Topic 8 – Chemical analysis

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8.1 Purity, formulations and chromatography

8.1.1 Pure substances

In Chemistry, pure substance is...

- Single element or compound
- Not mixed with any other substance
- Eg vaporised iodine

Pure elements and compounds

- Melt & boil at specific temp
- Melting & boiling point data → distinguish pure substances from mixtures

In everyday language, pure substance is...

- Substance that has had nothing added to it
- Unadulterated & in its natural state
- Eg pure milk

8.1.2 Formulations

Formulations

- Mixture that has been designed as a useful product
- Made by mixing components in carefully measured quantities → ensure product has the required properties
- Eg fuels, cleaning agents, paints, medicines, alloys, fertilisers & foods

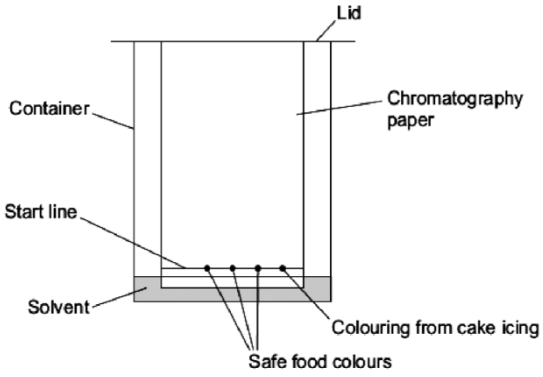
8.1.3 Chromatography

What is chromatography used for?

- To separate mixtures & give info to help identify substance

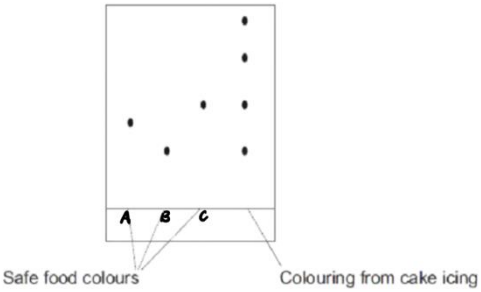
How to set up?

1. Draw a pencil line on the paper.
2. Place ink on the baseline in a dot.
3. Place the paper into the beaker which has water in it. Make sure the baseline is above water level so dye doesn't dissolve in water.
4. Hang paper over edge of beaker to keep it right.
5. Put a lid on coz $H_2O(s) \rightleftharpoons H_2O(g)$ & lid → closed reaction
6. Wait for solvent to go up paper near the top.
7. Remove paper & let it dry.
8. Draw circles around spots.



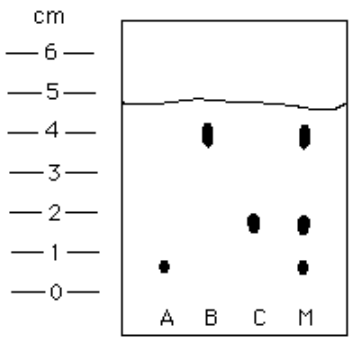
Describe the results

- A is made up of 1 dye
- B is made up of 1 dye
- C is made up of 1 dye
- A & C matches the colouring from cake icing



Calculate the distance moved by the solvent (2)

$$Rf = \frac{distance\ tranvelled\ by\ dye}{distance\ from\ baseline\ to\ solvent\ front}$$



A: $Rf = \frac{0.7\ cm}{4.7\ cm} = 0.15$

B: $Rf = \frac{4.1\ cm}{4.7\ cm} = 0.87$

C: $Rf = \frac{1.8\ cm}{4.7\ cm} = 0.38$

Explain how different dyes are separated by paper chromatography. (4)

- Solvent moves through paper
- Different dyes have different solubility in solvent & different attractions for paper
- So they are carried to different distances

Why do different compounds separate in a gas chromatograph column? (1)

- Different substances travel at different speeds

Identify the errors & describe problem each error would cause (4)

- Baseline drawn in ink - dissolves in solvent
- Dye under solvent - dissolves in solvent
- Water level above start line
- Food colours would dissolve into water
- Start line drawn in ink
- Ink would 'run' on the paper

8.2 Identification of common gases

8.2.1 Test for hydrogen

8.2.2 Test for oxygen

8.2.3 Test for carbon dioxide

8.2.4 Test for chlorine

Gases	Test	Positive Result
Hydrogen (H_2)	Burning spit held at the open end of a test tube of gas	Burns rapidly with a squeaky pop sound
Oxygen (O_2)	Insert glowing splint into a test tube of gas	Relights
Carbon dioxide (CO_2)	Bubble through limewater	Goes milky or cloudy
Chlorine (Cl_2)	Damp (blue) litmus	(Goes red), then bleaches and turns white
Ammonia (NH_3)	Damp red litmus	Turns blue

8.3 Identification of ions by chemical and spectroscopic means (chemistry only)

8.3.1 Flame tests

Positive Ion (Cation)	Test	Positive Result
Lithium, Li^+	Flame Test • Clean wire loop by dripping it in HCl • Place loop in solid of dry sample A • Place loop in blue Bunsen burner	Crimson Red
Sodium, Na^+		Yellow
Potassium , K^+		Lilac
Calcium, Ca^{2+}		Orange-Red
Copper, Cu^{2+}		Green

Why should wire be clean when used for a flame test? (1)

- To prevent contamination that gives an accurate result

What are the properties that wire must have for a flame test? (2)

- High melting point
- Unreactive

Why is it not possible to tell from the flame test that both ions are present in low concentration? (1)

- Colours mask each other

8.3.2 Metal hydroxides

Positive Ion (Cation)	Test	Positive Result
Zinc, Zn^{2+}	Precipitation • NaOH is added dropwise at first • A precipitate will appear depending on the ion in the solution	White
Calcium, Ca^{2+}		White
Aluminium, Al^{3+}		White, redissolves in excess NaOH
Copper (II), Cu^{2+}		Blue
Iron (II), Fe^{2+}		Green
Iron (III), Fe^{3+}		Brown
Magnesium, Mg^{2+}		White

8.3.3 Carbonates

8.3.4 Halides

8.3.5 Sulfates

Negative Ion (Anion)	Test	Positive Result
Carbonate, CO_3^{2-}	• Dissolve a fresh sample A in water to make a solution • Add dilute acid	Bubbles of CO_2 gas will produce → turn limewater milky
Chloride, Cl-	Precipitation • Dissolve a fresh sample A in water to make a solution • Add $AgNO_3$ and dilute HNO_3	White precipitate
Bromide, Br-		Cream precipitate
Iodide, I-		Yellow precipitate
Sulfate, SO_4^{2-}	• Dissolve a fresh sample A in water to make a solution	White precipitate

	• Add $BaCl_2$ and dilute HCl	

8.3.6 Instrumental methods

State the adv of using instrumental methods compared with chemical tests (1)

- Accurate (machines can be more accurate than humans)
- Sensitive (only a small amount of sample is needed)
- Rapid (the information can be found very quickly)

8.3.7 Flame emission spectroscopy

Name one instrumental method used to identify elements or compounds (1)

- Atomic absorption (/emission) spectroscopy

Why would use atomic absorption spectroscopy instead of flame test?

- In flame test, 2 different colours mask each other (esp in low concentration)
- AES separates out individual colours more accurately
- Quicker
- Use a small amount of sample
- More sensitive / accurate / precise

Flame emission spectroscopy

1. A sample of metal ion in solution is placed into a flame
2. The light given out is then passed through a spectroscope
3. Spectroscope converts light into a line spectrum
4. Positions of lines in spectrum are specific for a given metal ion so can be analysed to identify metal ions in solution & measure their concentration coz lines become more intense at higher concentration

- Higher con of ion, greater intensity of light given out