Exercise-1

OBJECTIVE QUESTIONS

Section (A) : Position of hydrogen in the periodic table; methods of preparation and properties

A-1. Hydrogen molecule differs from chlorine molecule in the following respect :
(1) hydrogen molecule is non-polar but chlorine molecule is polar.
(2) hydrogen molecule is polar while chlorine molecule is non-polar.
(3) hydrogen molecule can form intermolecular hydrogen bonds but chlorine molecule does not.
(4) hydrogen molecule cannot participate in co-ordinate bond formation but chlorine molecule can.

A-2. Which one of the following properties shows that hydrogen resembles alkali metals ?
(1) It shows metallic character like alkali metals.
(2) It is diatomic like alkali metals.
(3) Its ionization energy is of the same order as that of alkali metals.
(4) When hydrogen halides and alkali metal halides are electrolysed, hydrogen and alkali metals are liberated at the cathode.

A-3. Hydrogen is :
(1) electropositive.
(2) electronegative.
(3) both electropositive as well as electronegative.
(4) neither electropositive nor electronegative.

A-4. A deuterium atom :
(1) has the same atomic mass as the hydrogen atom.
(2) has the same electronic configuration as the hydrogen atom.
(3) has the same composition of the nucleus as the hydrogen atom.
(4) contains one proton more than a hydrogen atom.

A-5. The first ionization energy for 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 ?
(1) 1681 (2) 1312 (3) 520 (4) 495

A-6. Reaction between following pairs will produce hydrogen except :
(1) Cu + HCl (2) Fe + H_2O (g) (3) Mg + H_2O (hot) (4) Na + Alcohol

A-7. Hydrogen is evolved by the action of cold dil. HNO_3 on :
(1) Fe (2) Mn (3) Cu (4) Al

A-8. Hydrogen from HCl can be prepared by :
(1) Cu (2) P (3) Mg (4) Hg

A-9. Which of the following statements is most applicable to hydrogen ?
(1) It can act as a reducing agent only
(2) It can act as an oxidising agent only
(3) It can act as both as oxidising and reducing agents
(4) It can act neither as an oxidising nor as a reducing agent

A-10. Hydrogen combines with other elements by :
(1) losing an electron (2) gaining an electron
(3) sharing an electron (4) losing, gaining and sharing of an electron

A-11. The colour of hydrogen is :
(1) black (2) yellow (3) orange (4) colourless

A-12. Which of the following explanations justifies for not placing hydrogen in either the group of alkali metals or halogens ?
(1) The ionization energy of hydrogen is too high for group of alkali metals and too low for halogen group.
(2) Hydrogen atom does not contain any neutron.
(3) Hydrogen is much lighter than alkali metals or halogens.
(4) Hydrogen can form compounds with almost all other elements.

A-13. Hydrogen accepts an electron to form inert gas configuration. In this it resembles :
(1) halogen (2) alkali metals (3) chalcogens (4) alkaline earth metals

A-14. In all its properties, hydrogen resembles :
(1) alkali metals only. (2) halogens only.
(3) both alkali metals and halogens. (4) neither alkali metals nor halogens.

A-15. Which of the following statements concerning protium, deuterium and tritium is not true ?
(1) They are isotopes of each other. (2) They have similar electronic configurations.
(3) They exist in the nature in the ratio 1 : 2 : 3. (4) Their atomic masses are in the ratio 1 : 2 : 3.

A-16. Which one is not an isotope of hydrogen ?
(1) Tritium (2) Deuterium (3) Ortho hydrogen (4) None of these

A-17. The oxidation states exhibited by hydrogen in its various compounds are :
(1) –1 only. (2) Zero only. (3) + 1, –1 and zero. (4) + 1 only.

A-18. 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 :
(1) 1 : 1 (2) 1 : 2 (3) 2 : 1 (4) 9 : 4

Section (B) : Hydrides

B-1. Which of the following groups represents the saline hydrides ?
(1) NaH, KaH, CaH_2 (2) NaH, SiH_4, CaH_2 (3) NH_3, BH_3, AlH_3 (4) None of these

B-2. Which of the following is a interstitial hydride ?
(1) $TiH_{1.5-1.8}$ (2) B_2H_6 (3) LiH (4) H_2S

B-3. In which of the following compounds does hydrogen have an oxidation state of – 1 ?
(1) PH_3 (2) NH_3 (3) HCl (4) CaH_2

B-4. Hydrogen acts as an oxidising agent in the reaction with :
(1) bromine (2) calcium (3) nitrogen (4) sulphur

B-5. Hydrogen does not combine with :
(1) Sb (2) Na (3) He (4) Bi

B-6. The metal which displaces hydrogen from a boiling caustic soda solution is :
(1) Mg (2) Fe (3) As (4) Zn

B-7. The adsorption of hydrogen by metals is called :
(1) dehydrogenation (2) hydrogenation (3) occlusion (4) adsorption

B-8. Which of the following represents a pair of covalent hydrides ?
(1) CsH, AlH_3 (2) KH, NaH (3) H_2S, HF (4) $VH_{0.56}$, NH_3

B-9. 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?
(1) $H^-(aq) + H_2O \longrightarrow H_3O^-(aq)$ (2) $H^-(aq) + H_2O(l) \longrightarrow OH^-(aq) + H_2(g)$
(3) $H^-(aq) + H_2O(l) \longrightarrow$ No reaction (4) None of these.

B-10. When electric current is passed through an ionic hydride in the molten state :
(1) hydrogen is liberated at the anode. (2) hydrogen is liberated at the cathode.
(3) no reaction takes place. (4) hydride ion migrates towards cathode.

B-11. Which of the following metals adsorbs hydrogen ?
(1) Zn (2) Pd (3) Al (4) K

Section (C) : Water

C-1. A variety of water which contains soluble salts of Ca and Mg is known as :
(1) heavy water. (2) soft water. (3) hard water. (4) conductivity water.

C-2. Temporary hardness of water is due to the presence of :
(1) $MgSO_4$ (2) $Mg(HCO_3)_2$ (3) $CaCl_2$ (4) $CaCO_3$

C-3. Temporary hardness may be removed from water by adding :
(1) $Ca(OH)_2$ (2) $CaCO_3$ (3) $CaSO_4$ (4) HCl

C-4. Permanent hardness of water is due to the presence of :
(1) $MgSO_4$ (2) $CaSO_4$ (3) $NaHCO_3$ (4) $Ca(HCO_3)_2$

C-5. Which of the following will cause softening of hard water ?
(1) Passing it through anion exchange resin. (2) Passing it through sand.
(3) Passing it through cation exchange resin. (4) Passing it through alumina.

C-6. Select the correct statement for heavy water.
(1) It is less denser than common water. (2) It is an oxide of deuterium.
(3) It has a heavy or bad taste. (4) It has a heavier isotope of oxygen.

C-7. Heavy water is :
(1) $H_2{}^{18}O$ (2) water obtained by repeated distillation.
(3) D_2O (4) water at 4°C.

C-8. Heavy water is used in nuclear reactors as :
(1) source of a particles. (2) slowing down the speed of high energy neutrons.
(3) transporting heat of the reactor. (4) heating purposes.

C-9. Hard water when passed through ion exchange resin containing, RCOOH groups, becomes free from :
(1) Cl^- ions (2) SO_4^{2-} ions (3) H_3O^+ ions (4) Ca^{2+} ions

C-10. One of the following is an incorrect statement, point it out.
(1) Permanent hardness can be removed by boiling water
(2) Hardness of water effects soap consumption
(3) Temporary hardness is due to bicarbonates of Ca and Mg
(4) Permanent hardness is due to the soluble SO_4^{2-}, Cl^-, NO_3^- of Ca and Mg

C-11. Water is said to be permanently hard when it contains :
(1) Chloride and sulphates of Mg and Ca. (2) Bicarbonates of Na and K.
(3) Carbonates of Na and K. (4) Phosphate of Na and K.

Section (D) : Hydrogen Peroxide (H_2O_2)

D-1. An oxide which gives H_2O_2 on treatment with dilute acid is :
(1) PbO_2 (2) Na_2O_2 (3) MnO_2 (4) TiO_2.

D-2. Now a day on industrial scale, H_2O_2 is generally prepared by :
(1) the action of H_2SO_4 on barium oxide. (2) the action of H_2SO_4 on sodium peroxide.
(3) by the electrolysis of H_2SO_4. (4) by burning hydrogen in an excess of O_2.

D-3. When H_2O_2 is oxidised by a suitable oxidant, one of the products is :
(1) O^{2-} (2) HO^{2-} (3) OH^- (4) O_2

D-4. In acidic medium, H_2O_2 acts as a reducing agent in its reaction with :
(1) $FeSO_4$ (2) $KMnO_4$ (3) K_2MnO_4 (4) $K_4[Fe(CN)_6]$

D-5. In basic medium, H_2O_2 acts as an oxidising agent in its reactions with :
(1) $Cr_2(SO_4)_3$ (2) Ag_2O (3) $K_3[Fe(CN)_6]$ (4) $K_2Cr_2O_7$

D-6. Bleaching action of H_2O_2 is due to its :
(1) oxidising nature (2) reducing nature (3) acidic nature (4) thermal instability

D-7. What would happen when a small quantity of H_2O_2 is added to a solution of $FeSO_4$?
(1) Colour of $FeSO_4$ disappears. (2) H_2 is evolved.
(3) An electron is added to Fe^{2+}. (4) An electron is lost by Fe^{2+}.

D-8. Which of the following compounds turns white on treatment with H_2O_2 ?
(1) HgS (2) PbS (3) NiS (4) CuS

D-9. A dilute solution of H_2O_2 is labelled as 20 volume. Its percentage strength is :
(1) 10% (2) 6.070% (3) 30% (4) 3%

D-10. The normality of 30 volume H_2O_2 solution is :
(1) 3.57 (2) 7.53 (3) 5.36 (4) 5.73

D-11. On an industrial scale, H_2O_2 is prepared by auto-oxidation of :
(1) 2-Ethylanthraquinol. (2) 2-Ethylanthraquinone
(3) 1-Ethylanthraquinol. (4) 1-Ethylanthraquinone.

D-12. Hydrogen peroxide is used as :
(1) an oxidant only. (2) a reductant only.
(3) an acid only. (4) an oxidant, a reductant and an acid.

D-13. Moist hydrogen peroxide can not be dried over conc. H_2SO_4 because :
(1) it can catch fire. (2) it is reduced by H_2SO_4.
(3) it is oxidised by H_2SO_4. (4) none of these

D-14. In which of the following equations, H_2O_2 acts as a reducing agent in the acidic medium ?
(1) $H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O$ (2) $H_2O_2 + 2OH^- \longrightarrow 2H_2O + O_2 + 2e^-$
(3) $H_2O_2 \longrightarrow 2H^+ + O_2 + 2e^-$ (4) $H_2O_2 + OH^- + 2e^- \longrightarrow 3OH^-$

D-15. Which of the following cannot be oxidised by H_2O_2 ?
(1) KI + HCl (2) O_3 (3) PbS (4) Na_2SO_3

D-16. When hydrogen peroxide is treated with a cold acidified $K_2Cr_2O_7$ solution containing ether, a blue colour is obtained. This is due to :
(1) chromium sulphate. (2) potassium chromate.
(3) perchromic acid. (4) chromium trioxide.

D-17. H_2O_2 is used as :
(1) antiseptic (2) bleaching agent (3) propellent (4) all

Exercise-2

OBJECTIVE QUESTIONS

1. Which of the following orders are correct ?
(a) $TiH_2 < BeH_2 < CaH_2$ - Electrical conductance. (b) LiH < NaH < CaH - Ionic character.
(c) F-F < H-H < D-D - Bond dissociation enthalpy. (d) $H_2O < MgH_2 < NaH$ - Reducing character.
(1) (a), (b) and (c) (2) (b), (c) and (d) (3) (a), (c) and (d) (4) (a), (b), (c) and (d)

2. Among the following elements, the element forming electron deficient hydride is :
(1) Cs (2) Ca (3) B (4) Mg

3. Which of the following pairs of molecules have practically the same mass ?
(1) H_2O and D_2O (2) H_2O and HTO (3) D_2O and HTO (4) DTO and HDO

4. What is false about ice ?
(1) It has open cage like structure.
(2) It has less density than water.
(3) Each O atom is surrounded by four H atoms.
(4) Each O atom has four H-bonds around it.

5. H_2O_2 is always stored in black bottles because :
(1) it is highly unstable.
(2) it's enthalpy of decomposition is high.
(3) it undergoes autoxidation on prolonged standing.
(4) none of these.

6. The correct increasing order of acidity of CO_2, H_2O and H_2O_2 is :
(1) $CO_2 > H_2O_2 > H_2O$ (2) $H_2O < H_2O_2 < CO_2$
(3) $H_2O < H_2O_2 > CO_2$ (4) $H_2O_2 > CO_2 > H_2O$

7. Which of the following reaction depicts with reducing action of H_2O_2 ?
(1) $C_6H_6 + H_2O_2 \longrightarrow C_6H_5OH + H_2O$
(2) $2I^- + 2H^+ + H_2O_2 \longrightarrow I_2 + 2H_2O$
(3) $2MnO_4^- + 6H^+ + 5H_2O_2 \longrightarrow 2Mn^{2+} + 5O_2 + 8H_2O$
(4) $PbS + 4H_2O_2 \longrightarrow PbSO_4 + 4H_2O$

8. Which one of the following reactions demonstrates that H_2O_2 acts as an oxidising agent in the basic medium :

(1) $Mn^{2+} + H_2O_2 + 2OH^- \longrightarrow MnO_2 + 2H_2O$

(2) $2[Fe(CN)_6]^{3-} + H_2O_2 + 2OH^- \longrightarrow 2[Fe(CN)_6]^{4-} + 2H_2O + O_2$

(3) $Na_2CO_3 + H_2O_2 \longrightarrow Na_2O_2 + H_2O + CO_2$

(4) $MnO_2 + H_2O_2 + 2H^+ \longrightarrow Mn^{2+} + 2H_2O + O_2$

9. Which of the following statements is incorrect for hydrogen peroxide ?

(1) It is stored in plastic bottles in dark.
(2) It acts as an oxidising as well as a reducing agents.
(3) It is used as a bleaching agent.
(4) It has acidic as well as basic properties.

10. 100 cm^3 of a given sample of H_2O_2 is labelled as 20 volume. Its percentage strength is :

(1) 10% (W/V) H_2O_2
(2) 90% (W/V) H_2O_2
(3) 6% (W/V) H_2O_2
(4) 12% (W/V) H_2O_2

Exercise-3

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. Which one of the following processes will produce permanent hard water ? **[AIEEE 2003]**

(1) Addition of Na_2SO_4 to water.
(2) Saturation of water with $CaCO_3$
(3) Saturation of water with $MgCO_3$
(4) Saturation of water with $CaSO_4$

2. The reagent commonly used to determine hardness of water titrimetrically is : **[AIEEE 2003]**

(1) oxalic acid
(2) disodium salt of EDTA
(3) sodium citrate
(4) sodium thiosulphate

3. In context with the industrial preparation of hydrogen from water gas ($CO + H_2$), which of the following is the correct statement ? **[AIEEE 2008]**

(1) CO is oxidised to CO_2 with steam in the presence of a catalyst followed by absorption of CO_2 in alkali.
(2) CO and H_2 are fractionally separated using differences in their densities.
(3) CO is removed by absorption in aqueous Cu_2Cl_2 solution.
(4) H_2 is removed through occlusion with Pd.

JEE(MAIN) ONLINE PROBLEMS

1. The isotopes of hydrogen are : **[JEE(Main) 2019 Online (09-01-19), 4/120]**

(1) Deuterium and tritium only
(2) Protium and deuterium only
(3) Protium, deuterium and tritium
(4) Tritium and Protium only

2. The total number of isotopes of hydrogen and number of radioactive isotopes among, them, respectively, are : **[JEE(Main) 2019 Online (10-01-19), 4/120]**

(1) 3 and 2 (2) 2 and 0 (3) 3 and 1 (4) 2 and 1

3. NaH is an example of : **[JEE(Main) 2019 Online (11-01-19), 4/120]**

(1) Electron-rich hydride (2) Saline hydride

(3) Molecular hydride (4) Metallic hydride

4. The correct statement among (a) to (d) regarding H_2 as a fuel are :

(a) It produces less pollutants that petrol.

(b) A cylinder of compressed dihydrogen weighs ~30 times more than a petrol tank producing the same amount of energy.

(c) Dihydrogen is stored in tanks of metal alloys like $NaNi_5$.

(d) On combustion, values of energy released per gram of liquid dihydrogen and LPG are 50 and 142 kJ, respectively. **[JEE(Main) 2019 Online (11-01-19), 4/120]**

(1) (a) and (c) only (2) (b) and (d) only

(3) (a), (b) and (c) only (4) (b), (c) and (d) only

5. The correct statements among (a) to (d) are : **[JEE(Main) 2019 Online (10-04-19), 4/120]**

(a) saline hydrides produce H_2 gas when reacted with H_2O

(b) reaction of $LiAlH_4$ with BF_3 leads to B_2H_6

(c) PH_3 and CH_4 are electron-rich and electron-precise hydrides respectively

(d) HF and CH_4 are called as molecular hydrides

(1) (a), (c) and (d) only (2) (a), (b), (c) and (d)

(3) (c) and (d) only (4) (a), (b) and (c) only

6. The metal that gives hydrogen gas upon treatment with both acid as well as base is :

[JEE(Main) 2019 Online (12-04-19), 4/120]

(1) zinc (2) mercury (3) iron (4) magnesium

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1. When zeolite, which is hydrated sodium aluminium silicate is treated with hard water, the sodium ions are exchanged with : **[IIT-JEE 1999]**

(A) H^+ ions (B) Ca^{2+} ions (C) SO_4^{2-} ions (D) OH^-

2. Polyphosphates are used as water softening agents because they : **[IIT-JEE : 2002]**

(A) form soluble complexes with anionic species.

(B) precipitate anionic species.

(C) form soluble complexes with cationic species.

(D) precipitate cationic species.

Answers

EXERCISE-1

A-1.	(4)	**A-2.**	(4)	**A-3.**	(3)	**A-4.**	(2)	**A-5.**	(2)	**A-6.**	(1)	**A-7.**	(2)
A-8.	(3)	**A-9.**	(3)	**A-10.**	(4)	**A-11.**	(4)	**A-12.**	(1)	**A-13.**	(1)	**A-14.**	(4)
A-15.	(3)	**A-16.**	(3)	**A-17.**	(3)	**A-18.**	(1)	**B-1.**	(1)	**B-2.**	(1)	**B-3.**	(4)
B-4.	(2)	**B-5.**	(3)	**B-6.**	(4)	**B-7.**	(3)	**B-8.**	(3)	**B-9.**	(2)	**B-10.**	(1)
B-11.	(2)	**C-1.**	(3)	**C-2.**	(2)	**C-3.**	(1)	**C-4.**	(2)	**C-5.**	(3)	**C-6.**	(2)
C-7.	(3)	**C-8.**	(2)	**C-9.**	(4)	**C-10.**	(1)	**C-11.**	(1)	**D-1.**	(2)	**D-2.**	(3)
D-3.	(4)	**D-4.**	(2)	**D-5.**	(1)	**D-6.**	(1)	**D-7.**	(4)	**D-8.**	(2)	**D-9.**	(2)
D-10.	(3)	**D-11.**	(1)	**D-12.**	(4)	**D-13.**	(3)	**D-14.**	(3)	**D-15.**	(2)	**D-16.**	(3)
D-17.	(4)												

EXERCISE-2

1.	(2)	**2.**	(3)	**3.**	(3)	**4.**	(4)	**5.**	(3)	**6.**	(2)	**7.**	(3)
8.	(1)	**9.**	(4)	**10.**	(3)								

EXERCISE-3

PART - I

JEE(MAIN) OFFLINE PROBLEMS

1.	(4)	**2.**	(2)	**3.**	(1)

JEE(MAIN) ONLINE PROBLEMS

1.	(3)	**2.**	(3)	**3.**	(2)	**4.**	(3)	**5.**	(2)	**6.**	(1)

PART - II

1.	(B)	**2.**	(C)