Atomic Spectra

Student Handout

Purpose

To observe emission spectra through a spectrometer and use the spectra observed to identify the metallic cations present in a mixture of salts.

Introduction

This experiment employs a direct vision spectrometer to observe atomic spectra. The line spectra observed in a spectrometer are not only beautiful, but also are direct evidence of quantized energy of atoms. Besides, the characteristic atomic emission and absorption spectra can serve as a "fingerprint" for analytical identification of elements.

Materials and Apparatus

$BaCl_2(s)$, $CuCl_2(s)$ 

$CaCl_2(s)$ 

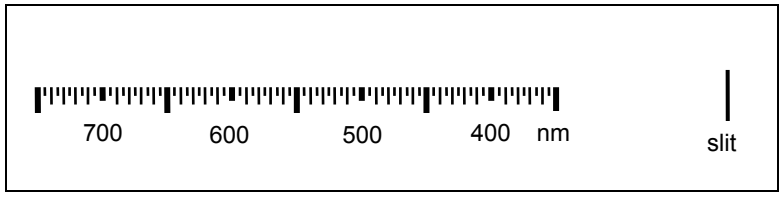
1 M HCl(aq), LiCl(s), NaCl(s), $SrCl_2(s)$, and a mixture of unknown salts, distilled water, direct vision spectrometer, platinum/nichrome wire, watch glass, coloured pencils.

Safety

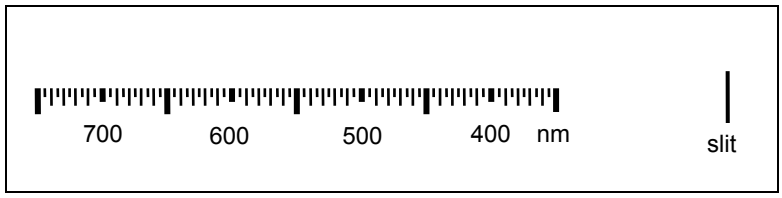
Do not place spectrometer too close to the Bunsen flame.

Experimental Procedures

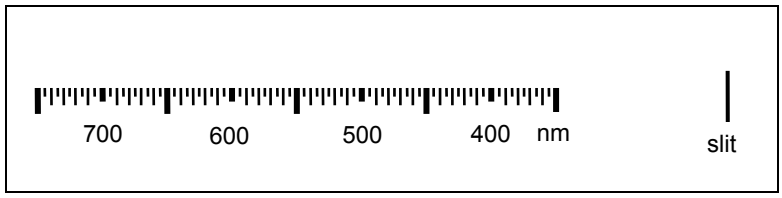
1. Observe the spectrum of an ordinary low wattage light bulb (incandescent light) through the spectrometer. You may need to adjust the position of the spectrometer to allow the light from the bulb to get into the spectrometer through the slit and rotate the diffraction grating of the spectrometer in order to see the emission lines. Describe what you see and sketch the range of colours observed using coloured pencils on the blank spectrum data sheet below.



2. Observe the spectrum of a fluorescent lamp (a mercury lamp) through the spectrometer. Describe what you see and sketch the range of colours observed using coloured pencils on the blank spectrum data sheet below.



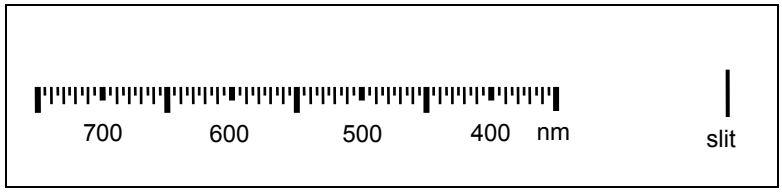
3. Take a piece of card and cut a hole (2 cm × 2 cm) at the centre of the card. Point the spectrometer slit (through the hole of the card) close to but not directly at the Sun. The card will shield your eyes from direct sunlight. You should see some dark lines called Fraunhofer lines after the discovery by Joseph Fraunhofer in 1814. Sketch these lines on the blank spectrum data sheet below.



4. Secure the spectrometer on a retort stand. Place a Bunsen burner at about 20 cm from the spectrometer. Adjust the vertical position of the spectrometer so that its slit is at the same level as the non-luminous part of a Bunsen flame.

5. Moisten a platinum wire with distilled water. Dip the wire into a pinch of sodium chloride. While you are viewing the flame through the spectrometer, ask your partner to place the platinum wire into the non-luminous part of the flame. Describe what you see and sketch the range of colours observed using coloured pencils on the blank spectrum data sheet below.

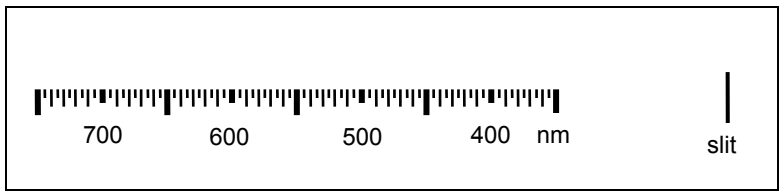
   Sodium



Flame colour: _____

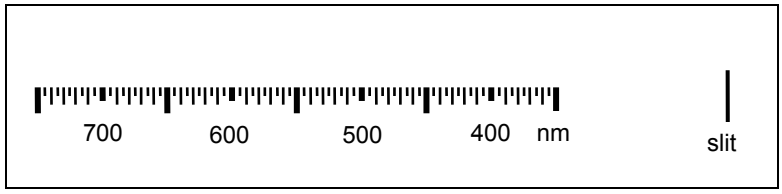
6. Repeat step 5 using $BaCl_2(s)$, $CaCl_2(s)$, $LiCl(s)$, $SrCl_2(s)$, $CuCl_2(s)$ and the unknown salt mixture. Clean the platinum wire with 1 M HCl(aq) before and after each flame test.

   Barium



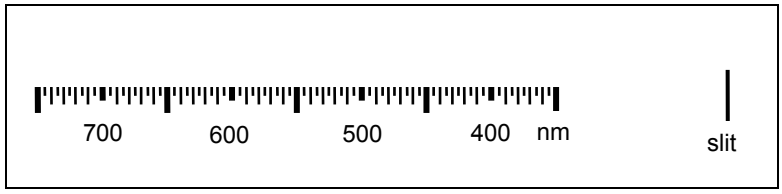
Flame colour: _____

   Calcium



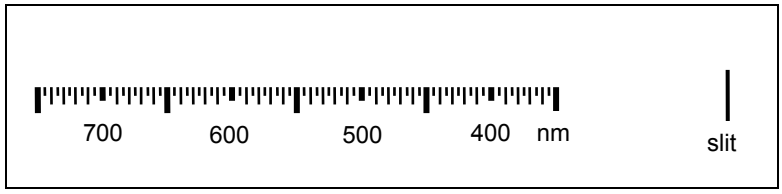
Flame colour: _____

Copper



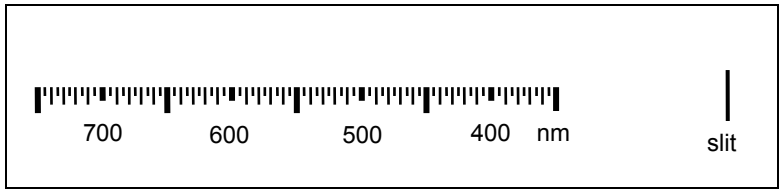
Flame colour: _____

Lithium



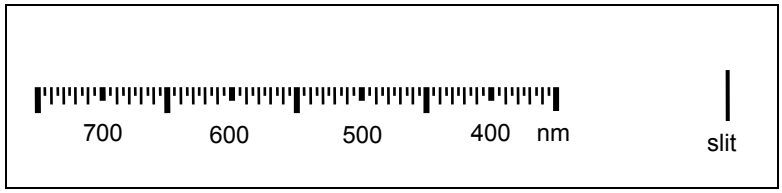
Flame colour: _____

Strontium



Flame colour: _____

Unknown



Flame colour: _____

Discussion Questions

1. Was the spectrum from an incandescent lamp similar to or different from that of a fluorescent lamp?
2. Account for the formation of the Fraunhofer lines.
3. Why is it necessary to heat the chemicals in the flame first before coloured light is emitted?
4. Why do different chemicals emit different flame colours?
5. What is the relationship between the frequency of the emitted light and the energy difference between the electron levels?
6. Base on your experimental results, what were the metallic cations present in the unknown salt mixture?