Atomic and nuclear physics

Atomic shell

Emission and absorption spectra

Recording the emission spectra of flame colouration

Description from SpectraLab (467 250)

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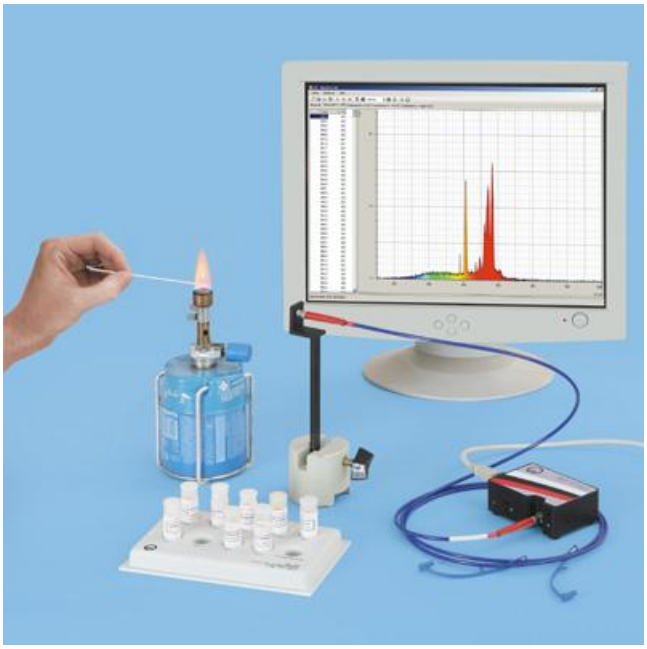
Recording the emission spectra of flame colouration



Hazard warnings

Barium chloride is harmful if inhaled and poisonous if swallowed.

Calcium chloride irritates the eyes. Do not inhale dust. Avoid contact with skin.

Copper (II) nitrate and lithium chloride are harmful if swallowed. They irritate the eyes and skin.

Hydrochloric acids cause chemical burns! Wear protective goggles!

Protect long hair from being burned!

Experiment description

Some metal salts, particularly alkaline and earth alkaline metals, exhibit characteristic light emissions in the visible range when thermally excited (e.g. by a non-luminous flame). The naked eye sees a coloured flame in these cases. By using a spectrometer, one can break down the spectral distribution of the emission spectrum and even differentiate between various mixtures of metal salts

Required equipment

1	Compact spectrometer, physics	467 251
1	Fibre holder	460 251
1	Saddle base	300 11
1	Butane gas cartridge burner	666 711
1	Butane gas cartridge, 190 g	666 712
1	Gas igniter, mechanical	666 731
1	Magnesia sticks, 25 each	673 0840
1	Powder spatula, 150 mm	604 5681
1	Salts for flame colouration	661 088
1	Dropping pipette, e.g. from	665 953
1	Rubber cap, e.g. from	665 954
1	Spot plate	667 089
1	Hydrochloric acid, e.g.	674 6850
1	PC with Windows 2000/XP/Vista/7/8	

Experiment setup (see picture)

Place a rubber bulb on the dropping pipette. Place a small amount (only a few crystals) of each of the various salts on the spot plate, each salt in a separate dimple, and mark them. Be careful that these samples do not get unintentionally mixed! Moisten each sample with 1 drop of hydrochloric acid.

Note

Even small traces of sodium salts will colour the flame yellow and cover up all other emissions. Therefore absolute cleanliness is to be observed for these experiments. Crystals may never be allowed to fall into the burner!

Performing the experiment

- Ignite the burner then open the air intake fully.
- Activate to begin a new measurement.
- Start the measurement with ▶.
- Open the **Offset I0** display.
- The displayed spectrum will be removed from subsequent measurements as the background spectrum.
- Select the **Intensity I1** display. Intensity now lies at 0 % for the entire spectral range.
- Thoroughly anneal a magnesia stick in the burner's flame (dip it in hydrochloric acid beforehand).
- Use the still-hot end of the magnesia stick to pick up a few salt crystals from the spot plate.
- Hold the magnesia stick in the burner's flame and observe the flame's colouration with the naked eye.
- Adjust integration time directly or with ⊖ or ⊕ such that the intensity of the lines is maximised. If necessary, align the fibre optic waveguide to maximise intensity.
- Save the spectrum with ●.
- Repeat the experiment with other salts. In subsequent repetitions of the experiment, either break off the magnesia stick's contaminated tip or use a new, clean magnesia stick.

Evaluation

The flame produces a characteristic colouration for every salt. This is a consequence of the colour and intensity of the given emission lines. The table below summarizes flame colouration and wavelength for the most important emission lines of individual elements.

Element	Flame colouration, visual	Wavelength of most important lines in nm
Barium	green	524.2 (green); 513.7 (green)
Calcium	tile red	622.0 (red); 553.3 (green)
Caesium	blue	458.0 (blue); 852.1 (IR); 894.3 (IR)
Copper	green (in the presence of Cl^-) blue (pure copper nitrate)	510.5; 515.3; 521.8 (all green)
Potassium	violet	786.3 (red); 404.4 (violet)
Lithium	red	670.8 (red)
Sodium	yellow	589.3 (yellow)
Rubidium	red-violet	780.0 (red); 794.8 (red); 420.0 (violet)
Strontium	scarlet red	604.5 (orange); 460.7 (blue); multiple red lines

As the spectra of individual example experiments show, some elements also emit strong lines in the ultraviolet and infrared ranges which cannot be observed with the naked eye (e.g. Cs), or only with difficulty such as with potassium (by filtering out the bright sodium line with cobalt glass).

Contamination with sodium is often difficult to avoid. Whereas the bright yellow sodium line easily covers up weaker lines to the naked eye, they are readily visible (even in mixtures) with the spectrometer.

Further investigations can be made with other samples, such as vegetation ash, wood ash, cooking salt or similar.

High potassium content can be seen in the wood ash example. Furthermore, lines of sodium and rubidium are visible.

Note

The Σ control can be used to reduce noise by averaging multiple individual spectra (also Offset and Reference). Alternatively, Smoothing to 1 nm resolution can be set in the settings options.