

CHAPTER NO.11

HYDROGEN AND WATER

Q1. Write down the introduction and occurrence of hydrogen.

INTRODUCTION:

1. Hydrogen was discovered by Cavendish in 1766.
2. The name hydrogen to the gas was given by Lavoiser.
3. Hydro means water and genan means producer.
4. Hydrogen is the lightest element known.
5. It exists as diatomic molecular gas (H₂).
6. Its atomic mass is 1 and molecular mass is 2.

OCCURRENCE:

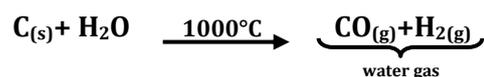
1. Hydrogen is one of the most abundant element in the universe.
2. In the earth crust hydrogen is the ninth (9th) most abundant element.

Q2. Write down the industrial preparation of hydrogen.

INDUSTRIAL PREPARATION OF HYDROGEN:

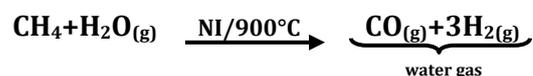
1. By passing steam over coke: (coke steam process)

When steam is passed over red hot coke at about 1000°C a mixture of carbon monoxide and hydrogen (called water gas) is formed.



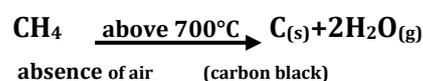
2. From natural gas: (Hydrocarbon steam process)

Hydrogen is also obtained by passing steam over hydrocarbons such as methane gas in the presence of nickel catalyst at temperature about 900°C to produce water gas.



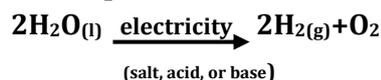
3. By thermal decomposition of methane:

When methane is heated above 700°C in the absence of the air, CH₄ decomposes thermally to produce carbon black and H₂ gas.



4. By the electrolysis of water:

H₂ gas can be produced by the electrolysis of water. When electric current is passed through water in the presence of salt, acid or base H₂ is produced at cathode.



Q3. Write down the uses of carbon black.

USES OF CARBON BLACK:

1. Carbon black is used in rubber industry as a filler for manufacturing motor tyres.
2. It is used in the preparation of inks, paints and polishes.
3. It is also used in the preparation of carbon paper and plastics.

Q4. Write down the physical and chemical properties of hydrogen.

PHYSICAL PROPERTIES OF HYDROGEN:

1. It is a colorless, odorless and tasteless gas.
2. It is insoluble in water.
3. It is highly inflammable gas and burns with blue flame.
4. Its electronegativity is 2.1 while its ionization energy is 13.54 e.v.
5. It liquefies at -252°C and freezes at -259°C.

CHEMICAL PROPERTIES OF HYDROGEN:

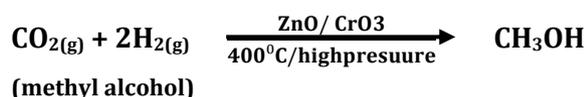
1. As a reducing agent:

Hydrogen shows greater affinity for oxygen and reduces many metal oxides into free metals.



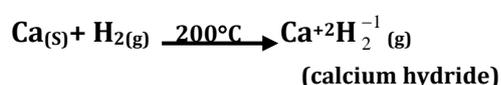
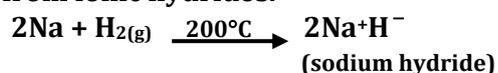
2. Hydrogenation Reaction:

The addition of hydrogen into other molecule or compound is called hydrogenation reaction.



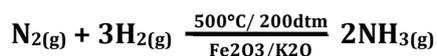
3- Reaction with metals:

Alkali metal like Na, K Li etc and alkaline earth metals like Ca, Ba, Mg react with hydrogen on heating to form ionic hydrides.



4- Reaction with non-metals:

Hydrogen reacts with many metals under different conditions to form addition products.



Q5. Briefly describe the isotopes of hydrogen.

ISOTOPES OF HYDROGEN:

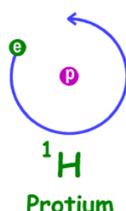
“The word isotope is defined as the atoms of same element having same atomic number but different atomic mass or mass number.”

Nearly all the elements found in nature are mixture of several isotopes. There are three isotopes of hydrogen.

(i) Protium (ii) Deuterium (iii) Tritium

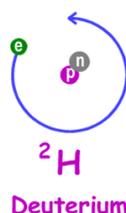
i. Protium or Ordinary hydrogen: (${}^1_1\text{H}$):-

This isotope of hydrogen contains one proton and no neutron in the nucleus and there is one electron present in its first orbit or shell. Its atomic number is 1 and mass number is also 1. About 99.8% of free hydrogen contains protium. It is stable isotope of hydrogen.



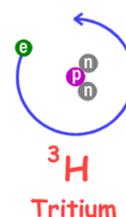
ii. Deuterium: (D or ${}^2_1\text{H}$):-

It is known as heavy hydrogen which is a misnomer. It was discovered in 1931 by Urey. This isotope of hydrogen contains one proton and one neutron in the nucleus and one electron is present in the first orbit or shell. Its atomic number is 1 and mass number is 2. It is also stable isotope of hydrogen.



iii. Tritium: (T or ${}^3_1\text{H}$):-

This isotope of hydrogen contains one proton and two neutrons in the nucleus and one electron is present in the first orbit or shell. Its atomic number is 1 and mass number is 3. It is radioactive isotope of hydrogen.



Q6. What is nascent hydrogen? Show by equations.

NASCENT HYDROGEN:[H] (Newly Born)

Hydrogen at the time of its generation is chemically more reactive than molecular hydrogen because at the time of its generation it is available in atomic form and atomic hydrogen is chemically reactive. This hydrogen is called nascent hydrogen.



Q7. Write down the uses of hydrogen?

USES OF HYDROGEN:

1. It is used in manufacture of fertilizers.
2. It is used in manufacture of tungsten bulb filaments.
3. It is used for the purification of metals.
4. It is used in weather balloons.
5. It is used as a fuel in the form of water gas.
6. It is used in the preparation of some chemical like NH_3 , CH_3OH etc.

Q8. Define the following terms:

1. Anomalous behavior of water.
2. Hydrates.
3. Water of crystallization
4. Natural water
5. Soft water.
6. Hard water.
7. Heavy water
8. Potable water
9. Hygroscopic substance.
10. Heat of hydration.

1. ANOMALOUS BEHAVIOR OF WATER:

“Water does not obey the law of contraction. It expand from 4°C to 0°C and contract form 0°C to 4°C . This unusual behavior of water is known as anomalous behavior of water.”

2. HYDRATES:

“The salt containing water molecule as water of crystallization are generally known as hydrates.”

Example:



3. WATER OF CRYSTALLIZATION:

“The molecules of water are mostly bounded to the crystals of salt. These molecules of water are generally known as water of crystallization.”

4. NATURAL WATER:

“Water which is found in natural state is known as natural water.”

5. SOFT WATER:

“Water containing dissolved impurities in small quantities and easily produces lather with soap is known as soft water.”

6. HARD WATER:

“Water containing dissolved impurities in large quantities and does not produce lather with soap easily is known as hard water.”

7. HEAVY WATER:

“Heavy water is a compound of oxygen with heavy hydrogen (deuterium D or 2_1H) its molecular formula is D_2O and it is called deuterium oxide.”

8. POTABLE WATER:

“The water that is fit for drinking purpose is called potable water.”

9. HYGROSCOPIC SUBSTANCES:

“Some chemical substances absorb moisture from atmosphere. These substances are generally known as hygroscopic substances.”

Example.



10. HEAT OF HYDRATION:

“The minimum amount of heat liberated in the formation of hydrate is known as heat of hydration .”

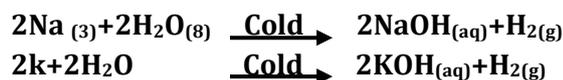
Q9. Write down the chemical properties of water.

CHEMICAL PROPERTIES OF WATER:

1. REACTION OF WATER WITH METALS:

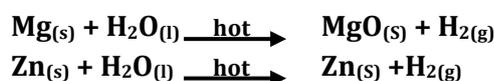
a. With more electropositive metals:

Sodium, potassium, calcium etc reacts with cold water to form their hydroxides with the liberation of H_2 gas.



b. With less electropositive metals:

Less electropositive metals like magnesium, zinc and iron reacts with hot water to liberate H_2 gas with the formation of their oxides.



2- Reaction of water with non – metals:

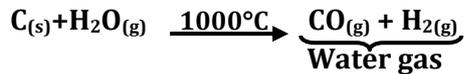
a. With chlorine:

Chlorine reacts with water to produce HCL and hypochlorous acid .



b. With Carbon:

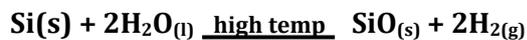
When steam is passed over heated coke at 1000°C a mixture of hydrogen and carbon monoxide , known as water gas is produced.



c. With silicon:

Silicon reacts with steam at very high temperature to form an oxide of silicon i.e.

Silicon dioxide (sand) with the liberation of H₂ gas



3- Action with calcium oxide (Quick Lime)

Calcium oxide partially dissolves in water to form calcium hydroxide (slaked lime)



(quick line)

(slaked lime)

Q10. How many types of hardness in water also define what are the causes of hardness in water?

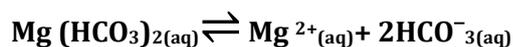
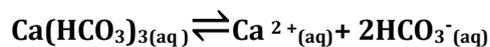
TYPES OF HARDNESS IN WATER:

These are two types of hardness in water.

1. Temporary hardness.
2. Permanent hardness.

1. Temporary hardness:

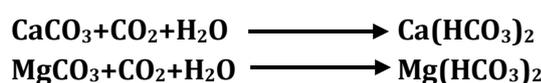
Temporary hardness is due is the presence of dissolved hydrogen carbonates of calcium and magnesium.



2. Permanent hardness:

CAUSES OF HARDNESS IN WATER:

The rain water on its way to the ground dissolves carbon dioxide gas from the atmosphere. this water which flowing through beds of soil or rock containing carbonates of Ca and Mg reacts with dissolved CO₂ in water to change the carbonates of Ca and Mg into their respective hydrogen carbonates which are soluble in water and causes temporary hardness.



Q11. Explain the methods to remove temporary hardness of water.

METHODS TO REMOVE TEMPORARY HARDNESS OF WATER:

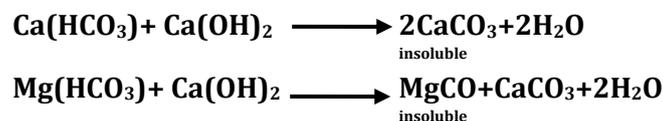
1. By heating:

Temporary hardness can be easily removed by boiling. This hardness is caused by the presence of dissolved calcium hydrogen carbonates and magnesium, hydrogen carbonates, which decomposes on heating to form carbonates of Ca and Mg which are insoluble in water and removed by filtration.



2. Clark's method:

Temporary hardness can also be removed by using slaked lime (Ca(OH)₂). This is a chemical method in which temporary hard water containing hydrogen carbonates of Ca and Mg is treated with Ca(OH)₂ in the tanks. The hydrogen carbonates of Ca and Mg are converted into their insoluble carbonates. These insoluble carbonate. These insoluble carbonates settle down at the bottom of the tanks while soft water is drained off for the use.

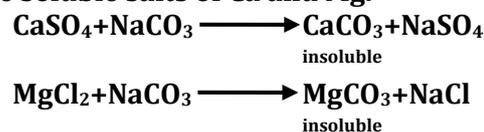


Q12. Explain the methods to remove permanent hardness of water.

METHODS TO REMOVE PERMANENT HARDNESS OF WATER:

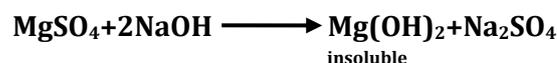
1. By using washing soda: (Na₂CO₃.10H₂O)

When washing soda is added to permanent hard water insoluble CaCO₃ and MgCO₃ are precipitated from the soluble salts of Ca and Mg.



2. By using caustic soda: (NaOH)

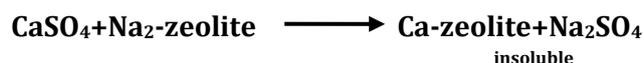
When caustic soda is added to permanent hard water, insoluble hydroxide of Mg²⁺ ion is precipitated from the salt of Mg while Ca(OH)₂ is partially soluble in water.



3. By using zeolite or permutit :

Permanent hardness is can also be removed by using ion exchange method. In this method Mg and Ca ions from water are removed as insoluble precipitates through the sodium zeolite. They form insoluble precipitates of Mg and Ca.

Sodium zeolite is normally occurring sodium aluminosilicate. The sodium will go into the solution while the unwanted Mg and Ca ions precipitate with zeolite.



Sodium zeolite can be regenerated by passing a strong NaCl solution through Ca - zeolite.



Q13. Write physical properties and uses of heavy water.

PHYSICAL PROPERTIES OF HEAVY WATER:

1. Its density is slightly greater than ordinary water.
2. It has low vapour pressure than ordinary water.
3. Its melting point is 3.81°C and boiling point is 101.42°C.
4. Its molecular mass is 20 a.m.u.

USES:

1. It is used as moderator in nuclear fission power reaction by slowing down the reactions.
2. It is also used as a tracer in biological and chemical researches.

Q14. Write down the characteristics of potable water.

CHARACTERISTICS OF POTABLE WATER:

1. It should be colorless, odourless and tasteless.
2. It should be free from germs, bacteria and pathogenic organisms.
3. It should not contain any toxic dissolved impurities.
4. It should have a pH in the change of 7 – 8.5.
5. It should be moderately soft.
6. It should not stain clothes.

Q15. Write down the difference between ordinary water and heavy water.

S.No	ORDINARY WATER	HEAVY WATER
	Formula	
1.	Its formula is H ₂ O	Its formula is D ₂ O
	Density	
2.	Its density is 1.1 gm/cm ³	Its density is 1.104 gm/cm ³
	Melting Point	
3.	Its melting point is 0°C	Its melting point is 3.81°C
	Boiling Point	
4.	Its boiling point is 100°C	Its boiling point is 101.42°C
	Molecular Mass	
5.	Its molecular mass is 18 a.m.u	Its molecular mass is 20 a.m.u

Q16. Write down the names of classification of water pollutants.

CLASSIFICATION OF WATER POLLUTANTS:

There are various types of water pollutants which can be broadly classified into different categories.

1. Oxygen demanding wastes.
2. Synthetic organic compound.
3. Disease causing wastes (micro organism)
4. Agricultural water pollutants.