C4.2.4 Instrumental Methods of Analysis

Previous knowledge:

Gas chromatography

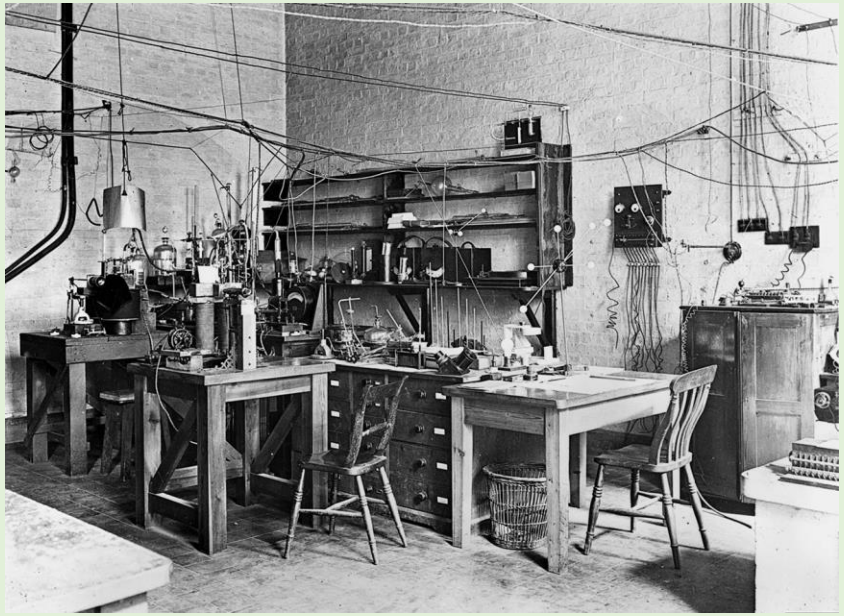
- Separates a mixture into the different chemicals that make up the mixture
- Measures the retention time – the time taken for each chemical to reach the detector
- The area under the peak is proportional to the amount of that chemical

Answer the quiz questions

Learning objectives

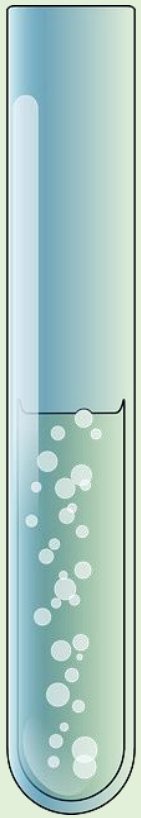
- List some instrumental methods of analysis
- Describe some advantages of instrumental analysis
- Justify the use of particular instruments to analyse given substances or mixtures

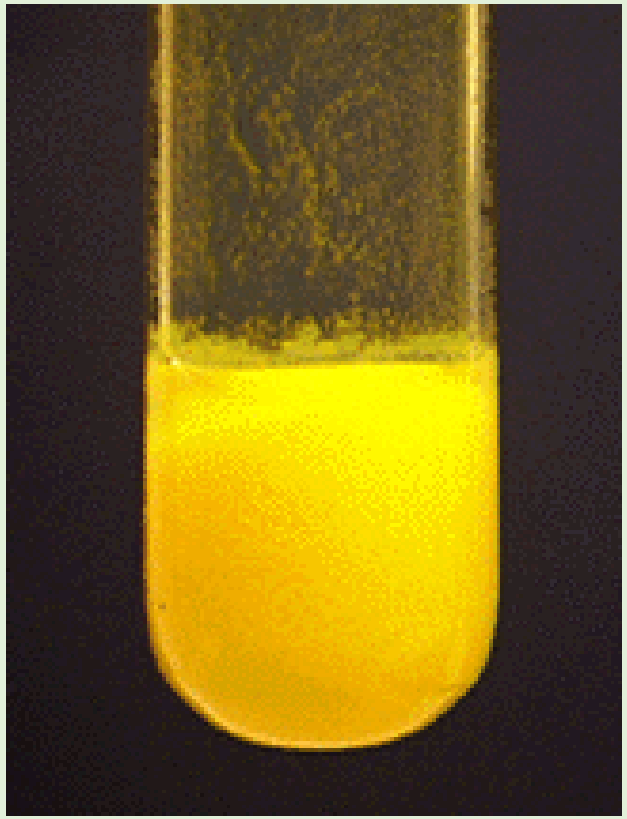
How have science research environments changed over time?



QUALITATIVE techniques

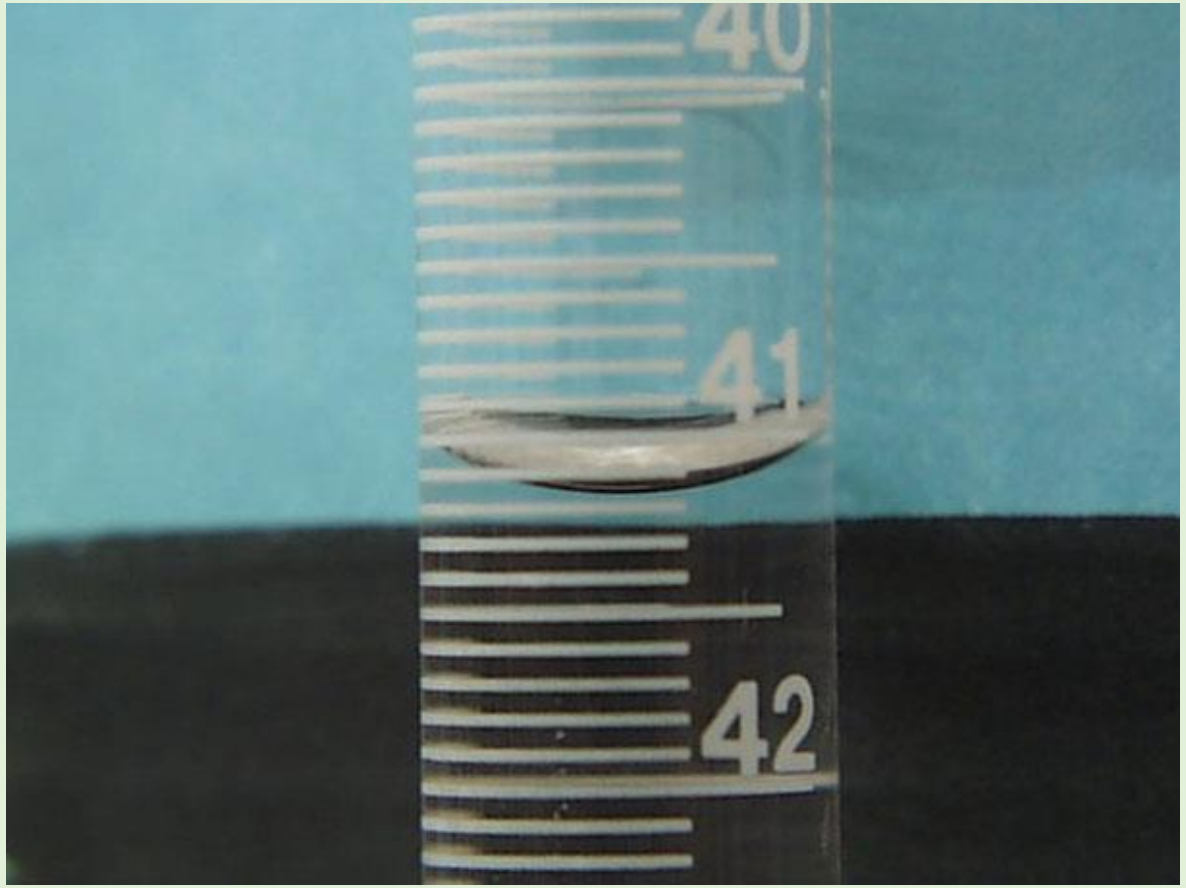
Testing that relies on **observations –** e.g. flame tests, tests for gases, sulfate ions etc





QUANTITATIVE techniques

Testing that relies on **measurements**.



TASK 1: Pros and Cons of using modern analytical methods – can you sort them out?

Require training to use

Small sample sizes can be analysed

Highly accurate and sensitive

Expensive

Results often need to be compared to known substances

Quick

An instrumental method of analysis relies on a machine to carry out an analysis of a substance.

Advantages of instrumental analysis:

- Sensitive – instruments can analyse very small amounts of a substance.
- Accurate – instruments are very accurate, they give a result that is very close to the true value.
- Speed – instruments can carry out analyses very quickly and can run all the time.

Uses of instrumental analysis:

- Process evidence from a crime scene
- Check blood alcohol level
- Test athletes blood for banned substances
- Test contaminated land or water
- Identify an unknown substance

Structure Determination

Unknown substance

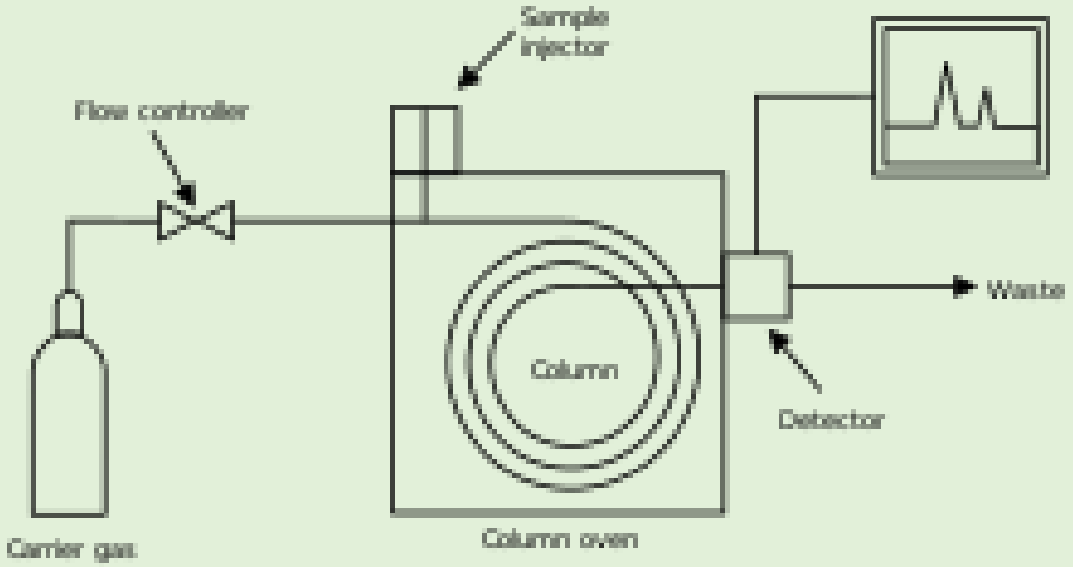
1. Purification- **Chromatography**

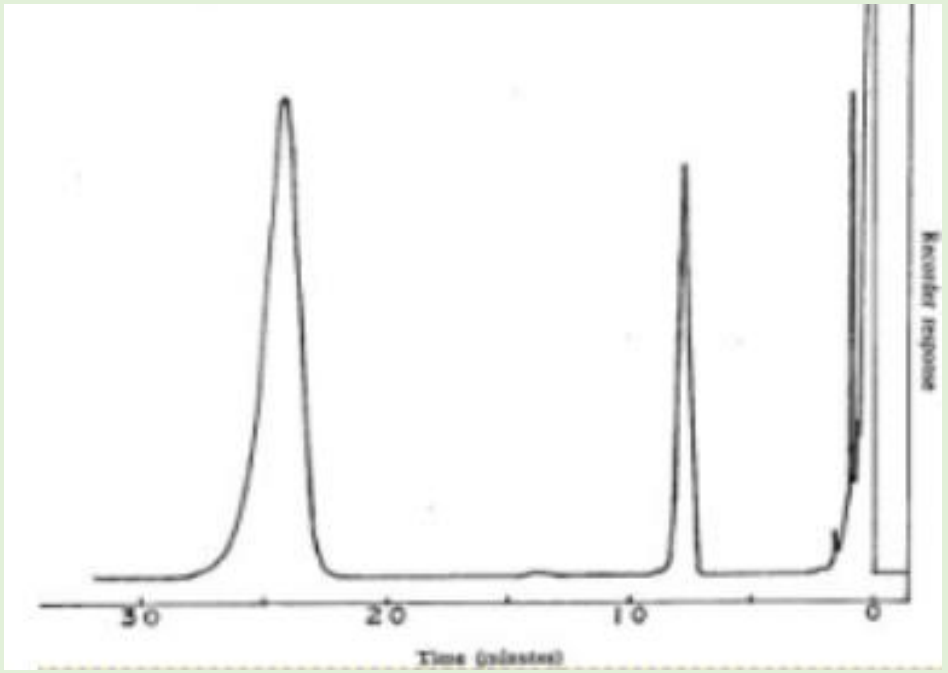
2. Determining relative formula mass - **Mass Spectroscopy**

3. Detection of functional groups- **I.R. (Infrared sectroscopy)**

Substance and its structure identified

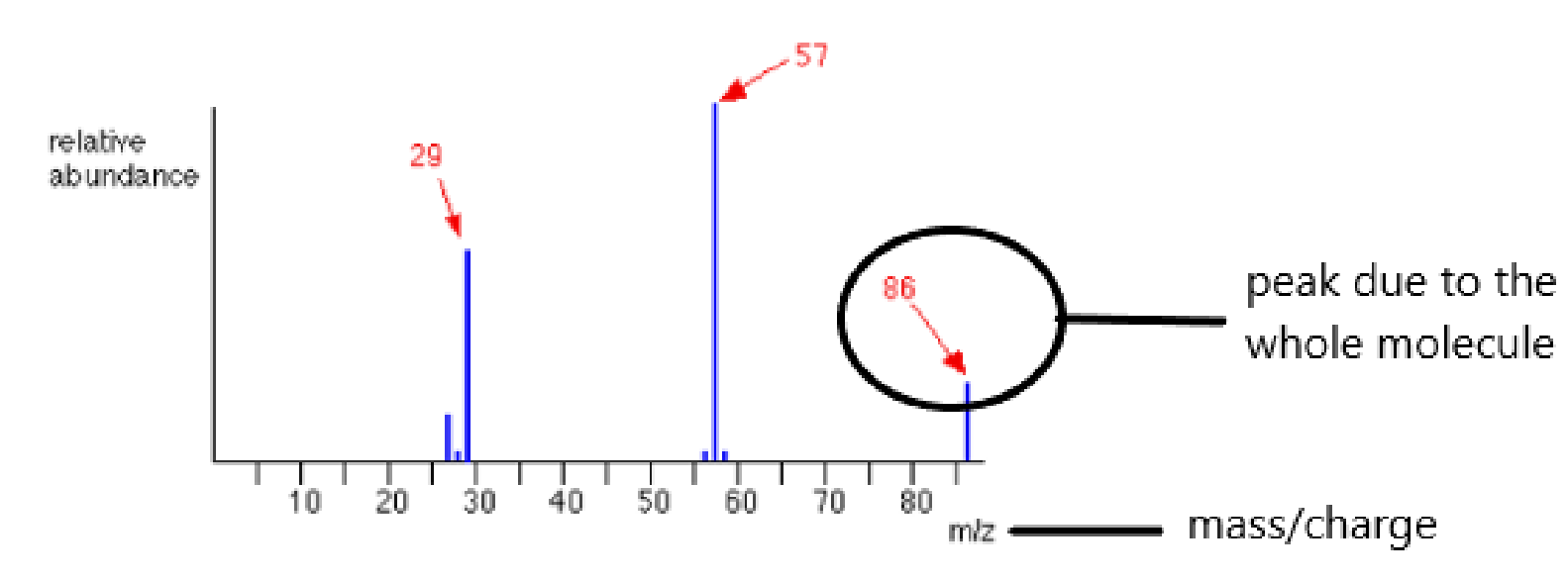
Gas Chromatography





Each peak represents a substance present in the mixture.
The areas under each peak show the relative amount of each substance in the mixture.
The retention time is different for different substances.

Mass Spectrometry



A mass spectrometer can measure the mass of atoms and molecules.

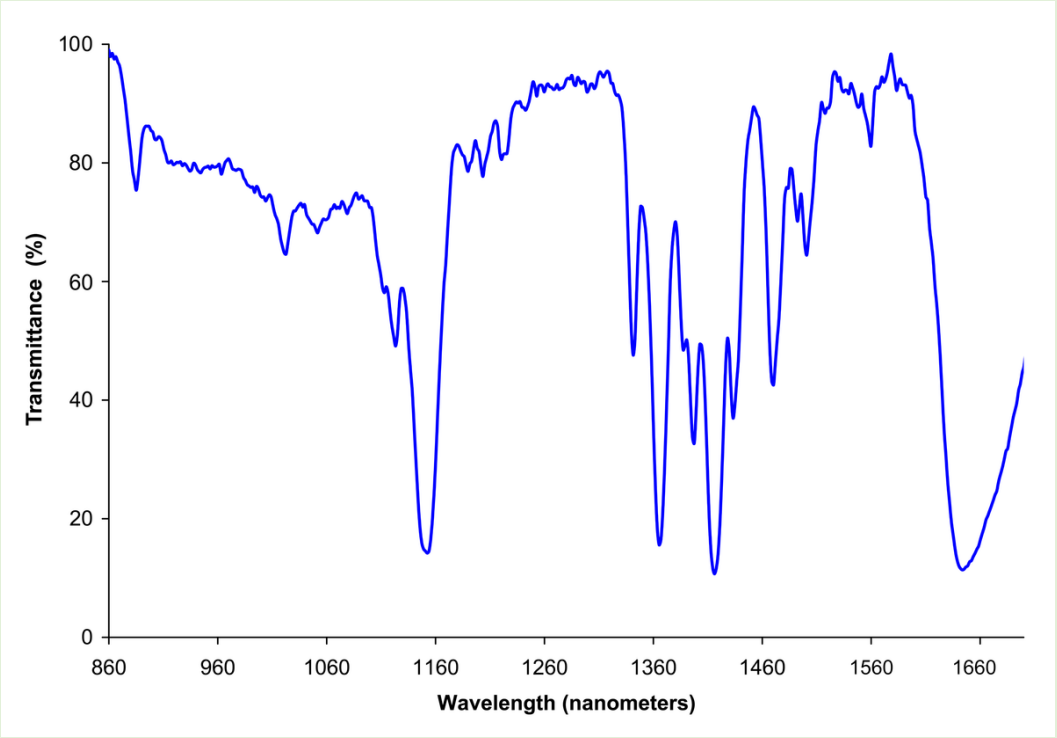
In a mass spectrum:

- Each peak represents a fragment of the molecule.
- The peak on the far right represents the molecular ion.
- The mass to charge ratio of the molecular ion peak is equal to the relative formula mass, Mr, or the molecule.

IR Spectroscopy

- Each type of bond gives a peak in a different place

Bond	Wavenumber
C-H	2850-3300
C-C	750-1100
C=C	1620-1680
C=O	1680-1750
C-O	1000-1300
O-H	3230-3550



TASK 2

A molecule of ethanol has peaks at 800, 1200, 2900 and 3400. Which four bonds does this chemical contain?

Bond	Wavenumber
C-H	2850-3300
C-C	750-1100
C=C	1620-1680
C=O	1680-1750
C-O	1000-1300
O-H	3230-3550

Answer the quiz questions