Is Matter Around us Pure?

Chapter 2

Class 9 Science

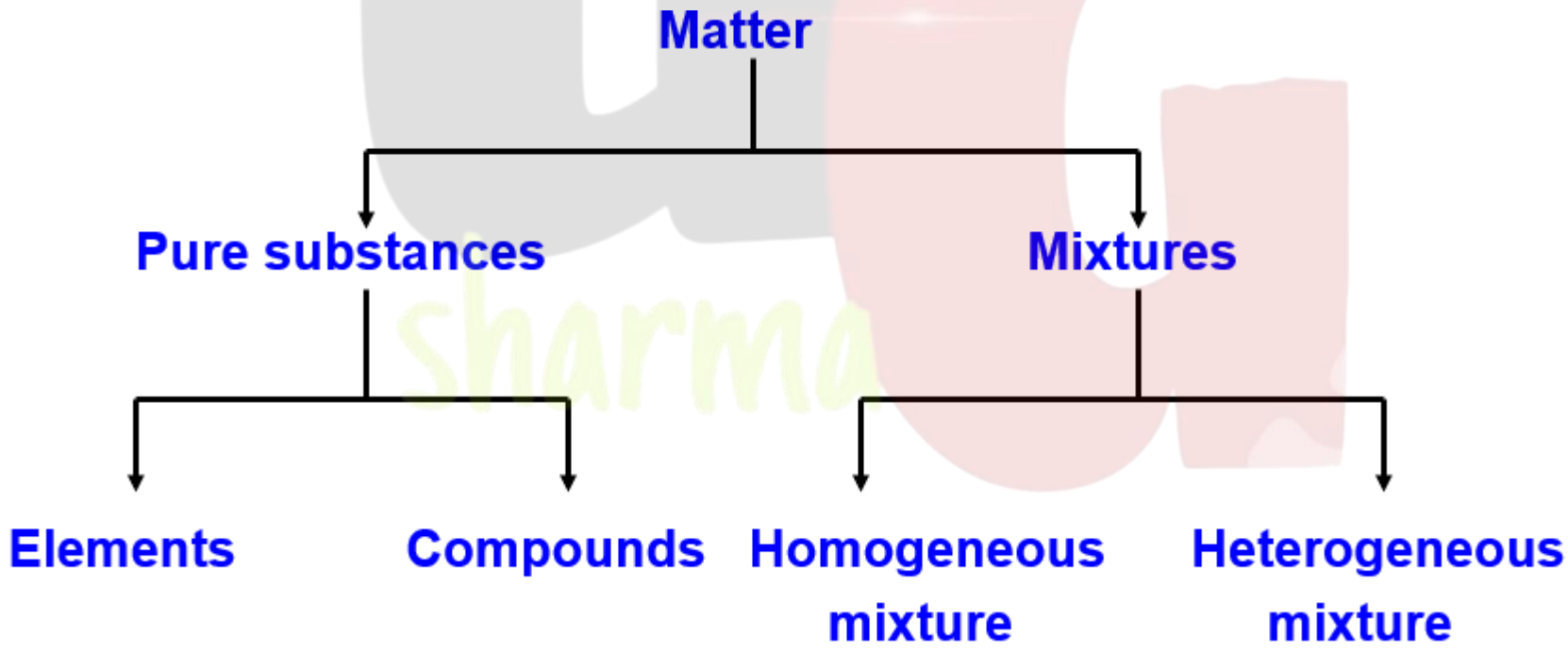
•Topics in the Chapter

- Introduction
- Types of pure substances
- Difference between mixtures and compounds
- Mixture and its types
- Solution and its properties
- Concentration of a solution
- Suspension and its properties
- Colloidal solution and its properties

Introduction

MATTER :- Anything that having mass and occupy some space.

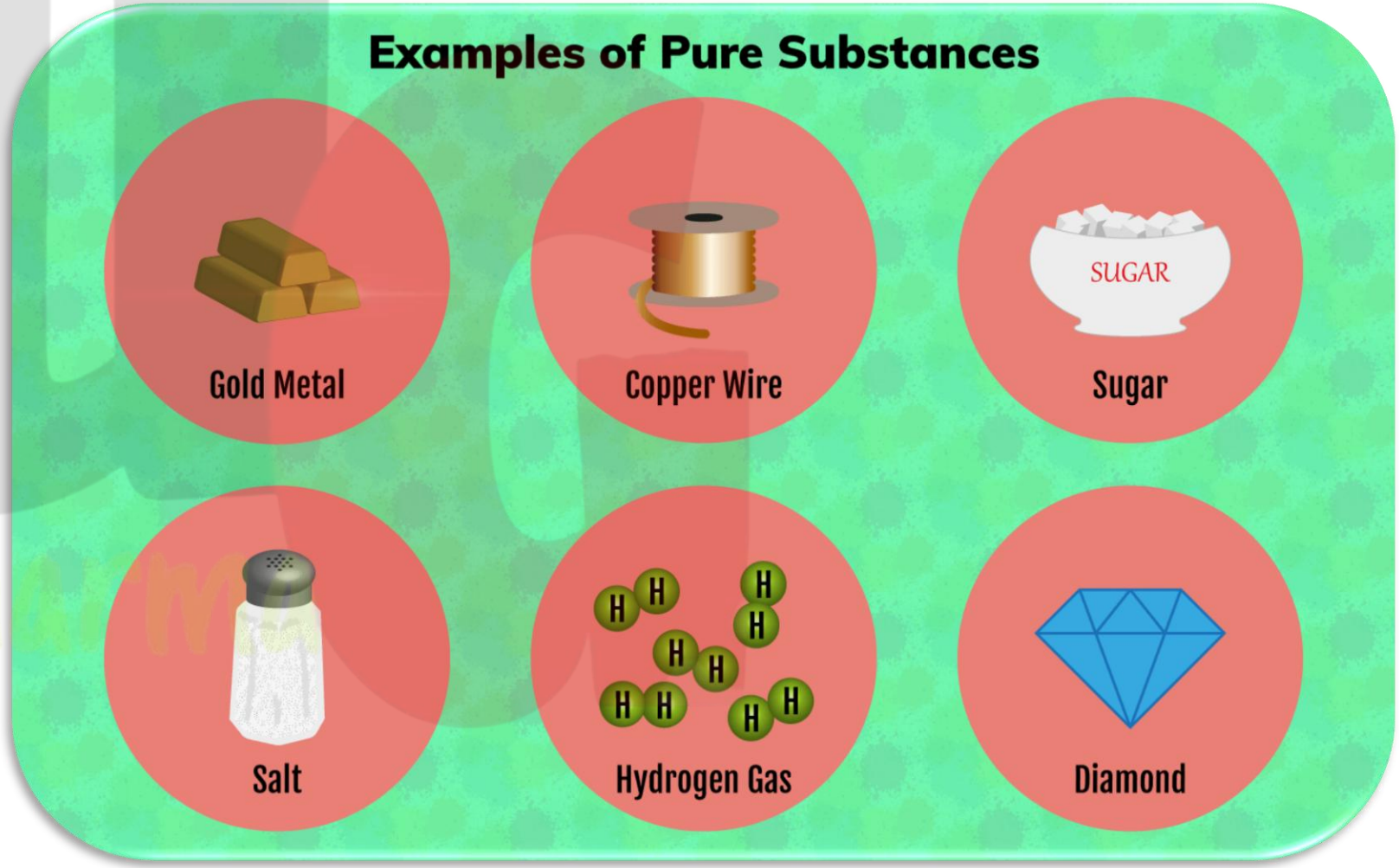
i) On the basis of the physical state, matter is classified into three main types. They are solids, liquids and gases.
ii) On the basis of chemical composition matter is classified into two main types. They are pure, substances and mixtures.



Pure Substance

It consists of single types of particles which are same in their chemical nature.

The pure substance is divided in two types on the basis of their chemical composition:
(i) Elements
(ii) Compounds

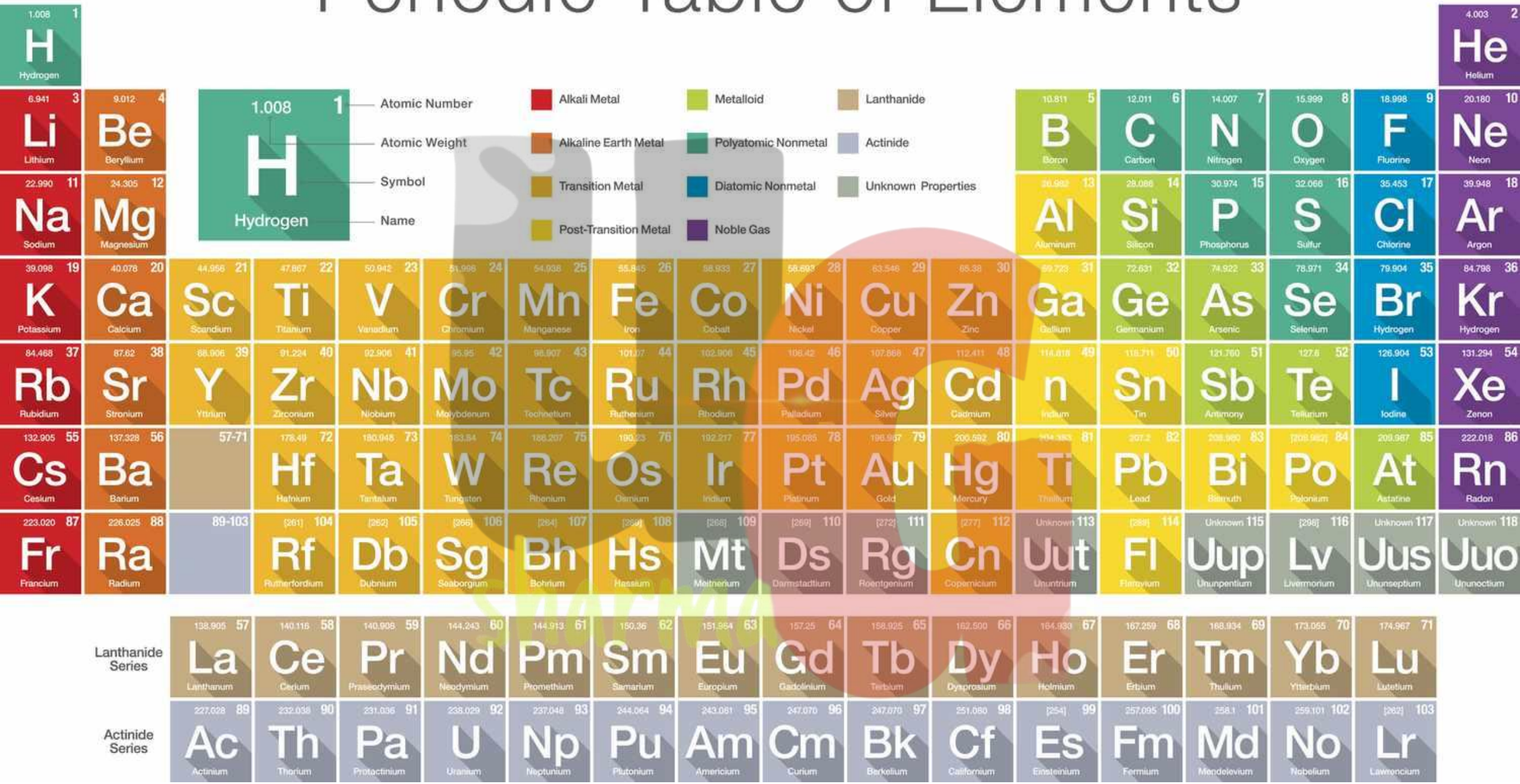


Element

- Robert Boyle was the first scientist to use the term element in 1661.
- Antoine Laurent Lavoisier (1743–94), a French chemist, was the first to establish an experimentally useful definition of an element.
- According to Antoine Laurent Lavoisier, element is a basic form of matter that cannot be broken down into simpler substances by chemical reactions.
- It is divided in three types which are :-

i. Metals
ii. Non-metals
iii. Metalloids.

Periodic Table of Elements



Properties of Metals

(i) They have a lustre (shine).
(ii) They have silvery-grey or golden-yellow colour.
(iii) They conduct heat and electricity.
(iv) They are ductile (can be drawn into wires).
(v) They are malleable (can be hammered into thin sheets).
(vi) They are sonorous (make a ringing sound when hit).

- Examples of metals are gold, silver, copper, iron, sodium, potassium etc.
- Mercury is the only metal that is liquid at room temperature.

Properties of non-metals

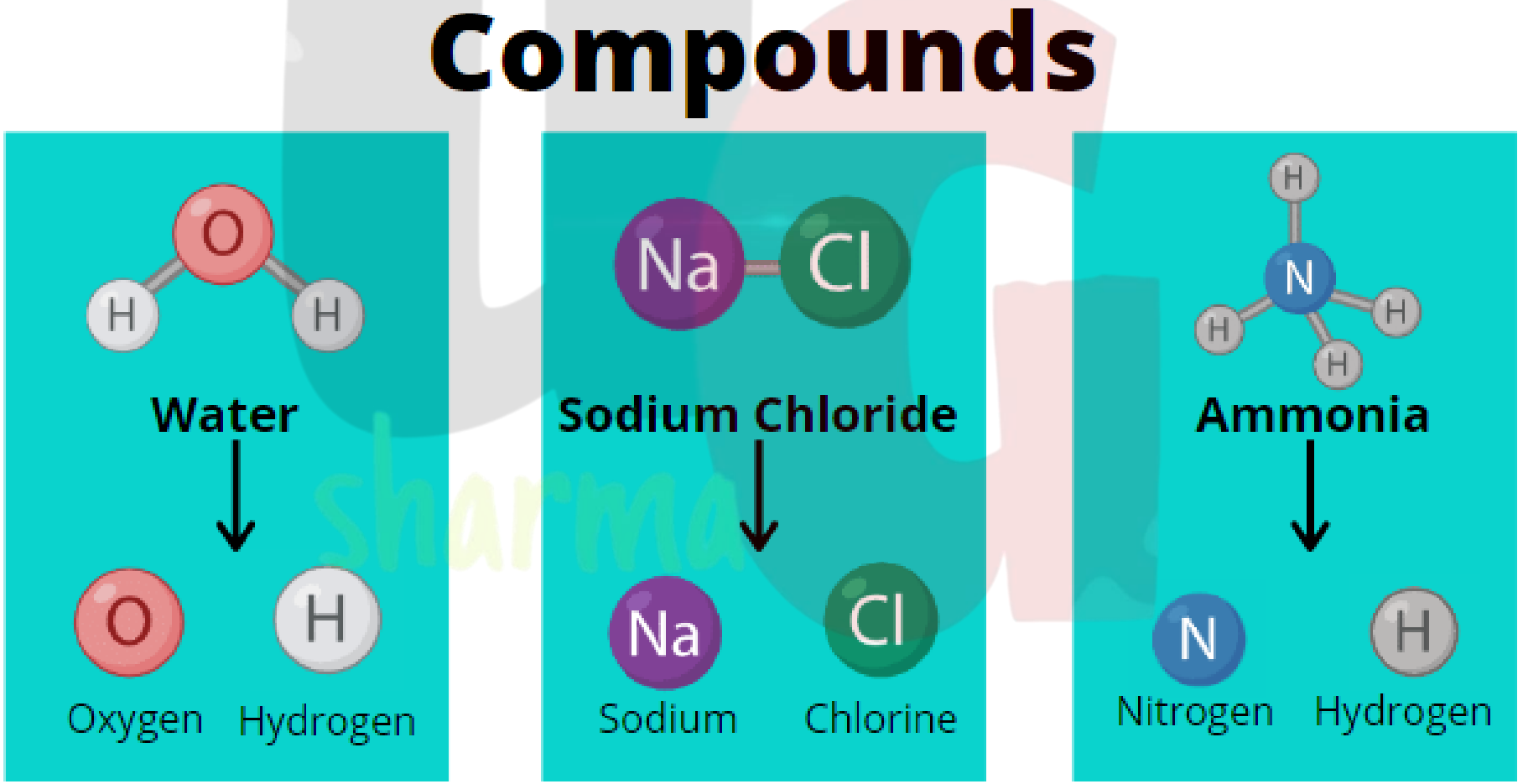
(i) They display a variety of colours.
(ii) They are poor conductors of heat and electricity.
(iii) They are not lustrous, sonorous or malleable.

- Examples of non-metals are hydrogen, oxygen, iodine, carbon (coal, coke), bromine, chlorine etc.

Metalloids: Elements having intermediate properties between those of metals and non-metals are called metalloids.
Examples are boron, silicon, germanium etc.

Compounds

A compound is a substance composed of two or more elements, chemically combined with one another in a fixed proportion.



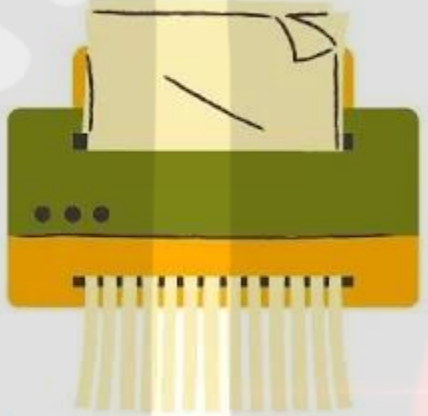
Elements	Compounds
Made up of atoms.	Made up of molecules.
It cannot be disintegrated further into fine particles by any chemical method.	It can be reduced down to simpler substance by using chemical method.
It shows same properties as that of constituent particle.	Its properties are totally different from its constituents.
E.g Oxygen, Hydrogen etc	E.g Water (compound) is made up of oxygen and hydrogen.

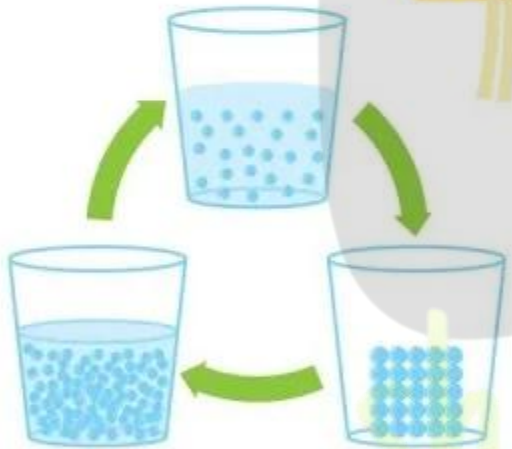
Physical and Chemical changes

- The process which brings about changes in physical properties and no new substances are formed are physical changes. The common physical changes are changes in colour, hardness, rigidity, fluidity, density, melting point, boiling point etc.

- The process in which new substances are formed and chemical properties of substances get changed are chemical changes. Some chemical properties are odour, inflammability etc.

Physical & Chemical Changes





Physical change	Chemical change
1. In a physical change, only physical properties such as colour, physical state, density, volume, etc. change; chemical properties remain unchanged.	1. In a chemical change, the chemical composition and chemical properties undergo a change.
2. No new substance is formed in a physical change.	2. A new substance is formed in a chemical change.
3. Very little or no energy in the form of heat, light or sound is usually absorbed or given out in a physical change.	3. A chemical change is always accompanied by absorption or evolution of energy.
4. A physical change is a temporary change.	4. A chemical change is a permanent change.
5. The original form of substance can be regained by simple physical methods.	5. Original substance cannot be obtained by simple physical methods.
6. A physical change is reversible.	6. A chemical change is irreversible.

Questions

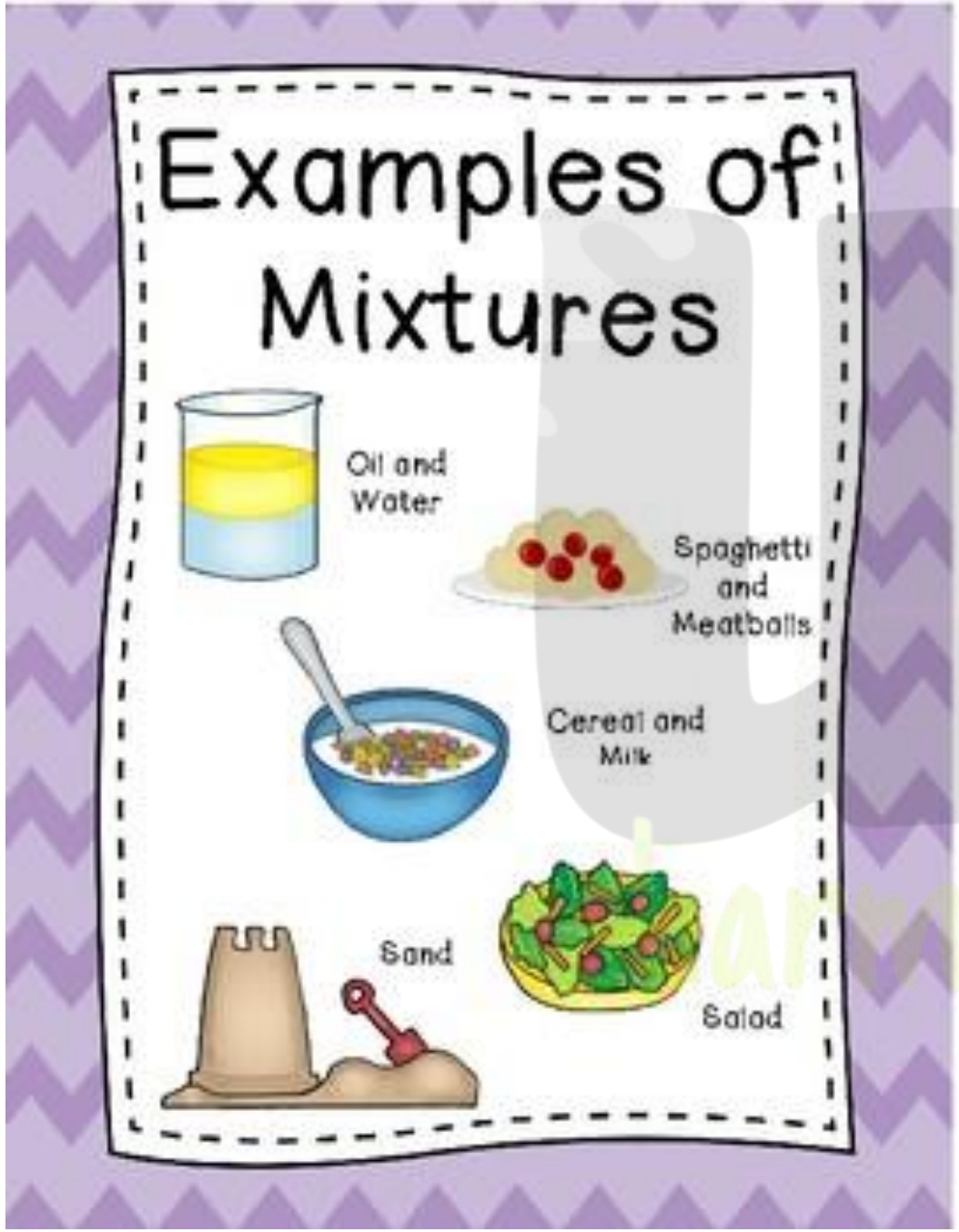
1. *Classify the following as chemical or physical changes:*
   - *cutting of trees,*
   - *melting of butter in a pan,*
   - *rusting of almirah,*
   - *boiling of water to form steam,*
   - *passing of electric current, through water and the water breaking down into hydrogen and oxygen gases,*
   - *dissolving common salt in water,*
   - *making a fruit salad with raw fruits, and*

Mixture

Mixture consists of more than one kind of pure substances which can be separated by physical method.

Mixtures are of two types
(i) Homogeneous mixture
(ii) Heterogeneous mixture

(i) Homogeneous mixture: A mixture is said to be homogeneous if all the components of the mixture are uniformly mixed and there are no boundaries of separation between them.
Ex: Sugar in water, etc.
(ii) Heterogeneous mixtures: A mixture is said to be heterogeneous if all the components of the mixture are not uniformly mixed and there are visible boundaries of separation between them.
Ex: Water and sand, Air etc.


Examples of Mixtures
Oil and Water
Spaghetti and Meatballs
Cereal and Milk
Sand
Salad

S.No.	Homogeneous solutions	Heterogeneous solutions
1.	Components are uniformly mixed.	Components are not uniformly mixed.
2.	It has single phase.	It has two or more distinct phases.
3.	No boundaries of separation between the components..	There are visible boundaries between the components.
4.	Components are invisible to naked eye.	Components are visible to naked eye.
5.	Examples of Homogeneous solutions are salt solution, lemonade, petrol etc.	Examples of Heterogeneous solutions are chalk in water, petrol in water, and sand in water.

Solution

A solution is a homogeneous mixture of two or more substances.
Ex: Lemonade, soda water etc.

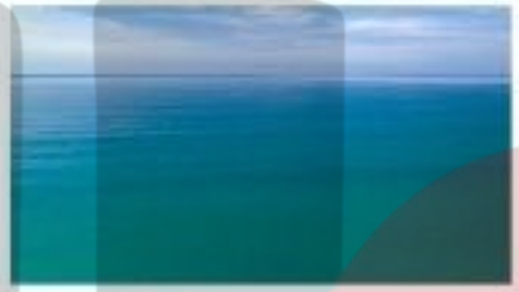
A solution has two components:
(i) Solvent
(ii) Solute

(i) Solvent: The component of the solution that dissolves the other component in it (usually the component present in larger amount) is called the solvent.

(ii) Solute: The component of the solution that is dissolved in the solvent (usually present in lesser quantity) is called the solute.

EXAMPLES OF SOLUTIONS

FOOD AND BEVERAGES



SALTWATER

AIR

HYDROGEN PEROXIDE

RUBBING ALCOHOL

BRASS

Properties of Solution:

1. A solution is a homogeneous mixture.

2. The particles of a solution are smaller than 1 nm (10^{-9}) in diameter which cannot be seen by naked eyes.

3. They do not scatter a beam of light passing through the solution that is they don't show tyndall effect. So, the path of light is not visible in a solution.

4. The solute particles cannot be separated from the mixture by the process of filtration.

5. The solution is stable and solute particles do not settle down when left undisturbed.

Concentration of a solution

Saturated solution: When no more amount of solute can be dissolved in a solution at a given temperature, it is called a saturated solution.

Unsaturated solution: When more amount of solute can be dissolved in a solution at a given temperature, it is called a unsaturated solution.

Solubility: The amount of the solute present in the saturated solution at the given temperature is
called its solubility.

The concentration of a solution is the amount of solute present in a given amount (mass or volume) of solution. Also, the amount of solute dissolved in a given mass or volume of solvent is called concentration of solution.

Concentration of a solution

Amount of solute/Amount of solvent or Amount of solute/Amount of solution (Here, amount means mass or volume).

(i) Mass by mass percentage of a solution

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

(ii) Mass by volume percentage of a solution

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

(iii) Volume by volume percentage of a solution

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

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.

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

Alloys:

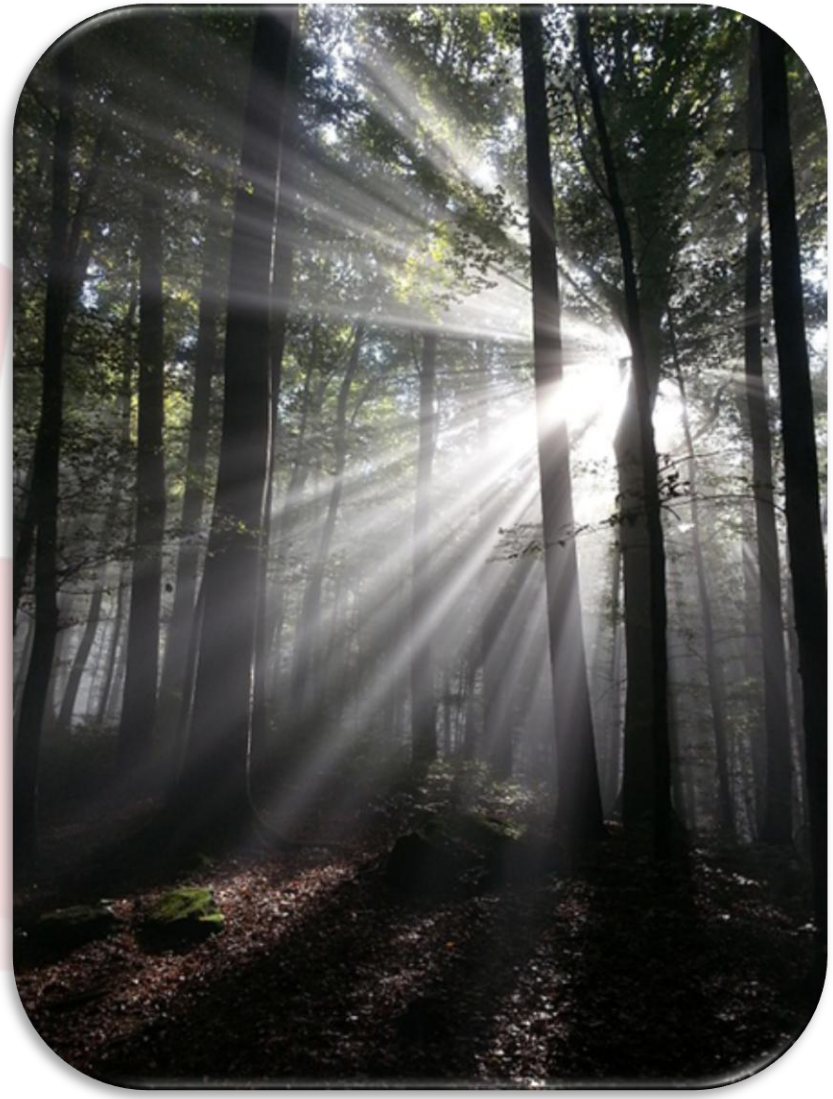
- Alloys are mixtures of two or more metals or a metal and a non-metal and cannot be separated into their components by physical methods.
- An alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition.
- For example, brass is a mixture of approximately 30% zinc and 70% copper.

Suspension

A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium.
Example: Chalk in water, smoke in the air

Properties of Suspension :

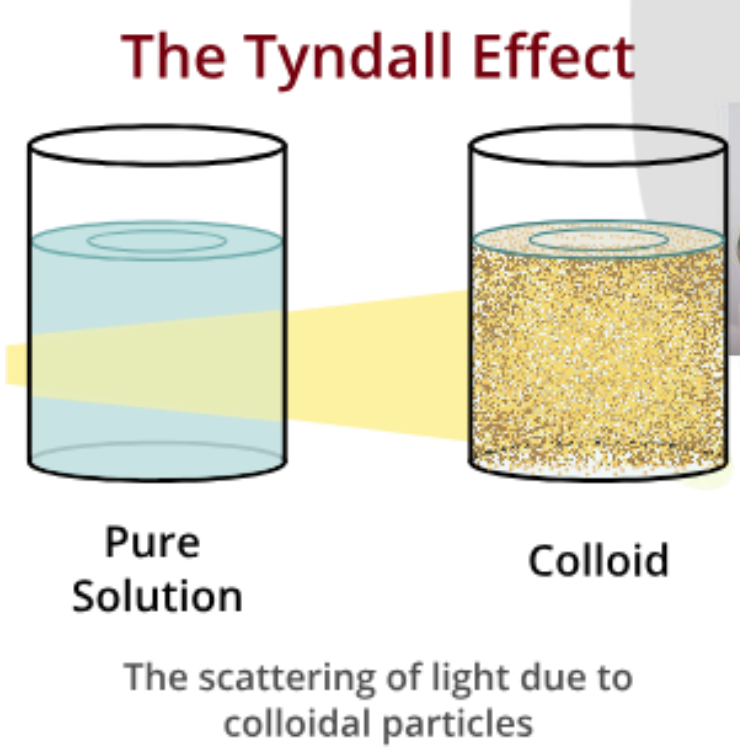
1. It is a heterogeneous mixture.
2. Particles of a suspension are visible to the naked eye.
3. Size of the particles is greater than 100 nm.
4. It is unstable mixture. Solute settles down at the bottom over period of time.
5. If the solution is passed through filter paper, solute and solvent gets separated.
6. It scatters light when light is passed through the solution i.e. it shows Tyndall effect.

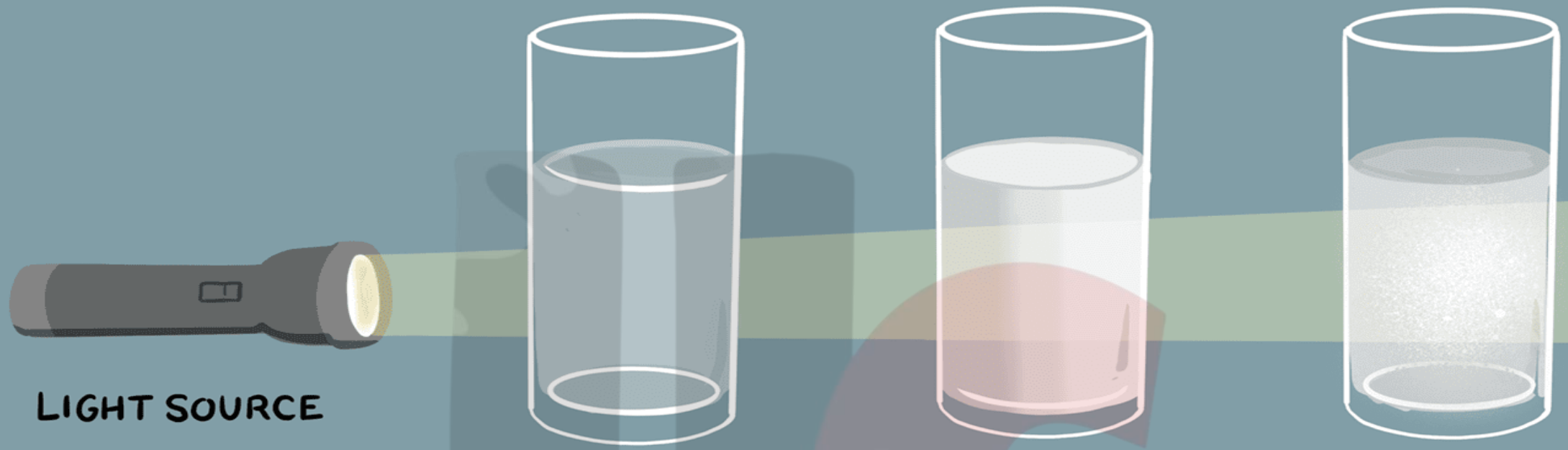


Colloidal solution

Colloid solution is heterogeneous mixture in which the size of particles lies between the true solutions and suspensions.

Colloidal particles can easily scatter a beam of visible light. This phenomenon is called **Tyndall effect.**





	SOLUTION	COLLOID	SUSPENSION
LIGHT BEAM:	NOT VISIBLE	VISIBLE	VISIBLE
EXAMPLE:	WATER	MILK	FLOUR AND WATER

THE TYNDALL EFFECT

THE TYNDALL EFFECT IS THE SCATTERING OF LIGHT BY PARTICLES IN A COLLOID OR SUSPENSION.

Properties of colloidal solution:

1. The particles of colloid can't be seen by naked eyes individually.

2. It is a heterogeneous mixture and thus solute and solvent can't be separated by filter paper.

3. Size of particles is smaller than suspensions but greater than solutions (1 nm to 100 nm).

4. It is a stable mixture. Particles do not settle down at the bottom over a period of time.

5. They do not settle down when left undisturbed which means colloid is quite stable.

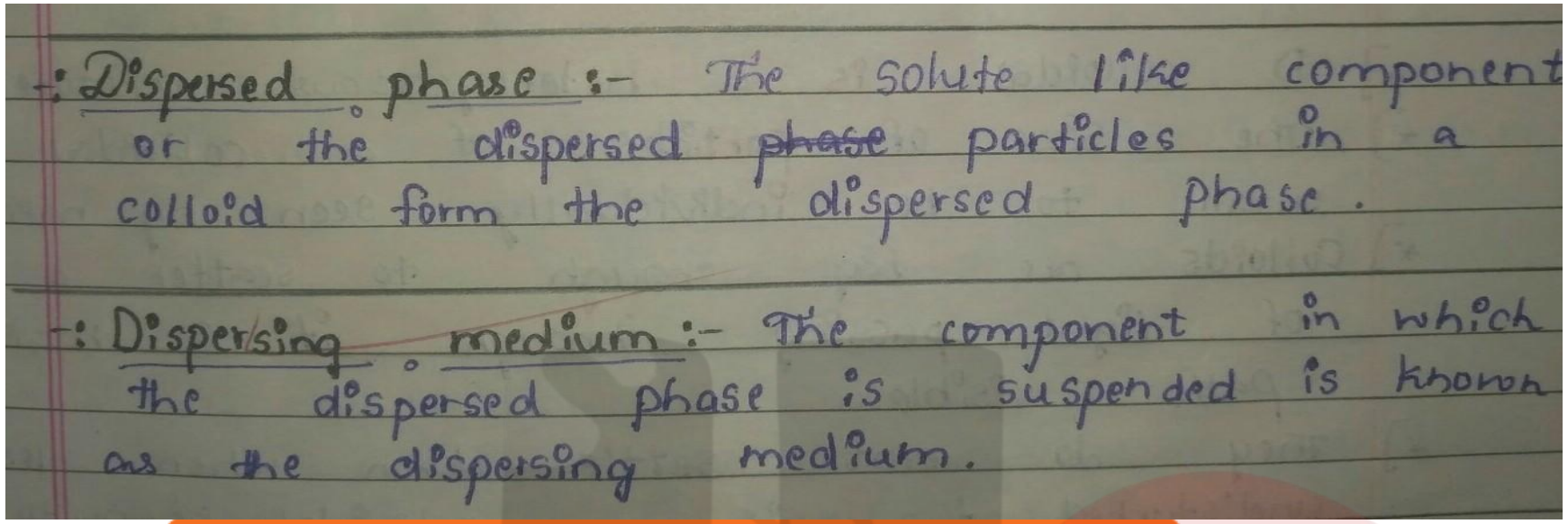
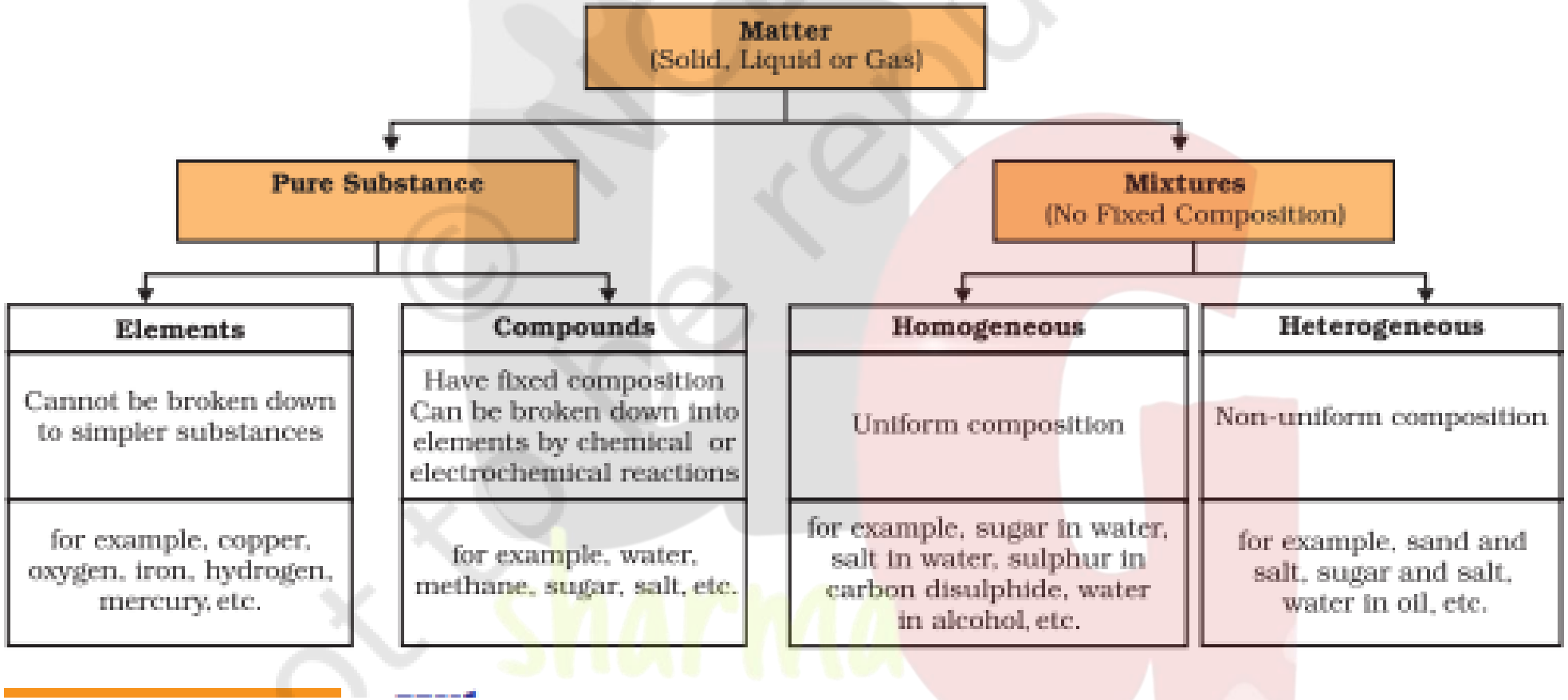


Table 2.1: Common examples of colloids

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

Mixtures	Compounds
1. Elements or compounds just mix together to form a mixture and no new compound is formed.	1. Elements react to form new compounds
2. A mixture has a variable composition.	2. The composition of each new substance is always fixed.
3. A mixture shows the properties of the constituent substances.	3. The new substance has totally different properties
4. The constituents can be separated fairly easily by physical methods.	4. The constituents can be separated only by chemical or electrochemical reactions.


Matter
(Solid, Liquid or Gas)
Pure Substance
Mixtures
(No Fixed Composition)
Elements
Cannot be broken down to simpler substances
for example, copper, oxygen, iron, hydrogen, mercury, etc.
Compounds
Have fixed composition Can be broken down into elements by chemical or electrochemical reactions
for example, water, methane, sugar, salt, etc.
Homogeneous
Uniform composition
for example, sugar in water, salt in water, sulphur in carbon disulphide, water in alcohol, etc.
Heterogeneous
Non-uniform composition
for example, sand and salt, sugar and salt, water in oil, etc.

2. Write the steps you would use for making tea. Use the words solution, solvent, solute, dissolve, soluble, insoluble, filtrate and residue.

3. 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?

(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.

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

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

4. Explain the following giving examples.
   (a) Saturated solution
   (b) Pure substance
   (c) Colloid
   (d) Suspension

5. Classify each of the following as a homogeneous or heterogeneous mixture.

   soda water, wood, air, soil, vinegar, filtered tea.

6. How would you confirm that a colourless liquid given to you is pure water?

7. Which of the following materials fall in the category of a "pure substance"?
   (a) Ice
   (b) Milk
   (c) Iron
   (d) Hydrochloric acid
   (e) Calcium oxide
   (f) Mercury
   (g) Brick
   (h) Wood
   (i) Air
8. Identify the solutions among the following mixtures.
   (a) Soil
   (b) Sea water
   (c) Air
   (d) Coal
   (e) Soda water
9. Which of the following will show "Tyndall effect"?
   (a) Salt solution
   (b) Milk
   (c) Copper sulphate solution
   (d) Starch solution
10. Classify the following into elements, compounds and mixtures.
   (a) Sodium
   (b) Soil
   (c) Sugar solution
   (d) Silver
   (e) Calcium carbonate
   (f) Tin
   (g) Silicon
   (h) Coal
   (i) Air
   (j) Soap
   (k) Methane
   (l) Carbon dioxide
   (m) Blood

11. Which of the following are chemical changes?

(a) Growth of a plant

(b) Rusting of iron

(c) Mixing of iron filings and sand

(d) Cooking of food

(e) Digestion of food

(f) Freezing of water

(g) Burning of a candle