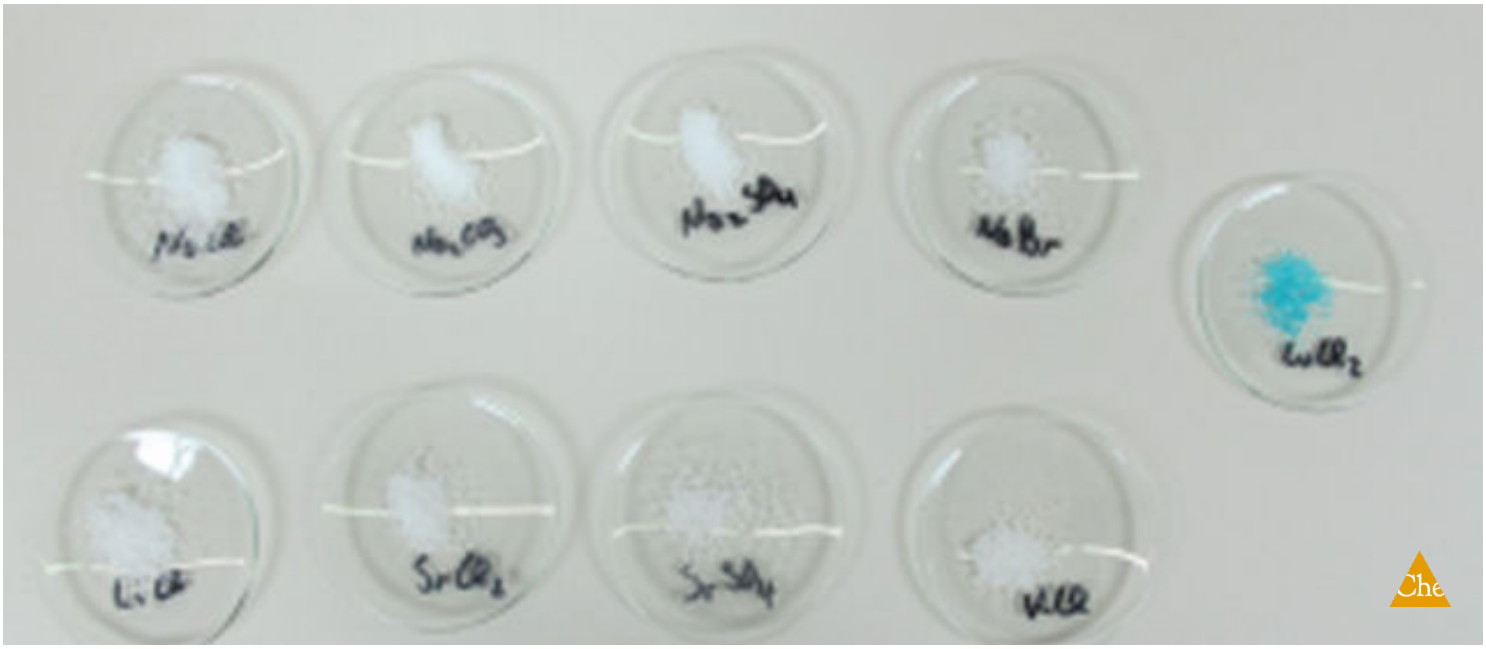
Identifying cations with a flame test



Chemistry > Inorganic chemistry > Chemistry of metals

Chemistry > Analytical Chemistry > Simple qualitative verifications

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	20 minutes

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Teacher information

Application

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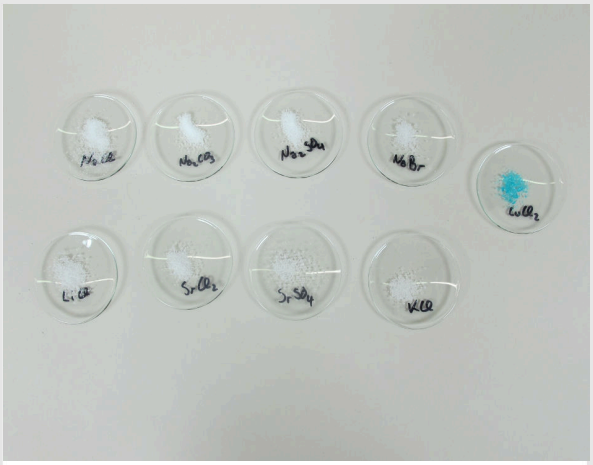

Sample preparation of the different metal salts

Metals usually have a metallic, shiny appearance. Metal salts of main group metals (for example sodium chloride) are often colourless.

Many initially colourless metal salts emit colours of different wavelengths when excited by heat.

This flame coloration is characteristic for the individual metal cations and can be used to identify them. In practice, it is used for spectroscopic investigations of corresponding compounds.

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Other teacher information (1/3)

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Prior knowledge

- The students should have gained initial experimental experience in using the Bunsen burner.
- In addition, the students should know the concept of the electron and simple connections between wavelengths and color.

Scientific principle

- Metal cations emit light at temperatures that prevail in Bunsen burner flames.
- The resulting coloration of the flame is characteristic for the individual ions and can be used to identify them.

Other teacher information (2/3)

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Learning objective

Metal salts colour an initially colourless flame differently, so that metal salts of the same metal cations produce the same flame colour. Small sodium impurities produce such a strong flame coloration that other flame colors are masked. By viewing the flame coloration through a cobalt glass, the disturbing sodium flame coloration can be filtered out.

Tasks

- In the experiment, a few grains of various alkali metal, alkaline earth metal and copper salts are held in a colourless Bunsen burner flame with the aid of magnesia rods.
- The students write their observations in a table and then compare the different colours.

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Other teacher information (3/3)

Methodological note

Flame coloration is a simple detection method that can be used in many different ways. To save time, the test can also be performed in groups, whereby the results of the other groups are transferred.

However, each group should also work with salts of different cation types, otherwise the metal ions will not be able to cause the flame coloration.

Safety Instructions (1/4)

- For this experiment the general instructions for safe experimentation in science lessons apply!
- Heavy metals are toxic. Do not swallow.
- Wear protective goggles!

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Safety Instructions (2/4)

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H and P phrases
Sodium carbonate:
H319: Causes severe eye irritation.
P260: Do not breathe dust / smoke / gas / mist / vapour / aerosol.
P305 + P351 + P338: In case of contact with eyes: Rinse carefully with water for several minutes. Remove existing contact lenses if possible. Rinse further.

Lithium chloride:
H302: Harmful if swallowed.
H315: Causes skin irritation.
H319: Causes severe eye irritation.
P302 + P352: After contact with skin: Wash with plenty of water.
P305 + P351 + P338: In case of contact with eyes: Rinse carefully with water for several minutes. Remove existing contact lenses if possible. Rinse further.

Safety Instructions (3/4)

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H and P phrases
Strontium chloride:
H315: Causes skin irritation.
H319: Causes severe eye irritation.
H335: May irritate the respiratory tract.
P261: Avoid inhalation of dust / smoke / gas / mist / vapour / aerosol.
P302 + P352: After contact with skin: Wash with plenty of water.
P305 + P351 + P338:
In case of contact with eyes: Rinse gently with water for several minutes. Remove existing contact lenses if possible. Continue rinsing.
P321: Special treatment (see ... on this label).
P405: Keep under lock and key.
P501: Feed contents / container

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Safety Instructions (4/4)

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H and P phrases

Copper chloride:
H302: Harmful if swallowed.
H315: Causes skin irritation.
H319: Causes severe eye irritation.
H410: Very toxic to aquatic organisms with long-term effects.
P260: Do not breathe dust / smoke / gas / mist / vapour / aerosol.
P273: Avoid release into the environment.
P302 + P352: After contact with skin: Wash with plenty of water.
P305 + P351 + P338:
In case of contact with eyes: Rinse gently with water for several minutes. Remove existing contact lenses if possible. Continue rinsing.

Disposal

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If the salts have not been contaminated, they can be used for similar experiments. Otherwise, precipitate as basic or sulphide and dispose of as heavy metal waste.

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Student Information

Motivation

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Colourful fireworks.

Why do fireworks glow in many different colours? This is because metal salts are added to the black powder. The electrons of the metal salt are excited by the high temperatures. When they fall back into the so-called ground state, different coloured light is emitted.

But which metal salt is responsible for which colour?

In this experiment you will examine different metal salts for their flame coloration.

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Tasks

Sketch of a salt photograph with a magnesia stick.

- Prepare different metal salt samples and glow the magnesia sticks over a Bunsen burner until no more flame coloration is visible.
- Dip the tip of a magnesia stick into each salt sample. Rotate the magnesia rod with a little pressure so that a visible amount of the salt to be tested adheres.
- Then hold the sample in the colourless Bunsen burner flame.
- Write down your observations for each metal salt.

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Equipment

Position	Material	Item No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Watch glass, d = 40 mm	34569-00	9
3	Cobalt glass plate, 50x50 mm	38770-00	1
4	Spatula, double blade, 150 mm	33460-00	1
5	Laboratory pen, waterproof, black	38711-00	1
6	Butane burner f.cartridge 270+470	47536-00	1
7	Sodium chloride 250 g	30155-25	1
8	SODIUM SULPHATE 250 G	30166-25	1
9	Sodium carbonate, anhyd. 250 g	30154-25	1
10	Sodium bromide 100 g	30153-10	1
11	Strontium chloride-6-hydrate 250g	31853-25	1
12	Lithium chloride 100 g	31526-10	1
13	Potassium chloride 250 g	30098-25	1
14	Copper-II chloride 100 g	30121-10	1
15	Magnesia sticks, 25 pcs, 1 set	CHE-881250592	1
16	Butane cartridge CV 300 Plus, 240 g	47538-01	1

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Set-up (1/2)

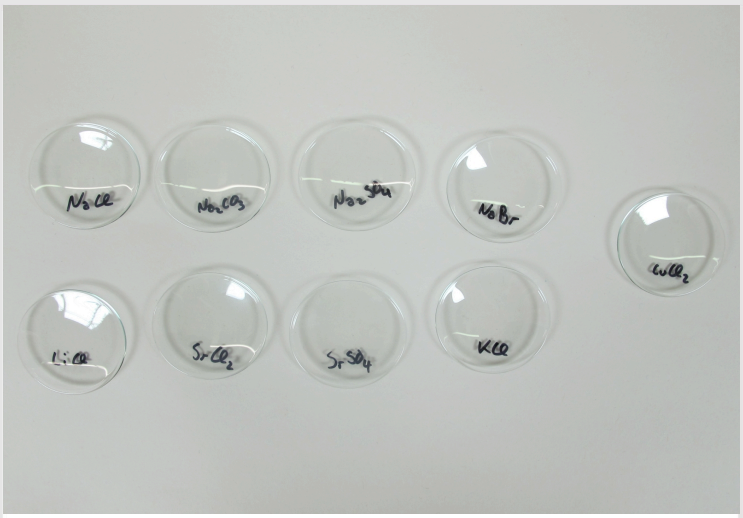

Figure 1: Sample preparation of the different salts

- Take one of the watch crystal bowls and a lab note
- Place the watch crystal bowls on the table and label them with the salts used to be examined (see Fig. 1).

Set-up (2/2)

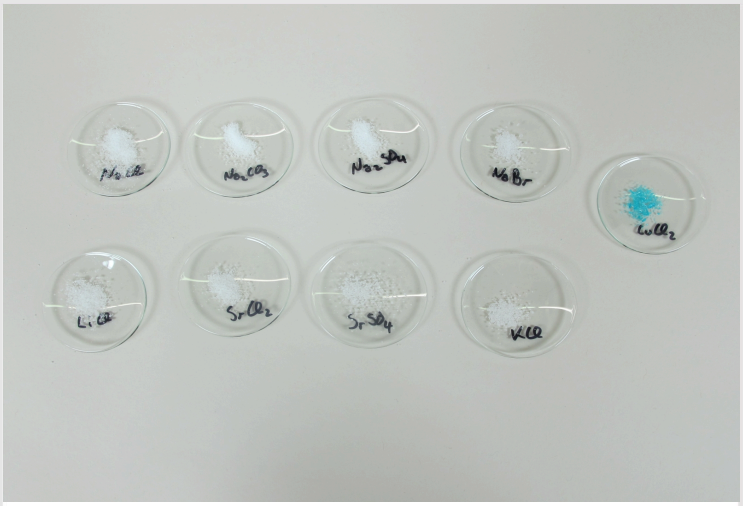

Figure 2: Petri dishes with the corresponding salts

- Take a spatula and the metal salt you have dispensed
- Apply one or two spatula tips of the salts to each of the watch crystal bowls (see fig. 2).
- Make sure that you work carefully, because heavy metals are toxic.

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Procedure (1/2)

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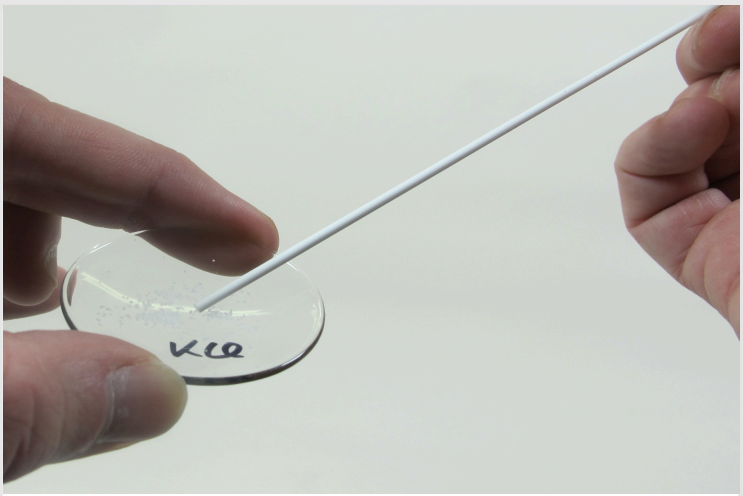

Figure 3: Exemplary sampling of the salt to be tested

- Now place the burner on a fireproof base.
- Set the non-luminous burner flame at half height and glow the front third of a magnesia rod in it until the burner flame shows no more change.
- Dip the still hot magnesia rod into the salt so that several crystals stick to it (see fig. 3).

Procedure (2/2)

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Figure 4: Illustration of the butane burner

- Hold the magnesia rod in the burner flame. Make sure that no melting salt crystals drip into the burner nozzle.
- Note your observation and place the magnesia stick on the fireproof base. Proceed in this way with all salts.
- Consider here the flame coloration of potassium chloride by a cobalt glass.

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Report

Task 1

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What is excited in the metal salt?

- ○ The electrons of the metal salt
- ○ The protons of the metal salt
- ○ The ambient air

Check

Fireworks.

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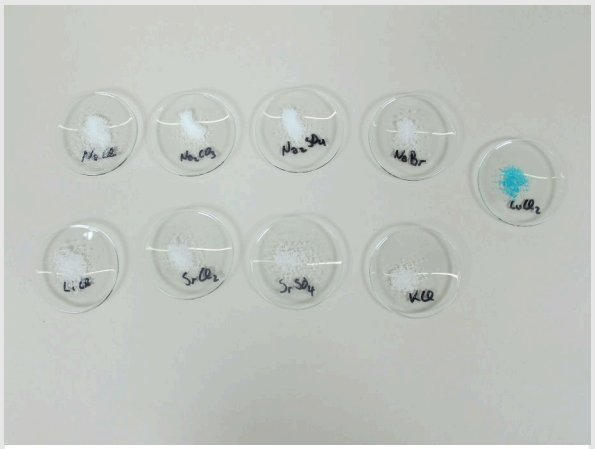
Task 2

What flame coloration shows lithium chloride?

- ○ Yellow
- ○ Red
- ○ Blue

Check



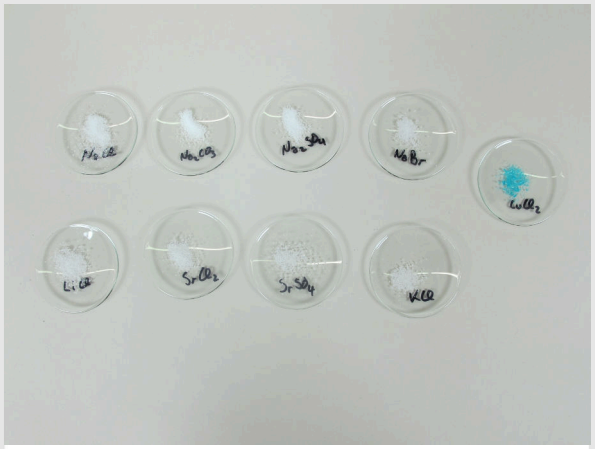
Metal salts

Task 3

Which flame coloration shows sodium chloride?

- ○ Red
- ○ Yellow
- ○ Blue

Check



Metal salts

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Slide	Score/Total
Slide 20: Metal salt	0/1
Slide 21: Lithium Chloride	0/1
Slide 22: Sodium chloride Flame colouring	0/1

Total amount 0/3

Solutions Repeat

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