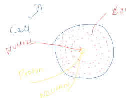
Pure Substances

Pure
- For a common person, pure means having no adulteration.
- Milk → water, fat, protein etc.
- But according to science, they are mixture of different substances & hence not pure.
- A pure substance consist of a single type of particles
  ↑
  All constituent particles of that substance are the same in their chemical nature.
  Gold → 24 K gold
  atoms

Particles : atoms / Molecules / ions



Subparticles of atoms
Electrons (-ve), Protons (+ve), Neutrons

→ Molecules – Atoms combine to form a group
→ ions – Initially, In any atom No of electrons = No of proton

For the sake of explanation
e^- 5 → 4, p^+ 5 — +ve ions
6, 5 — -ve ions

Element – An element is defined as the simplest form of a pure substance which can't be broken into simpler substance by chemical method.

Ex. Gold → Small pieces of gold.
Ex – Iron, silver, sulphur, oxygen, hydrogen.

CO_2 → C & O_2
Compound

→ An element is now defined as a pure substance that has only one kind of atom
→ which are identical in size, mass, composition, etc.

118 → Elements have been discovered so far
90 (natural) 28 → Man made element

Elements
- Solid → Iron, copper, silver, gold etc.
- liquid → Mercury, bromine
- gas → Oxygen, hydrogen, Nitrogen

Physical Properties of Metals

→ Metals are Malleable
⇑ hammered or beaten up to form thin sheets w/o breaking
Ex – Gold & Silver
Silver foils etc

→ Metals are ductile
Stretched into thin wires.
Ex – Gold & Silver
1 gm of gold can form of a wire of 2.4 Kms.

→ Metals are good conductor of heat & electricity
- Silver is the best conductor of heat.
- Copper is the
- Aluminium.

Periodic table

H_2O
1 atm of H = 1 u
2 atm of H = 2 u
1 atm of O_2 = 16
Σ 18

⊙ Metal are lustrous
↑ Shining surface.

○ Metals have high tensile strength.
↑
Metals can hold large weight w/o breaking

Ex – Steel (Iron & Carbon)
↑ used for building bridges, railways lines.

→ Metals are solid at room temp, except mercury which is liquid.

→ Metal have high melting & boiling points.
↳ Sodium (Na) → (371 K)
low melting point: Potassium (K) → (336 K)

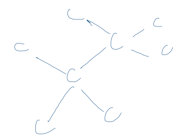
→ Metal are sonorous
Cymbals, guitar etc.

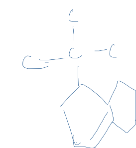
→ Non metals are not malleable but are brittle (break easily).
Ex – Sulphur & phosphorous.

→ Non metals are not ductile.
Ex – Sulphur & Phosphorous.

→ Non-metals are non conductor of heat & electricity.
Ex – Non metals acts as insulators.

⊖ Diamonds are good conductor of heat, but bad conductor of electricity.
⊖ Graphite good conductor of electricity.
} allotropes of Carbon


Diamond


Graphite

Total 118 elements

92 elements → occurred naturally

26 elements — Man-made elements

Metals | Non metals | Metalloids

✓ Elements which have properties in b/w those of metals & non metals are called metalloids or semimetals.

Ex - Silicon (Si), Germanium (Ge) etc

✓ They are neither good conductors of electricity nor non conductors like non metals.

Si
↓
Metalloid

Solar cells

✓ Energy in form of heat or light is usually evolved or absorbed when a compound is formed.

✓ A compound is a homogeneous substance

$Fe + S \xrightarrow{\Delta} FeS$

Ferrous sulfide

Compounds

✓ A compound is defined as a pure substance made up of two or more elements chemically combined together in a proportion by mass.

H_2O → H → 2(1u)
O → 16u

1:8

CO_2

C

O

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

$C + O_2 \longrightarrow CO_2$

C — 12u.

O — (16u) x2 = 32u

$\frac{C}{O} = \frac{12u}{32u} = \frac{3}{8} = 3:8$ by mass

NaCl

Na → 23u.

Cl → 35.5u

Na:Cl = 23:35.5

$CaCO_3$ — Ca C $(O)_3$

40 12 16 x3 = 48

10 : 3 : 12

- A chemical compound is formed as a result of a chemical change (or reaction) & its properties are entirely different from those of its constituents.

$H_2 + O \longrightarrow H_2O$

✓ A compound can't be separated into its constituents by simple physical means.

Mixture

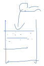
A mixture is a material which consists of two or more pure substances (elements or compounds) which are not chemically combined but are physically mixed in any proportion.

Fe + S $\xrightarrow{\Delta}$ (FeS)

Ex- Milk, lemonade, blood, Face cream etc

Types of Mixtures

- Homogeneous
- Heterogeneous



Uniformly mixed

✓ A mixture is said to be homogeneous if all the components of the mixture are uniformly mixed & there are no boundaries of separation b/w them.

✓ will consist of only one phase (solid / liquid / gas)

Ex- Air, Alloys.

Heterogeneous mixture.

Heterogeneous mixture: A mixture is said to be heterogeneous if all the components of the mixture are not thoroughly mixed & there are visible boundaries of separation b/w them.

✓ Doesn't have a uniform composition.

Ex - oil & water, salt & sulphur, Chalk powder & water,

Properties of Mixture

(i) A mixture — homogeneous / heterogeneous.

(ii) Components of mixture may be present in any proportion by mass.

(iii) Mixture doesn't have a definite melting & boiling point.

(iv) Fe + S $\xrightarrow{\Delta}$ FeS ← compound; (FeS) ← physically

Constituents of mixture can be separated by simple physical methods

Ex - Filtration, distillation, evaporation, sublimation etc.

Mixtures	Compounds
(i) 2 or more element physically mixed.	(i) Chemically mixed.
(ii) easily separated by physical method	(ii) Can only be separated by chemical method
(iii) Variable proportion by mass	(iii) Fixed proportion by mass
(iv) Energy is neither absorbed nor evolved	(iv) Energy is either absorbed & evolved.

Physical & Chemical Changes

✓ Melting of ice to form water & freezes of water to from ice

✓ Sugar solution

Chemical: Burning of piece of paper; $H_2 + O \rightarrow H_2$; Rusting of iron; Fe + S → (FeS)

Solution

✓ A solution is defined as a homogeneous mixture of two or more components in which the particle size is smaller than 1nm.

✓ A mixture is to be called a solution, it should satisfy the following conditions:

→ Particle size should be 1nm.

→ Mixture should be homogeneous.

→ components of a mixture should be non-reacting.

Components of Solutions

→ Component of the solution which is present in small amount is called Solute.

→ Component of the solution which is present in large amount is called Solvent.

Solute — Salt & water — Solvent

✓ Aqueous & Non aqueous solution.

- Aqueous: water acts as a solvent
- Non aqueous: any other liquid acts as a solvent. Ex (iodine in alcohol)

→ water → Universal Solvent.

↑ Must of the substances are soluble in water.

→ Another solvents

Ex - ether, alcohol, Carbon tetrachloride etc

Types of Solutions:-

- Solid solutions → Solid acts as solvent
- liquid Solutions. → liquid acts as solvent.
- Gaseous Solutions → gas acts as solvent

Solid solutions

↳ A solid is the solvent while solute can be either a solid, liquid or gas.

Solid in solid — Ex - Alloys — mixture of two or more metals.

liquid in solid — blue vitriol, green vitriol, white vitriol; (blue vitriol ↓ hydrated copper sulphate)

Gas in solid → Gases adsorbed on the surfaces of metals such as nickel, Platinum etc.

liquid Solutions

Solute → Solid, liquid or gas; Solvent → liquid

- Solid in liquid ↳ sugar & water
- ✓ liquid in liquid ↳ ink & water, alcohol & water.
- ✓ Gas in liquid ↳ soda, sprite ↳ solvent (liquid), solute (CO_2)

Gas Solutions

Solute → solid, liquid, gas; Solvent → Gas

→ Solid in gas → Ex - Napthelene, camphor, etc

→ liquid in gas → LPG, clouds, fog etc.

→ Gas in gas. → Air — Oxygen (21%), Nitrogen (78%), carbon dioxide & inert gases (1%)

Saturated, Unsaturated & Supersaturated soln

A Soln which contains the maximum amount of solute dissolved in a given quantity of solvent at the given temperature & which can't dissolve any more at that temperature is called a saturated soln.

Unsaturated soln - A soln that can dissolve more solute in it at the given temp is called an unsaturated soln.

Ex - 100g of salt in 1000mL / 36g common in 100mL of water.

Supersaturated soln:

A soln which temporarily contains more solute than the saturation level at a particular temp is called the supersaturated

Ex. Sodium acetate & Sodium thio sulphate

Solubility

Maximum amount of solute in grams which can be dissolved in 100 grams of the solvent at the given temp to form a saturated soln is called the solubility of the solute in that solvent at that given temp.

Ex - Max of 36g of NaCl can be dissolved in 100g of water at 20°c, the solubility of common salt in water at 20°C is 36gr

Solubility

→ Effect of temp & pressure on solubility.

↑

Saturated soln → unsaturated

↑

Soft drink pressure inside decreases & the solubility of CO_2 also decreases

Example 2.1 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.

Mass of common salt (solute) = 40g

Mass of water (solvent) = 320g

$$\text{Mass by mass \%} = \frac{\text{Mass of Solute}}{\text{Mass of soln}} \times 100$$

$$= \frac{40g}{360g} \times 100 = \frac{100}{9} = 11.1\%$$

Q Calculate the mass of glucose & mass of water required to make 250g of 25% soln of glucose.

$$\text{Mass by mass \% of the soln} = \frac{\text{mass of the solute}}{\text{Mass of the solution}} \times 100$$

$$25 = \frac{\text{Mass of the glucose}}{250} \times 100$$

$$\text{Mass of the glucose} = 25 \times \frac{250g}{100} = 62.5g$$

Soln = glucose + water

250g = 62.5 + water

water = 250 − 62.5g

= 187.5g

(Q) A soln contains 5 mL of alcohol in 70 mL of water. Calculate volm by volm % of the solution.

$$\text{Volm by volm \% the soln} = \frac{\text{Volm of solute}}{\text{Volm of soln}} \times 100$$

$$= \frac{5}{75} \times 100 = 6.66\%$$

(6) 2.5 g of solute are dissolved in 25g of water to form a saturated soln at 298K. Find out the solubility of the solute at this temp.

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

(Q) Find out the mass by volm % of 15% soln of sulphuric acid. (density = 1.02g cm^{-3}) H_2SO_4

$$\text{Density} = \frac{\text{mass}}{\text{Vol}}$$

$$\text{Vol of soln} = \frac{\text{mass of soln}}{\text{density of soln}} = \frac{100g}{1.02g/ml}$$

15% soln of H_2SO_4 means 15g of H_2SO_4 are present in 100g of soln.

$$\text{Mass by volm \% of soln} = \frac{\text{Mass of the solute}}{\text{Volm of the soln}} \times 100 = \frac{15}{98.03} \times 100$$

$$51 \overline{)5000}\ 98.03$$

$$\frac{100}{1.02} \times \frac{50}{100} = \frac{5000}{51}$$

$$\frac{51}{9} \times \frac{8}{108}$$

True Solution ?

↑ Soln of sugar, common salt, acetic acid etc in water, because the particles of solution are so thoroughly mixed with water that we can't distinguish from one another.

Proportion of solute: Dilute soln → soln with less solute concentration; Concentrated soln → soln with high solute concentration

Concentration of soln

↑ amount of solute in a given soln is called concentration of soln

Colloidal Solution

✓ Particles of true soln are smaller than 1nm
10^{-9} m = 10^{-7} cm

✓ Solid particles of a suspension are quite large having diameters, greater than 100nm (10^{-5} cm) hence are clearly visible to the naked eye
↳ Eg - muddy water, Chalk powder in water

10^{-7} cm & 10^{-5} cm
↑ Colloidal soln
1 – 100 nm

✓ Soln in which size of the particles lies in b/w those of true solns & suspensions are called colloidal soln or simply colloids

✓ heterogeneous

✓ To distinguish them to form true solution, the term "Sol"

Dispersed phase & Dispersion medium

Solute like component which has been dispersed or distributed throughout in a solvent-like medium is called dispersed phase / discontinuous phase.

Solvent like medium in which dispersed phase has arrived or dispersed is called dispersion medium. / continuous phase.