AQA Chemistry Chemical Analysis Journey of Knowledge

Context and introduction to the unit:
Analysts have developed a range of qualitative tests to detect specific chemicals. The tests are based on reactions that produce a gas with distinctive properties, or a colour change or an insoluble solid that appears as a precipitate. Instrumental methods provide fast, sensitive and accurate means of analysing chemicals, and are particularly useful when the amount of chemical being analysed is small. Forensic scientists and drug control scientists rely on such instrumental methods in their work.

KS3:
Particles & Separating Mixtures units – Pupils explore atoms, elements, compounds and mixtures. They also learn about purity and various separating techniques, including chromatography.
Chemical reactions unit – Pupils learn about various reactions and the linked equations, where gases are released.

CORE KNOWLEDGE

5.8.1.1 Pure substances - In chemistry, a pure substance is a single element or compound, not mixed with any other substance. Pure elements and compounds melt and boil at specific temperatures. Melting point and boiling point data can be used to distinguish pure substances from mixtures. In everyday language, a pure substance can mean a substance that has had nothing added to it, so it is unadulterated and in its natural state, eg pure milk.

5.8.1.2 Formulations - A formulation is a mixture that has been designed as a useful product. Many products are complex mixtures in which each chemical has a particular purpose. Formulations are made by mixing the components in carefully measured quantities to ensure that the product has the required properties. Formulations include fuels, cleaning agents, paints, medicines, alloys, fertilisers and foods.

5.8.1.3 Chromatography - Chromatography can be used to separate mixtures and can give information to help identify substances. Chromatography involves a stationary phase and a mobile phase. Separation depends on the distribution of substances between the phases. The ratio of the distance moved by a compound (centre of spot from origin) to the distance moved by the solvent can be expressed as its Rf value:

$$\textbf{Rf} = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$

Pupils must ensure the solvent is added below the samples on the chromatogram. His will prevent them from washing away. They should also draw the start line in pencil to prevent the samples running and mixing. Each sample must be placed with a clear gap between to ensure they do not run or blend in with each other when they are being separated. The chromatography paper will absorb the solvent which will be in the mobile phase during the practical.
Different compounds have different Rf values in different solvents, which can be used to help identify the compounds. The compounds in a mixture may separate into different spots depending on the solvent but a pure compound will produce a single spot in all solvents.

5.8.2.1 Test for hydrogen - The test for hydrogen uses a burning splint held at the open end of a test tube of the gas. Hydrogen burns rapidly with a pop sound.

5.8.2.2 Test for oxygen - The test for oxygen uses a glowing splint inserted into a test tube of the gas. The splint relights in oxygen.

5.8.2.3 Test for carbon dioxide - The test for carbon dioxide uses an aqueous solution of calcium hydroxide (lime water). When carbon dioxide is shaken with or bubbled through limewater the limewater turns milky (cloudy).

5.8.2.4 Test for chlorine - The test for chlorine uses litmus paper. When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white.
A splint is the name given to the wooden stick used to light Bunsen burners. If the splint is lit – it should have a flame, if it is glowing, the flame must be extinguished with only a glowing ember present on the splint. Litmus paper is an indicator and will change colour in the presence of an acid or alkali (in this case chlorine which will turn into bleached white). By pressing your thumb over the top of the test tube, a pressure will build up which indicates that a gas is trying to escape, if this is held for a short period of time, enough gas can be collected for testing.

Disciplinary knowledge
Required practical activity 12: investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.
WS 2.2, 4.1
WS 1.4, 2.2
WS 2.2, 3.1, 2, 3

Vocabulary
Formulation, mixture, unadulterated, mobile, stationary, solvent, retention,
Reading is Power

Where next?
Chemistry & The Atmosphere

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CORE KNOWLEDGE (separates only)

4.8.3.1 Flame tests - Flame tests can be used to identify some metal ions (cations). Lithium, sodium, potassium, calcium and copper compounds produce distinctive colours in flame tests: • lithium compounds result in a crimson flame • sodium compounds result in a yellow flame • potassium compounds result in a lilac flame • calcium compounds result in an orange-red flame • copper compounds result in a green flame. If a sample containing a mixture of ions is used some flame colours can be masked.

4.8.3.2 Metal hydroxides - Sodium hydroxide solution can be used to identify some metal ions (cations). Solutions of aluminium, calcium and magnesium ions form white precipitates when sodium hydroxide solution is added but only the aluminium hydroxide precipitate dissolves in excess sodium hydroxide solution. Solutions of copper(II), iron(II) and iron(III) ions form coloured precipitates when sodium hydroxide solution is added. Copper(II) forms a blue precipitate, iron(II) a green precipitate and iron(III) a brown precipitate.
The filament wire used for flame tests should be carefully dipped into the solution. Place this in the flame at arm's length and observe the colour of the flame. The solution will vaporise quite quickly and this may need repeating. The word excess refers to adding more than is necessary.

4.8.3.3 Carbonates - Carbonates react with dilute acids to form carbon dioxide gas. Carbon dioxide can be identified with limewater.

4.8.3.4 Halides - Halide ions in solution produce precipitates with silver nitrate solution in the presence of dilute nitric acid. Silver chloride is white, silver bromide is cream and silver iodide is yellow.

4.8.3.5 Sulfates - Sulfate ions in solution produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid.

4.8.3.6 Instrumental methods - Elements and compounds can be detected and identified using instrumental methods. Instrumental methods are accurate, sensitive and rapid.

4.8.3.7 Flame emission spectroscopy - Flame emission spectroscopy is an example of an instrumental method used to analyse metal ions in solutions. The sample is put into a flame and the light given out is passed through a spectroscope. The output is a line spectrum that can be analysed to identify the metal ions in the solution and measure their concentrations.

Disciplinary knowledge
Required practical 7: use of chemical tests to identify the ions in unknown single ionic compounds covering the ions from sections
WS 2.2
WS 3.6

Vocabulary
Cation, anion, masking, emission, spectroscope, instrument, sensitivity, precipitate, excess
Reading is Power

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