FifeX LED Array Demonstration

-Arranged by Fergus Walker-

Introduction

The FifeX LED array is a great piece of equipment that can be used to explain wavelengths of different colours and to prove and work out Planck's constant. It can also be a good experiment for showing how to measure with errors.

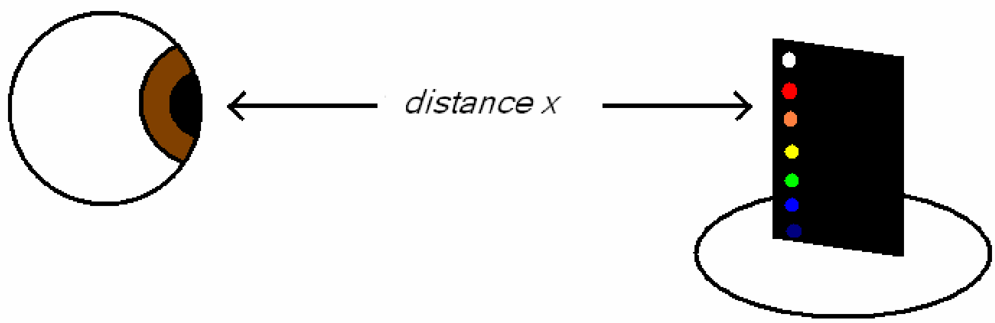
Apparatus

1. Your FifeX LED array
2. A measuring tape
3. Diffraction grating (can be supplied by FifeX)
4. A sheet of A2 white paper

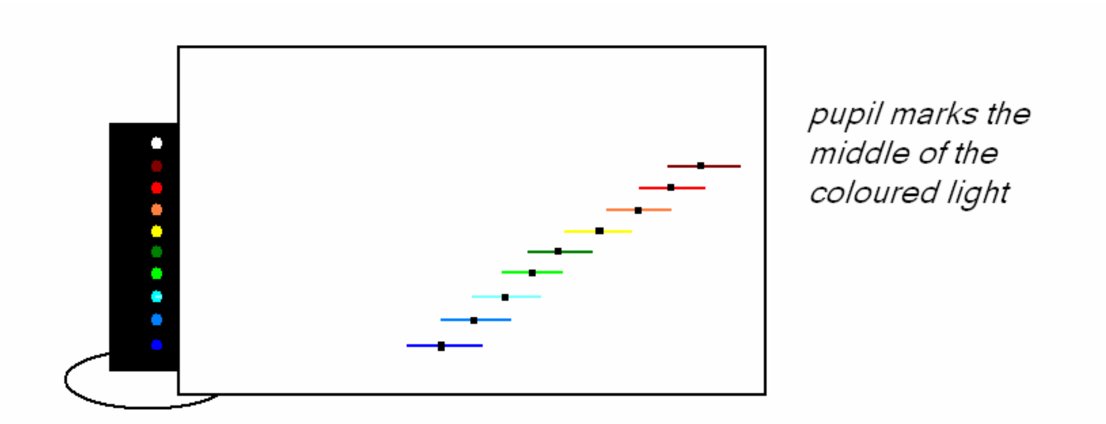
Getting Started

1. Ensure the LED array is connected to the mains properly with the power supply that comes with the kit. Move the switch on the side of the array to on.

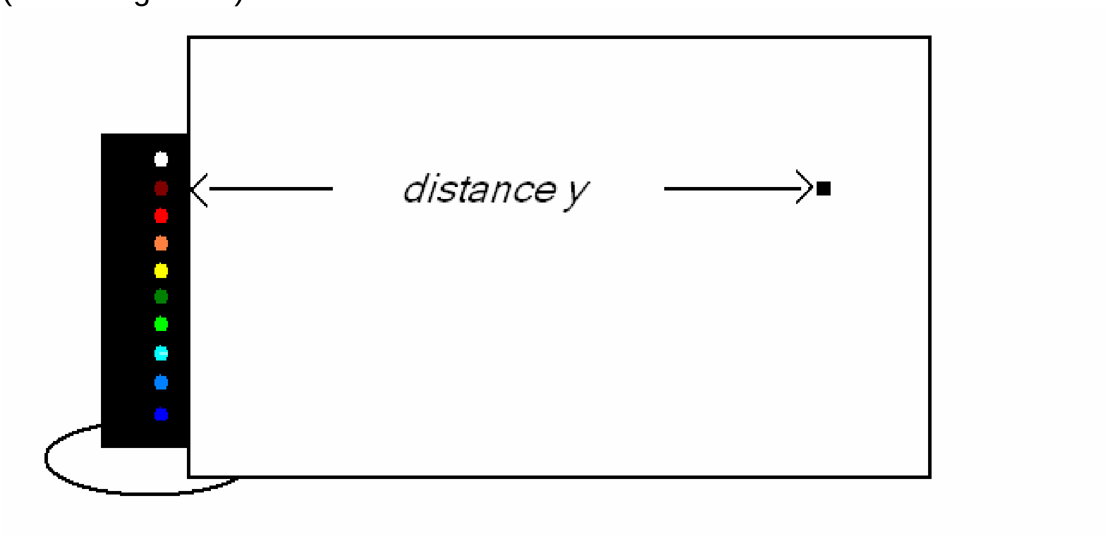
2. Put the diffraction grating right up against your eye – this is how you will use it. Now measure the distance ***x*** from where you are, to the LED array. (It is easier to try and set it up to be 1m away)



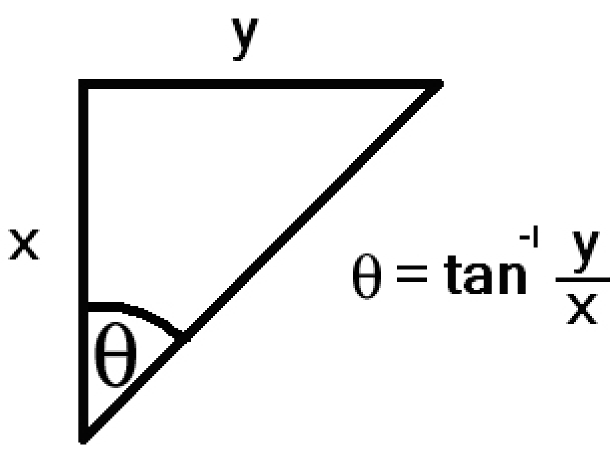
3. A pupil looks through the diffraction grating and informs another pupil where to mark the location of the coloured light on the sheet of A2 paper.



4. Measure the distance ***y*** from the array to each of the colours own mark. (Excluding white)



5. Now use the following formula;



5. (i) then use the formula to find the wavelength.

$$m\lambda = d \sin\theta$$

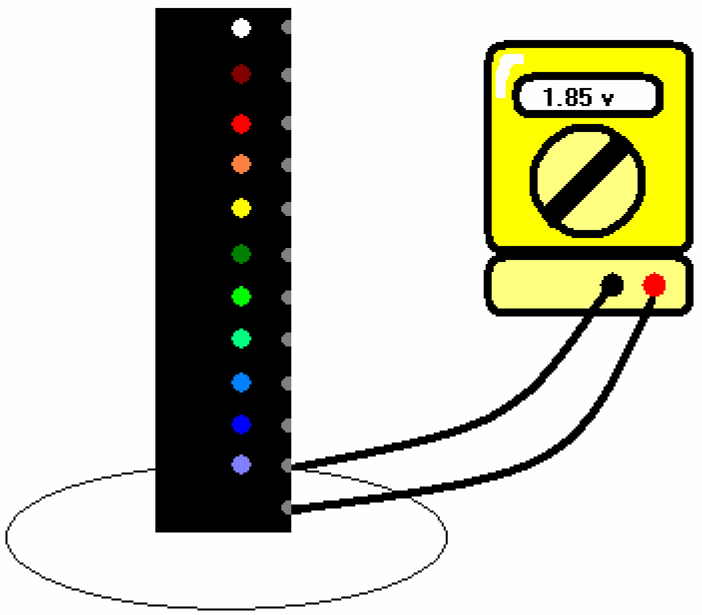
- *d=1/number of lines on diffraction grating*
- *m=1*

6. Now you have the wavelength you can use it to find the frequency in Hertz.

$$f = \frac{c}{\lambda}$$

Planck's Constant

7. Now measure the forward voltage across the each of the LEDs. Do this by placing one probe on the area marked 'common' and the other on the metal tab next to the LED that you wish to measure.



8. Given that we know forward voltage and

E_{input} = eV (where V is voltage)

E_{output} = hf (where h is Planck's constant)

Then hypothetically we can assume that;

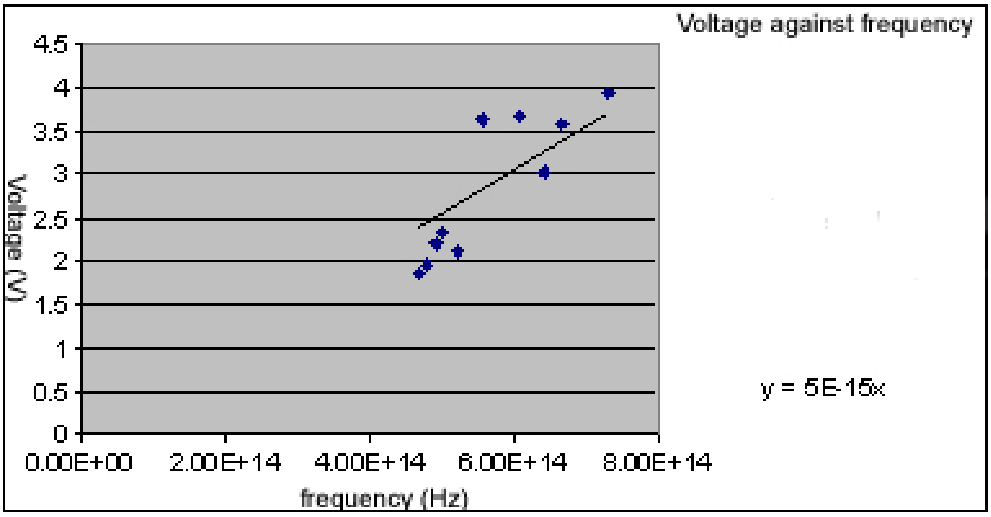
$V = \frac{h}{e} f$ *(this is a big assumption as it would suggest 100% efficiency)*

So if you plot voltage against frequency, then the gradient of the graph= $\frac{h}{e}$.

9. My results from the experiment came out as;

led colour	Wavelength(nm)	freq (Hz)	forward voltage (V)
deep red	641	4.68E+14	1.85
red	627	4.78E+14	1.96
orange	609	4.93E+14	2.2
yellow	600	5.00E+14	2.35
green	574	5.23E+14	2.12
bright green	539	5.57E+14	3.63
turquoise	494	6.07E+14	3.68
blue	468	6.41E+14	3.04
deep blue	451	6.65E+14	3.58
violet	411	7.30E+14	3.94

The graph I produced from this was as follows



We know that $y = mx + c$ and the equation of the trend line above is $y = 4E - 15x$, we can use the previous formula $gradient = \frac{h}{e}$ and rearrange it into the new formula for finding Planck's constant;

$h = e(5x10^{-15})$ *(Where e is a known constant, the electron charge)*

Therefore

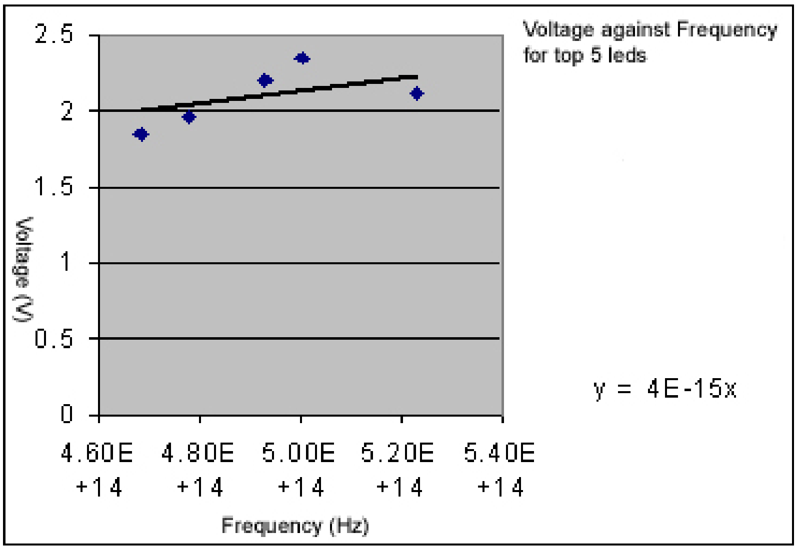
$h = 8.01x10^{-34}$

Conclusion

The actual value for Planck's constant is $6.63x10^{-34}$

I believe this to be a close answer because the output voltage would never be equal to the input voltage and the measuring of the position of the light on the paper will be inaccurate.

I also noticed that there was a large gap in the output voltage between the green and the bright green LED. So I decided to reproduce the graph only using the top 5 LEDs and discovered my final result was much closer to the value of Planck's constant.



$h = e(4x10^{-15})$

Therefore $h = 6.41x10^{-34}$ which is a much closer answer to the actual value of Plank's constant.