Spectrometer

1 Objective

- Calculating the diffractive index of the prism for each wavelength.
- Calculating the resolving power of the prism.

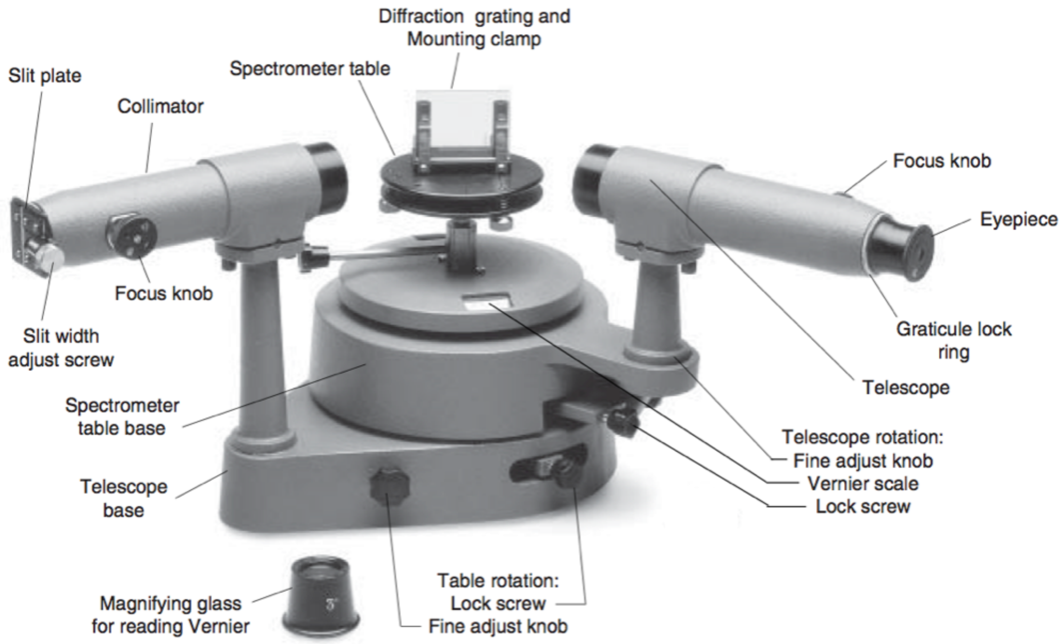
2 Prelab Questions

1. Briefly explain what is meant by the resolving power of the prism.
2. Write a short description of a prism and explain how it disperses light.
3. By using an illustration, compare between the spectra obtained from a diffraction grating and from a prism.

3 Principles

Light from a light source with a discrete spectrum is passed through a collimator. The light is then refracted by a prism and studied using a telescope.

4 Apparatus



5 Precautions

1. Optical systems are sensitive and are often fine-tuned. Be very careful with the equipment, as a slight nudge might damage the equipment.
2. The prism is a delicate component, do not scratch its surface.
3. Stray light can obscure the images seen through the telescope. Preform the experiment in pitch-black darkness.

6 Experimental Steps

Referring to the figure in [Section 4]:

1. The prism in front of you is mounted and fixed to the spectrometer table. Notice that the telescope is free to move in a semicircle about the prism.

2. With the prism in place, identify the direction of the refracted light. Rotate the telescope towards that general direction and look through the telescope. You should be able to see discrete spectral lines (colours). Lock the telescope in place using the telescope lock screw.
3. While looking through the telescope, slightly rotate the spectrometer table clockwise and notice how the spectrum behaves. The spectral lines under observation should move and change their positions. Now rotate the table counter clockwise and see how they return to their original position. Keep rotating the spectrometer table gently until you observe the spectral lines stopping momentarily before reversing the direction of their motion. The position at which the spectral lines reversed their motion is defined as the position of *minimum deviation*.
4. Lock the spectrometer table at the position of minimum deviation (screw it tightly and make sure that it does not move). Using the telescope fine adjust knob, move the telescope to align the vertical cross hair with the first colour (red). Record the reading of the vernier scale θ.
5. Repeat step [4] for all the colours.
6. Carefully unscrew the prism and remove it without changing the position of the spectrometer table. Unlock the telescope and rotate it until you can see the image of the slit. Record the angle θ_0.
7. Place the prism on a white sheet of paper and calculate the internal angle of the prism A.
8. Measure the length of the prisms base b.

7 Evaluation

1. Calculate the angle of minimum deviation for each colour using:
$$D_m = |\theta - \theta_0| \tag{1}$$
2. Using the refractive index equation, calculate the refractive index for each colour:
$$n = \left(\frac{\sin\left(\frac{A+D_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} \right) \tag{2}$$
3. Plot the wavelength versus the refractive index and use the slope to calculate the resolving power of the prism, given the resolving power equation:
$$R = b\frac{dn}{d\lambda} \tag{3}$$

8 Postlab Questions

1. Explain why each colour has its own refractive index.
2. When immersing a colourful object in a glass of water (e.g a yellow pencil), the object appears broken but its colour does not change. By using the explanation in Question 1, explain why the object appears broken but its colour does not change.
3. If a monochromatic light source was used instead of the one used in this experiment, what do you expect to observe?