

UNIT 9

“HYDROGEN”

Questions with score 1

1. Which among the following is a molecular hydride?
a) LiH b) NH₃ c) CrH d) LaH_{2.87}

Ans: b) NH₃

2. ‘Syn gas’ is a mixture of
- . i) CO and H₂O ii) CO and H₂ iii) CO₂ and H₂ iv) CH₄ and CO

Ans: : a) CO and H₂

3. Give examples of any two electron-rich hydrides.

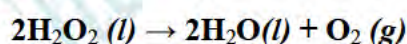
Ans) NH₃, H₂O

4. . Hard water contains calcium and magnesium salts. Therefore it does not lather with soap. Hard water is harmful for boilers. Why?

Ans) Hard water results in scale formation in boilers, which leads to boiler explosion.

5. Hydrogen peroxide is stored in plastic vessels in dark. Why?

Ans) This is because in presence of light, H₂O₂ decomposes slowly and forms water and dioxygen.



6. Suggest a disadvantage of hard water.

Ans) It is not suitable for laundry. Also it reduces the efficiency of boilers.

7. Hard water does not give ready lather with soap. Account for this observation

Ans) Hard water forms scum/precipitate with soap. Soap containing sodium stearate ($C_{17}H_{35}COONa$), it reacts with hard water to precipitate out Ca/Mg stearate. So it will not form lather.

8. The process of producing 'syngas' from coal is called....

Ans) Coal gasification

9) Elements in which one of the following group/groups of the periodic table do not form hydrides?

- i) Groups 15, 16, 17 ii) Group 18 iii) Groups 7, 8, 9 iv) Group 14

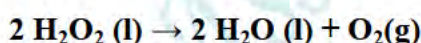
Ans) ii) Group 7, 8, 9

Answer the Questions (2 score each)

10. Give a reason for the following :

- a) H_2O_2 is stored in wax-lined glass or plastic vessels in dark.
b) Hard water is not suitable for laundry.

Ans: a) This is because in presence of light, H_2O_2 decomposes slowly and forms water and dioxygen.



b) Hard water does not readily form lather with soap. So it is not suitable for laundry

11. A sample of river water does not give lather with soap easily when it is cold, but on heating gives ready lather with soap. Why?

Ans. It is due to temporary hardness. Bicarbonate of calcium or magnesium is dissolved in this water. On heating the bicarbonates decomposes and form insoluble carbonates.

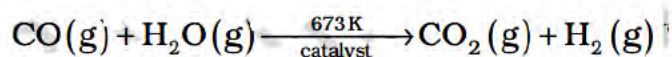
12) Hydrides are binary compounds of hydrogen with other elements. Give one example each for electron deficient and electron rich hydrides.

Ans) Electron deficient hydride: B_2H_6

Electron rich hydride: NH_3

13. What is water-gas shift reaction ?

Ans. The production of dihydrogen can be increased by reacting carbon monoxide of syngas mixtures with steam in the presence of iron chromate as catalyst.



14. Hard water does not give ready lather with soap. What is the reason for hardness?

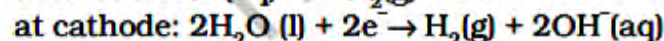
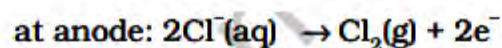
Ans. Presence of calcium and magnesium salts in the form of hydrogencarbonate, chloride and sulphate in water makes water 'hard'

15. How high purity (>99.95%) dihydrogen is prepared?

Ans. High purity (>99.95%) dihydrogen is obtained by electrolysing warm aqueous barium hydroxide solution between nickel electrodes

16. Explain the production of dihydrogen by the electrolysis of brine solution.

Ans) Dihydrogen is obtained as a byproduct during the electrolysis of brine solution. During electrolysis, the reactions that take place are:



The overall reaction is,



Answer the Questions (Each carry 3 score)

17. Briefly explain the different types of hydrides.

Ans: Hydrides are classified into three:

i) Ionic or saline or salt-like hydrides: These are stoichiometric compounds of hydrogen with s-block elements. They are crystalline, non-volatile solids and conduct electricity in the molten state or in aqueous solution state.

e.g. NaH, KH, Ca H₂, Ba H₂ etc.

ii) **Covalent or Molecular Hydrides:** These are the hydrides of p-block elements.

Examples are CH₄, NH₃, H₂O and HF. Being covalent, they are volatile compounds. Molecular hydrides are further classified into three according to the relative numbers of electrons and bonds in their Lewis structure - (i) **electron-deficient**, (ii) **electron-precise** and (iii) **electron-rich hydrides**.

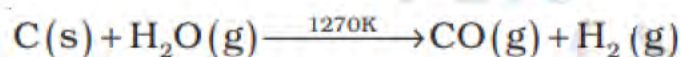
iii) **Metallic or interstitial Hydrides:** These are formed by d-block and f-block elements. However, the metals of group 7, 8 and 9 do not form this hydride. They are almost always nonstoichiometric, being deficient in hydrogen. They conduct heat and electricity. e.g. LaH_{2.87}, YbH_{2.55}, etc

18. About 18% of the total production of dihydrogen is from coal.

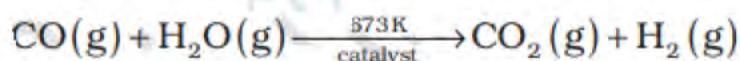
- What is 'coal gasification'?
- How is dihydrogen produced by 'water gas shift reaction'?

Ans:

a) **The process of producing 'syngas' from coal is called 'coal gasification'.**



b) **When steam is passed over syngas mixture in the presence of iron chromate as catalyst, we get more amount of H₂. This is called water-gas shift reaction.**



19. Hydrogen is the most abundant element in the universe. But in free state it is almost not found in earth's atmosphere.

- Suggest any methods for the preparation of H₂ gas by selecting suitable substance given below.
- Do you expect carbon hydrides of the type C_nH_{2n+2} to act as Lewis acid or base? Why?

Ans: a)1. Electrolysis of acidified water using platinum electrodes gives hydrogen

2. High purity (>99.95%) dihydrogen is obtained by electrolysis of warm aqueous barium hydroxide solution between nickel electrodes

b) They cannot act as Lewis acid or Lewis base because they do not contain vacant orbitals or lone pairs of electrons. They are electron precise hydrides.

20. Hydrogen reacts with most of the metals and non metals to form hydrides. Explain the different types of covalent hydrides with suitable examples.

Ans) Covalent hydrides are of three types - electron-deficient, electron-precise and electron-rich hydrides.

An electron-deficient hydride has very few electrons for writing its Lewis structure. E.g. Diborane (B_2H_6). All elements of group 13 will form electron-deficient compounds. They act as Lewis acids (i.e. they accept electron pairs).

Electron-precise hydrides have the required number of electrons to write their Lewis structures. All elements of group 14 form such compounds (e.g., CH_4 , SiH_4 etc.)

Electron-rich hydrides have excess electrons which are present as lone pairs. Elements of group 15 to 17 form such compounds. They behave as Lewis bases (i.e., electron donors)

Answer the Questions (4 score each)

21. The efficiency of a boiler is found to decrease when boiler scales are formed.

a) Which are the possible compounds present in water for scale formation?

(b) Write the chemistry of scale formation.

Ans: a) $Ca(HCO_3)_2$ or $Mg(HCO_3)_2$ (Calcium bicarbonate or Magnesium bicarbonate)

b) On heating the bicarbonates decomposes to form carbonates, which are responsible for scale formation.



22. Explain different methods to prepare Hydrogen commercially.

(i) Electrolysis of acidified water using platinum electrodes gives hydrogen.

(ii) High purity (>99.95%) dihydrogen is obtained by electrolysis of warm aqueous barium hydroxide solution between during the electrolysis of brine solution.

(iii) Reaction of steam on hydrocarbons or coke at high temperatures in the presence of catalyst yields hydrogen