

GCSE Chemistry

Worksheet: Flame emission spectroscopy

TIME 25 min	TOTAL 25 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Flame emission spectroscopy

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

0 1 . 1

Name the piece of equipment used to produce and record the line spectrum of a sample in flame emission spectroscopy.

.....

.....

.....

.....

[1 mark]

0 2

0 2 . 1

What does flame emission spectroscopy detect?

Tick (✓) **one** box.

The mass of a sample

☐

Light given out by metal ions in a flame

☐

The pH of a solution

☐

The boiling point of a liquid

☐

[1 mark]

0 3

Flame emission spectroscopy is 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.

0 3 . 1

What is the output from the spectroscope called?

Tick (✓) **one** box.

A chromatogram

☐

A line spectrum

☐

A precipitate

☐

A reaction profile

☐

[1 mark]

0 3 . 2

Give **two** things that the output can be used to find out about the metal ions in the solution.

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.....

.....

.....

[2 marks]

0 4

0 4 . 1

Explain the similarity and the key difference between a flame test and flame emission spectroscopy.

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[2 marks]

0 5

A 'low-sodium salt substitute' contains mainly potassium chloride with some sodium chloride. The manufacturer must check that each batch contains no more than a stated amount of sodium ions.

When a flame test is done on a solution of the product, the flame is yellow.

0 5 . 1

Explain why a flame test cannot be used to check the product.
Describe how flame emission spectroscopy could be used to identify the metal ions in the product and to measure the concentration of sodium ions.

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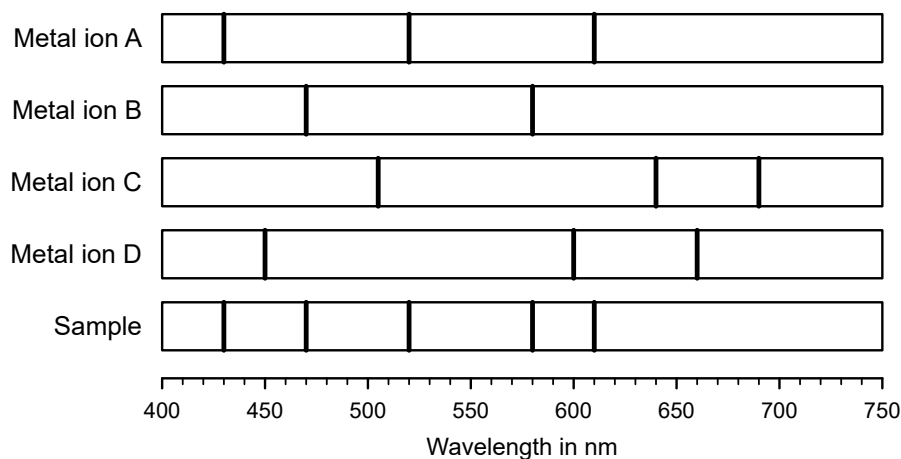
[6 marks]

0 6

A scientist used flame emission spectroscopy to analyse a solution containing a mixture of metal ions.

Figure 1 shows the spectra of four metal ions, A, B, C and D, and the spectrum of the sample.

Figure 1



0 6 . 1

Which metal ions are in the sample?

Explain your answer.

.....

.....

.....

.....

[2 marks]

0 6 . 2

Explain how Figure 1 shows that metal ion D is **not** in the sample.

.....

.....

[1 mark]

0 6 . 3

Give **one** advantage of using flame emission spectroscopy rather than a flame test to identify the metal ions in this sample.

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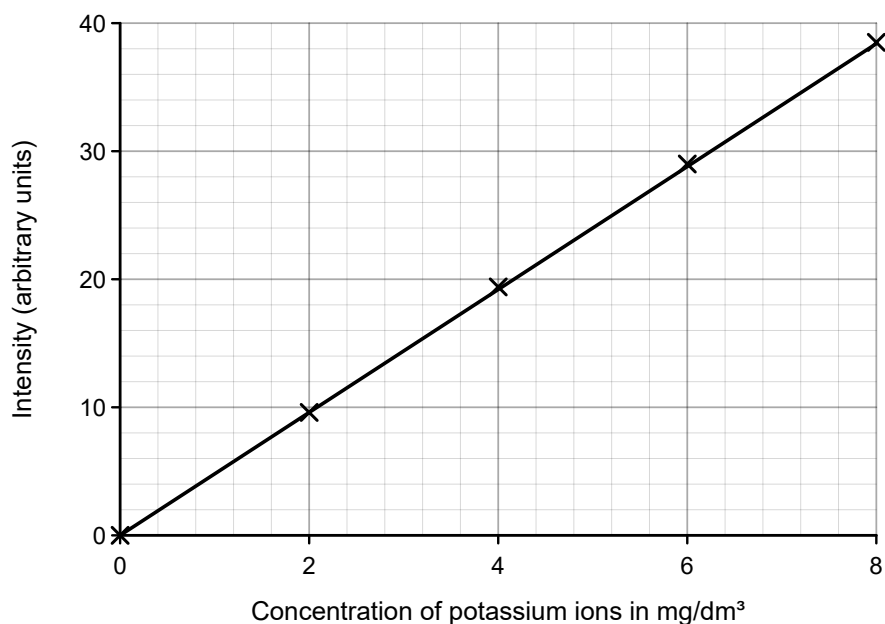
.....

[1 mark]

0 7

Figure 2 shows a calibration graph of line intensity against concentration of potassium ions, made using flame emission spectroscopy.

Figure 2



0 7 . 1

A sample gives an intensity of 24.0 arbitrary units.

Use Figure 2 to find the concentration of potassium ions in the sample.

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.....

.....

Concentration = mg/dm³

[1 mark]

0 7 . 2

Explain why it is important that the calibration solutions and the unknown sample are analysed using the same instrument settings.

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[2 marks]

0 8

Table 1 shows the wavelengths of the main lines in the emission spectra of four metal ions.

Table 1

Metal ion	Wavelengths of the main lines in nm
Lithium	460, 610, 671
Sodium	589
Potassium	404, 767
Calcium	423, 559, 616, 644

0 8 . 1

The spectrum of a sample had lines at these wavelengths:

423 nm 559 nm 589 nm 616 nm 644 nm

Identify the **two** metal ions in the sample.

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.....

.....

.....

[2 marks]

0 8 . 2

A flame test on the same sample gave a yellow flame.

Explain why the flame test did not identify both metal ions.

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.....

[2 marks]

0 8 . 3

There was no line at 671 nm in the spectrum of the sample.

What does this show?

.....

.....

[1 mark]

END OF QUESTIONS

Mark scheme

GCSE Chemistry · Worksheet: Flame emission spectroscopy · 25 marks

Question 1 (1 mark)

01.1 [1 mark]

Answer: a spectroscope

- a spectroscope (allow a spectrometer) (1)
-

Question 2 (1 mark)

02.1 [1 mark]

Correct: Light given out by metal ions in a flame

Question 3 (3 marks)

03.1 [1 mark]

Correct: A line spectrum

03.2 [2 marks]

- which metal ions are present / the identity of the metal ions (1)
 - the concentration of the metal ions (1)
-

Question 4 (2 marks)

04.1 [2 marks]

- both rely on metal ions giving out light of characteristic colours / wavelengths when heated in a flame (1)
 - flame emission spectroscopy uses an instrument to detect and measure the exact wavelengths and intensities present (allowing mixtures to be identified and concentrations to be measured), rather than relying on the human eye judging an overall colour (1)
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Question 5 (6 marks)

05.1 [6 marks]

Answer: Sodium ions give a yellow flame that masks the lilac flame of potassium ions, and a flame test cannot measure how much sodium is present. In flame emission spectroscopy a solution of the sample is put into a flame and the light is passed through a spectroscope to give a line spectrum; its lines are matched with reference spectra to identify both sodium and potassium ions. The intensity of a sodium line depends on the concentration, so solutions of known concentration are used to make a calibration curve from which the sodium concentration of the sample is read and compared with the limit.

Levels of response

- **Level 3 (5–6)** A detailed, coherent answer. Relevant points are accurate, linked in a logical sequence and use correct scientific terms.
- **Level 2 (3–4)** Several relevant points with some linking, but the answer has gaps, errors or lacks detail.
- **Level 1 (1–2)** Simple statements making one or two relevant points, with little or no linking.
- **No marks (0)** Nothing relevant or worthy of credit.

Indicative content

- potassium ions give a lilac flame but sodium ions give a yellow flame; the bright yellow masks the lilac, so a flame test cannot show that potassium ions are present
- a flame test does not measure how much sodium is present (it is not quantitative)
- in flame emission spectroscopy, a solution of the sample is put into a flame and the light given out is passed through a spectroscope
- the output is a line spectrum; each metal ion gives lines at its own characteristic wavelengths
- the spectrum of the sample is compared with reference spectra for sodium and potassium ions; matching lines show that both ions are present, even though they are mixed
- the intensity of a sodium line depends on the concentration of sodium ions in the solution
- measurements for solutions of known sodium ion concentration are used to draw a calibration curve; the intensity for the sample is read off the curve to find its sodium ion concentration, which is compared with the stated limit

Notes: Level 3 (5–6 marks): explains the masking problem and/or the lack of a quantitative result for the flame test, and describes how the line spectrum identifies both ions by comparison with reference spectra and how the line intensity, with calibration, gives the sodium concentration.

Level 2 (3–4 marks): describes how flame emission spectroscopy identifies ions or measures concentration, with some explanation of the problem with the flame test.

Level 1 (1–2 marks): simple statements, e.g. 'the yellow flame hides the lilac' or 'the spectroscope gives a line spectrum'.

Question 6 (4 marks)

06.1 [2 marks]

Answer: A and B

- A and B (1)
- all the lines of A and all the lines of B are in the spectrum of the sample (1)

Notes: Both letters are needed for the first mark.

06.2 [1 mark]

- the lines of D (at about 450, 600 and 660 nm) are not in the spectrum of the sample (1)
-

06.3 [1 mark]

- it can identify more than one metal ion in a mixture (colours are not masked) / it is more sensitive / it is more accurate / it can measure concentrations (1)
-

Question 7 (3 marks)

07.1 [1 mark]

Answer: 5.0 mg/dm³

- 5.0 (mg/dm³) (1)

Notes: Allow 4.8–5.2.

07.2 [2 marks]

- the intensity recorded depends on the instrument's settings (e.g. its sensitivity), as well as the concentration (1)
 - if the settings differed, the calibration graph would not give an accurate concentration for the unknown sample (1)
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Question 8 (5 marks)

08.1 [2 marks]

Answer: calcium and sodium

- calcium (1)
 - sodium (1)
-

08.2 [2 marks]

- the yellow colour of sodium masks other flame colours (1)
 - so the orange-red colour of calcium could not be seen (1)
-

08.3 [1 mark]

- lithium ions are not present (in a detectable amount) (1)
-