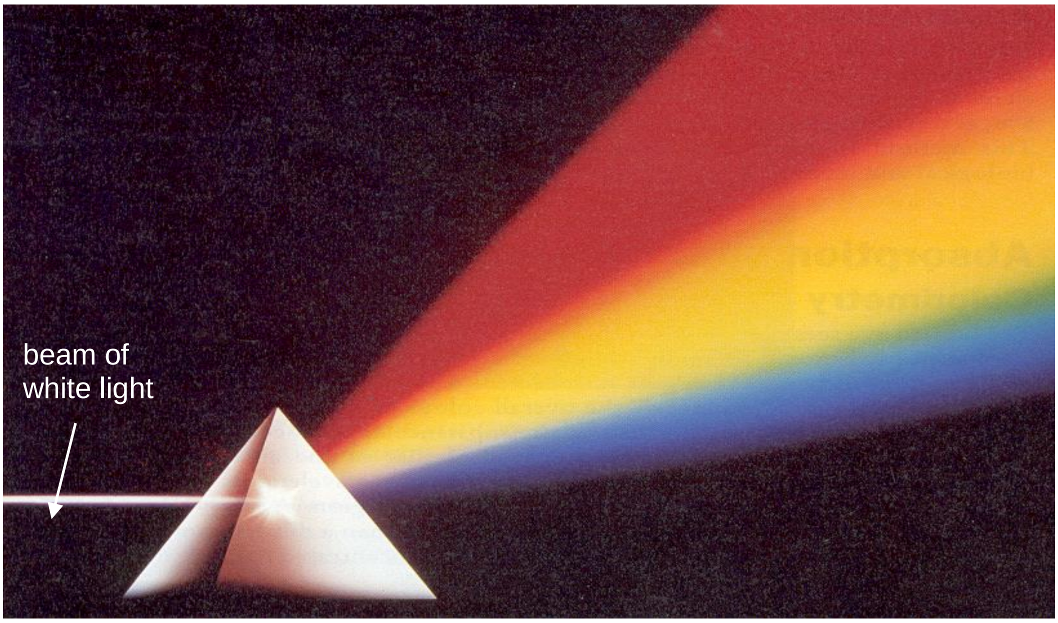
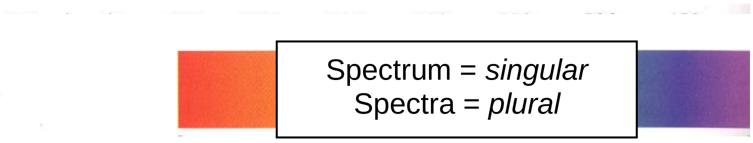
EMISSION SPECTRA

To explain how an emission spectrum is produced, we will need to look at what happens to normal white light (from the sun, light bulbs etc.) when it passes through a glass triangular prism.

White light is a mixture of different colours. When white light enters a glass prism it is separated into the individual colours that make it up. Each colour will come out of the prism at a different angle causing its separation from the others.

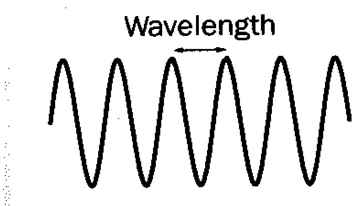


The individual colours will line up along side each other against a background to produce what is known as an **emission spectrum.** The emission spectrum below is also known as the **visible spectrum** as it contains all the colours of light that are visible to the human eye.



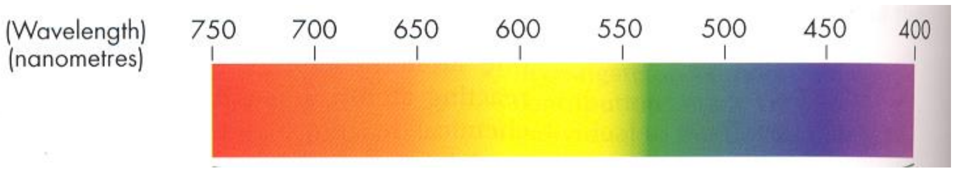
Spectrum = *singular*
Spectra = *plural*

This visible spectrum represents the colours of light that we can see. Light that is unable to be detected by the human eye such as infrared and ultraviolet is said to lie outside the visible spectrum. Each colour represents light of different energy. The motion of light is wave like and can be compared to the waves produced by sounds or the waves produced by the motion of the sea. Light of high energy will produce waves that have a shorter distance between their crests than the waves of light of lower energy. This distance is known as **wavelength** and is usually measured in nanometers (nm). **One nanometer is equal to 10^{-9} metres**.



The shorter the wavelength the greater the energy of the light.

On the visible spectrum, the wavelength **decreases** and hence the energy of the light **increases** as we move from left to right.



Increasing Energy

Invisible light such as infrared and ultraviolet have wavelengths that are either greater than 750 nm or less than 400 nm

← 750 nm 400 nm →

INVISIBLE REGION	VISIBLE REGION	INVISIBLE REGION

ATOMIC EMISSION SPECTROMETRY (A QUALITATIVE TECHNIQUE)

Atomic Emission Spectrometry (AES) uses the same principles as flame tests. It is a superior technique because it overcomes some of the limitations of flame tests. This is due to 2 main modifications made to the flame test procedure:

Modification 1

AES uses a flame that is much hotter than that produced by a regular Bunsen burner. The hotter flame means that metals whose electrons cannot be excited by a regular Bunsen burner flame can now be analysed.

Modification 2

The coloured light emitted is passed through a glass triangular prism and an **EMISSION SPECTRUM** is produced. This emission spectrum will not be the same as the spectrum for white light (which contains all visible colours). When the excited electrons of an atom fall back down to the ground state, light of only a small number of wavelengths will be produced. If this light is passed through a glass prism, the emission spectrum produced will only contain a small number of coloured bands or lines set against a black background. These lines of colour will appear in the same position as the corresponding wavelengths of colour in the spectrum for white light. The black background can be thought of as representing all the wavelengths of visible light that were not emitted by the element. No two atoms will produce the same emission spectrum, therefore emission spectra can be used as a "finger print" to identify elements.

Emission spectrum For Na

PERFORMING AES IN THE LAB

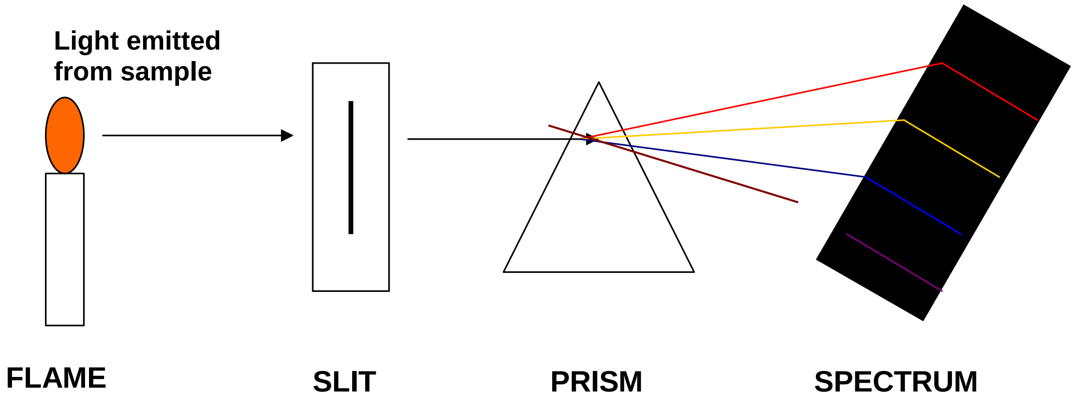
Steps 1 and 2:

Are the same as the corresponding steps for "Performing Flame Tests in The Lab".

Step 3:

The metallic sample to be analysed is vapourised in a very hot flame. The light emitted is allowed to pass through a slit which directs a narrow beam of light moving in one direction towards the glass prism. The prism splits the light into its component colours and the emission spectrum of the sample is observed.

To identify the sample, the emission spectrum is compared with the spectra of known samples that have been produced under the same conditions.



EXAMPLE 1
Briefly describe an experiment that you could perform to show that non-metals are not responsible for the flame colours produced during a flame test?

Solution

Analyse a series of ionic compounds that contain different metals but the same non-metals. Eg:

$NaCl$
$CuCl_2$
$SrCl_2$
$LiCl$

Expose each of these to a Bunsen burner flame and observe the results. Each compound will produce a different coloured flame, suggesting that the metal part of the compound is responsible for the flame colour. If the non-metal (Cl^-) part of the compound was responsible for the flame colour, all 4 compounds would produce the same flame colour as they all contain the chloride ion.

EXAMPLE 2
Why is there usually more than one line on an element's emission spectrum?

Solution

When a metallic sample is exposed to a flame, it is possible for more than one electron to become excited and make a transition. A transition is when an electron migrates to a higher energy level (excited state) and then comes back down again. When an electron makes a transition it absorbs a specific amount of energy and that energy is released as light of a specific wavelength when the electron comes back down to the ground state. So each transition will produce a line corresponding to a specific wavelength of energy on the emission spectrum. Excited electrons will sometimes fall back down to an energy level that was not their original ground state level. This will also produce different lines on the emission spectrum.

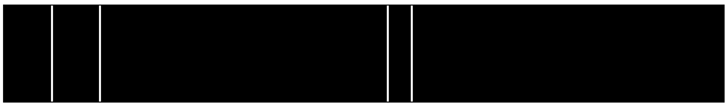
EXAMPLE 3
A jeweller wishes to determine the composition of a rare ring that is believed to be an alloy. He dissolves part of the ring in acid and analyses the resultant solution using AES. The emission spectrum produced is shown below:

The emission spectra of pure metals believed to be in the ring are given below:

Metal A

Metal B

Metal C



Which metal, A, B or C is present in the ring?

Solution

An emission spectrum is like a finger print for an element. For a metal to be present in the ring, every single spectral line in the metal must match up to a line in the ring's spectrum. So the answer is **Metal B**.

Ring

Metal B