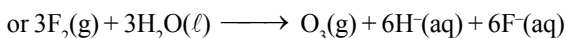
Ex. 12 Is demineralised or distilled water useful for drinking purpose ? If not, how can it be made useful ?

Sol. Demineralised or distilled water is not useful for drinking purpose because it does not contain even useful minerals. Therefore, to make it useful for drinking purposes, useful minerals in proper amounts should be added to demineralised or distilled water.

Ex. 13 Consider the reaction of water with F₂ and suggest in terms of oxidation and reduction which species are oxidised/reduced ?



(oxidant) (reductant)



(oxidant) (reductant)

In these reactions, water acts as a reducing agent and gets oxidised to either O₂ or O₃ on the other hand, F₂ acts as an oxidising agent and gets reduced to F⁻ ion.

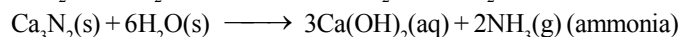
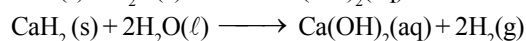
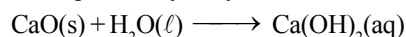
Ex. 14 Describe the usefulness of water in biosphere and biological systems.

Sol. Water is essential for all forms of life. It constitutes about 65-70% of the body mass of animals and plants, In comparison to other liquids, water has high specific heat, thermal conductivity, surface tension, dipole moment and dielectric constant, etc. These properties allow water to play a key role in biosphere. The high heat of vaporisation and high heat capacity are responsible for moderation of the climate and body temperature of living beings. It is an excellent solvent for transportation of minerals and other nutrients for plant and animal metabolism. Water is also required for photosynthesis in plants which releases O₂ into the atmosphere.

Ex. 15 What properties of water make it useful as a solvent ? What type of compounds can it (i) dissolve (ii) hydrolyse ?

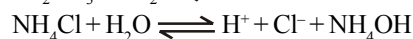
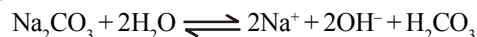
Sol. Water has high dielectric constant (79.39) and high dipole moment (1.84 D). Because of these properties, water dissolves most of the inorganic (ionic) compounds and many covalent compounds. That is why water is called a universal solvent. Ionic compounds dissolve in water due to ion dipole interaction but, covalent compounds such as alcohol, amines, urea, glucose, sugar, et., dissolve in water due to H-bonding.

Water can hydrolyse many metallic or non-metallic oxides, hydrides, carbides, nitrides, phosphides and other salts. Some of the important hydrolytic reactions are given below.

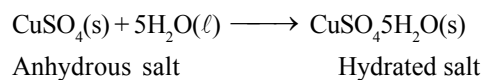
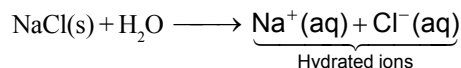


Ex. 16 What is the difference between hydrolysis and hydration ?

Sol. Hydrolysis refers to the reaction of salt or more precisely ions of the salt to form acidic or basic solution. For example,



Hydration, refers to the addition of H_2O to ions or molecules to form hydrated ions or hydrated salts. For example,



Ex. 17 Consider the following statements.

S1 : Water at 4°C having maximum density is known as heavy water.

S2 : Heavy water is formed by the combination of hydrogen and oxygen.

S3 : D_2O has higher density than H_2O .

S4 : D_2O is obtained by exhaustive electrolysis of water.

Which of the statements are correct ?

(1) S_1 and S_2

(2) S_2 and S_3

(3) S_3 and S_4

(4) S_2 and S_4

Sol. S_3 : Heavy water is oxide of deuterium. Its density is 1.106 gm^{-3} and that of H_2O is 1.00 gm^{-3} .

S_4 : Correct statement.

Ans. (3)

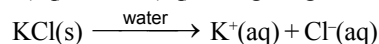
Ex. 18 How can saline hydrides remove traces of water from organic compounds ?

Sol. Saline hydrides (i.e. NaH , CaH_2 , etc.) react with water forming their corresponding metal hydroxides with the liberation of H_2 gas. Thus traces of water present in organic solvents can be easily removed by distilling them over saline hydrides when H_2 escapes into the atmosphere, metal hydroxide is left in the flask while dry organic solvent distills over.

Alternatively, organic compounds containing traces of water can be dried by placing them in a desiccator containing saline hydrides at the bottom for a few hours or preferably overnight.

Ex. 19 Do you expect different products in solution when aluminium (III) chloride and potassium chloride are treated separately with **(i)** normal water **(ii)** acidified water, and **(iii)** alkaline water ?

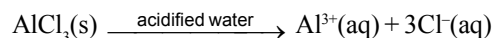
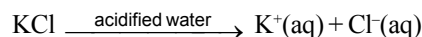
Sol. KCl is the salt of a strong acid and a strong base. It does not undergo hydrolysis in normal water. It just dissociates to give $\text{K}^+(\text{aq})$ and $\text{Cl}^-(\text{aq})$ ions giving neutral solution.



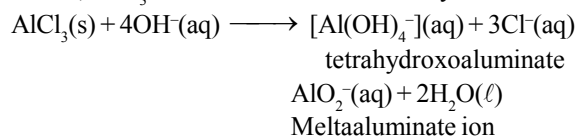
AlCl_3 , on the other hand, is a salt of a weak base Al(OH)_3 and a strong acid HCl . Therefore, in normal water, it undergoes hydrolysis, as follows giving acidic solution.



In acidic water, both KCl and AlCl_3 undergo ionisation.



In alkaline water, AlCl_3 reacts to form soluble tetrahydroxoaluminate (III) complex or metaaluminate ion, i.e. AlO_2^-



KCl does not react and only undergoes ionisation as K^+ and Cl^- ions.

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Ex. 20 What do you expect the nature of hydrides if formed by elements of atomic numbers 15, 19, 23 and 44 with dry dihydrogen? Compare their behaviour towards water.

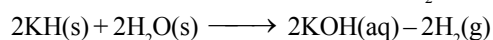
Sol. (i) Element with $Z = 15$ is a non-metal (i.e., P) and hence forms covalent hydride (i.e., PH_3).

(ii) Element with $Z = 19$ is an alkali metal (i.e., K) and hence forms saline or ionic hydride (i.e., $\text{K}^+ \text{H}^-$)

(iii) Element with atomic number $Z = 23$ is a transition metal (i.e., V) belonging to group 3. Hence it forms interstitial hydride (i.e., $\text{VH}_{1.6}$)

(iv) Element with $Z = 44$ is a transition metal (i.e., Ru) belonging to group 8. It does not form any hydride.

Only ionic hydrides react with water evolving H_2 gas.



Ex. 21 **Assertion :** H_2O_2 is not stored in glass bottles.

Reason : Alkali metal oxides present in glass catalyse the decomposition of H_2O_2 .

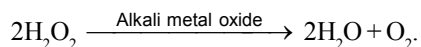
(1) If both Assertion and Reason are true and Reason is a correct explanation of Assertion.

(2) If both Assertion and Reason are true and Reason is not a correct explanation of Assertion.

(3) If Assertion is true but Reason is false.

(4) If Assertion is false but Reason is true.

Sol. Assertion and reason both are correct statements and the reason is the correct explanation of the assertion.



Ans. (1)

Exercise # 1

[Single Correct Choice Type Questions]

- Hydrogen is :
 (A) electropositive. (B) electronegative.
 (C) both electropositive as well as electronegative. (D) neither electropositive nor electronegative.
- Dihydrogen has :
 (A) two isotopes and no isomers. (B) three isotopes and two nuclear isomers.
 (C) three isotopes and two optical isomers. (D) two isotopes and two geometrical isomers.
- A deuterium atom :
 (A) has the same atomic mass as the hydrogen atom.
 (B) has the same electronic configuration as the hydrogen atom.
 (C) has the same composition of the nucleus as the hydrogen atom.
 (D) contains one proton more than a hydrogen atom.
- Hydrogen is evolved by the action of cold dil. HNO_3 on :
 (A) Fe (B) Mn (C) Cu (D) Al
- Hydrogen from HCl can be prepared by :
 (A) Cu (B) P (C) Mg (D) Hg
- Nascent hydrogen consists of :
 (A) Hydrogen atoms with excess of energy (B) Hydrogen molecules with excess energy
 (C) Hydrogen ions in excited state (D) solvated protons
- 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 co-ordinate bond formation but chlorine molecule can.
- Which one of the following properties shows that hydrogen resembles alkali metals ?
 (A) It shows metallic character like alkali metals.
 (B) It is diatomic like alkali metals.
 (C) Its ionization energy is of the same order as that of alkali metals.
 (D) When hydrogen halides and alkali metal halides are electrolysed, hydrogen and alkali metals are liberated at the cathode.
- Hydrogen has three isotopes, the number of possible diatomic molecules will be :
 (A) 3 (B) 6 (C) 9 (D) 12
- The first ionization energy in KJ mol^{-1} H, Li, F, Na has one of the following values 1681, 520, 1312, 495. Which of these values corresponds to that of hydrogen ?
 (A) 1681 (B) 1312 (C) 520 (D) 495
- Reaction between following pairs will produce hydrogen except :
 (A) $\text{Cu} + \text{HCl}$ (B) $\text{Fe} + \text{H}_2\text{O}(\text{g})$ (C) $\text{Mg} + \text{H}_2\text{O}(\text{hot})$ (D) $\text{Na} + \text{Alcohol}$
- Which of the following statements is most applicable to hydrogen ?
 (A) It can act as a reducing agent only
 (B) It can act as an oxidising agent only
 (C) It can act as both as oxidising and reducing agents
 (D) It can act neither as an oxidising nor as a reducing agent

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13. In all its properties, hydrogen resembles :
(A) alkali metals only. (B) halogens only.
(C) both alkali metals and halogens. (D) neither alkali metals nor halogens.
14. The colour of hydrogen is :
(A) black (B) yellow (C) orange (D) colourless
15. Which one is not an isotope of hydrogen ?
(A) Tritium (B) Deuterium (C) Ortho hydrogen (D) None of these
16. Hydrogen combines with other elements by :
(A) losing an electron (B) gaining an electron
(C) sharing an electron (D) losing, gaining and sharing of an electron
17. Which of the following explanations justifies for not placing hydrogen in either the group of alkali metals or halogens ?
(A) The ionization energy of hydrogen is too high for group of alkali metals and too low for halogen group.
(B) Hydrogen atom does not contain any neutron.
(C) Hydrogen is much lighter than alkali metals or halogens.
(D) Hydrogen can form compounds with almost all other elements.
18. Hydrogen accepts an electron to form inert gas configuration. In this it resembles :
(A) halogen (B) alkali metals (C) chalcogens (D) alkaline earth metals
19. 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 1 : 2 : 3. (D) Their atomic masses are in the ratio 1 : 2 : 3.
20. Deuterium or heavy hydrogen is prepared :
(A) from ordinary hydrogen in a nuclear reactor. (B) from ordinary hydrogen by fractionation.
(C) by electrolysis of acidulated water. (D) by reaction of electropositive elements with ordinary water.
21. The oxidation states exhibited by hydrogen in its various compounds are :
(A) -1 only. (B) Zero only. (C) +1, -1 and zero. (D) +1 only.
22. 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 :
(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 9 : 4
23. Hydrogen acts as an oxidising agent in the reaction with :
(A) bromine (B) calcium (C) nitrogen (D) sulphur
24. The metal which displaces hydrogen from a boiling caustic soda solution is :
(A) Mg (B) Fe (C) As (D) Zn
25. Hydrogen does not combine with :
(A) Sb (B) Na (C) He (D) Bi
26. Which of the following groups represents the saline hydrides ?
(A) NaH, KaH, CaH₂ (B) NaH, SiH₄, CaH₂ (C) NH₃, BH₃, AlH₃ (D) None of these
27. Which of the following is a interstitial hydride ?
(A) TiH_{1.5-1.8} (B) B₂H₆ (C) LiH (D) H₂S
28. In which of the following compounds does hydrogen have an oxidation state of -1 ?
(A) PH₃ (B) NH₃ (C) HCl (D) CaH₂
29. Which of the following metals adsorbs hydrogen ?
(A) Zn (B) Pd (C) Al (D) K

HYDROGEN AND ITS COMPOUNDS

30. Which of the following represents a pair of covalent hydrides ?
 (A) CsH, AlH₃ (B) KH, NaH (C) H₂S, HF (D) VH_{0.56}, NH₃
31. The adsorption of hydrogen by metals is called :
 (A) dehydrogenation (B) hydrogenation (C) occlusion (D) adsorption
32. 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?
 (A) H⁻(aq) + H₂O → H₃O⁻(aq) (B) H⁻(aq) + H₂O(l) → OH⁻(aq) + H₂(g)
 (C) H⁻(aq) + H₂O(l) → No reaction (D) None of these.
33. 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.
34. Temporary hardness of water is due to the presence of :
 (A) MgSO₄ (B) Mg(HCO₃)₂ (C) CaCl₂ (D) CaCO₃
35. Temporary hardness may be removed from water by adding :
 (A) Ca(OH)₂ (B) CaCO₃ (C) CaSO₄ (D) HCl
36. Permanent hardness of water is due to the presence of :
 (A) MgSO₄ (B) CaSO₄ (C) NaHCO₃ (D) Ca(HCO₃)₂
37. A variety of water which contains soluble salts of Ca and Mg is known as :
 (A) heavy water. (B) soft water. (C) hard water. (D) conductivity water.
38. Heavy water (D₂O) freezes at :
 (A) 0°C (B) 3.8°C (C) -3.8°C (D) 38°C
39. Heavy water is used in nuclear reactors as :
 (A) source of α particles. (B) slowing down the speed of high energy neutrons.
 (C) transporting heat of the reactor. (D) heating purposes.
40. Heavy water is :
 (A) H₂¹⁸O (B) water obtained by repeated distillation.
 (C) D₂O (D) water at 4°C.
41. Select the correct statement for heavy water.
 (A) It is less denser than common water. (B) It is an oxide of deuterium.
 (C) It has a heavy or bad taste. (D) It has a heavier isotope of oxygen.
42. Permutit is a technical name given to :
 (A) aluminates of Ca and Na. (B) hydrated silicates of Al and Na.
 (C) silicates of Ca and Na. (D) silicates of Ca and Mg.
43. Which of the following will cause softening of hard water ?
 (A) Passing it through anion exchange resin. (B) Passing it through sand.
 (C) Passing it through cation exchange resin. (D) Passing it through alumina.
44. Heavy water is manufactured by :
 (A) combination of hydrogen and heavier isotope of oxygen.
 (B) electrolysis of water containing heavy hydrogen dissolved in it.
 (C) repeated electrolysis of 3% aqueous solution of NaOH.
 (D) none of the above.

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45. Deionized water is obtained by passing hard water through :
(A) zeolite. (B) cation exchanger.
(C) anion exchanger. (D) both cation and anion exchanger one after the other.
46. Hard water when passed through ion exchange resin containing, RCOOH groups, becomes free from :
(A) Cl^- ions (B) SO_4^{2-} ions (C) H_3O^+ ions (D) Ca^{2+} ions
47. One of the following is an incorrect statement, point it out.
(A) Permanent hardness can be removed by boiling water
(B) Hardness of water effects soap consumption
(C) Temporary hardness is due to bicarbonates of Ca and Mg
(D) Permanent hardness is due to the soluble SO_4^{2-} , Cl^- , NO_3^- of Ca and Mg
48. Water is said to be permanently hard when it contains :
(A) Chloride and sulphates of Mg and Ca. (B) Bicarbonates of Na and K.
(C) Carbonates of Na and K. (D) Phosphate of Na and K.
49. Which of the following is not true ?
(A) Ordinary water is electrolysed more rapidly than D_2O .
(B) D_2O freezes at lower temperature than H_2O .
(C) Reaction between H_2 and Cl_2 is much faster than D_2 and Cl_2 .
(D) Bond dissociation energy for D_2 is greater than H_2 .
50. Water can be tested by :
(A) smell (B) taste
(C) hydrated CuSO_4 (D) anhydrous $\text{CoCl}(\text{blue})$ which changes to pink.
51. An ionic compound is dissolved simultaneously in heavy water and soft water. Its solubility is :
(A) larger in heavy water. (B) same in both.
(C) smaller in heavy water. (D) smaller in simple water.
52. Heavy water is a compound of :
(A) hydrogen and heavier isotope of oxygen.
(B) heavier isotope of hydrogen and heavier isotope of oxygen.
(C) oxygen and heavier isotope of hydrogen.
(D) none of the above.
53. An oxide which gives H_2O_2 on treatment with dilute acid is :
(A) PbO_2 (B) Na_2O_2 (C) MnO_2 (D) TiO_2 .
54. Now a day on industrial scale, H_2O_2 is generally prepared by :
(A) the action of H_2SO_4 on barium oxide. (B) the action of H_2SO_4 on sodium peroxide.
(C) by the electrolysis of H_2SO_4 . (D) by burning hydrogen in an excess of O_2 .
55. When H_2O_2 is oxidised by a suitable oxidant, one of the products is :
(A) O^{2-} (B) HO^{2-} (C) OH^- (D) O_2
56. The dihedral angle in gaseous H_2O_2 is :
(A) 180° (B) 90° (C) 111.5° (D) $109^\circ-28'$
57. In acidic medium, H_2O_2 acts as a reducing agent in its reaction with :
(A) FeSO_4 (B) KMnO_4 (C) K_2MnO_4 (D) $\text{K}_4[\text{Fe}(\text{CN})_6]$
58. In basic medium, H_2O_2 acts as an oxidising agent in its reactions with :
(A) $\text{Cr}_2(\text{SO}_4)_3$ (B) Ag_2O (C) $\text{K}_3[\text{Fe}(\text{CN})_6]$ (D) $\text{K}_2\text{Cr}_2\text{O}_7$

59. The decomposition of H_2O_2 can be checked by the addition of :
 (A) alkali metal oxides (B) benzene (C) acetanilide (D) MnO_2
60. Bleaching action of H_2O_2 is due to its :
 (A) oxidising nature (B) reducing nature (C) acidic nature (D) thermal instability
61. What would happen when a small quantity of H_2O_2 is added to a solution of FeSO_4 ?
 (A) Colour of FeSO_4 disappears. (B) H_2 is evolved.
 (C) An electron is added to Fe^{2+} . (D) An electron is lost by Fe^{2+} .
62. Which of the following compounds turns white on treatment with H_2O_2 ?
 (A) HgS (B) PbS (C) NiS (D) CuS
63. A dilute solution of H_2O_2 is labelled as 20 volume. Its percentage strength is :
 (A) 10% (B) 6.070% (C) 30% (D) 3%
64. The normality of 30 volume H_2O_2 solution is :
 (A) 3.57 (B) 7.53 (C) 5.36 (D) 5.73
65. The reaction $\text{Ag}_2\text{O} + \text{H}_2\text{O}_2 \longrightarrow 2\text{Ag} + \text{H}_2\text{O} + \text{O}_2$ takes place in :
 (A) basic medium. (B) acidic medium.
 (C) neutral medium. (D) both in acidic and basic medium.
66. In which of the following equations, H_2O_2 acts as a reducing agent in the acidic medium ?
 (A) $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \longrightarrow 2\text{H}_2\text{O}$ (B) $\text{H}_2\text{O}_2 + 2\text{OH}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2 + 2\text{e}^-$
 (C) $\text{H}_2\text{O}_2 \longrightarrow 2\text{H}^+ + \text{O}_2 + 2\text{e}^-$ (D) $\text{H}_2\text{O}_2 + \text{OH}^- + 2\text{e}^- \longrightarrow 3\text{OH}^-$
67. Moist hydrogen peroxide can not be dried over conc. H_2SO_4 because :
 (A) it can catch fire. (B) it is reduced by H_2SO_4 .
 (C) it is oxidised by H_2SO_4 . (D) none of these
68. Hydrogen peroxide is used as :
 (A) an oxidant only. (B) a reductant only.
 (C) an acid only. (D) an oxidant, a reductant and an acid.
69. On an industrial scale, H_2O_2 is prepared by auto-oxidation of :
 (A) 2-Ethylanthraquinol. (B) 2-Ethylanthraquinone
 (C) 1-Ethylanthraquinol. (D) 1-Ethylanthraquinone.
70. H_2O_2 is used as :
 (A) antiseptic (B) bleaching agent (C) propellant (D) all

Exercise # 2

Part # I

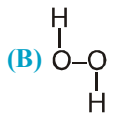
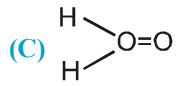
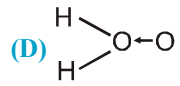
[Multiple Correct Choice Type Questions]

- In which of the following properties hydrogen does not resemble with halogen ?
(A) Atomicity (B) Ionisation energy (C) Reducing nature (D) Electropositive nature.
- Which of the following elements are oxidised when they react with dihydrogen ?
(A) Ca (B) S₈ (C) Li (D) C
- Among the hydrides given below which are reasonably good acids ?
(A) NH₃ (B) HF (C) HN₃ (D) NaH.
- What is true about saline hydrides ?
(A) They are binary compounds of hydrogen and metallic elements.
(B) They are crystalline solids.
(C) They are generally very soft.
(D) Their common examples are, SiH₄, CH₄ etc.
- Which of the following is/are basic hydride ?
(A) HCl (B) NH₃ (C) H₂S (D) PH₃
- Water can act as :
(A) an acid (B) as a base (C) as a reductant (D) as an oxidant
- Which of the following will not liberate dihydrogen ?
(A) Zn + H₂SO₄ (dil.) (B) Zn + NaOH (aq) (C) Cu + H₂SO₄ (conc.) (D) F₂ + H₂O
- Which of the following statements are correct ?
(A) H₂O₂ reduces MnO₄⁻ both in acidic and basic media.
(B) H₂O₂ oxidises Fe²⁺ ions both in acidic and basic media.
(C) H₂O₂ oxidises Mn²⁺ to Mn⁴⁺ ions in basic medium.
(D) H₂O₂ liberates I₂ from acidified KI solution and reduces I₂ to I⁻ ions in basic medium.
- Which is/are true about heavy water?
(A) All physical constant of heavy water are higher than the corresponding values of ordinary water.
(B) rate of chemical reactions are slower than those of ordinary water.
(C) It is obtained as a byproduct in some fertilizer industries.
(D) It is used in exchange reactions for the study of the reaction mechanism.
- Non-stoichiometric hydrides are produced by :
(A) palladium (B) vanadium (C) manganese (D) nickel
- Which of the following statements is/are correct ?
(A) The elements of f-block like Ce, Eu, Yb on heating with H₂ under pressure form hydrides.
(B) Ionic hydrides are formed by transfer of electrons from the metals to the hydrogen atoms.
(C) The density of ionic hydrides is higher than those of the metals from which they are formed.
(D) Covalent hydrides are mainly formed by s-block elements.
- Which of the following is/are characteristic(s) of molecular hydrides ?
(A) They are bad conductor of electricity.
(B) Covalent hydrides are usually volatile compounds having low melting and boiling points.
(C) Covalent hydrides like BH₃, AlH₃ etc act as Lewis acids.
(D) HF forms strong H-bond in liquid as well as in solid state.

HYDROGEN AND ITS COMPOUNDS

13. Which of the following cannot be oxidised by H_2O_2 ?
(A) $\text{KI} + \text{HCl}$ (B) O_3 (C) PbS (D) Na_2SO_3
14. When hydrogen peroxide is treated with a cold acidified $\text{K}_2\text{Cr}_2\text{O}_7$ solution containing ether, a blue colour is obtained. This is due to :
(A) chromium sulphate. (B) potassium chromate.
(C) perchromic acid. (D) chromium trioxide.
15. 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
16. The isotopes of hydrogen which is radioactive is :
(A) tritium (B) deuterium (C) para hydrogen (D) nascent hydrogen
17. Hydrogen will not reduce :
(A) heated cupric oxide. (B) heated ferric oxide.
(C) heated stannic oxide. (D) heated aluminium oxide.
18. Of which group elements form interstitial hydrides with hydrogen ?
(A) 5 (B) 7 (C) 8 (D) 9
19. Which of the following is an electron rich hydride ?
(A) B_2H_6 (B) GeH_4 (C) H_2O (D) SiH_4
20. A sample of H_2O_2 is labelled as 10 volume. Its strength in gram/litre is :
(A) 30.35 (B) 60.7 (C) 15.17 (D) 45.42
21. Hydrogen peroxide cannot be concentrated by simple distillation easily because :
(A) it is highly volatile in nature. (B) it is not miscible with water.
(C) it decomposes at its boiling point. (D) it has a very high boiling point
22. Aqueous solution of hydrogen peroxide is :
(A) alkaline (B) neutral (C) strongly acidic (D) weakly acidic
23. Which of the following is used as a moderator in nuclear reactors ?
(A) Ordinary water. (B) Heavy water. (C) Hard water. (D) Hydrogen peroxide.
24. 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) $\text{Ca}(\text{OH})_2$ (D) $\text{Ca}(\text{HCO}_3)_2$
25. Which of the following statements is correct ?
(A) Hydrogen has same ionization potential as alkali metals.
(B) H^- has same electronegativity as halogens.
(C) H^- has oxidation number of -1 .
(D) H^- will not be liberated at anode.
26. The high density of water as compared to ice is due to :
(A) Hydrogen bonding interactions. (B) Dipole dipole interactions.
(C) Dipole induced dipole interactions. (D) Induced dipole induced dipole interactions.
27. Which of these contains only an electron and a proton?
(A) Tritium (B) Hydrogen (C) Deuterium (D) Helium

CHEMISTRY FOR JEE MAIN & ADVANCED

28. Metal hydride on treatment with water gives :
 (A) H_2O_2 (B) H_2O (C) acid (D) hydrogen
29. Which of the following is the true structure of H_2O_2 :
 (A) $H-O-O-H$ (B)  (C)  (D) 
30. Hydrogen resembles in many of its properties :
 (A) halogen (B) alkali metals (C) both (A) and (B) (D) none of these
31. The structure of H_2O_2 is :
 (A) planar (B) non-planar (C) spherical (D) linear
32. Free hydrogen is found in :
 (A) Water gas (B) Marsh gas (C) Water (D) Acids
33. When a substance A reacts with water, it produces a combustible gas B and a solution of substance C in water. When another substance D reacts with this solution of C, it produces the same gas B on warming but D can produce gas B on reaction with dilute sulphuric acid at room temperature. A imparts a deep golden yellow colour to a smokeless flame of bunsen burner : A, B, C and D respectively are :
 (A) Na, H_2 , NaOH, Zn (B) K, H_2 , KOH, Al
 (C) Ca, H_2 , Ca(OH) $_2$, Sn (D) CaC_2 , C_2H_2 , Ca(OH) $_2$, Fe
34. Which of the following pairs of substances on reaction will not evolve H_2 gas?
 (A) Fe and H_2SO_4 (aqueous). (B) Copper and HCl (aqueous).
 (C) Sodium and ethyl alcohol. (D) Iron and steam.
35. The boiling point of water is exceptionally high because :
 (A) there is covalent bond between H and O.
 (B) water molecules is linear
 (C) water molecules associate due to hydrogen bonding
 (D) water molecules is not linear
36. In which of the following reactions, H_2O_2 acts as a reducing agent
 (A) $PbO_2(s) + H_2O_2(aq) \rightarrow PbO(s) + H_2O(l) + O_2(g)$
 (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) $KNO_2(aq) + H_2O_2(aq) \rightarrow KNO_3(aq) + H_2O(l)$
37. Which of the following hydrides is electron deficient?
 (A) NaH (B) CaH_2 (C) CH_4 (D) B_2H_6
38. Which is distilled first ?
 (A) Liquid CO_2 (B) Liquid N_2 (C) Liquid O_2 (D) Liquid H_2
39. Action of water or dilute mineral acids on metal can give :
 (A) monohydrogen (B) tritium (C) dihydrogen (D) trihydrogen
40. 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

41. H_2O_2 acts as an oxidising agent in :
 (A) neutral medium (B) acidic medium
 (C) alkaline medium (D) acidic and alkaline medium
72. Which of the following acid is formed when SiF_4 reacts with water :
 (A) SiF_4 (B) H_2SiF_4 (C) H_2SO_4 (D) H_2SiF_6
43. Commercial 11.2 volume H_2O_2 solution has a molarity of :
 (A) 1.0 (B) 0.5 (C) 11.2 (D) 1.12
44. 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
45. K_a of H_2O_2 is of the order of :
 (A) 10^{-16} (B) 10^{-14} (C) 10^{-12} (D) 10^{-10}
46. What is false about H_2O_2 ?
 (A) acts as both oxidising and reducing agent. (B) two OH bonds lie in the same plane.
 (C) pale blue liquid. (D) can be oxidised by O_3 .
47. Which of the following is a true peroxide ?
 (A) NO_2 (B) MnO_2 (C) BaO_2 (D) SO_2
48. Water gas is :
 (A) $\text{CO} + \text{N}_2$ (B) $\text{CO} + \text{CO}_2 + \text{CH}_4$ (C) $\text{CO}_2 + \text{H}_2$ (D) $\text{CO} + \text{H}_2$
49. Which of the following has the highest proton affinity ?
 (A) Stibine (SbH_3) (B) Arsine (AsH_3) (C) Phosphine (PH_3) (D) Ammonia (NH_3)
50. The bond angle and dipole moment of water respectively are :
 (A) 109.5° , 1.84 D (B) 107.5° , 1.56 D (C) 104.5° , 1.84 D (D) 1025° , 1.56 D
51. The hardness of water sample containing 0.002 mole of magnesium sulphate dissolved in a litre of water is expressed as
 (A) 20 ppm (B) 200 ppm (C) 2000 ppm (D) 120 ppm
52. When hydrogen peroxide is added to acidified potassium dichromate, a blue colour is produced due to formation of
 (A) CrO_3 (B) Cr_2O_3 (C) CrO_5 (D) CrO_4^{2-}
53. Which of the following is the correct order of increasing enthalpy of vaporisation ?
 (A) $\text{NH}_3 < \text{PH}_3 < \text{AsH}_3$ (B) $\text{ArH}_3 < \text{PH}_3 < \text{NH}_3$ (C) $\text{PH}_3 < \text{AsH}_3 < \text{NH}_3$ (D) $\text{NH}_3 < \text{AsH}_3 < \text{PH}_3$
54. In alkaline medium, H_2O_2 reacts with Fe^{3+} and Mn^{2+} respectively to give :
 (A) Fe^{4+} , and Mn^{4+} (B) Fe^{2+} and Mn^{2+} (C) Fe^{2+} and Mn^{4+} (D) Fe^{4+} and Mn^{2+}
55. Hydrogen gas is not liberated when the following metal is added to dil. HCl :
 (A) Mg (B) Sn (C) Ag (D) Zn

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56. In transforming 0.01 mole of PbS to PbSO_4 , the volume of '10 volume H_2O_2 ' required will be :
(A) 11.2 ml (B) 22.4 ml (C) 33.6 ml (D) 44.8 ml
57. Usually high boiling point of water is result of :
(A) intermolecular hydrogen bonding.
(B) intramolecular hydrogen bonding.
(C) both intra and intermolecular hydrogen bonding.
(D) high specific heat.
58. **S1** : Water is an covalent hydride.
S2 : In the reaction of H_2O_2 and Na_2CO_3 , H_2O_2 acts as acid.
S3 : Auto-oxidation of 2-ethylanthraquinol by air produces hydrogenperoxide.
(A) FFF (B) FTF (C) TTT (D) FTT
59. **S₁** : In acidic medium H_2O_2 reduces KMnO_4 to colourless Mn^{2+} .
S₂ : Oxygen atoms and hydrogen atoms in H_2O_2 are co-planer.
S₃ : D_2O is more polar than H_2O .
(A) TTF (B) FTF (C) TFT (D) FTT
60. **S₁** : Tritium, the isotope of hydrogen is radio-active in nature.
S₂ : Dihydrogen of high degree of purity is prepared by the electrolysis of water containing small amount of acid or base.
S₃ : Water gas shift reaction involves the reduction of H_2O by H_2 .
(A) TTF (B) FTF (C) TFF (D) TTT
61. **S₁** : The electrolysis of molten hydrolith liberates hydrogen gas at cathode.
S₂ : Use of hydrogen peroxide as fuel, it produces pollution free atmosphere because it's combustion product is water.
S₃ : D_2O has higher enthalpy of vaporization than that of H_2O at 373 K.
(A) TTF (B) FTF (C) TFF (D) FTT
62. **S₁** : D_2O is prepared by the prolonged electrolysis of ordinary water.
S₂ : Water which does not produce lather with soap solution easily is called hard water.
S₃ : The Ca^{2+} and Mg^{2+} ions of hard water react with calgon to form corresponding precipitates.
(A) TTF (B) FTF (C) TFF (D) FTT

Part # II

[Assertion & Reason Type Questions]

Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

- (A) Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation for Statement-1
(B) Statement-1 is true, Statement-2 is true and Statement-2 is not correct explanation for Statement-1
(C) Statement-1 is true, Statement-2 is false
(D) Statement-1 is false, Statement-2 is true
(E) Both Statement are false

1. **Statement-1** : H_2 gas is liberated at anode because.
Statement-2 : Sodium hydride contains H^- ion.
2. **Statement-1** : Ionic hydrides like hydrolith liberates hydrogen gas on reaction with water.
Statement-2 : The resultant solution acts as strong base.
3. **Statement-1** : Reaction between protium and chloride is much faster than between deuterium and chlorine.
Statement-2 : Enthalpy of dissociation of D_2 is less than H_2 .
4. **Statement-1** : NH_3 is an electron precise hydride.
Statement-2 : NH_3 has one lone pair of electrons on N atom.
5. **Statement-1** : The water gas shift reaction can be used to increase the amount of H_2 in the 'syn gas' mixture.
Statement-2 : In this reaction water is reduced to H_2 by CO .
6. **Statement-1** : D_2O has higher boiling point than H_2O .
Statement-2 : Viscosity of $\text{H}_2\text{O}(\ell)$ is less than that of $\text{D}_2\text{O}(\ell)$.
7. **Statement-1** : Calgon is used in manufacture of soft water being used for laundry purpose.
Statement-2 : Ca^{2+} and Mg^{2+} ions present in hard water are rendered ineffective by calgon forming their soluble complexes.
8. **Statement-1** : H_2O_2 decomposes carbonates and bicarbonates to evolve CO_2 gas.
Statement-2 : H_2CO_3 is stronger acid than H_2O_2 .
9. **Statement-1** : H_2O_2 is used as a bleaching agent for delicate materials like silk, wool, etc.
Statement-2 : The bleaching action of H_2O_2 is due to reduction.
10. **Statement-1** : The decomposition of H_2O_2 is a disproportionation reaction.
Statement-2 : $2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$
11. **Statement-1** : Heavy water is widely used as a moderator in nuclear reactors.
Statement-2 : It slows down the fast moving neutrons and thus helps in controlling the nuclear reactions.
12. **Statement-1** : Demineralised water does not contain any ions.
Statement-2 : Permutit process for water softening gives demineralised water.

Exercise # 3

Part # I

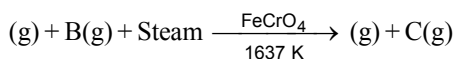
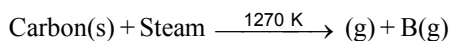
[Matrix Match Type Questions]

1. Match the compounds given in column-I with their characteristics/uses given in column – II
- | | |
|---|---|
| <p>Column – I</p> <p>(A) Heavy water
(B) Hydrolith
(C) Calgon
(D) Zeolites</p> | <p>Column – II</p> <p>(p) Causes sequestration of C^{2+} and Mg^{2+} ions.
(q) Hydrated sodium aluminium silicate
(r) In molten state on electrolysis produces H_2 gas at anode
(s) Used as tracer compound for studying reaction mechanism
(t) Used as moderator in nuclear reactors</p> |
|---|---|
2. Match the processes/reactions listed in column-I with the resultant product(s) listed in column – II
- | | |
|---|---|
| <p>Column – I</p> <p>(A) Prolonged electrolysis of water (H_2O)
(B) Electrolysis of 50% H_2SO_4
(C) Water gas shift reaction
(D) Auto-oxidation of 2-Ethylanthraquinol</p> | <p>Column – II</p> <p>(p) H_2O_2
(q) H_2
(r) CO_2
(s) D_2O
(t) CO</p> |
|---|---|

Part # II

[Comprehension Type Questions]

Comprehension # 1



Gas (B) burns with blue flame.

1. Gas is :
- | | | | |
|-----------|----------|-----------|------------|
| (A) H_2 | (B) CO | (C) O_2 | (D) CO_2 |
|-----------|----------|-----------|------------|
2. Gas B is :
- | | | | |
|----------------------|-------------------|------------------|-----------------|
| (A) Amphoteric oxide | (B) neutral oxide | (C) acidic oxide | (D) basic oxide |
|----------------------|-------------------|------------------|-----------------|
3. Gas C is :
- | | | | |
|-----------|----------|-----------|------------|
| (A) H_2 | (B) CO | (C) N_2 | (D) CO_2 |
|-----------|----------|-----------|------------|

Comprehension # 2

Binary compounds of hydrogen with other elements are called hydrides. These hydrides can be classified into different classes depending upon their nature and type of bonding.

1. Which of the following hydrides are generally non-stoichiometric in nature ?
- | | | | |
|-------------------|------------------------|--------------------------|-----------------------|
| (A) Ionic hydride | (B) Molecular hydrides | (C) Interstitial hydride | (D) Covalent hydrides |
|-------------------|------------------------|--------------------------|-----------------------|
2. Among the hydrides given below which is reasonably electron precise hydride ?
- | | | | |
|------------|-------------|----------|------------|
| (A) NH_3 | (B) SiH_4 | (C) NH | (D) H_2S |
|------------|-------------|----------|------------|
3. Which of the following statements is false ?
- | |
|---|
| (A) Saline hydrides are formed by the transference of electron from the metal atom to hydrogen atom. |
| (B) Along any given row of periodic table, generally the covalent hydrides become increasingly acidic in nature from left to right. |
| (C) Metallic hydrides are good conductors of electricity and also have high thermal conductivity. |
| (D) None of these. |

Exercise # 4

Part # I

[Previous Year Questions] [AIEEE/JEE-MAIN]

- In context with the industrial preparation of hydrogen from water gas ($\text{CO} + \text{H}_2$), which of the following is the correct statement ? [AIEEE 2008]
 - CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali.
 - CO and H_2 are fractionally separated using differences in their densities.
 - CO is removed by absorption in aqueous Cu_2Cl_2 solution.
 - H_2 is removed through occlusion with Pd.

- In which of the following reactions H_2O_2 acts as a reducing agent? [JEE MAIN 2014]
 - $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \longrightarrow 2\text{H}_2\text{O}$
 - $\text{H}_2\text{O}_2 - 2\text{e}^- \longrightarrow \text{O}_2 + 2\text{H}^+$
 - $\text{H}_2\text{O}_2 + 2\text{e}^- \longrightarrow 2\text{OH}^-$
 - $\text{H}_2\text{O}_2 + 2\text{OH}^- - 2\text{e}^- \longrightarrow \text{O}_2 + 2\text{H}_2\text{O}$

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

- The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is : [JEE MAIN 2015]
 - London force
 - hydrogen bond
 - ion-ion interaction
 - ion-dipole interaction

- From the following statements regarding H_2O_2 , choose the incorrect statement? [JEE MAIN 2015]
 - It has to be stored in plastic or wax lined glass bottles in dark
 - It has to be kept away from dust
 - It can act only as an oxidizing agent
 - It decomposes on exposure to light

- Which one of the following statements about water is **FALSE** ? [JEE MAIN 2016]
 - Water can act both as an acid and as a base.
 - There is extensive intramolecular hydrogen bonding in the condensed phase.
 - Ice formed by heavy water sinks in normal water.
 - Water is oxidized to oxygen during photosynthesis.

- The concentration of fluoride, lead, nitrate and iron in a water sample from an underground lake was found to be 1000 ppb, 40 ppb, 100 ppm and 0.2 ppm, respectively. This water is unsuitable for drinking due to high concentration of : [JEE MAIN 2016]
 - Lead
 - Nitrate
 - Iron
 - Fluoride

1. Hydrogen bonding plays a central role in the following phenomena : [IIT-JEE : 2014]
- (A) Ice floats in water
 - (B) Higher Lewis basicity of primary amines than tertiary amines in aqueous solutions.
 - (C) Formic acid is more acidic than acetic acid
 - (D) Dimerisation of acetic acid in benzene
2. Which of the following combination will produce H_2 gas? [IIT-JEE : 2017]
- (A) Cu metal and conc. HNO_3
 - (B) Zn metal and $NaOH(aq)$
 - (C) Au metal and $NaCN(aq)$ in the presence of air
 - (D) Fe metal and conc. HNO_3

MOCK TEST

SECTION - I : STRAIGHT OBJECTIVE TYPE

- Hydrogen is :
 (A) electropositive. (B) electronegative.
 (C) both electropositive as well as electronegative. (D) neither electropositive nor electronegative.
- Reaction between following pairs will produce hydrogen except :
 (A) $\text{Cu} + \text{HCl}$ (B) $\text{Fe} + \text{H}_2\text{O} (\text{g})$ (C) $\text{Mg} + \text{H}_2\text{O} (\text{hot})$ (D) $\text{Na} + \text{Alcohol}$
- The colour of hydrogen is :
 (A) black (B) yellow (C) orange (D) colourless
- Which of the following explanations justifies for not placing hydrogen in either the group of alkali metals or halogens ?
 (A) The ionization energy of hydrogen is too high for group of alkali metals and too low for halogen group.
 (B) Hydrogen atom does not contain any neutron.
 (C) Hydrogen is much lighter than alkali metals or halogens.
 (D) Hydrogen can form compounds with almost all other elements.
- Hydrogen accepts an electron to form inert gas configuration. In this it resembles :
 (A) halogen (B) alkali metals (C) chalcogens (D) alkaline earth metals
- Which of the following is a interstitial hydride ?
 (A) $\text{TiH}_{1.5-1.8}$ (B) B_2H_6 (C) LiH (D) H_2S
- Hydrogen does not combine with :
 (A) Sb (B) Na (C) He (D) Bi
- 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?
 (A) $\text{H}^-(\text{aq}) + \text{H}_2\text{O} \longrightarrow \text{H}_3\text{O}^-(\text{aq})$ (B) $\text{H}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \longrightarrow \text{OH}^-(\text{aq}) + \text{H}_2(\text{g})$
 (C) $\text{H}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \longrightarrow \text{No reaction}$ (D) None of these.
- Which of the following will cause softening of hard water ?
 (A) Passing it through anion exchange resin. (B) Passing it through sand.
 (C) Passing it through cation exchange resin. (D) Passing it through alumina.
- Permutit is a technical name given to :
 (A) aluminates of Ca and Na . (B) hydrated silicates of Al and Na .
 (C) silicates of Ca and Na . (D) silicates of Ca and Mg .
- When H_2O_2 is oxidised by a suitable oxidant, one of the products is :
 (A) O^{2-} (B) HO^{2-} (C) OH^- (D) O_2
- The dihedral angle in gaseous H_2O_2 is :
 (A) 180° (B) 90° (C) 111.5° (D) $109^\circ-28'$
- What would happen when a small quantity of H_2O_2 is added to a solution of FeSO_4 ?
 (A) Colour of FeSO_4 disappears. (B) H_2 is evolved.
 (C) An electron is added to Fe^{2+} . (D) An electron is lost by Fe^{2+} .

CHEMISTRY FOR JEE MAIN & ADVANCED

14. The reaction $\text{Ag}_2\text{O} + \text{H}_2\text{O}_2 \longrightarrow 2\text{Ag} + \text{H}_2\text{O} + \text{O}_2$ takes place in :
(A) basic medium. (B) acidic medium.
(C) neutral medium. (D) both in acidic and basic medium.
15. In which of the following equations, H_2O_2 acts as a reducing agent in the acidic medium ?
(A) $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \longrightarrow 2\text{H}_2\text{O}$ (B) $\text{H}_2\text{O}_2 + 2\text{OH}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2 + 2\text{e}^-$
(C) $\text{H}_2\text{O}_2 \longrightarrow 2\text{H}^+ + \text{O}_2 + 2\text{e}^-$ (D) $\text{H}_2\text{O}_2 + \text{OH}^- + 2\text{e}^- \longrightarrow 3\text{OH}^-$
16. H_2O_2 is used as :
(A) antiseptic (B) bleaching agent (C) propellant (D) all

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

17. Among the hydrides given below which are reasonably good acids ?
(A) NH_3 (B) HF (C) HN_3 (D) NaH.
18. Non-stoichiometric hydrides are produced by :
(A) palladium (B) vanadium (C) manganese (D) nickel
19. Which of the following statements is/are correct ?
(A) The elements of f-block like Ce, Eu, Yb on heating with H_2 under pressure form hydrides.
(B) Ionic hydrides are formed by transfer of electrons from the metals to the hydrogen atoms.
(C) The density of ionic hydrides is higher than those of the metals from which they are formed.
(D) Covalent hydrides are mainly formed by s-block elements.

SECTION - III : ASSERTION AND REASON TYPE

Each question has 5 choices (A), (B), (C), (D) and (E) out of which only one is correct.

- (A) Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation for Statement-1
(B) Statement-1 is true, Statement-2 is true and Statement-2 is not correct explanation for Statement-1
(C) Statement-1 is true, Statement-2 is false
(D) Statement-1 is false, Statement-2 is true
(E) Both Statements are false
20. **Statement-1** : H_2 gas is liberated at anode because.
Statement-2 : Sodium hydride contains H^- ion.
21. **Statement-1** : Ionic hydrides like hydrolith liberates hydrogen gas on reaction with water.
Statement-2 : The resultant solution acts as strong base.
22. **Statement-1** : Calgon is used in manufacture of soft water being used for laundry purpose.
Statement-2 : Ca^{2+} and Mg^{2+} ions present in hard water are rendered ineffective by calgon forming their soluble complexes.

23. **Statement-1** : D_2O has higher boiling point than H_2O .
Statement-2 : Viscosity of $H_2O(\ell)$ is less than that of $D_2O(\ell)$.

SECTION - IV : COMPREHENSION TYPE

Read the following comprehensions carefully and answer the questions.

Comprehension # 1

Binary compounds of hydrogen with other elements are called hydrides. These hydrides can be classified into different classes depending upon their nature and type of bonding.

24. Which of the following hydrides are generally non-stoichiometric in nature ?
(A) Ionic hydride **(B)** Molecular hydrides **(C)** Interstitial hydride **(D)** Covalent hydrides
25. Among the hydrides given below which is reasonably electron precise hydride ?
(A) NH_3 **(B)** SiH_4 **(C)** NaH **(D)** H_2S
26. Which of the following statements is false ?
(A) Saline hydrides are formed by the transference of electron from the metal atom to hydrogen atom.
(B) Along any given row of periodic table, generally the covalent hydrides become increasingly acidic in nature from left to right.
(C) Metallic hydrides are good conductors of electricity and also have high thermal conductivity.
(D) None of these.

SECTION - V : MATRIX - MATCH TYPE

27. Match the processes/reactions listed in column-I with the resultant product(s) listed in column – II

Column – I

- (A)** Prolonged electrolysis of water (H_2O)
(B) Electrolysis of 50% H_2SO_4
(C) Water gas shift reaction
(D) Auto-oxidation of 2-Ethylanthraquinol

Column – II

- (p)** H_2O_2
(q) H_2
(r) CO_2
(s) D_2O
(t) CO

SECTION - VI : SUBJECTIVE TYPE

28. Complete the following chemical equations.
 (i) + $H_2O \longrightarrow CaCO_3 + NH_3$
 (ii) $Al_4C_3 + H_2O \longrightarrow \dots + \dots$
 (iii) + $H_2O_2 + H^+ \longrightarrow CrO_5 + \dots$
29. Give two important uses of interstitial hydrides.
30. Give two advantages of using hydrogen as a fuel as compared to gasoline.

ANSWER KEY

EXERCISE - 1

1. C 2. B 3. B 4. B 5. C 6. B 7. D 8. D 9. B 10. B 11. A 12. C 13. D
 14. D 15. C 16. D 17. A 18. A 19. C 20. B 21. C 22. A 23. B 24. D 25. C 26. A
 27. A 28. D 29. B 30. C 31. C 32. B 33. A 34. B 35. A 36. B 37. C 38. B 39. B
 40. C 41. B 42. B 43. C 44. C 45. D 46. D 47. A 48. A 49. B 50. D 51. C 52. C
 53. B 54. C 55. D 56. C 57. B 58. A 59. C 60. A 61. D 62. B 63. B 64. C 65. A
 66. C 67. C 68. D 69. A 70. D

EXERCISE - 2 : PART # I

1. C,D 2. A,C 3. B,C 4. A,B 5. B,D 6. A,B,C,D 7. C,D 8. A,B,C,D
 9. A,B,C,D 10. A,B,D 11. A,B,C 12. A,B,C,D 13. B 14. C 15. D 16. A 17. D 18. A
 19. C 20. A 21. C 22. D 23. B 24. C 25. C 26. A 27. B 28. D 29. B 30. C 31. B
 32. A 33. A 34. B 35. C 36. A 37. D 38. D 39. C 40. D 41. D 42. B 43. A 44. A
 45. C 46. B 47. C 48. D 49. D 50. C 51. B 52. C 53. C 54. C 55. C 56. D 57. A
 58. C 59. C 60. A 61. D 62. A

PART # I

1. A 2. B 3. C 4. D 5. A 6. B 7. A 8. D 9. C 10. A 11. A 12. D

EXERCISE - 3 : PART # I

1. $A \rightarrow (s, t), B \rightarrow (r), C \rightarrow (p), D \rightarrow (q)$ 2. $A \rightarrow (s), B \rightarrow (p), C \rightarrow (q, r), D \rightarrow (p)$

PART # II

- Comprehension # 1: 1. A 2. B 3. D Comprehension # 2: 1. C 2. B 3. D

EXERCISE - 4 : PART # I

1. 1 2. 2 3. 2 4. 3 5. 2 6. 2

PART # I

1. A,B,D 2. B

MOCK TEST

1. C 2. A 3. D 4. A 5. A 6. A 7. C 8. B 9. C 10. B 11. D 12. C 13. D
 14. A 15. C 16. D 17. B 18. B,C 19. A,B,D 20. A,B,C 21. A 22. B 23. A
 24. B 25. C 26. B 27. D 28. $A \rightarrow (s), B \rightarrow (p), C \rightarrow (q, r), D \rightarrow (p)$