Teacher and Technician Sheet

In this practical students will:

- Observe and record the findings of the practical
- Provide oral and written explanations of their observations, based on scientific evidence and understanding.
- Compare and group materials on the basis of their observable properties.

Introduction:

This is an old and tested experiment but when dealing with colour and chemistry it would be difficult to leave it out – particularly if spectroscopy is to be considered.

It is possible to create a variety of coloured flames by burning a small amount of different metal salts in a fire. This is the basis of fireworks.

In chemistry terms the fact some metals burn with a characteristic flame colour is important since it allows us to introduce the concept of spectroscopy.

As an introduction fireworks might be a good starting point. A discussion could begin with what it is that makes them spectacular and lead to the types of effects seen in fireworks, especially the colours.

Curriculum range:

This activity is designed for secondary age students but could be used with upper primary pupils. It links with:

- reporting on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions;
- using straightforward scientific evidence to answer questions or to support their findings;
- comparing and grouping together materials on the basis of their properties;
- building a more systematic understanding of materials by exploring; and comparing the properties of a broad range of materials.

Going further:

Working pairs students can look at the flame colour using a spectroscope which can be a laboratory one or one they build themselves. A smartphone spectrometer can be made using the instructions found here.

Hazard warnings:

Calcium ethanoate – Low hazard

Ethanol (IDA) – Flammable may be harmful by inhalation, ingestion or skin absorption may act as an irritant.

Lithium chloride – Solid is Acute Toxin Cat 4 (HARMFUL)

Copper(II) chloride – Acute Toxin Cat 4 (HARMFUL) and a SKIN/EYE IRRIRANT (Cat 2) and HAZARDOUSTO THE AQUATIC ENVIRONMENT WITH LONG LASTING EFFECTS (cat 1)

Sodium chloride – No significant risk (Low Hazard)

Potassium chloride – No significant risk (Low Hazard)

Strontium chloride – Can cause SERIOUS EYE DAMAGE (Cat 1) and is a SKIN IRRITANT (Cat 2) and a RESPIRATORY IRRITANT.

Safety goggles and should be worn. Long hair should be tied back and secured when using naked flames in a laboratory.

Avoid permanganates, nitrates and chlorates. These produce harmful by-products when burned.

Equipment for method 1:

- Saturated calcium ethanoate solution (must be saturated)
- Ethanol
- Lithium chloride (LiCl) solution in a spray bottle; 1 spatula amount in 100 cm^3 water
- Copper(II) chloride ($CuCl_2$) solution in a spray bottle; 1 spatula amount in 100 cm^3 water
- Sodium chloride (NaCl) solution in a spray bottle; 1 spatula amount in 100 cm^3 water
- 2 heat resistant mats
- 1 spatula
- 1 beaker (250 cm^3)

Equipment for method 2:

- Lithium chloride (LiCl) solution in a beaker; 1 spatula amount in 100 cm^3 water
- Copper(II) chloride ($CuCl_2$) solution in a beaker; 1 spatula amount in 100 cm^3 water
- Sodium chloride (NaCl) solution in a beaker; 1 spatula amount in 100 cm^3 water
- 1 heat resistant mats
- Bunsen burner

- 12 cm length of nichrome or platinum wire

Equipment for method 3:

The following solutions each in a 250 cm^3 conical flask:

- 2 M calcium chloride (SKIN/EYE IRRITANT)
- 1 M copper(II) chloride (SKIN/EYE IRRITANT)
- 2 M lithium chloride Low hazard
- 2 M potassium chloride (Low Hazard)
- 1 M strontium chloride (SKIN IRRITANT, EYE DAMAGE)
- 2 M sodium chloride (Low Hazard)

Access to:

- Plenty of spills soaked in water overnight.
- Bunsen burners
- Heatproof mats
- Matches
- Dry spills

Technical notes:

This experiment can be accompanied by the RSC's Flame Colours – a demonstration carried out by the teacher as instructed.

The teacher demonstration is the only time that ethanol should be near a naked flame.

The metal salt solutions can be made and stored in conical flasks stoppered with rubber bungs prior to using.

Some spills are soaked in water to ensure that the flame colour can be observed properly before the spill burns away and reduces the risk of burning to the student.

When preparing for use, the excess water can be squeezed from the spills that have been soaking in water overnight before placing some of them in each of the conical flasks containing the metal salt solutions.

Beakers (or similar) containing water could be provided for the students to use to extinguish their spills.

Results:

Method 3 is very easy to set up and use.

It is safe from Year 7 upwards and the teacher demonstration suggested can accompany it.

The students should be able to observe and record the relevant flame colours and understand the reasons behind this from the accompanying notes.

Cobalt blue glass can be provided if available. The metal salt's flame colour may be observed more easily when the yellow light is absorbed by the blue in the glass.

Lithium – magenta red flame

Calcium - orange red flame

Potassium - lilac flame

Strontium – crimson red flame

Copper – blue or green flame (depends on the copper used)

Sodium - yellow flame

The accompanying notes may need to be adjusted depending upon whether all the method options are provided or not.