IS MATTER AROUND US PURE

9th Class

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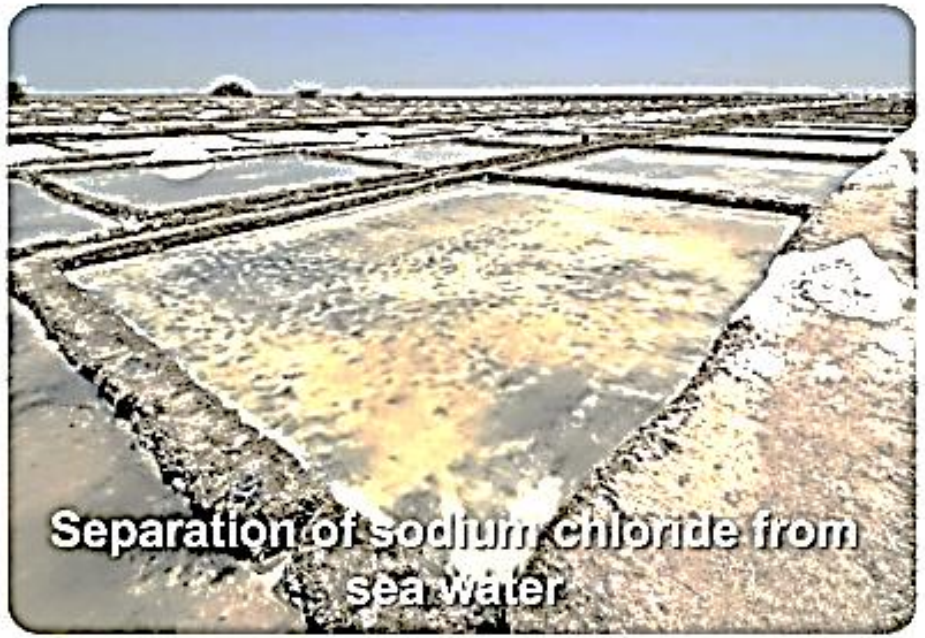
INTRODUCTION

- In science, a **pure substance** means all the **particles** of that substance have **same chemical properties.** E.g., **sodium chloride, sugar** etc.
- In the normal sense, unadulterated milk is pure. But in scientific sense, it is not pure because it is a mixture of water, fat, proteins, etc.
- A **pure substance** consists of a **single type of particle.** i.e., a substance is a **pure single form of matter.**

WHAT IS A MIXTURE?

- A **mixture** is a combination of two or more pure matters. E.g., sea water, minerals, soft drink, soil, etc.
- Dissolved **sodium chloride** can be separated from water by **evaporation** (a physical process). However, sodium chloride is a pure substance and cannot be separated by physical process into its chemical constituents.

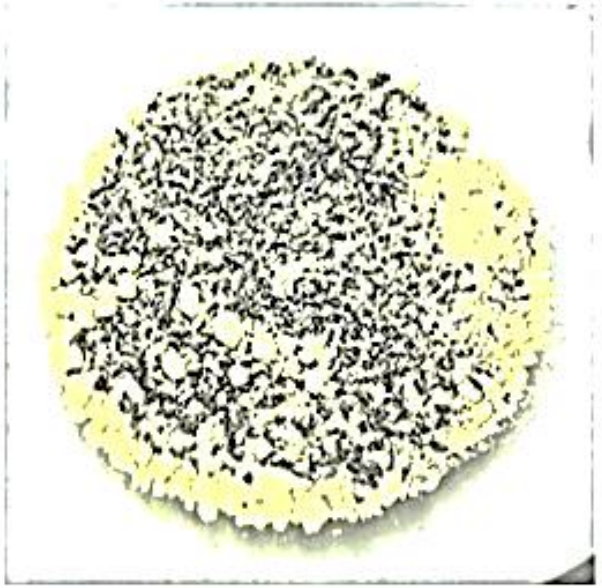


WHAT IS A MIXTURE?

Types of Mixtures

Based on the nature of components, mixtures are 2 types:

- Homogeneous mixture (solution)
- Heterogeneous mixture



WHAT IS A MIXTURE?

Types of Mixtures

Homogeneous mixture (solution)

In this, the **components are uniformly distributed** throughout the mixture **(uniform composition).** E.g.,

- Copper sulphate ($CuSO_4$) dissolved in water.
- Salt dissolved in water.
- Sugar dissolved in water.

$CuSO_4$ dissolved in water

More $CuSO_4$ dissolved

Salt dissolved in water

When more $CuSO_4$ is added to water, the intensity of blue colour increases. This shows that a homogeneous mixture can have a variable composition.

WHAT IS A MIXTURE?

Types of Mixtures

Heterogeneous mixture

It is a mixture which contains **physically distinct parts** and have **non-uniform compositions.** E.g.,

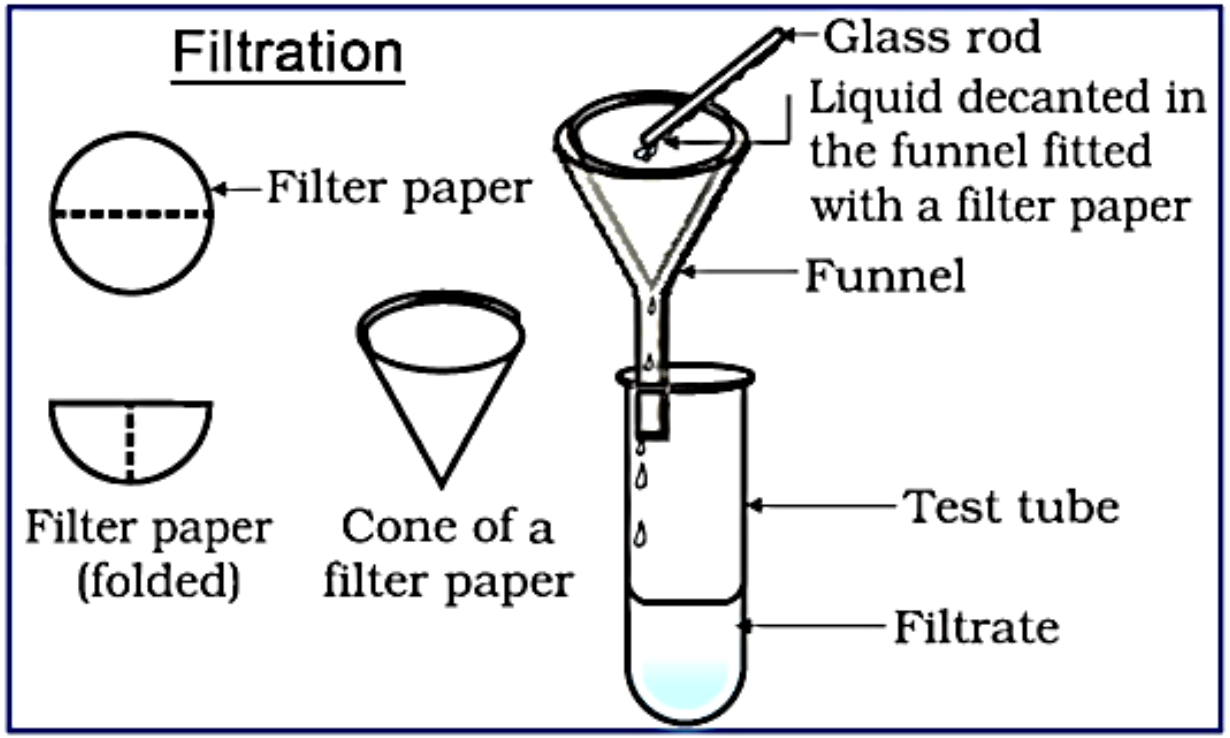
- Mixture of sodium chloride & iron filings.
- Mixture of salt & sulphur.
- Mixture of oil & water.
- Mixture of $CuSO_4$ & potassium permanganate.

WHAT IS A MIXTURE?

Types of Mixtures

Activity

- Take few $CuSO_4$ crystals, one spatula full of $CuSO_4$, chalk powder (or wheat flour) and few milk drops (or ink). Add each of them in separate water samples taken in beakers. Stir well.
- In $CuSO_4$ solutions, particles are not visible.
- Direct a beam of light through the beakers. The path of the beam is not visible in $CuSO_4$ solutions.
- Leave the mixtures undisturbed. $CuSO_4$ solutions remain stable. Chalk powder (or wheat flour) and milk (or ink) particles settle over time.
- Filter the mixture. $CuSO_4$ solutions have no residue on the filter paper. Chalk powder (or wheat flour) and milk (or ink) leave residue.



Mixture of $CuSO_4$ and water is a solution.

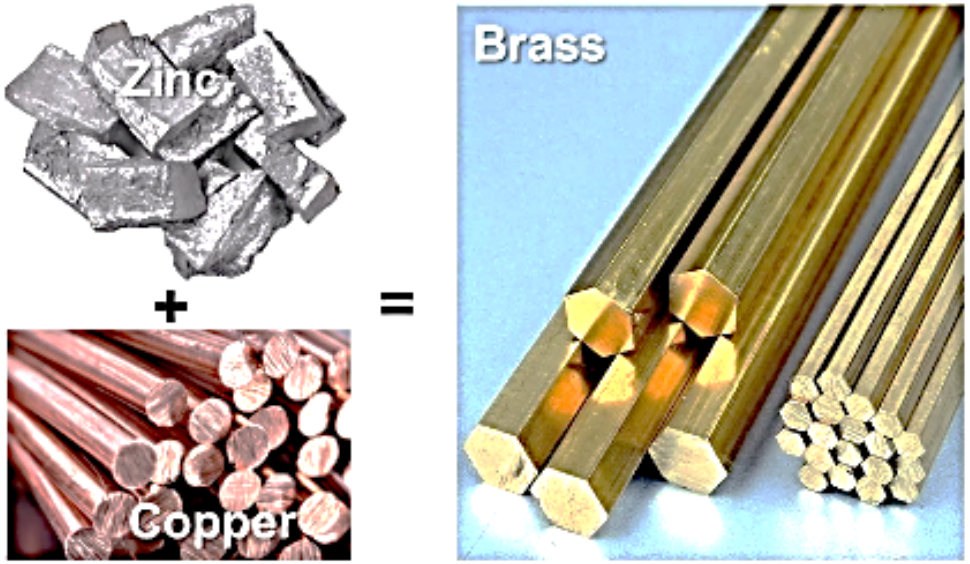
Mixture of chalk powder and water is a suspension.

Mixture of milk and water is a colloidal solution.

WHAT IS A SOLUTION?

- A **solution** is a homogeneous mixture of two or more substances. E.g., Lemonade, soda water, etc.
- Besides **liquid,** there are **solid solutions** (alloys) and **gaseous solutions** (air).
- In a solution, there is homogeneity at the particle level. E.g., lemonade tastes the same throughout. This shows that particles of sugar or salt are evenly distributed in the solution.

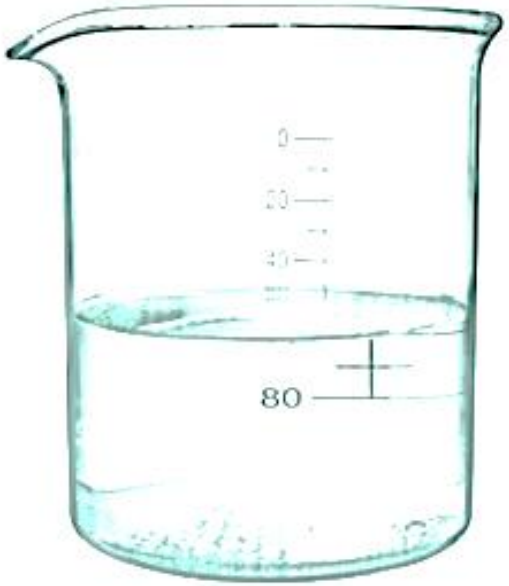
Alloys are mixtures of two or more metals or a metal and a non-metal. They cannot be separated into their components by physical methods. An alloy is a mixture because it shows the properties of its constituents and can have variable composition. E.g., **brass** is a mixture of 30% zinc and 70% copper.



WHAT IS A SOLUTION?

A solution has 2 components:

- **Solvent:** The component that **dissolves the other component** in the solution. It is usually present in **larger amount.**
- **Solute:** The component that is **dissolved in the solvent.** It is usually present in **lesser amount.**



Solvent (Water)

+

Solute ($CuSO_4$)

=

Solution ($CuSO_4$ solution)

WHAT IS A SOLUTION?

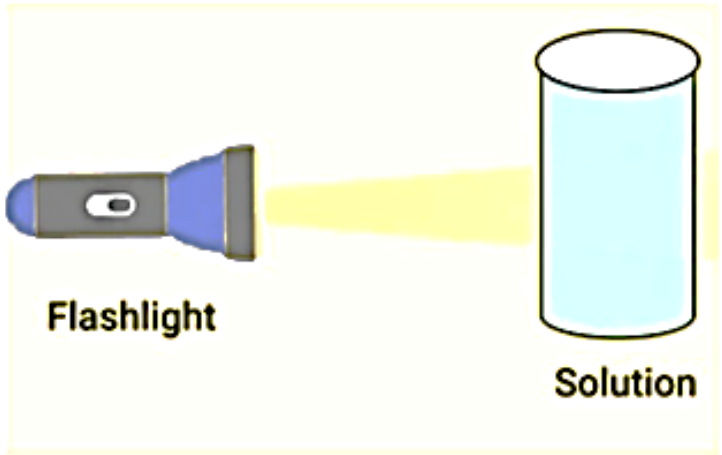
Examples for solutions

- **Sugar solution:** It is a **solid in liquid** solution. **Sugar** is the **solute** and **water** is the **solvent.**
- **Tincture of iodine: Iodine** (solid) is the **solute,** and **alcohol** (liquid) is the **solvent.**
- **Aerated drinks** (e.g., soda water): **Gas in liquid** solutions. **CO_2** (gas) is **solute** & **water** (liquid) is **solvent.**
- **Air:** A homogeneous mixture of **gas in gas. Oxygen** (21%) and **nitrogen** (78%) are two main constituents . Other gases are present in very small amount.

WHAT IS A SOLUTION?

Properties of a Solution

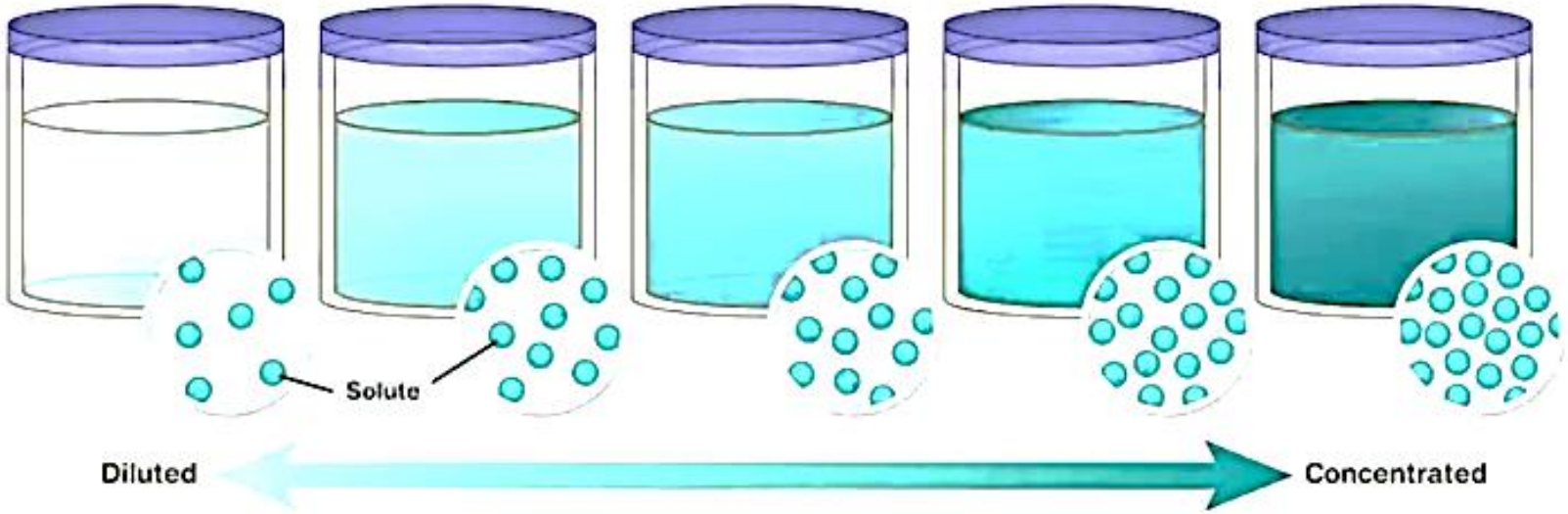
- **Homogeneous** mixture.
- **Particles are smaller than 1 nm** (10^{-9} metre) in diameter. So, they are invisible to naked eyes.
- Being small in size, the particles **do not scatter light,** so the path of light is not visible.
- Solute particles **cannot be separated from the mixture by filtration.**
- A solution is **stable** (solute particles do not settle down).



WHAT IS A SOLUTION?

Concentration of a solution

- In a solution, the relative proportion of the solute and solvent can be varied.
- Based on the amount of solute, a solution can be called **dilute, concentrated** or **saturated.** These are comparative terms. E.g., A solution with few $CuSO_4$ is dilute. But as its quantity increases, it becomes concentrated.

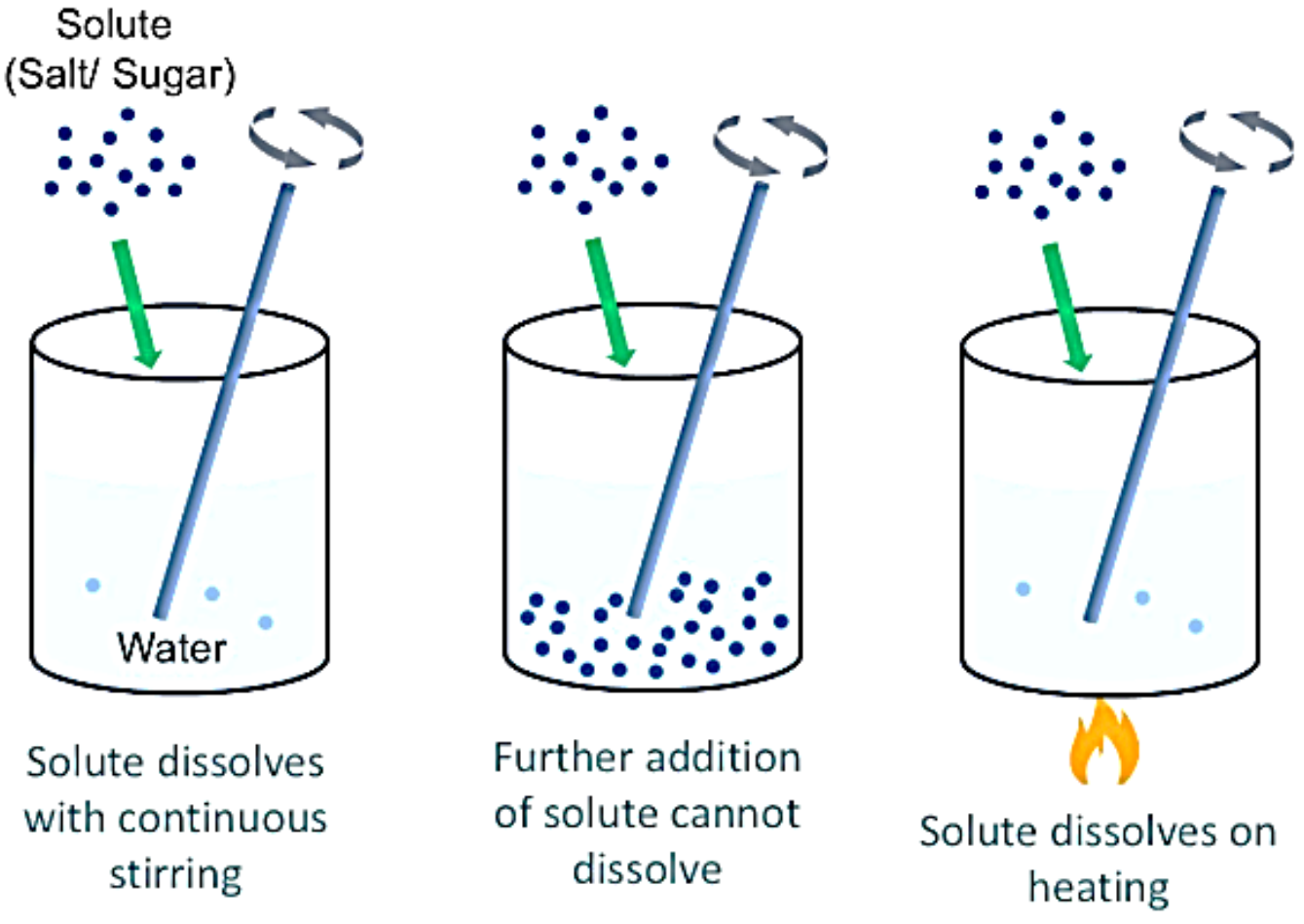


WHAT IS A SOLUTION?

Concentration of a solution

Activity

- Take 50 mL of water each in two separate beakers.
- Add salt in one beaker and sugar or barium chloride in the second beaker with continuous stirring.
- When no more solute can dissolve, heat the contents of the beaker to raise the temperature by about 5°C.
- Start adding the solute again.
- As the temperature rises, more solute can be dissolved.

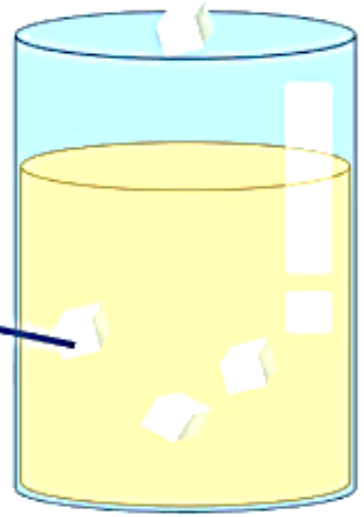


WHAT IS A SOLUTION?

Concentration of a solution

Saturated solution

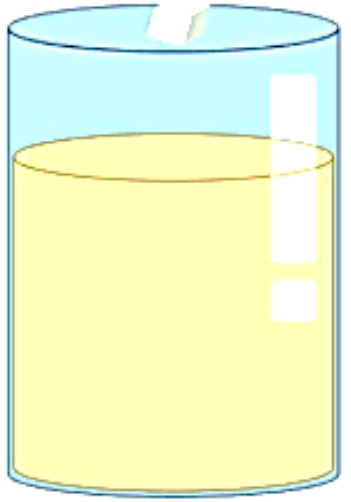
- It is a solution that has dissolved **maximum amount of solute** at a given temperature. i.e., no more solute can dissolve at that temperature.
- The amount of the solute present in the saturated solution at this temperature is called its **solubility.**



Saturated Solution

Unsaturated solution

- It is a solution that contains **solute less than the saturation level.**



Unsaturated Solution

- If a saturated solution is cooled slowly, some solute may crystallize out as the solution's capacity to hold solute decreases.
- Different substances in a given solvent have different solubilities at the same temperature.

WHAT IS A SOLUTION?

Concentration of a solution

- The **concentration of a solution** is the amount (mass or volume) of solute present in a given amount (mass or volume) of solution.
- Concentration of a solution can be expressed in various ways. 3 methods are given below:

(i) Mass by mass percentage of a solution:

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

(ii) Mass by volume percentage of a solution:

$$= \frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$$

(iii) Volume by volume percentage of a solution:

$$= \frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$$

WHAT IS A SOLUTION?

Concentration of a solution

Example

A solution contains 40 g of common salt in 320 g of water. Calculate the concentration in terms of mass by mass percentage of the solution.

Solution

- Mass of solute (salt) = 40 g
- Mass of solvent (water) = 320 g
- Mass of solution = Mass of solute + Mass of solvent

  = 40 g + 320 g

  = 360 g

Mass percentage of solution

$$= \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$$

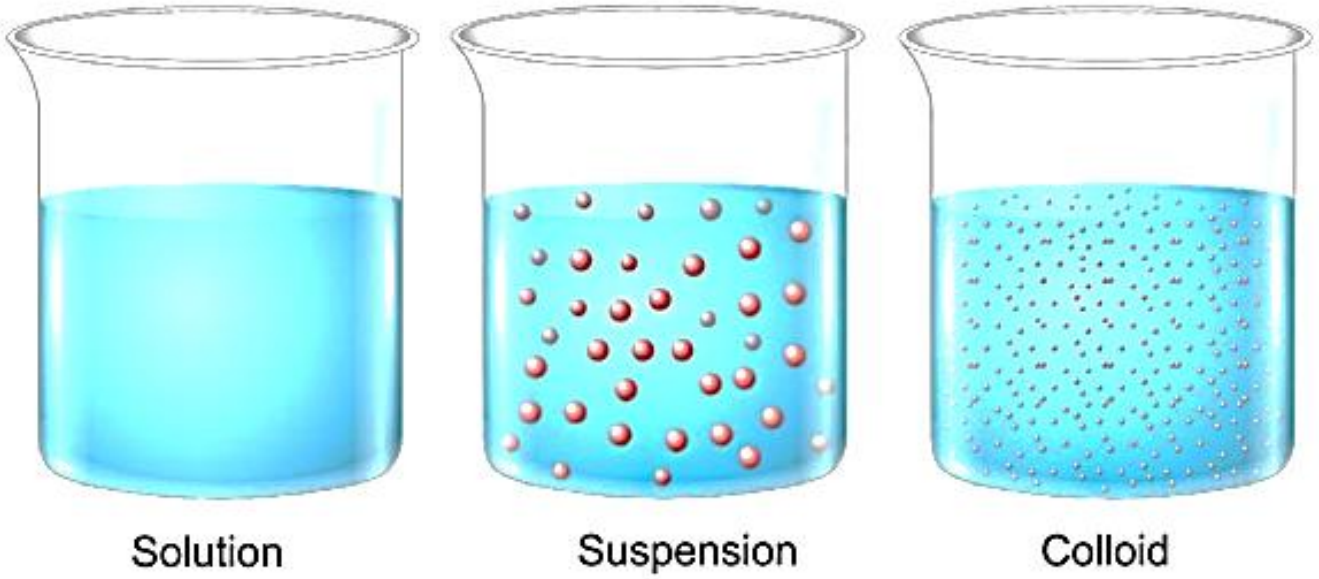
$$= \frac{40}{360} \times 100$$

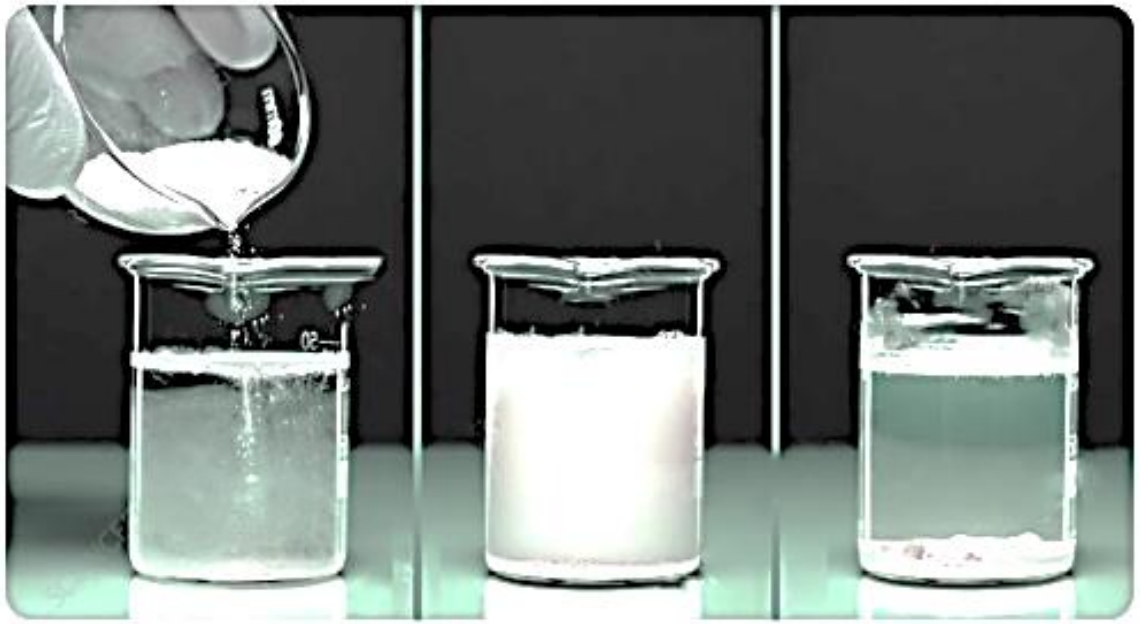
$$= 11.1\%$$

WHAT IS A SOLUTION?

What is a Suspension?

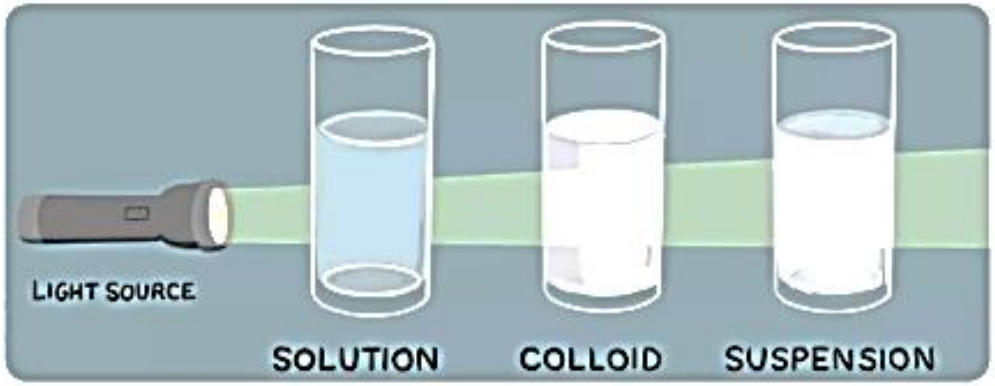
- It is a **non-homogeneous** systems (**heterogeneous** mixture) in which solids are dispersed in liquids. E.g., chalk powder mixed in water.
- In this, the solute particles do not dissolve but remain suspended throughout the bulk of the medium.





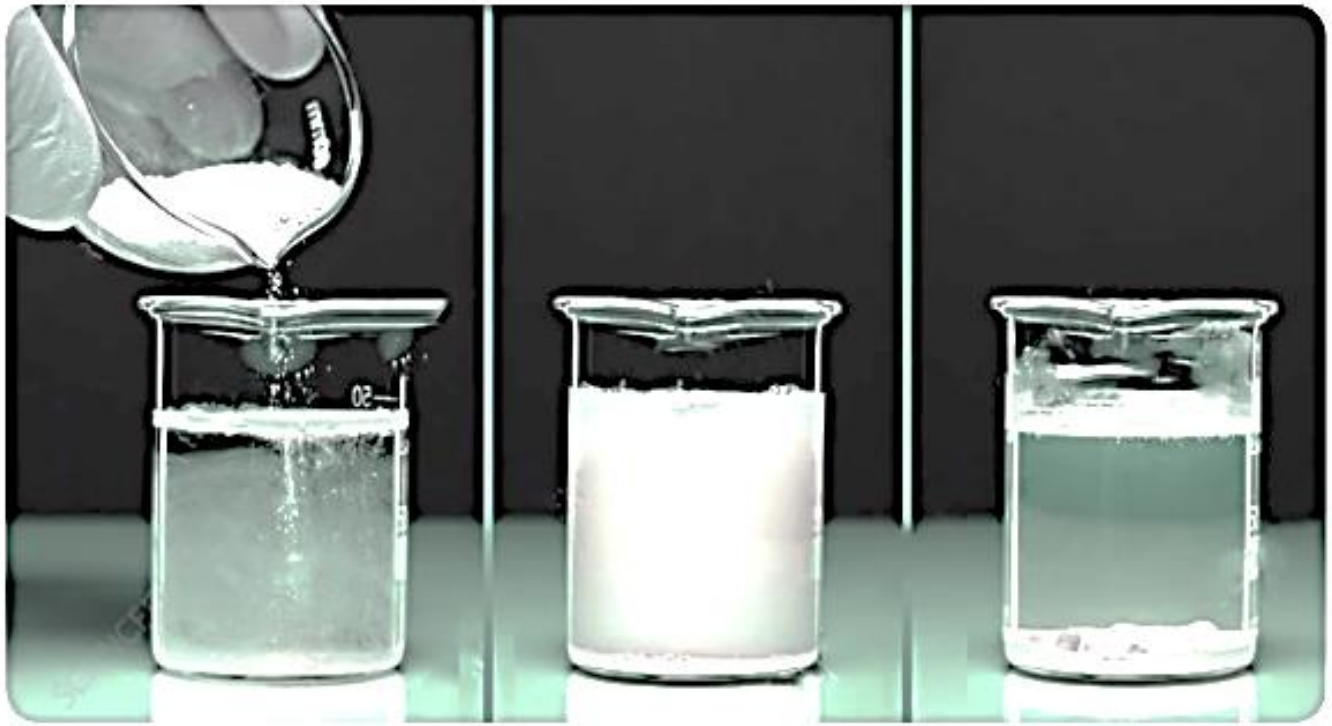
WHAT IS A SOLUTION?

What is a Suspension?



Properties of a Suspension

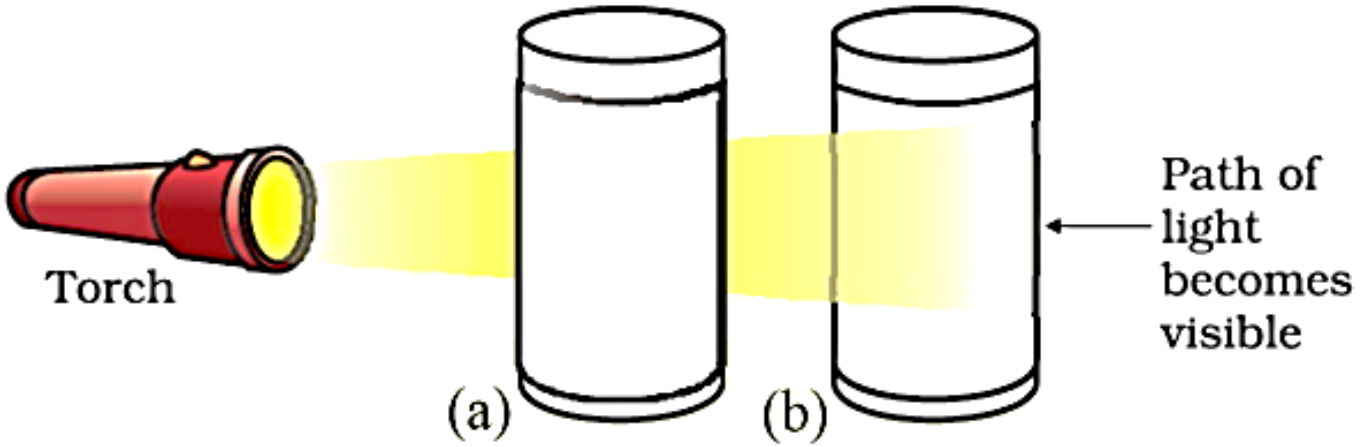
- **Heterogeneous** mixture.
- Particles are **visible** to the naked eye.
- Particles **scatter a beam of light** passing through it and make its path visible.
- **Unstable** (solute particles settle down). They can be separated from the mixture by filtration. When the particles settle down, the suspension breaks and it does not scatter light.

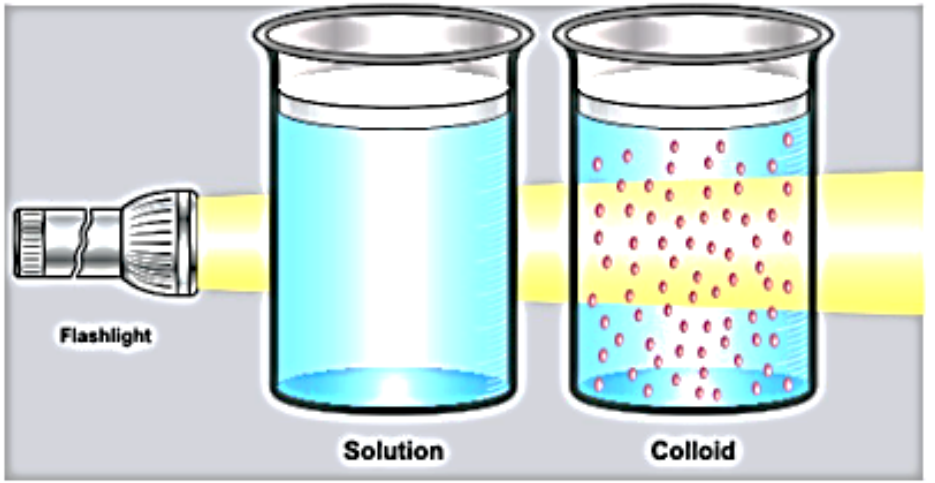


WHAT IS A SOLUTION?

What is a Colloidal solution?

- It is a type of mixture in which **tiny particles are dispersed** within a medium.
- Particles are uniformly spread throughout the solution.
- Due to the small size of particles, a colloid appears homogeneous. But it is **heterogeneous.** E.g., milk.
- The particles can easily scatter a beam of light. This is called **Tyndall effect** (discovered by **Tyndall**).





(a) Solution of $CuSO_4$ does not show Tyndall effect (b) mixture of water and milk shows Tyndall effect.

WHAT IS A SOLUTION?

What is a Colloidal solution?

Other examples of Tyndall effect

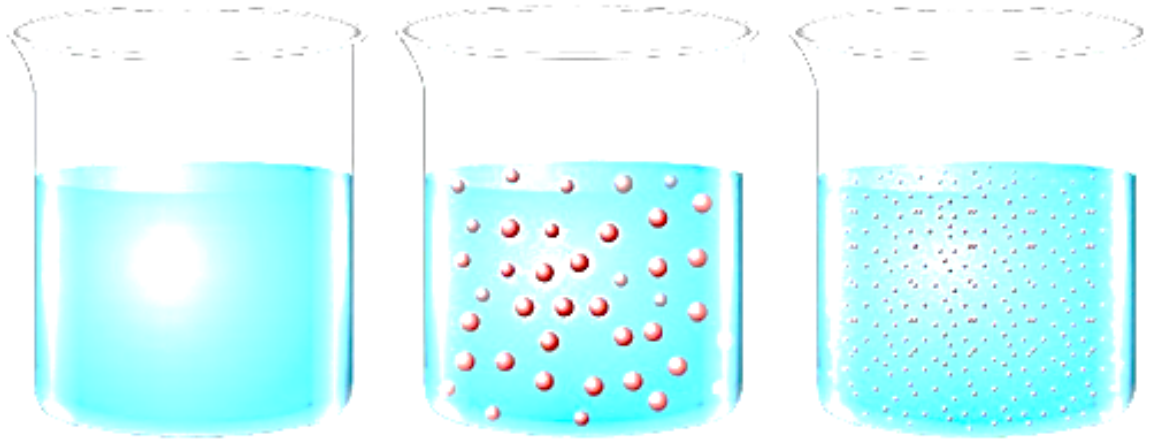
- Light scatters off dust and smoke particles when a beam of light enters a room through a small hole.
- Sunlight passing through a dense forest canopy, where mist droplets act as colloid particles dispersed in the air.

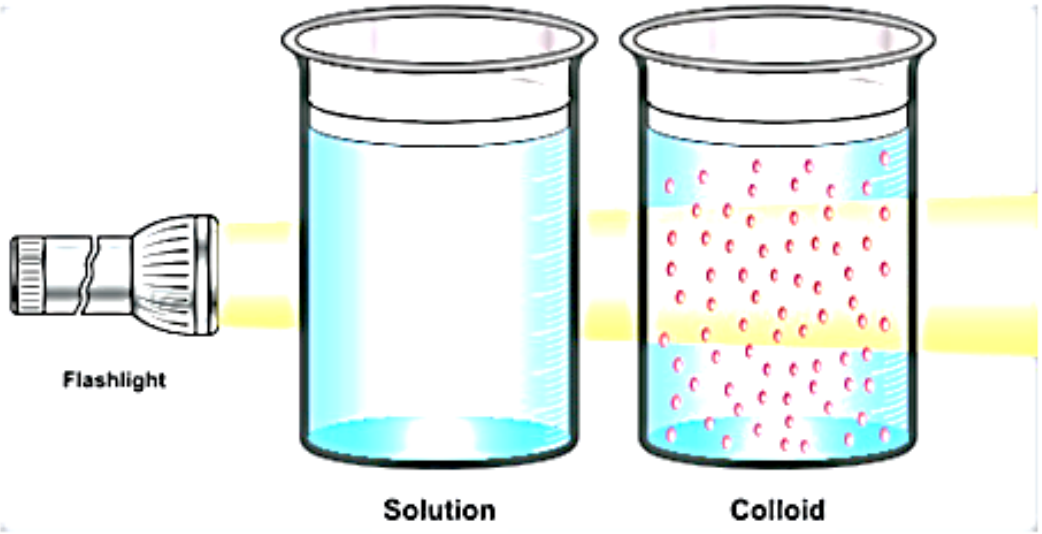
WHAT IS A SOLUTION?

What is a Colloidal solution?

Properties of a Colloid

- **Heterogeneous** mixture.
- **Particles are too small** to be seen with the naked eye.
- Colloids are big enough to **scatter light** making its path visible.
- **Stable** (do not settle down).
- Colloidal particles cannot be separated by filtration, but can be separated by **centrifugation.**



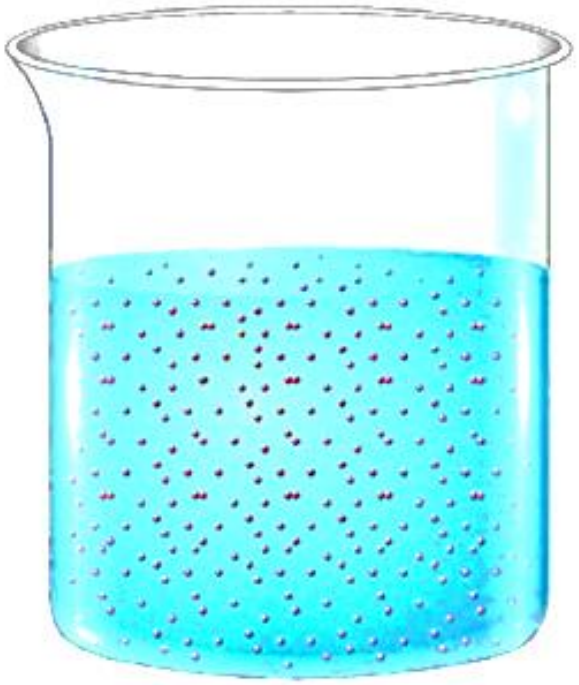


WHAT IS A SOLUTION?

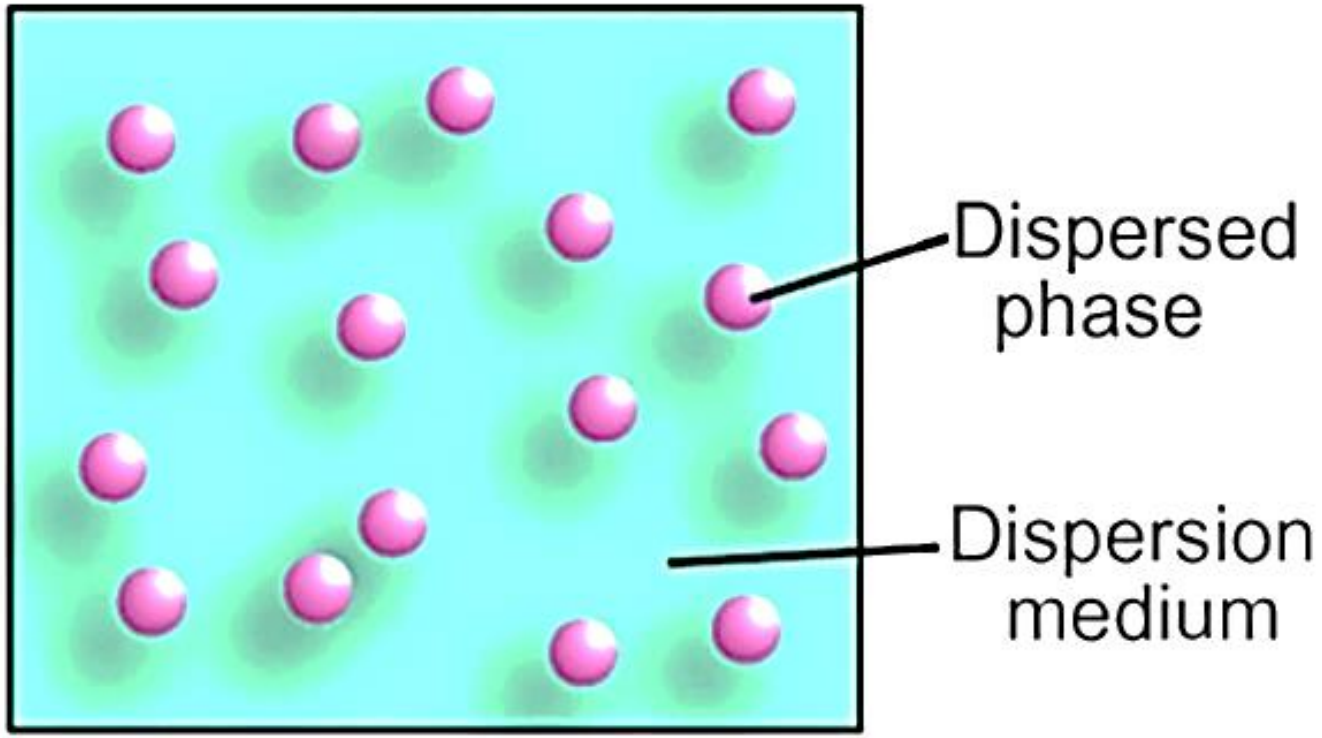
What is a Colloidal solution?

Components of a colloidal solution

- **Dispersed phase:** It is the **solute-like** component or the **dispersed particles** in a colloid.
- **Dispersing medium:** It is the component in which the **dispersed phase is suspended.**



Colloid



WHAT IS A SOLUTION?

What is a Colloidal solution?

Colloids are classified based on the state of the dispersing medium and dispersed phase.

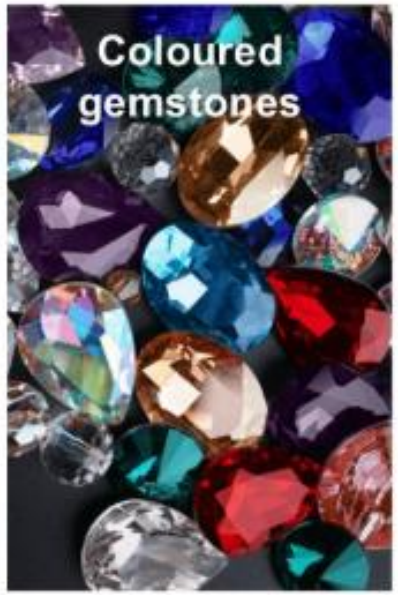
Dispersed phase	Dispersing Medium	Type	Example
Liquid	Gas	Aerosol	Fog, clouds, mist
Solid	Gas	Aerosol	Smoke, automobile exhaust
Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream

WHAT IS A SOLUTION?

What is a Colloidal solution?

Colloids are classified based on the state of the dispersing medium and dispersed phase.

Dispersed phase	Dispersing Medium	Type	Example
Solid	Liquid	Sol	Milk of magnesia, mud
Gas	Solid	Foam	Foam rubber, sponge, pumice
Liquid	Solid	Gel	Jelly, cheese, butter
Solid	Solid	Solid Sol	Coloured gemstone, milky glass



PHYSICAL AND CHEMICAL CHANGES

- Interconversion of states is a physical change because it does not change composition and chemical nature of the substance.
- **Ice, water** and **water vapour** have different physical properties but are chemically the same.
- Water & cooking oil are liquids but differ in chemical properties. They differ in odour and inflammability. Oil burns in air but water extinguishes fire.



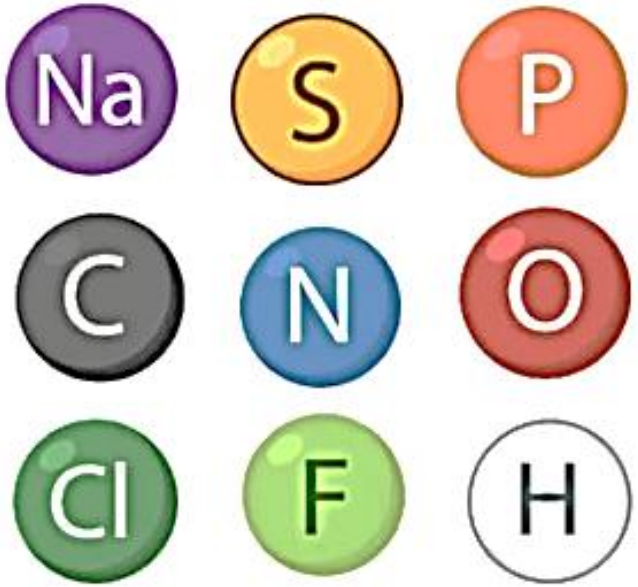
PHYSICAL AND CHEMICAL CHANGES

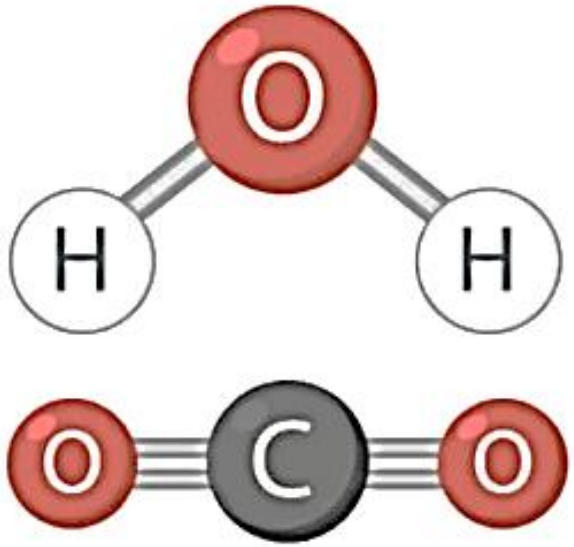
- **Burning** is a chemical change. Chemical changes (chemical reaction) alter chemical properties and composition of matter forming new substances.
- **Physical & chemical changes in candle burning:**
  - **Physical changes:** Solid wax melts into liquid and liquid wax turns into gas.
  - **Chemical changes:** Combustion of wax into CO_2, H_2O and energy.

WHAT ARE THE TYPES OF PURE SUBSTANCES?

Based on the chemical composition, substances are 2 types:

- **Elements**
- **Compounds**



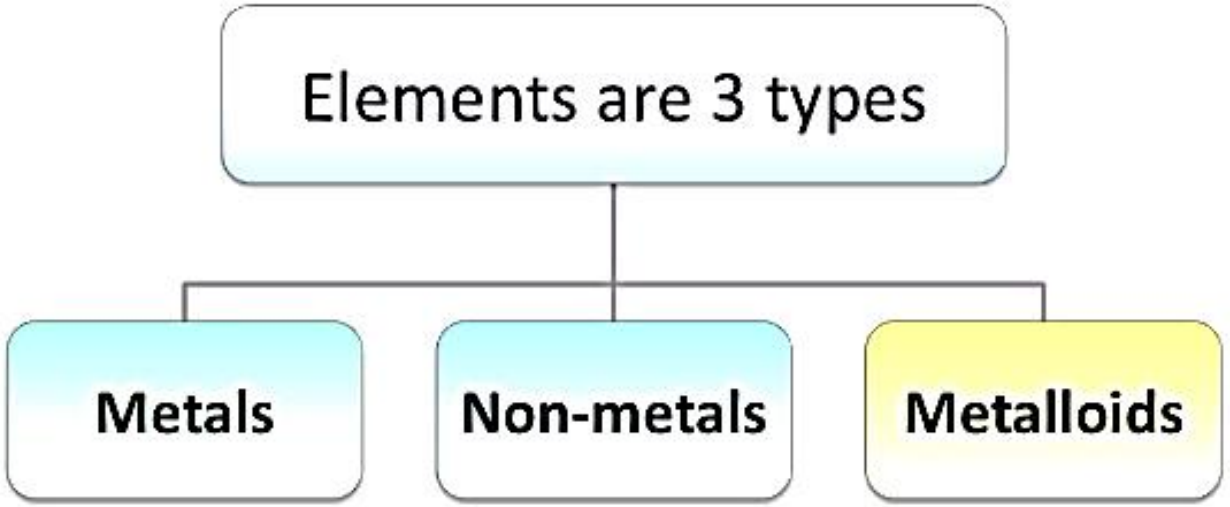


WHAT ARE THE TYPES OF PURE SUBSTANCES? ELEMENTS

- **Robert Boyle** (1661) first used the term **element.**
- **Antoine Laurent Lavoisier** (1743–94), a French chemist, gave an experimentally useful definition of an element. According to him, an element is ***a basic form of matter that cannot be broken down into simpler substances by chemical reactions.***

Robert Boyle

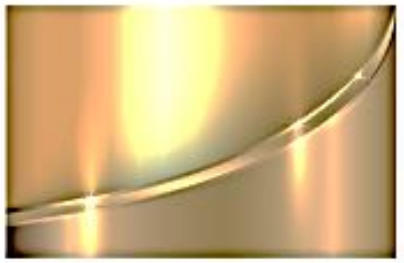
Lavoisier



WHAT ARE THE TYPES OF PURE SUBSTANCES? ELEMENTS

Properties of Metals

- Have a **lustre** (shine).
- Have silvery-grey or golden-yellow colour.
- Conduct heat and electricity.
- **Ductile** (can be drawn into wires).
- **Malleable** (can be hammered into thin sheets).
- **Sonorous** (make a ringing sound when hit).



Copper Metal

Copper Wire

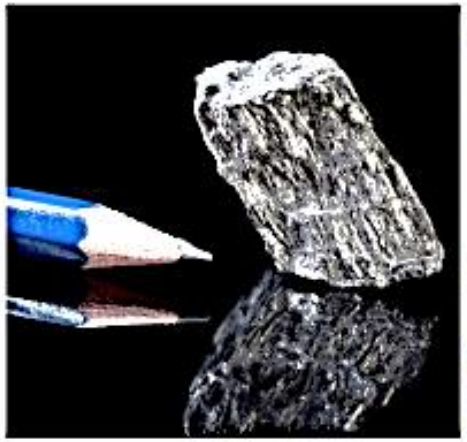
WHAT ARE THE TYPES OF PURE SUBSTANCES? ELEMENTS

Properties of Non-metals

- They display a **variety of colours.**
- They are **poor conductors** of heat and electricity.
- They are **not lustrous, sonorous or malleable.**

Examples of Non-metals

Hydrogen, oxygen, iodine, carbon (coal, coke), bromine, chlorine etc.



Carbon (Graphite)

Carbon (Coal)

Carbon (Coke)

Iodine

Bromine

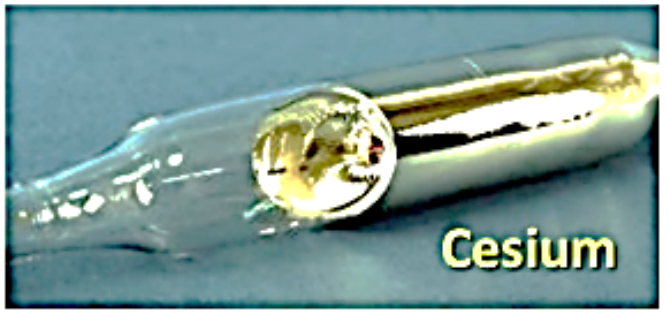
Chlorine

WHAT ARE THE TYPES OF PURE SUBSTANCES? ELEMENTS

Metalloids

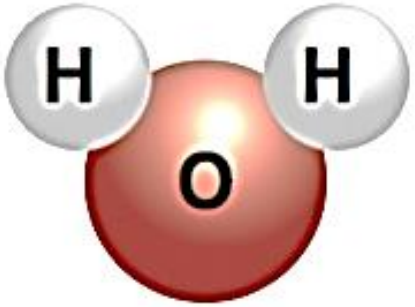
- These are elements having intermediate properties between metals and nonmetals.
- E.g., boron, silicon, germanium, etc.

- There are **more than 100 elements** known at present.
- **92 elements** are **natural.** Others are man-made.
- Majority of the elements are **solid.**
- 11 elements are in gaseous state at room temperature.
- 2 elements are liquid at room temperature - **mercury** & **bromine.** Elements, **gallium & cesium** become liquid at a temperature slightly above room temperature (303 K).

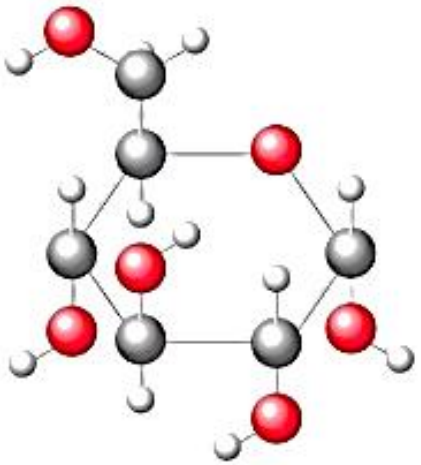


WHAT ARE THE TYPES OF PURE SUBSTANCES? COMPOUNDS

A **compound** is a substance composed of two or more elements, chemically combined with one another in a fixed proportion.



Water
H_2O

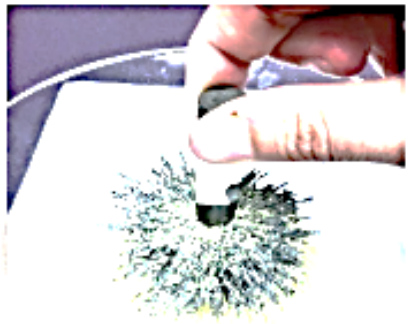


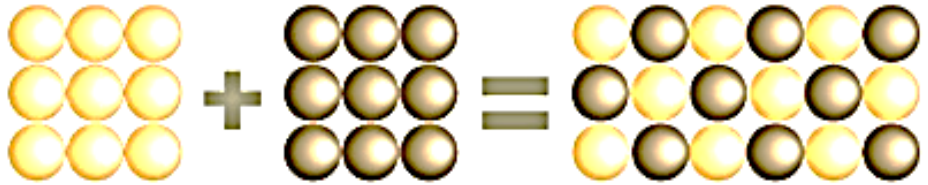
Glucose
$(C_6H_{12}O_6)$

WHAT ARE THE TYPES OF PURE SUBSTANCES? COMPOUNDS

What do we get when two or more elements are combined? (An experiment using iron and sulphur)

	Mixture of iron and sulphur	Compound of iron and sulphur
Preparation	Mix and crush 5 g of iron filings and 3 g of sulphur powder in a China dish.	Mix and crush the same substances in a China dish and heat strongly till red hot. Allow to cool.
Showing magnet	Shows magnetism (attracts towards the magnet).	Does not show magnetism.



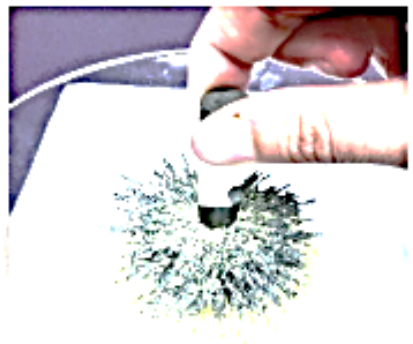


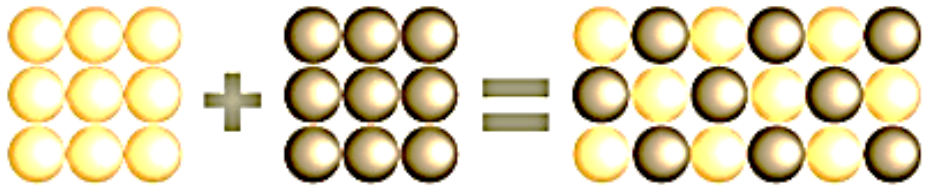
Iron (Fe) Sulphur (S) Iron sulphide (FeS)

WHAT ARE THE TYPES OF PURE SUBSTANCES? COMPOUNDS

What do we get when two or more elements are combined? (An experiment using iron and sulphur)

	Mixture of iron and sulphur	Compound of iron and sulphur
Physical/chemical change	Physical change	Chemical change
Properties	Same as that of its constituents.	Different properties compared to the combining elements.



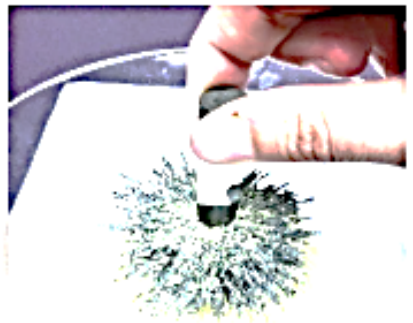


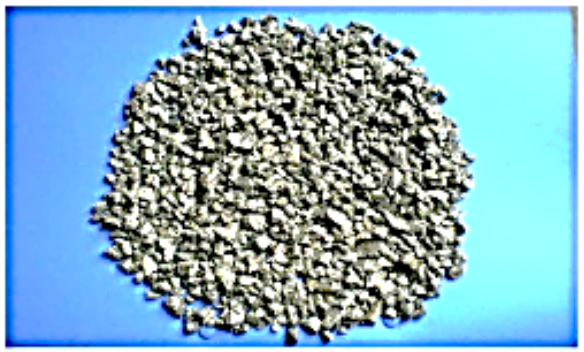
Iron (Fe) Sulphur (S) Iron sulphide (FeS)

WHAT ARE THE TYPES OF PURE SUBSTANCES? COMPOUNDS

What do we get when two or more elements are combined? (An experiment using iron and sulphur)

	Mixture of iron and sulphur	Compound of iron and sulphur
Texture and colour	Granular. Color is a mix of gray (iron filings) and yellow (sulphur powder).	Solid mass. Dark colour.
Can separate the components of the material obtained?	Yes	No



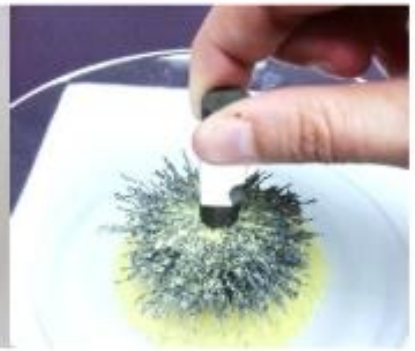


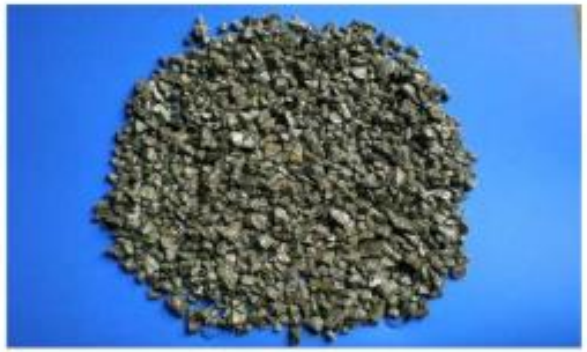
Iron sulphide (FeS)

WHAT ARE THE TYPES OF PURE SUBSTANCES? COMPOUNDS

What do we get when two or more elements are combined? (An experiment using iron and sulphur)

	Mixture of iron and sulphur	Compound of iron and sulphur
Add carbon disulphide. Stir well and filter. Add dilute sulphuric acid or dilute hydrochloric acid.	Produces hydrogen gas. It is colourless, odourless and combustible.	Produces hydrogen sulphide (a colourless gas with the smell of rotten eggs).





Iron sulphide (FeS)

WHAT ARE THE TYPES OF PURE SUBSTANCES?

Differences between Mixtures and Compounds

Mixtures	Compounds
1. Elements or compounds just mix together and no new compound is formed.	Elements react to form new compounds.
2. A mixture has a variable composition.	Fixed composition.
3. Shows the properties of the constituent substances.	New substance has totally different properties.
4. The constituents can be separated by physical methods.	The constituents can be separated only by chemical or electro-chemical reactions.

WHAT ARE THE TYPES OF PURE SUBSTANCES?

Matter (Solid, Liquid or Gas)

Pure substance		Mixtures (No Fixed Composition)	
Elements	**Compounds**	**Homogeneous**	**Heterogeneous**
Cannot be broken down to simpler substances E.g., Cu, O, Fe, H, Hg etc.	Fixed composition. Can be broken down into elements by chemical or electrochemical reactions. E.g., water, methane, sugar, salt etc.	Uniform composition E.g., sugar in water, salt in water, sulphur in carbon disulphide, water in alcohol etc.	Non-uniform composition E.g., sand and salt, sugar and salt, water in oil etc.


thank you