Chapter = 06

Environmental Chemistry II: Water

Chemical formula H_2O

Properties

It doesn't have Odour, colour, and smell.

Q1. Describe the Occurrence of water.

Occurrence of water

Water makes up around one third of the Earth's surface. Oceans, rivers, glaciers, lakes, wells, and groundwater are the primary sources of water. Water covers around 70% of the Earth's surface, while land covers the remaining 30%. The majority of the water on Earth (about 97%) is salt water, largely found in the seas, with only 3% being fresh water. Fresh water accessible for human needs accounts for less than 1% of the total quantity on the planet. The issue is that fresh water is not distributed equitably across the globe.

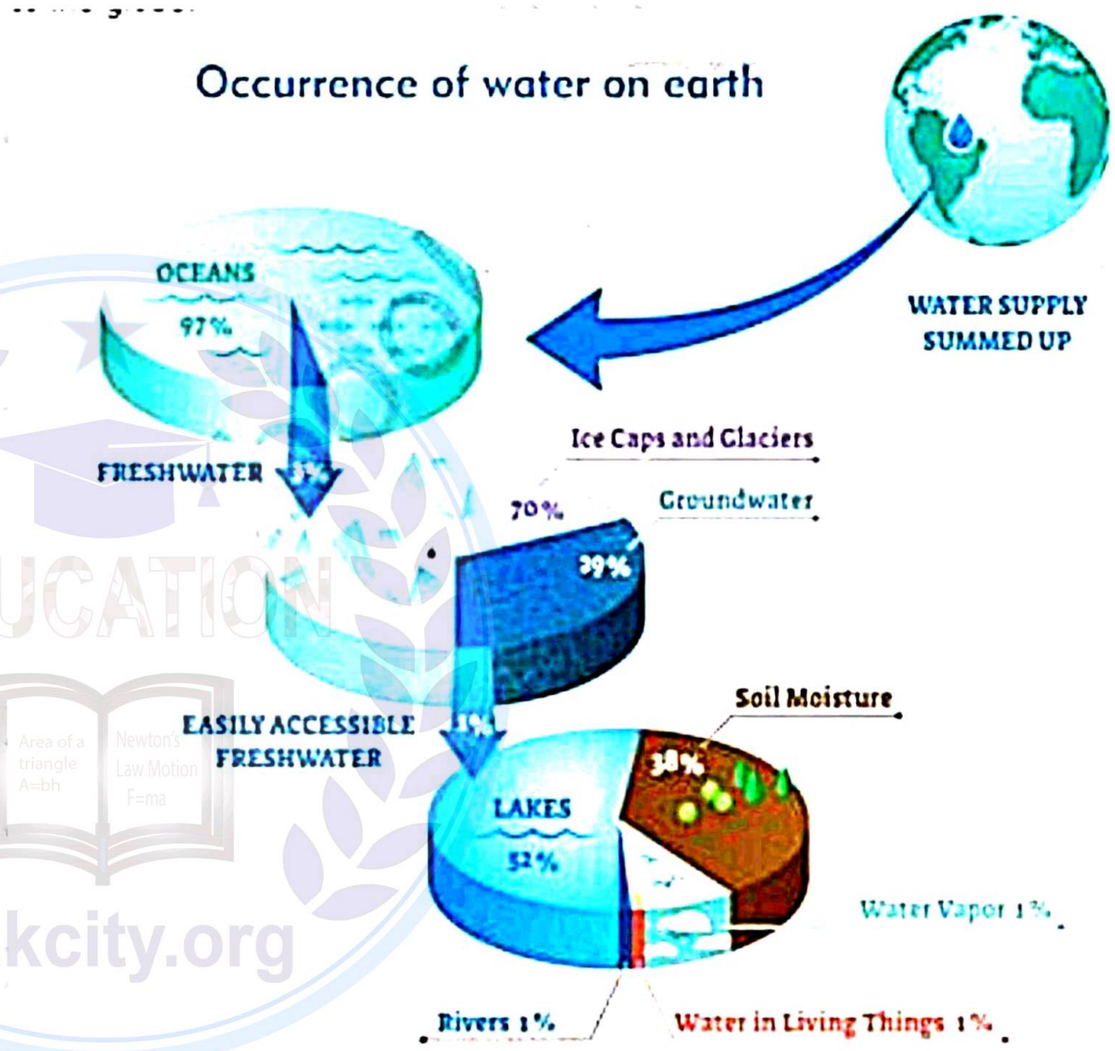

Figure 6.1 Occurrence of water

Q2. List some of the importance of water

Importance of water:

1. Our organs need water to work properly and toxins are removed from our body through urine.
2. Fatigue is also caused by dehydration; therefore, water prevents fatigue.
3. It is necessary for washing and sanitation.

4. It is used in cooking.

5. It is used for growing food (Agriculture).

6. Thermal power plants use water for the production of energy (electricity).

7. In many medical procedures water act as an important component in e.g: In dialysis, water containing fluid is used to remove waste from blood.

8. Fatal diseases are prevented by clean water e.g cholera, typhoid etc.

Q3. **What are the properties of water?**

Properties of water:

Pure water is a transparent, colorless, odorless, and tasteless liquid possessing the attributes listed below:

1. It is litmus-neutral.

2. At sea level, it has a freezing point of 0°C and a boiling point of 100°C.

3. At 4°C, its maximum density is 1 $g.cm^{-3}$.

4. It's a great solvent for both ionic and molecular substances.

5. It has a very high heat capacity of 4.2 $J.Kg^{-1}K^{-1}$,which is almost six times that of rocks.

6. This feature of water is responsible for maintaining the Earth's temperature within responsible bounds. Otherwise, the temperature during the day would have been too hot to handle, and the temperature during the night would have been too cold to freeze everything.

7. It has a lot of surface tension. Water's remarkable capillary strength is due to its one-of-a-kind action. The mechanism by which the water rises from the roots of plants to the leaves is known as capillary action. The survival of terrestrial plants depends on this mechanism.

Q4. What do you know about the Composition of water?

Composition of water:

Water molecule is made up of one atom of oxygen and two atoms of hydrogen connected by covalent bond. Rainwater is considered the purest form of water drinking. Drinking water contains ions necessary for our body i.e. Na^+, Cl^-,K^+,Mg^{2+} etc. Water is a polar molecule due to difference in electronegativity between H and O.

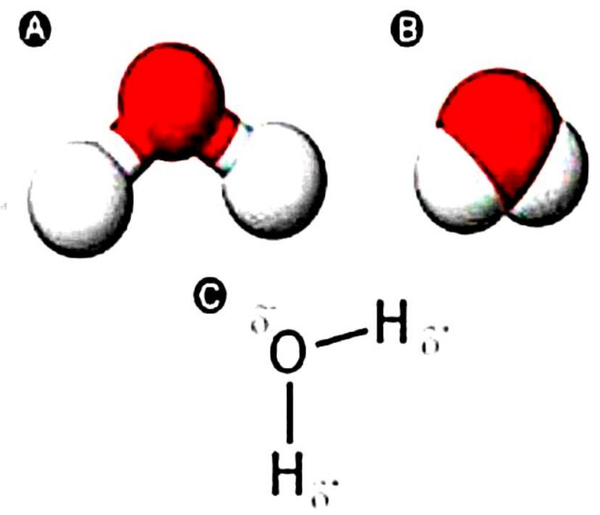

Figure 6.3 Molecular structure of water

Structure of water:

Water is a simple molecule consisting of one oxygen atom bonded to two different hydrogen atoms. Because of the higher electronegativity of the oxygen atom, the bonds are polar covalent (polar bonds). The oxygen atom attracts the shared electrons of the covalent bonds to a significantly greater extent than the hydrogen atoms. As a result, the oxygen atom requires a partial negative charge (δ^-),while the hydrogen atoms each acquire a partial positive charge (δ^+)

Q5. Discus the qualities of water

Water as a solvent:

Water can dissolve practically all minerals; water is known as the universal solvent. Water's capacity to dissolve compounds is due to two distinct qualities of the molecule:

1. Polar nature of water.
2. Extensive hydrogen bonding ability.

Polar nature of water:

The water molecule has a polar structure because of the electronegativity difference between oxygen and hydrogen atoms, which means one end of the molecule is partially positive and the other is partially negative.

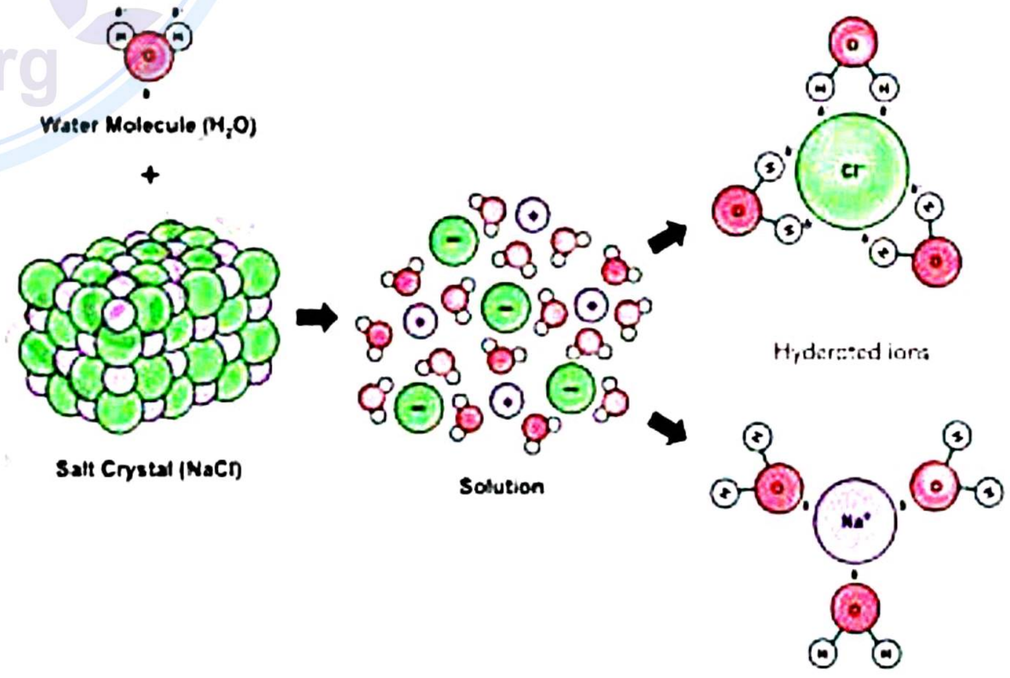

Figure 6.4 Polar structure of water

Water dissolves all other polar compounds because the positive end of the substance is drawn to the water's negative end ($O^{\delta-}$) and the negative end is

attracted to the water's positive end ($H^{\delta+}$). The ion-dipole forces of attraction between ions and water molecules overcome the electrostatic interactions among the ions. The positive and negative ions of the compounds are separated in this manner. These oppositely charged ions are eventually enveloped by water molecules, which keeps them separated in solution.

Most salts, such as NaC, KCl, Na_2SO_4, and others, are soluble in water. Water molecules, on the other hand, are not attracted to numerous covalent compounds that lack polar ends or links, such as benzene, ether, oil and petrol. Non-polar chemicals do not dissolve in water as a result.

Extensive hydrogen bonding ability:

The oxygen and hydrogen atoms make up the water molecule. One H_2O molecule can create hydrogen bonds with maximum 4 additional H_2O molecules stacked tetrahedrally around the H_2O molecule due to two O-H bonds and two lone pairs. By establishing hydrogen bonds with various polar non-ionic molecules containing hydrogen groups (-OH), such as alcohols, organic acids, glucose, sugar, and so on, water is able to dissolve them.

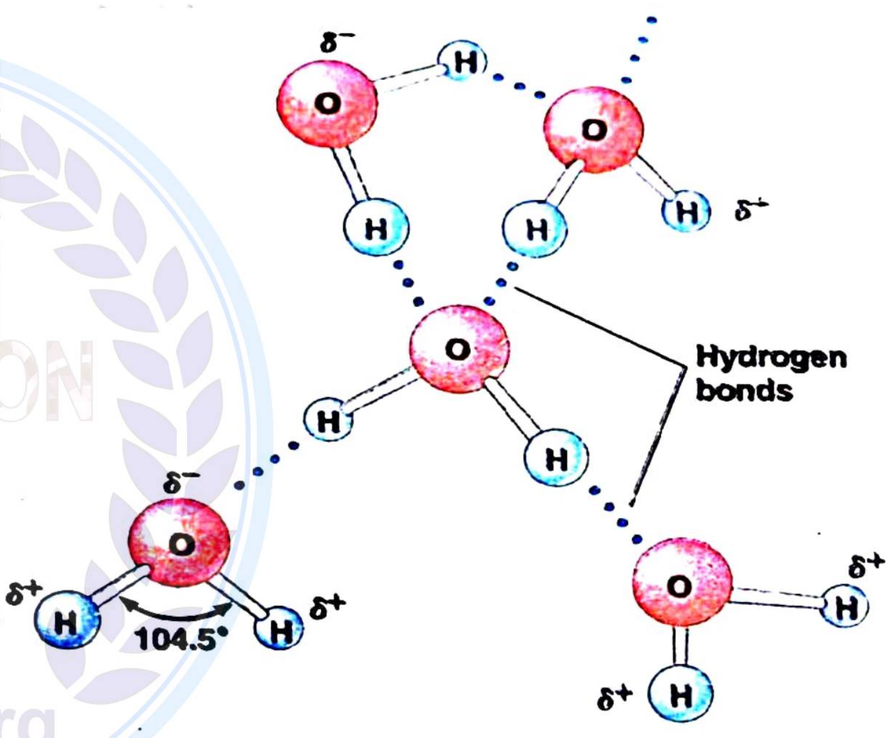

Figure 6.5 Hydrogen bonding

Q6. What is soft water and hard water?

Soft water

Soft water is water that generates an excellent leather when used with soap. It contains dissolved impurities but in small quantity.

Hard water: Hard water is defined as water that does not leather with soap. Hardness in water is caused by a variety of factors.

Q7. Discus the Types of Hardness

Types of Hardness There are two types of hardness in water:

(I)TEMPORARY HARDNESS

Temporary hardness is due to the presence of dissolved hydrogen carbonates of calcium and magnesium. These salts are water soluble and ionize into water

(II) PERMANENT HARDNESS:

Permanent hardness is due to dissolved chlorides and sulphates of Ca and Mg, for example, $MgCl_2$, $MgSO_4$ and $CaCl_2$. They are also soluble in water and ionize in water.

Q8. List the Degree of hardness of water

Degree of hardness of water on the basis of dissolved calcium (Ca^{+2}) ion and (Mg^{+2}) ion	
Soft water	0 – 16.1 mg /liter
Slightly hard water	16.1 – 60 mg /liter
Moderate hard water	61 – 120 mg /liter
Hard water	121 – 180 mg /liter
Very hard water	More than 180 mg /liter

Q9. What are the Methods of removing Hardness?

Methods of removing Hardness

1. **Removal of temporary hardness:**

(a) Boiling water:

A temporary hardness can be readily eliminated by boiling it. When calcium bicarbonate, $(HCO_3)_2$, is heated, it decomposes into insoluble calcium carbonate, which precipitates out of the solution.

$$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O + CO_2$$

(b) Clark's method:

The addition of slaked lime $Ca(OH)_2$ is a chemical approach for removing temporary hardness. Temporary hard water is treated using a determined amount of lime water. As a result of the precipitation of magnesium and calcium ions, water becomes soft.

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_20$$

$$Mg(HCO_3)_2 + Ca(OH)_2 \rightarrow MgCO_3 + CaCO_3 + 2H_20$$

2. Removal of permanent hardness:

Using washing soda: Adding washing soda to the calcium and magnesium ions results in the formation of insoluble calcium and magnesium carbonates.

$$Na_2Co_3 + CaSO_4 \rightarrow CaCO_3 + Na_2SO_4$$

$$Na_2Co_3 + MgSO_4 \rightarrow MgCO_3 + Na_2SO_4$$

Q10. What are the Disadvantages of water hardness?

Disadvantages of water hardness

1. **Leather formation:** When you wash your clothing in hard water, the soap generates a white precipitate instead of leather. The scum is the white precipitate. Without the development of leather, your garments will not be cleansed.

2. **Stains:** Hard water leaves stains on your clothes. They fade the colours of your garments. calcium scum also causes your garments to become rough.

3. **Effects on hair:** If you continue to wash your hair with hard water, you will continue to have awful hair days. Your hair becomes dry and scratchy when you wash it with hard water.

4. **Effects on skin:** Bathing with hard water causes your skin to become dry and irritated. It's because the soap residue left behind adheres to your skin. Eczema-like symptoms are caused by the remaining residue. Children are more likely to have such a problem.

5. **Reduces the life of Appliances**: If you continue to use hard water with your household equipment, the lifespan of the appliances will be dramatically reduced. The appliances steadily deteriorate due to the hard water, and they finally fail.
6. **Corrosion of pipes:** Hard water deposits may corrode pipes as well as obstruct them. As a result, the amount of water that can flow through the pipe is limited. And all that this does is slow down the flow of water. Pipe corrosion can also cause metals to leak into the water, making it unsafe to drink.

Q11. What is Water Pollutants? Also discus them in with fields

Water Pollutants

Pollutants are dumped directly or indirectly into water bodies without proper treatment to eliminate dangerous substances, resulting in water pollution.

Industrial waste: Industrial units are erected to create the needed substances. However, all industrial units, sadly, release their waste (chemicals and solid materials) into the open land or into waterways. The term for this is industrial wastewater. Organic compounds, inorganic salts, heavy metals, mineral acids, oil and greases, and other very poisonous substances may be found in industrial waste.

The effects of industrial waste:

1. They degrade the quality of water.
2. They lower the amount of dissolved oxygen in the water, which has an impact on aquatic life and ecosystems.
3. They can also leak into the groundwater and influence the deposits. They pollute the water reserves. When this water is used by humans, it causes significant illnesses such as cancer and gastroenteritis. Soil, crops, plants and animals are all harmed by this filthy water.
4. Heavy metals such as cadmium, lead, and mercury are harmful to humans and pose a health risk. Acute cadmium poisoning results in elevated blood pressure, renal damage, and red blood cell disintegration.

Household waste:

The usage of detergents for cleaning purposes in homes and businesses is growing by the day. It's because detergents, even in hard water, have a stronger cleaning activity than soap. However, they have a significant disadvantage over soaps in that certain detergents are non-biodegradable. Water contamination occurs when domestic water containing these detergents is dumped into streams, ponds, lakes, and rivers.

The detergent lingers in the water for an extended period of time, rendering it unsuitable for aquatic life. Detergents include phosphate salts, which allow algae to develop quickly in water bodies and float on the surface. It is known as Eutrophication.

A wide range of dissolved and suspended pollutants can be found in domestic sewage. Food and vegetable waste, rubbish, cans, bottles, chemical soaps, washing powder, and other items are among them. It also has disease-causing bacteria in it. All of these things pollute the water.

Agricultural waste: Effects of water pollutants on life: the usage of fertilizers and pesticides causes water contamination on two agriculture waste.

The effects of agriculture waste:

1. Chemicals from fertilizers and pesticides leak into groundwater as a result of rain and intensive crop production, a process known as leaching. Irrigation run-off from agricultural fields is the primary source of excessive nitrate levels in groundwater.

2. Runoff from agricultural land (which has been treated with fertilizers and pesticides) reaches ponds, streams, and rivers. Nitrate NO^- and phosphate (PO^{3-}) salts are present in this water. These compounds cause algae to develop quickly and float on the water's surface. They block the passage of sunshine and oxygen to aquatic life. When algae dies, microorganisms eat oxygen from the water to help the algae decompose. As a result, the water loses oxygen. Due to a lake of oxygen, aquatic creatures experience asphyxia and eventually perish.

Q12. What are the Effects of water pollutants on life?

Effects of water pollutants on life:

Following are the effects of water pollutants.

1. It is helpful to people's health. Chris, typhoid, and diarrhea can all be caused by drinking contaminated water.

2. The use of dirty water is harmful not only to humans, but also to animals and birds.

3. It promotes algae to develop quickly. The death and breakdown of algae results in a lack of oxygen in the water, which impacts aquatic organisms.

4. It harms aquatic life, causing a food chain link to be broken.

5. It degraded the appearance of lakes and rivers.

6. It is not suitable for cleaning or washing.

Q13. What is Water Borne diseases?

Waterborne infectious illnesses are diseases that spread by drinking dirty water or eating food prepared with polluted water. Toxins or bacteria can cause water contamination. Arsenic, mercury, calcium, lead, and a variety of organic substances are examples of toxins. Viruses, bacteria protozoa, and warms are examples of microorganisms.

The major reason of quickly spreading waterborne illnesses is a lack of sufficient sanitary facilities.

Q14. List some common Water Borne diseases.

Following are of the most frequent illnesses:

1. **Diarrheal diseases:** Intestinal illnesses that can lead to serious dehydration, such as cholera. Viruses, bacteria, and parasites all can cause diarrhea.

2. **Dysentery:** Dysentery is a kind of gastrointestinal infection caused by bacteria or parasites. It's characterized by severe diarrhea, which may include blood or mucus.

3. **Cholera:** The bacteria Vibrio cholerae, which may be found in water tainted by human feces, causes cholera. Cholera is a disease that produces severe diarrhea and is potential lethal.

4. **Cryptosporidium:** Cryptosporidiosis is a gastrointestinal ailment caused by a waterborne microbe (protozoa) that causes diarrhea and vomiting. Surface water sources such as reservoirs, lakes, and rivers contain these microscopic germs.

5. **Fluorosis:** Fluorosis is a condition caused by too much fluoride in the body. Fluorosis can harm your bones and teeth.

6. **Hepatitis:** Hepatitis A,B,C,D, and E are the five viruses that often cause liver inflammation. Viruses like hepatitis A and E can be spread through polluted water.

7. **Hook warm:** Hookworm is a parasitic warm that lives in the small intestine and causes disease. Anemia and slowed development in children can occur in severe situations. Hookwarm larvae enter the body via the skin, most commonly through the feet. Hookwarms which are spread by unsanitary settings, infect nearly one billion individuals each year throughout the world.

8. **Jaundice:** An excess of bile pigments in the blood causes jaundice. The liver stops working, and the eyes turn yellow. The patient is weak and tied.

9. **Typhoid:** A severe bacterial illness spreads often through polluted water or food cooked with contaminated water.

Multiple choice Question

1. Which of the following water borne diseases is of viral origin.

(a) Typhoid fever (b) Polio (c) Dysentery (d) Diarrhea

2. How much percentage (%) of the Earth's Surface is covered with water?

(a) 70% (b) 60% (c) 90% (d) 75%

3. Which type of bond is formed between H2O molecules:

(a) Hydrogen bond (b) ionic bond (c) covalent bond (d) all of these

4. The permanent hardness of water is due to presence of:

(a) $MgSO_4$ (b) $Mg(HCO_3)_2$ (c) $Ca(HCO_3)_2$ (d) all of these

5. How much freshwater is present on earth:

(a) 0.3% (b) 3% (c) 0.2% (d) 2%

6. Which salts are excessively dissolved to make temporary hard water:

(a) $CaSO_4$ and $CaCl_2$ (b) KNO_3 and KOH (c) $CaCO_3$ and $Ca(OH)_2$ (d) $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$

7. Water is a:

(a) Polar solvent (b) Non polar solvent (c) Amphipathic solvent (d) Non polar charged solvent

8. The taste of water is:

(a) Sour (b) Bitter (c) Sweet (d) Tasteless

9. Which of the following is helpful for removal of permanent hardness:

(a) Na_2CO_3 (b) $Ca(OH)_2$ (c) $CaCO_3$ (d) Na_2SO_4

1.Diarrhea	2.70%	3.Hydrogen bond	4.$MgSO_4$	5. 3%
6.$Ca(HCO_3)_2$ and $Mg(HCO_3)_2$	7.Polar solvent	8.Tasteless	9.Na_2CO_3	