

HOMOGENEOUS vs HETEROGENEOUS MIXTURES

Mixtures can be of two types depending on the nature of their composition.

HOMOGENEOUS MIXTURES

A homogeneous mixture has a **uniform composition** throughout.
Its components are evenly distributed and cannot be seen separately.

KEY FEATURES

- Uniform composition
- Components are not visible
- Stable (do not settle on standing)
- Do not scatter light (No Tyndall effect)
- Components cannot be separated by filtration



EXAMPLES



Salt solution
(Salt + Water)



Brass
(Copper + Zinc)

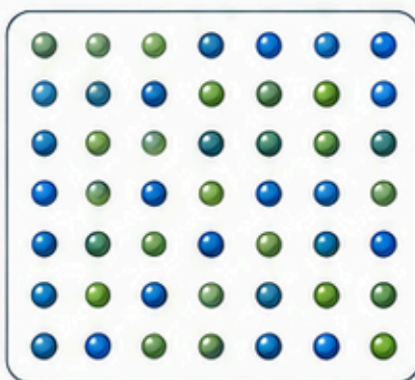


Vinegar
(Acetic acid + Water)



Air
(Gases)

PARTICLE REPRESENTATION



- Component A
- Component B

Particles are uniformly mixed throughout.

OBSERVATION

The mixture looks the same at every part (e.g., the same taste of salt water from top to bottom of a glass).

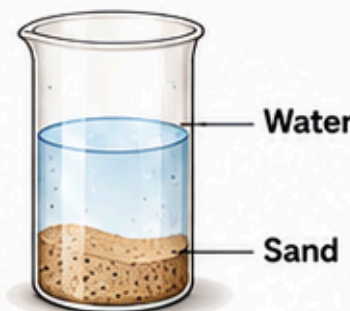
VS

HETEROGENEOUS MIXTURES

A heterogeneous mixture has a **non-uniform composition**.
Its components are not evenly distributed and can be seen separately.

KEY FEATURES

- Non-uniform composition
- Components are visible
- Unstable (may settle on standing)
- Scatter light (Tyndall effect)
- Components can be separated by filtration



EXAMPLES



Mud in water
(Soil + Water)



Salad
(Different vegetables)

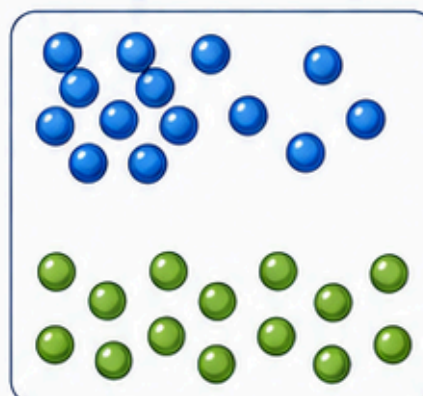


Oil and water
(Oil + Water)



Granite
(Different minerals)

PARTICLE REPRESENTATION



- Component A
(Concentrated in one region)
- Component B
(Concentrated in another region)

Particles are not uniformly mixed.

OBSERVATION

Different parts of the mixture may have different composition (e.g., muddy water has soil at the bottom and water above).



IN SHORT:

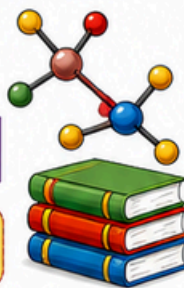
- **Homogeneous** mixture → Uniform composition, components not visible.
- **Heterogeneous** mixture → Non-uniform composition, components visible.



ONLINE TEACHING
With Nikita



SOLUTION – SOLUTE, SOLVENT & SOLUTION



A solution is a **homogeneous mixture** in which one substance (**solute**) is uniformly dissolved in another substance (**solvent**).

1. SOLUTE

The substance which gets dissolved in the solvent is called the **solute**.



Example:
Salt

- Usually present in smaller amount
- Can be solid, liquid or gas

2. SOLVENT

The substance in which the solute is dissolved is called the **solvent**.



Example:
Water

- Usually present in larger amount
- Determines the state of solution
- Can be liquid, solid or gas

3. SOLUTION

The homogeneous mixture formed when the solute is dissolved in the solvent is called the **solution**.



Example:
Salt solution
(Salt + Water)

- Uniform throughout
- Single phase
- Stable mixture

HOW A SOLUTION IS FORMED (Example: Salt in Water)

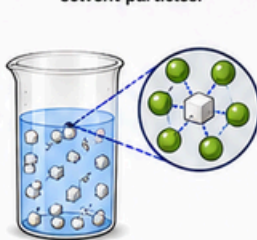
1 Solute (salt) is added to the solvent (water).



2 Stirring causes the solute particles to separate.



3 Solute particles get surrounded by solvent particles.



4 Solute particles spread uniformly throughout.



5 A homogeneous solution is formed.

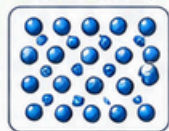


PARTICLE VIEW

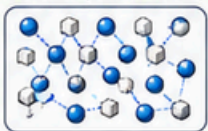
Solute (Salt)



Solvent (Water)



Solution (Salt in Water)



■ Salt particle (solute) ● Water particle (solvent)

EXAMPLES OF SOLUTIONS



Sugar in water
(Solid in liquid)



Acetic acid in water
(Liquid in liquid)



Soda water
(Gas in liquid)



Air
(Gases in gas)



IN SHORT:

- **Solute** → Gets dissolved (usually smaller amount)
- **Solvent** → Dissolves the solute (usually larger amount)
- **Solution** → Homogeneous mixture of solute and solvent

The solvent is like the "dissolver" and the solute is what gets "dissolved"!



ONLINE TEACHING
With Nikita



CHAPTER 5

SOLUTION, SUSPENSION & COLLOID – PARTICLE COMPARISON



Mixtures can be classified based on the size of particles and their behaviour.



FEATURE	SOLUTION	SUSPENSION	COLLOID
Nature	Homogeneous mixture	Heterogeneous mixture	Heterogeneous mixture (appears homogeneous)
Particle size (approx.)	< 1 nm	> 1000 nm	1 nm – 1000 nm
Visibility of particles	Particles are not visible to the naked eye	Particles are visible to the naked eye	Particles are not visible to the naked eye
Stability (settling)	Stable (Do not settle on standing)	Unstable (Settle on standing)	Fairly stable (Do not settle on standing)
Filtration	Particles cannot be separated by filtration	Particles can be separated by filtration	Particles cannot be separated by ordinary filtration
Light scattering (Tyndall effect)	Do not scatter light (No Tyndall effect)	Scatter light (Show Tyndall effect)	Scatter light (Show Tyndall effect)
Examples	Salt solution, Sugar solution, Vinegar, Air	Chalk in water, Mud in water, Sand in water	Milk, Fog, Smoke, Gelatin, Starch sol

PARTICLE REPRESENTATION

SOLUTION

● Solute particle
● Solvent particle

Particles are very small and uniformly mixed.

SUSPENSION

● Solute particle (large)
● Solvent particle (small)

Large particles are scattered and not uniformly mixed.

COLLOID

● Dispersed particle
● Dispersion medium

Particles are medium-sized, spread uniformly.

TYNDALL EFFECT – LIGHT SCATTERING

SOLUTION

No visible path of light. (No Tyndall effect)

SUSPENSION

Path of light is clearly visible. (Shows Tyndall effect)

COLLOID

Path of light is visible but less clear. (Shows Tyndall effect)

REMEMBER

- ✓ Smaller the particle size, more stable is the mixture.
- ✓ Solutions have the smallest particles, suspensions the largest, and colloids are in between.

IN SHORT:

- **Solution** → Very small particles, do not settle, do not scatter light.
- **Suspension** → Large particles, settle on standing, scatter light.
- **Colloid** → Medium particles, do not settle, scatter light.



ONLINE TEACHING
With Nikita



CHAPTER 5



TYNDALL EFFECT – LIGHT SCATTERING

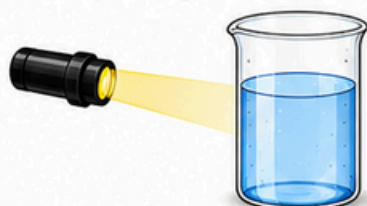
The scattering of light by the particles of a colloid is called the **Tyndall effect**.



OBSERVE THE EFFECT

1. SOLUTION (No Tyndall Effect)

Light does not scatter in a true solution.
The path of light is not visible.



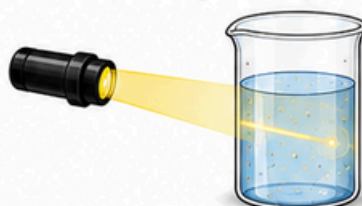
Example: Salt solution, Sugar solution

EXPLANATION

Particles in solution are very small ($< 1 \text{ nm}$).
They do not scatter light.

2. COLLOID (Shows Tyndall Effect)

Light is scattered by colloidal particles.
The path of light is visible.



Example: Milk, Fog, Starch sol, Gelatin sol

EXPLANATION

Particles in colloid are medium-sized ($1 \text{ nm} - 1000 \text{ nm}$). They scatter light.

3. SUSPENSION (Shows Tyndall Effect)

Light is scattered by large particles.
The path of light is clearly visible.



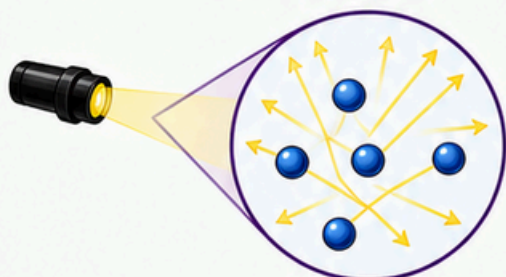
Example: Muddy water, Chalk in water

EXPLANATION

Particles in suspension are large ($> 1000 \text{ nm}$).
They scatter light strongly.

WHY DOES IT HAPPEN?

When light enters a colloid, its particles act as tiny obstacles.
They scatter the light in different directions.
This makes the path of light visible.



Scattering of light by colloidal particles

APPLICATIONS



• Headlights in fog:

The light from vehicles gets scattered by fog droplets and helps in seeing the path.



• Stage lights:

The light beam is visible in smoky or dusty air due to scattering.



• Blue colour of the sky:

Sunlight is scattered by tiny particles in the atmosphere (another example of scattering).



• Red colour of the sun at sunrise and sunset:

Due to scattering of shorter wavelengths (blue) by air molecules.

COMPARISON TABLE

Property	Solution	Colloid	Suspension
Nature	Homogeneous	Heterogeneous (appears homogeneous)	Heterogeneous
Particle size	$< 1 \text{ nm}$	$1 \text{ nm} - 1000 \text{ nm}$	$> 1000 \text{ nm}$
Visibility of light path	Not visible	Visible	Clearly visible
Tyndall effect	Not shown	Shown	Shown (strongly)
Example	Salt solution, Sugar solution	Milk, Fog, Starch sol	Muddy water, Chalk in water

KEY TAKEAWAYS

- ✓ The Tyndall effect is the scattering of light by colloidal particles.
- ✓ It helps us to distinguish between a true solution and a colloid.
- ✓ Solutions do not show the Tyndall effect.
- ✓ Colloids show Tyndall effect (light path visible).
- ✓ Suspensions show Tyndall effect more clearly due to larger particles.



IN SHORT:

- No scattering in solutions.
- Scattering in colloids (light path visible).
- Strong scattering in suspensions.



ONLINE TEACHING
With Nikita

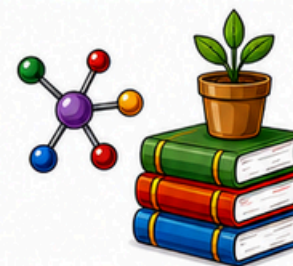


CHAPTER 5



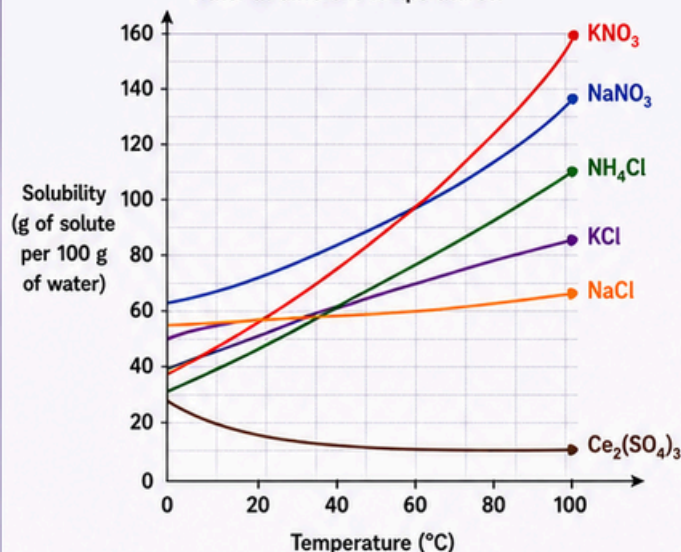
SOLUBILITY CURVE

Solubility of a substance is the maximum amount of solute that can dissolve in 100 g of solvent at a particular temperature to form a saturated solution.



SOLUBILITY CURVE

A solubility curve shows the solubility of a solid in 100 g of water at different temperatures.

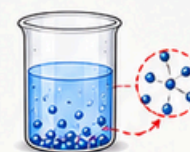


HOW TO READ A SOLUBILITY CURVE

- Choose a substance (e.g., KNO_3).
- Choose a temperature on the x-axis (e.g., 60°C).
- Move vertically upward till the curve of that substance.
- Read the solubility value on the y-axis.
- It gives the maximum grams of solute that can dissolve in 100 g of water at that temperature.

EXAMPLE

From the solubility curve:
At 60°C , the solubility of KNO_3 is about 110 g per 100 g of water.



IMPORTANT POINTS

- Most solids show increase in solubility with increase in temperature.
- Some solids show decrease in solubility with increase in temperature (e.g., $\text{Ce}_2(\text{SO}_4)_3$).
- Solubility curves help in choosing the best method of separation of a soluble solid (using crystallization).
- Each substance has its own solubility curve.

INTERPRETATION OF THE CURVE

1 BELOW THE CURVE

Less solute is dissolved.
The solution is unsaturated.



More solute can dissolve.

2 ON THE CURVE

Maximum solute is dissolved.
The solution is saturated.



No more solute can dissolve.

3 ABOVE THE CURVE

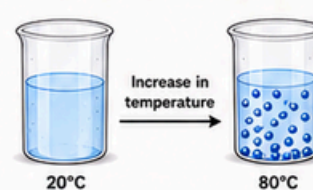
More solute than solubility is present.
The solution is supersaturated (or unstable).



The extra solute will not dissolve and may separate out.

4 EFFECT OF TEMPERATURE

Solubility of most solids increases with temperature.



More solute dissolves at higher temperature.

REMEMBER

Solubility is affected by:

- ✓ Temperature
- ✓ Nature of solute and solvent
- ✓ Pressure (mainly for gases)

EXAMPLES FROM THE CURVE

Substance	Solubility at 20°C (g per 100 g water)	Solubility at 60°C (g per 100 g water)	Trend
KNO_3	≈ 32 g	≈ 110 g	Increases sharply
NaNO_3	≈ 88 g	≈ 140 g	Increases
NH_4Cl	≈ 37 g	≈ 66 g	Increases moderately
KCl	≈ 28 g	≈ 45 g	Increases slightly
NaCl	≈ 36 g	≈ 39 g	Almost constant
$\text{Ce}_2(\text{SO}_4)_3$	≈ 10 g	≈ 4 g	Decreases

IN SHORT:

- Solubility curve is a graph that shows how solubility of a solid changes with temperature.
- It helps us understand and predict the solubility of substances at different temperatures.



ONLINE TEACHING
With Nikita

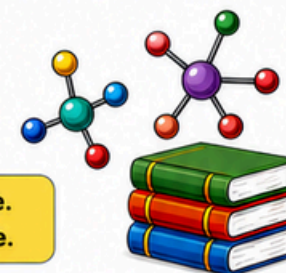


CHAPTER 5



EFFECT OF TEMPERATURE ON SOLUBILITY

For most solids, solubility **increases** with increase in temperature.
For some solids, solubility **decreases** with increase in temperature.



WHY DOES TEMPERATURE AFFECT SOLUBILITY?

When temperature increases:

- The kinetic energy of molecules increases.
- For most solids → solvent molecules can surround and separate more solute particles, so more solute dissolves.
- For a few solids → higher temperature reduces attraction between solute and solvent, so solubility decreases.



EXAMPLES OF CHANGE IN SOLUBILITY WITH TEMPERATURE

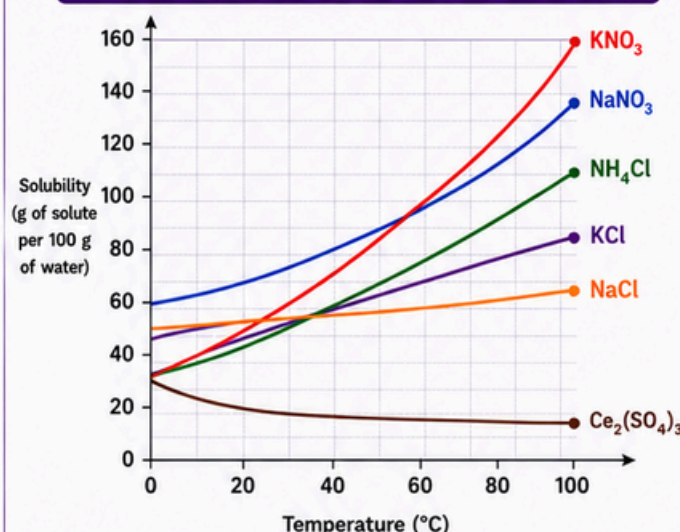
Solubility Increases

- KNO_3 (Potassium nitrate)
- NaNO_3 (Sodium nitrate)
- NH_4Cl (Ammonium chloride)
- KCl (Potassium chloride)
- Most other solid salts

Solubility Decreases

- $\text{Ce}_2(\text{SO}_4)_3$ (Cerium(III) sulfate)
- Some gases (e.g., CO_2 in water)

SOLUBILITY CURVES OF SOME SUBSTANCES



OBSERVATIONS

1. LOW TEMPERATURE



Less solute dissolves. Solution is more concentrated or unsaturated.

2. TEMPERATURE INCREASES



Solute particles move faster. More collisions between solute and solvent particles.

3. MORE SOLUTE DISSOLVES



More solute dissolves in the solvent.

4. HIGHER TEMPERATURE



Even more solute dissolves.

5. VERY HIGH TEMPERATURE



Maximum solubility (for that temperature) is reached.

REAL LIFE EXAMPLES



More sugar dissolves in hot tea than in cold tea.



Washing powder works better in hot water because more of it dissolves.



Salt is obtained from seawater by evaporation. As temperature increases, water evaporates and leaves salt behind.

KEY TAKEAWAYS

- ✓ Most solid salts show increase in solubility with increase in temperature.
- ✓ A few solids (e.g., $\text{Ce}_2(\text{SO}_4)_3$) show decrease in solubility with increase in temperature.
- ✓ Higher temperature usually helps more solute to dissolve.
- ✓ Each substance has its own solubility curve.

QUICK REFERENCE TABLE

Substance	Solubility (g per 100 g water)		Trend
	at 20°C	at 80°C	
KNO_3	≈ 32	≈ 138	Increases sharply
NaNO_3	≈ 88	≈ 160	Increases
NH_4Cl	≈ 37	≈ 70	Increases moderately
KCl	≈ 28	≈ 50	Increases slightly
NaCl	≈ 36	≈ 39	Almost constant
$\text{Ce}_2(\text{SO}_4)_3$	≈ 10	≈ 4	Decreases



IN SHORT:

- Increase in temperature → Solubility of most solids increases.
- Increase in temperature → Solubility of some solids **decreases**.
- Solubility curves help us compare and understand this effect easily.



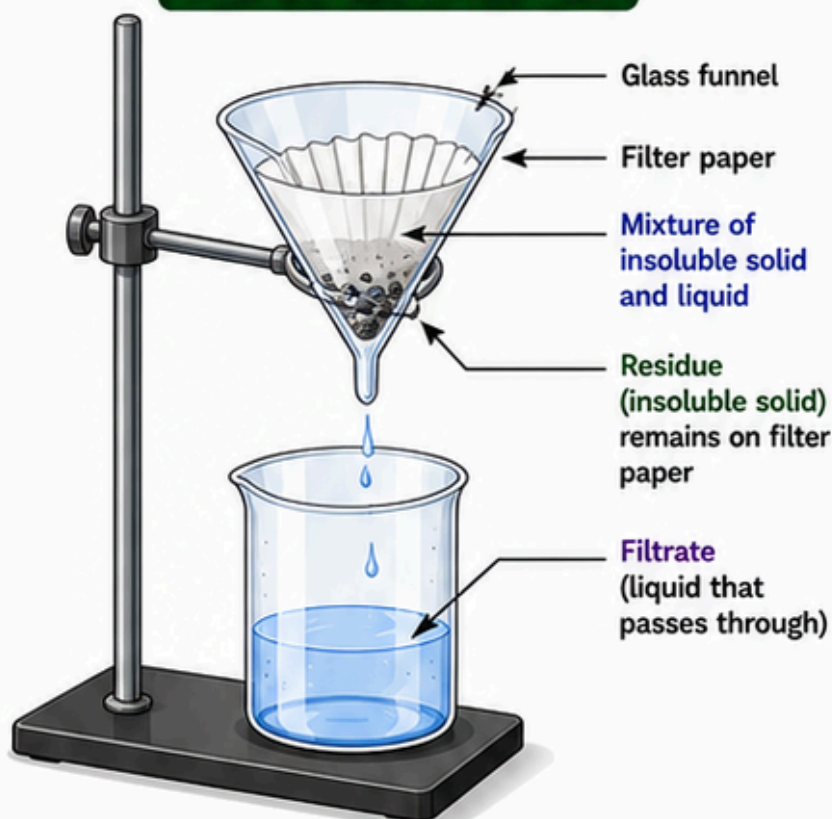
ONLINE TEACHING
With Nikita



FILTRATION - SEPARATION OF INSOLUBLE SOLID FROM A LIQUID

Filtration is a method of separating an **insoluble** solid from a liquid using a filter paper.

FILTRATION APPARATUS

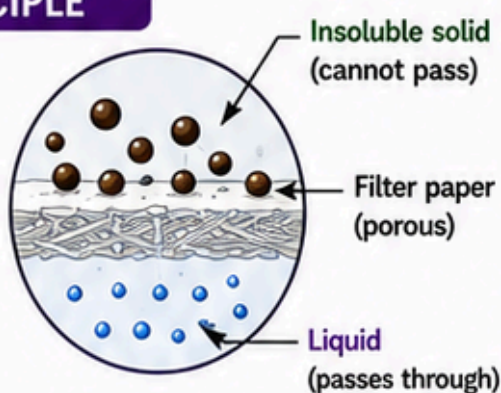


STEPS OF FILTRATION

1. Fold a circular filter paper into a cone.
2. Place the filter paper in the funnel with its edges below the rim.
3. Place the funnel in a stand over a beaker.
4. Pour the mixture (insoluble solid + liquid) slowly into the funnel.
5. The liquid passes through the filter paper and collects in the beaker as **filtrate**. The insoluble solid remains on the filter paper as **residue**.

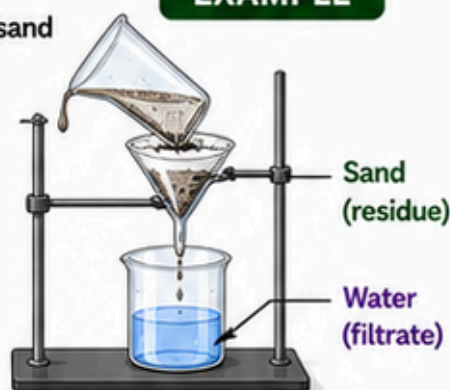
PRINCIPLE

The filter paper has tiny pores. The liquid particles are small enough to pass through these pores, but the insoluble solid particles are too large to pass through and get trapped on the filter paper.



EXAMPLE

Separating sand from water.



RESULT:

Sand remains on the filter paper and clean water is collected in the beaker.

USES OF FILTRATION

- ✓ To separate insoluble solids from liquids.
- ✓ To obtain clear liquids.
- ✓ Used in water purification.
- ✓ Used in laboratories in many experiments.
- ✓ Used in tea strainer, coffee filter, and water filters.



TYPES OF FILTRATION

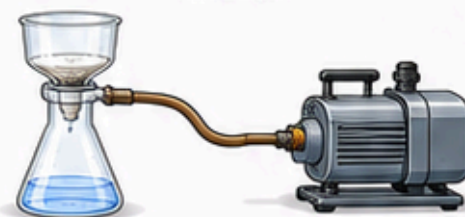
Gravity Filtration

Uses gravity to filter the mixture.



Suction Filtration

Uses a vacuum pump to speed up filtration.



KEY TAKEAWAYS

- ✓ Filtration is used to separate insoluble solids from liquids.
- ✓ The solid is called residue; the liquid is called filtrate.
- ✓ Filter paper allows liquid to pass but not solid particles.
- ✓ It is a simple, effective, and widely used separation method.



IN SHORT:

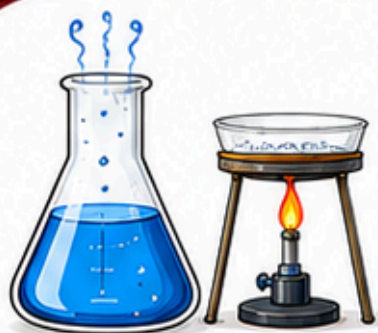
- **Filtration** → Separates insoluble solid from a liquid.
- **Residue** → Insoluble solid left on filter paper.
- **Filtrate** → Liquid that passes through the filter paper.



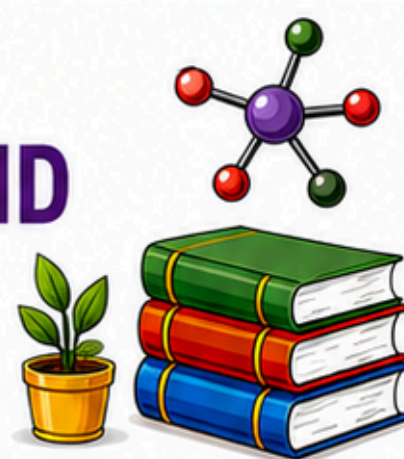
ONLINE TEACHING
With Nikita



EVAPORATION - SEPARATION OF SOLUBLE SOLID FROM A SOLUTION



Evaporation is a method of separating a soluble solid from its solution by heating the solution and **evaporating** the solvent.



PRINCIPLE

The solvent (liquid) is heated and converted into vapour. The vapour escapes into the air, leaving behind the soluble solid as crystals or solid residue.



STEPS OF EVAPORATION

1. Take a solution of a soluble solid in a china dish.
2. Place the dish on a tripod stand and heat it gently.
3. The solvent starts to evaporate as water vapour.
4. Continue heating until most of the solvent evaporates.
5. Cool the dish. The soluble solid is left behind as crystals or solid residue.

APPARATUS USED

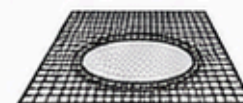
• China dish



• Tripod stand



• Wire gauze



• Burner



• Tongs



EXAMPLE: SEPARATING SALT FROM SALT SOLUTION



USES OF EVAPORATION

- ✓ To obtain common salt from sea water.
- ✓ To obtain sugar from its solution.
- ✓ To obtain salts from their solutions.
- ✓ Used in industries to obtain solid products from liquid solutions.



IMPORTANT POINTS

- ✓ Evaporation is done by heating the solution.
- ✓ The solvent evaporates, leaving the solute behind.
- ✓ It is suitable for heat-stable soluble solids.
- ✓ Care should be taken not to overheat as it may cause loss of solid by splashing.
- ✓ The solid obtained may be in the form of crystals or powder.

KEY TAKEAWAYS

- ✓ Evaporation separates a soluble solid from its solution.
- ✓ The solvent evaporates; the solute remains.
- ✓ Simple and easy method.
- ✓ Used for heat-stable solutions.
- ✓ Example: Obtaining common salt from sea water.



IN SHORT:

- Heat the solution → Solvent (water) evaporates as vapour.
- Evaporation → Vapour escapes into the air.
- Solute remains → Soluble solid is left behind as crystals or solid.



ONLINE TEACHING
With Nikita





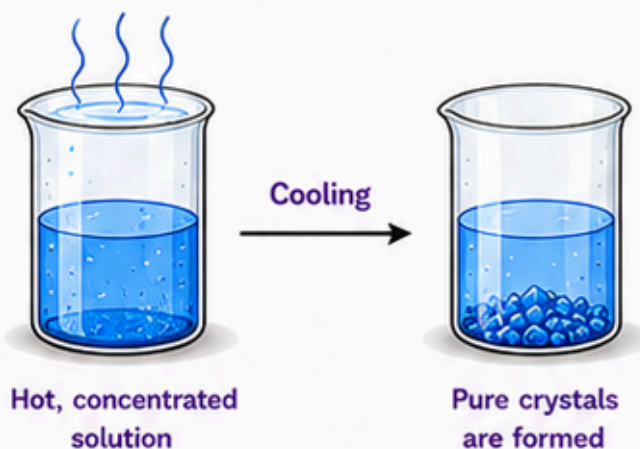
CRYSTALLISATION - SEPARATION OF SOLUBLE SOLID BY CRYSTAL FORMATION

Crystallisation is a method of obtaining a pure solid from its solution in the form of crystals.



PRINCIPLE

When a hot, concentrated solution of a soluble solid is allowed to cool, the solubility of the solid decreases. The excess solute comes out of the solution in the form of pure crystals.



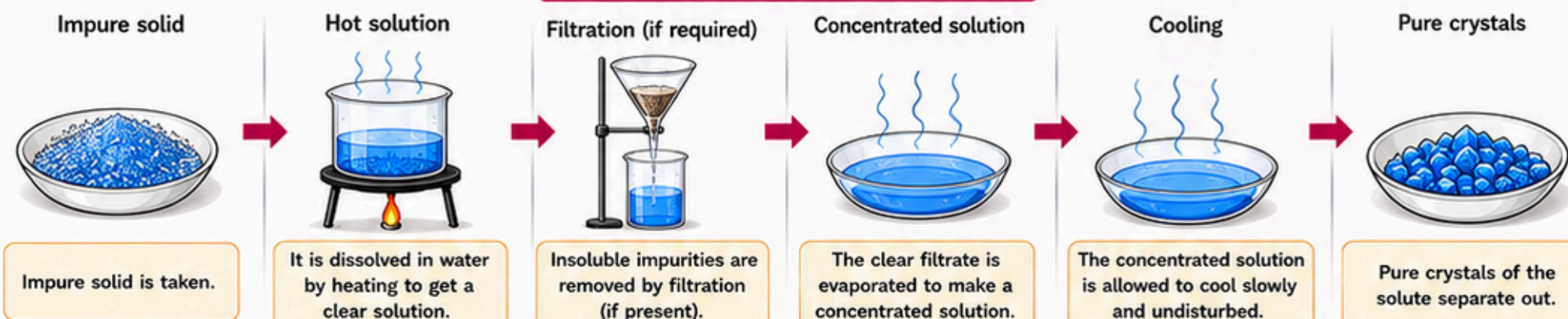
STEPS OF CRYSTALLISATION

1. Take the impure solid (e.g., Copper sulphate) in a beaker and add water.
2. Heat the mixture with stirring until the solid dissolves and a clear solution is obtained.
3. If insoluble impurities are present, filter the hot solution to obtain a clear solution.
4. Pour the hot filtrate into an evaporating dish.
5. Allow the solution to cool undisturbed. Do not shake the dish while cooling.
6. Crystals of the pure solid separate out. Remove the crystals, wash and dry them.

EXAMPLE: COPPER SULPHATE

1. Impure copper sulphate
2. Dissolve in water by heating
3. Filter the hot solution
4. Pour the filtrate into dish
5. Cool the solution undisturbed
6. Blue crystals of copper sulphate are obtained

THE PROCESS OF CRYSTALLISATION



USES

- ✓ Used to obtain common salt from sea water.
- ✓ Used in the sugar industry to obtain sugar crystals from sugar solution.
- ✓ Used to obtain alum, copper sulphate, etc.
- ✓ Used in laboratories to purify solid chemicals.



IMPORTANT POINTS

- ✓ Crystallisation is suitable for heat-stable soluble solids.
- ✓ The solution should be saturated or nearly saturated for better crystal formation.
- ✓ Slow cooling gives larger and purer crystals.
- ✓ Disturbing the solution during cooling may form small crystals or no crystals.
- ✓ The crystals obtained are washed with a small amount of cold water and dried.

KEY TAKEAWAYS

- ✓ Crystallisation separates a soluble solid by forming crystals.
- ✓ It is based on the decrease in solubility of a solid on cooling.
- ✓ It is a simple, effective and economical separation method.
- ✓ Purity of crystals increases with slow cooling and careful handling.



IN SHORT:

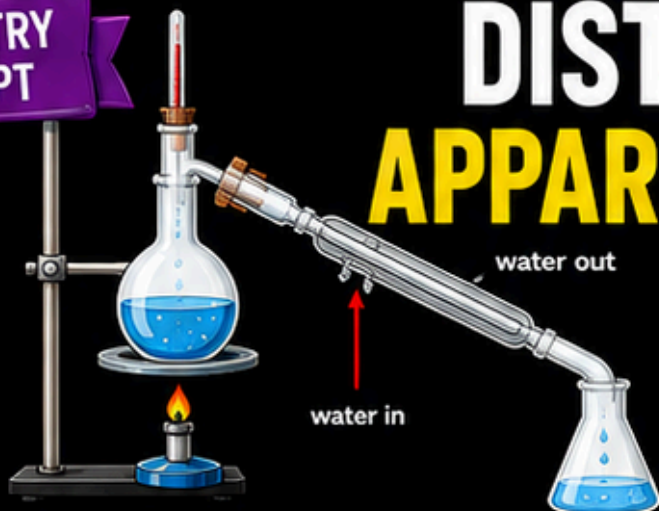
Hot concentrated solution → Cooling → Decrease in solubility → Crystals separate out → Pure solid obtained



ONLINE TEACHING
With Nikita



DISTILLATION – APPARATUS & PROCESS



Distillation is a method of separating a liquid from a solution or a mixture or separating two or more miscible liquids having different boiling points. It is based on the **difference in their boiling points**.



PRINCIPLE

When a liquid mixture is heated, the component with the lower boiling point vaporizes first. The vapour is cooled and condensed back to liquid, which is then collected separately. Thus, the components are separated based on their boiling points.

• Lower boiling point component vaporizes first.

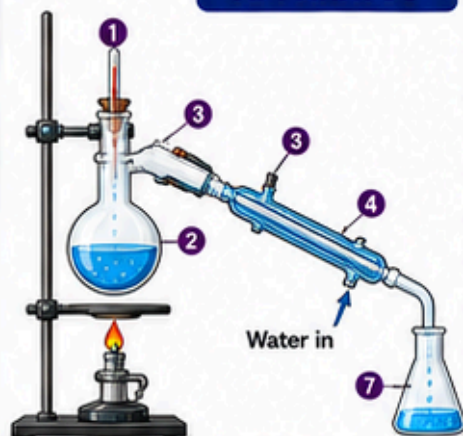
• Vapour is condensed and collected, leaving the higher boiling point component behind.

Boiling Point

The temperature at which a liquid changes into vapour at atmospheric pressure.



APPARATUS



Functions of Parts

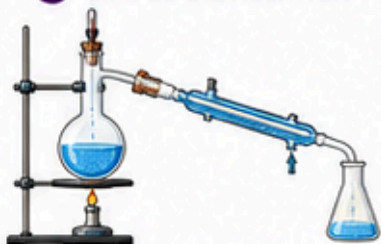
- ★ Thermometer – measures vapour temperature (boiling point).
- ★ Distillation flask – contains the mixture to be distilled.
- ★ Liebig condenser – cools the vapour and converts it to liquid.
- ★ Water in (bottom) & Water out (top) – maintains efficient cooling.
- ★ Receiving flask – collects the distilled liquid.

PROCESS (STEP BY STEP)

- 1 Pour the liquid mixture into the distillation flask.
- 2 Insert the thermometer through the cork so that its bulb is level with the side arm.
- 3 Assemble the apparatus as shown and ensure all joints are tight.
- 4 Start the flow of cooling water (enter from bottom, exit from top).
- 5 Heat the flask gently.
- 6 The component with lower boiling point vaporizes first.
- 7 The vapour passes through the condenser, cools and condenses back to liquid.
- 8 The distilled liquid is collected in the receiving flask.

TYPES OF DISTILLATION

1 SIMPLE DISTILLATION



Used to separate a liquid from a solution or to separate two miscible liquids having a large difference in their boiling points (difference $\geq 25^\circ\text{C}$).

Example: Separating water from salt solution.

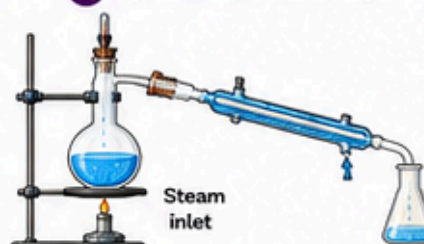
2 FRACTIONAL DISTILLATION



Used to separate two or more miscible liquids having close boiling points (difference $< 25^\circ\text{C}$).

Example: Separation of ethanol (78°C) and water (100°C).

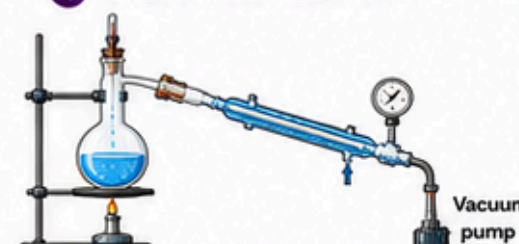
3 STEAM DISTILLATION



Used to separate volatile substances from non-volatile or heat-sensitive impurities using steam.

Example: Extraction of essential oils from flowers.

4 VACUUM DISTILLATION



Used to distill liquids with very high boiling points or those that decompose at high temperature by reducing pressure.

Example: Purification of glycerol.

APPLICATIONS

- ★ Purification of water.
- ★ Separation of components of crude oil.
- ★ Manufacture of alcoholic beverages.
- ★ Isolation of essential oils and perfumes.
- ★ Used in chemical, pharmaceutical and petroleum industries.



KEY POINTS

- ✓ Separation is based on difference in boiling points.
- ✓ Lower boiling point component distils over first.
- ✓ Use gentle and uniform heating.
- ✓ Ensure continuous water flow in condenser.
- ✓ Distillation is a physical method of separation.



IMPORTANT NOTES

- ⚠ Do not heat the flask rapidly.
- ⚠ Ensure all joints are tight and dry.
- ⚠ Water must enter from the bottom and leave from the top in the condenser.
- ⚠ Do not collect the first few drops.
- ⚠ Do not allow the flask to boil dry.

BOILING POINTS OF SOME COMMON SUBSTANCES

Substance	Boiling Point ($^\circ\text{C}$)
Diethyl ether	34.6
Ethanol	78.1
Water	100.0
Acetone	56.1
Chloroform	61.2



DID YOU KNOW?



The temperature shown by the thermometer during distillation is the boiling point of the vapour, not the boiling point of the liquid in the flask.

IN SHORT



SAFETY PRECAUTIONS

- ♥ Wear safety goggles and gloves.
- ♥ Work in a well-ventilated area.
- ♥ Handle hot glassware carefully.
- ♥ Keep flammable liquids away from flame.

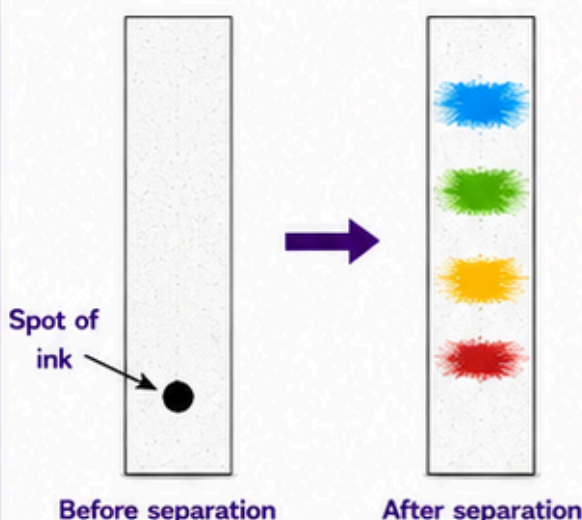


CHROMATOGRAPHY - SEPARATION OF COLOURED SUBSTANCES

Chromatography is a technique used to separate components of a mixture based on their different affinities for a **stationary** phase and a **mobile** phase (solvent).

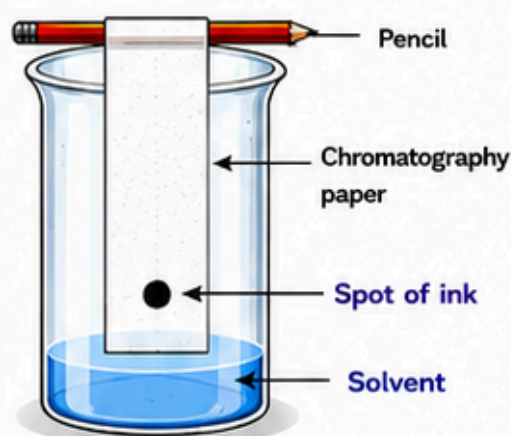
PRINCIPLE

The components of a mixture move at different speeds on a **stationary phase** (paper) with the help of a **mobile phase** (solvent). The component that has more affinity for the solvent moves faster, while the one that has more affinity for the paper moves slower. This causes separation.



MATERIALS REQUIRED

- Chromatography paper
- Beaker or glass jar
- Pencil
- Dropper
- Solvent (water or alcohol)
- Ink or coloured marker



STEPS OF CHROMATOGRAPHY

- 1 Draw a pencil line about 1–2 cm from the bottom of the chromatography paper and put a small spot of ink on it.
- 2 Pour a small amount of solvent in a beaker. The level of solvent should be below the pencil line.
- 3 Suspend the paper in the beaker so that the spot is above the solvent level.
- 4 Allow the solvent to rise up the paper. Do not disturb the setup.
- 5 When the solvent front is near the top, remove the paper and mark the solvent front with a pencil.
- 6 Allow the paper to dry. Different coloured components will be separated.

HOW CHROMATOGRAPHY WORKS

- 1 **Spot applied**
A small spot of ink is placed on the pencil line above the solvent level.
- 2 **Solvent starts moving up**
Solvent rises up the paper by capillary action.
- 3 **Separation begins**
Components start separating based on their solubility in the solvent and attraction to the paper.
- 4 **Further separation**
Different components move at different speeds and separate into distinct bands.
- 5 **Solvent front reaches top**
Solvent front reaches near the top of the paper.
- 6 **Paper removed and dried**
Paper is removed, solvent front is marked and paper is dried to see clear bands.

KEY POINTS

- ✓ Different substances have different solubilities in the solvent.
- ✓ Different substances have different attractions for the paper.
- ✓ Due to these differences, they move at different speeds.
- ✓ Hence, the mixture separates into individual components.

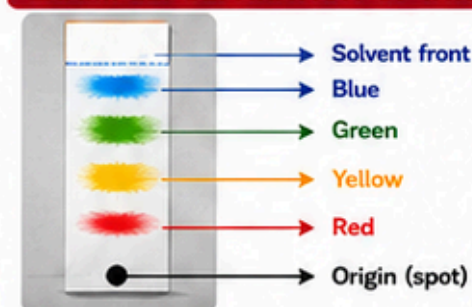
APPLICATIONS

- ✓ Used to separate and identify dyes in inks and food colours.
- ✓ Used in pharmaceutical industries to test purity of medicines.
- ✓ Used in forensic science to analyse samples.
- ✓ Used in research laboratories for separation and purification of compounds.

IMPORTANT POINTS

- ★ Always use pencil for marking (ink may dissolve in solvent).
- ★ The spot should be small and above the solvent level.
- ★ Do not let the spot touch the solvent.
- ★ Do not disturb the setup while the solvent is rising.

EXAMPLE: SEPARATION OF INK



FACT

Chromatography is based on the competition between the solubility of a substance in the mobile phase (solvent) and its attraction to the stationary phase (paper).

IN SHORT



ONLINE TEACHING
With Nikita

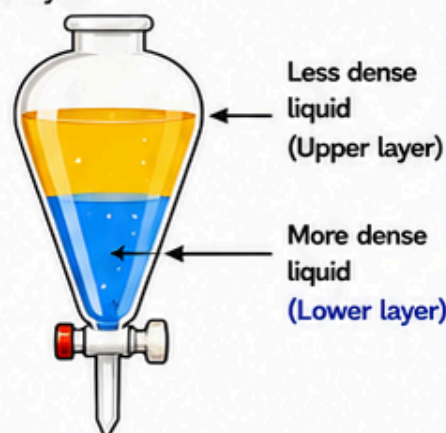


SEPARATING FUNNEL - IMMISCIBLE LIQUIDS

A separating funnel is used to separate two **immiscible liquids** (liquids that do not mix) based on their **difference in density**.

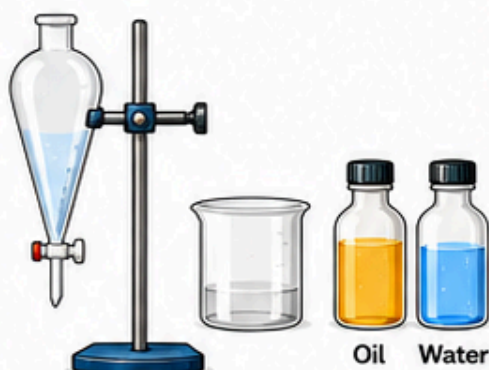
PRINCIPLE

Immiscible liquids do not mix and form separate layers due to different densities. The denser liquid settles at the bottom, while the less dense liquid floats on top. They can be separated using a separating funnel by draining off one layer.



MATERIALS REQUIRED

- Separating funnel with stopper
- Retort stand and clamp
- Two immiscible liquids (e.g., oil and water)
- Beaker or conical flask
- Funnel (for filling)
- Labels (optional)



STEPS / PROCEDURE

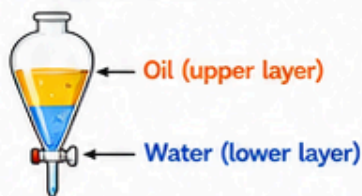
1. Pour the mixture of immiscible liquids into the separating funnel through a funnel.
2. Insert the stopper and hold the funnel properly.
3. Attach the separating funnel to the retort stand using a clamp.
4. Allow the mixture to stand undisturbed until two distinct layers are clearly formed.
5. Place a beaker (or conical flask) below the stopcock.
6. Open the stopcock slowly to drain the lower (denser) layer into the beaker. Close the stopcock at the interface.
7. Collect the upper layer in another container by removing the stopper or pouring it out carefully.

HOW IT WORKS - STEP BY STEP

1. **Mixture added**
The mixture of immiscible liquids is poured into the separating funnel.
2. **Stopper inserted**
The stopper is inserted tightly to prevent leakage.
3. **Funnel placed on stand**
The funnel is placed on a retort stand with a clamp.
4. **Layers separate**
The liquids settle into two layers based on density. Upper layer (Less dense), Lower layer (More dense).
5. **Lower layer drained**
The stopcock is opened to drain the lower (denser) layer.
6. **Stopcock closed**
Stopcock is closed at the interface between layers.
7. **Upper layer collected**
The upper (less dense) layer is collected in another container.

EXAMPLE

Separating a mixture of oil and water.



KEY POINTS

- ✓ Immiscible liquids do not mix.
- ✓ They form two separate layers.
- ✓ The denser liquid settles at the bottom.
- ✓ The less dense liquid floats on top.
- ✓ They can be easily separated using a separating funnel.



APPLICATIONS

- ★ Used in chemical laboratories to separate immiscible liquids.
- ★ Used in extraction processes.
- ★ Used in the petroleum industry.
- ★ Used in environmental testing for oil-water separation.



IMPORTANT NOTES

- ⚠ Do not shake the funnel vigorously.
- ⚠ Releasing pressure: Point the funnel away from your face, open the stopper slightly to release pressure.
- ⚠ Open the stopcock slowly to get a clear separation.
- ⚠ Ensure the stopcock is closed before removing the funnel.

SAFETY PRECAUTIONS

- ★ Wear safety goggles and gloves.
- ★ Handle chemicals and glassware carefully.
- ★ Ensure the stopcock is closed before mounting the funnel on the stand.
- ★ Point the stopper away from your face when opening.



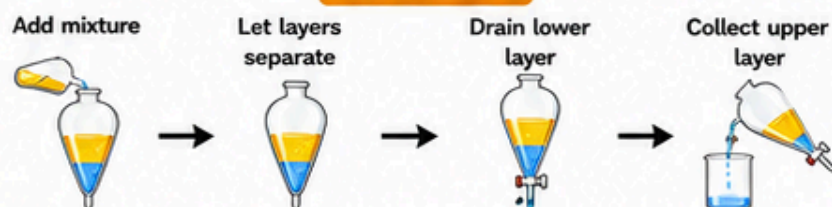
QUICK FACT



Density decides the position of the layers:

Less dense → Upper layer
More dense → Lower layer

IN SHORT



ONLINE TEACHING
With Nikita



SUBLIMATION - SEPARATION OF SUBLIMABLE SOLID

Sublimation is a process in which a **solid** changes directly into vapour **without passing through the liquid state**, and the vapour on cooling changes back into solid.



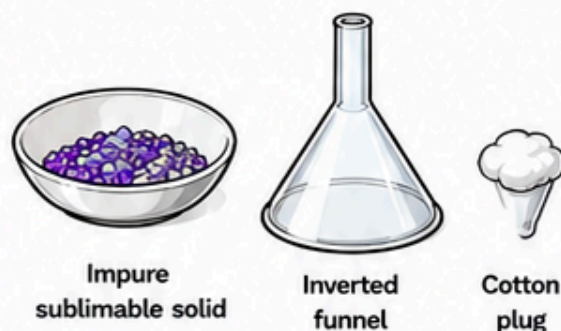
PRINCIPLE

Some solids on heating change directly into vapour (sublime) and on cooling, revert back to solid without becoming liquid. This property is used to separate a sublimable solid from a non-sublimable impurity.



MATERIALS REQUIRED

- China dish
- Inverted funnel
- Cotton plug
- Heat source (Bunsen burner)
- Tripod stand and wire gauze
- Sublimable solid mixture (e.g., ammonium chloride + sand, camphor + common salt, naphthalene + sand)
- Spatula



PROCEDURE

- Take the impure sublimable solid in a china dish.
- Place an inverted funnel over the china dish.
- Plug the stem of the funnel with cotton.
- Heat the china dish gently.
- On heating, the sublimable solid changes directly into vapour and rises up.
- The vapour touches the cooler inner surface of the funnel and changes back into solid.
- After sufficient sublimation, allow it to cool. Remove the funnel. Scrape off the deposited solid. The non-sublimable impurity remains in the china dish.

HOW SUBLIMATION WORKS - STEP BY STEP

- Mixture taken**
Impure sublimable solid is taken in a china dish.
- Funnel placed**
An inverted funnel is placed over the china dish.
- Cotton plug**
The stem of the funnel is plugged with cotton.
- Heating**
The mixture is gently heated.
- Vapour formation**
Sublimable solid changes directly into vapour and rises up.
- Deposition**
Vapour cools on the funnel surface and deposits as solid.
- Collection**
The deposited solid is collected. Impurity remains in the dish.

EXAMPLE

Separation of ammonium chloride from sand.

Before heating



- Ammonium chloride (sublimable)
- Sand (non-sublimable)

After heating



KEY POINTS

- Sublimable solids change directly from solid to vapour.
- They re-form solid on cooling.
- Non-sublimable impurities do not sublime and remain behind.
- Sublimation is reversible.
- Examples: ammonium chloride, camphor, naphthalene, iodine.

APPLICATIONS

- Used to purify sublimable solids.
- Used in the purification of camphor, iodine, naphthalene.
- Used in dry cleaning (naphthalene balls).
- Used in the pharmaceutical and chemical industries.



IMPORTANT NOTES

- Heat gently, as strong heating may cause the sublimable solid to decompose.
- Ensure the funnel is properly plugged to prevent vapour escape.
- Keep the funnel cool for better deposition.
- Do not disturb the setup during heating.

SAFETY PRECAUTIONS

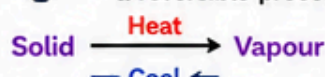
- Handle chemicals carefully.
- Do not inhale vapours.
- Use gentle heating.
- Wear safety goggles and gloves.



QUICK FACT



Sublimation is a physical change and a reversible process.



IN SHORT



ONLINE TEACHING
With Nikita

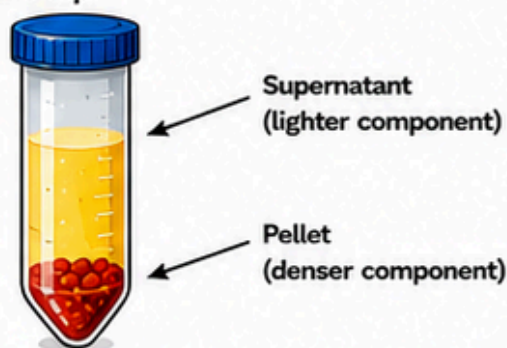


CENTRIFUGATION – SEPARATION BY SPINNING

Centrifugation is a technique used to separate components of a mixture based on their **density** by spinning the mixture at **high speed**. Denser particles move outward and **settle at the bottom**.

PRINCIPLE

When a mixture is spun at high speed in a centrifuge, the denser and heavier particles experience a greater centrifugal force and move outward and downward to form a pellet at the bottom of the tube, while the lighter components remain as supernatant at the top.



Centrifugal force (RCF) = $1.118 \times 10^{-5} \times r \times (\text{RPM})^2$
where, r = radius in cm, RPM = revolutions per minute

MATERIALS REQUIRED

- Centrifuge machine
- Centrifuge tubes with caps
- Sample mixture
- Pipette (for collecting supernatant)
- Balance (optional)



PROCEDURE

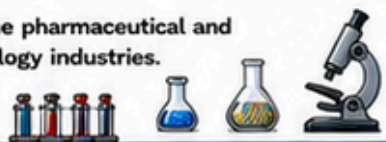
- Fill the centrifuge tube with the mixture. Seal the tube tightly with a cap.
- Place the tubes in the centrifuge machine. Make sure tubes are placed opposite each other for balance.
- Close the lid of the centrifuge.
- Set the required speed (RPM) and time.
- Start the centrifuge and let it run for the set time.
- After spinning, stop the machine and carefully remove the tubes.
- Observe the separated layers: pellet at the bottom and supernatant at the top.
- Use a pipette to carefully collect the supernatant without disturbing the pellet.

HOW CENTRIFUGATION WORKS – STEP BY STEP

- Mixture taken**
The mixture containing suspended particles is taken in a centrifuge tube.
- Tube placed in machine**
The tubes are placed in the centrifuge in balanced position.
- Spinning starts**
The machine is started and the tubes spin at high speed.
- Particles move outward**
Denser particles experience greater force and move towards the outer end of the tube.
- Pellet forms at bottom**
Dense particles settle down to form a pellet at the bottom of the tube.
- Supernatant remains on top**
Lighter components remain as supernatant on the top of the pellet.
- Separation complete**
The components are separated based on their density.

APPLICATIONS

- Used in clinical laboratories to separate blood components (plasma, serum, cells).
- Used to separate precipitates from solutions.
- Used in the purification of proteins, enzymes and biomolecules.
- Used in DNA, RNA and cell organelle isolation.
- Used in the pharmaceutical and biotechnology industries.



KEY POINTS

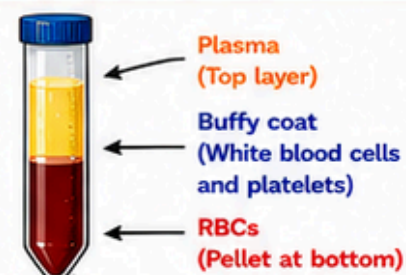
- Separation is based on density.
- Denser particles move outward and form a pellet.
- Lighter components remain as supernatant.
- Higher RPM increases the separation efficiency.
- Balance of tubes is essential to prevent vibration.



IMPORTANT NOTES

- Do not overfill the tubes.
- Always balance the tubes opposite to each other.
- Ensure the lids are tightly closed before spinning.
- Do not open the lid while the machine is running.
- Handle the tubes carefully after spinning.

EXAMPLE: SEPARATION OF BLOOD



Centrifugation separates blood into plasma, buffy coat and RBCs.

SAFETY PRECAUTIONS

- Wear lab coat, gloves and safety goggles.
- Ensure the centrifuge is placed on a stable surface.
- Do not exceed the maximum speed limit.
- Clean any spills immediately.

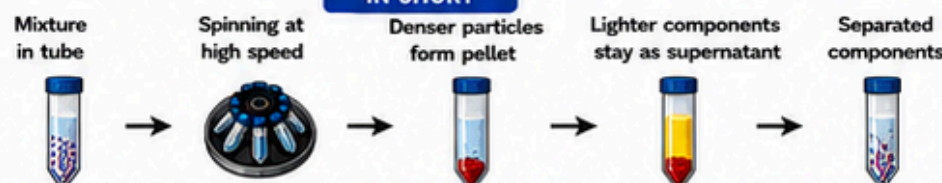


QUICK FACT

The speed of centrifugation is measured in RPM (Revolutions Per Minute) and the separating power in RCF (Relative Centrifugal Force).



IN SHORT

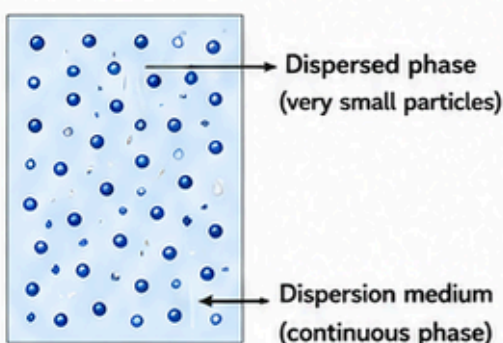


COLLOIDS – DISPERSED PHASE & DISPERSION MEDIUM

Colloids are heterogeneous mixtures in which very fine particles of one substance (**dispersed phase**) are evenly dispersed in another substance (**dispersion medium**). The particle size of colloids lies between that of solutions and suspensions (1 nm – 1000 nm).

WHAT IS A COLLOID?

A colloid is a mixture in which the particles of the dispersed phase are too small to be seen with the naked eye, but large enough to scatter light and not pass through a semi-permeable membrane.



TYPES OF COLLOIDS

Type	Dispersed Phase (Particles)	Dispersion Medium	Example
Aerosol (Solid in Gas)	Solid	Gas (Air)	Smoke, Dust in air
Aerosol (Liquid in Gas)	Liquid	Gas (Air)	Fog, Mist, Deodorant spray
Sol (Solid in Liquid)	Solid	Liquid (Water)	Paint, Ink, Starch sol
Emulsion (Liquid in Liquid)	Liquid	Liquid (Another liquid)	Milk, Mayonnaise, Vinegar in oil
Sol (Gas in Solid)	Gas	Solid	Pumice stone, Foam, Rubber
Gel (Liquid in Solid)	Liquid	Solid	Jelly, Cheese, Butter

PROPERTIES OF COLLOIDS

- ✓ Particle size lies between 1 nm and 1000 nm.
- ✓ Particles are not visible to the naked eye.
- ✓ Particles can scatter light (Tyndall effect).
- ✓ Particles do not settle down on standing.
- ✓ Particles pass through filter paper but not through a semi-permeable membrane.
- ✓ Colloids appear homogeneous but are actually heterogeneous.
- ✓ Colloids are generally stable.



COMMON EXAMPLES OF COLLOIDS

Smoke
(Solid in Gas)



Solid particles of carbon in air.

Fog
(Liquid in Gas)



Tiny water droplets dispersed in air.

Milk
(Liquid in Liquid)



Fat droplets dispersed in water.

Paint
(Solid in Liquid)



Solid pigment particles dispersed in water.

Gelatin (Jelly)
(Liquid in Solid)



Water dispersed in gelatin.

Pumice Stone
(Gas in Solid)



Gas bubbles dispersed in solid.

Butter
(Water in Fat)



Water droplets dispersed in fat.

APPLICATIONS OF COLLOIDS

- ★ Removal of dust and smoke from air (precipitation in Cottrell's smoke precipitator).
- ★ Medicines, creams, and ointments.
- ★ Food items like ice cream, butter, cheese.
- ★ Emulsifying agents in cosmetics.
- ★ Water purification.
- ★ Photography (silver bromide sol).



KEY POINTS

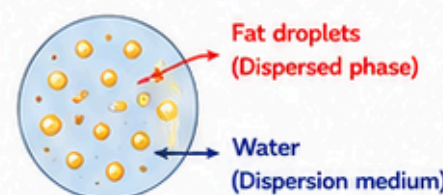
- ✓ Dispersed phase: the substance that is dispersed.
- ✓ Dispersion medium: the substance in which it is dispersed.
- ✓ Colloids show the Tyndall effect.
- ✓ Colloid particles are larger than those in a solution but smaller than those in a suspension.



DIFFERENCE BETWEEN

Property	Solution	Colloid	Suspension
Particle size	< 1 nm	1 – 1000 nm	> 1000 nm
Visibility	Not visible	Not visible	Visible
Tyndall effect	No	Yes	Yes
Stability	Very stable	Stable	Unstable
Settling	Do not settle	Do not settle	Settle down
Filter paper	Pass	Pass	Do not pass
Semi-permeable membrane	Pass	Do not pass	Do not pass

EXAMPLE: MILK



In milk, tiny fat droplets are dispersed in water, forming an emulsion (liquid in liquid).



DID YOU KNOW?



The blue color of the sky is due to the scattering of sunlight by colloidal particles of air.

MEMORY TIP

Remember the order of particle size:
Solution < **Colloid** < **Suspension**

ONLINE TEACHING
With Nikita

