Science study guide - Elements, compounds & mixtures + Sep. Techs

SI Science

Elements, Compounds & Mixtures - Quick Summary

Elements

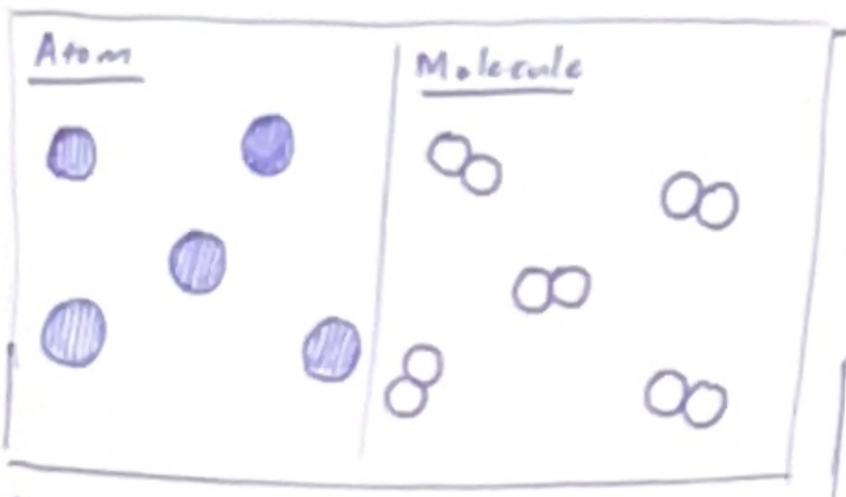
- Definition: An element is a substance that cannot be broken down into simpler substances by chemical methods.
- Pure substance → fixed melting and boiling points
  → Temperature stays constant during melting and boiling
- Own unique set of properties
- cannot be separated/broken down into further components

Compounds

- Definition: A compound is a substance that contains two or more different types of atoms chemically joined together, in a fixed ratio.
- Pure substance
- Different properties from those of their constituent elements
  → Constituent elements: elements that combine together to make the compound
- Cannot be separated into its components through physical methods (only chemical methods)
- Chemical reactions occur (and heat and/or light may be produced) when compounds are formed.
- Formed in fixed ratios of different components.

Mixtures

- Definition: A mixture is a substance that consists of two or more substances that are physically combined.
- May consist of elements and/or compounds
- Components can be solids, liquids or gases.
- Impure substance → varied melting/boiling points
  → temperature varies during melting and boiling.
- Same properties as that of the components of the mixture.
- can be separated into components through physical methods.

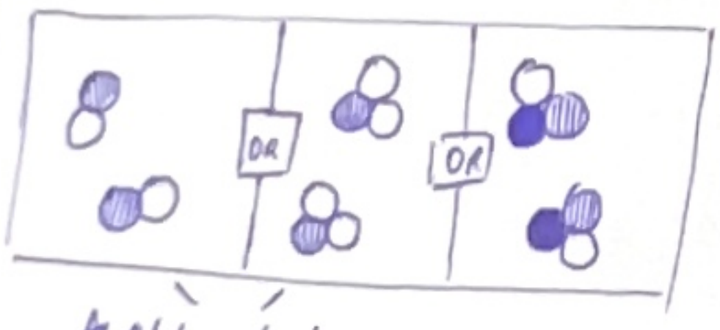


☆ Atom vs Molecule

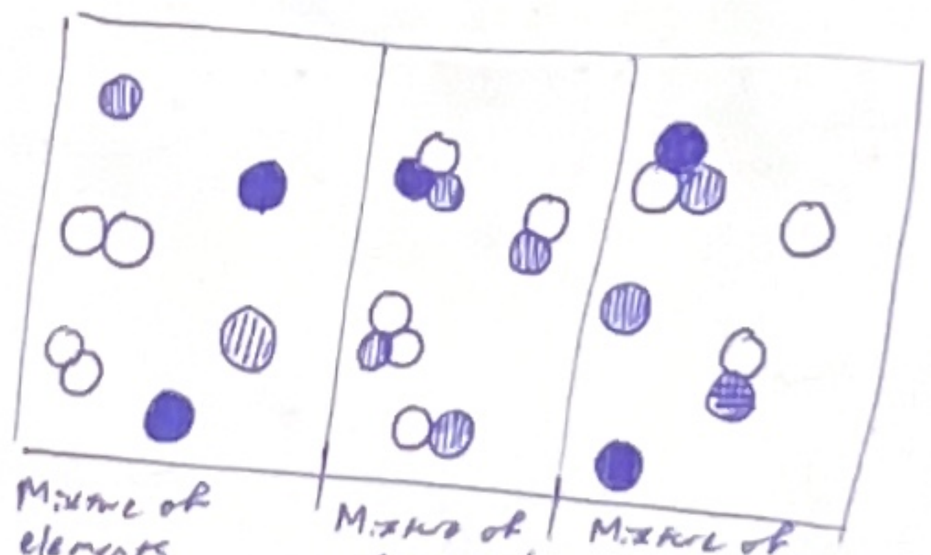
Atom: literally 1 atom.

Molecule: 2 or more atoms chemically combined

* Molecules can be either:
  - 1 element → 2 or more atoms of the same element chemically joined (eg. O_2)
  - ≥ 2 elements → 2 or more atoms of different elements chemically joined (eg H_2O)



* Although they are both made of ● and ○, the ratio/proportion of ●:○ in each samples' particles is different. Therefore, ●○ is not the same as ●○.

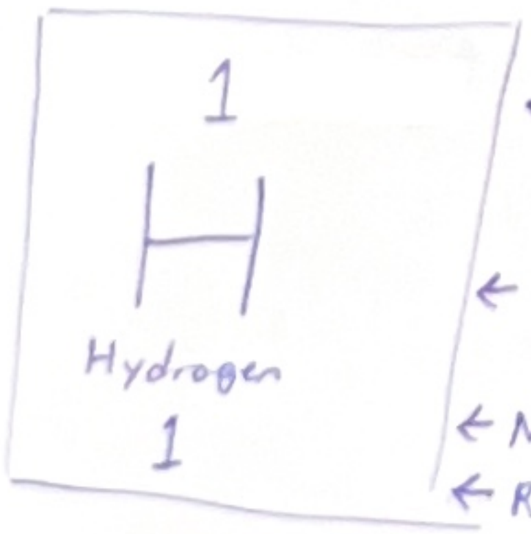


☆ Elements can be made of either atoms or molecules.
  → eg. Sodium → atoms
  → eg. Hydrogen → molecules (exists as diatomic molecules)

☆ Compounds are only made of molecules.
  → Compounds: "2 or more different types of atoms"
  => cannot be just 1 atom
  ∴ Compound particles are molecules.

The Periodic Table

How to read each box:



← Proton/Atomic no. — Used to identify the element / No. of protons the atom has — increases as we go along the Periodic Table

← atomic symbol — The letter(s) used to identify the element / Used when writing chemical formulas

← Name of element

← Relative atomic mass — Total no. of protons + neutrons in each nucleon / (doesn't really matter in this chapter)

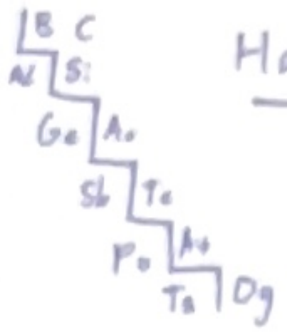
Reading the Periodic Table
  → groups: vertical columns. (18 in total)
  → periods: horizontal rows. (7 in total)

Groups
- similar chemical properties
- chemically react in similar ways

Periods
- similar physical properties

Left ⟶ Right

Metals → → → → → Non-metals



Hays - McDaniel line

→ left of line ⇒ metals
→ right of line ⇒ non-metals
→ touching line ⇒ metalloids (in between metal/non-metal)

Compounds

→ Cannot be separated through physical methods.
→ They are formed only when the elements are chemically combined, so they must also be separated by chemical methods.

How are compounds formed? (all chemical)
→ combustion (burned in the air)
→ reactions (element and compounds)
→ reactions (compounds)
→ decomposition (of compounds)

Solutions & Suspensions ⇒ 2 different types of mixtures

Solution	Suspension
- Solute dissolves in solvent	- insoluble solute (size or solubility)
- homogeneous	- heterogeneous
- no residue when filtered	- leaves residue when filtered
- eg. salt dissolves in water	- eg. milo / bubble tea (tapioca pearls + tea)

★ Solution with water as solvent = aqueous solution

* more about solute and suspension, solubility & rate of dissolving on next page

★ Solute is the substance being dissolved in the solvent.

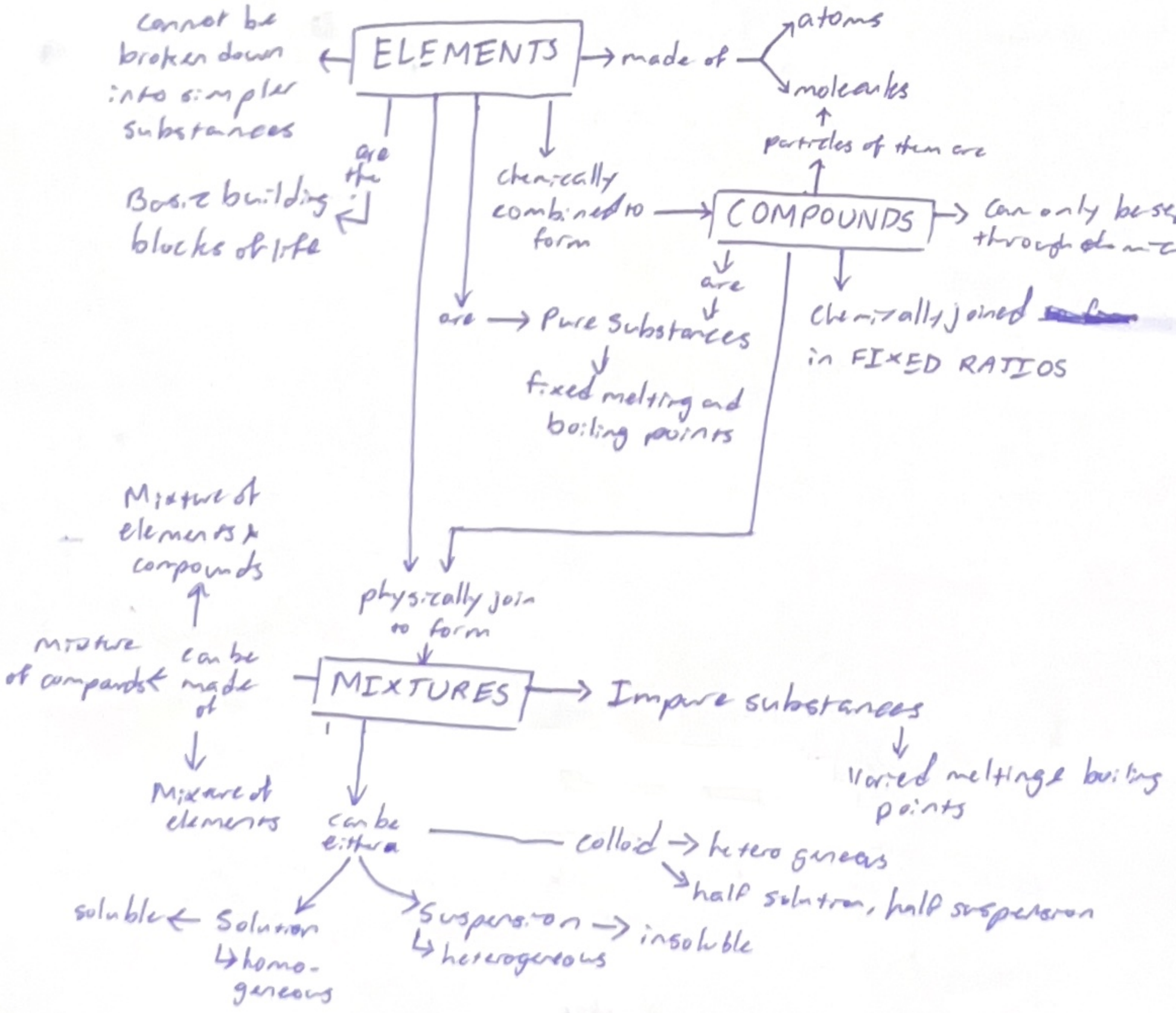
Solute + Solvent = Solution

Colloids (between solution/suspension)

- heterogeneous
- doesn't settle upon standing
- can be filtered
- scatters light / opaque

eg. milk / blood.

Mindmap



Solutions & Suspensions

Solutions

→ homogeneous
⇒ solute is evenly distributed throughout solvent (colour and density included)

→ usually clear/transparent - allows light to pass through (solute particles too small to reflect/block light)

→ No residue when filtered - particles small enough to pass through filter paper.

Suspensions

→ heterogeneous
⇒ solute is unevenly distributed throughout solvent (gathers at bottom of container)

→ cloudy / opaque - cannot see through
- reflects / blocks light from passing through (particles large enough to block/reflect light)

→ leaves residue when filtered - particles too big to pass through filter paper.

Concentration types

- Diluted - small amt of solute dissolved in solvent (eg. 30g of salt in 1 l of water)

Concentrated - large amount of solute dissolves in solvent (eg. 300g of salt in 1 l of water)

saturated - max amt of solute that can dissolve in solvent at given temp

Colloids

Definition: Special type of suspension wherein suspended particles are usually much smaller than those in suspensions.

- does not settle at bottom when left to stand
- cannot be separated by filtration

Solubility

Definition: Solubility is the maximum amount of solute that can dissolve in a given ~~amount~~ amount of solute.

Factors affecting Solubility

① Nature of Solute
- different solutes have different solubilities in the same solvent.

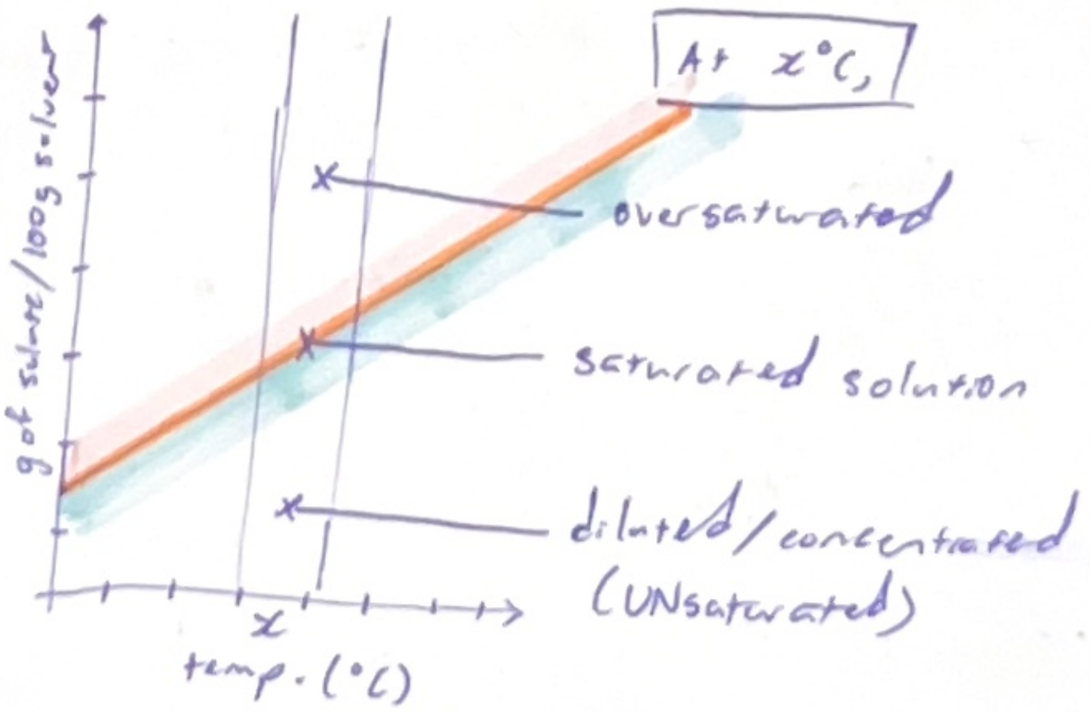
eg. At room temperature, 2000g sugar dissolves in 1 l of water, while salt dissolves in water at about 359 g/l of water

② Nature of Solvent
- different solvents can dissolve different amounts of solute in them.

③ Temperature of solution
- Usually, the higher the temperature of a solution, the more solute can dissolve. This is because of the rapid movement of particles when hotter, allowing them to have more solute dissolve in it.
- However, for gases, they work the other way. Because gases move too fast, they can 'escape' from the solvent easier.

Solubility Graph

→ shows max amt of solute that can dissolve in a given solvent at a given temperature



↑ that's how it works for most solutions APART from gases.

Rate of dissolving

→ Time taken for a solute to completely dissolve in a solvent.

Factors affecting Rate of Dissolving

① Surface area of solute

- the more surface area of solute exposed to solvent, the faster all the solute will dissolve.
- Eg. Sugar cubes dissolve slower than fine sugar.

② Temperature.

- Higher temp = faster dissolving.
- Still works opposite way for gases.

③ Rate of stirring

- Stirring ensures that new surfaces of solute and solvent are constantly touching, mixing better and dissolving the solute faster.
- Faster stirring = faster dissolving.

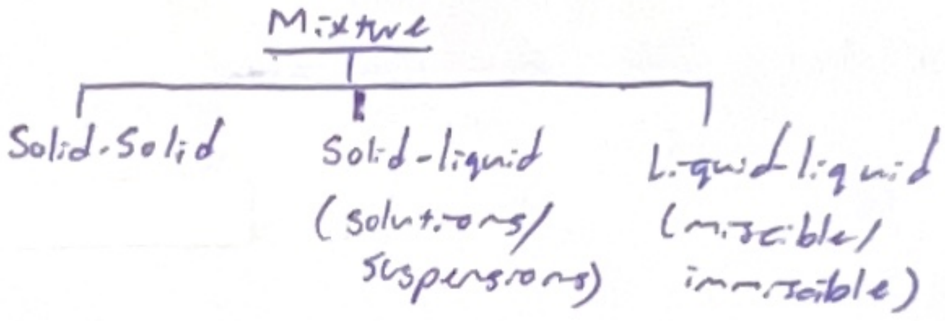
Rate of dissolving | VS | Solubility

→ how fast it dissolves	→ how much can dissolve

Separation Techniques (physical)

☆ Recap: Physical separation techniques will only work on Mixtures.

Kinds of mixtures



Solid-Solid Mixtures - Sep. Techs.

① Magnetic Separation. - magnetic attraction

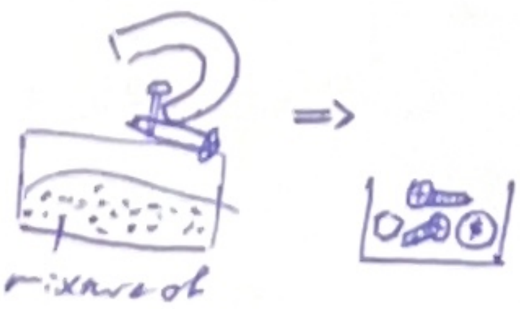
→ Suitable for: one of the components is magnetic while the other is non-magnetic.

→ Steps

- Use magnet (preferably electromagnet) to attract the magnetic component while leaving non-magnetic component behind.
- Move magnet to another container and de-activate magnet / brush the magnetic material off magnet.

Applications

- recycling sorting - separate recyclables into metal/non-metal; separate metals into magnetic/non-magnetic.
- Mining - separate iron from non-magnetic metals (iron ores)



② Sublimation

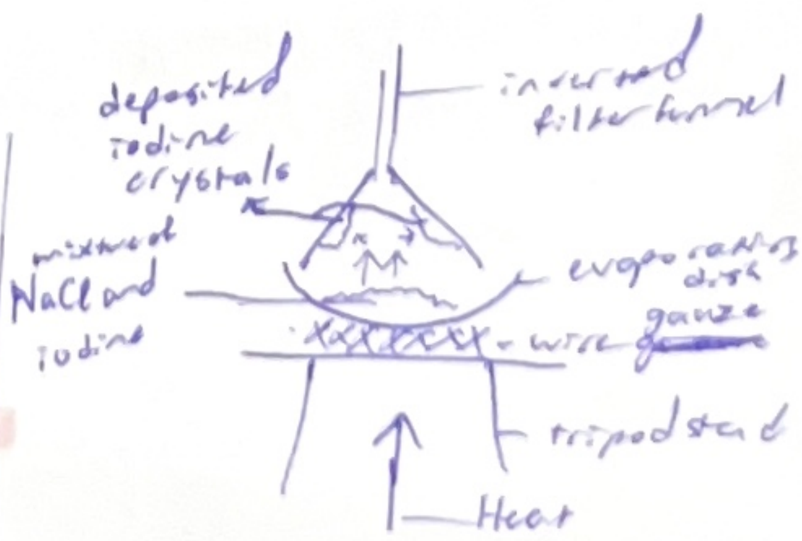
→ Suitable for: one of the components sublimes while the other doesn't sublime

→ Steps

- Put mixture in an evaporating dish, with a filter funnel placed upside down on top.
- Use Bunsen burner to heat up mixture.
- Substance A sublimes while B will either remain solid or melt. A will deposit onto the filter funnel when cooled.
- Scrape deposited solid off surface of filter funnel.

Applications

- purify iodine to produce disinfectants/ antiseptics

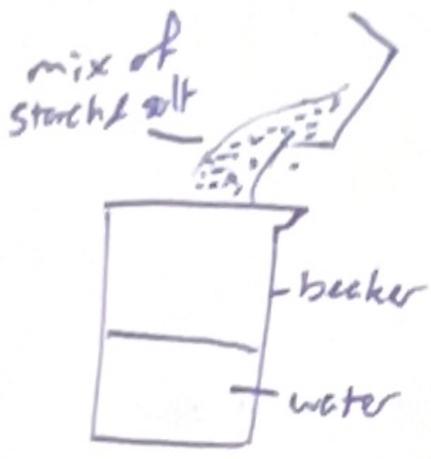


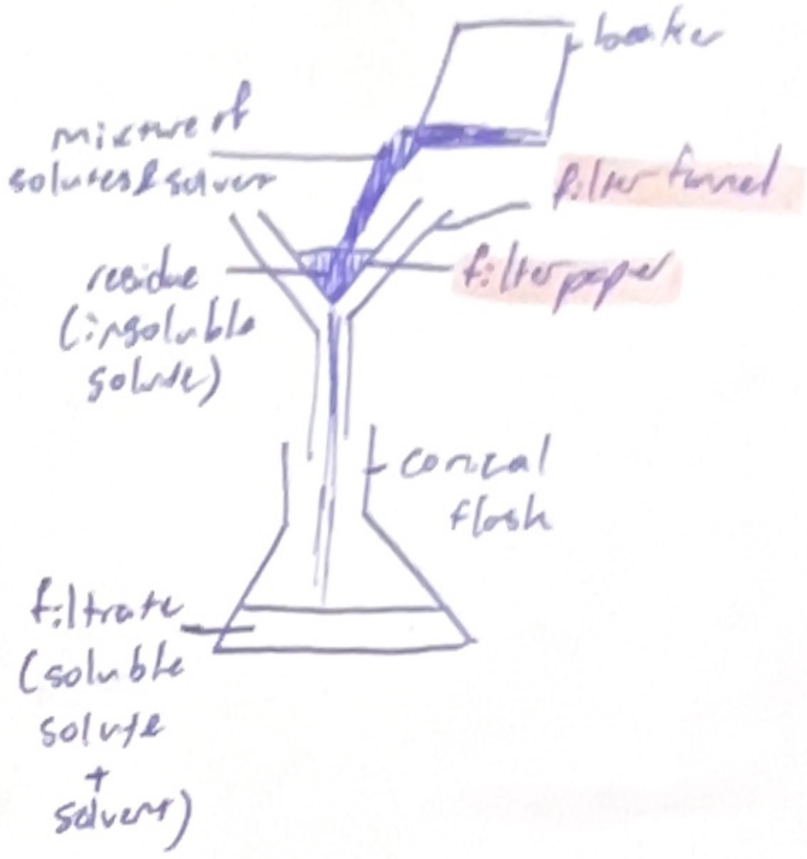
③ Dissolving followed by filtration

→ Suitable for: One of the components is soluble in a certain solvent while the other is insoluble in it.

→ Steps
- dissolve the two in the solvent (soluble one will dissolve & insoluble one will not dissolve)
- Filter the mixture. Soluble solute goes through while insoluble substance is left as residue.
- (optional) separate solvent from soluble solute (more later)

Applications
- Separating sand & salt / starch & salt (kitchen setting)





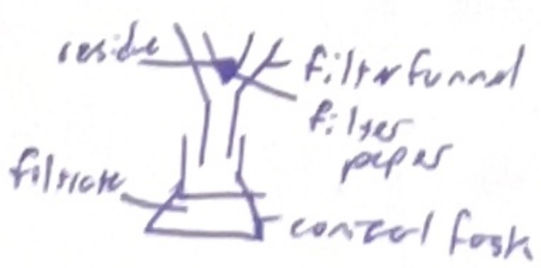
Separating Solid-Liquid Mixtures

① Filtration - Size & solubility

→ Suitable for: Suspensions

→ Steps
- pour mixture down filter funnel / lined w/ filter paper.
- Insoluble will be collected as residue, solvent will be collected as filtrate.

Applications
- coffee-brewing
- air-purifying

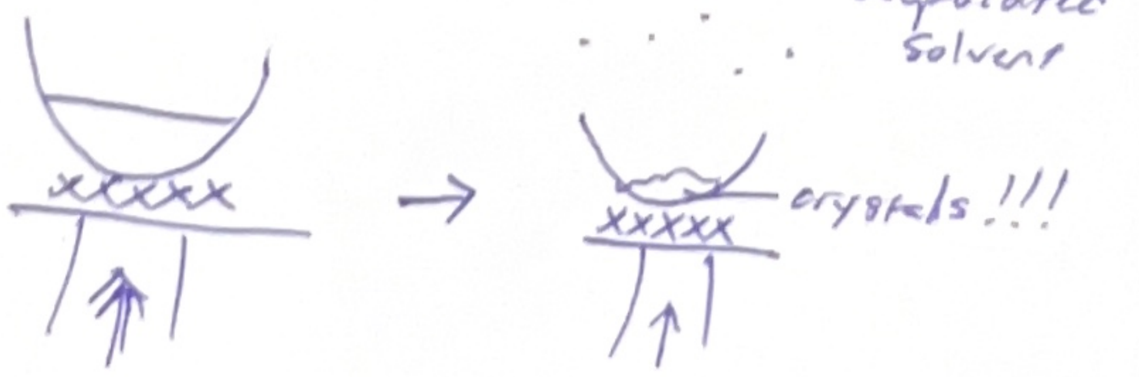


② Evaporation to dryness - heat-stability

→ Suitable for: heat-stable solid dissolved in liquid (soluble!) → won't decompose when heated (eg. sugar burns)

Applications
- Sea salt from seawater.

→ Steps
- heat mixture using Bunsen Burner (strong heating)
- liquid component of the mixture evaporates completely.
- solid will be left as crystals.



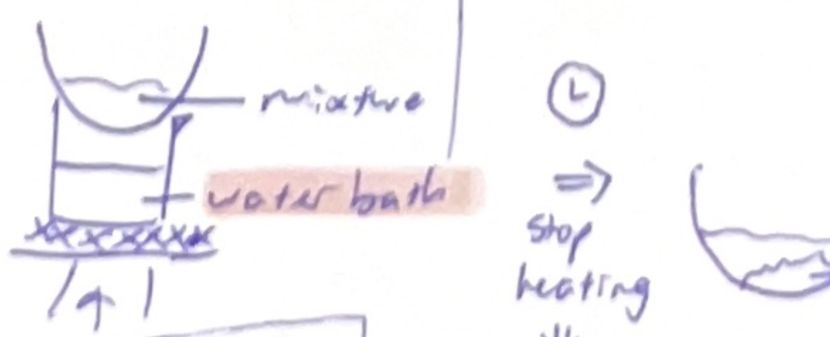
③ Crystallisation - heat-stability

→ Suitable for: heat-unstable soluble solid in liquid solvent.

Applications
- Make rock candy

→ Steps
- Heat solution to saturation (gentle heating)
- Leave it to cool → crystals will form.

Water baths allow gentler, indirect heating. Also used to be



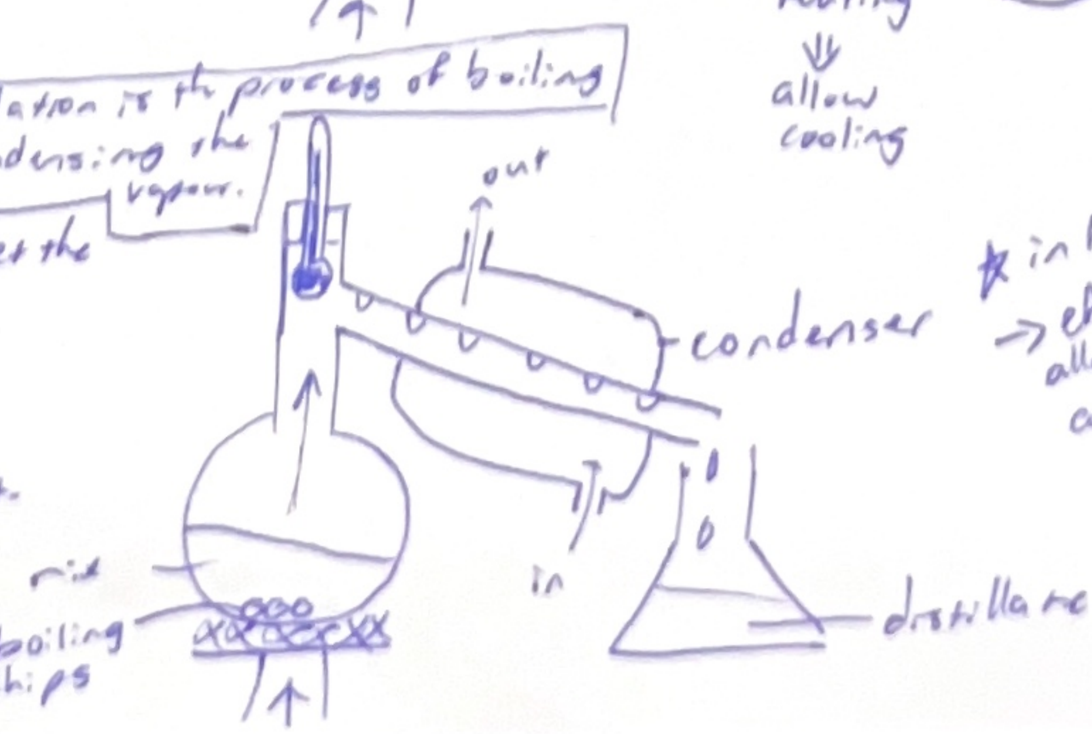
④ Simple Distillation

★ Definition: Distillation is the process of boiling a liquid and condensing the vapour.

→ Suitable for: When you want to collect the SOLVENT.

→ Steps
- Heat mixture
- let vapour rise into condenser to condense into collection flask as distillate

Applications
- desalinate salt-water.



★ in from bottom !!
→ efficient cooling to allow more vapour to condense before being collected as distillate.

Separating Liquid-Liquid Mixtures

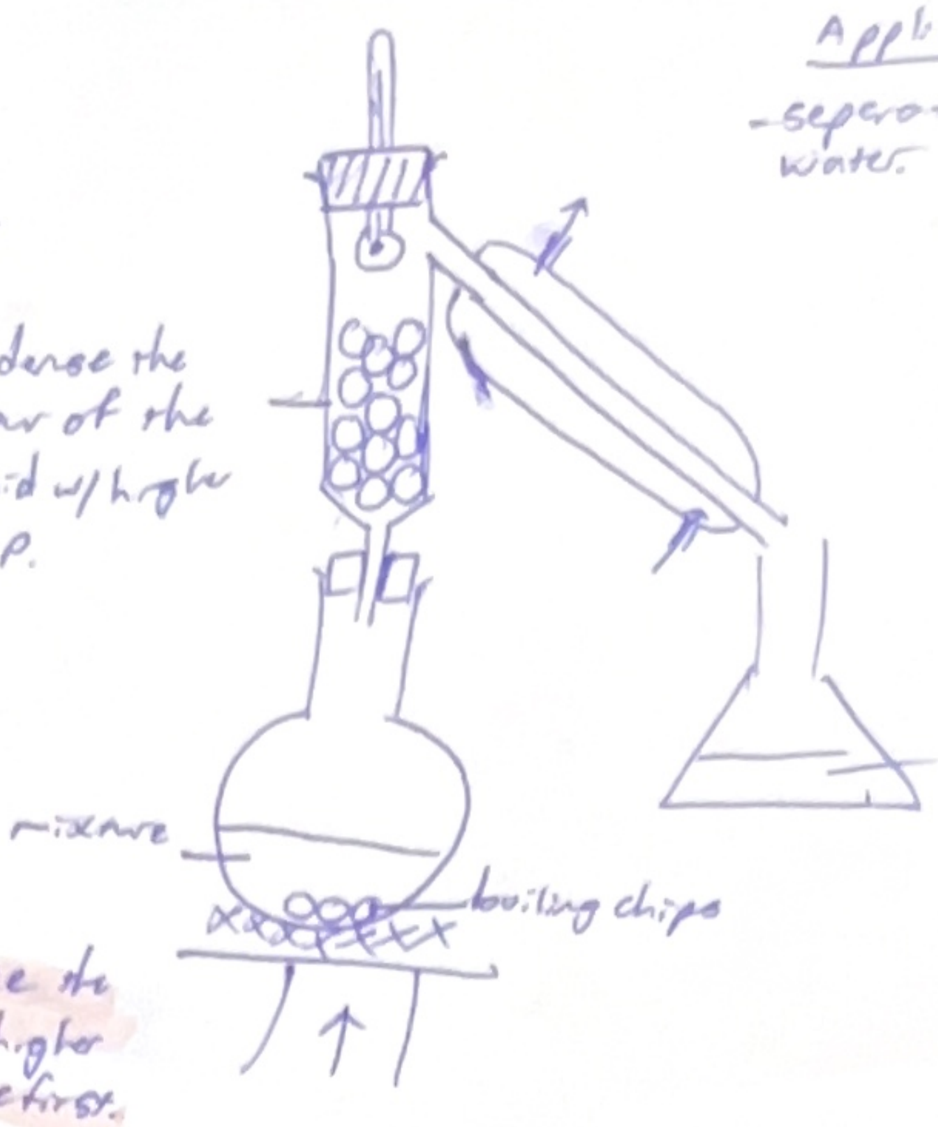
① Fractional Distillation - diff. boiling points

→ Suitable for: miscible liquids w/ different boiling points

→ Steps
- heat liquid mixture
- liquid with lower BP will vaporize first (higher BP will also vaporize but less)
- LBP will move on to condenser, HBP will condense in Fractionating Column and return to flask. (improve efficiency)

condense the vapour of the liquid w/ higher BP.

helps to make the liquid with the higher BP to condense first.



Applications
- separating ethanol & water.

② Separating Funnel - diff. density

→ Suitable for: immiscible liquids w/ diff. densities.

→ Steps
- turn tap on & let higher density liquid drip into beaker
- turn tap off when almost all of the higher density liquid is out.
- Turn tap back on after switching beakers. Stop when the dividing line has passed.
- Collect rest of lower-density liquid with new container.