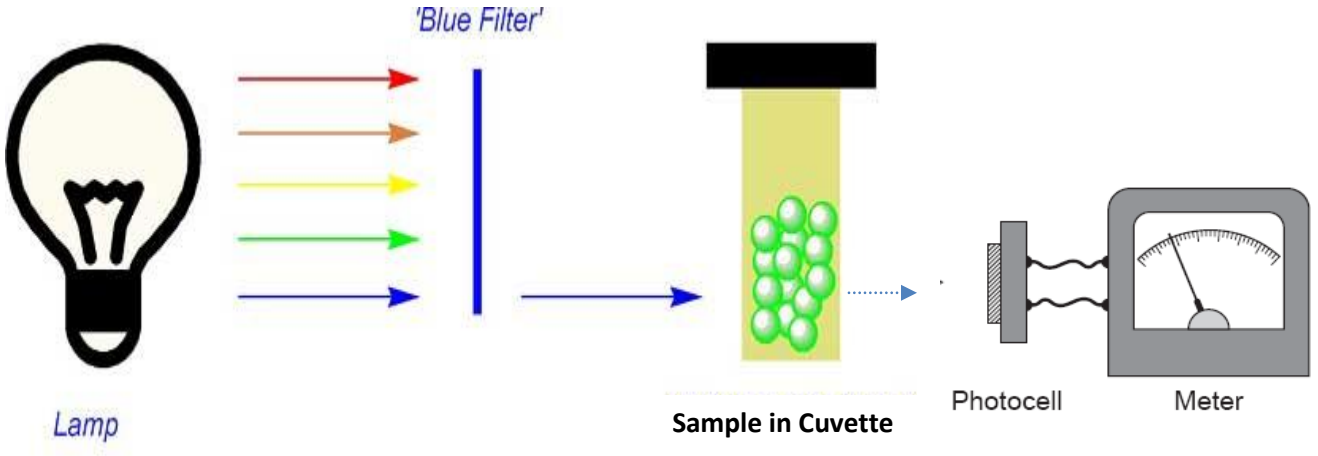
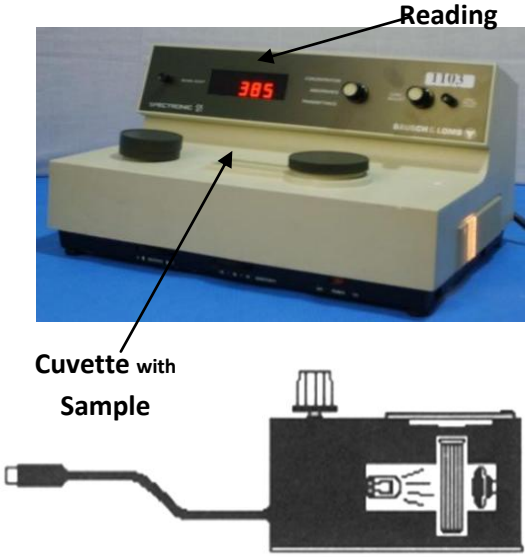
Colorimetry

Principle

- If a solution is coloured then the intensity of the colour is proportional to the concentration.
- The percentage of light absorbed by the coloured solution in the colorimeter is proportional to the concentration.





Processes

1. Light of a particular wavelength is passed through a number of samples of known concentration.
2. A graph of absorbance against concentration is plotted
3. The absorbance of the unknown is noted and using the graph the concentration versus absorbance the concentration of the unknown can be found

Uses

Analysis

1 Lead in water

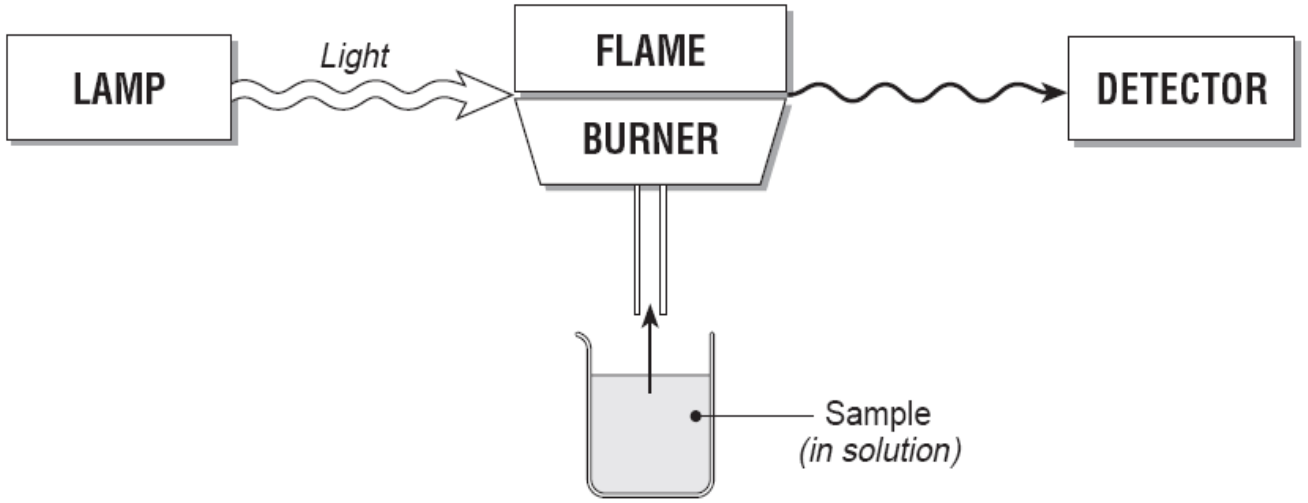
2 Fertilisers in water

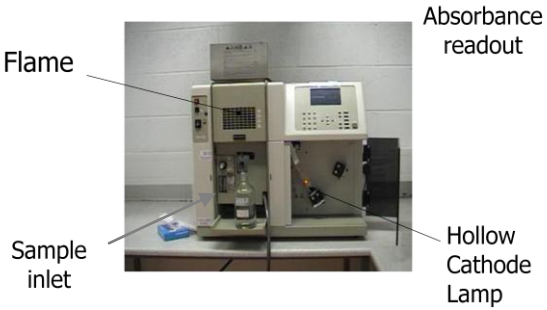
e.g. nitrates & phosphates

Atomic Absorption Spectrometry

Principle

- Atoms in the ground state absorb light of a particular wavelength characteristic of the element.
- Absorbance is directly proportional to concentration





Processes

1. Sample solution is sprayed into the flame, where the sample element is converted into atoms in the element.
2. Ground state atoms absorb radiation from a source made from the element
3. Absorbance is measured

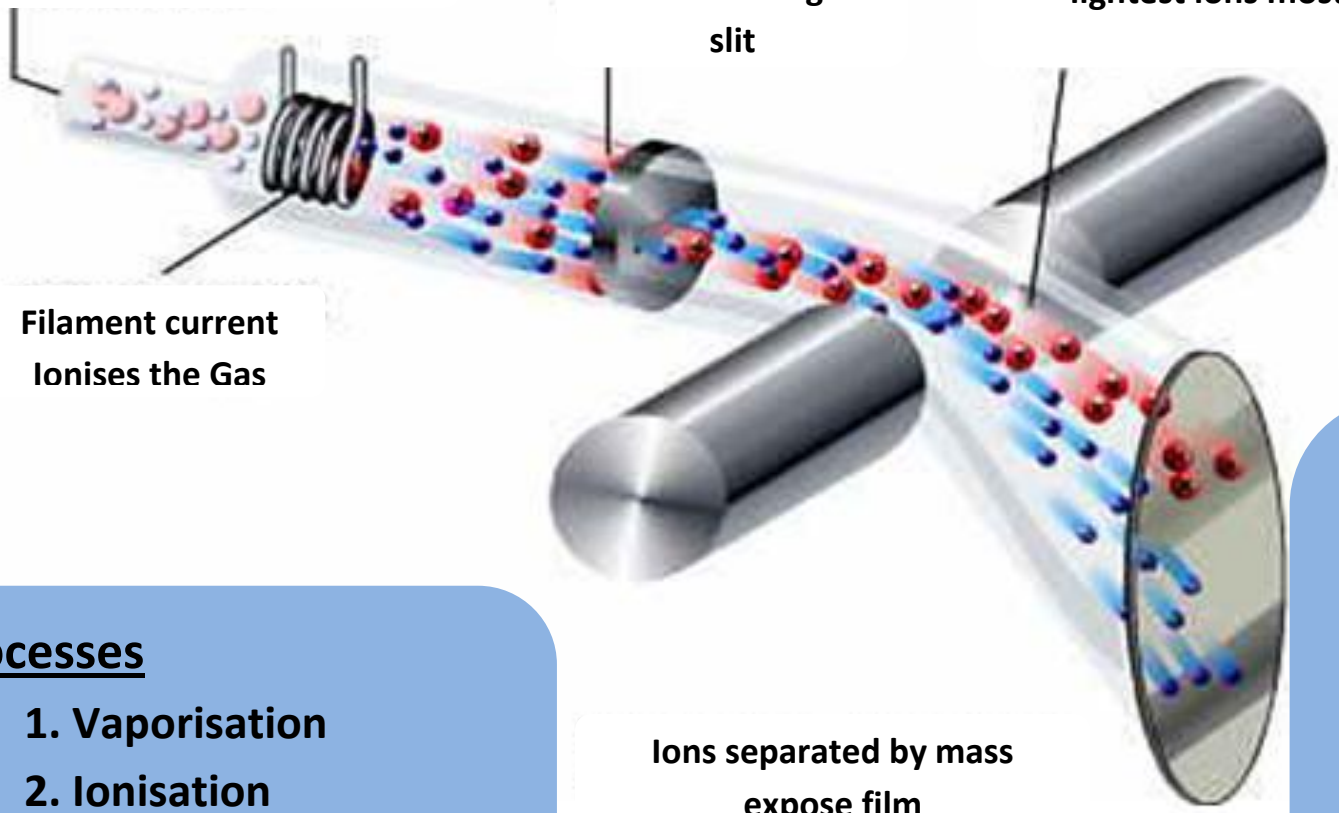
Uses

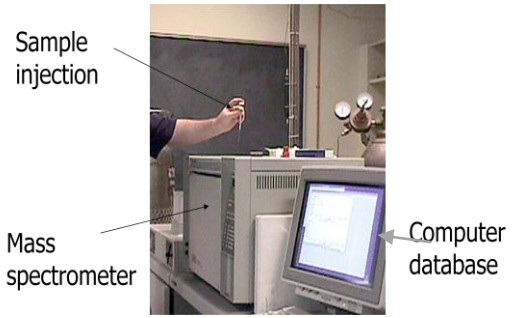
1 Identification of elements
2 Concentration of elements
3 Analysis of heavy metals in water e.g. lead, cadmium

Mass Spectrometry

Principle

Positively charged ions are separated on the basis of their relative masses as they move in a magnetic field





Processes

1. Vaporisation
2. Ionisation
3. Acceleration
4. Separation
5. Detection

Uses

Identify compounds e.g.

1. **in analysis of gases from waste dumps**
2. **In trace organic pollutants in water**
3. **In drug testing**

Measure relative atomic mass

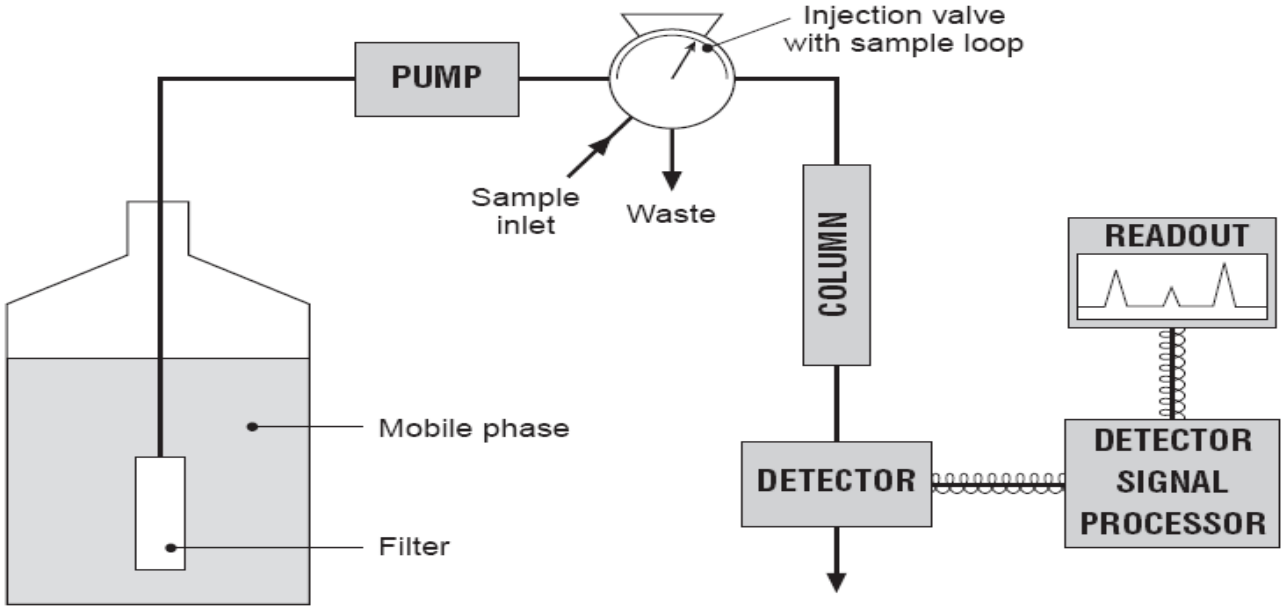
Measure relative abundance of isotopes

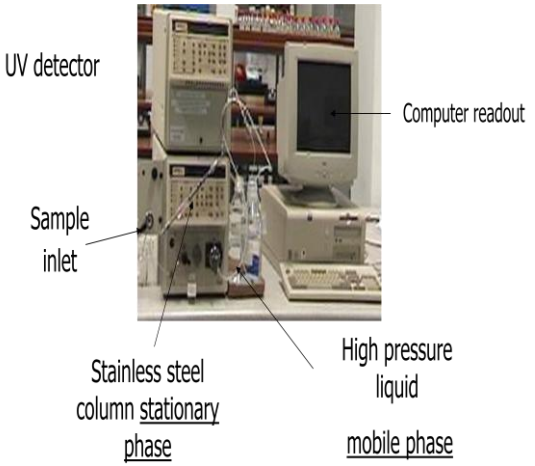
High Performance Liquid Chromatography (HPLC)

Principle

Different components of the mixture have different tendencies to absorb onto very fine particles of a solid in the HPLC column. The solvent is pumped through the column under pressure. The different components of the mixture will travel at different speeds along the column.

This separates the components of the mixture.





Stationary phase – fine solid particles e.g. silica.

Mobile phase – solvent under pressure

Processes

1. Injection
2. Transport of the sample along the column
3. Separation in the column
4. Detection

Uses

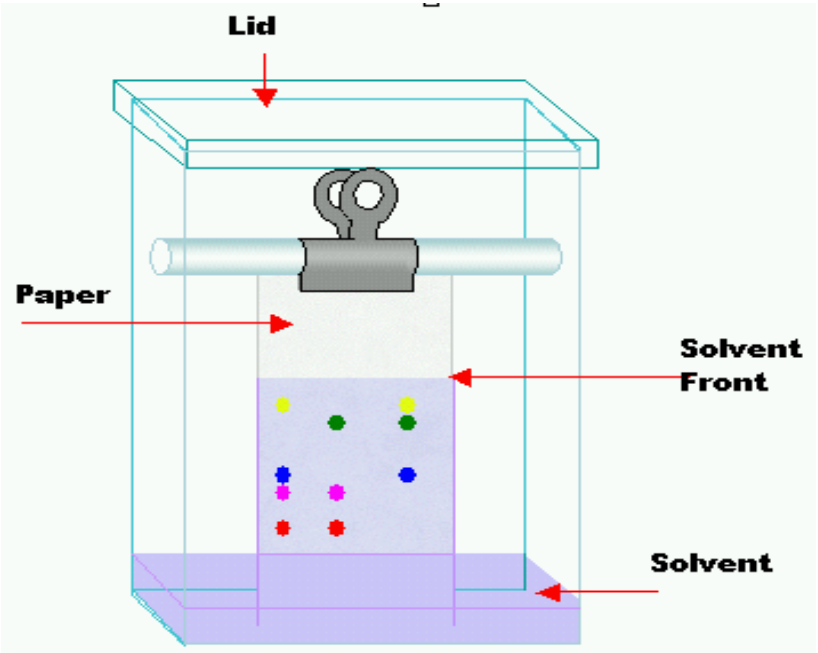
1. Analysis of Growth promoters in meat
2. Analysis of Vitamins in food

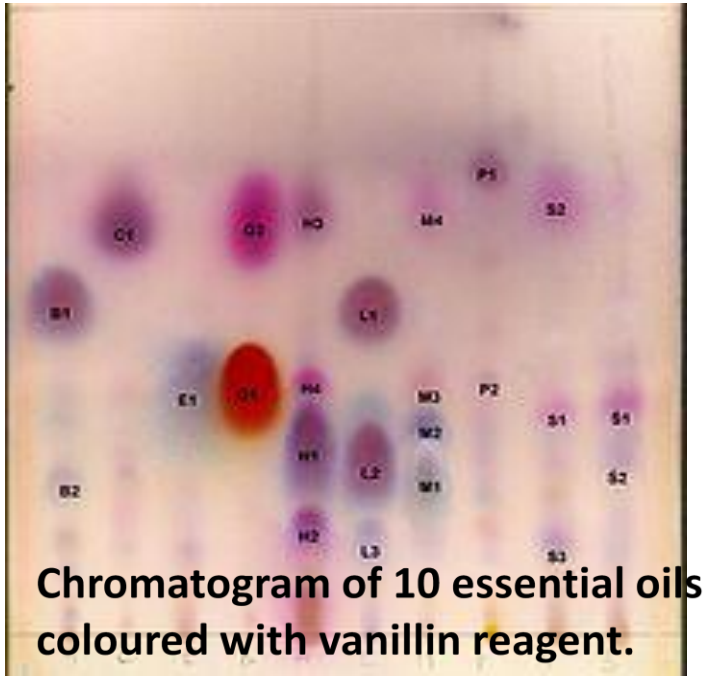
Paper Chromatography

Principle

Different components of the mixture have different interactions with the mobile phase and stationary phase so the different components of mixture will travel different distances along the paper.

This separates the components of the mixture.





Chromatogram of 10 essential oils coloured with vanillin reagent.

Processes

1. Add solvent (mobile phase) to chromatography tank
2. Apply spot of mixture to chromatography paper
3. Dry
4. Place in chromatography tank so that spot is just above mobile phase.
5. Components of mixture separate out as the mobile phase moves up through the paper

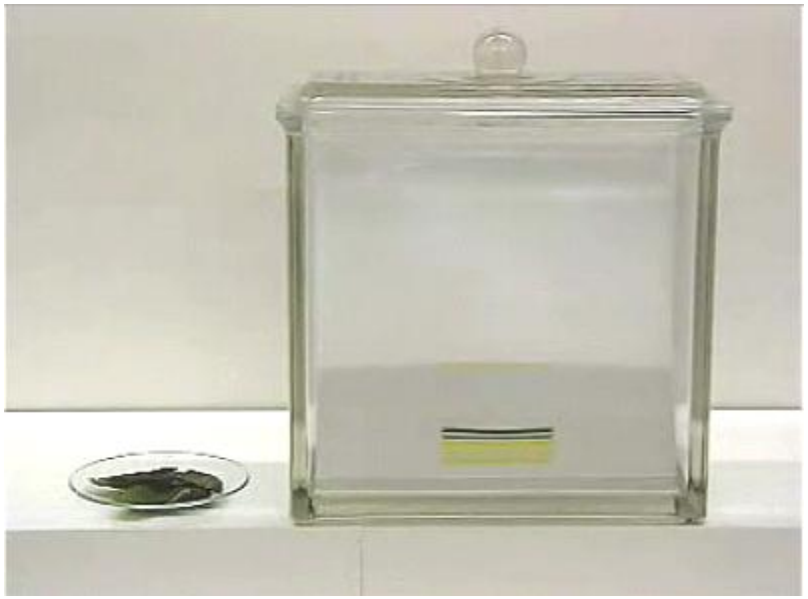
Uses

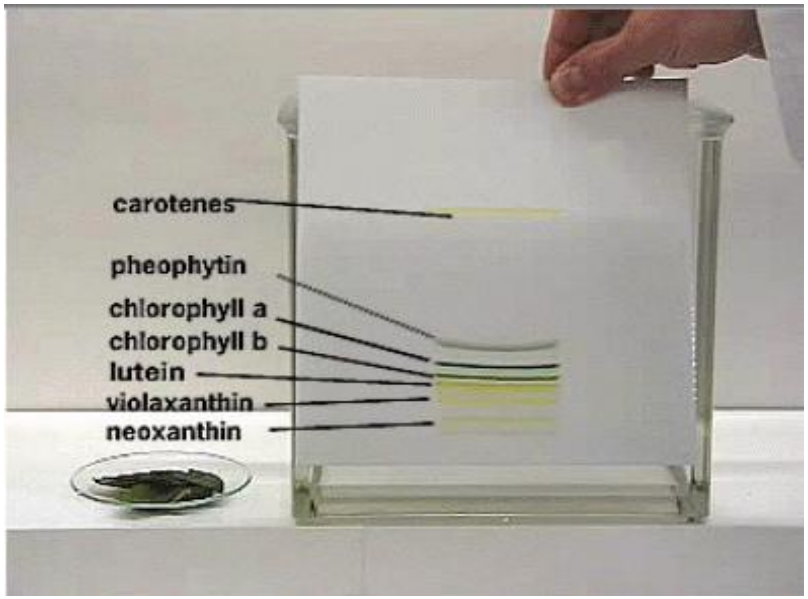
Separates Coloured Substances

Thin Layer Chromatography

Principle

Different components of the mixture have different interactions in the mobile phase and the stationary phase (a thin layer of silica on the glass plate).
The different components will travel different distances along the silica.
This separates the components of the mixture.





Processes

1. **Add solvent (mobile phase) to chromatography tank**
2. **Apply spot of mixture to TLC plate**
3. **Dry**
4. **Place in chromatography tank so that spot is just above mobile phase.**
5. **Components of mixture separate out as the mobile phase moves up along the TLC plate**

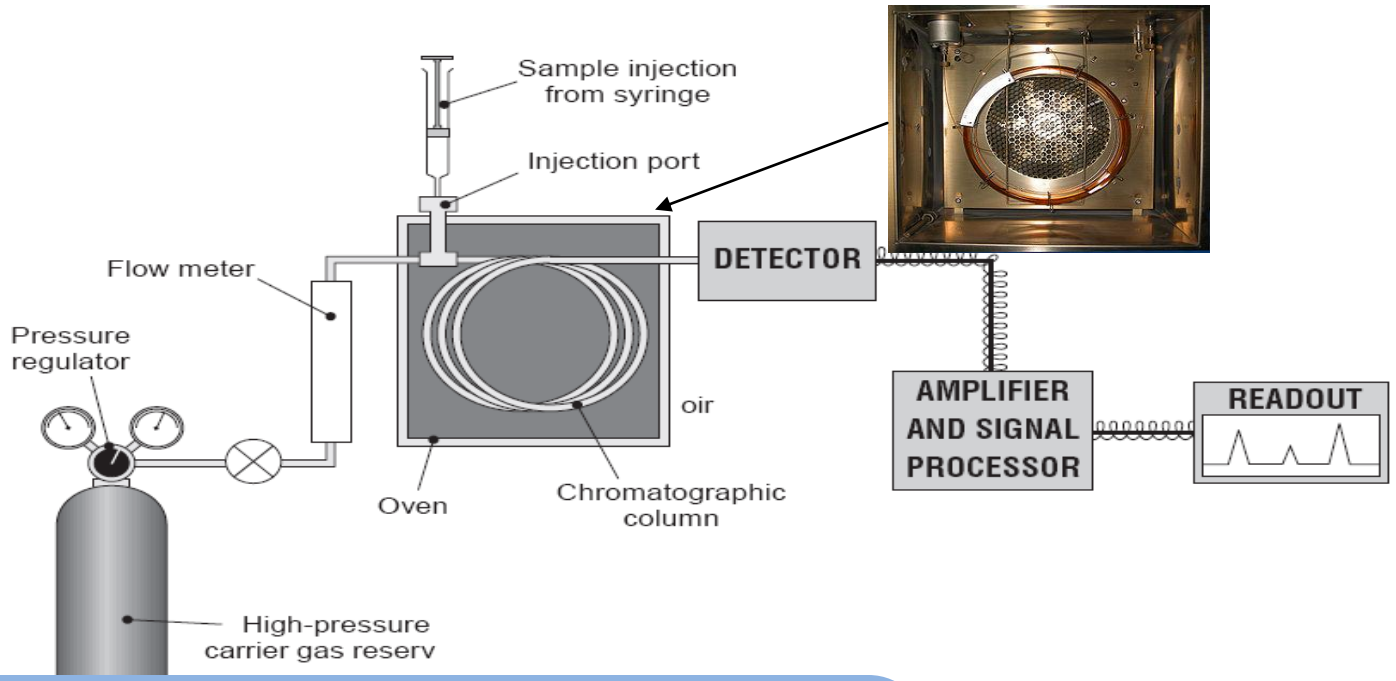
Uses

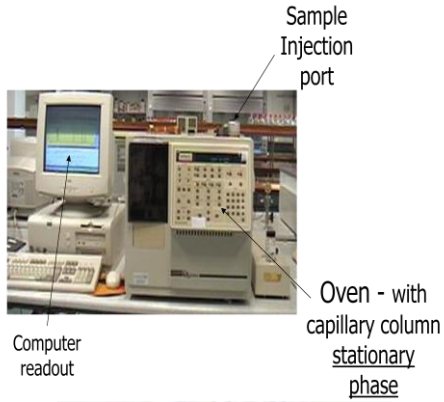
Separation of dyes taken from fibres in forensic work

Gas Chromatography

Principle

Different components of the mixture have different interactions with the stationary phase (liquid supported on a porous bed inside a long coiled column) and the mobile phase (inert gas for example nitrogen or argon).
The different components will travel at different speeds along the column.
This separates the components of the mixture.





Processes

1. **Injection**
2. **Transport of the sample along the column**
3. **Separation in the column**
4. **Detection**

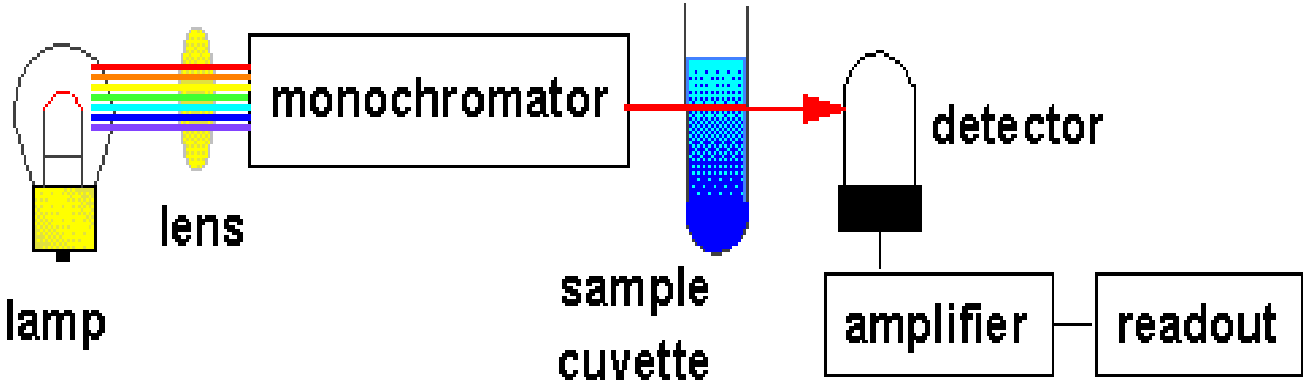
Uses

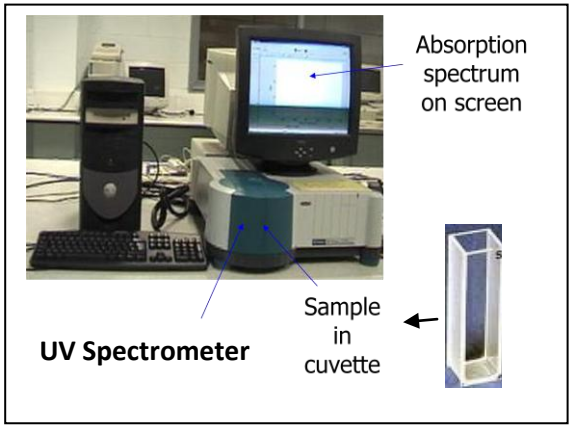
1. **Drug tests on athletes**
2. **Blood alcohol tests**

Ultraviolet Absorption Spectrometry

Principle

- Absorption of ultraviolet radiation by molecules results in the promotion of electrons from their ground state energy levels to higher energy levels
- Absorbance is directly proportional to concentration





Processes

1 Ultraviolet light is passed through the sample and a blank
2. The sample absorbs ultra violet radiation at specific wavelengths which are detected
3. Absorption spectrum is produced

Uses

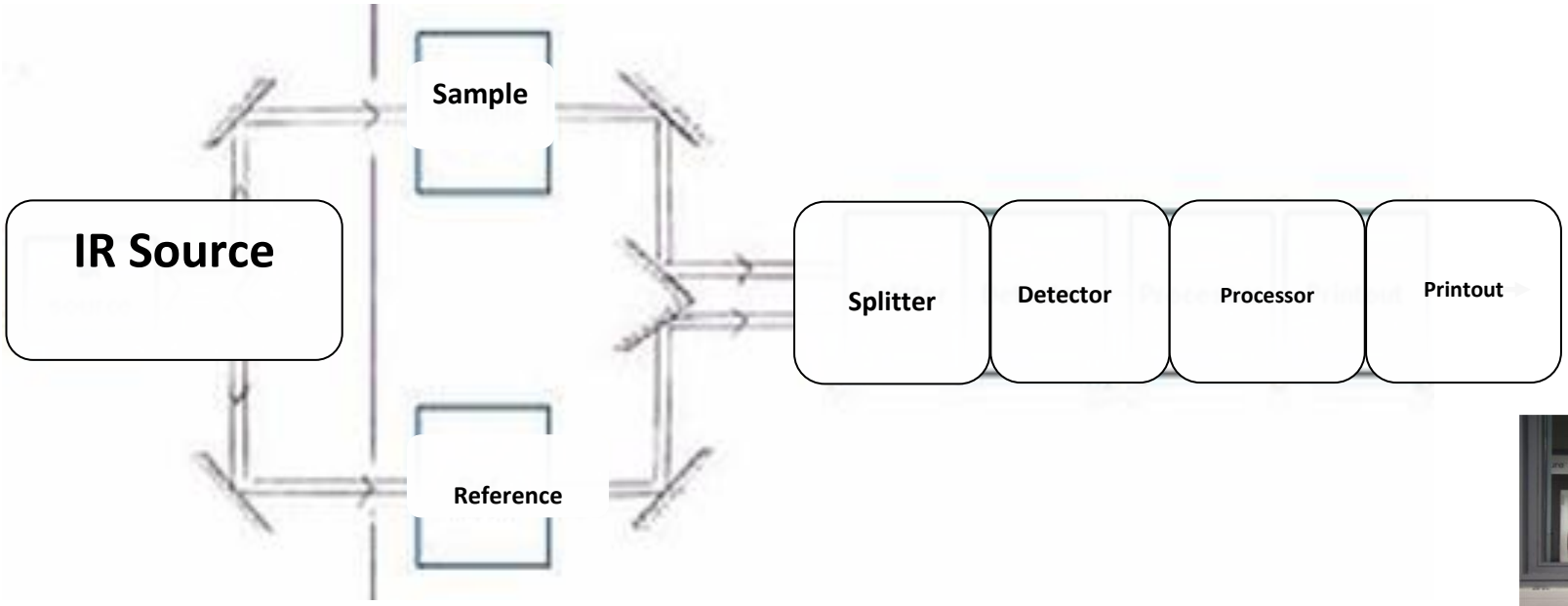
Quantitative determination of organic compounds

1 Drug metabolites
2 Plant pigments

Infra Red Absorption Spectrometry

Principle

Molecules of a substance absorb infra red light of different frequencies. The infra red radiation is absorbed by vibrations of the bonds in the molecules. The combination of frequencies absorbed is peculiar to the molecules of that substance (fingerprinting technique).



IR spectrometer

Processes

1. Infra red radiation passes through the sample
2. The sample absorbs infrared radiation at specific wavelengths which are detected
3. Absorption spectrum is produced

Uses

Identification of compounds e.g. in

1. Plastics
2. Drugs

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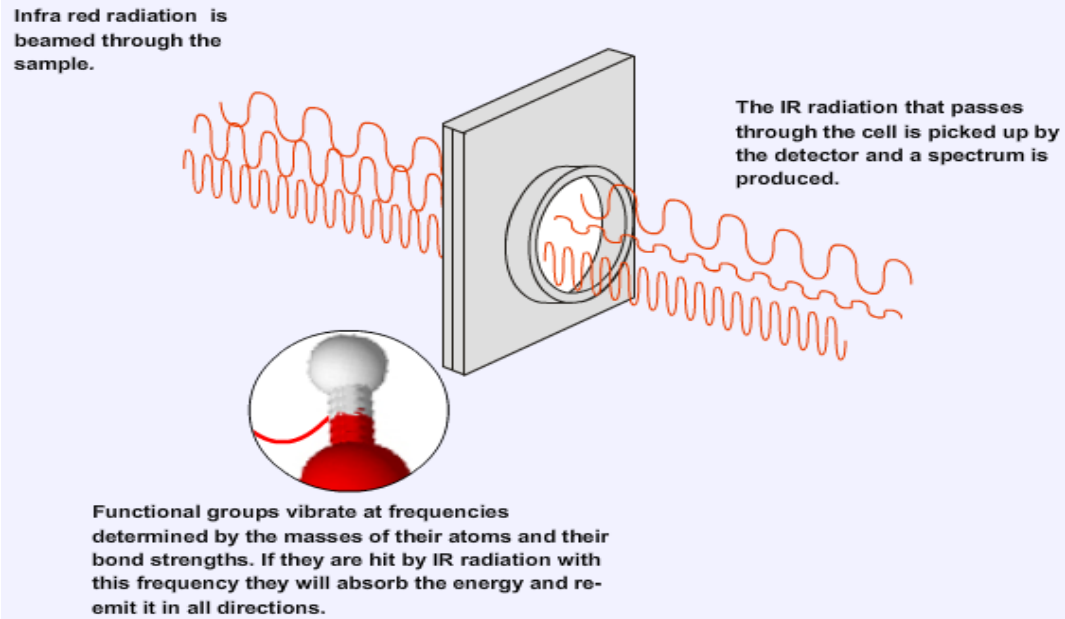

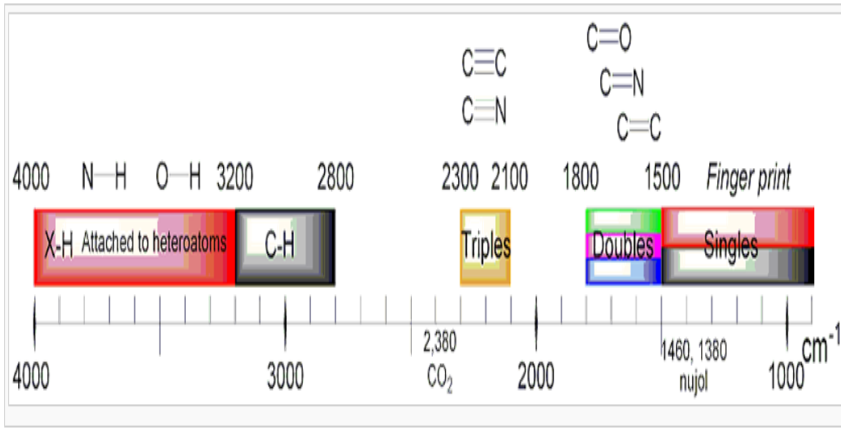

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3. Absorption spectrum is produced

Uses

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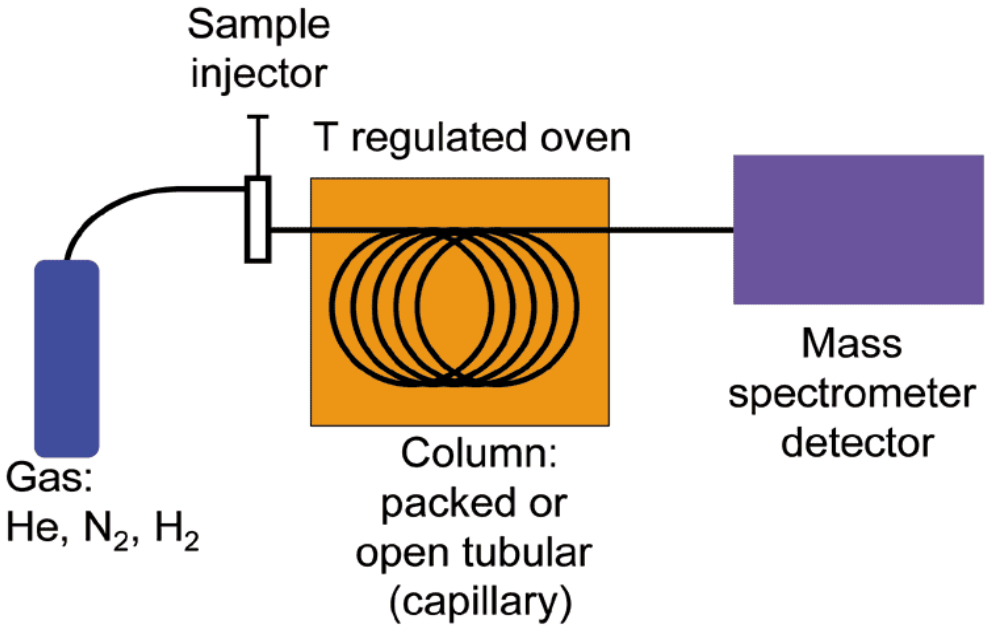
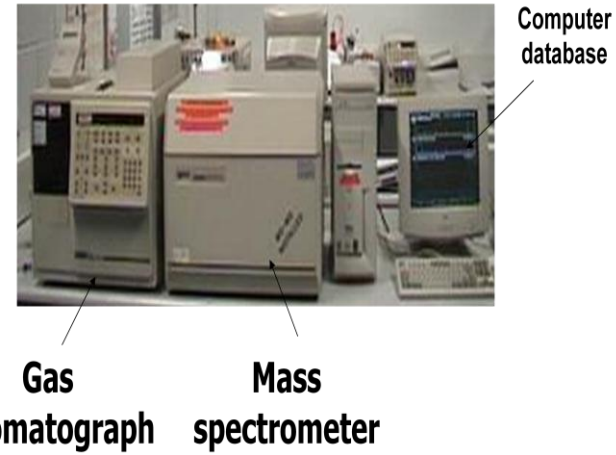
GC MS

Principle

- Mass spectrometry is commonly used in association with other analytical techniques such as Gas Chromatography (GC-MS) or High Performance Liquid Chromatography (HPLC-MS).
- The chromatographic techniques allow the components of a mixture to be separated before each one is analysed by a mass spectrometer.





Processes

The molecules take different amounts of time to move through the gas chromatograph

This allows the mass spectrometer downstream to detect the ionized molecules separately using their mass to charge ratio.

Uses

1. To monitor drugs in the body.
2. Analysis of gases from waste dumps.
3. Analysis of trace organic water pollutants.
4. Analysis of drugs in forensic science.

Sewage Treatment

Primary Treatment

Solids and large floating debris are screened from the waste water

Remaining solids are removed by allowing the waste to settle in sedimentation tanks

Secondary Treatment

Aerobic Microorganisms break down organic waste in the sewage by oxidation in air to carbon dioxide and water

Tertiary Treatment

Removal of nitrates and phosphates

Phosphates are removed by precipitation with Aluminium Phosphate

Nitrates are removed by biological nitrification.

Sewage Treatment

Your House Water from your pipes enters the sewer

Primary Treatment
Bar Screens catch large debris like branches and rocks

Primary Treatment
In **Grit Chambers** gravity pulls the larger particles to the bottom of the tank.

Secondary Treatment
Trickling Filters pour water over a bed of rocks where microorganisms digest the nutrients in the presence of air.

Primary Treatment
In the **Settlement Tanks** gravity pulls the larger particles to the bottom of the tank.

Secondary Treatment
In the Activated Sludge method the effluent is fed continuously into an aerated tank that is kept oxygenated by mechanical agitators. The microorganisms decompose most of the organic matter.

Solids removed from the water are reprocessed and used for fertiliser

Secondary Treatment
In the Settlement Tank gravity pulls the larger particles to the bottom of the tank.

Tertiary Treatment
removes nitrates and phosphates.
Phosphates are removed by precipitation with Aluminium Phosphate
Nitrates are removed by biological nitrification.

Clean Water returned to local streams and rivers

Water Treatment

Screening — Removal of large floating debris such as twigs etc. by passing the water through a wire mesh

Flocculation — Flocculating agent (Aluminium Sulfate) is added which causes the suspended particles to coagulate into large flocs which settle out of the water

Settlement — The water is passed into settlement tanks and more of the suspended particles settle out of the water.

Filtration — Any remaining particles are removed by passing the water through a bed of sand supported on layers on gravel

Chlorination — Chlorine gas is added to the water to kill harmful microorganisms and to prevent reinfection

Fluoridation — A compound of fluorine such as sodium fluoride is added to prevent tooth decay

pH adjustment — The treated water should be slightly alkaline to prevent corrosion of pipes. If the water is too acidic lime is added to raise the pH. If it is too alkaline dilute sulphuric acid is added.

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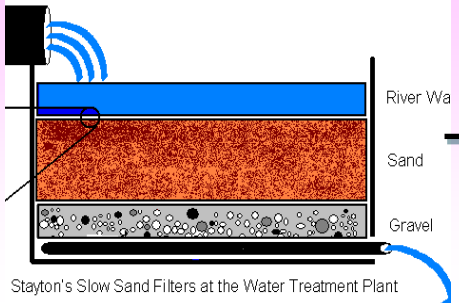

Stayton's Slow Sand Filters at the Water Treatment Plant

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