Flame tests

4.8.3.1 · Chemical analysis · revision notes

Flame tests identify some metal ions from the colour they give to a flame. This is in GCSE Chemistry only (not Combined Science) and is part of the required practical on identifying ions: learn the five colours, the method and why mixtures cause problems.

Key facts

- Li^+: crimson
- K^+: lilac
- Cu^{2+}: green
- Na^+: yellow
- Ca^{2+}: orange-red
- Method: clean loop (acid + flame) → dip in sample → hot blue Bunsen flame → record colour
- Mixtures: one colour can mask another (sodium's yellow hides others)

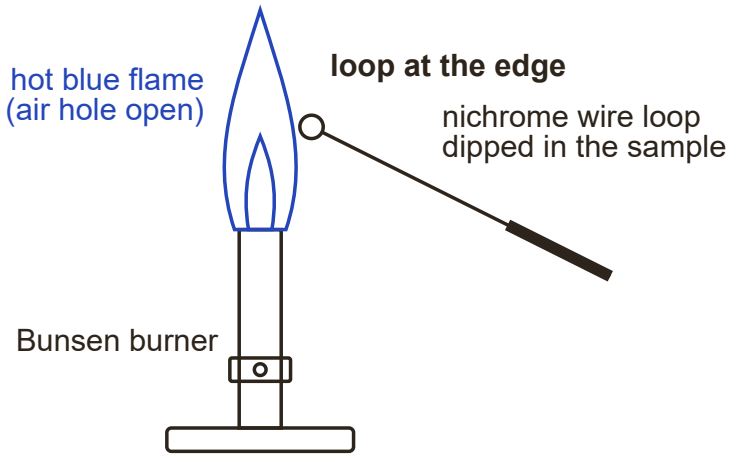
Notes

The flame colours

- Flame tests identify some metal ions (cations).
- **Lithium** compounds: **crimson** flame.
- **Sodium** compounds: **yellow** flame.
- **Potassium** compounds: **lilac** flame.
- **Calcium** compounds: **orange-red** flame.
- **Copper** compounds: **green** flame.
- The colour comes from the metal ion, so sodium chloride and sodium sulfate both give a yellow flame. Some metal ions, such as magnesium, give no distinctive colour.

Method

- Clean a nichrome wire loop: dip it in hydrochloric acid, then hold it in the flame until it gives no colour.
- Dip the loop into the solid sample or its solution.
- Hold the loop at the edge of a hot, **blue** Bunsen burner flame and record the colour. The yellow safety flame would hide the colours.



Clean loop, sample on the loop, edge of a blue flame; then read the colour.

- Clean the loop again before testing the next sample.

Limitations

- If a sample contains a **mixture** of metal ions, some flame colours can be **masked** (hidden). The strong yellow of sodium hides other colours, such as the lilac of potassium.
- A flame test shows which metal ion is present, not how much of it there is.
- Judging a colour by eye can be difficult, and a faint colour is easy to miss.

How to answer each type of question

Identify the metal ion from a flame colour

1 to 3 marks | Grade 3

1. Learn the five colours using the exact spec words.
2. Match each colour in the question to its metal ion.
3. Name the ion, e.g. 'potassium ions' or K^+.

Example. A student did flame tests on three white solids.

Solid	Flame colour
1	lilac
2	crimson
3	orange-red

Name the metal ion in each solid.

Model answer.

Solid 1: potassium / K^+ (1)

Solid 2: lithium / Li^+ (1)

Solid 3: calcium / Ca^{2+} (1)

Describe how to carry out a flame test

3 to 4 marks | Grade 4

1. Clean the wire loop (hydrochloric acid, then the flame).
2. Dip the loop into the sample.
3. Hold it in a hot, blue Bunsen flame.
4. Observe and record the colour of the flame.

Example. Describe how a student could carry out a flame test on a solid compound.

Model answer. Dip a nichrome wire loop in hydrochloric acid and hold it in a flame until it gives no colour, to clean it (1). Dip the loop into the solid (1). Hold the loop in a hot, blue Bunsen burner flame (1). Record the colour of the flame (1).

Explain why a flame test result is unclear or misleading 2 marks **Grade 5**

1. Say what the problem is: a mixture of ions, or a dirty loop.
2. Explain the effect: one colour masks (hides) another, or leftover ions add an extra colour.
3. If asked for a better method, suggest flame emission spectroscopy.

Example. A sample contains both sodium ions and potassium ions. A flame test on the sample gives a yellow flame.
Explain why the flame test does not show that potassium ions are present.

Model answer. Sodium ions give a strong yellow flame (1), which masks / hides the lilac flame of the potassium ions (1).

Don't lose marks

- Using vague colours such as 'red', 'purple' or 'blue'. Use the spec words: crimson, yellow, lilac, orange-red, green.
- Not cleaning the loop, or using the yellow safety flame, which hides the colours.
- Saying the colour comes from the chloride or sulfate ion. The flame colour identifies the metal ion.
- Assuming a yellow flame means sodium is the only metal ion present: other colours may be masked.

More tips

Memory tricks

- Picture them: sodium street lamps glow yellow; old copper roofs turn green; Potassium = Pale Purple (lilac); Calcium = Carrot (orange-red); Lithium = Lipstick (crimson).
- Crimson (lithium) is a deep red; orange-red is calcium. Never write just 'red'.
- If a question mentions a mixture of metal ions, think 'masking'.

Exam technique

- Name the ion, not just the element: 'lithium ions' or Li^+.
- In method questions, include cleaning the loop and using a hot, blue flame.
- For 'identify the compound' questions, use the flame test for the metal ion and another test (carbonate, halide or sulfate) for the negative ion.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 **Recall the five flame test colours**
Lithium crimson, sodium yellow, potassium lilac, calcium orange-red, copper green.

Grade 4 **Identify a metal ion from a flame colour**
Match the colour seen to the metal ion that gives it.

Grade 4 **Describe how to carry out a flame test**
Dip a clean wire loop in the sample and hold it in a hot, blue Bunsen flame.

Explain why the wire loop must be clean

Grade 5 Traces of other metal ions would add their own colour and give a false result.

Grade 5 **Explain why mixtures give unclear results**
Some flame colours can be masked by others, e.g. by the strong yellow of sodium.

Grade 7 **Evaluate flame tests as a method**
Quick and cheap, but they work for only some ions, rely on judging colours and fail with mixtures.

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