

Spectroscope

Direct Vision



HL3791-001 With Scale & Adjustable Slit

Description:

The IEC spectroscope is a self contained device for separating the optical light components from a light source and for measuring their wavelength in nanometres.

The instrument is hand held and is directed to the source of the light. The viewing hole carries a diffraction grating which behaves as a prism and causes the light source to deflect on its way to the viewer's eye. Shorter wavelengths (higher frequencies) deflect more than the longer wavelengths.

This deflection of the light rays makes the light **appear** to the viewer's eye to be coming from inside the housing slightly to the viewer's right hand side. A scale is mounted inside the box and this allows the amount of deflection to be measured and this deflection is calibrated as wavelength in nanometres.

The various different components of colour that make up the original light source are easily seen as colour bands at various wavelengths.

| | | | |
|---------------|--------------|-----------------|--------------|
| Length: 190mm | Width: 100mm | Thickness: 25mm | Weight: 150g |
|---------------|--------------|-----------------|--------------|



Instructions For Use

Hold the spectroscope so that the small protruding eye piece is towards the eye and the narrow slit is pointing towards a light source. Be sure you hold the unit so that the eye piece is on the left side of the housing.

Look through the eyepiece so that the light source is visible passing through the adjustable width slit. A spectrum should appear on the right hand side of the slit and the scale of wavelength (in hundreds of nanometres) is visible directly above the spectrum.

The scale is used to read the wavelength of the different colours that make up the visible spectrum. Bright bands will be evident on the spectrum indicating the predominant colours present in the light source.

Notes:

- If the spectrum appears partly over the scale, the image can be lowered by placing your finger over the upper tip of the slit to slightly shorten the image.
- The slit is adjustable in width by using your thumbnail against the rib near the slit to slide the slit plate sideways to open or close the slit. If the light source is dull, the slit may require adjusting to a larger width. If the light source is bright, the slit can be reduced to the minimum width that will provide a usable spectrum. The narrower the slit, the sharper will be the bright or dark bands and the more accurate will be your results.
- If the spectrum is too faint when the slit is adjusted to the maximum width, shield your eye from external light by placing your hand around the eye piece and pressing your hand against the area around your eye.
- If the light source is white, the whole spectrum will be visible. If the light source is not white, only part of the spectrum will be visible, or certain areas of the spectrum will be brighter than others.

Measurements Of Wavelength & Calibration Check:

The scale is calibrated in 'nanometres' which is today's unit for wavelength of light.

One nanometre is 10^{-9} metres, or one millionth of a millimetre.
The abbreviation for nanometre is 'nm'.

An older unit of wavelength is the 'Angstrom unit'. This is equal to 0.1 nanometre.

The abbreviation of 'Angstrom unit' is 'A'.

Each number on the scale of the spectrometer represents 100nm or 1000A.

If a normal fluorescent light is used as a light source, the spectrum will appear but with two bright bands; one in the violet area of the spectrum at 436nm and one in the green area at 546nm.

Check where the bright bands appear on the scale. If they are not exactly at these wavelengths, make a note of the error and allow for this error in all readings taken with the instrument.

The Meaning Of 'Spectrum':

When white light is passed through a prism (that is, passing from one medium to another) or through a diffraction grating (a very fine grille of parallel lines), it is deflected from a straight line.

The angle that the light deflects depends on the wavelength of the light, thus, since white light is made up from all wavelengths or visible colours, each wavelength deflects a slightly different amount.

This splitting of white light into its component colours creates a smooth, continuous band of colour that changes from violet at one end to red at the other. This is known as the 'Spectrum'. The violet colour is the short wavelength (smaller nanometre reading) and the red colour is the longer wavelength.

Any wavelength shorter than violet is not visible to the human eye and is known as 'Ultra Violet'. These short wavelengths are dangerous to our bodies and they include various types of UV Rays, Xrays, Cosmic Rays and others. Light from the sun contains a high proportion of ultra violet rays and this causes sunburn.

Any wavelength longer than red is not visible to the human eye and is known as 'Infra Red'. These long wavelengths are not generally dangerous to our bodies and they include Infra Red heat, various types of high frequency Radar and Radio waves and the whole range of lower frequency Radio waves that we hear on our radios.

Fundamentally, there are three basic types of spectra:

1. Continuous spectrum - This is created when all wavelengths are present.
2. Emission (bright line) spectrum - appears when a gas is radiating a limited number of wavelengths and is thus producing a limited number of bright lines.
3. Absorption (dark line) spectrum - results from the absorption of certain wavelengths by a gas, liquid, or other filtering substance located between the radiating source and the observer. Only the wavelengths NOT absorbed by the filtering materials are visible in the spectrum.

When any element is radiating light (heated, burning etc) and if that light is examined, it will be found that every single element has its own unique set of spectral lines.

Therefore, emission and absorption spectra can be used as a 'fingerprint' in the precise identification of any substance that causes either the emission or the absorption of light.

In modern day Spectroscopy, not only visible light is used, but also Infra Red and Ultra Violet radiation as well. When the student understands the principles of Spectroscopy and has performed both emission and absorption experiments in the visible spectrum, there will be a good understanding of the more advanced techniques used in today's research.

Refer to the IEC 'Flame Spectrometer' CH3792-001 for further study of emission and absorption of light when analysing materials.



Laboratory Work:

Each element in its gaseous form will emit its 'fingerprint' of the various wavelengths of light when subjected to high temperatures or to an electric arc. Strontium, sodium, lithium and copper salts produce easily recognisable emission spectra if vapourised in a bunsen burner flame. Helium, oxygen, hydrogen, mercury, neon, etc. are more easily recognised if a current is passed through the gas so that the gas itself emits light.

Conversely, elements and compounds may be identified by the wavelengths of light that they absorb. Colour filters or combinations of colour filters placed in the path of the light permit investigations of this type.

The observation of the absorption spectrum of a chlorophyll or haemoglobin solution with the IEC Direct Vision Spectroscope is an excellent experiment for the student. Students should be required to identify materials by both the emission and absorption spectra. They can work in groups and the details of their procedures will depend on the particular study in which they are involved. eg. Physics, Chemistry, Biology, Earth Science or Astronomy.

The following chart lists the wavelengths emitted by some elements.

| ELEMENT | WAVELENGTH (nanometres) |
|------------------------|-------------------------------|
| SODIUM | 589 |
| STRONTIUM | 606 |
| LITHIUM | 670.8 |
| COPPER | 430, 630 |
| HYDROGEN (vacuum tube) | 431, 483, 653 |
| MERCURY (vacuum tube) | 436, 546, 577 |
| HELIUM (vacuum tube) | 447, 468, 492, 501, 587, 667. |

Caution: The sodium line (589nm) may appear as a contaminant in all spectra.

Making Filter Solutions:

The following solutions are suggested to be made up to be used as filters for the production of absorption spectra (each solution absorbs in the spectral range indicated):

Aqueous Copper Sulphate - absorbs wavelengths greater than 645nm.

Aqueous Potassium Permanganate - absorbs wavelengths from 455 to 575nm.

Designed and Manufactured in Australia