IS MATTER AROUND US PURE-2

SUBSTANCE: A substance is a kind of matter that cannot be separated into other kind of matter by any physical process.

PURE SUBSTANCE-It means that all the constituent particles of that substance are the same in their chemical nature. A pure substance consists of a single type of particles.

MIXTURE-Mixtures are constituted by more than one kind of pure form of matter, known as a substance.

Examples:-

1. Air is a mixture of nitrogen, oxygen, carbon dioxide, water vapour (moisture) and a small amount of other substances.
2. Salt and water

PROPERTIES OF MIXTURE:-

- The constituents of a mixture can be separated by physical methods like filtration, evaporation, sublimation, magnetic separation, etc.
- In the preparation of a mixture, energy is usually neither given out nor absorbed.
- The composition of a mixture is not fixed.
- Moisture has no definite melting point, boiling point, etc.
- In the formation of a mixture, no chemical reaction occurs.

Types of Mixture : Mixtures are of two types on the basis of their composition - Homogeneous mixture and Heterogeneous mixture.

HOMOGENEOUS MIXTURE

Mixtures which have uniform composition throughout are called Homogeneous Mixture.

For example – mixture of salt and water, mixture of sugar and water, air, lemonade, soda water, etc.

General Properties of Homogeneous Mixture:

- All solutions are the examples of homogeneous mixture.
- The particles of a homogeneous mixture are less the one nanometer

- A homogenous mixture does not show Tyndall effect.
- The boundaries of particles cannot be differentiated.
- The constituent particles of homogenous mixture cannot be separated using centrifugation or decantation.

HETEROGENEOUS MIXTURE

Mixtures which do not have uniform composition throughout are called Heterogeneous Mixture.

For example – mixture of soil and sand, mixture of sulphur and iron fillings, mixture of oil and water etc.

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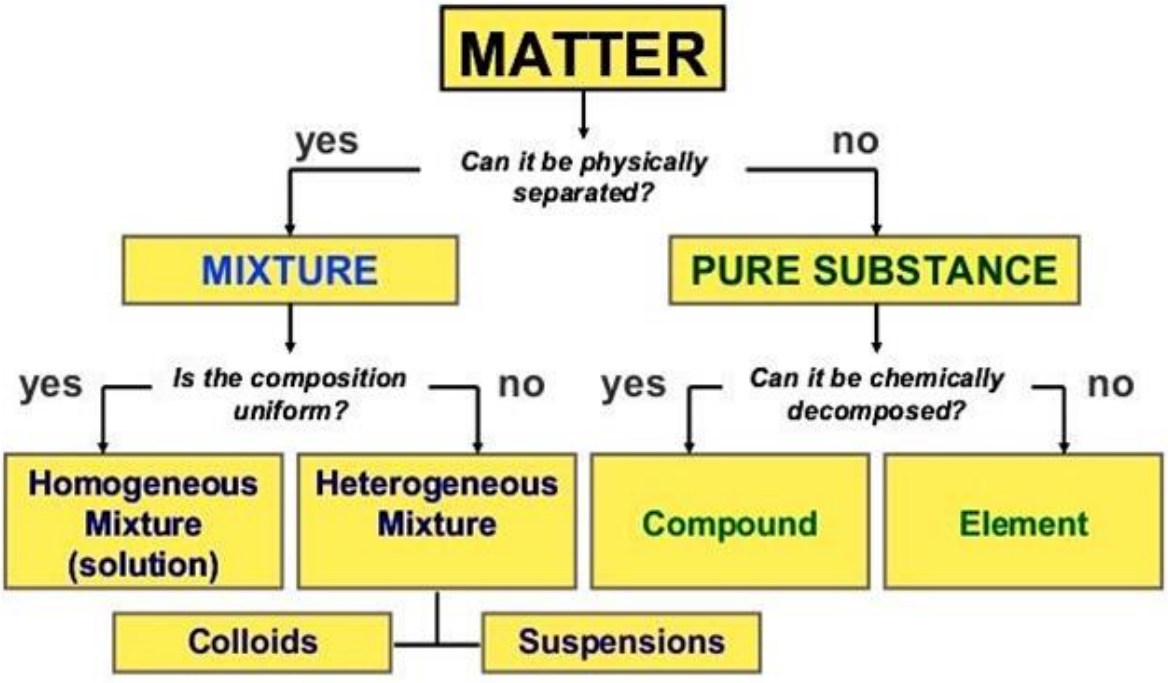
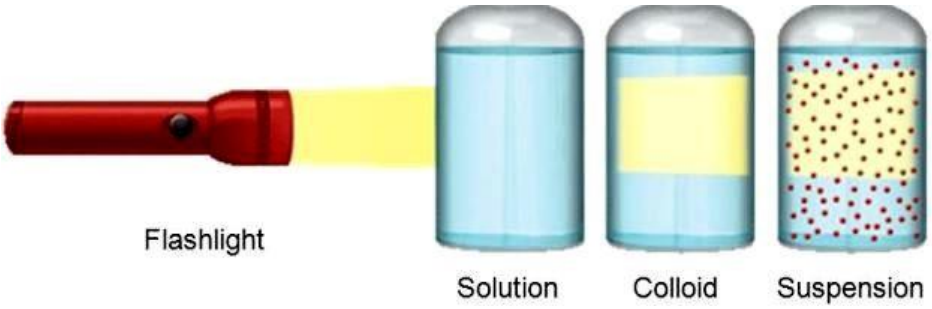
General Properties of Heterogeneous Mixture:

- Most of the mixtures are heterogeneous except solutions and alloys.
- The components of a heterogeneous mixture can be identified easily.
- Generally, two or more phases are present in a heterogeneous mixture.
- Particles of a heterogeneous mixture are sized between one nanometer and one micrometer or more.
- Heterogeneous mixtures show Tyndall effect.



Mixture can be categorized in three types on the basis of their particles' size.

1. **Solution,**
2. **Suspension**
3. **Colloid.**



SOLUTION

A solution is defined as a homogeneous mixture of two or more chemically non-reacting substances whose composition can be varied within limits.

A solution has two components i.e solute and solvent

SOLVENT:- The part of solution that is present in larger quantity is called solvent.

SOLUTE:- The part of solution that is present in small quantity is called solute.

Example – if a solution contain 12g of sugar and 300g of water then water is solvent and sugar is solute.

Examples of solution:

(i) A solution of sugar in water is a solid in liquid solution. In this solution, sugar is the solute and water is the solvent.

(ii) A solution of iodine in alcohol known as 'tincture of iodine', has iodine (solid) as the solute and alcohol (liquid) as the solvent.

(iii) Aerated drinks like soda water etc., are gas in liquid solutions. These contain carbon dioxide (gas) as solute and water (liquid) as solvent.

(iv) Air is a mixture of gas in gas. Air is a homogeneous mixture of a number of gases. Its two main constituents are: oxygen (21%) and nitrogen (78%). The other gases are present in very small quantities.

Properties of a solution

- A solution is a homogeneous mixture.
- The particles of a solution are smaller than 1 nm (10^{-9} metre) in diameter. So, they cannot be seen by naked eyes.
- Because of very small particle size, they do not scatter a beam of light passing through the solution. So, the path of light is not visible in a solution.
- The solute particles cannot be separated from the mixture by the process of filtration.
- The solute particles do not settle down when left undisturbed, that is, a solution is stable.

TYPES OF SOLUTION:- Solutions can be divided into two classes depending upon the amounts of solute dissolved.

1. **Unsaturated solution**:- An unsaturated solution is one in which more solute can be dissolved without increasing the temperature.

For example, a solution of sugar in water in which more sugar can dissolve at a given temperature is an unsaturated solution.

2. **Saturated solution:-** At any particular temperature, a solution that has dissolved as much solute as it is capable of dissolving, is said to be a saturated solution.

SOLUBILITY -The amount of the solute present in the saturated solution at this temperature is called its solubility.

CONCENTRATION OF SOLUTION

Concentration: Concentration is the amount of solute present in a given amount of solvent or solution.

$$This\ means\ Concentration = \frac{Amount\ of\ solute}{Amount\ of\ Solvent}\ or\ \frac{Amount\ of\ solute}{Amount\ of\ Solution}$$

Thus, concentration is the ratio of amount of solute and amount of solvent.

Concentration can be expressed in mass percentage or volume percentage of a solution.

(a) Mass percentage of a solution

$$Concentration = \frac{Mass\ of\ solute}{Mass\ of\ solution} \times 100$$

This means when concentration is expressed in mass percentage, it is called concentration by mass percentage.

(b) Volume percentage of a solution

$$Concentration = \frac{Volume\ of\ solute}{Volume\ of\ solution} \times 100$$

This means when concentration is expressed in volume percentage, it is called concentration by volume percentage.

State of Solvent	State of Solute	State of Solution	Examples
Gas	Gas	Gas	Air, natural gas
Liquid	Liquid	Liquid	Alcoholic beverages, Antifreeze solution;
Liquid	Solid	Liquid	Seawater, sugar solution
Liquid	Gas	Liquid	Carbonated water (soda) Ammonia solution;
Solid	Solid	Solid	Metal alloys: brass, bronze,..
Solid	Gas	Solid	Hydrogen in platinum

SUSPENSION

A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium. Particles of a suspension are visible to the naked eye.

Properties of a Suspension

- Suspension is a heterogeneous mixture.
- The particles of a suspension can be seen by the naked eye.
- The particles of a suspension scatter a beam of light passing through it and make its path visible.
- The solute particles settle down when a suspension is left undisturbed, that is, a suspension is unstable. They can be separated from the mixture by the process of filtration.

COLLOIDAL SOLUTIONS

Colloidal solution appears homogenous but actually it sis heterogenous.A colloidal solution is somewhat between a true solution and a suspension. The sizse of a colloidal particle is larger than that of one in a true solution but smaller than that of one in a suspension.

Properties of a colloid

- A colloid is a heterogeneous mixture.
- The size of particles of a colloid is too small to be individually seen by naked eyes.
- Colloids are big enough to scatter a beam of light passing through it and make its path visible.
- They do not settle down when left undisturbed, that is, a colloid is quite stable.
- They cannot be separated from the mixture by the process of filtration.

Table 2.1: Common examples of colloids

Dispersed phase	Dispersing Medium	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
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

S.No.	Property	True Solution	Colloidal Solution	Suspension
1.	Size of Particles	Less than 10^{-9} m	Between range of 10^{-9} m – 10^{-6} m	More than 10^{-6} m
2.	Nature	Homogeneous	Appears homogeneous but is heterogeneous.	Heterogeneous
3.	Visibility	The solute particles are invisible to naked eye and also under the microscope.	The solute particles are invisible to naked eye but can be viewed under powerful microscope.	The solute particles are visible to naked eye.
4.	Stability	The solute particles do not settle down and are stable.	The solute particles do not settle down and are stable. (On centrifugation the particles can settle)	The solute particles settle down and are unstable.
5.	Filtration	The solute particles can pass through filter paper and no residue is seen on filter paper.	The solute particles passes through filter paper and no residue is left. (But the particles cannot pass through parchment membrane)	The solute particles can not pass through filter paper and residue is collected on filter paper.
6.	Transparency	Transparent	Translucent	Opaque

(1) Evaporation :

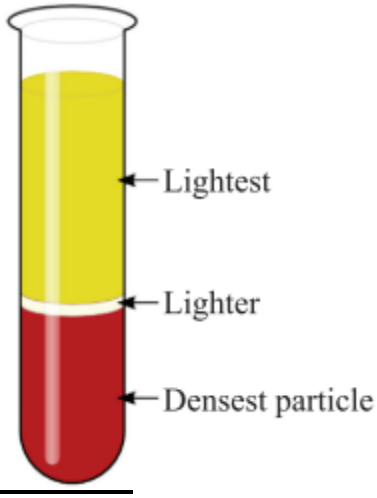
Basic principle : Out of the two components of a mixture one can evaporate [i.e., has less boiling point] and other has higher boiling point.

Example: Mixture of dye [higher boiling point] and water. Out of water and dye, water evaporates but dye is left behind in petri dish.

Fig. 2.5: *Evaporation*

(2) Centrifugation :

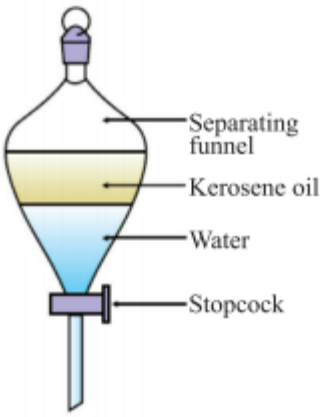
Basic principle : When mixture is rotated very fast, then denser particles are forced at the bottom and lighter particles stay above.
Example : Separating cream from milk.
Can you think what is toned and double toned milk ?
Applications :
(a) Used in diagnostic labs for blood and urine tests.
(b) Used in dairies and home to separate butter from cream.
(c) Used in washing machines dryers to squeeze out water from clothes.



(3) Differential e

Basic principle : Two immiscible liquids (which do not dissolve in each other) can be easily separated by putting in a differential separating funnel.

Example : Water from oil can be separated by first opening the stop cock till water is removed in one beaker, then afterwards oil can be collected in a separate beaker.

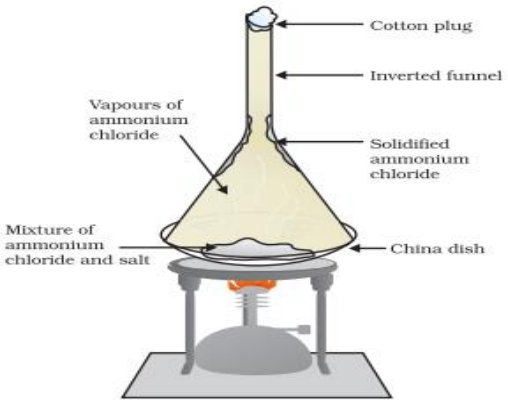


Applications :

(a) Separation of oil from water.
(b) Extraction of iron from its ore. Lighter slag is removed from above the molten iron.

(4) Sublimation :
Basic principle : Out of the two components, one will sublime (directly converts to gas from solid) and other will not.

Example : NH4Cl (ammonium chloride) and NaCl common salt mixture can be easily separated by heating so that NH4Cl sublimes but common salt remains behind.



Applications

Fig. 2.7: *Separation of ammonium chloride and salt by sublimation*

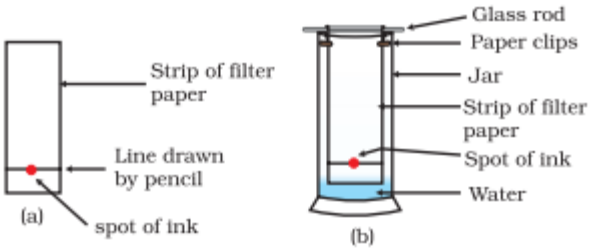
(a) Camphor, naphthalene, anthracene, NH4Cl can sublime.

(4)Chromatography :

Basic principle : Coloured components of a mixture can be separated by using an adsorbent on which they are adsorbed at different rates.

PROCEDURE

- Take a thin strip of filter paper.
- Draw a line on it using a pencil, approximately 3 cm above the lower edge .
- Put a small drop of ink (water soluble, that is, from a sketch pen or fountain pen) at the centre of the line. Let it dry.
- Lower the filter paper into a jar/glass/ beaker/test tube containing water so that the drop of ink on the paper is just above the water level, as shown in Fig . and leave it undisturbed.
- Watch carefully, as the water rises up on the filter paper.
- You will see that the colours got separated.



Applications :

(a) To separate colours of a dye.
(b) To separate pigments from natural colours like chlorophyll.
(c) To separate drugs from blood.

Distillation

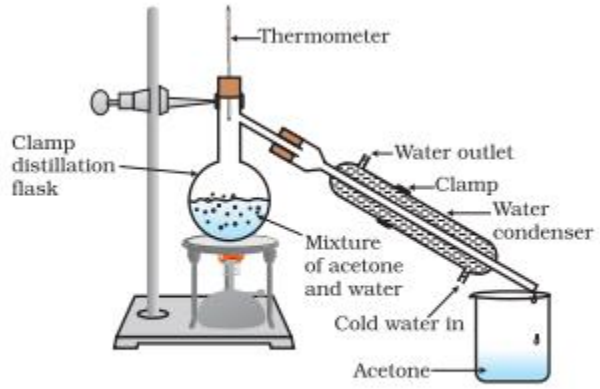
Basic principle : Out of the two components one has a lower boiling point and other has higher boiling point. This is used to separate two or more miscible liquids.

PROCEDURE

Let us try to separate acetone and water from their mixture.

- Take the mixture in a distillation flask. Fit it with a thermometer.
- Arrange the apparatus as shown in Fig.

- Heat the mixture slowly keeping a close watch at the thermometer.
- The acetone vaporises, condenses in the condenser and can be collected from the condenser outlet.
- Water is left behind in the distillation flask.



Separation of two miscible liquids by distillation

Fractional Distillation

To separate a mixture of two or more miscible liquids for which the difference in boiling points is less than 25 K, fractional distillation process is used.

Example-

- for the separation of different gases from air
- different petroleum products from crude oil.

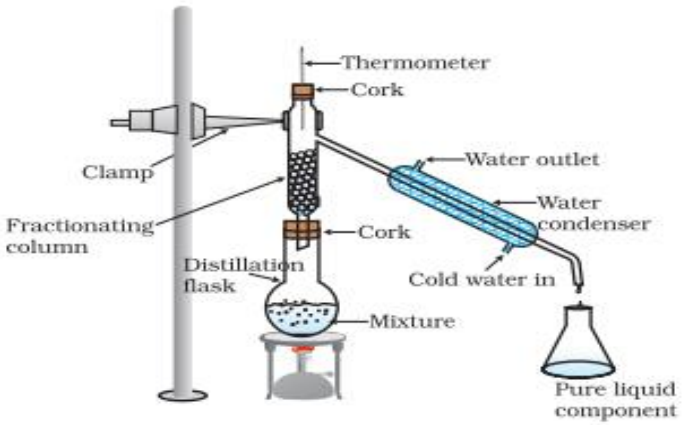
APPARATUS

- The apparatus is similar to that for simple distillation, except that a fractionating column is fitted in between the distillation flask and the condenser.

- A simple fractionating column is a tube packed with glass beads.

- The beads provide surface for the vapours to cool and condense repeatedly, as shown in Fig.

SEPARATIO



- Air comprises of nitrogen, oxygen, carbon dioxide and argon as major components.
- Since air is the cheapest source of these gases, thus these are extracted from air at large scale
- After liquefaction of air by repeated compression and cooling; nitrogen, oxygen, carbon dioxide and argon are extracted using fractional distillation.
- Liquid nitrogen has boiling point equal to - 190^0C and thus turns into gas first and separated from air.
- The boiling point of argon is - 186^0C, therefore it is extracted after argon.
- The boiling point of oxygen is - 183^0C, thus it is collected after the extraction of argon.
- Carbon dioxide turns into solid at a temperature of - 97^0C, therefore, it is removed while air is put under liquefaction.

USE

Nitrogen is used as fertilizers, oxygen is used in hospitals and argon is used in bulbs.

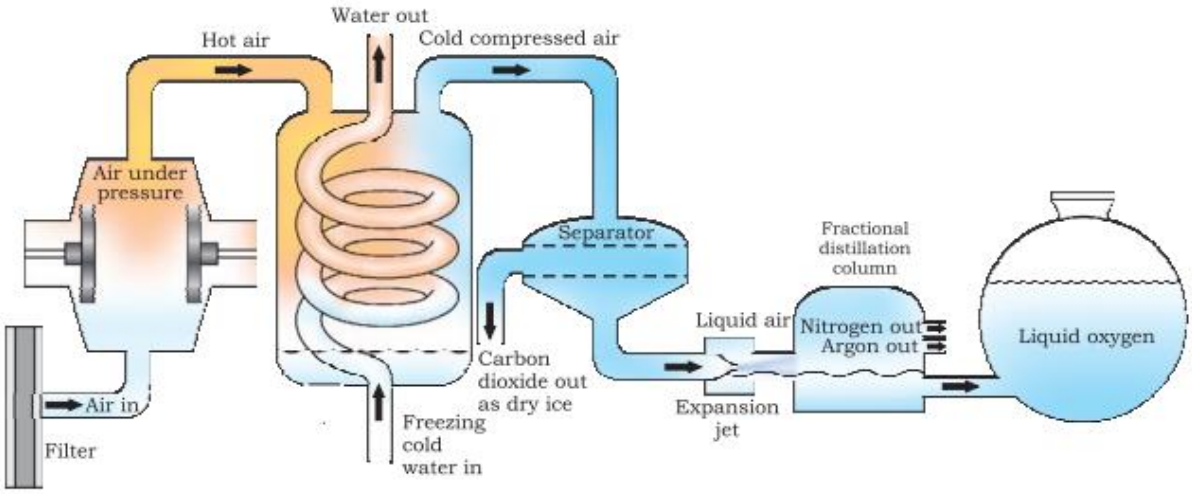


Fig. 2.12: *Separation of components of air*

Crystallisation

Basic principle :

To remove impurities from a mixture by first dissolving in a suitable solvent and then crystallising out one component.

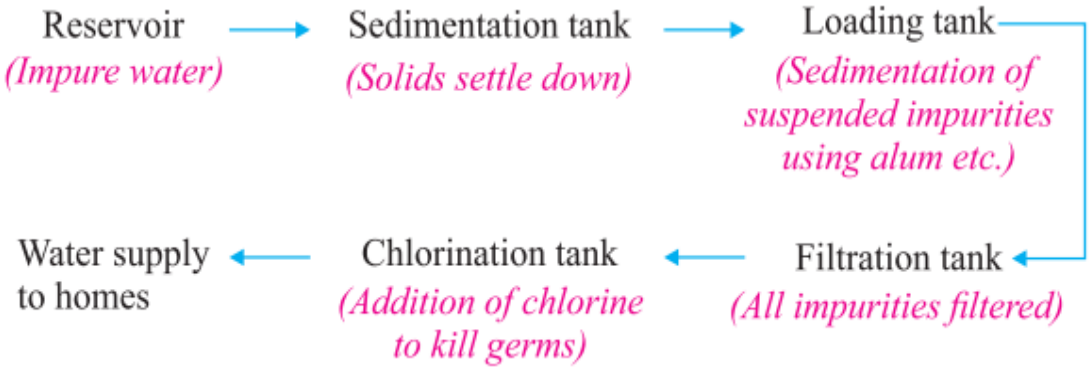
PROCEDURE

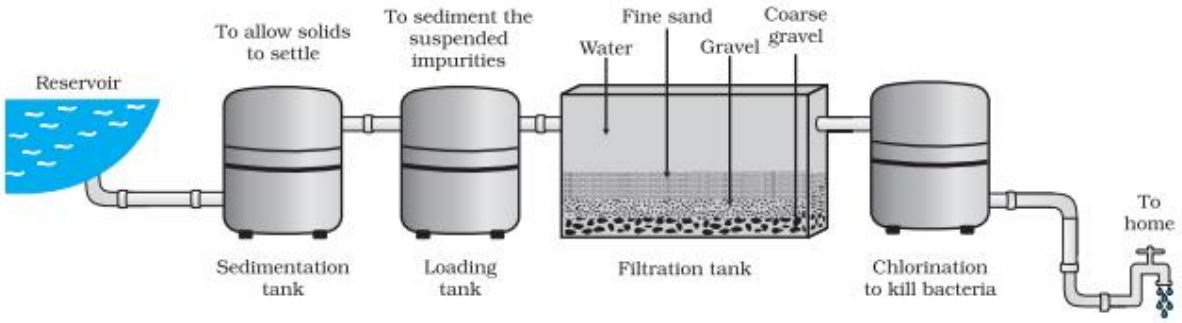
- Take some (approximately 5 g) impure sample of copper sulphate in a china dish.
- Dissolve it in minimum amount of water.
- Filter the impurities out.
- Evaporate water from the copper sulphate solution so as to get a saturated solution. Cover the solution with a filter paper and leave it undisturbed at room temperature to cool slowly for a day.
- You will obtain the crystals of copper sulphate in the china dish.

Applications

(1) Purification of salt that we get from sea water.
(2) Separation of crystals of alum (phitkari) from impure samples.

Water purification in water treatment plants

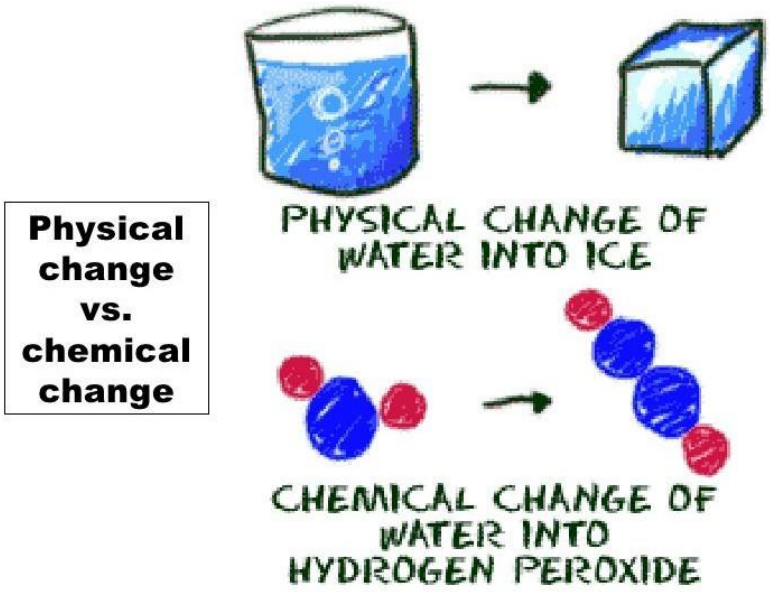




PHYSICAL CHANGE:

The change in which no new substance is formed is called a physical change. During a physical change, chemical properties do not change but physical properties do change.

CHEMICAL CHANGE: The change in which a new substance is formed is called a chemical change. During a chemical change, chemical properties change.

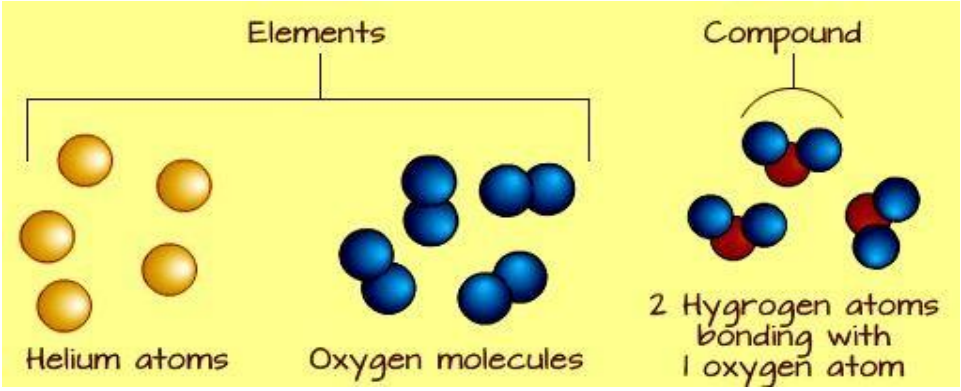


PURE SUBSTANCES

Elements and Compounds are considered as pure substances.

Elements – Substances that is made of only one element are called elements, such as hydrogen, carbon, oxygen, silver, gold, etc.

Compounds – Substances that is made of one or more elements by chemical combination are called compounds, such as water, carbon dioxide, copper oxide, hydrochloric acid, etc.



	Compound	Element
Distinguishing Feature	Compounds contain different elements in a fixed ratio arranged in a defined manner through chemical bonds.	Elements are distinguished by their atomic number (number of protons in their nucleus).
Ability to Breakdown	A compound can be separated into simpler substances by chemical methods/reactions.	Elements cannot be broken down into simpler substances by chemical reactions.
Types	The list of compounds is endless.	There are about 117 elements that have been observed. Can be classified as metal, non-metal or metalloid.
Representation	A compound is represented using a formula.	An element is represented using symbols.
Examples	Water (H_2O), Sodium chloride ($NaCl$), Sodium bicarbonate ($NaHCO_3$) etc.	Iron, copper, silver, gold, nickel etc.

Mixture	Compound
Elements are physically mixed in any ratio and no new compound is formed.	Elements are chemically combined in a fixed ratio to form a new compound.
They have no sharp or definite melting point, boiling point, density etc.	They have definite melting point, boiling point, density etc.
A mixture exhibits the properties of its constituent or component elements.	Property of a compound is different from its constituent or component elements.
They are either homogeneous or heterogeneous in nature.	They are always homogeneous in nature.
Constituents of a mixture can be separated by physical methods like filtration, magnetic separation etc.	Constituents of a compound cannot be separated by physical methods.