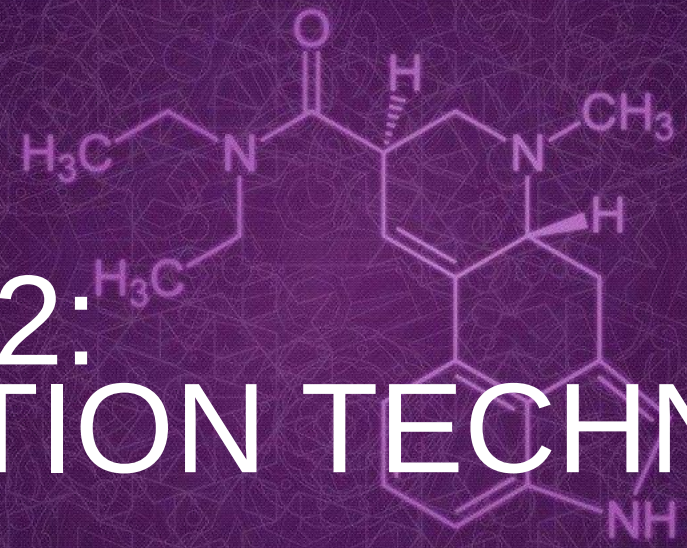


TOPIC 1.2: SEPARATION TECHNIQUES

THE ABOUT

CHAPTER ANALYSIS

TIME

- Relatively straight forward chapter
- 2 **key** concepts
- 4 **advanced** concepts

EXAM

- Usually tested in MCQs
  → 2009 (3), 2012 (1), 2013 (2), 2014 (2), 2015 (1)
- Tested as add-on to other chapters
  → Salts, Fuels & Crude Oil

WEIGHTAGE

- Light overall weightage
- Constitute to **0.5%** of marks for past 5 year papers

DIFFERENT SEPARATION TECHNIQUES

DIFFERENT SEPARATION TECHNIQUES

9 IN TOTAL

MUST KNOW

PURE SUBSTANCE VS IMPURE MIXTURE

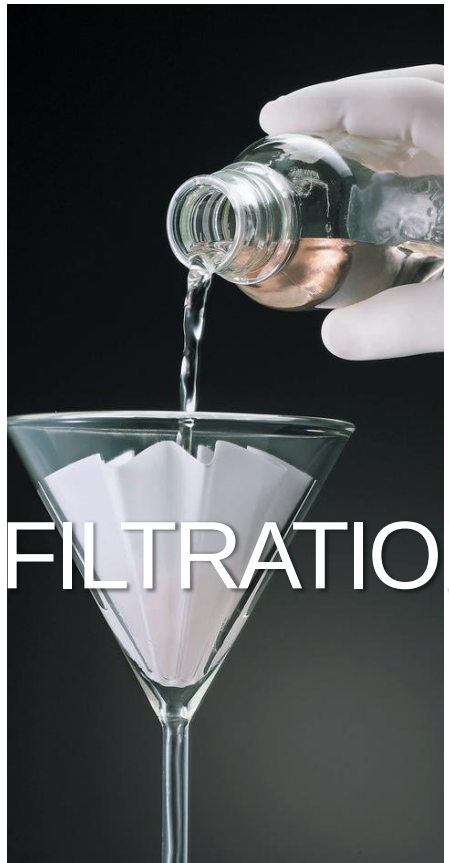
	Pure Substance	Impure Mixture
Definition	**One** type of substance only	**Two or more** substances
Physical properties	**Fixed** proportion	Any ratio
	Fixed mp & bp	Melts and boils over a **range of temperature**
	Single spot on chromatogram	Multiple spots on a chromatogram

MUST KNOW

COMPOUND VS MIXTURE

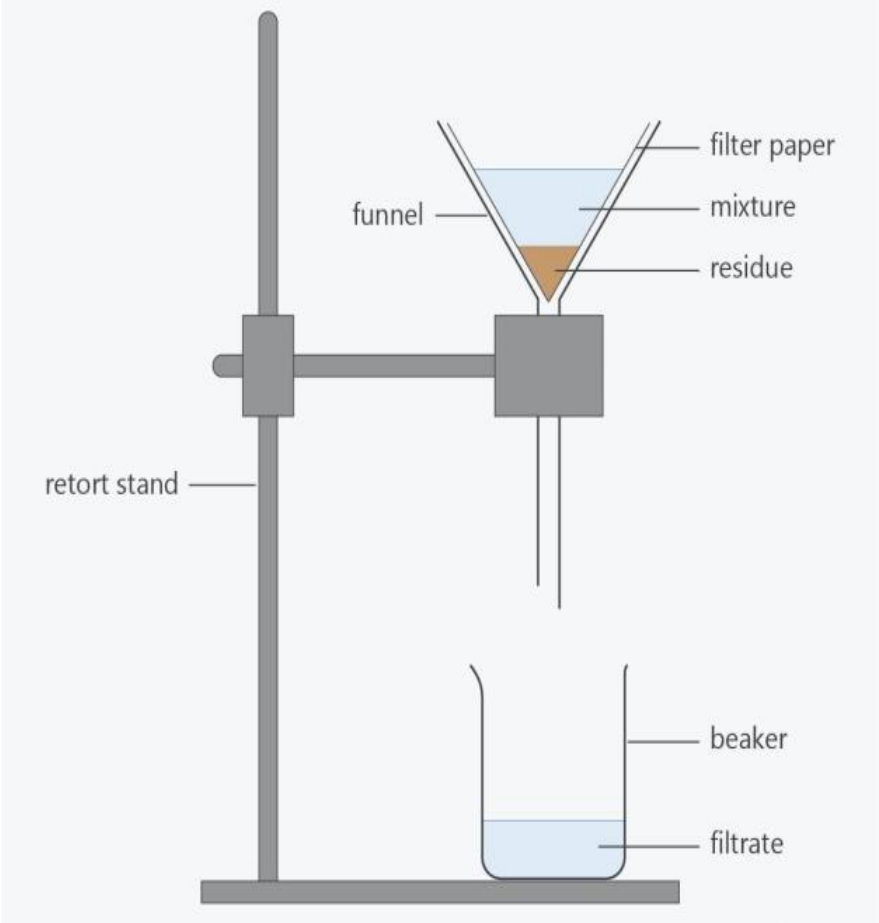
	Compound	**Mixture**
Formation	**Chemically** combined	**Physically** combined
Separation technique	Separated using chemical methods (Decomposition, electrolysis, reduction with carbon)	Separated using physical methods (**separation techniques**)
Composition	**Fixed** ratio	Any ratio
m.p/b.p	**Fixed** mp & bp	Melts and boils over a **range of temperature**

Let’s get over the 3 simpler ones first



MUST KNOW

FILTRATION



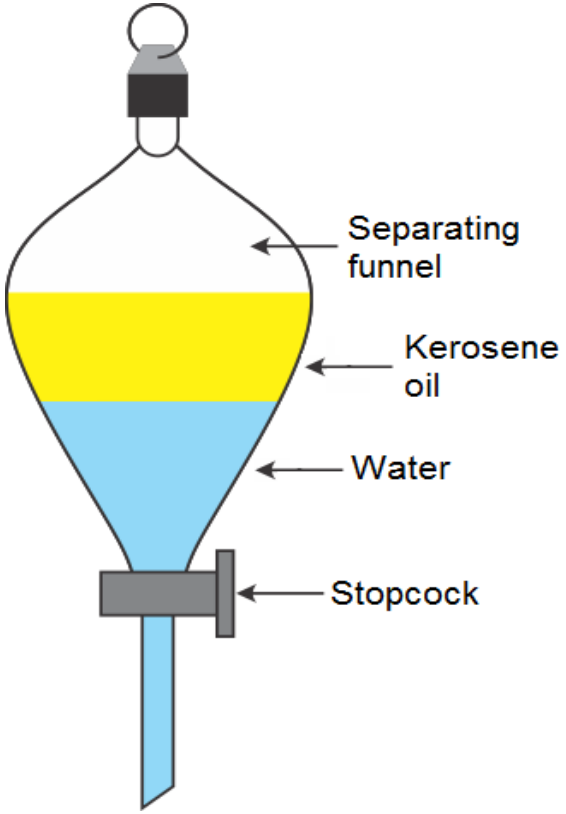
1) Put a filter paper onto filter funnel.

2) Pour the impure mixture into the filter funnel.

3) The **residue** will remain in the filter funnel while the **filtrate** will be collected in the beaker.

MUST KNOW

SEPARATING FUNNEL (IMMISCIBLE LIQUIDS)



1) Oil is less dense than water, forms an immiscible layer which floats on water.

2) Open to tap and collect the water in a beaker.

3) Tighten the tap when almost all the water has been collected.

4) Collect the remaining water and some of the oil in a separate beaker. (impure mixture here. Throw away.)

5) Collect the remaining oil in a separate beaker.

MUST KNOW

MAGNETIC SEPARATION

Magnetic Materials

Nickel

Iron

Cobalt

Steel

Magnetic separation is used to separate from a mixture containing other magnetic material and non-magnetic materials.

Use a strong magnet to attract magnetic substances while leaving behind other non-magnetic substances.

At the scrapyards, an electromagnet is used for the recycling of metals such as iron.

St' Nics girls are pretty right? Are you attracted?
That's right, magnetic material.

KEY CONCEPT

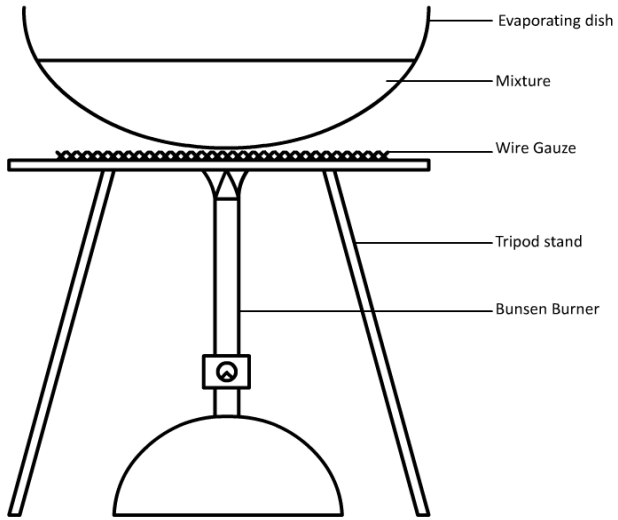
Many students are confused when it comes to these 2 separation techniques:

How **exactly are they different and in which scenarios** do we use them?

TWO METHODS
EVAPORATION TO DRYNESS
CRYSTALLISATION

MUST KNOW

EVAPORATION TO DRYNESS



For this method, the solution is heated and all the **water will be evaporated** completely, **leaving behind only the solid.**

However, there is a **limitation** to this method.

It **cannot be used for solids that decompose on heating**. For example, sugar decomposes upon heating, salt however does not.

*A saturated solution contains the maximum amount of solute that can be dissolved in the solvent at a particular temperature.

MUST KNOW

CRYSTALLISATION

Crystallisation is different from evaporation to dryness.

Crystallisation does not evaporate ALL the water, instead it focuses on heating it till saturation. After which, it then allow it to cool to obtain the crystals.

This **allows crystals which decompose upon heating to be collected.** (ie: sugar)

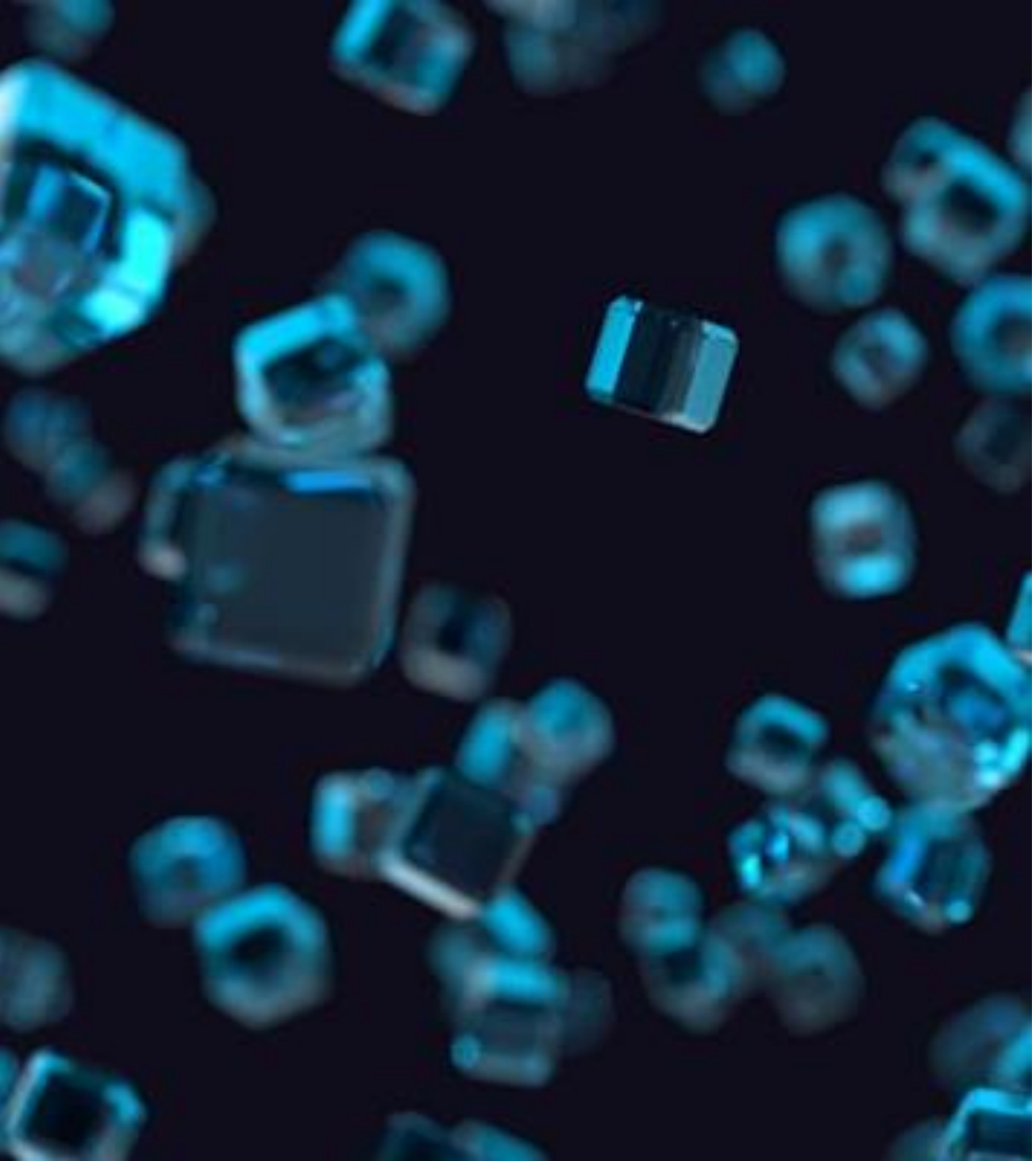
Steps:

1) Heat the solution until a **saturated solution*** is obtained.

2) Allow the hot, saturated solution to cool down to room temperature. Pure solid crystals will form slowly.

3) Filter to collect the crystals.

4) Wash the crystals with cold distilled water and dry with filter paper.



Ultimately, what it comes down to is the nature of the salt.

The critical question to ask is:

Will the solute **decompose under heating**?

If yes, use crystallisation.

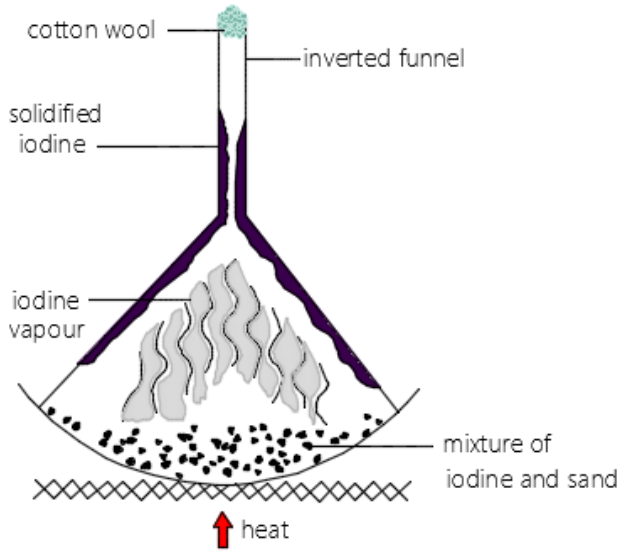
If not, use evaporation to dryness.

Example:
Sugar decomposes under heat, crystallisation is the correct choice.
Salt has high melting & boiling point, evaporation to dryness will get the job done.

EVAPORATION TO DRYNESS VS CRYSTALLISATION

MUST KNOW

SUBLIMATION



METHOD

1) Heat the mixture of solids. The volatile substance (iodine) will start to sublime (solid to gas).

2) Place a funnel over the evaporating dish. The gaseous form of the iodine will condense on the funnel and forms pure iodine crystals.

3) Collect the iodine crystals periodically to prevent it from subliming again.

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SUBLIMATION & DEPOSITION

Commonly Tested

Iodine is a dark purple solid at room temperature. When heated with low heat, it undergoes sublimation and turns into violet gas.

Dry ice is often used as a cooling agent to maintain low temperatures. It is preferred over normal ice as it sublimes to give gaseous carbon dioxide, rather than water.

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SUBLIMATION & DEPOSITION

Mothballs are made of a chemical called naphthalene and sublime to produce gaseous fumes that repel household pests.

Reverse sublimation, also known as **deposition**, occurs when a gas enters the solid phase directly. During winter it snows, that's when a gas → solid.

KEY CONCEPT

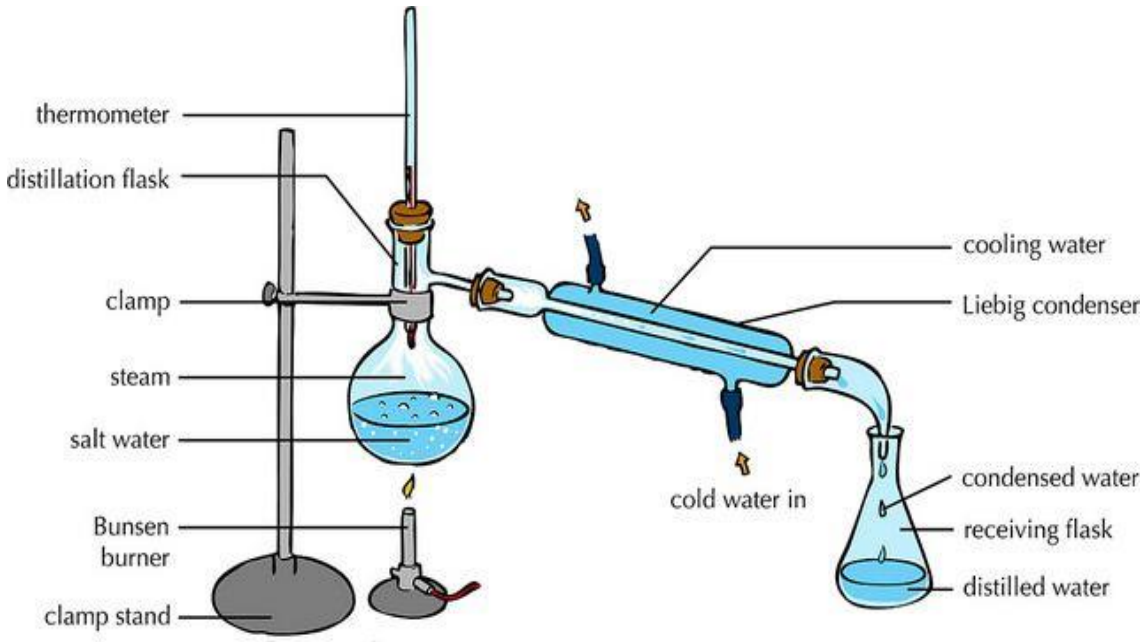
FATHER & SON
SIMPLE DISTILLATION & FRACTIONAL DISTILLATION

When do we do simple distillation and when do we do fractional distillation?

Is one method better than the other?

KEY CONCEPT

SIMPLE DISTILLATION



1) Heat the solution in a round-bottomed flask until it boils. Boiling chips are added to ensure smooth boiling.

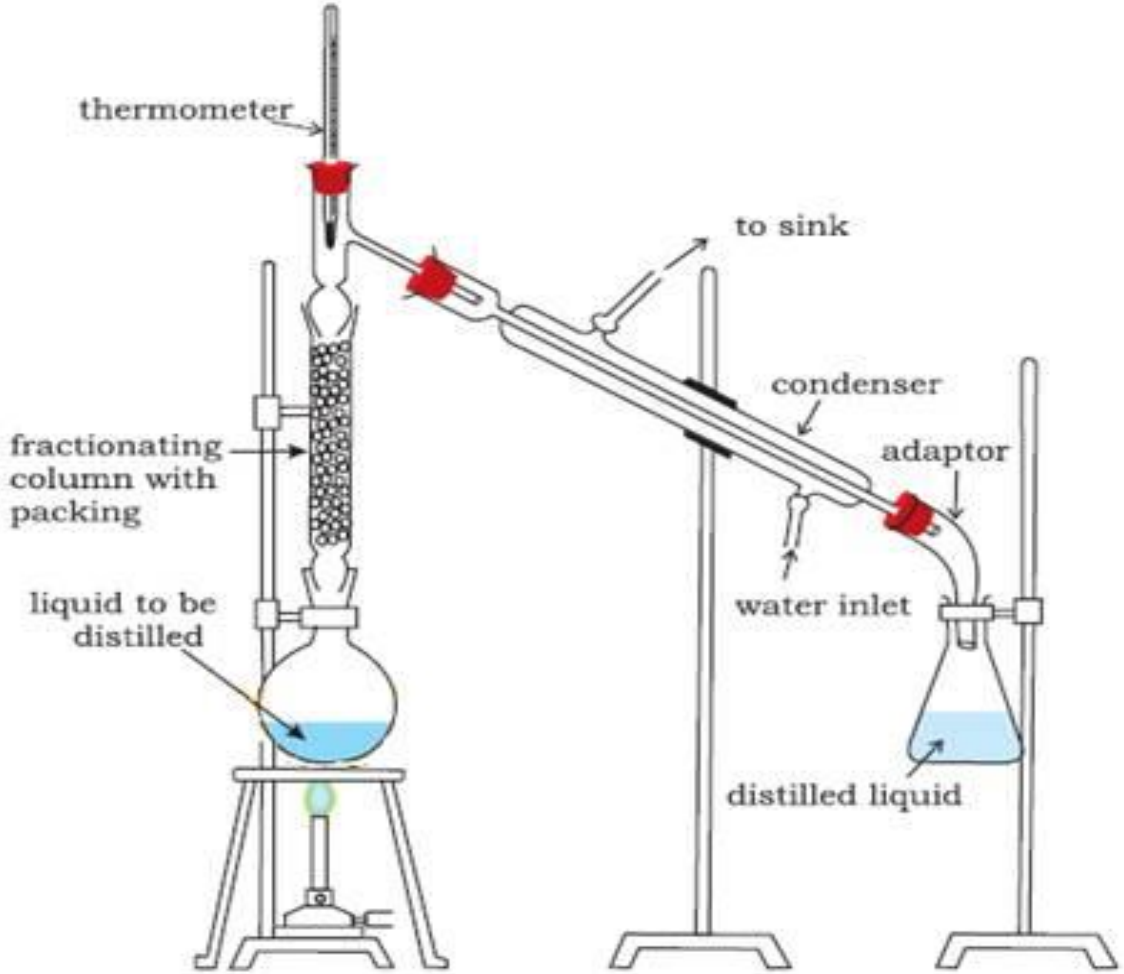
2) Water vapour rises and enters the condenser. The vapour cools and condenses to form the distillate.

3) The distillate is collected in a conical flask.

4) After all the solvent has been evaporated, solid impurities will be left in the flask.

KEY CONCEPT

FRACTIONAL DISTILLATION



1) Heat the solution. The liquid with the lowest boiling point will be the first to vapourise.

2) Vapour will reach the top of the fractionating column, passing through the condenser and be collected as the distillate. Ensure the temperature is constant till all of first vapour has condensed.

3) Collect the distillate in the conical flask.

4) Repeat the process and collect the different distillate.

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things to note

Understanding the science behind fractional distillation

Difference in boiling points

The reason behind why fractional distillation works is because of the miscible liquids in solution have a minimum of **at least 10°C** difference in boiling point.

By boiling the liquids at their respective boiling point, we are able to separate them.

Purpose of fractionating column

A fractionating column contains a large number of glass beads, providing **a greater surface area for condensation of vapours** for substances that have yet to reach their boiling point. So only the correct vapour will escape.

Purpose of thermometer

The thermometer is placed at the tip of the fractionating column, right before the gas enters the condenser.

By doing so, we can **monitor the boiling point of the gas that is escaping** accurately, hereby adjusting the intensity of the heat accordingly.

KEY CONCEPT

FATHER & SON
SIMPLE DISTILLATION & FRACTIONAL DISTILLATION

→ So in which situations is simple distillation used and which situations do we use fractional distillation?

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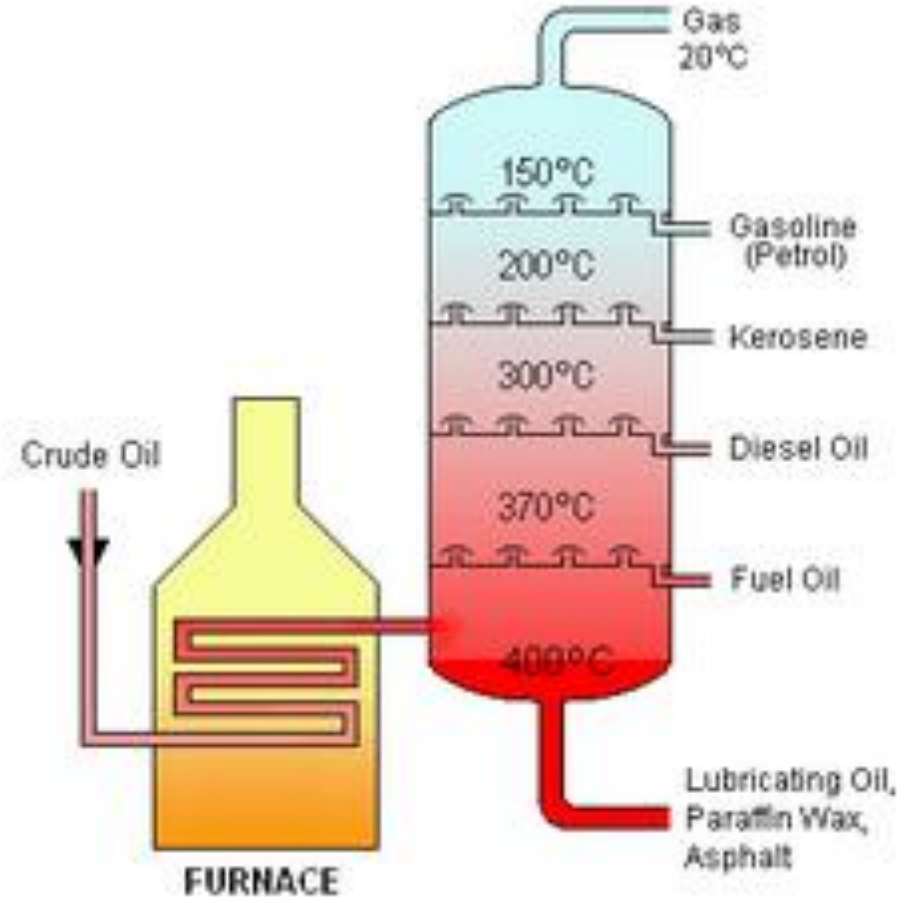
APPLICATION: OIL REFINERY



*Key concept from Fuel and Crude Oil chapter in Organic Chemistry.

See you again soon!

MUST KNOW

CHROMATOGRAPHY

Chromatography is used to separate and identify small amounts of solutes that are dissolved together.

If the substance is a mixture, chromatography can be used to identify the different components in a mixture by using **Rf values** (retention factor).

The Rf value is the **ratio of the distance travelled by the substance to the distance travelled by the solvent.**

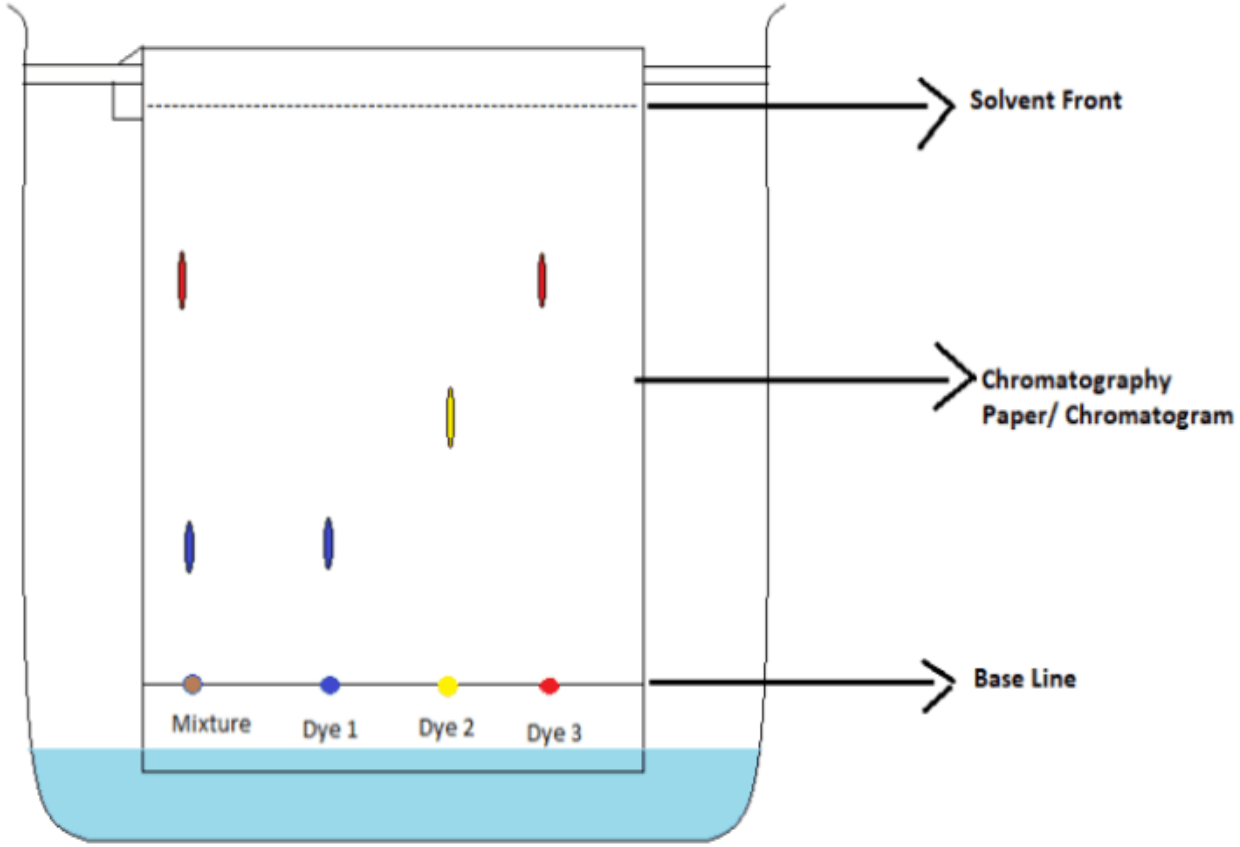
$$R_f = \frac{\text{distance travelled by substance}}{\text{distance moved by solvent}}$$

Chromotography works under this principle: **the rate at which a particular solute moves relative to the solvent is fixed.**

Given that the Rf value for a particular substance is constant for the same solvent, substances can be identified by comparing their Rf value with known values.
(Oo, forensic scientist in the making.)

MUST KNOW

CHROMATOGRAPHY



CHROMATOGRAPHY

Why are there ***differences in Rf values***?

- degrees of absorption by the **chromatography paper** (The stronger the absorption, the slower a substance travels.)

- **solubility of the substances** in the solvent (The greater the solubility, the more easily a substance travels.)

- **molecular masses** of the components (The lower the molecular mass, the faster a component travels. Refer to periodic table!)

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things to note

Chromatography is a method used to separate and identify small amounts of solutes that are dissolved in solvents.

Substance solubility in solvent

A **substance's solubility in a particular solvent** is usually the main reason which results in **differing Rf values**.

Locating Agent

For colourless substances, we need to use a **locating agent to make the colourless solution visible.**

Knowing the names of specific locating agents is not needed. Yay!

Precaution

Starting line should be drawn with pencil. Using ink is a bad idea as the **ink may dissolve in the solute** and cause the results to be not desirable. Commonly tested!

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