

V. Scally Flame test assignment

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UWTSD
OME DEGREE COURSE

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The Flame test Lab assignment

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Academic integrity declaration

I declare that:

- the thesis submitted has been written by me alone.
- the thesis submitted has not been previously submitted to this university or any other.
- that all content, including primary and/or secondary data, is true to the best of my knowledge.
- that all quotations and references have been duly acknowledged according to the requirements of academic research.

I understand that to knowingly submit work in violation of the above statement will be considered by examiners as academic misconduct.

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Introduction, Results and Discussion are usually main sections of the report, not the subsections. relevance to OME however could be the subsection in Discussion.

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1. INTRODUCTION

Flame Test/ Flame Photometry *excellent explanation of absorption-emission spectra*

The Flame Test, also known as Flame Photometry is a visible light-spectrum analysis technique. This test is predominantly used to identify metal ions in solutions of salts, this is done by heating the solutions within a flame and observing the colours emitted.

There are many metal ions that when heated, will emit colour which changed the visible colour of the flame, this can be used to identify which metal is present.

The heating of these solutions will 'excite' the electrons within the atoms, moving them to a higher energy level. These electrons cannot stay in this state and so will fall back down to the lower energy levels, in doing this they emit photons of light that can be seen as coloured flame. in theory each metal will emit a different colour.

$E = hc/\lambda$ h is Planck's ^{constant} 6.626×10^{-34} constant and c is the speed of light 3×10^8 . UNITS!!!

in equations use symbols, do not write 'lambda'

The frequency of a photon is related to its energy in terms $C = f \times \lambda$

aim? hypothesis? variables?

1.1 Results

Table 1 represents the flame test results

Metal Salt	Flame Colour	Identity	Wavelength
DI Water	No change	/	/
1M HCl	No change	/	/
A	Orange/Yellow	Na	589
B	Purple	K	405
C	Red/Orange	Ca	620
D	Red	Sr	606
E	Green/Blue	Cu	325
F	Red/Pink	Li	670
G	Yellow/Green	Ba	554
H	Orange- Lavander	Mix	600-405 2

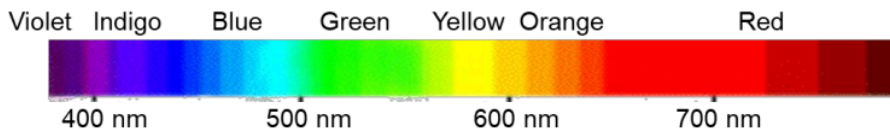


Table 2 coloured wavelengths

As seen in Table 1 – results were not clear and concise.

There is a large margin of error and colours can be subjective according to a person's point of view. By comparing the results, it was possible to use common sense to match colours to metals. *very good statement, critical thinking*

As seen in Table 2 – each wavelength will have a different colour. The wavelengths in this case are recorded in table 1.1

1.2 Discussion

Each flame as expected, showed a different colour per solution when heated using a Bunsen flame. The flame colour shown will depend on the energy emitted by the electrons moving back down to a lower frequency level.

As show above in Table 1, there was a high error margin for this experiment. Many of the samples showed similar colours and the tests had to be done multiple times to compare the difference of the colours seen.

Comparing Lithium and Strontium:

Lithium emitted red/crimson light when burned under the Bunsen flame –

Approximately 670nm

Strontium emitted a more brightly red flame when burned – Approximately 606 nm.

$c = \lambda \nu$ is the equation used to calculate frequency. *use consistent units for frequency*

$$\text{Lithium } \frac{300 \times 10^8 \text{ms}}{6.7 \times 10^{-7}} = 4.47 \times 10^{16}$$

$$\text{Strontium } \frac{300 \times 10^8 \text{ms}}{6.06 \times 10^{-7}} = 4.95 \times 10^{16}$$

unit of c is m/s not ms!

$E = h\nu$ is used to find out the Energy

$$\text{Lithium } E = 6.626 \times 10^{-34} \times 4.47 \times 10^{16} \\ = 2.96 \times 10^{-17} \text{ J}$$

$$\text{Strontium } E = 6.626 \times 10^{-34} \times 4.95 \times 10^{16} \\ = 3.28 \times 10^{-17} \text{ J}$$

Wavelength and frequency are related. Lithium has a lower frequency and lower energy as it has a larger wavelength, where Strontium has a higher frequency and higher energy due to its lower wavelength.

As seen in the calculations above Lithium has a lower photon energy than Strontium. This I also shown by the different colours emitted during the flame test. The different colours show the electrons release of photon energy when returning to their lower energy levels.

As other students conducted the experiment there was the risk of cross contamination of the solutions due to bad practice. This includes not cleaning the

metal rod thoroughly enough between solutions.

A way to ensure less risk of cross contamination would be to have a metal rod per solution, this would mean more cleaning on conclusion of the experiment but more chance for accurate results.

2. Relevance to OME

The flame test is relevant to OME as it can be used to identify the metal base of compounds residue that are used in incendiaries, signalling devices and pyrotechnics. This can help to ensure that these are handled and processed effectively. Though it is important to note that putting any kind of heat or flame near an unknown device is a huge safety risk and should not be done.

2.1 Other applications of the flame test phenomenon

Flame application in the Ordnance, munitions and explosive industry.

Flares have a variety of different uses and are known for the colours they emit. Red flares for example are used on ships for emergencies.

"Red hand flares are a critical safety tool used in various emergency situations to signal distress and attract attention. These pyrotechnic devices are designed to emit a bright red light, visible from great distances, making them indispensable for maritime, roadside, and wilderness rescue operations".⁴

Flares must be kept in a dry area, they must be easily accessible in an emergency and also must have their shelf life (the time at which they decay) checked regularly.

"Nothing replaces the immediacy of a flare when it comes to signalling in an emergency" [Ref] ???

Aircraft Flares, also known as countermeasures are important for military aircraft and will provide defence against heat-seeking missiles. Magnesium is the metal usually used in these flares. ³

Conclusion

Although the experiment was successful in identifying the different metals within the solutions, there is a margin or error in this experiment. It was necessary to test some of the solutions a number of times to compare the colour with another solution so as to ascertain which metal was which. The colours can often burn in a very similar colour until tested and compared one after the other.

For future research, it could be interesting to see if the strength of the solution has any influence on the strength of the colour burning.

This test is simple and relatively effective, it can show you the different metals contained in the solutions but accuracy as discussed can easily be effected.

References

1. SQA Databook for HN Chemistry, Flame Colours, Scottish Qualifications Authority 2018, page 17.
2. SQA Databook for HN Chemistry, Flame Colours, Scottish Qualifications Authority 2018, page 17.
3. RAGE X, "Lighting Up the Skies: The Intricate History and Mechanism of Aircraft Flares," *RAGE X*, Jun. 18, 2023. <https://ragex.co/history-and-mechanism-of-aircraft-flares/> (accessed Mar. 14, 2025).
4. Marineteck Safety, "What Are Red Hand Flares?," *Marineteckss.com*, 2024. <https://marineteckss.com/blog/red-hand-flares-introduction> (accessed Mar. 14, 2025).

Appendix

Materials

Bunsen burner

Heat-resistant mat

Matches

Metal Rod

1m solutions of unknown metal salts appropriately labelled

Beaker with 1M HCl

Beaker with deionised water

Blue cobalt glass

Method

1. A Bunsen burner is set up, connected to the lab gas supply and lit. While not in use it is kept on the visible yellow safety flame.
2. The metal rod is cleaned by dipping into the 1M HCl and heated in the hottest part of the Bunsen flame (the Bunsen is set to the open settings and the flame burns with a white/blue coned centre). This process is repeated till there is no colour shown within the flame. If the flame changes colour, there is an impurity on the wire.
3. The metal rod is then dipped into Deionised water to remove any excess HCl, it is then burned in the Bunsen flame again.
(steps 2 & 3 must be completed before/after each test is completed)
4. The wire is cooled and dipped into the unknown solution and heated in the hot part of the Bunsen flame. The results are observed and recorded. The cobalt glass is used to identify the mixture of sodium and potassium, this is because the lilac flame will not be visible alongside the other flame and cobalt glass will show it.
5. Steps 2-4 are repeated till all solutions are tested.
6. The colour of the flame for the deionised water and the 1M HCl must also be recorded.

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GRADEMARK REPORT

FINAL GRADE

66/100

GENERAL COMMENTS

Engagement with Literature Skills 8/15

Use peer-reviewed sources such as journal articles. Reference is missing.

Used sources are not well integrated and OME relevance is not backed by literature. IEEE referencing is inconsistent, and no evidence of wide reading is present.

Feedback: Ensure all references are complete, correctly formatted, and used to support analysis, especially regarding OME relevance.

Knowledge and Understanding Skills 12/20

There is an excellent explanation of absorption-emission spectra, showing solid understanding. However, aim, hypothesis, and variables are missing, which is a significant omission. Units and terminology (e.g., using 'lambda' instead of λ) need attention.

Feedback: Include aim, hypothesis, and clearly define variables; use correct symbols and units consistently.

Cognitive and Intellectual Skills 15/25

Results are well-analysed, metals correctly identified, and there's critical thinking evident in interpreting data. Some unit inconsistencies and equation formatting issues detract slightly from clarity. OME application is implied but not fully explored. Feedback: Expand on OME relevance and limitations of the experiment.

Practical Application Skills 20/25

All metals are identified correctly meaning that the procedure was followed properly. Results are clearly presented in well-labelled table.

Transferable Skills 11/15

Report is structured well, though Introduction and Discussion are formatted as subsections, which is incorrect. Language is mostly professional; passive voice could be more consistent. Visual presentation is clear.

Feedback: Follow standard report structure. Attach the original data sheet.

Text Comment. Introduction, Results and Discussion are usually main sections of the report, not the subsections. relevance to OME however could be the subsection in Discussion.

Strikethrough.

Text Comment. excellent explanation of absorption-emission spectra

Text Comment. constant

Strikethrough.

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Text Comment. use consistent units for frequency

Text Comment. unit of c is m/s not ms!

Text Comment. excellent analysis

Text Comment. [....]

Text Comment. [Ref] ???

Text Comment. good idea :-)

Text Comment. scan of original report not attached