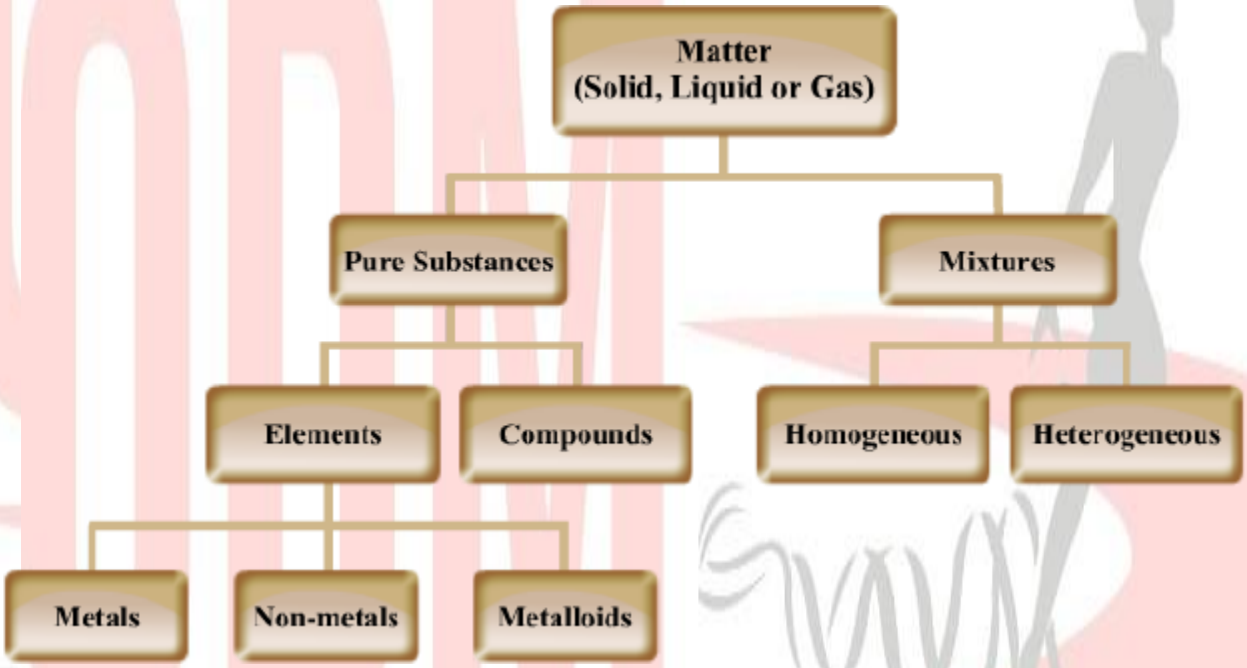
Chapter-5

PURE SUBSTANCES & MIXTURES; SEPARATION OF MIXTURES

STUDY NOTES

Classification of Matter



Characteristics of pure substances

- Pure substances have a perfectly homogeneous nature.
- Pure substances are made up of only one type of atoms (elements)or molecules(compounds).
- Pure substances have a fixed composition.

- Pure substances have a fixed density, melting point, boiling point physical and chemical properties

- All elements are mostly pure substances. A few of them include gold, copper, oxygen, chlorine, diamond, etc.

Characteristics of compounds:

- A compound is formed by mixing two or more elements in a fixed ratio by mass. For example, water is formed by mixing hydrogen and oxygen in the fixed ratio of 1:8 by mass.

- The properties of a compound are entirely different from the properties of its constituents.

- For example, oxygen supports combustion and hydrogen is an inflammable gas, while water is neither combustible nor does it support combustion.

- Whenever a compound is formed, it releases or absorbs heat. For example, when nitrogen and hydrogen combines to form ammonia, it releases a lot of heat.

- Since a compound is a pure substance, it will have fixed melting and boiling points. For example, ice melts at 0ºC, while water boils at 100ºC.

- The constituents of a compound cannot be separated using simple physical methods.

For example, water cannot be reduced to hydrogen and oxygen just by heating or filtering.

- Compounds such as water, salt or crystals, baking soda amongst others are also grouped as pure substances

Substances

Pure substances find uses in several industries. They can be used in medicines, chemicals, scientific research and experiments.

Substances may be separated from mixtures.

All solutions are mixtures but all mixtures are not solutions.

Mixtures

Matter generally exists as mixtures of two or more pure components or substances

Characteristics of a mixture:

Elements and compounds just mix to form a mixture, no chemical reaction.

- Composition variable.
- Retains properties of constituents, which can be separated by physical means.

- Mixtures may be homogeneous or heterogeneous.

Differences between substances and mixtures

Properties	Pure substances	Mixtures
Made of	Atoms or molecules.	Made of elements or compounds or both.
Composition	Compounds have fixed composition. The elements are always present in a definite proportion. E.g. sodium chloride will always contain one atom of sodium chemically bound to one atom of chlorine irrespective of its source.	A mixture does not have a definite composition. The percentage of each substance in a mixture can vary.
Physical properties	Fixed boiling and melting points.	No definite properties. Boiling point and melting point will depend on the amounts of the constituents present in the mixture.

Chemical properties	Properties of compounds are different from the properties of its constituent elements. E.g. Water is a liquid while hydrogen and oxygen are gases.	Components are loosely held together and they retain their individual properties
Formation	Formation of a compound is accompanied by energy change in the form of heat, light, sound or color.	Formation of the mixture does not involve any energy change.
Separation	Cannot be broken down into constituents by physical means. Chemical processes are needed.	Can be easily separated into its components by physical means.
Appearance	Characteristic taste, smell, odor.	Take the appearance of the components.
Uniformity	Always homogeneous.	Can be homogeneous or heterogeneous.
Examples	Lead, gold, silver, aluminum (elements). Carbon dioxide, ammonia, water,	Salt solution, sugar solution, alloys like bronze and brass, milk, air, honey

	calcium carbonate (compounds).	(homogeneous mixtures. Chalk in water, dust in air, Sulphur and iron filings, soil (heterogeneous mixture).

SEPARATION OFMIXTURES

The process of separating the ingredients of a mixture from one another so as to obtain pure substances is known as separation of mixtures.

Uses of separation of mixtures

- To remove impurities.

Example: Rice and cereals may have small stones, husk or soil particles which must be removed before cooking.

- To get useful substances.

Examples: 1. Salt is obtained from sea water which is a mixture.

2. Petrol, diesel and kerosene are obtained from crude petroleum oil which is a mixture of several different compounds.

- To obtain pure substances.

Example: Distilled water from tap water.

SEPARATION OF SOLID- SOLID MIXTURES

Process	Principle	Examples
Hand-picking	Based on the difference in size and appearance of components. Can be used only for substances that are large enough to be seen.	Removing stones from rice, rotten fruits from a basket of fruits.
Winnowing	Based on the difference in mass of components. Lighter solids can be blown away by the wind while heavier particles settle down.	Separation of rice from the husk.

Sieving	Based on the difference in size of components. The smaller ones pass through the sieve and the larger ones remain in the sieve.	Separation of: Impurities from flour. Sand from stones in construction sites. Coins of different sizes.
Magnetic separation	Based on the principle that one component is magnetic and is attracted by a magnet while the other is not.	Iron filings from sand or sulphur, metal scrap from garbage.
Sublimation	Based on the principle that one component can pass directly into vapour phase when heated and can be collected by condensing the vapours. One component remains in solid state.	For separating mixture of sand and iodine (iodine is sublime), mixture of common salt and ammonium chloride (ammonium chloride is sublime), for obtaining pure

		camphor.
Solvent extraction	Based on the principle that one component is soluble in water while the other is not.	Separating mixture of sand and salt. Salt dissolves in water while sand settles down.

Separation of solid-liquid mixtures

Process	Principle	Examples
Sedimentation and decantation	Based on the difference in density of components. Heavier particles settle down and liquid is transferred to another container.	Separating sand and water.
Filtration	The filter will allow only liquid to pass through and will retain the solid.	Removing tea leaves from tea, sawdust from water.

		Removing chalk particles from water.
Evaporation	One component can move into the gaseous state on heating while the other remains in the solid form.	Salt from salt water.
Crystallisation	Solid is obtained by heating its solution and evaporating the solvent.	Copper sulphate crystals from its solution.

Separation of miscible liquids

Process	Principle	Examples
Distillation	Based on the principle that pure substances have fixed boiling points and can be condensed from vapour form.	Acetone from water, alcohol from water, distilled water from tap water.

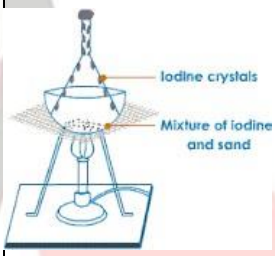
Centrifugation	Based on the difference in density of components. Heavier particles settle down and light particles float on top.	Separating cream from milk, remove water drops from wet clothes in washing machines, separating RBCs from plasma to do blood tests.

Separation of immiscible liquids

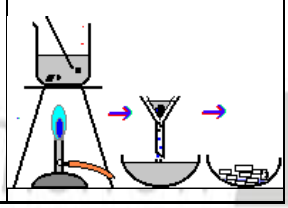
Process	Principle	Examples
Separating funnel	Based on the difference in density of two liquids. Lighter one floats on top and heavier one settles down.	Kerosene from water, oil from water.

METHODS OF SEPARATION OF MIXTURES

Separating components of solid- solid mixtures

Handpicking – based on difference in size, shape, colour of constituents  Stones from grains	Sieving- based on difference in size of constituent particles  Bran from wheat flour	Winnowing-based on difference in the weights of the constituent particles  Grains from chaff	Magnetic separation- one constituent is magnetic and can be picked up by a magnet (iron and sand) 	Sublimation- based on property of solid going directly into vapour state  Iodine and sand (iodine alone is sublime)

Separation of solid-liquid mixtures

Sedimentation and decantation- insoluble heavy solid particles settle down at bottom due to gravity and clear liquid above can be removed (muddy water)	Filtration- based on solid being insoluble and lighter than liquid particles (clay and water)	Centrifugation- when rotated, lighter particles move to top and heavier particles settle at bottom	Evaporation- Liquid constituent evaporates leaving solid behind (salt from water)	Crystallization-pure crystals of solid separate out on cooling saturated solution (copper sulphate) 

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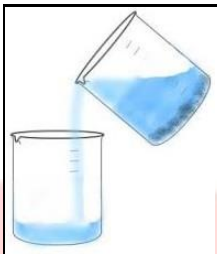
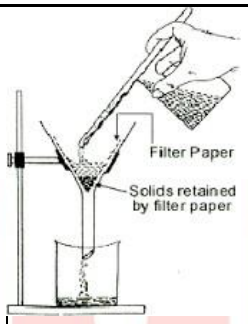
<td>  </td>
<td> 
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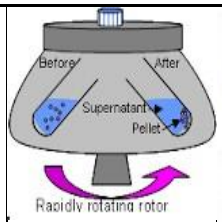
<td> 
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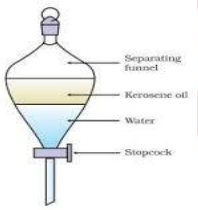
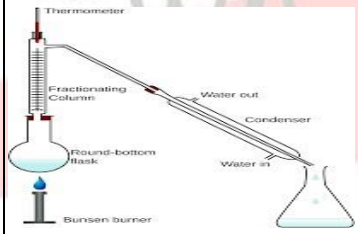
Separation of liquid -liquid mixture	
Separating funnel- heavier liquid forms lower layer, lighter liquid forms upper layer. Only for immiscible liquids  kerosene and water	Distillation- based on difference in boiling points of miscible liquids  methyl and ethyl alcohol