Exercise walk-through

8.3
Identification of ions – chemistry only (4.8.3.1–4.8.3.2)

AQA · GCSE · Chemistry

Purity and formulations

- In everyday language, "pure" means nothing has been added: "pure orange juice".
- In chemistry, a **pure substance** is a single **element** or a single compound, with nothing else mixed in.
- Orange juice is a **mixture** of water, sugars, acids and much more, however natural it is.
- A **pure substance** melts and boils at one exact temperature.

Identifying negative ions (chemistry only)

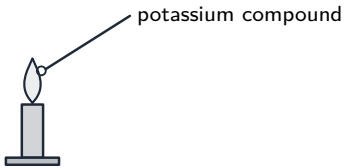
- The acid removes carbonate ions, which would otherwise also give a **precipitate**.
- Use nitric acid, not hydrochloric acid, in the halide test, because hydrochloric acid contains chloride ions and would always give a white precipitate.
- Use a fresh sample of the unknown for each test, so that the chemicals from one test do not affect the next.
- **Worked example 6.** A white solid gives a lilac flame, and its solution gives a cream precipitate with nitric acid and **silver nitrate**.

Sources for this lesson

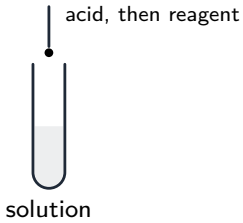
- AQA, *GCSE Chemistry (8462) specification*, section 4.8, and the required practicals handbook (Required practicals 6 and 7).
- J. C. Whorton, *The Arsenic Century: How Victorian Britain was Poisoned at Home, Work, and Play* (2010), on the Bradford sweets poisoning of 1858.
- *Pharmacy Act 1868* (31 & 32 Vict. c. 121), on the sale of poisons.
- G. Kirchhoff and R. Bunsen, "Chemische Analyse durch Spectralbeobachtungen", *Annalen der Physik* (1860), the origin of flame **spectroscopy**.

Exercises 2.1·2.2

2.1 Give potassium's flame colour. [1]

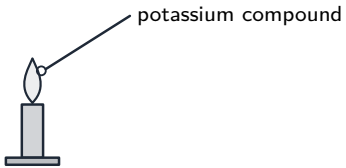


2.2 Give the acid and following reagent used for sulfate ions. [2]



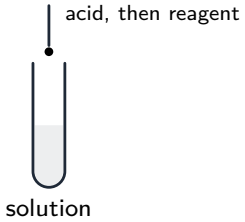
Exercises 2.1·2.2

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2.1 Lilac, not calcium's orange-red.

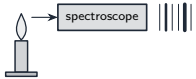
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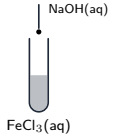
2.2 Dilute hydrochloric acid, then barium chloride solution.

Exercise 2.3

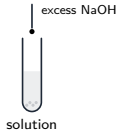
2.3 What can calibrated spectral-line intensity be used to measure? [1]



2.4 Complete and balance, with states: $FeCl_3(aq) + NaOH(aq) \rightarrow \ldots + \ldots$. Name the precipitate colour. [3]

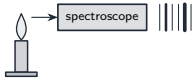


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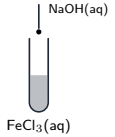


Exercise 2.3

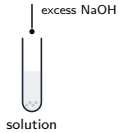
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2.3 Metal-ion concentration, using an appropriate calibration.

2.4 $FeCl_3(aq)$ + **$3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3NaCl(aq)$**: correct products/states, balanced coefficients. Brown precipitate. Check Fe1,Cl3,Na3,O3,H3 each side; $Fe(OH)_2$ would describe a different iron ion.

Full solution on next slide

Full solution 2.3

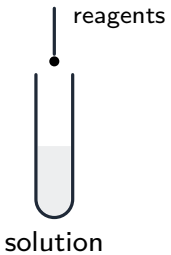
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2.5 Calcium and magnesium ions. An orange-red flame supports calcium; absence of that colour alone is weaker evidence if contamination/masking is possible. Aluminium's white precipitate would dissolve under the specified excess test.

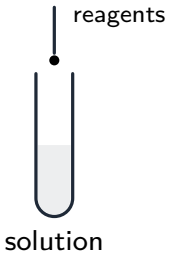
Exercise 3.1

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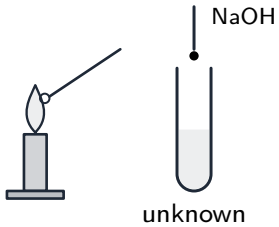
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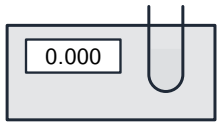
3.1 Add dilute nitric acid, then silver nitrate solution; yellow precipitate, silver iodide. Hydrochloric acid would introduce chloride and contaminate this test.

Setup for exercise 3.2

3.2 An unknown gives a green flame, but a separate NaOH test records no precipitate. Explain the inference and discrepancy; suggest how to improve the evidence. [4]

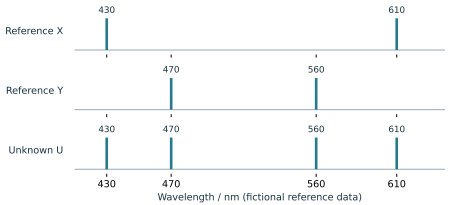


3.3 Explain two advantages of instrumental analysis over the specified simple tests, developing each with a measurement purpose. [4]



Exercise 3.2

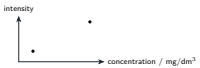
3.4 Fictional metal references X and Y and unknown U have the spectra below. Identify the supported components of U, justify your inference and describe how the spectrum is obtained. [4]



3.5 Fresh portions of one pure soluble salt give a crimson flame, effervescence with dilute acid and gas making limewater cloudy. Identify the cation and anion and explain why effervescence alone is insufficient. [4]

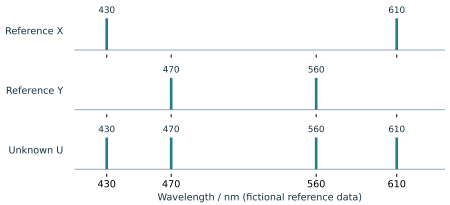


3.6 A linear calibration gives intensities 12 and 52 at concentrations 1.0 and 5.0 mg/dm³. An unknown gives intensity 32. Calculate its concentration and explain two controls/limits needed before accepting the result. [4]



Exercise 3.2

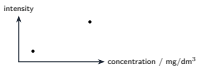
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3.2 Green flame suggests copper ions, but contamination or mixture masking limits the result. Copper(II) should give a blue NaOH precipitate, so the inconsistent result requires review rather than a confident identification. Repeat with clean apparatus/fresh reference and sample portions, or compare a supplied reference emission spectrum. No precipitate alone does not establish that copper is absent at every concentration.

3.3 Any two developed advantages: sensitive detects small amounts that a simple visible test may miss; rapid obtains results more quickly for many samples; accurate gives measurements close to accepted values with calibration. A spectrum can distinguish supplied mixed-metal line patterns rather than an obscured flame colour. Four marks maximum;

Full solution on next slide

Full solution 3.2 (1/2)

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3.4 X and Y: U includes X's 430/610 nm and Y's 470/560 nm reference lines. Put sample in a flame and pass emitted light through a spectroscope to record the line spectrum.

Full solution 3.2 (2/2)

Positions are supplied fictional data. A missing faint line would not necessarily prove an ion absent.

3.5 Lithium ion from the crimson flame; carbonate ion, supported by the evolved gas making limewater cloudy and therefore identified as carbon dioxide. Effervescence only shows gas evolution and does not name the gas; the positive gas test is needed. The task specifies one salt; do not generalise the combination to every mixture.

3.6 Fraction of calibrated interval $= (32 - 12)/(52 - 12) = 0.50$. Concentration $= 1.0 + 0.50 \times (5.0 - 1.0) =$ **3.0 mg/dm^3**. Any two controls/limits: retain the stated linear model within its calibration range; compare using the same measurement conditions and suitable references; use clean apparatus/blank to check contamination; repeat measurements to assess consistency. Intensity alone is not an absolute concentration scale without calibration.