Is Matter Around Us Pure?

Chapter 2

Is Matter Around Us Pure?

Distilled water — Pure

H_2O

O_2 N_2 H_2

Cow milk :→ [Water + Protein + fat + minerals]

Not Pure

Au

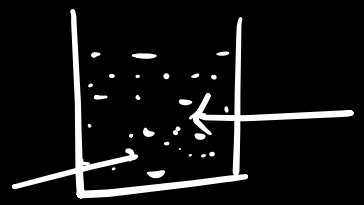
Fe

Distilled water is Pure

water H_2O salt partic.

NaCl $MgCl_2$

Bleaching Powder



Solution

Solvent

Milk

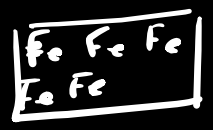
Matter

Pure Substance

Element

Single atom

Iron



Compound.

more than one type of atom.

Water

H_2O

Salt

Mixture

Homogeneous mixture

(Solution)

(Solvent)

(Solute)

Size

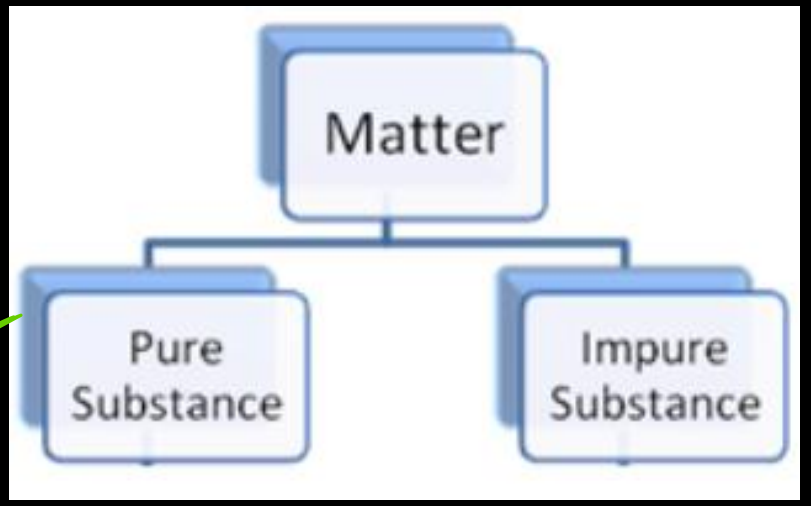
Heterogeneous mixture.

Suspension

Colloid

Substance

- Anything that cannot be broken into further particles by applying any physical processes is called a **Substance.**
- Matter can be classified into two types of substances – Pure substances and Mixtures.



Pencil

Wood

Mixtures.

Pure Substance

- A substance that consists of only one type of particle is called a Pure Substance.
- For Example, Diamond, Salt, Sulphur, Tin.

S-S-S-

HNO_3

$NaCl$

$H_2O + CO_2$

$Cu + Zn$

Alloy

Water

H_2O

CO_2

$CaCO_3$

Diamond

C

- Elements
- Compounds

Gold

Au

Mixture

in any ratio

- When we combine different substances into each other a mixture is formed.
- For Example, Lemonade is a mixture of three substances, Lemon Juice, Sugar and Water.

100 ml water + 2 g salt

100 ml water + 10 g salt

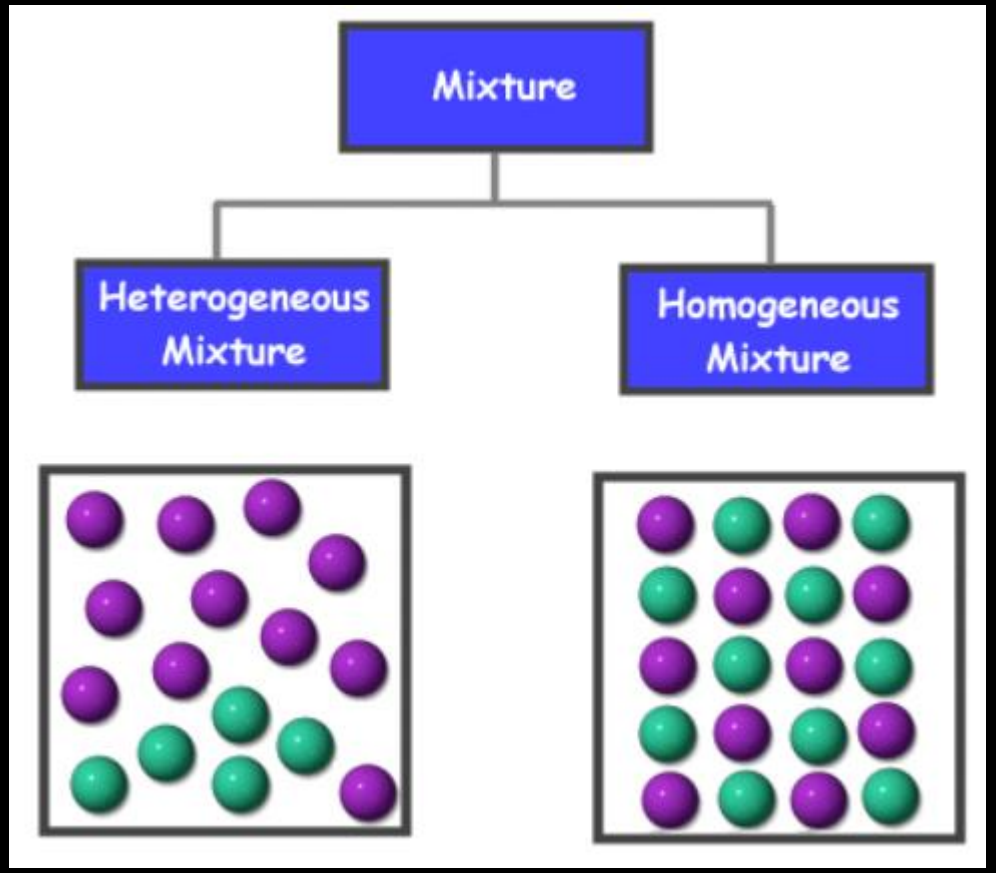
Which of these is a mixture or a pure substance?
Water, Copper, Chocolate cake, Hydrogen, Soil, Air

Pure Substance :- Hydrogen, Copper, Water

mixt

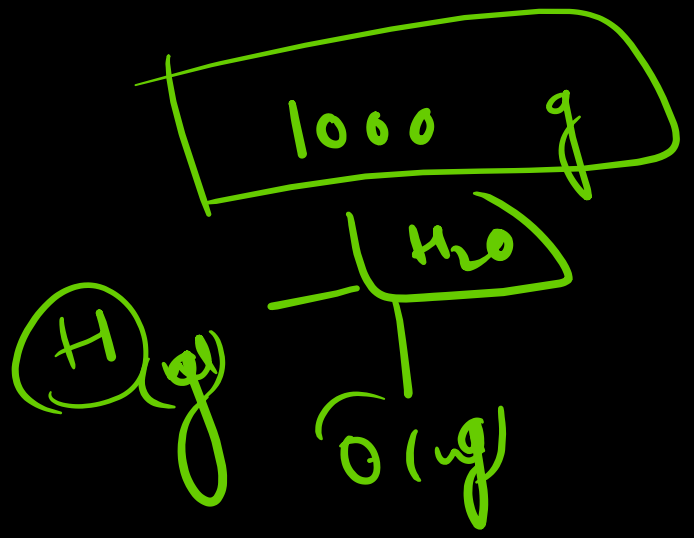
Types of Mixtures

- *There are two categories of mixtures: Homogeneous Mixtures and Heterogeneous Mixtures*



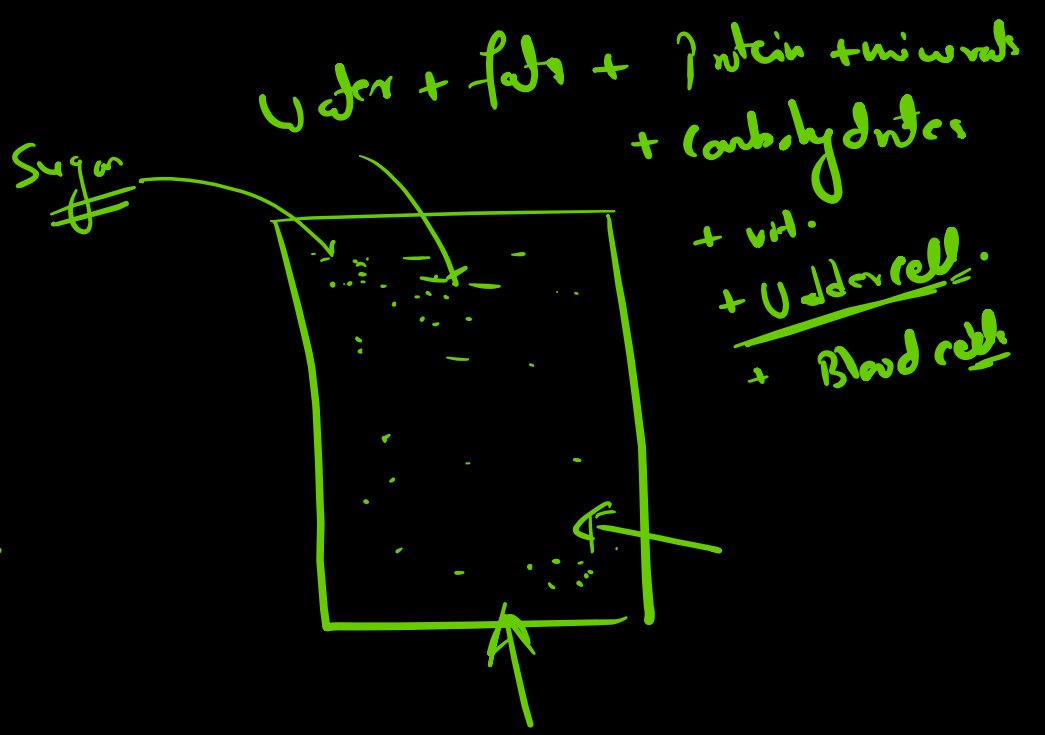
Homogeneous Mixture

- mixtures in which the components mix with each other uniformly are called Homogeneous Mixtures.
- Example: When we add sugar, water and lemon juice together they all uniformly mix with each other.
- The ratio of compositions of homogeneous mixtures can be different.
  - For Example, one may add two spoons of sugar in lemonade while someone else may add only one spoon of sugar in their lemonade. Still, lemonade is a homogeneous mixture.



Heterogeneous Mixtures

- The components in a heterogeneous mixture do not completely dissolve in each other and we can separate them by physical means.
  - In other words, the composition of such mixtures is not uniform.
- Example: If we mix sand in water the sand settles down in water after some time and we can separate it by filtration.



Homogeneous vs Heterogeneous mixtures

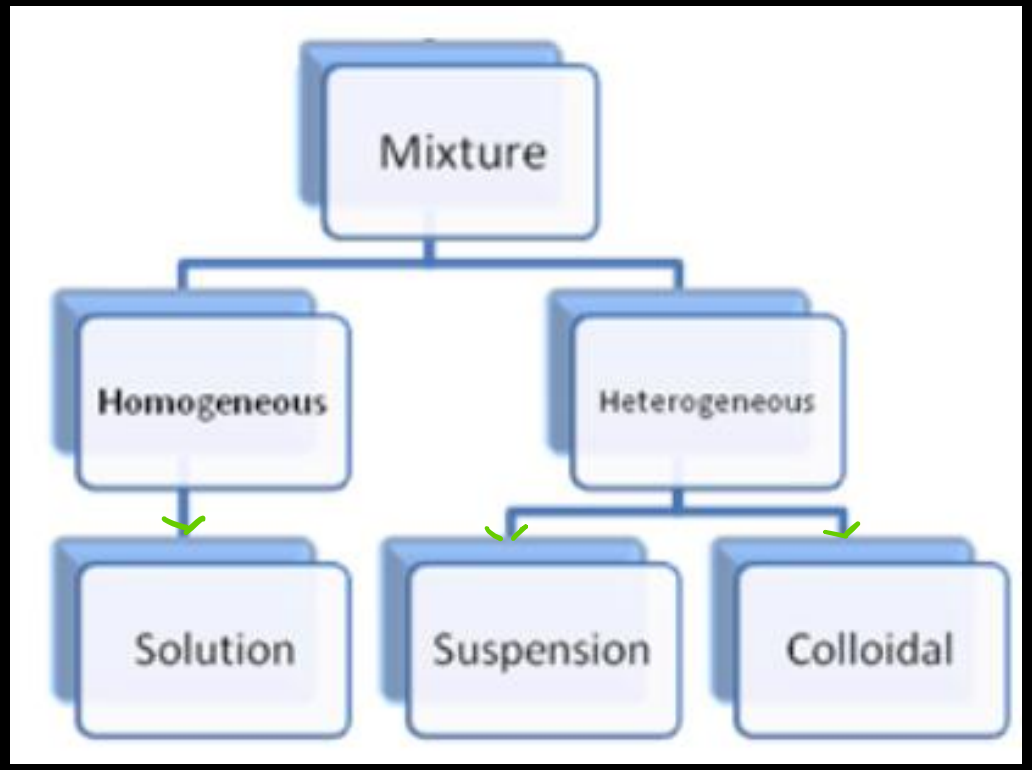
Homogenous Mixtures	Heterogeneous Mixtures
They have a uniform composition throughout	They have a non-uniform composition
We can separate the components of the mixture through physical processes	We can separate the components through physical processes
Components cannot be seen through naked eyes	Components can easily be seen through naked eyes
The mixture is in single-phase throughout	The substances can be of two different phases and we may see separate layers of the substances
Example: A mixture of water and salt	**Example**: A mixture of oil in water

Solutions

- A solution is a uniform mixture of two or more substances.
- Homogenous Mixtures are solutions.

Solution of -

- **Liquid into a liquid:** Water and Ink (Solid solution)
- **Solid into solid:** Alloys
- **Gas into gas:** Air
- **Solid into a liquid:** Sugar and Water
- **Gas into solid:** Hydrogen and Metals (Platinum)
- **Gas into liquid:** Carbon Dioxide and Water → Fog



Solid into gas ⇒ Smoke

Alloy

Metal + metal

Metal + non-metal

Metal + metal + non-metal

- An alloy is a mixture of different metals or nonmetals and metals that cannot be separated from each other using physical methods.
- Alloy is a solution of solid in solid.
- For Example
  - Brass – Copper with up to 50% zinc
  - Bronze – Copper with up to 12% tin

99% Fe + Ni + Cr + C

Components of a Solution

- Solution consists of two components, a solute and a solvent.
- Solution = Solute + Solvent

less amt.

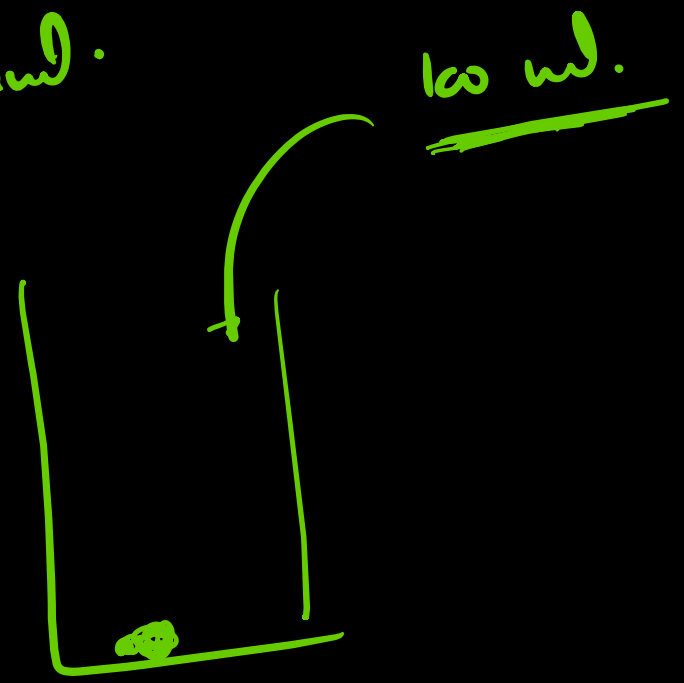
large amt.

Solvent – The substance in which another substance is mixed is called the **Solvent**. **For Example**, Water is a solvent in which we can mix different substances such as salt or sugar.

Solvent is usually present in larger quantity.

Solute – The substance that is added to the solvent to form a solution is called a **Solute**. **For Example**, Salt, when mixed in water, acts as a solute for the mixture.

Solute is usually present in lesser quantity in a solution.



Examples

- A solution of sugar in water is a solid in liquid solution. In this solution, sugar is the solute and water is the solvent.
- A solution of iodine in alcohol known as 'tincture of iodine', has iodine (solid) as the solute and alcohol (liquid) as the solvent.
- Aerated drinks like soda water etc., are gas in liquid solutions. These contain carbon dioxide (gas) as solute and water (liquid) as solvent.
- Air is a mixture of gas in gas. Air is a homogeneous mixture of several 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.
- We cannot see the particles of a solution through naked eyes as they are smaller than 1 nanometer in diameter.
- The path of light is not visible through the solution. The particles of a solution do not scatter light through them as they are extremely small.
- We cannot separate the particles of a solution by methods of filtration.
- Solute particles do not settle down when left undisturbed, i.e. solution is stable.

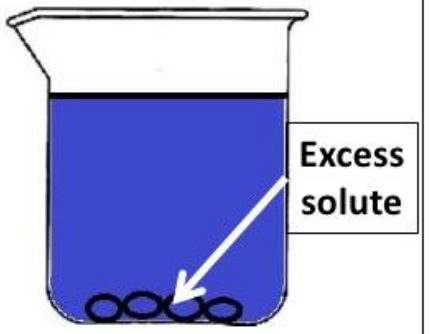
What is a Stable Solution?

- A stable solution is a solution in which particles do not settle down if we leave the solution undisturbed for some time.
  - This is because the particles of a stable solution are very small and homogeneously spread.

Concentration of a Solution

Important Terms:

- Dilute Solution
- Concentrated Solution
- Unsaturated solution
- Saturated solution
- Solubility

Diluted solution	Concentrated solution	Saturated solution
		
Has very little solute in it	Has a lot of solute in it	Has the maximum amount of solute in it
Can dissolve a lot more solute	Can dissolve a little more solute	Cannot dissolve any more solute

Concentration of a Solution

Dilute Solution:- A solution in which the concentration of the solute is much less than that of the solvent.

For Example, If we mix 1g of salt in 1000 ml of water, the salt solution thus obtained will be very diluted. If we keep on adding the solute in a solution, there comes a point when no more solute dissolves in the solution. This is called the **Saturation Point of a Solution**.

Unsaturated Solution:- A solution, in which we can add more solute as it has not achieved its saturation level yet, is called an Unsaturated Solution. A dilute solution can be called an **Unsaturated Solution**.

Concentrated Solution:- A solution with a large amount of solvent is called a **Concentrated Solution**.

Saturated Solution:- A solution in which no more solute can be added since it has already dissolved the maximum amount of solute it can is called a **Saturated Solution**.

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

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Is the amount of salt and sugar or barium chloride, that can be dissolved in water at a given temperature, the same? (from activity 2.3)

No, the different substances in a given solvent have different solubilities at the same temperature.

What would happen if you were to take a saturated solution at a certain temperature and cool it slowly?

What is Concentration of a solution?

- *The concentration of a solution is the amount (mass or volume) of solute present in a given amount (mass or volume) of solution.*

$$\text{Concentration of Solution} = \frac{Amount\ of\ Solute}{Amount\ of\ Solution}$$

$$\text{Percentage Concentration of Solution} = \frac{Amount\ of\ Solute}{Amount\ of\ Solution} \times 100$$

Methods to Express Concentration of Solution

Percentage Concentration of Solution= $\frac{Amount\ of\ Solute}{Amount\ of\ Solution} \times 100$

Method 1: Mass by mass percentage of Solution= $\frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 100$

Method 2: Mass by volume percentage of Solution= $\frac{Mass\ of\ Solute}{Volume\ of\ Solution} \times 100$

Method 3: Volume by volume percentage of Solution= $\frac{volume\ of\ Solute}{Volume\ of\ Solution} \times 100$

Other Methods: Molarity, Molality, Normality, Formality, ppm, etc.

Question

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.

Solution = Solute + Solvent
= 40 g + 320 g
= 360 g.

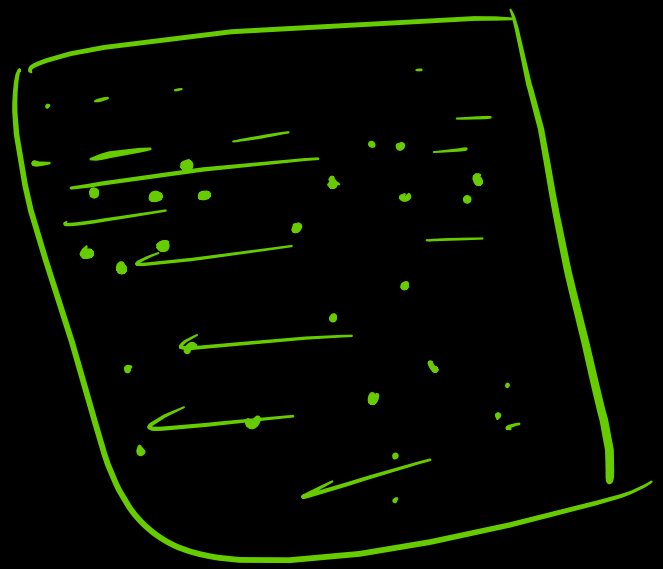
$$\text{Mass by mass \% g} = \left(\frac{\text{mass of solute}}{\text{mass of solution}} \times 100\right)\%$$

$$= \frac{40}{360} \times 100$$

$$= \frac{100}{9} = \simeq 11.1\ \%$$

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 air, dust in air, etc.



Properties of Suspension

- It is a heterogeneous mixture.
- The particles of suspension can be seen through naked eye.
- The particles of a suspension (if small enough) scatter a beam of light passing through it and make its path visible.
- Suspension is unstable i.e., the solute particles settle down when a suspension is left undisturbed.
  - When the particles settle down, the suspension breaks and it does not scatter light any more.
- Solute particles of suspension can be separated by filtration method.
  - → filter papers

Colloidal Solution (Colloid)

- A colloidal solution or a colloid is a heterogeneous mixture of two or more substances in which size of particle/solute lie in between solution and suspension.
- The particles of colloids are almost uniformly spread throughout the solution.
- The particles are relatively very small as compared to suspension and the solution appears as a homogeneous mixture but colloidal solution is a heterogeneous mixture.
- Example: milk, jelly, cream, fog, mist, etc.

Properties of Colloid

- Colloids are heterogeneous in nature.
- The particles of a colloid cannot be seen through naked eyes.
- The particles scatter a beam of light passed through a colloid and produce the Tyndall effect.
- Colloids are stable in nature. The particles of colloids do not settle down if left uninterrupted.
- We cannot separate the particles of a colloid through filtration. We use a method called Centrifugation to separate the particles of a colloid.

Tyndall Effect

- "When a beam of light is passed through a colloid the particles of the colloid scatter the beam of light and the path of light becomes visible in the solution. This phenomenon is called Tyndall Effect."

- Milk in water shows Tyndall Effect. ✓
- Copper sulphate solution does not show Tyndall Effect. ✗ (True solution)
- Water does not show Tyndall Effect.

Tyndall Effect Examples

- When a ray of light enters a dark room, it is scattered by the dust particles present in the air and we can see the path of light clearly.
- When sunlight passes through the canopy of a dense forest. In the forest, mist contains tiny droplets of water, which act as particles of colloid dispersed in air.

Components of Colloidal Solution

- **Dispersed Phase** – The dispersed particles or the solute-like components in a colloid.

- **Dispersing Medium** – The substance in which these solute-like particles are suspended/spread.

Types of Colloidal Solution

Based on the physical state of the dispersing medium and dispersed phase colloids are classified as:

Colloid Type	Dispersed Phase	Dispersing Medium	Example
Aerosol	Liquid	Gas	Fog, Cloud, mist, Aerosol sprays
Aerosol	Solid	Gas	Smoke, Airborne bacteria, Automobile exhaust
Foam	Gas	Liquid	Shaving Cream, Whipped cream, Soapsuds
Emulsion	Liquid	Liquid	Milk, Mayonnaise, face cream
Sol	Solid	Liquid	Paints, milk of magnesia, mud
Solid foam	Gas	Solid	Marshmallow, Styrofoam, rubber, pumice, sponge
Gel	Liquid	Solid	Jelly, Gelatin, Butter, cheese,
Solid sol	Solid	Solid	Ruby glass, Coloured gemstones