UNIVERSITY OF WOLLONGONG IN DUBAI

LAB REPORT 10

SPECTRA

Subject: PHYS143 (DB123) Physics for Engineers.

Group Members:

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EXPERIMENT 1

Purpose

The goal of this experiment was to determine the wavelength of each of the colours observed using the spectrophotometer system. These colours are observed at different angles which can be used to find their experimental wavelengths.

Hypothesis

It is expected that the spectral lines produced by the mercury vapor light will be at specific angles, corresponding to specific wavelengths of light. By measuring the angle of each spectral line using the rotary motion sensor, and the intensity of each line using the high sensitivity light sensor to graph it, it should be possible to determine the wavelength of each colour in the spectrum.

Materials used

- Hg light source
- PASCO universal interface
- Focusing Lens
- Spectrophotometer kit
- Grating mount
- High sensitivity light sensor
- Collimating slits
- Computer (PASCO capstone)

Procedure

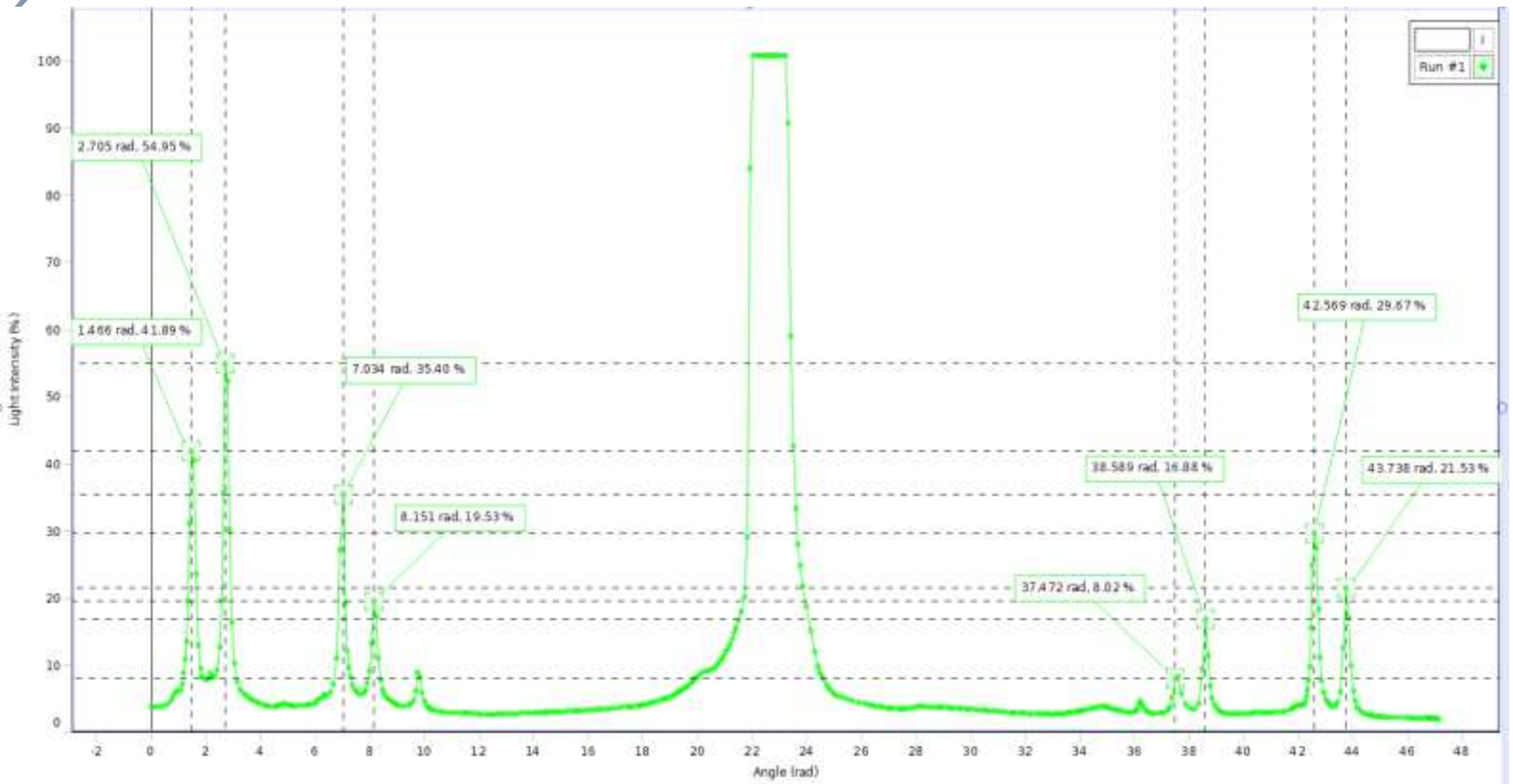
1) Set up the experiment by placing the Hg light source a bit far from the collimating slits. (If the light source is too close or too far from the collimating lens, it may give inaccurate results).
2) Turn on the light source.
3) Set the gain on the light sensor to 100, adjust the light source, collimating slits, collimating lens and focusing lens such that clear images of the central ray and the first order spectral lines are observed on the aperture disk.
4) Rotate the light sensor such that all the colours are to the left of the 0.1 mm central ray on the aperture disk.
5) To start obtaining results, rotate the threaded post under light sensor at a steady speed to continuously scan the spectrum in one direction. Scan all the way through the first order spectral lines on one side of the central ray. Then through the central ray then through the first order spectral lines on the other side of the central ray.
6) When rotating the light sensor, make sure the rotary motion senor is also rotating and a proper graph is observed on the computer.
7) Set the gain on the light sensor to 10 and repeat the experiment from step 4.

Data

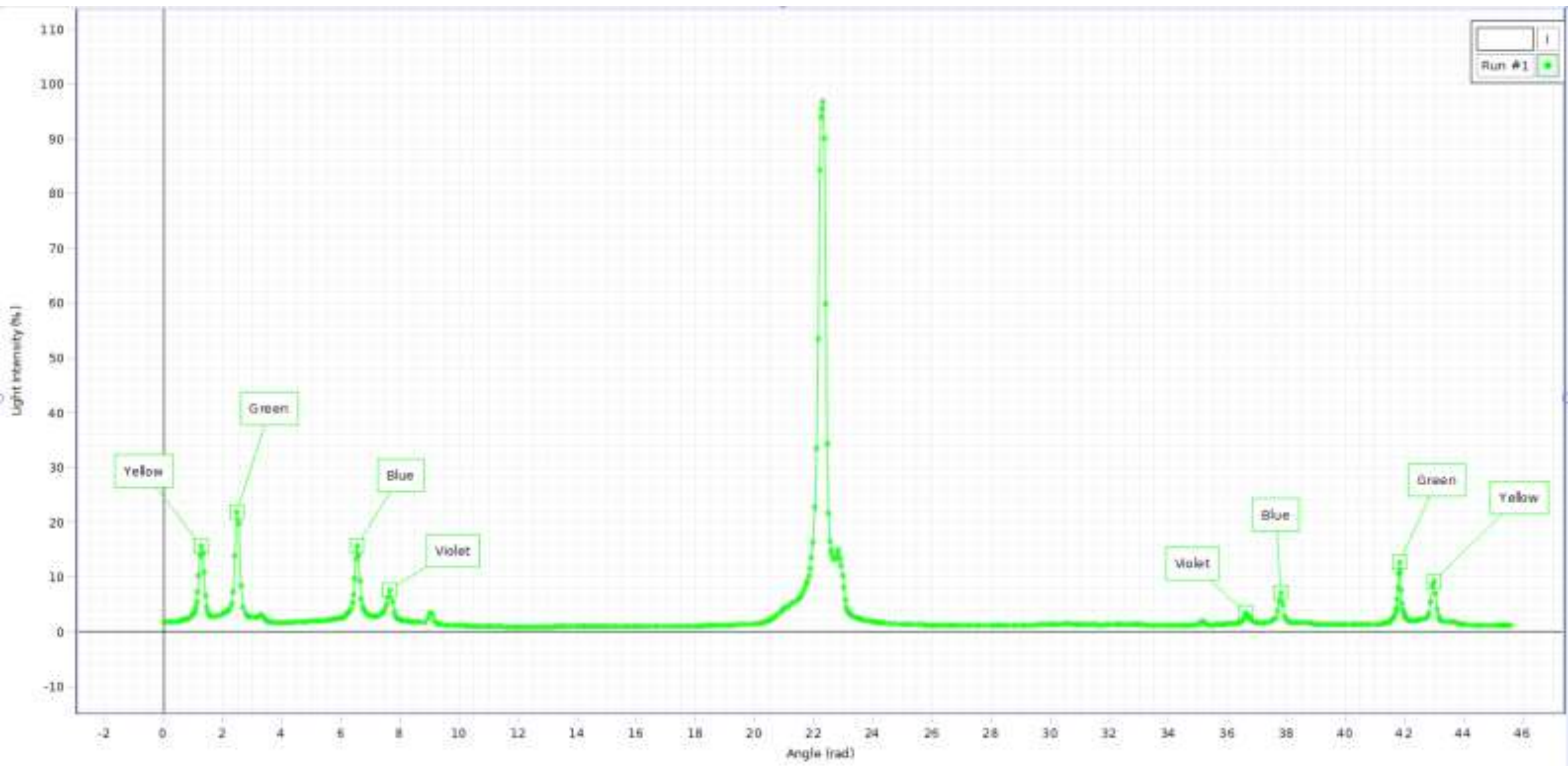
Colour	Θ_1	Θ_2	Θ_2-Θ_1	Θ	$\lambda = d \sin \Theta$ (nm)	Actual wavelength (nm)	%Difference
Yellow	1.466	43.738	42.272	21.136	600.73	575-579	4.47-3.74
Green	2.705	42.569	39.864	19.932	567.94	~546	4.02
Blue	7.034	38.589	31.555	15.7775	452.99	~435	4.14
Violet	8.157	37.472	29.315	14.6575	421.57	404-408	4.35-3.33

Graphs

Graph for when Gain is set at 100



Graph for when Gain is set at 10



Observations

As we can see from the table and graph, yellow light has the biggest wavelength and green had the highest intensity (54.95%).

Calculations

$\Theta = \Theta_2 - \theta_1/2$

Example: 42.272/2 = 21.136

$\lambda = d \sin \Theta$

d = 1666 nm

Example: λ = 1666*sin (21.136) = 600.73 nm.

Conclusion

The objective of this experiment was to find the experimental wavelength of light with different colours using a spectrophotometer system. Set up the experiment by aiming the light source at the collimating slits and set the aperture disk such that the colours are observed to the left of the 0.1 mm gap on the aperture disk. Set the gain on the light sensor to 100, adjust the light source, collimating slits, collimating lens and focusing lens such that clear images of the central ray and the first order spectral lines are observed on the aperture disk. Rotate the light sensor at a steady speed so that the results can be shown clearly on the computer. Repeat this experiment but with a gain of 10. Some problems experienced were that setting up the experiment was a bit difficult but manageable. Aligning the light with the grating and focusing lens was tough.

Some sources of error may include:

- Alignment of the light with the grating and focusing lens may not be accurate.
- Focusing lens may not be clean.
- Distance between the collimating lens and the light source may not be perfect.

We learnt that by measuring the absorption spectra of a substance we can identify the wavelengths of light that are absorbed by the substance. When repeating the experiment, we would make sure that the set up is more stable and perfect to obtain accurate values.

EXPERIMENT 2

Purpose

The purpose of the experiment is to determine the wavelengths of the colours absorbed by a liquid sample using a spectrophotometer system or kit to measure the relative intensity of colours of light in an absorption spectrum produced by light from a mercury vapor light source passing through a cuvette and a grating. These colours are observed at different angles which can be used to find their experimental wavelengths.

Hypothesis

It is expected that when white light passes through a liquid sample, the sample will absorb certain wavelengths of light, resulting in an absorption spectrum with dark lines or gaps corresponding to those absorbed wavelengths.

Materials used

- Hg light source
- PASCO universal interface
- Focusing Lens
- Spectrophotometer kit
- Grating mount
- High sensitivity light sensor
- Collimating slits
- Computer (PASCO capstone)

Procedure

1) Set up the experiment by placing the Hg light source a bit far from the collimating slits. (If the light source is too close or too far from the collimating lens, it may give inaccurate results).
2) Turn on the light source.
3) Set the gain on the light sensor to 100, adjust the light source, collimating slits, collimating lens and focusing lens such that clear images of the central ray and the first order spectral lines are observed on the aperture disk.
4) Rotate the light sensor such that all the colours are to the left of the 0.1 mm central ray on the aperture disk.
5) Put the empty container/filled container between the light sensor and the aperture disk.
6) To start obtaining results, rotate the threaded post under light sensor at a steady speed to continuously scan the spectrum in one direction. Scan all the way through the first order spectral lines on one side of the central ray. Then through the central ray then through the first order spectral lines on the other side of the central ray.
7) When rotating the light sensor, make sure the rotary motion senor is also rotating and a proper graph is observed on the computer.

Data

Empty container

Dark line	Θ_1	Θ_2	Θ_2-Θ_1	Θ	$\lambda = d \sin \Theta$ (nm)	Actual wavelength (nm)	% Difference
Yellow	2.496	45.082	42.586	21.293	604.99	575-579	5.22-4.49
Green	3.735	43.825	40.09	20.045	571.03	~546	4.58
Blue	7.941	39.636	31.695	15.8475	454.95	~435	4.59
Violet	8.971	39.397	30.426	15.213	437.17	404-408	8.21-7.15

Filled container

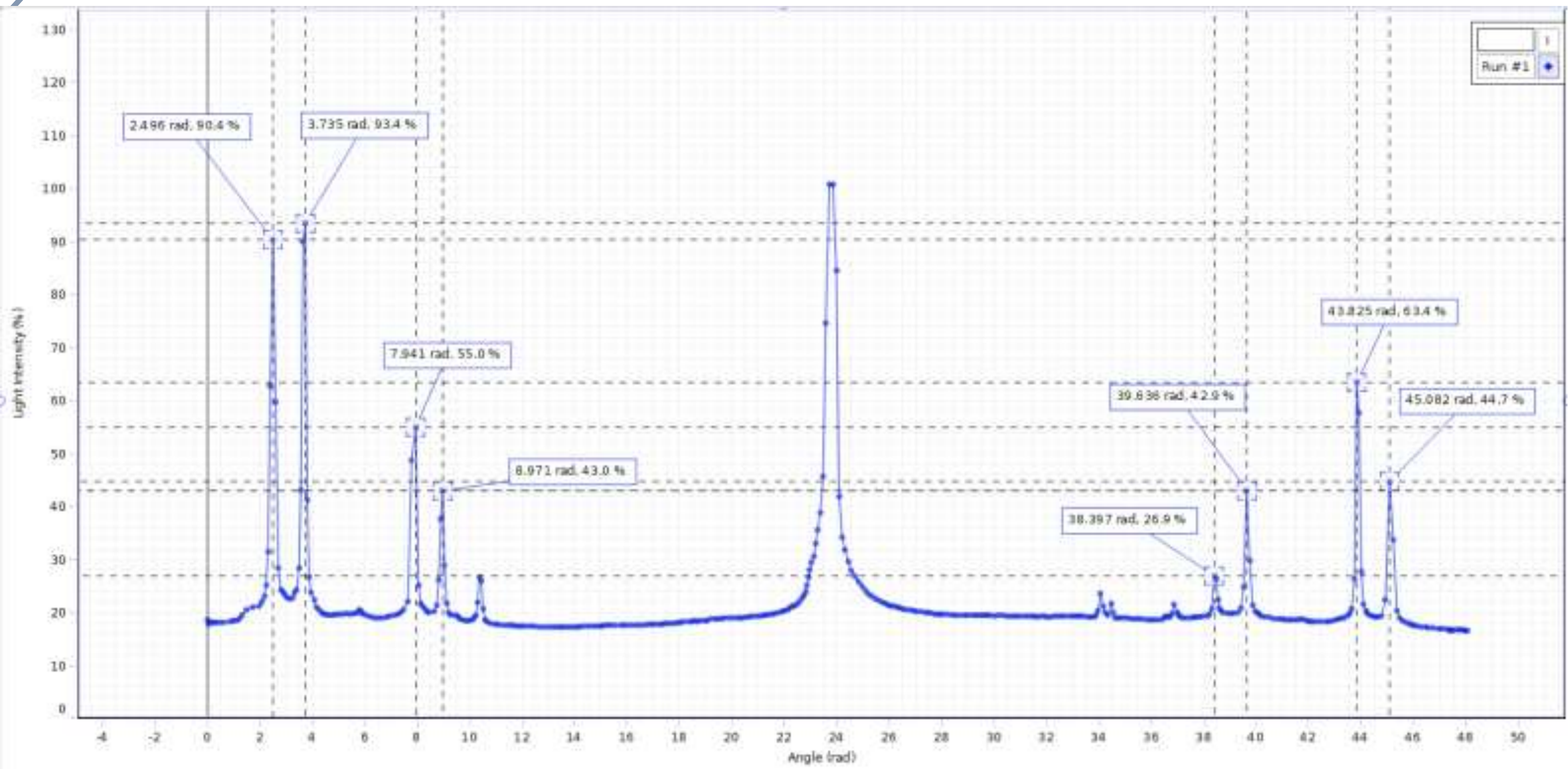
Dark line	Θ_1	Θ_2	Θ_2-θ_1	Θ	λ = d sin Θ (nm)	Actual wavelength (nm)	% Difference
Blue	8.849	40.282	31.433	15.7165	451.28	~435	3.74
Violet	10.036	39.095	29.059	14.5295	417.96	404-408	3.46-2.44

Observations

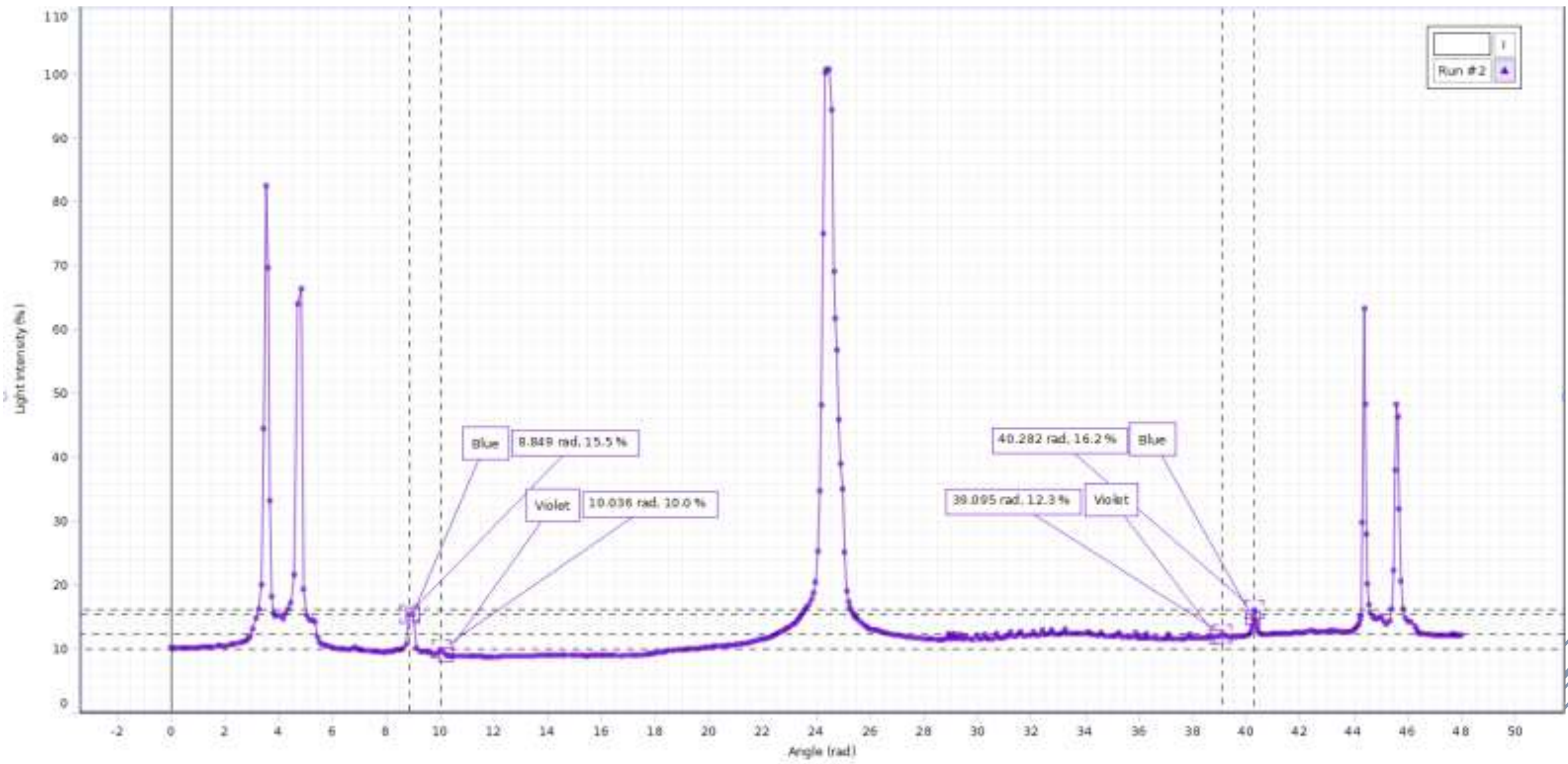
From the tables, we can see that yellow has the biggest wavelength with the empty container. In the filled container experiment, only blue and violet are absorbed. The blue light has a higher intensity than violet as seen from the graph.

Graphs

Empty container



Filled container



Calculations

$\Theta = \Theta_2 - \theta_1 / 2$

Example: 42.586/2 = 21.293

$\lambda = d \sin \Theta$

d = 1666 nm

Example: λ = 1666*sin (21.293) = 604.99 nm.

Conclusion

The experiment aims to determine the wavelengths of colours absorbed by a liquid sample using a spectrophotometer system. The hypothesis suggests that when white light passes through a liquid sample, the sample will absorb certain wavelengths of light, resulting in an absorption spectrum with dark lines corresponding to the absorbed wavelengths.

The materials used include an Hg light source, PASCO universal interface, spectrophotometer kit, grating mount, high sensitivity light sensor, collimating slits, and a computer (PASCO capstone).

The steps of the experiment involve setting up the equipment, adjusting the gain on the light sensor, collimating slits, collimating lens, and focusing lens to observe clear images of the central ray and the first order spectral lines. Then, the rotary motion sensor is rotated to scan the spectrum in one direction, and a graph is observed on the computer. The experiment is repeated by setting the gain on the light sensor to 10. The experiment aims to determine the wavelengths of the colours absorbed by the liquid sample, and the results can be analysed to understand the absorption spectrum of the sample.

Some of the sources in this experiment can be:

1. Any residue or impurities in the cuvette can alter the absorption spectrum and lead to incorrect results.
2. The volume of the liquid sample and the thickness of the cuvette can affect the results of the experiment. Inconsistent measurements can lead to incorrect calculations of the absorption coefficient.
3. If the Hg light source, collimating slits, collimating lens, and focusing lens are not correctly aligned, the intensity of the light passing through the cuvette can vary, leading to errors in the measurement.
4. The spectrophotometer system needs to be calibrated periodically to ensure accurate measurement of the absorption spectrum. Any errors in the calibration can lead to incorrect results.
5. Human errors can occur due to mistakes in measurement, recording, or data analysis.

We learnt that if there is a liquid in the container, some light may be absorbed and some light may not be observed. When repeating the experiment, we would make sure to calibrate the spectrophotometer properly and avoid human errors as much as possible.