Water

- **Sources of water:** The common sources of water are ponds, lakes, rivers, wells, and reservoirs.
- **Water cycle:** Water undergoes different processes in the environment and is found in different states during these processes. This cyclic process through which water circulates in the environment is called the **water cycle**.
- **Importance of water**
    - Water is necessary for germination of seeds, transportation of nutrients from soil and food from the leaves to different parts of the plant, in preparation of food through photosynthesis.
    - Aquatic animals and plants get their nutrients as well as oxygen supply from the water. These substances are present in water in dissolved form.
    - Water is used for many other purposes such as in cooking, cleaning, industrial work, running hydroelectric and thermal electric power plants. Sea water is also used as a medium of transportation.

- A solution has two components, namely the solvent and the solute.
- **Solvent** is that part of the solution in which the other component is dissolved. In other words, solvent is that component of a mixture that is present in large amounts.
- **Solute** is that part of the solution that is dissolved in the solution. This is present in a lesser quantity as compared to the solvent. Also, more than one solute can be present in a solution.

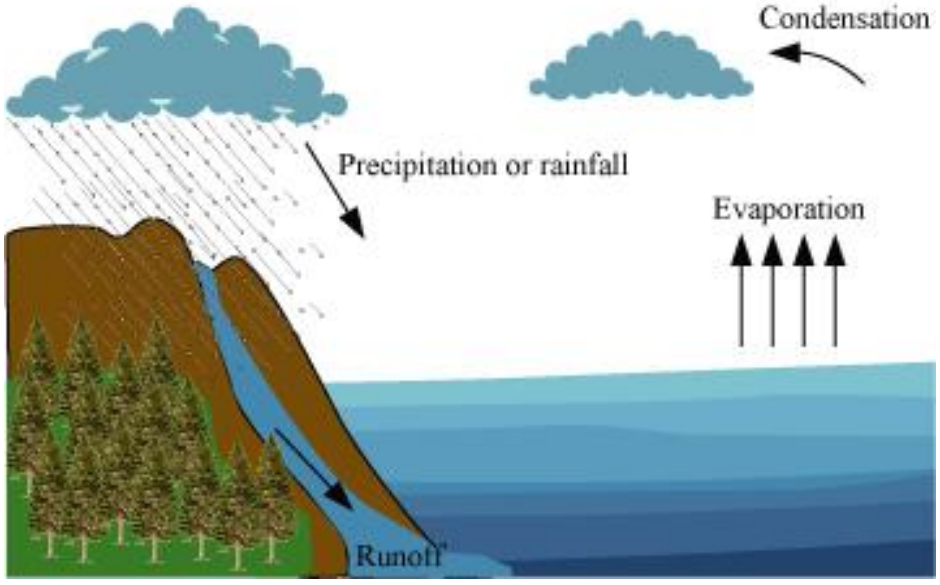
- **Properties of a solution**
    - It is a homogeneous mixture of solutes and solvents
    - The solute particles in a solution are extremely small in size. They are less than 1 nm (10^{-9} m) in diameter.
    - Solute particles are not visible to the naked eye.
    - As a result of the small size of the solute particles, a solution does not scatter light.
    - Solute particles being small in size get dissolved in the solvent. Hence, the solute cannot be separated from the solution by filtration.
    - Solute particles do not settle down when left undisturbed.
    - The addition of harmful substances to water which causes its physical, chemical and biological properties to change is called **water pollution**.

- **Uses of Water**

Water is used for many purposes like drinking, washing clothes and utensils, generating electricity, bathing, irrigation etc.

- Water is essential for life.
- About 71% of the earth's surface is covered with water. It is present as ground water, in seas, oceans, rivers, lakes, ice caps, and in atmosphere.
- Wells, rivers, ground water reservoirs or lakes are sources of fresh water.
- Ocean and sea water is not potable because they contain large amount of dissolved salts.
- Water is a necessity for every form of life. It is used for domestic activities, irrigation, industrial purposes, etc.
- 22nd March is celebrated as World Water day.

- **Water Cycle**: The circulation of water between water bodies, lands and clouds is known as water cycle.



  - The change of water into its vapour is known as **evaporation**.
  - The change of vapour back into water is known as **condensation**.
  - Fall of water from clouds is known as **precipitation** or **rainfall**.

- **Runoff** is the process by which rain water returns back to the water bodies.

- **Clouds** are formed during the process of condensation.
- Rain, snow, hail, etc. replenish rivers, lakes, and wells and recharge the ground water.

1. Water is present in three forms.
2. Solid form − snow and ice
3. Liquid form − oceans, lakes, rivers, and underground water
4. Gaseous form − water vapour in the atmosphere
5. The three forms of water circulate through the water cycle and keep the total amount of water constant on the earth.

- In free state, water occurs in solid, liquid, and gaseous state while in combined state, it is found in proteins, carbohydrates, etc.
- It is colourless, odourless, and tasteless.
- It boils at 100°C and freezes at 0°C.
- Pure water is a poor conductor of electricity. It has high latent heat of vaporisation and fusion and specific heat capacity.
- Water is a universal solvent as it dissolves maximum number of substances.
- It is stable to heat.
- Water has anomalous expansion property, i.e. it expands on cooling below 4 ^{0}C and it has maximum density at 4 ^{0}C

1. Solubility is defined as the dissolution of solute in particular amount of solvent.

2. Concentration is defined as the amount of solute dissolved in particular amount of

solvent. The solution in which greater amount of solute is dissolved is called as concentrated solution and the solution in which amount of solute dissolved is less is called dilute solution.

3. The maximum amount of solute dissolved in particular amount of solvent forms a saturated solution. For example 35.7 g of salt dissolved in 100 mL of water forms a

saturated solution.

4. The solubility of substance in water can be increased on heating the solution.

5. When the temperature of saturated solution is increased, more quantity of solute can be added. If this solution is allowed to cool at room temperature and there is no precipitation of solute, then the resulting solution is called supersaturated solution.

6. Supersaturated solution tends to get disturbed when seed of the crystal is added in it as it is returned back to its saturated state. So when a crystal is added in such solution, then deposition of extra solute on the crystal starts. This process is known as crystallisation.

- **Water of crystallisation :** It refers to a fixed number of water molecules present in one formula unit of salt.
- **Example -** In gypsum, the water of crystallisation is 2.

$$CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O \ (solid)$$

(Gypsum)

- **Hydrated substances:** Substances containing water of crystallisation for example, hydrated copper sulphate ($CuSO_4.5H_2O$).
- **Anhydrous substances:** Substances either not containing water of crystallisation or from which water of crystallisation is removed, for example, sodium chloride (NaCl) and anhydrous copper sulphate ($CuSO_4$).
- **Drying agents:** Substances that absorb moisture without undergoing a chemical reaction, for example, anhydrous calcium chloride ($CaCl_2$).
- **Dehydrating agents:** Substances the remove chemically bonded water from a compound, for example, concentrated sulphuric acid (H_2SO_4).

- **Experiment to Show the Presence of Dissolved Solids in Tap Water**

  Take some tap water in a beaker and heat it. Place a watch glass over the beaker and raise the edge of the watch glass from one side by placing a folded paper. Then pour about 10 mL of tap water into the watch glass. The steam produced from the boiling beaker water starts evaporating the water in the watch glass slowly. As the water evaporates slowly, the dissolved solids deposit and as a result, the concentric rings of the solid materials are formed. The dissolved salts in water are important because they provide taste to water and some of them are also required by our body.

- **Experiment to Show the Presence of Dissolved Gases in Tap Water**

  Take some tap water in a round bottom flask. Fix a cork fitted with a delivery tube in mouth of the flask. The lower end of the delivery tube should be in line with under-surface of the cork. Its other end should be in the beehive shelf, placed in a trough of water. Heat the water in the round bottom flask. Water starts boiling and the gas bubbles start coming out of the beehive shelf. Invert a graduated tube completely filled with tap water over the beehive shelf. The boiled-off air starts collecting in the tube by replacing water.

  Collect the tube filled with boiled off air and introduce a glowing splinter in it. The glowing splinter will burst into flame. It can be concluded that oxygen is dissolved in water. Similarly, gases such as nitrogen, carbon dioxide are dissolved in water. Dissolved oxygen and carbon dioxide in water is important because of the following reasons:

- **Oxygen** is required by animals living in water during their respiration. It helps to keep water purified by killing germs and bacteria.

- **Carbon dioxide** is required by water plants during photosynthesis.

- Dissolved carbon dioxide reacts with limestone to form soluble calcium carbonate, which is used by animals living in water to form hard shells for the protection of their soft bodies.
- Pure water can be obtained by the process known as distillation.
- Water obtained form distillation process is known as distilled water and is free from any salts and minerals.
- Distilled water should not be used in drinking purpose.

(i) Water containing Ca^{2+} and Mg^{2+} ions and their salts is considered to be hard water.

(ii) Water free from Ca^{2+} and Mg^{2+} ions is called soft water.

(iii) Soft water forms lather with soap, while hard water forms insoluble scum with soap.

1.Types of hardness

(i) Hardness due to the presence of bicarbonate salts of calcium and magnesium is known as temporary hardness.

(ii) Hardness due to the presence of chloride and sulphate salts of calcium and magnesium is known as permanent hardness.

(iii) Temporary hardness can be removed by simple methods like boiling, while permanent hardness is removed by special methods.

2. Disadvantages of using hard water

(i) Causes dryness and leaves whitish residue on skin

(ii) Leaves yellow stain on clothes if used for washing clothes

(iii) Causes scales on inner walls of containers used for boiling and cooking food

3. Advantages of using hard water

(i) Enhances the taste of beverages and wines

(ii) Helps in strengthening of bones and teeth

(iii) Checks lead poisoning of water in lead water pipelines

4. Removal of hardness of water

(i) Temporary hardness can be removed by simple boiling or with Clark's method using $Ca(OH)_2$.

(ii) Permanent hardness can be removed by distillation, soda process and permutit method.

(a) Permutit is a sodium aluminium silicate, also known as zeolite.

(b) The principle of the permutit method is exchange of basic ions, Ca^{2+} and Mg^{2+}, with Na^{+} ion of the permutit.

Removal of hardness of water

(i) Boiling of hard water converts soluble bicarbonate into insoluble carbonate, which can be removed by simple filtration.

(ii) Certain metal ions like lead, iron and manganese cannot be removed by permutit method.

(iii) Water obtained from permutit method is soft water and not pure water.

(iv) Water that is free from any ions is known as distilled water.

- The addition of harmful substances to water, as a result of which its physical, chemical, and biological properties get altered, is called **water pollution.**

- **Types of water pollutants**
- **Domestic sewage**
    - It is composed of food wastes, detergents, and disease-causing pathogens.
    - The bacteria present in faecal matter of mammals indicate the pollution levels in a river and if such water is consumed, it may cause various diseases.
- **Industrial waste**
    - It is rich in toxic chemicals such as arsenic, fluorides, and lead.
    - It causes toxicity in plants and animals.
    - It affects the soil by causing changes in its acidity and growth of worms.
- **Agricultural waste**
    - It is rich in agricultural pesticides and weedicides.
    - It causes ground water pollution.
    - It causes an increase in the population of algae in water.
    - When these algae die, they are acted upon by decomposers, which use lots of oxygen dissolved in water leading to depletion of dissolved oxygen.
    - This results in the death of fish and other aquatic organisms.

- **Release of Superheated Water**
    - The release of superheated water from some industries and nuclear power plants causes thermal pollution of the water bodies.
    - The abrupt change in the temperature of water body can kill the fish and other organisms adapted to particular temperature range.

Methods of preventing water pollution

- Industrial waste must be chemically treated to remove harmful substances before dumping into the water bodies.
- Disposal of human and animal excreta into water should be avoided.
- Sewage water must be treated before releasing into the rivers.

- **Water resources**
  - Basic need of life
  - Most of the Indian agriculture is dependent on monsoons
  - Local people have adopted traditional methods to conserve water

- **Traditional water-harvesting systems**
  - Khadins and nadis in Rajasthan
  - Bandharas and tals in Maharashtra
  - Bundhis in Madhya Pradesh and Uttar Pradesh
  - Ahars and Pynes in Bihar
  - Kulhs in Himachal Pradesh
  - Ponds in Jammu
  - Eris in Tamil Nadu
  - Surangamo in Kerala
  - Kattas in Karnataka

- Traditional water-harvesting structures use crescent-shaped earthen embankments or low-strait check dams, built across seasonal flooded gullies, for storing monsoon water and allowing it to seep into the ground.

- After the arrival of Britishers, large dams and canal system were introduced for irrigation purposes.

- Although canal system has benefits, it causes inequitable distribution of resources.

- Major river-valley projects like Sardar Sarover Dam on Narmada has resulted in social crises due to relocation of large number of people and has also resulted in environmental degradation.