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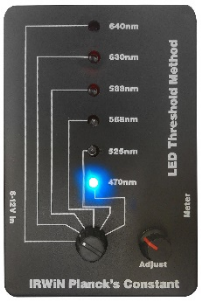

Planck's Constant by LED Threshold Voltage Method

Connect the apparatus to a 6-12V dc power supply and switch on. Turn the adjustment dial up and you should see one of the LEDs illuminate. The LED that illuminates is dependent on the position of the selector switch. Connect a multimeter set to 20V dc to the labelled terminals.

Select the red (640nm) LED and, in a darkened room, turn the adjustment dial down so that the LED is at the faintest that you can see. It is worth moving your point of view slightly as the light from a LED is not uniform. It is useful to view the led through a black sugar paper tube so that you can easily detect the lowest brightness.

Record the so called "Threshold Voltage" (also known as the Striking Voltage) as well as the wavelength of the light and then select the next LED. Repeat as above. Repeat the experiment for all the LEDS.

Now plot a graph of Threshold Voltage against the reciprocal of the wavelength.

The photon energy in eV is equivalent to the threshold voltage. To convert to energy in Joules, the threshold voltage should be multiplied by the electronic charge, 1.6×10^{-19}.
$E = hf = hc/\lambda$; therefore $h = \frac{E \times \text{gradient}}{c}$

Using data from our experiment we got a gradient of 1.246×10^{-6}

Thus, $h = \frac{1.6 \times 10^{-19} \times 1.246 \times 10^{-6}}{3 \times 10^{8}} =$ **6.65×10^{-34} Js**

The accepted value of Planck's constant is **6.63×10^{-34} Js.**

Please note that the slope of the line of best fit is crucial, so care should be taken in ensuring that you genuinely do have a line of best fit.

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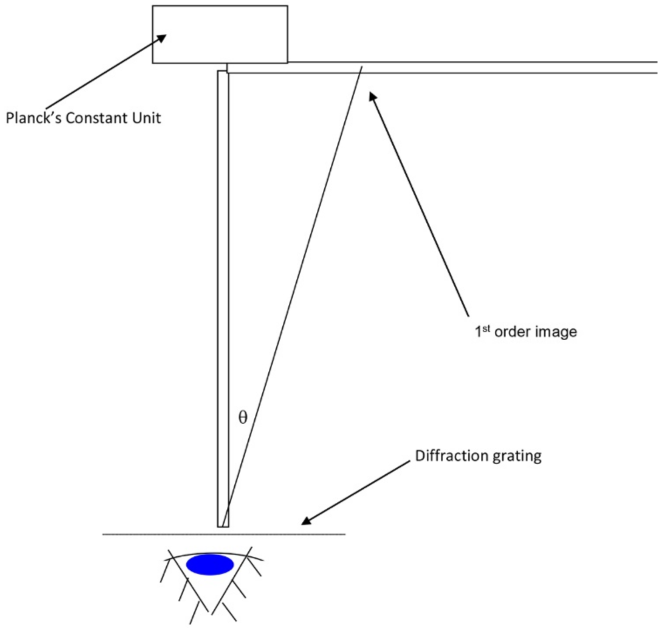
Transmission through colour filters.
Use colour filters, typically red, green, yellow, magenta, cyan and blue.

View the box's LEDs through the filters and note which colours are reduced in intensity when viewed through the filters. You should note that, for example, the red LED, when viewed through a red filter, shines brightly, as it does when viewed through yellow and magenta filters. When viewed through other filters the red LEDs intensity is diminished. It should be possible to work out secondary colour mixing.

Transmission through a diffraction grating.
View the LEDs through the diffraction grating. It should be noted that first order diffraction patterns are shown. It will be noted that the first order diffraction pattern of the red LED is wider than that of the blue LED. It should also be noted that none of the LEDs gives off a pure colour (monochromatic light).

Measuring the wavelength of coloured light.
Set two metre rules at right angles and set the unit as shown below.



Using the formula **$n\lambda = dSin\theta$**, the wavelength of the red light may be calculated. **d** is the diffraction grating spacing $= \frac{1}{500,000} = 2x10^{-6}$m

(this is calculated for a 500lines/mm grating), **n** is the order of the image (in this case 1).

Using the diffraction grating, view the LEDs from the end of the metre rule as shown
Get a partner with a retort stand to move along the perpendicular metre rule until the retort stand is in the position where, say, the red end of the partial spectrum formed by the red LED is– this point is labelled "1st order image" on the diagram. You now need to work out the angle. This may be done by using a protractor set at the end of the ruler (where your eye was) and sighting along it to the clamp stand. Alternatively, the angle may be calculated by trigonometry. It should also be possible to view the 2nd order spectrum and apply the formula above.

The experiment may be repeated for the other five LEDs.

It is often useful to cover the wavelength markings on the unit with black tape so that it is a genuine experiment!