

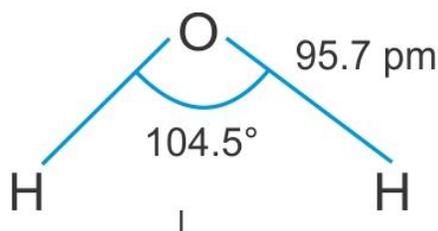
**Class: 11**  
**Subject: Chemistry**  
**Topic: Hydrogen**  
**No. of Questions: 20**

Q1. Discuss the structure of water.

Sol. In the gas phase water is a bent molecule with a bond angle of  $104.5^\circ$ , and O-H bond length of 95.7pm.

It is a highly polar molecule. In the liquid phase water molecules are associated together by hydrogen bonds.

The crystalline form of water is ice. At atmospheric pressure ice crystallizes in the hexagonal form, but at low temperature it condenses to cubic form.

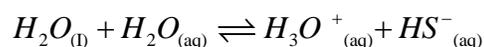
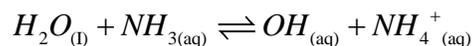


Q2. Write the uses of dihydrogen?

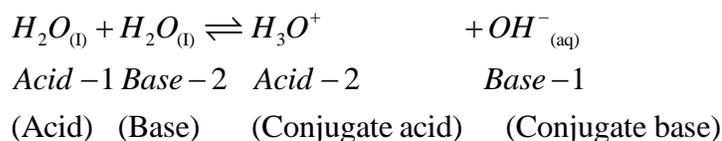
Sol. The largest single use of dihydrogen is in the synthesis of ammonia that is used in the synthesis of nitric acid and in the nitrogenous fertilizers. Dihydrogen is used in the manufacture of vanaspati fat and in the manufacture of bulk organic chemicals like methanol. It is also used in the manufacture of hydrogen chloride and metal hydrides.

Q3. Explain the amphoteric nature of water.

Sol.



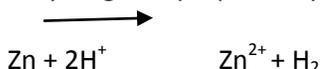
The auto-protolysis (self ionisation) of water takes place as follows:



Water is amphoteric in nature i.e. it can act as an acid as well as a base. in the bronsted sense it acts as an acid with  $NH_3$  and a base with  $H_2S$ .

Q4. Comment on any one laboratory method of preparation of dihydrogen?

Sol. Dihydrogen is prepared by the reaction of granulated zinc with dihydrochloric acid.



Q5. How hydrogen resembles alkali metals and halogens?

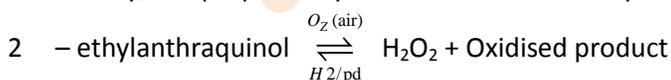
Sol. Hydrogen has an electronic configuration of  $1s^1$ . Its electronic configuration is similar to the outer electronic configuration  $ns^1$  of alkali metals which belong to the first group of the periodic table, and like halogens (with electronic configuration  $ns^2np^5$ ) it is short by one electron to the corresponding noble gas configuration, helium  $1s^2$ .

Q6. Why  $H^+$  ion does not exist freely?

Sol. When hydrogen atom loses an electron it results in nucleus ( $H^+$ ) of  $1.5 \times 10^{-3}$  pm size, which is very small as compared to normal atomic or ionic sizes. As a result  $H^+$  ion does not exist freely.

Q7. Give the industrial method of preparation of hydrogen peroxide.

Sol. Industrially, it is prepared by auto-oxidation of 2-alkylanthraquinols.



Q8. Give an example of coordinated water molecule.

Sol. An example of coordinated water molecule is  $[Cr(H_2O)_6]^{3+} 3Cl^-$

Q9. Why does hydrogen occur in a diatomic form rather than in a monoatomic form under normal conditions?

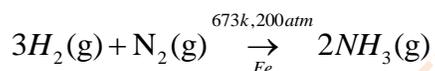
Sol. The ionization enthalpy of hydrogen atom is very high ( $1312 \text{ kJ mol}^{-1}$ ). Hence, it is very hard to remove its only electron. As a result, its tendency to exist in the monoatomic form is rather low. Instead, hydrogen forms a covalent bond with another hydrogen atom and exists as a diatomic ( $\text{H}_2$ ) molecule.

Q10. What are ionic hydrides?

Sol. These are stoichiometric compounds of dihydrogen formed with most of the s-block elements which are highly electropositive in character. The ionic hydrides are crystalline and non-volatile and non-conducting in solid state.

Q11. What happens when dihydrogen reacts with dinitrogen?

Sol. When dihydrogen reacts with dinitrogen it forms ammonia.



Haber's process is used in the manufacture of ammonia.

Q12. How does hydrogen differ from alkali metals?

Sol. Hydrogen differs from alkali metals as it does not possess metallic character.

Q13. Give an example of hydrogen bonded water molecule.

Sol. An example of hydrogen bonded water molecule is  $[\text{Cu}(\text{H}_2\text{O})_4]^{2+} \text{SO}_4^{2-} \cdot \text{H}_2\text{O}$

Q14. Give an example of interstitial water molecule.

Sol. An example of interstitial water molecule is  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ .

Q15. Discuss the consequences of high enthalpy of H-H bond in terms of chemical reactivity of dihydrogen.

Sol. The ionization enthalpy of H-H bond is very high ( $1312 \text{ kJ mol}^{-1}$ ) This indicates that hydrogen has a low tendency to form  $\text{H}^+$  ions. Its ionization enthalpy value is comparable to that of halogens. Hence, it forms diatomic molecules ( $\text{H}_2$ ), hydrides with since ionization enthalpy is very high, hydrogen does not possess metallic characteristics (lustre, ductility, etc.) like metals.

Q16. What is the reaction of dihydrogen with metals?

Sol. With metals it combines at a high temperature to yield the corresponding hydrides.  
 $\text{H}_2 (\text{g}) + 2\text{M} (\text{g}) \rightarrow 2\text{MH} (\text{s})$ , where M is an alkali metal.

Q17. Give four uses of hydrogen peroxide.

Sol. a) In daily life it is used as hair bleach and as a mild disinfectant. As an antiseptic it is sold in the market as perhydrol.

b) It is used to manufacture chemicals like sodium perborate and percarbonate, which are used in high quality detergents.

c) It is used in the synthesis of hydroquinone, tartaric acid and certain food products and pharmaceuticals (cephalosporin) etc.

d) It is employed in the industries as a bleaching agent for textiles, paper pulp, leather, oils, fats, etc.

Q18. How do you expect the metallic hydrides to be useful for hydrogen storage? Explain.

Sol. Metallic hydrides are hydrogen deficient, i.e., do not hold the law of constant composition. It has been established that in the hydrides of Ni, Pd, Ce, and Ac, hydrogen occupies the interstitial position in lattices allowing further absorption of hydrogen on these metals. Metals like Pd, Pt, have the capacity to accommodate a large volume of hydrogen. Therefore, they are used for the storage of hydrogen and serve as a source of energy.

Q19.  $\text{H}_2\text{O}_2$  can be used as:

- a) Bleaching agent
- b) Oxidizing agent
- c) Antiseptic
- d) All the above Solution

Sol. d)  
 $\text{H}_2\text{O}_2$  can be used as bleaching agent, oxidizing agent and as an antiseptic.

Q20. Water has maximum density at:

- a)  $0^\circ\text{C}$
- b)  $1^\circ\text{C}$
- c)  $4^\circ\text{C}$
- d) 4K

Sol. Density of water is maximum at  $4^\circ\text{C}$ .

The increase in temperature results in increase in kinetic energy so increasing volume and hence decreasing density.