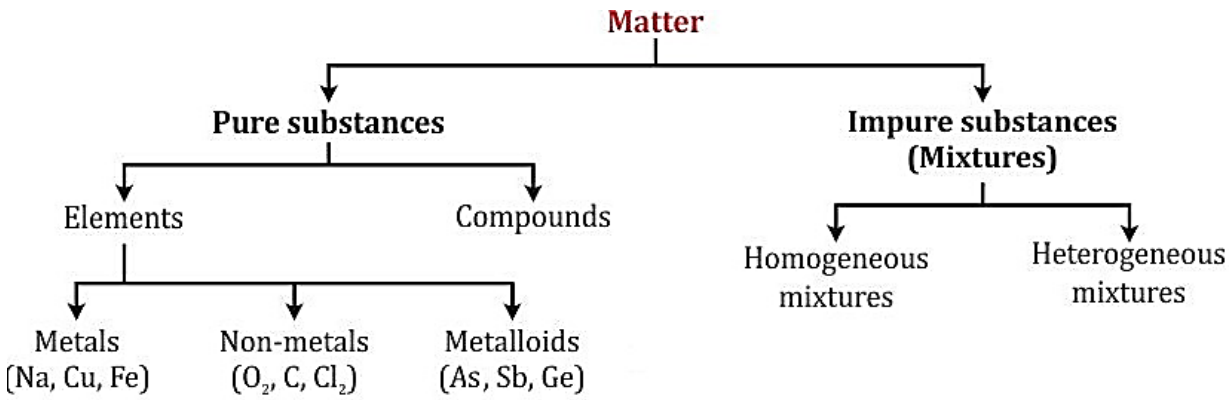
Is Matter Around Us Pure?



Pure Substance

- A pure substance is a homogeneous material with definite, invariable chemical composition and physical and chemical properties.
- A pure substance consists of only one type of atoms or molecules.
- On the basis of their chemical composition, pure substances are classified into elements and compounds.

Impure Substance

- Impure substances are mixtures of two or more elements, compounds or both, and they generally have different compositions and properties in their different parts.

What is a Mixture?

- A mixture contains more than one substance mixed in any random proportion. For example: milk, soil, lemon juice etc.
- Mixtures are constituted by more than one kind of pure form of matter known as a substance.
- A substance cannot be separated into other kinds of matter by any physical process.
  Example: Dissolved sodium chloride can be separated from water by the physical process of evaporation. However sodium chloride itself is a substance and cannot be separated by physical processes into its chemical constituents.

Properties of a Mixture

- In a mixture, two or more elements or compounds are not chemically combined together.
- The constituents of a mixture retain their original properties.
- The constituents of a mixture can be separated by using a physical process such as hand picking, filtration, holding a magnet etc.

Types of Mixtures

Homogeneous mixture

A mixture which has uniform composition and properties throughout its mass is called a homogeneous mixture.

Example: All **solutions** such as sugar solution, salt solution etc.

Heterogeneous mixture

A mixture which has a different composition and properties in different parts of their mass is called a heterogeneous mixture.

Example: Suspension (sand mixed with salt, sugar in oil) and colloids (milk in water).

Solution

- A homogeneous mixture of two or more substances which are chemically non-reacting, whose composition can be varied within certain limits, is called a solution.

Solution = Solute + Solvent

- Solute: A substance which gets dissolved in a solvent is called a solute.
- Solvent: A substance in which a solute gets dissolved is called a solvent.

Concentration of a Solution

- The properties of a solution depend upon the nature of the solute and the solvent, and also on the proportion of the dissolved solute.
- A solution which has a high quantity of solute is said to be a concentrated solution, and a solution which has comparatively lesser quantity of solute is said to be a dilute solution.
- The concentration of a solution is the amount of solute present in a given amount (mass or volume) of solution or the amount of solute dissolved in a given mass or volume of solvent.

$$\text{Concentration of Solution} = \frac{\text{Amount of Solute}}{\text{Amount of Solution}}$$

Or

$$\text{Concentration of Solution} = \frac{\text{Amount of Solute}}{\text{Amount of Solvent}}$$

Methods of Expressing the Concentration of a Solution

$$\text{Mass by Mass percentage of a Solution} = \frac{Mass\ of\ Solute}{Mass\ of\ Solution}\ x\ 100$$

$$\text{Mass by Volume percentage of a Solution} = \frac{Mass\ of\ Solute}{Volume\ of\ Solution}\ x\ 100$$

Saturated Solution

A solution, in which more solute cannot be dissolved at that temperature, is called a saturated solution.

Unsaturated Solution

A solution, in which more quantity of solute can be dissolved without raising its temperature, is called an unsaturated solution.

Solubility

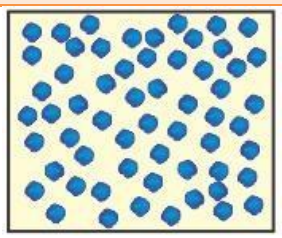
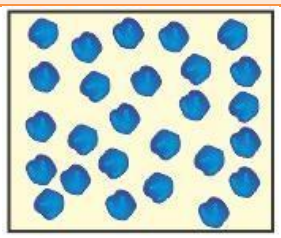
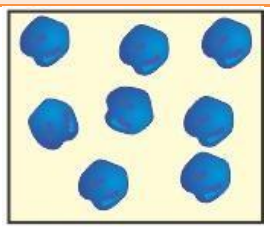
The maximum amount of a solute which can be dissolved in 100 grams of a solvent at a specified temperature is known as the solubility of that solute in that solvent at that temperature.

Effect of Temperature and Pressure on Solubility

The effect of temperature and pressure on the solubility of a substance is as follows:

- The solubility of solids in liquids usually increases on increasing the temperature and decreases on decreasing the temperature.
- The solubility of solids in liquids remains unaffected by changes in pressure.
- The solubility of gases in liquids usually decreases on increasing the temperature and increases on decreasing the temperature.
- The solubility of gases in liquids increases on increasing the pressure and decreases on decreasing the pressure.

Distinguishing Properties of Solution, Suspension and Colloidal Solution

<table>
<tr><th colspan="3">Properties</th></tr>
<tr><th>Solution</th><th>Suspension</th><th>Colloids</th></tr>
<tr>
<td>  </td>
<td>  </td>
<td>  </td>
</tr>
<tr>
<td>A solution is a homogeneous mixture.</td>
<td>A suspension is a heterogeneous mixture.</td>
<td>A colloid is a homogeneous looking heterogeneous mixture.</td>
</tr>
<tr>
<td>The dispersion medium is generally liquid.</td>
<td>Solids are dispersed in any medium such as liquid or gas.</td>
<td>Particles are dispersed in a continuous medium.</td>
</tr>
<tr>
<td>Size of the particle is about 10^{-10} m.</td>
<td>Very fine particles, about 10^{-7} m.</td>
<td>Particles having a size between 10^{-10} m and 10^{-7} m.</td>
</tr>
<tr>
<td>Due to very small particle size, they do not scatter a beam of light passing through a solution. So, the path of light is not visible in a solution.</td>
<td>The particles of a suspension scatter a beam of light passing through it and make its path visible.</td>
<td>Colloids are big enough to scatter a beam of light passing through it and make its path visible.</td>
</tr>
<tr>
<td>Dispersed substance:
• Can pass through a filter paper and a semi-permeable membrane.
• It is not visible to the naked eye.
• They do not settle down.

Example:
<table>
<tr><th>Solution</th><th>Solute</th><th>Solvent</th></tr>
<tr><td>Salt solution</td><td>NaCl</td><td>Water</td></tr>
<tr><td>Sugar solution</td><td>Sugar</td><td>Water</td></tr>
<tr><td>Copper sulphate solution</td><td>$CuSO_4$</td><td>Water</td></tr>
</table>
</td>
<td>Dispersed substance:
• Cannot pass through a filter paper or through a semi-permeable membrane.
• It is visible to the naked eye.
• They settle down after sometime.
Example:
<table>
<tr><th>Solution</th><th>Solute</th><th>Solvent</th></tr>
<tr><td>Chalk in water</td><td>Chalk</td><td>Water</td></tr>
<tr><td>Sand in water</td><td>Sand</td><td>Water</td></tr>
<tr><td>Coagulated matter</td><td>Coagulated matter</td><td>Water</td></tr>
</table>
</td>
<td>Dispersed substance:
• Can pass through a filter paper but not through a semi-permeable membrane.
• It is not visible to the naked eye.
• They do not settle down.

Example:
<table>
<tr><th></th><th>Dispersed phase</th><th>Dispersion medium</th></tr>
<tr><td>Emulsion</td><td>Liquid</td><td>Liquid</td></tr>
<tr><td>Sol</td><td>Solid</td><td>Liquid</td></tr>
<tr><td>Aerosol</td><td>Liquid</td><td>Gas</td></tr>
</table>
</td>
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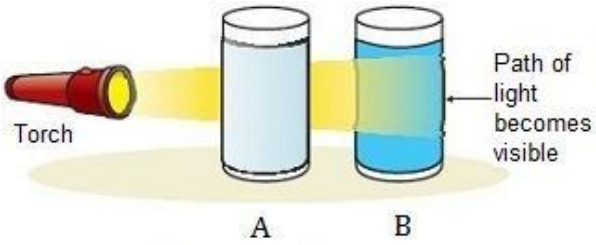
Dispersion System in Colloids

- A system consisting of a substance distributed as very small particles of a solid, droplets of liquids or tiny bubbles of a gas in a suitable medium is called as **dispersion system**.
- The distributed substance in the solution is called as **dispersed phase**.
- The medium in which the distributed substance is dispersed is referred to as the **dispersion medium**.

Tyndall Effect

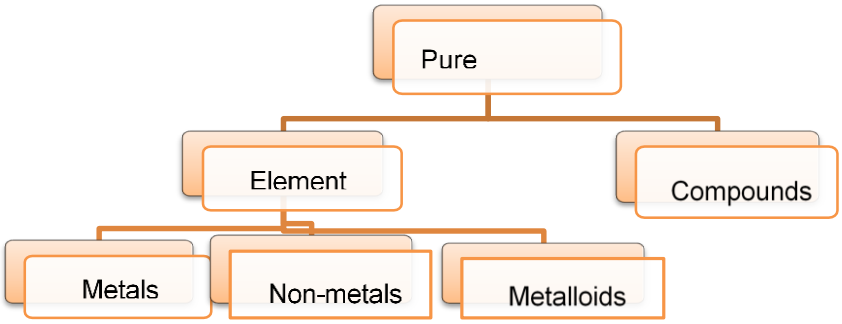
- Tyndall effect can be defined as the scattering of a beam of light by colloidal particles present in a colloidal solution.



Tyndall Effect

- This effect can be observed when a fine beam of light passes through a small hole in a dark room. This effect occurs due to the scattering of light by particles of dust or smoke present in the air.
- The Tyndall effect can also be observed when sunlight passes through the canopy of a dense forest. In the forest, the mist contains tiny droplets of water which act as colloidal particles dispersed in the air.

Physical and Chemical Changes



Element

- An element can be defined as a basic form of matter which cannot be broken down into simpler substances by any physical or chemical means.

Characteristics of an Element

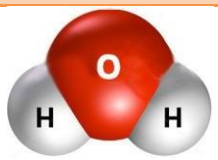
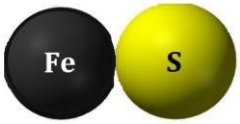
- An element is made up of only a single type of atoms.
- It is a pure and homogeneous substance.
- It has a fixed melting and boiling point.
- An atom is the smallest particle of an element which takes part in a chemical reaction.
- An element may chemically react with other elements or compounds.
- An element can occur in the solid, liquid or gaseous state.

Classification of Elements

Metals	Non-metals	Metalloids
• Have metallic lustre. • Are good conductors of heat and electricity. • Are malleable and ductile. • Are solids. • Contain one kind of atoms.(Mono-atomic) Examples: Iron, copper, sodium, calcium etc. Exceptions: 1. Zinc is non-malleable and non-ductile. 2. Mercury is a liquid at room temperature. 3. Tungsten is a poor conductor of electricity. 4. Sodium and potassium are not hard. They are so soft that they can be cut easily with a knife.	• Do not have lustre. • Are bad conductors of heat and electricity. • Are neither malleable nor ductile. • Are solids, liquids and gases. • Contain two kinds of atoms. (Mono-atomic or di-atomic) Examples: Solid: Carbon, silicon, phosphorous etc. Liquid: Bromine Gas: Hydrogen, chlorine etc. Exceptions: 1. Carbon fibre is ductile but not malleable. 2. Graphite is a good conductor of electricity. 3. Iodine and graphite are lustrous.	• Properties are midway between metals and non-metals. • Contain one kind of atoms. (Mono-atomic) Examples: Boron, germanium, silicon, arsenic, antimony, bismuth etc.

Compound

- A compound is a pure substance composed of two or more elements combined chemically in a fixed proportion by mass.
- The properties of compounds are different from the properties of their constituent elements. Example: H_2O, CO_2 etc.
- The smallest part of a compound is a molecule. All the molecules of a compound are alike and have properties similar to that of the compound.

Compound	Molecular Formula	Composition of molecule	Structure
1. Water	H_2O	2 atoms of hydrogen and 1 atom of oxygen	
2. Iron sulphide	FeS	1 atom of iron and 1 atom of sulphur	

Characteristics of Compounds

- Components in a compound are present in a definite proportion.
- A compound has a homogeneous composition.
- Particles in a compound are of one type.
- A compound is made up of one or more atoms of the same or different elements.
- In a compound the elements are present in a fixed ratio by mass.
- A compound can be divided into simpler substances by a chemical process.
- The physical and chemical properties of a compound are completely different from those of its constituents.

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