

Chapter 9. Hydrogen

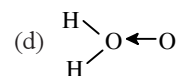
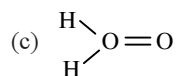
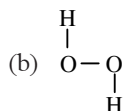
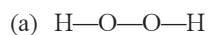
- Which of the following statements about hydrogen is incorrect?
 (a) Hydronium ion, H_3O^+ exists freely in solution.
 (b) Dihydrogen does not act as a reducing agent.
 (c) Hydrogen has three isotopes of which tritium is the most common.
 (d) Hydrogen never acts as cation in ionic salts.
 (NEET-I 2016)
- 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 (ii) (b) (i), (ii) and (iii)
 (c) (ii) and (iii) (d) (i) and (iii)
 (Mains 2010)
- The structure of H_2O_2 is
 (a) spherical (b) non-planar
 (c) planar (d) linear
 (2003)
- Which one of the following pairs of substances on reaction will not evolve H_2 gas?
 (a) Copper and HCl (aqueous)
 (b) Iron and steam
 (c) Iron and H_2SO_4 (aqueous)
 (d) Sodium and ethyl alcohol
 (1998)
- The volume strength of 1.5 N H_2O_2 solution is
 (a) 8.8 (b) 8.4
 (c) 4.8 (d) 5.2
 (1997, 1996)
- The O – O – H bond angle in H_2O_2 is
 (a) 106° (b) $109^\circ 28'$
 (c) 120° (d) 97° (1994)
- 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. (1994)
- One would expect proton to have very large
 (a) charge
 (b) ionization potential
 (c) hydration energy
 (d) radius. (1993)
- 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 molecules shrinks in size
 (d) ice forms mostly heavy water on first melting.
 (1992)
- Hydrogen peroxide molecules are
 (a) monoatomic and form X_2^{2-} ions
 (b) diatomic and form X^- ions
 (c) diatomic and form X_2^- ions
 (d) monoatomic and form X^- ions.
 (1991)
- The ionization of hydrogen atom would give rise to
 (a) hydride ion (b) hydronium ion
 (c) proton (d) hydroxyl ion.
 (1990)

12. Which of the following metal evolves hydrogen on reacting with cold dilute HNO_3 ?

- (a) Mg (b) Al (c) Fe (d) Cu

(1989)

13. Which of the following is the true structure of H_2O_2 ?



(1989)

14. The reaction of H_2O_2 with H_2S is an example of reaction.

- (a) addition (b) oxidation
(c) reduction (d) acidic

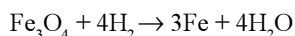
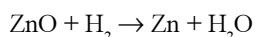
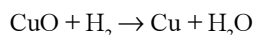
(1988)

Answer Key

1. (b, c) 2. (a) 3. (b) 4. (a) 5. (b) 6. (d) 7. (b) 8. (c) 9. (b) 10. (b)
11. (c) 12. (a) 13. (b) 14. (b)
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EXPLANATIONS

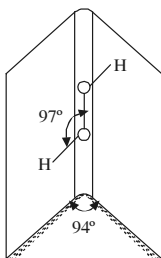
1. **(b, c)** : Dihydrogen acts as a powerful reducing agent and reduces metal oxides such as CuO, ZnO, PbO and Fe₃O₄ to their respective metals.



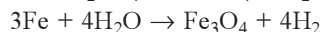
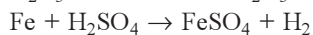
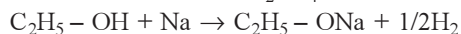
Hydrogen has three isotopes of which protium is the most common and tritium is radioactive.

2. **(a)** : Heavy water is used for slowing down the speed of neutrons in nuclear reactors, hence used as moderator. Boiling point of heavy water is greater (374.42 K) than that of ordinary water (373 K), hence heavy water is more associated. Dielectric constant of ordinary water is greater than that of heavy water, hence ordinary water is a better solvent.

3. **(b)** : In H₂O₂, the O-H groups are not in the same plane. So it has non-planar structure. It has a half-opened book structure in which the two O—H groups lie on the two pages of the book. The angle between two pages of the book is 94° and H—O—O bond angle is 97°.



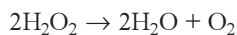
4. **(a)** : Copper is a noble metal, as it lies below hydrogen in the electrochemical series. Therefore it can't displace hydrogen from dilute HCl. While iron and sodium lie above hydrogen in the electrochemical series, so they can liberate H₂ either from steam or H₂SO₄ solution.



5. **(b)** : Normality (N) = 1.5

We know that equivalent weight of H₂O₂ is 17 and strength of H₂O₂ = Normality × Equivalent weight

$$= 1.5 \times 17 = 25.5$$



$$(2 \times 34 = 68 \text{ g}) \quad (22.4 \text{ litre})$$

Since 68 grams of H₂O₂ produces 22.4 litres oxygen at NTP, therefore 25.5 grams of H₂O₂ will produce

$$= \frac{22.4}{68} \times 25.5 = 8.4 \text{ litre of oxygen.}$$

Thus, volume strength of given H₂O₂ solution is 8.4.

6. **(d)** : Bond angle of O—O—H in H₂O₂ is 97°.

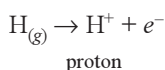
7. **(b)** : Hardness of water, due to the presence of chlorides and sulphates of Ca and Mg is called permanent hardness. Hence, hard water will consist of Mg²⁺ and Cl[−] ions.

8. **(c)** : Proton (H⁺) ion being very small in size would have very large hydration energy.

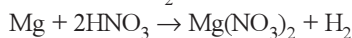
9. **(b)** : When ice melts, its molecules move into the holes or open spaces and comes closer to each other than they were in solid state. Thus, ice has lower density than water and there is contraction in volume.

10. **(b)** : H₂O₂ is diatomic and forms H⁺ + HO₂[−] (X[−]) (hydroperoxide ion).

11. **(c)** : It gives rise to proton.



12. **(a)** : Mg reacts with nitric acid to give Mg(NO₃)₂ and evolves H₂



13. **(b)** : $\begin{array}{c} \text{H} \\ | \\ \text{O}-\text{O} \\ | \\ \text{H} \end{array}$ is the true structure.

14. **(b)** : It is an example of oxidation reaction.

