Chapter #02

Date

Matter

① → Matter and its states

(i) Solid	★ Exotic or intermediate states :-
(ii) Liquid	(i) Bose-Einstein condensate
(iii) Gas	(ii) Liquid crystals.
(iv) Plasma	

② → Propeeties of different states of matter

(i) shape and volume
(ii) structuse
(iii) Intermolecular forces
(iv) Density
(v) Compressibility
(vi) Fluidity.

Comparison of elements, compounds and mixture

④ Allotropes (e.g ⇒ Graphite, diamond, bucky balls)

⑤ Solutions (solute + solvent) + Aquous solution

★ 9 Types of solutions {Dependng on physical state of solvent}

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* 3 Types of solutions { Depending on amount of solute with T }

* 2 Types of solutions { Depending on amount of solute w.r.t solvent }

(6) Solubility + Effect of T on solubility

* Solubility curve

(7) Differentiate between

* solution
* Colloid
* Suspension

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① Matter :-

→ Anything that has mass and occupies space is called matter.

e.g:- Air, water, rocks, people etc.

→ The atom is the building block of all matter and it is the various combinations of these atoms that make up all the matter around us.

States of matter :-

→ A state of matter refers to the

* distinct physical forms, that matter can take characterized by different physical properties like

* shape
* volume and
* the arrangement of particles.

e.g:- Solid, liquid, gas and plasma.

Exotic or intermediate states :- BEC, LC.

② Properties of different states of matter :-

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Physical Property	Solid	Liquid	Gas
① Shape & volume	Definite shape and volume	Definite volume and takes the shape of the container	No definite shape or volume
② Structure	Particles are tightly packed in a fixed arrangement	Particles are close together but can move past one another	Particles are far apart and move freely
③ I.M.F and fluidity	Strong inter-molecular forces prevent flow	Moderate intermolecular forces allow fluidity	Weak intermolecular forces allow fluidity
④ Compressibility	Not Compressible	Moderately compressible	Very compressible because of large empty spaces
⑤ Density at normal condition	High density	High density	Low density due to large spaces b/w molecules
e.g	Ice or rock	water	air

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(i) Solid state:-

→ A solid state has following characteristics:-

* definite volume
* definite shape
* particles are tightly packed in a fixed arrangement
* high density at normal conditions
* not compressible
* can not flow.

eg:- Ice, diamond, metals, graphite etc.

(ii) Liquid state:-

→ A liquid state has following characteristics.-

* definite volume
* takes the shape of its container
* particles are close together but can move past one another
* high density at normal conditions
* Moderately compressible
* can flow

e.g:- Oxygen gas, hydrogen

e.g:- water, oils, milk, honey etc.

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(iii) Gas state:-

→ A gas state has following characteristics:-

* No definite volume
* No definite shape
* particles are far apart and move freely.
* Low density at normal condition, due to large spaces between molecules
* very compressible because of large empty spaces
* can flow

e.g:- Oxygen gas (O_2), hydrogen gas (H_2) etc.

(iv) Plasma state:-

→ It is a state of matter, which consists of

* a highly ionized gas,

where electrons are seperated from atoms.

→ It is often found in high energy environments.

→ Plasmas are electrically conductive.

e.g:- Sun, lightening, welding arc, solar winds et

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Exotic or Intermediate states of matter:-

(i) Bose-Einstein Condensate BEC:-

→ It is a state of matter, that occurs at

★ near absolute zero temperatures,

where particles occupy the same quantum state, acting as a single quantum entity.

e.g:- BEC of rubidium atoms at extremly low temperature (-273.14°C).

(ii) Liquid crystals:-

→ Intermediate states between liquid and solids,

★ where molecules flow like liquids, but

★ retain some ordered structure like solids.

are called liquid crystals.

use:- Liquid crystals commonly used in display technology.
e.g :- Liquid crystal displays. (LCDs)

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③ Elements, compounds & mixtures :-

* Definition
* Composition DCSP e.g
* Separation
* Properties

(i) Element :-

→ An element is a pure substance, made up of

* only one type of atom.

→ Elements contain only one type of atoms.

→ It cannot be broken down into simpler substances by

* chemical means.

→ Elements have unique physical and chemical propest

e.g :- Oxygen (O_2), Gold (Au), Carbon (C).

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(ii) Compound :-

→ A compound is a pure substance, made up of

* two or more elements chemically combined in a fixed ratio.

→ They can only be seperated into their elements.

* through chemical reactions.

→ They consists of two or more elements

* chemically bonded in fixed propotions.

→ They have different properties from the elements that make them.

e.g:- Water (H_2O), Carbon dioxide (CO_2), Sodium (NaCl) etc.

(iii) Mixture :-

→ A combination of two or more substances (elements or compounds)

* that are physically mixed together, but
* not chemically combined

is called as mixture.

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→ They contain elements, compounds or both in varying propotions.

→ They can be separated into their components

* by physical means,

→ Mixtures consist of multiple substances, that retain their individual properties.

e.g:- → Air (a mixture of nitrogen, oxygen, carbondioxide)

→ salt water (a mixture of salt and water)

→ sand and iron fillings. etc.

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④ Allotropy:-

→ The property of an element to exist in

*different physical forms

is called allotropy.

Allotropes:-

→ These different forms

* in the same physical state

are called allotropes.

Explanation:-

→ Atoms of the same element arranged in different manners in the same physical state in allotropes.

→ They are different structural forms of the same element.

e.g:- Diamond, graphite and bucky balls are three important allotropes of carbon.

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(i) Graphite:-

Structure:-

→ It is composed of flat two dimentional layers of

* hexagonally arranged carbon atoms.

→ In a layer, each C-atom is covalently bonded to three other carbon atoms.

Intermolecular forces:-

→ Weak intermolecular bonds exist between each layer which allows the layers to slide over one another, without breaking the bonds.

Uses:-

→ This arrangement makes graphite soft and slippery, making it ideal to be used as a lubricant.

Properties:-

→ Graphit is a good conductor of electricity.

(ii) Diamond:-

Structure:-

→ It is the hardest and the purest crystalline allotrope of carbon.

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→ In its structure, each C-atom is covalently bonded to

* four other carbon atoms

forming a rigid network of tetrahedral shape.

Properties:-

→ This tetrahedral three-dimentional arrangement makes it

* the hardest substance
* with a very high melting point.

→ Since all the carbon atoms are bounded with four other carbon atoms, no free electrons are present, making it

* non-conductor of electricity.

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(iii) Buckyballs (C-60):-

Structure:-

→ Buckyballs (also known as fullerenes), have a football like fused ring structure made up of

* twenty hexagones and
* twelve pentagons.

→ Each of its 60 carbon atoms are bonded to

* 3-carbon atoms.

(5) Solution:-

Solute:-

→ The component of solution, which is present

* in smaller quantity

is called solute.

→ Solute is dissolved in solvent to make solution.

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e.g:- In salt solution, salt is solute, and water is solvent.

Solvent:-

→ The component of a solution, which is present

* in larger quantity

is called solvent.

→ Solute is dissolved is solvent to make solutions.

e.g:- In sugar solution, sugar is solute and water is solvent.

Solution:-

→ A solution is a homogeneous mixture of

* two or more substances

in which one substance is dissolved in the other.

→ Homogeneous means that no particles of different substances can be seen.

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→ Solute is dissolved in solvent to make solutions.

Explanation :-

→ In solution, the particles are microscopic, less than 1nm in diameter.

→ A solution is very stable mixture, and the solute does not seperate from the solvent itself.

e.g.:- In salt solution, salt is salute and water is solvent

* More than one solute :-

→ More than one salute can be present in a solution.

e.g.:- In soft drinks, water is solvent, while other substances like

* sugar
* salts and
* CO_2 are solutes.

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e.g:- In air, nitrogen gas is solvent, while other gases like,

* oxygen
* carbon dioxide and
* trace gases

are solutes.

Classification of Solutions:-

① On the basis of physical states of

*** solvent:-**

→ Generally, solutions are found in three physical states, depending upon the physical state of the solvent.

e.g:- ① gaseous solutions

② Liquid solutions

③ Solid solutions.

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Gaseous solutions:-

⊛ Solute	Solvent	Examples
① Gas	Gas	*Mixture of N_2 & H_2 to form NH_3, in Haber's process
		* Mixture of CO_2 & NH_3 to form Urea
② Liquid	Gas	* Fog, Clouds & mist (water droplets suspended in air)
③ Solid	Gas	* Smoke (Carbon particles in air)

Liquid solutions:-

Solute	Solvent	Examples
① Gas	Liquid	* Carbonated drinks (CO_2 in water)
② Liquid	Liquid	* Rectified spirit {from fermentation of sugar cane} (95% ethanol and 5% water by weight)
		* Vinegar (4→6% of acetic acid in water)
③ Solid	Liquid	* Brine (Salt + H_2O), * Sugar syrup

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Solid solutions :-

Solute	Solvent	Examples
① Gas	Solid	* H_2 gas on Ni metal surface (used in ghee industry)
② Liquid	solid	* liquid mercury in any metal (amalgum)
③ Solid	Solid	* Alloys (Brass, Bronze, steel) (mixing of different metals).

② On the basis of amount of solute in solution :-

→ Depending on the amount of salute, Solutions can be classified as:-

① unsaturated solution
② Saturated solution
③ Super-saturated solution

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① Unsaturated solution:-

→ A solution which contains

* lesser amount of solute

than that which is required to saturate it, at a given temperature,

is called unsaturated solution.

Note:- Such solutions have the capacity to dissolve more solute, to become a saturated solution.

e.g:- Solution of NaCl in water $< 36.5\,g\ NaCl / 100mL$

② Saturated solution:-

→ A solution which contains

* maximum amount of solute

at a given temperature

is called saturated solution.

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Note:- Such solution donot have capacity to dissolve more solute at a given temperature.

e.g:- Solution of NaCl in water, $36\frac{5}{g}$ NaCl/100mL

Explanation:-

→ When a small amount of solute is added in a solvent, at a given temperature, it dissolves very easily.

→ If the addition of solute is kept on, a stage is reached, when solvent cannot dissolve any more solute.

→ At this stage, further added solute remains undissolved and

it settles down at the bottom of the container.

Dynamic equilibrium:-

→ On the particle level, in the saturated solution

★ undissolved solute is in equilibrium with dissolved solute

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→ At this stage, dynamic equilibrium is established.

→ Although dissolution and crystallization continue at a given temperature,

but the net amount of dissolved solute remains constant.

③ Supersaturated solution :-

→ A solution which contains

* greater amount of solute

than that which is required to make a saturated solution,

is called supersaturated solution.

Note:- Such solutions are more concentrated → than the saturated solutions, and are not stable.

e.g:- Solution of NaCl in water, $>36\frac{5}{9}$ g NaCl/100mL

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Explanation:-

→ When saturated solutions are heated, they develop further capacity to dissolve more solute.

→ So, an easy way to get a supersaturated solution is,

* to prepare a saturated solution at high temperature.

→ When supersaturated solution is cooled down, then excess solute crystallizes out and leaves behind a saturated solution.

Note:-

→ A supersaturated solution is not stable in the presence of

* Crystals of solute.

→ If we add a crystal of solute to a saturated solution,

* it will simply drop to the bottom, without dissolving.

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→ But, if we add a crystal of solute to a supersaturated solution,

* it will start crystallization.

→ After the crystallization has finished, we will have a saturated solution, in the presence of crystals of solute.

③ On the basis of relative amount of solute :-

→ Depending upon the relative amount of solute,

solutions can be classified as:-

① Dilute solutions
② Concentrated solutions

① Dilute solutions :-

→ The solutions which contain relatively

* small amount of dissolved solutes

are called dilute solutions.

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② Concentrated solutions:-

→ The solutions which contain relatively

* large amount of dissolved solutes

are called concentrated solutions.

e.g:- Brine is a concentrated solution of

* common salt (NaCl) in water.

e.g:- 0.5M NaOH is dilute solution, as compared to 1M NaOH, (concentrated solution).

Note:-

→ The terms dilute and concentrated describe

* the concentration of the solution.

→ Addition of more solvent will dilute the solution and its concentration decreases.

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⑥ Solubility :-

→ The maximum amount of solute, which dissolves

* in a specified amount of solvent,
* at a specific temperature

is called solubility.

OR

→ The number of grams of solute, dissolved

* in 100 g of solvent, to prepare a saturated solution,
* at a specific temperature

is called solubility.

e.g:- Solubility of NaCl at :-

$20^{\circ}C \rightarrow 36.5\,g/100\,g$ of H_2O

$100^{\circ}C \rightarrow 39.2\,g/100\,g$ of H_2O

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Factors affecting solubility:-

→ The solubility of a substance depends on:

① Solvent (like dissolves like)
② Temperature
③ Pressure (For gases). $P \propto$ Solubility.

Effect of temperature on solubility:-

→ Depending on the nature of solute, there is either:-

① increase in solubility with temperature

e.g:- KCl, NH_4Cl

② decrease in solubility with temperature

e.g:- Na_2SO_4, $Ca(OH)_2$ and gases.

Graph of Solubility Curves

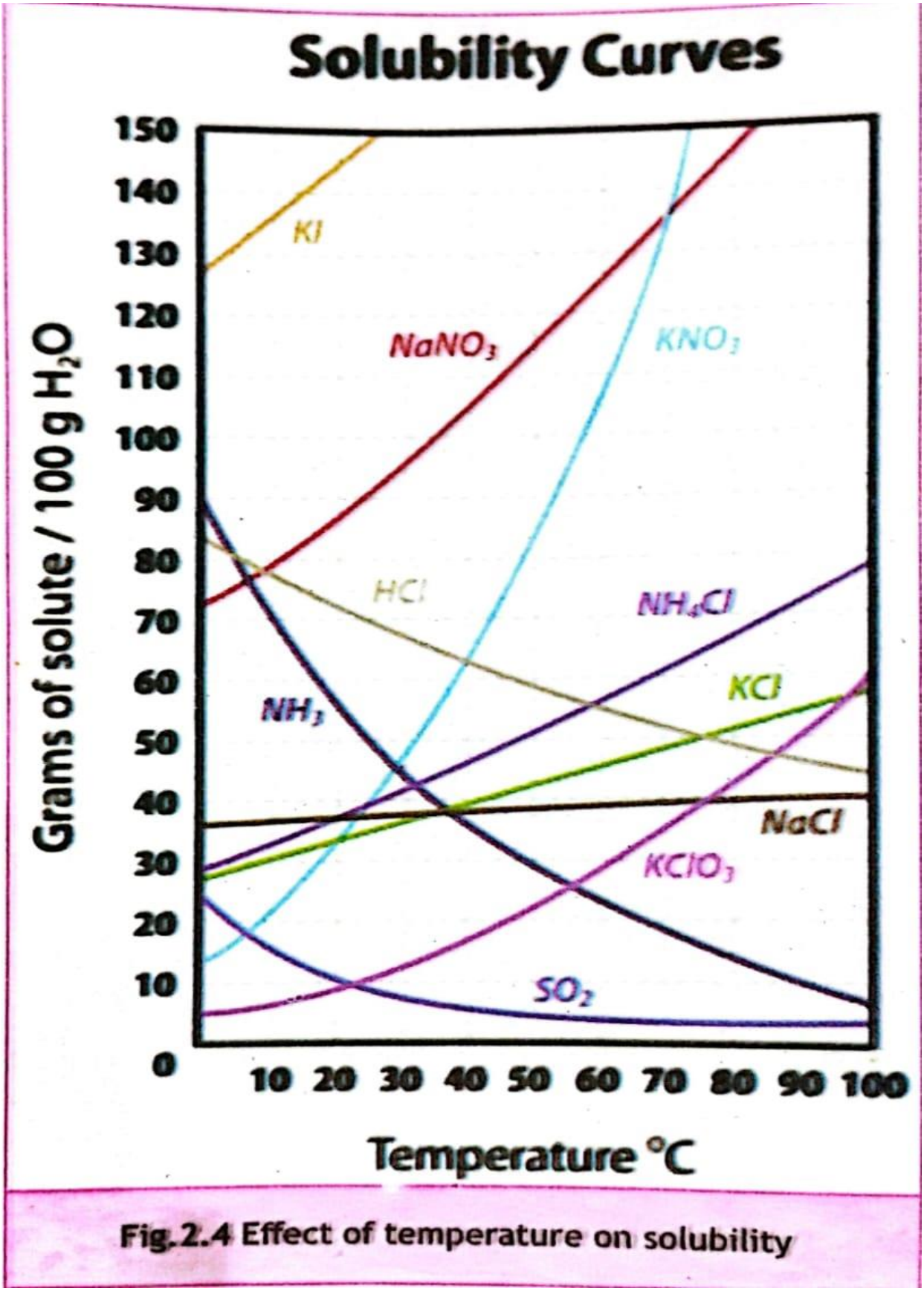

Fig. 2.4 Effect of temperature on solubility

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⑦ Differentiate between
* Solution
* Colloid &
* Suspension :-

* Definition
* Particle size & visibility DPV FTS
* Filteration
* Tyndall effect
* Settle down

① Solution:-

→ A homogeneous mixture of two or more components, in which one substance is dissolved in the other.

→ Particle size is less than 1nm. Not visible by naked eye.

→ Particles can pass through normal as well as ultra-filter papers.

→ Particles of solution are very small, so they cannot scatter the beam of light. (No Tyndall effect)

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→ Particles donot seperate or settle down when stationary

e.g:- Sea water, sugar solution etc.

② Colloids :-

→ A heterogeneous mixture of two or more components, in which solute particles are larger than those present in solutions.

→ Particle size vary from $1 \rightarrow 10^3$ nm. Not visible by naked eye.

→ Particles can pass through normal filter paper but not through ultra-filter paper.

→ Particles of colloids are big enough to scatter the beam of light.

(show Tyndall effect).

→ Particles donot seperate or settle down when stationary

e.g:- Milk, Gelatin, glue, rubber, jellies, paints blood etc.

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③ Suspension:-

→ A heterogeneous mixture of two or more components, in which solute particles are spread throughout the liquid,

*without dissolving in it.

→ Particle size greater than 10^3 nm. Visible by naked eye.

→ Particles cannot pass through normal as well as ultra-filter paper.

→ Particles of suspension are big, and can scatter the beam of light.

(show Tyndall effect)

→ Particles seperate or settle down, when stationary.

e.g:- Muddy water, chalk in water, sand in H_2O etc.

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Aqueous solution:-

→ It is formed by dissolving

* different substances (solids, liquids or gases) other in water.

Note:- Water is called universal solvent.

→ Aquous solutions are mostly used in laboratories.

Exercise # CH-02

Q #02:

(i) Can you write the formula of carbon-dioxide gas that we exhale?

Ans:- CO_2

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(ii) ✓

(iii) ✓

(iv) ✓

Q#3. ✓

Q#4:- What is the difference between homogenous and heterogeneous solution?

Mixture:-

→ A combination of two or more substances (elements or compounds)

* that are physically mixed together, but
* not chemically combined

is called as mixture.

Types:-

→ Mixtures can be classified into:-

① Homogenous solution
② Heterogeneous solution

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① Homogeneous solution:-

→ Solutions that have uniform composition throughout

are called homogeneous solution.

e.g:- air, gasoline, ice cream, salt solution, sugar solution etc.

② Heterogeneous solution:-

→ Solution that donot have uniform composition throughout

are called heterogeneous solution

e.g:- soil, rock and wood, muddy water etc.

Q # 5:- ✓

Q # 6:- If there are 18 protons in the argon atom, then what is the atomic number of argon?

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Ans:- Atomic number is the number of protons present in the nucleus.

So, number of protons (At) = Atomic number (Ar) = 18

Q # 7:- ✓

Q # 8:- ✓

Q # 9:- ✓

Chapter Completed