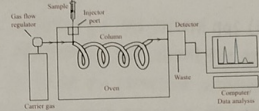
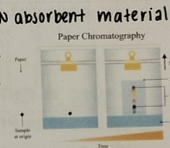


THIN LAYER CHROMATOGRAPHY:

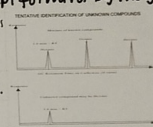
- **Qualitative analysis**, individual components of a mixture can be identified as each has a different retardation factor.
 - TLC can be used to compare a known sample with an unknown sample in the same conditions. Same R_f value = same substance.
 - The SP is a very absorbent material bonded to glass or a plastic support, i.e aluminium oxide. The absorbent material has many microscopic plates to increase SA for a large separation of the mixture.
 - The MP is the chosen solvent.
 - The solvent will travel up the SP due to capillary action → the process of a liquid flowing through a narrow space opposite to gravity
 - The mixture will desorb into the solvent and travel up with it.
 - **Particles more attracted to the SP move slower while particles more attracted to the MP move faster.**
 - **Retardation factor** aka R_f value: the distance the chemical has moved compared to the distance the solvent has moved.
- $$R_f = \frac{\text{distance travelled by compound}}{\text{distance travelled by solvent front}}$$
- The R_f is characteristic to a substance with a GIVEN absorbent material AND mobile/stationary phase system. (same conditions)
 - R_f value of a substance is not constant, depends on conditions. So to compare R_f values of diff pure substances, same conditions must be used.
 - **Max R_f is 1** → substance moves at same rate as solvent.
 - R_f of 0 → substance does not move from origin.
 - **Solvent carries components at diff rates depending on their polarity.**
 - Results in pure components of the mixture separating along the glass slide

will readily dissolve into that type of solvent, depending on polarity which will affect solubility



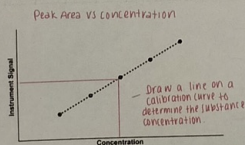
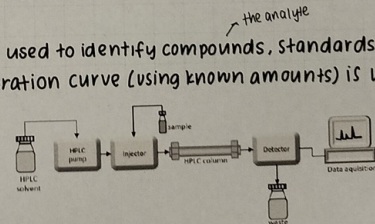
GAS CHROMATOGRAPHY

- Used for small organic molecules that can withstand high temp.
- A glass or metal looped column is the SP. A unreactive carrier gas is the MP → neon, nitrogen, helium
- The sample is vaporised and injected into a machine and the carrier gas (MP) pushes it along a long, thin column (SP).
- As the sample passes through the instrument, the components interact with the SP whilst being swept forward by the gas.
- **Smaller particles / those that adsorb onto the SP least exit the column first.** → low BP, high volatility, weak intermolecular forces
- **Larger particles / those that adsorb onto the SP most exit the column last.**
- **Retention time:** (R_t) time it takes for the compound / solute to pass through the chromatography column.
- ↳ R_t can identify the components of a mixture as they will be different
- The height and area of the chromatogram peak produced can also be used to determine the concentration of an analyte in a mixture. The unknown analyte must be run by a set of standards of known concentration, then comparing its height on the peak of the graph to the other substances. **Quantitative analysis.**
 - R_t is affected by the solvent gas (the gas that pushes the analyte through)
 - R_t is affected by the solvent the analyte is dissolved into.
 - for GC to be an effective analytical technique, the gas and solvent need to be the same for the entire experiment, and must be the same for the standards (known) as well as the analyte (unknown).
 - Retention time depends on their volatility, BP and molecular mass.



High-Performance Liquid Chromatography - HPLC

- used for larger organic molecules and those that are unstable to heat, because it has no oven.
- The stationary phase column is shorter than the one used in GC.
- Liquid acts as the mobile phase, not gas.
- The same analysis process is used: R_t values are used to identify compounds, standards (known) are run to confirm the identity (same R_t), and a calibration curve (using known amounts) is used to determine the amount of substance present.
- Packed with silica beads to increase SA in tube.



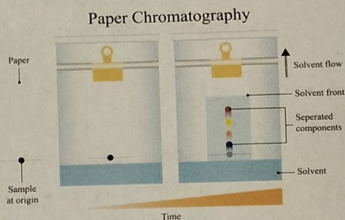
- You measure the distance the chemical/spot has moved compared to the distance the solvent has moved. This is called the Rf value, or Retardation factor.
- The Rf is characteristic for a particular substance with a given absorbent and solvent (stationary/mobile) system.
- Rf** : the ratio of the solute/compounds distance travelled to the distance the solvent travelled (determined by the solvent front).

↳ $Rf = \frac{\text{distance travelled by compound}}{\text{distance travelled by solvent front}}$

↳ In TLC, Rf can identify the components in a mixture as they will have different Rf.

Application

- TLC can be used to compare a known sample with a unknown sample in the same conditions.
- If the Rf values are the same, then the substances are the same.



Gas Chromatography - GC

- This is a technique used for small organic molecules that can withstand high temperatures i.e. blood alcohol levels are measured by GC.
 will turn into a gas, not decompose
- The sample is injected into the machine and gas (mobile phase) pushes it along a thin, long column (stationary phase).
 the glass column
- Smaller particles and those that adsorb onto the stationary phase the least come out the column first.
- Larger particles and those that adsorb onto the stationary phase the most come out last.
- The carrier gas used is very unreactive like nitrogen, helium and neon.
- RT** : (retention time) the time it takes for the compound/solute to pass through the chromatography column.

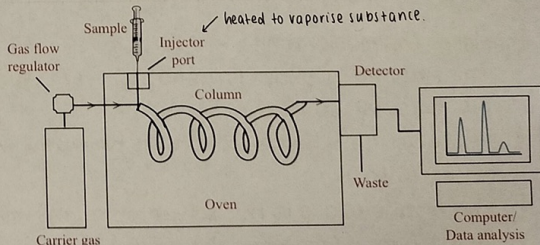
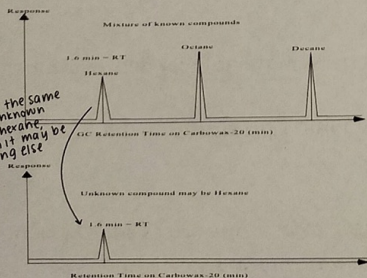
↳ In GC, Rt is used to identify the components in a mixture, as they will be different.

↳ Rt can also measure how much analyte is present, by running the unknown analyte by a known set of standards and comparing the height of the peak on the graph to other substances.

Retention Time

- RT is affected by the solvent gas (the gas that pushes the analyte through)
- RT is affected by the solvent the analyte is dissolved into.
- ° for GC to be an effective analytical technique, the gas and solvent need to be the same for the entire experiment, and must be the same for the standards (known) as well as the analyte (unknown).

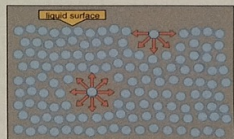
TENTATIVE IDENTIFICATION OF UNKNOWN COMPOUNDS



Gas Chromatography Graph

Surface Tension

- **surface tension**: A measure of the force required to break or stretch the surface of a liquid. and increase the SA
- water has an unusually high surface tension for its molecule size due to the relatively high attraction of the water molecules to each other (cohesive forces) through a web of hydrogen bonds.
- Due to strong cohesive forces in water all water molecules are pulling/attracting each other equally. The water molecules on the surface do not have the same forces pulling on them (as there are none 'above' them) so they are pulled inwards. This creates **internal pressure** as all 'sides' are being pulled in, forcing the liquid to become as small as possible. If the ST is high enough, a liquid can sustain its form
- The tendency of liquid surfaces at rest to shrink into the minimum surface area possible. Water forms round shapes % pulled inwards.



Despite gravity

Definition of surface tension

: the attractive force exerted upon the surface molecules of a liquid by the molecules beneath that tends to draw the surface molecules into the bulk of the liquid and makes the liquid assume the shape having the least surface area

Vapour Pressure

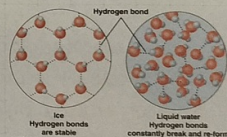
- The pressure exerted by a vapour in contact with its liquid or solid form.
 - Water has a low vapour pressure meaning that there are few gas molecules exerting downward pressure on the liquid water.
- ↳ This is because of the strong hydrogen bonding, so less liquid molecules are able to evaporate as easily and become gas.
- Vapour pressure can only be measured in a closed container.
 - when evaporation rate = condensation rate % an equilibrium

Density

- In most compounds the particles move closer together as they get colder and then solidify. However water is most dense at 4°C as the water molecules are packed closest together at this temperature.

Water is ..

- most dense at 4°C
 - contracts until 4°C
 - Expands from 4°C to 0°C
 - Ice is about 10% less dense than water at 4°C
- ↳ When water reaches 0°C it becomes locked in a crystalline lattice with each molecule bonded to a maximum of four partners. As ice starts to melt, some hydrogen bonds break and some water molecules can slip closer together than they can while in the ice/solid state.



Universal Solvent

- Water forms **aqueous solutions** when a solute dissolves in it.
- Universal Solvent because many substances will dissolve in it due to its polarity.
- Substances that readily dissolve into water are **hydrophilic**.
- A solute may form ion-dipole, dipole-dipole or hydrogen bonding with water.

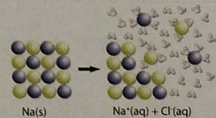
HYDROPHILIC

- Ionic compounds dissolve in water
- Polar molecules are generally water soluble

HYDROPHOBIC

- Non-polar compounds generally don't dissolve in water

No attraction to polar sides of the water molecule or the molecule is too large to fit in between the water molecules.



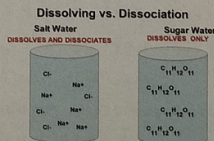
dissociation of NaCl whilst dissolving in water.

Dissolving and Dissociating

- **Dissociation** is a process where a compound separates into 2 or more parts.

eg. N_2O_4 dissolves into 2 NO_2 molecules. $O_2N-NO_2 \rightarrow 2NO_2$

- Dissolving (**dissolution**) is the process of particles of a substance move into the solvent. May or may not involve dissociation.



WATER AND ITS UNIQUE PROPERTIES

Water and Bonding

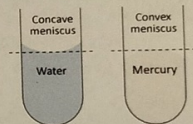
- water has several unique properties due to the several types of bonding that exist in it.
- Strong covalent bonding with the H and O → intramolecular bonding
- Dispersion forces between water molecules → intermolecular forces
- Hydrogen bonding between H and O on different molecules → intermolecular forces

Water Properties

- Unusual melting and boiling points
- unusual density in solid and liquid phases
- surface tension
- good solvent

Cohesion

- cohesive forces: the attractive forces that cause molecules in the same substance to 'stick' together and maintain a certain shape of the liquid
- water is extremely cohesive
 - Hydrogen bonds are relatively strong
 - Each water may be bonded to as many as four other molecules at the same time.
- Produces surface tension



Adhesion

- adhesive forces: the attractive forces between molecules of different substances.
 - When adhesive forces > cohesive forces a meniscus can be formed.
 - meniscus: the curve in the upper surface of a liquid close to the surface of the container or another object, caused by surface tension.
- ↳ a water meniscus is formed because water molecules are attracted to the molecules in the wall of the glass beaker. The water molecules touching the glass will cling to it, and since water likes to stick together, other water molecules cling to the outer ones already touching the glass, forming a meniscus that is concave shaped.

Capillary Action

- capillary action: water rising in a narrow tube against the force of gravity.
- important for life, as it allows plants to take water up from roots to leaves
- water is attracted to the glass by adhesive forces and moves up along the glass. The rest of the water is pulled up with those water molecules due to cohesive forces.

Heat Capacity

- Water has multiple hydrogen bonds, thus a large amount of heat energy is required to cause molecules to move faster and raise the temperature of the water.
- very important for life
 - Prevents ocean from freezing/boiling
 - allows cells to function at a wide range of temperatures.
- Cohesive forces: attractive forces between the same type of particles.