#3. PHYSICAL SEPARATION OF MIXTURES

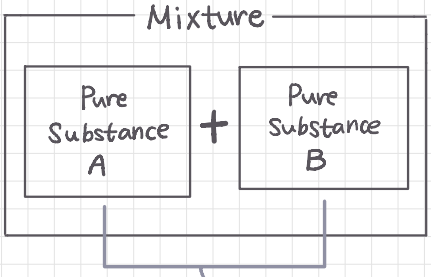
In this section, students will learn to:

★ **Explore homogeneous mixtures and heterogeneous mixtures through practical investigations:**

(a) using separation techniques based on physical properties

#3.1 WHY DO WE NEED SEPARATION TECHNIQUES

* **Physical separation techniques**: rely on differences in the physical properties of the components in the mixture
  → physical state, solubility, boiling point, density, melting point, electrical & magnetic properties
- condition for every separation technique is the distinguishable properties of each component



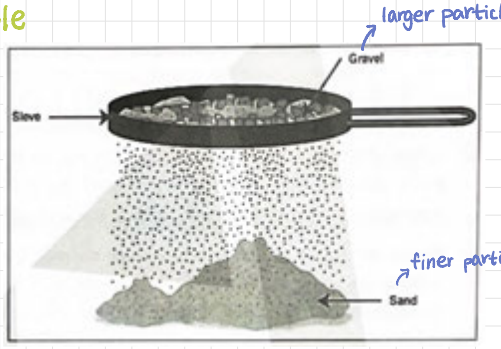
→ Every pure substance (components) has its own characteristic physical properties, which are clearly different (unique) to any other pure substances

#3.2 SEPARATING SOLIDS

* **Sieving**: separating solid particles of various sizes

① two solids ② significantly different particle size

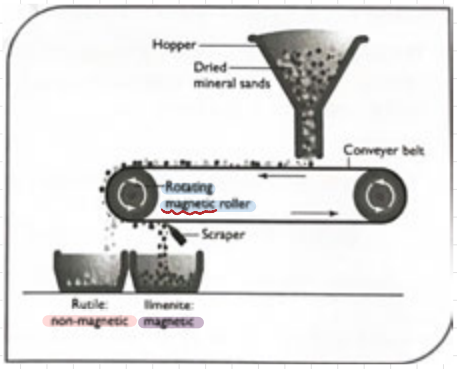
- Example



* **Magnetic separation**: magnetic components (attracted towards magnets) of a mixture are separated from the rest

magnetic solid + non-magnetic solid

- Example



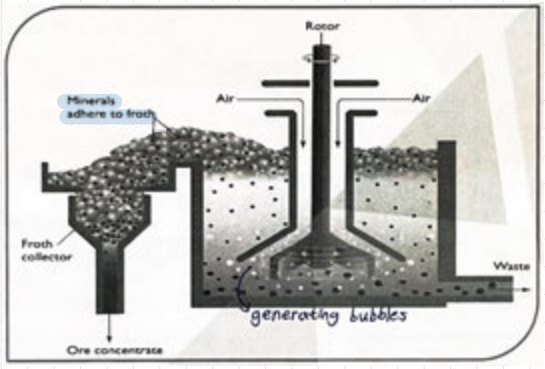
* **Froth Flotation**

adsorption properties (molecules) of the components to the water = hydrophobicity of the components in the mixture

- hydrophobic minerals w/ low density adhere / absorb to the froth (oily) — carried to the surface in order to be scraped from the surface & removed for further treatment
- hydrophilic gangue w/ high density does not float — sediments to the bottom of the vessel

hydrophilic – attracted towards water

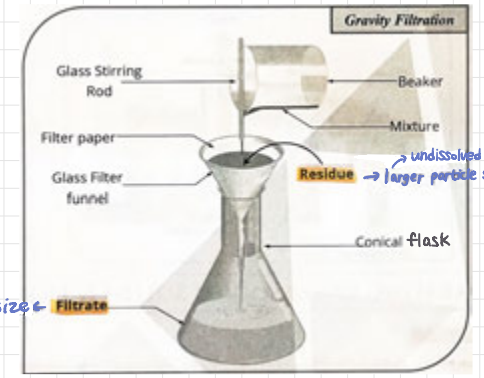
hydrophobic – X attracted towards water (i.e. attracted towards oily substances)



#3.3 SEPARATING UNDISSOLVED SOLIDS & LIQUIDS

* **(Gravity) Filtration**: undissolved solid particles are separated from a liquid by passing the mixture through a screen such as a filter paper

different particle sizes

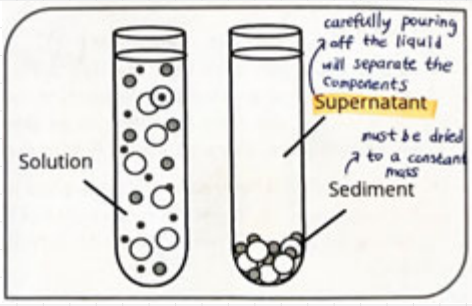


- the residue on the filter paper → washed with clean water & then dried in a low temperature oven (to avoid any unwanted chemical reaction) or use a dessicator (wet solid, drying crystal, air-tight sealed)
  - ↳ drying the residue to constant mass
  - ↳ in order to get pure solid (component)
- using a glass rod – prevent splashing by pouring the liquids along the rod ↳ for ensuring safety
- particle size of undissolved solid ≫ pore size of filter paper
- solutions X be separated into solute & solvent by filtering
  → only the colloids & suspensions can be separated by filtration

* **Sedimentation (using gravity)**: undissolved solids settle to the bottom of a container

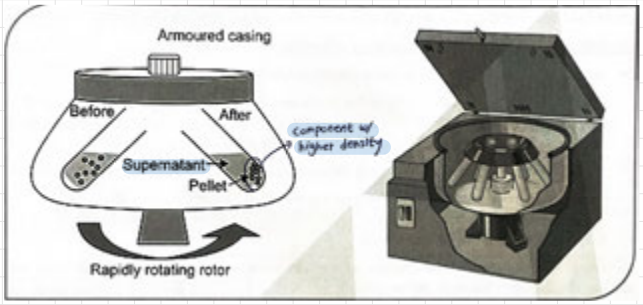
difference in the densities of the components

- more dense solids in less dense liquids → sedimentation
  less dense solids in more dense liquids → solid floats on the top of liquid



* **Centrifugation**: accelerate the process of sedimentation by using a machine called centrifuge

difference in density / particle size & weight



#3.4 SEPARATING DISSOLVED SOLIDS FROM SOLUTIONS

solute

↳ separating a solution into a solute & solvent

* **Vaporisation (Evaporation & Boiling)**: separating solids & liquids by vaporising off the liquid

- **evaporisation** – liquid is heated to a temperature below its boiling point (L → G below BP)

vaporisation – L → G @ or above the BP

difference in boiling points of the components (or volatility)

- **volatile** – a liquid that easily becomes a vapour

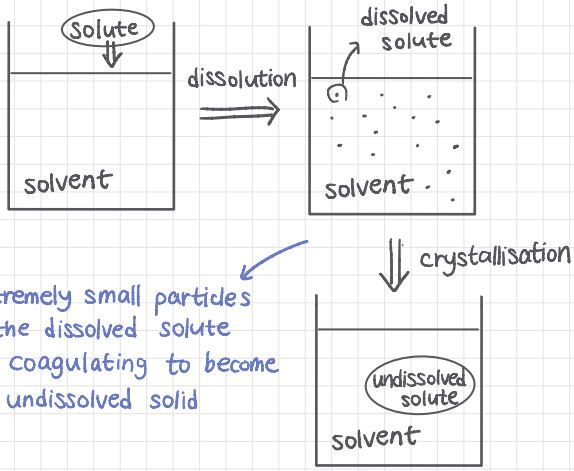
∴ a more volatile liquid → has a lower BP

- 'evaporate to dryness' – heating a solution in an evaporating basin to drive off all the solvent
- if we want solid → boiling or evaporating off the liquid is effective

if we want liquid or both S & L → X use vaporisation

↗ opposite of dissolution (process of dissolving)

* **Crystallisation**: dissolved solute turns back into undissolved solute



extremely small particles of the dissolved solute are coagulating to become the undissolved solid

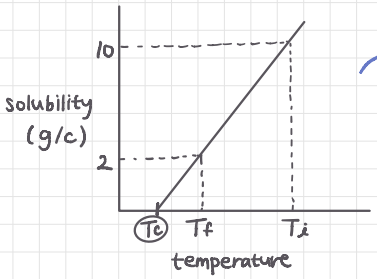
based on the principles of solubility

- compounds (solutes) tend to be more soluable in hot liquids (solvents) than they are in cold liquids

– if a solution is allowed to cool,

→ the solute is no longer soluable

→ forms the pure solid crystals



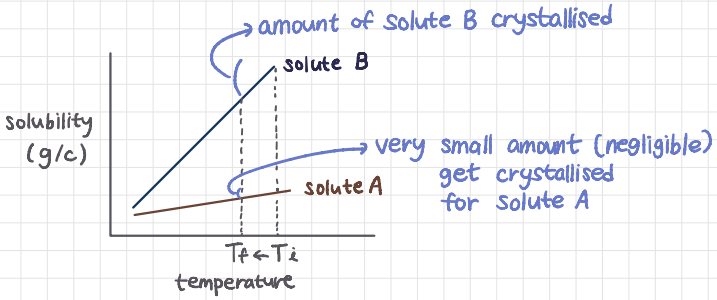
@ T_i → 10g dissolved

As temp. ↓ to T_f

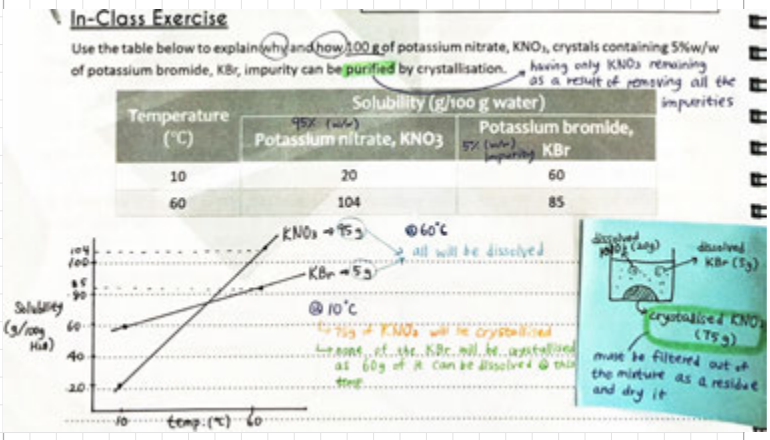
↳ 8g of solid has been crystallised

- the compounds of the mixture having different solubilities

– E.g. a mixture of salt and baking soda can be separated by dissolving in hot water → cooling the resultant solution

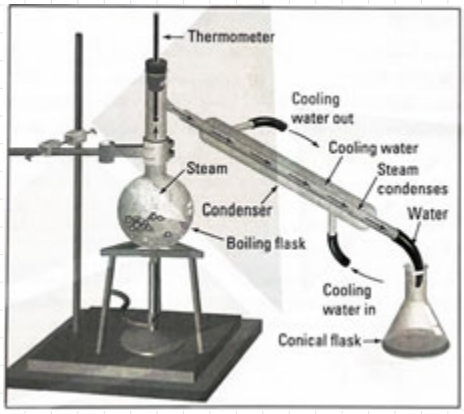


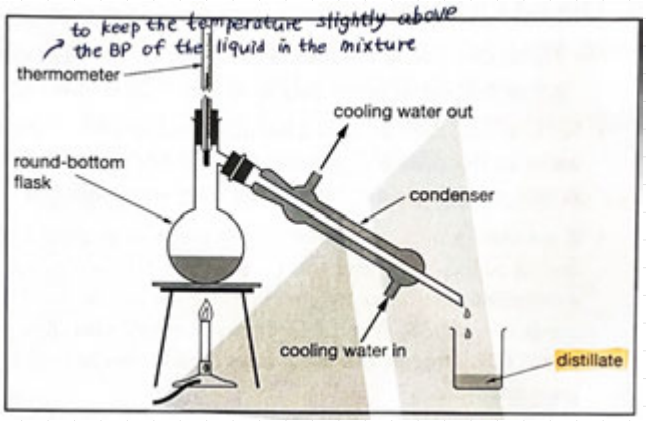
– Example



* **Distillation**: a solution is boiled with the vapour formed being condensed back to a liquid in a different part of the apparatus

difference in the boiling points of the components





- **distillate**: the component w/ lower BP

Why must the Water Enter from the Bottom in a Condenser?

- This ensures that the entire length of the condenser will always be full of cooling water

#3.5 SEPARATING MISCIBLE LIQUIDS

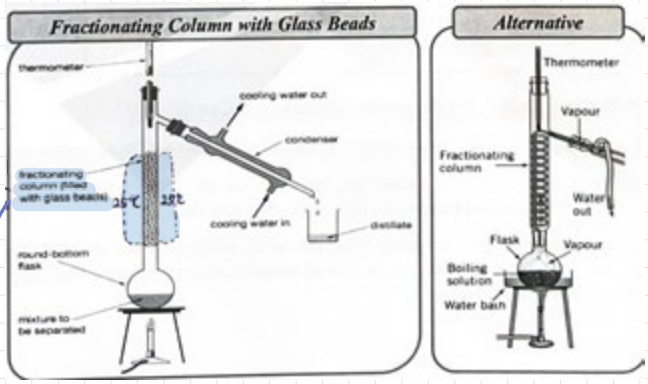
- when a liquid dissolves in another liquid → miscible
- when a solid dissolves in a liquid → soluable

* **Distillation**: separate a mixture of two miscible liquids if the boiling points of the liquids are sufficiently different (about 30°C or more)

Significant difference in BP

- E.g. separating a mixture of ethanol & water

* **Fractional Distillation**: separation of a mixture of a mixture of two or more miscible liquids for which the difference in boiling points is less than 25°C (components w/ similar BP)



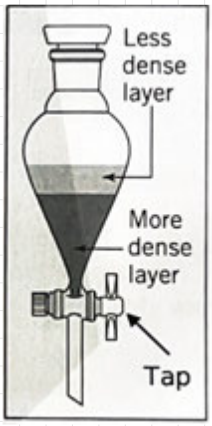
↳ provide surface for the vapors to cool & condense repeatedly

↳ small decrease in terms of gases rising

#3.6 SEPARATING IMMISCIBLE LIQUIDS

* Immiscible Liquids : do not form a homogeneous mixture when they are mixed, separate into two distinct layer
  e.g. water and cooking oil

* Separating funnel : allows us to run out the bottom liquid without getting it contaminated w/ any of the top one



① immiscible liquids
② significantly different densities

#3.7 SEPARATING SOLIDS USING SOLUBILITY

* Dissolution, Filtration & Evaporation

• Mixtures of solids can be easily separated if one solid is soluble in a particular solvent while the others are not

difference in solubility

• Sufficient solvent is added to a mixture to dissolve the soluble component
→ insoluble component(s) is (are) filtered off
→ soluble solid is recovered by evaporating the filtrate (solution of that solid) to dryness