Matter and Minerals
Fall 2005

Chemistry Workshop
Week 7

We will meet in Lab II, 1234 on Thursday of Week 7, from 9 a.m. – 12 noon

"Properties of Light"

Prepared & Presented by

Dr. Dharshi Bopegedera

Work in pairs.

Experiment 1: Interference with Diffraction Gratings

Diffraction gratings are pieces of glass (or plastic) with many very closely ruled lines on them, often between 100 and 1200 lines per millimeter. These ruled lines have the effect of acting as multiple slits in the glass, an extension to the extreme of the double slit experiment. When monochromatic light (light of one wavelength) is shined through the grating, the rays which pass through each slit interfere with each other, constructively and destructively, creating a pattern of light and dark bands on a screen placed in front of the grating. The more lines / slits there are, the narrower the bright bands get, and the wider the dark bands become, until we see only a series of evenly spaced dots of light on a dark background.

There is an equation which describes the relationship between the distance from the grating to the screen (L), the distance from the central bright spot on the screen to the first bright spot to either side (x), the spacing between lines on the grating (d), and the wavelength of the light (λ):

$$d(x/L)=\lambda$$

This equation is quite accurate as long as L is large compared to x (at least five times larger), for we have simplified Bragg's equation

$$d(\sin\theta)=n\lambda$$

with θ being the angle between the central ray, and the ray which makes the first bright spot to either side. In the equation, n signifies whether we are measuring θ and x as the first side spot (n=1), or the second (n=2), third (n=3), etc.

1. You will use a red laser of known wavelength (be sure to get the correct wavelength from the instructors) to determine d for your grating. Then you will use the value of d and the same setup to determine the wavelength of another laser (green). Perform this experiment.
2. You can also use the same setup to determine the spacing between two slits (d). You can also use it, unchanged, to determine the width of a thin fiber. Place a piece of your hair in a slide holder, and set it in front of your laser in place of the grating. Now proceed as you did in part 1, to determine d, but this time d will be the width of your hair.

Experiment 2: The relationship between wavelength and frequency using water waves

You are required to obtain 3 data points. We will input your data into a **class spreadsheet** and use the class data for data analysis.

You are provided with a water table and a wave generator. You will use this setup to generate water waves on the water table (instructions will be provided in lab). You will

also use a light frequency generator to generate light waves with frequencies ranging between 600-3500 cycles per minute (units are minute^{-1}). The light frequency generator is placed under the water table. When the light waves and water waves have the same frequency you will note that the water waves look stationary. When this happens, measure and record the wavelength of the water waves in millimeters (follow instructions provided in lab). Also record the frequency of the light waves. You need to records in 2 places.

- In your lab note book
- Class data sheet (on paper) available with the instructors
- In the class spreadsheet on the teaching computer in the CAL using Microsoft Excel

Your 3 data points should be about 200 cycles/minute apart. Do not repeat data points recorded already by your classmates.

When everyone in the class has input their data into the class spreadsheet, copy the class spreadsheet to your folder in the M&M share for data analysis.

From now on, work on your own. You can get help from others but you must do your own data analysis with this data.

1. Create the following table using Microsoft Excel.

Name of student	**Wavelength**	**Frequency**	**Frequency (ν)**	**Wavelength (λ)**	**$\nu\lambda$**
	(mm)	**(min^{-1})**	**(s^{-1})**	**(m)**	**(ms^{-1})**

2. Put your name on top of the spreadsheet (in Excel, not by hand), print out the spreadsheet and attach to your lab report.
3. Plot a graph of $\nu\lambda$ versus λ using Microsoft Excel. Place this graph on a separate sheet as a chart (you will learn how to do this in lab). Clean up your chart, add a title to it as well as your name (all in Excel, not by hand). Add a trend line to your chart. Print out the chart. Attach to your lab notebook.
4. What is the average speed of the water waves? Write a paragraph comparing it with the speed of light waves.