# IS MATTER AROUND US PURE?

- Matter
  - Pure Substances
    - Elements
      - Metals
      - Non-mentals
      - Metalloid
    - Compounds
  - Impure Substances
    - Homogenous Mixture
      - solution
    - Hetrogenous Mixture
      - colloids
      - Suspension

## Pure Substances :- → Elements and Compounds

substances that are made up of only one type of particles (i.e only one type of atoms or only one type of molecules)

Examples :-

IRON GOLD HYDROGEN OXYGEN WATER CARBON DIOXIDE

## Characteristics of pure Substances :-

(1) Homogeneous in Nature :- A pure substance has a fixed and uniform composition.

You cannot see any different parts in it

(2) Definite Properties :-
Physical and chemical properties of a pure substance are definite (fixed).
for example- melting point, boiling point, density, colour, smell, taste etc.

3) Physically Inseparable :- pure substances cannot be separated into simpler substances using physical methods like filteration, evaporation or magnet.
for example- We cannot separate pure water into Hydrogen and Oxygen by filteration, evaporation, etc.

- PURE SUBSTANCE
  - Elements
  - Compounds

| Elements | Compounds |
| --- | --- |
| • A form of matter which can not be broken down into simpler substances by chemical reaction. (Antoine lavoisier) | • A compound is a substance composed of two or more elements, chemically combined with one another in a fixed proportion. |

- They are made up of only one kind of atoms

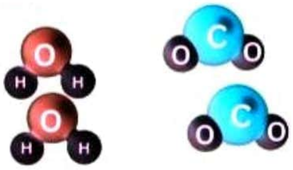
Examples :-

Gold | Iron (Fe) | Oxygen(O)

- They are made up of two or more kinds of atoms

Examples :-

Water ($H_2O$)



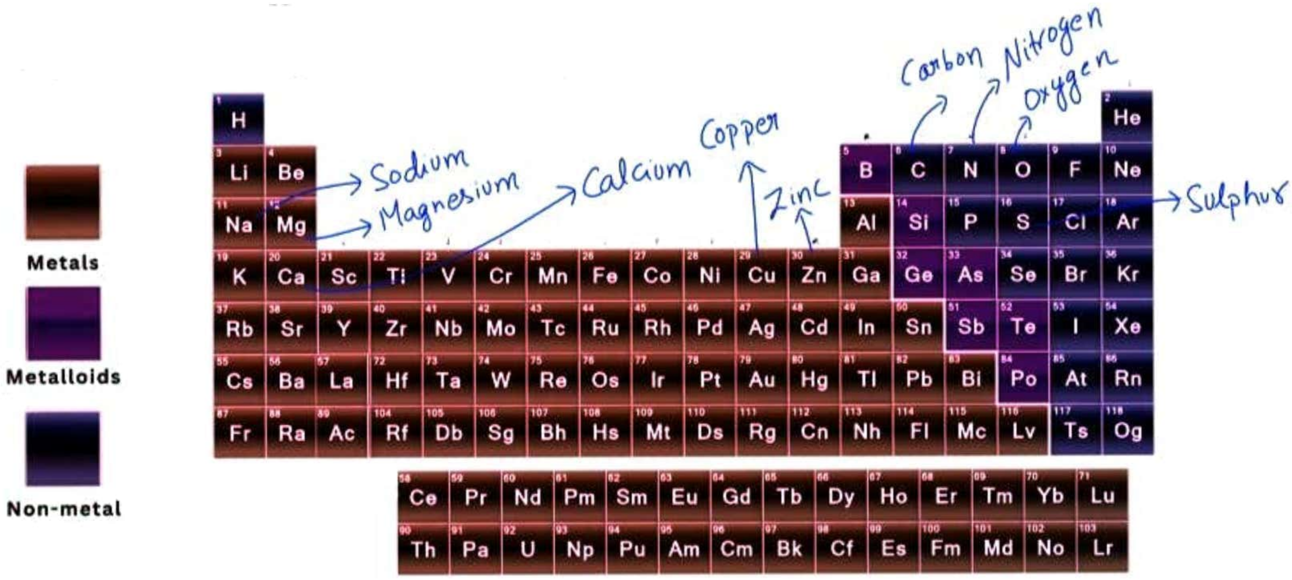
Carbon Dioxide ($CO_2$)

## How Many Elements are there ?

✓ The periodic Table – 118 elements

✓ 92 Elements are naturally occuring, Rest are Man-made.

✓ 91 Metals, 20 Non-Metals, 7 Metalloids

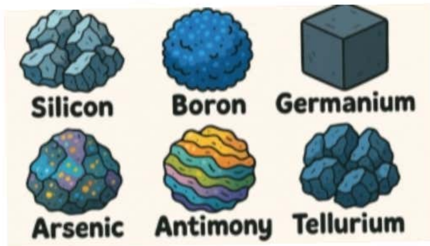



| Metals | Non-metals |
|---|---|
| Metals are Lustrous: have shining surface (in pure state), metallic lustre | Non-lustrous |
| Metals have silver-grey or golden-yellow colour | Display a variety of colours |
| Metals are Malleable: Metals can be beaten into thin sheets [Gold & Silver Most Malleable] | Non-malleable |
| Metals are Ductile: Metals can be drawn into thin wires (1g of Gold metal → 2 km length of wire) | Non-ductile |
| Metals are Good Conductor of Heat and Electricity (Best are Silver & Copper) | Poor conductors of heat and electricity |
| Metals are Sonorous: Produce a ringing sound when hit | Non-sonorous |
| Physical state: All metals except mercury exist as solids at room temperature. | Physical state:<br>• Solid → Carbon, Sulphur<br>• Liquid → Bromine<br>• Gases → Nitrogen, Chlorine Oxygen, Fluorine |

## Metalloids :-

some elements have intermediate properties between those of metals and non-metals, so they are called metalloids.

Examples - Boron, Silicon, Germanium.




**Q) Name one metal and one non-metal which exist in liquid state at room temperature ?**

**Ans -**

**Metal - Mercury**

**Non Metal - Bromine**

## Compounds :-

A Substance composed of two or more elements, chemically combined together in fixed proportion.

Example: water($H_2O$), Methane($CH_4$), calcium carbonate ($CaCO_3$), sugar ($C_{12}H_{22}O_{11}$), salt($NaCl$), calcium oxide ($CaO$), Hydrogen chloride gas ($HCl$).

**Q) Classify the following into elements and compounds**

**(a) Sodium** → $Na$ → E

**(b)Methane** → $CH_4$ → C

**(c) Carbon dioxide** $CO_2$ → C

**(d) Silver** → $Ag$ → E

**(e) Calcium carbonate** $CaCO_3$ → C

**(f) Tin** $Sn$ → E

**(g) Silicon** → $Si$ → E

## Properties of a Compound :-

(1) Elements in a compound combine chemically in a fixed proportion.

water ($H_2O$):

mass of O atom = 16 amu　　H : O

Mass of H atom = 1 amu　　1 : 8

$$\text{Ratio of mass} = \frac{\text{Mass of Hydrogen in water}}{\text{Mass of oxygen in water}} = \frac{1\times 2}{16} = \frac{2}{16} = \frac{1}{8}$$

✲ This ratio or properties is always fixed for a compound.

(2) The elements in a compound can only be separated by chemical or electrochemical method.

- Never by physical methods (like filtration, evaporation, or magnet)

Examples :- water ($H_2O$) $\xrightarrow{\text{(Electric current)}}$ $H_2 + O_2$ electrochemical.

(3) The properties of a compound are different from its constituent elements.

| water (compound) ($H_2O$) | Hydrogen (H) | Oxygen (O) |
| --- | --- | --- |
| ✓ liquid at room temperature.<br>✓ Helps to put out fire | ✓ Gas at room temperature<br>✓ Combustible | ✓ Gas at room temperature<br>✓ Supporter of Combustion. |

## Impure Substance ⟶ Mixtures

When two or more pure substances (elements or compounds) are just mixed together in any proportion without any chemical reaction, they form a mixture.

**Example:**

1. Air → Nitrogen gas ($N_2$) (78%) + Oxygen gas ($O_2$) (21%) + Carbon dioxide ($CO_2$)
2. Sugar Solution → Sugar ($C_{12}H_{22}O_{11}$) + Water ($H_2O$)
3. Salt Solution → Salt (NaCl) + Water ($H_2O$)
4. Soda Water → Carbon dioxide ($CO_2$) + Water ($H_2O$)
5. Blood → Water ($H_2O$) + Sodium$^+$ + Potassium$^+$ + RBC$^+$ + WBC$^+$ + Sugar + Proteins.......
6. Milk → Water + Proteins + Sugar + Calcium + Potassium.............
7. Wood→ Cellulose + Hemicellulose + lignin.
8. Brick→ Clay + Sand + Water.

## Properties of a Mixture:-

(1) A Mixture has variable proportion of constituents (element and compounds just mixed physically)

Example:- Air at the sea has more water vapour than air at mountains.

(2) Constituents of Mixture (elements and Compounds mixed physically) can be separated by physical methods (like filteration, evaporation, magnet)

Examples:- salt can be separated from salt solution by evaporation.

(3) properties of a mixture are same as that of its constituents

Examples:- Air supports combustion, $O_2$ supports combustion

| Compounds | Mixtures |
|---|---|
| • Pure substances | • Impure substances |
| • Two or more elements combine together chemically (Example: Water – $H_2O$) H–O–H H–O–H | • Two or more pure substances (elements or compounds) combine together just by mixing physically (Examples: Air → $N_2 + O_2$, Salt solution → Salt + Water) $Na^+Cl^-$, $H_2O$ |
| • Fixed composition of constituents Water → mass ratio of H : O = 1 : 8 Applies anywhere and anytime | • Variable composition of constituents (Example: Air at the sea has more water vapor than air at mountains) |
| • Can only be separated by chemical or electrochemical methods (Example: Water → electric current → $H_2 + O_2$) | • Can be separated by physical methods (Example: Salt can be separated from salt solution by evaporation) |
| • Properties of compound are different from properties of its constituents Water = non-flammable, used to put off fire $H_2$ = combustible $O_2$ = supports combustion | • Properties of mixture are same as that of its constituents (Example: Air supports combustion, $O_2$ supports combustion) |

## Alloys → Mixture OR Compound ?

✓Alloys are combination of two or more metals or a metal and non-metal.
✓Alloys cannot be separated into their constituents components by physical methods – property of compound!
✓But, alloys are considered as Mixture because
1) it shows the Properties of its constituents.
2) it can have variable composition.

Example :– Brass – an alloy of Zinc and Copper is a mixture of approximately 30% Zinc and 70% Copper.

Mixture
- variable composition ✓
- shows the properties of its constituents ✓
- can be separated into its components by physical methods ✗

**Which of the following materials fall in the category of a "pure substance"?**

**(a) Ice** → $H_2O$ → C → Pure  Pause Comment
**(b) Milk** → Mix → Imp
**(c) Iron** → Metal → Pure
**(d) Hydrochloric acid** → $HCl$ → E + E → C → Pure
**(e) Calcium oxide** → $CaO$ → C → Pure
**(f) Mercury** → Metal → Pure
**(g) Brick** → Mix → Impure
**(h) Wood** → " → "
**(i) Air** → " → "

Mixture
- Solutions — Homogeneous Mixture → Components are uniformly mixed
- Colloids — Heterogeneous Mixture → non-uniform; components are non-uniformly mixed
- Suspension

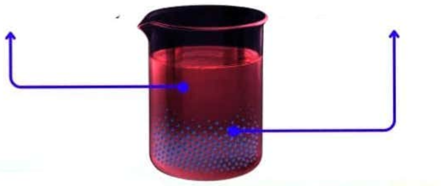
**Solution** :– A solution is a homogenous mixture of two or more substance

solution = solvent + solute

solution = Solvent + solvent

Solvent: That Component which dissolves the other component (present in larger amount).

solvent: That component which is dissolved in solvent (present in lesser Quantity)



Larger quantity → Solvent

76% solution of Glucose in water

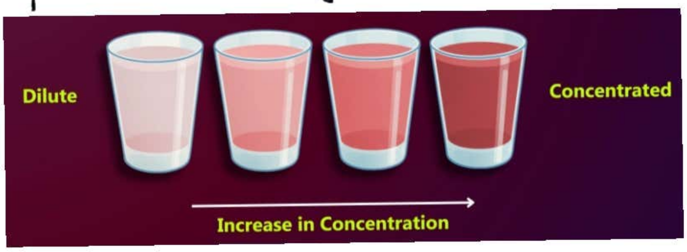
| 76% | 24% |
|---|---|
| Glucose | Water |

76% Glucose → Solvent

| Solution | Solvent | Solute |
|---|---|---|
| Sugar Solution | Water (Liquid) | Sugar (Solid) |
| Salt Solution | Water (Liquid) | Salt (Solid) |
| Soda water | Water (Liquid) | $CO_2$ (Gas) |
| Sea Water | Water (Liquid) | Salts (Solid) |
| Tincture of Iodine | Alcohol (Liquid) | Iodine (Solid) |
| Air | Nitrogen (Gas) | Oxygen (Gas) |

## Concentration of a Solution :-

- The concentration of a solution is the amount of solute present in a given amount of solution.
- More is the amount of solute, we say more concentrated is the solution.




## How to find Concentration of a Solution?

(1) Mass by Mass% of a Solution = $\frac{\text{Mass of solute (g)}}{\text{Mass of Solution (g)}} \times 100$

(2) Mass by Volume % of a solution = $\frac{\text{Mass of solute (g)}}{\text{Vol of solution (ml)}} \times 100$

(3) Volume by Volume % of a solution = $\frac{\text{Volume of solute (ml)}}{\text{Volume of solution (ml)}} \times 100$

A solution contains 20g of common salt in 480g of water. Calculate the concentration in terms of mass by mass %.

- **A** 4.16 %
- **B** 4.24 %
- **C** 4 % ✓
- **D** 14 %

Comment

$$\frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

$$= \frac{20}{500} \times 100$$

$$= 4\%$$

Solute $\downarrow$ Salt $\rightarrow$ 20g

Solution = 500g $\downarrow$ Solute + Solvent (water)

20g + 480g

## Saturated Solution

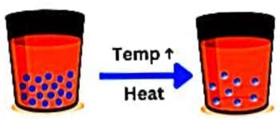
- A solution in which no more solute can be dissolved at a given temperature

## Unsaturated Solution

- A solution in which more solute can be dissolved at a given temperature

## Effects of Temperature on saturated solution

(1) Temperature increased




More solute can dissolve

(2) Temperature Decreased


Solute separates out (less solute can dissolve)

## Solubility:-

- The Maximum amount of solute that can be dissolved in 100g of solvent at a given temperature.
  $\rightarrow$ water.

OR

- The amount of solute present in 100g of a saturated solution at a given temperature.

Temp $\uparrow$ $\Rightarrow$ more solute dissolves $\Rightarrow$ solubility $\uparrow$

Q)To make a saturated solution, 36g of sodium chloride is dissolved in 100g of water at 293K. Find its concentration at this temperature.

$$\text{Conc} \rightarrow \text{mass by mass \%} = \frac{\text{Mass solute}}{\text{Mass of Solution}} \times 100 = \frac{36}{136} \times 100$$

$$\approx 26.4\%$$

36g $\rightarrow$ Solute

100g $\rightarrow$ Solvent

Sol = Solute + Solvent = 136

Q)Pragya tested the solubility of three different substances at different temperatures and collected the data as given below (results are given in the following table, as grams of substance dissolved in 100 grams of water to form a saturated solution).

| Substance Dissolved | Temperature in K | | | | |
|---|---|---|---|---|---|
| | 283 | 293 | 313 | 333 | 353 |
| | Solubility | | | | |
| Potassium nitrate | 21 | 32 | 62 | 106 | 167 |
| Sodium chloride | 36 | 36 | 36 | 37 | 37 |
| Potassium chloride | 35 | 35 | 40 | 46 | 54 |
| Ammonium chloride | 24 | 37 | 41 | 55 | 66 |

(a) What mass of potassium nitrate would be needed to produce a saturated solution of potassium nitrate in 50 grams of water at 313 K?

31g

(b) Pragya makes a saturated solution of potassium chloride in water at 353 K and leaves the solution to cool at room temperature. What would she observe as the solution cools? Explain. Crystals of P.Cl will separate out.

(c) Find the solubility of each salt at 293 K. Which salt has the highest solubility at this temperature? A.Cl

(d) What is the effect of change of temperature on the solubility of a salt?

a) 313K 62g P.N. $\longrightarrow$ 100g water

100g water $\rightarrow$ 62 PN

50g water $\rightarrow$ 31g PN

$1nm = 10^{-9} m$

**Two other types of Mixtures are Suspensions and Colloid.**

| Property | Solution (True) | Colloid | Suspension |
|---|---|---|---|
| Particle Size (Solute) | Less than 1 nm | 1 nm – 1000 nm | Greater than 1000 nm |
| Particle Visibility (Solute) | Cannot be seen by naked eye | Cannot be seen by naked eye | Can be seen by naked eye |
| Uniformity | Homogeneous | Heterogeneous | Heterogeneous |
| Settling of Particles | Do not settle (Stable) | Do not settle (Stable) | Settle on standing (Unstable) |
| Filtration | Cannot be filtered | Cannot be filtered by normal filter (but by a special method: Centrifugation) | Can be filtered easily |
| imp Scattering of Light | Not shown | Shown | Shown — Exam |
| Examples | Salt solution, Sugar solution, Soda water, Air | Milk, Clouds, Shaving cream, Smoke, Butter, Fog | Sand in water, Chalk in water, Mud in water, Dust in air, Flour in water |

## Colloid or Colloidal Solution:-

✓A Colloid is a heterogenous mixture in which the size of solute particles is in the range of 1 – 1000 nm.

✓The particles are too small that they don't settle down, nor they can be seen with naked eye but they are large enough to scatter light.

colloid $\longrightarrow$ Dispersed phase + Dispersion medium

Dispersed phase (the solute-like particles)

Dispersion medium (the component in which the dispersed phase is suspended - solvent like particles)

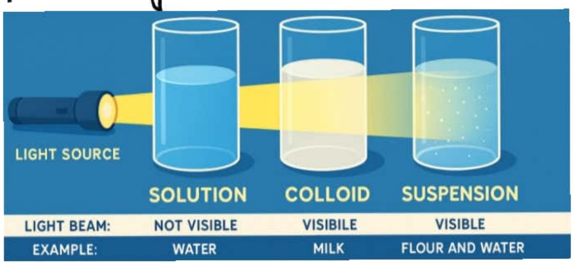
| Dispersed Phase (Solute) | Dispersing Medium (Solvent) | Type | Example |
|---|---|---|---|
| Liquid | Gas | Aerosol | Fog, clouds, mist |
| Solid | Gas | Aerosol | Smoke, automobile exhaust |
| Gas | Liquid | Foam | Shaving cream |
| Liquid | Liquid | Emulsion | Milk face cream |


| Dispersed Phase (Solute) | Dispersing Medium (Solvent) | 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 |


## Tyndall Effect

The scattering of a beam of light when it passes through a colloidal solution is called Tyndall effect.

The path of the light becomes visible in Tyndall effect.



* Tyndall Effect can also be observed when a fine beam of light enters a room through a small hole.
  This happens due to scattering of light by particles of dust and smoke in the air.
* Tyndall Effect can be observed when sunlight passes through the canopy of a dense forest. Mist contains tiny droplets of water, which act as colloid particles dispersed in air.


Q) Which of the following will show "Tyndall effect"?

| Salt solution | Milk | Copper sulphate solution | Starch solution |
|---|---|---|---|
| Solution ✗ | Colloid ✓ | Solution ✗ | Solid in Liq ✓ Sol colloid |

| Homogeneous Mixture | Heterogeneous Mixture |
|---|---|
| Uniform composition throughout | Non-uniform composition |
| Looks the same everywhere | Looks different in different parts |
| Only one visible phase | Two or more visible phases |
| Salt water, Air, Vinegar | Oil & water, Sand in water, Wood, Coal, Soil |
| Difficult to separate by simple methods | Can be separated easily |

Pure Substances & Solution
(Elements + Compounds) → Always Homogns

Q) Identify the solutions among the following mixtures.

| Soil | Sea water | Air | Coal | Soda water |
|---|---|---|---|---|
| Mixture | Solution | Solution | Mixture | Solution |

Q) Classify each of the following as a homogeneous or heterogeneous mixture. → Solution

| Soda water (H) | wood | air | soil | vinegar | filtered tea. |
|---|---|---|---|---|---|
| Homo | Mixture Hetro | Solution Homo | Mixture Hetro | Compound $CH_3COOH$ → Homo | Homo Solution |

## Chemical Change

- A change in which new substance is formed.
- changes in physical and chemical properties.
- Usually irreversible $A \to B$ New

**Example:**

- **Rusting of iron** $O_2 + H_2O + Fe \to$ Comp
- **Digestion of food** → $HCl$ + food → Gluc
- **Curdling of milk** → Sugar → lactic acid
- **Ripening of grapes** → Sugar → Alcohol
- **Electrolysis of water** → $H_2O \to H_2 + O_2$
- **Cooking of food** →
- **Growth of a plant** $P + C \Rightarrow$ Chem Chem
- **Burning of paper** → $CO_2$ → New Comp

## Physical change

- A change in which No new substance is formed.
- only physical properties (like shape, size, state) changes
- Usually Reversible.

$A \rightleftharpoons B$

**Example:**

- **Melting of Ice**
- **Boiling of water**
- **Breaking of glass**
- **Cutting of trees**
- **Melting of butter**
- **Dissolving salt in water**
- **Making a fruit salad with raw materials**
- **Freezing of water**

$H_2O$ $H_2O$
ice → water
water → $H_2O$ vapour

## Burning of a Candle :-

Melting of wax ⟶ physical change
solid ⟶ liquid
state change

✓ Burning of wax with oxygen in air to give carbon dioxide and water ⟶ new compound
chemical change

**Which of the following are chemical changes?**

H.W.

(a) Growth of a plant → C

(b) Rusting of iron → C

(c) Mixing of iron filings and sand → P

(d) Cooking of food → C

(e) Digestion of food → C

(f) Freezing of water → P

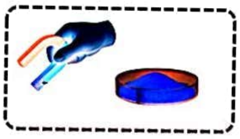
(g) Burning of a candle → P + C → C

## Activity 2.4

(i) Mix and crush Iron filings and Sulphur Powder

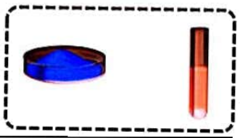
(ii) The mixture is magnetic (attracted by magnet)
Its constituent Iron is also magnetic

- Properties of mixture are same as that of its constituents



(iii) Iron filings and sulphur powder can be separated:
a) with help of magnet
b) by dissolving in carbon disulphide

- The constituents of a mixture can be separated physically.



(iv) On adding dilute hydrochloric acid or dilute sulphuric acid,a gas is evolved

- Iron reacts individually with acid to produce a colourless, odourless gas hydrogen

## Activity 2.4

Experiment: Iron and Sulphur Reaction

Step:

- Mix and crush Iron filings and Sulphur powder.
- Heat this mixture strongly. Remove and let it cool.
- (Chemical reaction happened)

(i) The new compound formed is non-magnetic

➤ Properties of compound is different from its constituents.

(ii) Iron filings and sulphur powder cannot be separated physically now.

➤ The constituents of a compound can only be separated chemically or electrochemically.

(iii) On adding dilute Hydrochloric acid or dilute Sulphuric acid,

- a gas with smell of rotten eggs is produced.

➤ Compound reacts with acid to produce hydrogen sulphide gas.