

The chemical reactions and their impact on water quality

properties of water

Chemically

water dissolves many chemical compounds as it is a good polar solvent

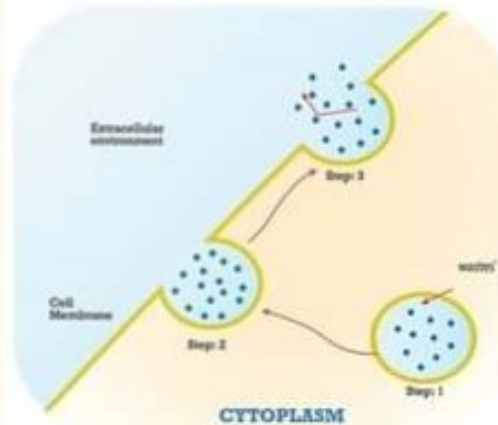
Physically

water exists in three states solid , liquid & gas within the temperature range known on earth



Biologically

- ◆ water is necessary to sustain life
- ◆ all living organisms are surrounded by membranes to separate their content from the outer environment
- ◆ the water passes from the environment to inside through this membrane as :
 - it carry the needed materials to produce energy
 - it can get rid of wastes to outside



the water exists in various spheres:

Atmosphere

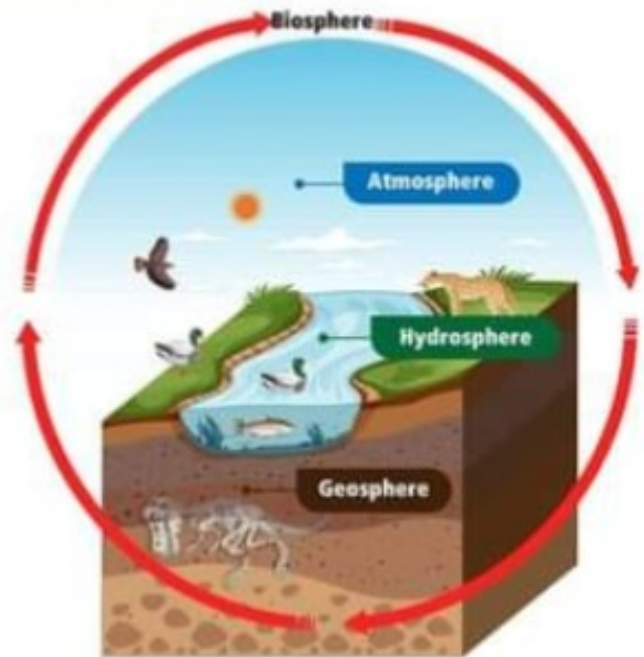
as water vapour is from the components of atmosphere in gaseous state

Geosphere

as water exists in solid state in the cryosphere, which refers to the frozen water in the polar regions, icebergs , and glaciers

Hydrosphere

Water covers about 70% of the Earth's surface. About 97% of this liquid water is found in oceans, seas, and salt lakes as salt water. The remaining part is fresh water found in rivers, freshwater lakes, and groundwater.



water cycle

◆ Water is constantly moving from one place to another through many different paths that form a nearly closed system called the water cycle in nature or the hydrological cycle

◆ the water cycle as a system is capable of Changing the Earth's surface physically, chemically and biologically.





Aquatic Ecosystem

water cycle's processes

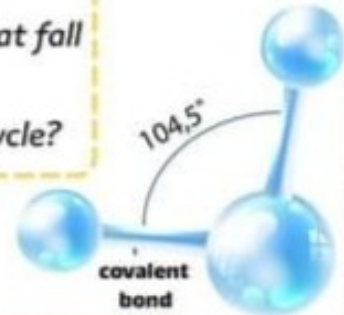
- 1 Evaporation :** water evaporates from water bodies , the biological processes such as transpiration in plants and respiration in plants and animals contribute in this process too
- 2 condensation :** water condenses to form clouds
- 3 precipitation :** rain or snow falls again to form water bodies
- 4 collection :** water seepage through the pores of soil and sedimentary rocks to form groundwater.

Note

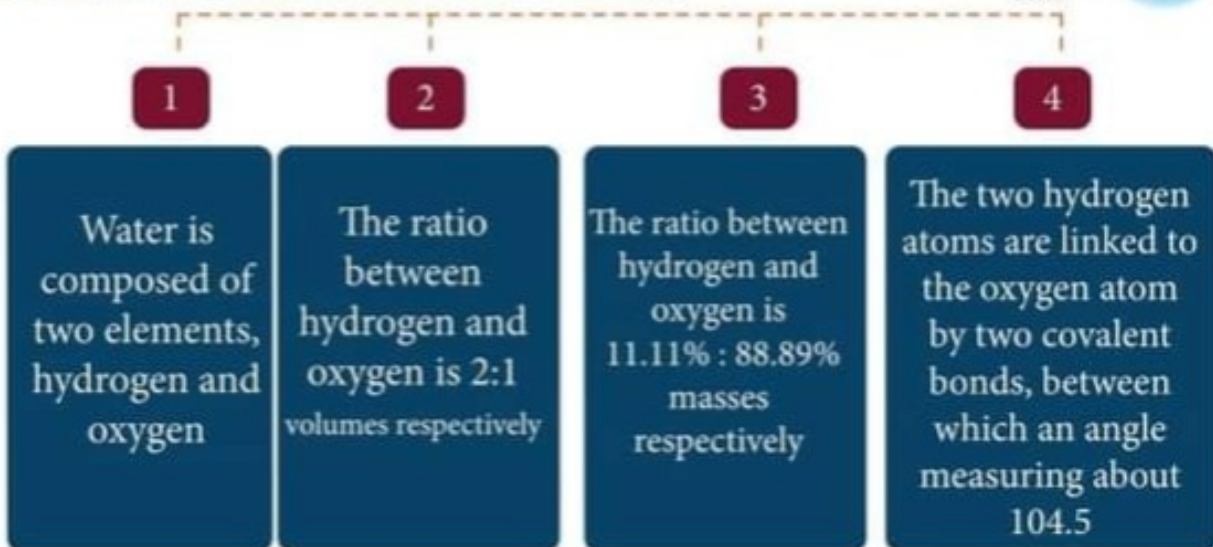
Water vapor in clouds may react chemically with compounds in the air, forming acids that fall as acid rain, which dissolves rocks

Research

- 1- What are the different tools and measurements that meteorologists use to measure the annual rainfall amounts that fall on a specific area of the Earth's surface?
- 2- Can scientists predict future changes in the Earth's water cycle?



Chemical composition of water



Chemical properties of water

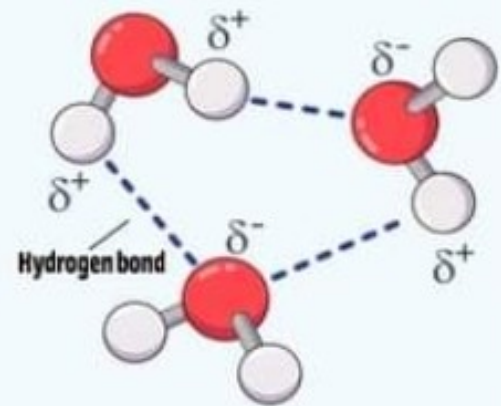
Water does not exist on the Earth's surface in a pure form, as it contains many ions and Chemical materials that interact with it in different ways.

◆ We will review Three of the main properties of water are:

water polarity

◆ The oxygen atom is characterized by its higher electronegativity than the hydrogen atom, so the bond electrons are attracted towards the oxygen atom, forming a partial negative charge on the oxygen atom and a partial positive charge on the hydrogen atom, which is known as the polarity of the water molecule.

◆ The polarity of water molecules results in their connection with other water molecules in what are called hydrogen bonds or polar molecules of other materials,



which gives water the ability to dissolve many salts and break them down into dissociated ions

Example

Sodium chloride solubility in water:

Also, the ability of water molecules to form hydrogen bonds between them is a major reason for the high boiling point of pure water :

as it reaches 100°C under normal atmospheric pressure Compared to the Boiling point of compounds similar to it in composition, such as hydrogen sulfide, which reaches at 61°C





Aquatic Ecosystem

water hydrolysis

- ◆ water is weakly ionized so a small percentage of water molecules are in the form of hydrogen ions (H) and hydroxide ions (OH)
- ◆ as a result of chemical reactions with various compounds, some salts present in natural water are ionized, which affects the balance of these ions, causing the *acidity* or *basicity* of the water.

paractical example

Hydrolysis of :

NaCl

When table salt (NaCl) is added to water, it ionizes into sodium ions (Na⁺) and chloride ions (Cl⁻), and the salt ions remain in the solution without binding to the water ions (H⁺ - OH⁻) making the solution **neutral**

Bec. the concentration of hydrogen ions (H⁺) equals the concentration of hydroxide ions (OH⁻).

for illustration only : $\text{NaCl} + \text{HOH} \rightarrow \text{H}^+ + \text{Cl}^- + \text{Na}^+ + \text{OH}^-$

NaHCO₃

when sodium bicarbonate is added to water, it ionizes into ion making the salt solution **basic**

bec. the concentration of hydrogen ions (H⁺) decreases and the concentration of hydroxide ions (OH⁻) increases

for illustration only : $\text{NaHCO}_3 + \text{HOH} \rightarrow \text{Na}^+ + \text{H}_2\text{CO}_3 + \text{OH}^-$

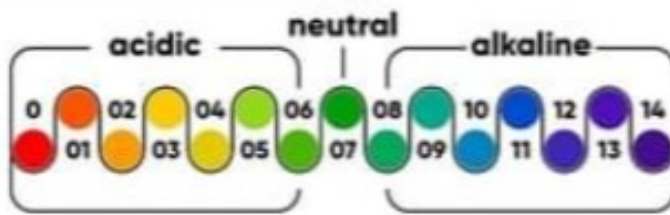
NH₄Cl

when ammonium chloride is added to water, it ionizes into ion making the salt solution **acidic**

bec. the concentration of hydrogen ions (H⁺) increases and the concentration of hydroxide ions (OH⁻) decreases

for illustration only : $\text{NH}_4\text{Cl} + \text{HOH} \rightarrow \text{H}^+ + \text{Cl}^- + \text{NH}_4\text{OH}$

acid - base balance



PH

is a measure of the acidity or basicity of water

- ◆ Acid-base balance in water depends on, the relationship between the concentration of hydrogen ions (H) and hydroxide ions (OH). which is called the pH of the solution.
- ◆ It is a graduated scale that takes values from 0 to 14. as following :

acidic

Neutral

basic

if the concentration of H⁺ increases

$$PH < 7$$

if the concentration of the two ions is equal

$$PH = 7$$

if the concentration of OH⁻ increases

$$PH > 7$$

types of water	pH	acid or base
Sea water	7,5 : 8,4	basic according to to the area & the environmental condition
Fresh water	6,5 : 8,5	Acidic or neutral
Distilled water	7	Neutral as it devoid from impurities or ion
underground water	variable	Neutral or basic as it dissolves calcium carbonate or magnesium carbonate rocks
clouds	4,5 : 5	acidic in general due to the presence of CO ₂ and other acidic gas dissolved in water

Note

These values vary depending on different environmental conditions , human activities in that area which can affect the pH value when clouds or rainwater are formed.



Aquatic Ecosystem

Example

Acid

Base

strong

Hydrochloric acid HCl
 Perchloric acid HClO₄
 Sulphuric acid H₂SO₄
 Hydroiodic acid HI
 Hydrobromic acid HBr
 Nitric acid HNO₃

Sodium hydroxide NaOH
 Potassium hydroxide KOH
 Barium hydroxide Ba(OH)₂
 calcium hydroxide Ca(OH)₂

weak

Carbonic acid H₂CO₃
 Phosphoric acid H₃PO₄
 Acetic acid CH₃COOH

Ammonium hydroxide NH₄OH
 Aluminum hydroxide Al(OH)₃
 Magnesium hydroxide Mg(OH)₂

Scientific activity

Measuring pH value in Different Water Samples

Required Materials

- Water samples (sea water, river water, and spring water)
- pH meter or pH test strips
- cups
- Distilled water
- Glass rod



pH meter

chart

Experiment procedures

- Titration** : titrate the pH meter using distilled water.
- sample preparation** : Number the cups and place a small amount of different type in each cup.
- Test**: Immerse the electrode of the pH meter into each sample and record the reading once it has stabilized.
- Measuring** : dip the strip into each sample for a few seconds and compare its color with the chart