

## DIFFRACTION GRATING

### OBJECTIVE

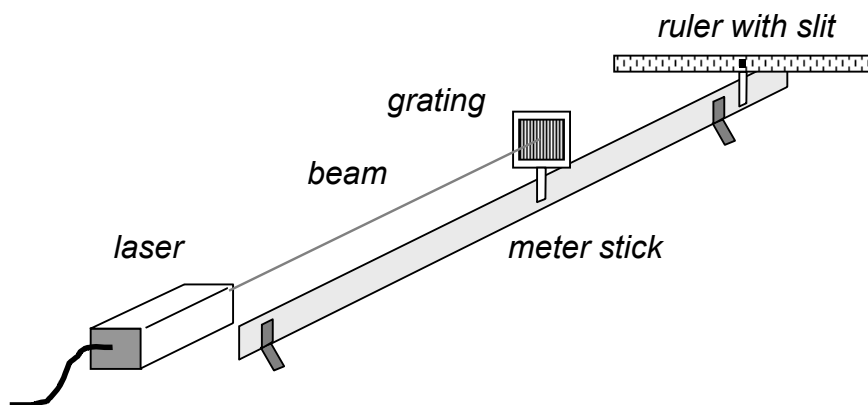
To verify the condition for interference maximum due to a diffraction grating ("the grating equation"):  $d \sin \theta = n\lambda$ ,  $n = 0, 1, 2, 3, \dots$

### EQUIPMENT

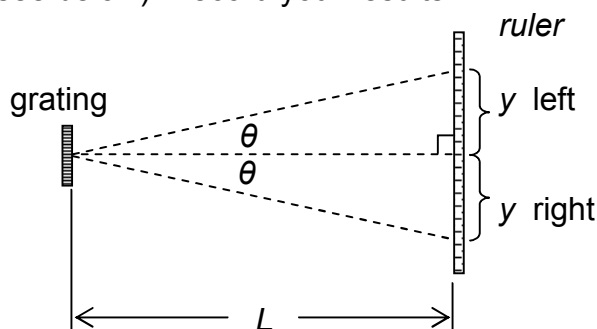
Diffraction grating with holder, ruler with slit at center, He-Ne laser, helium light source, light bulb with holder, meter stick, meter stick holders.

### SET-UP AND PROCEDURE

#### PART I – Determining the Grating Spacing $d$



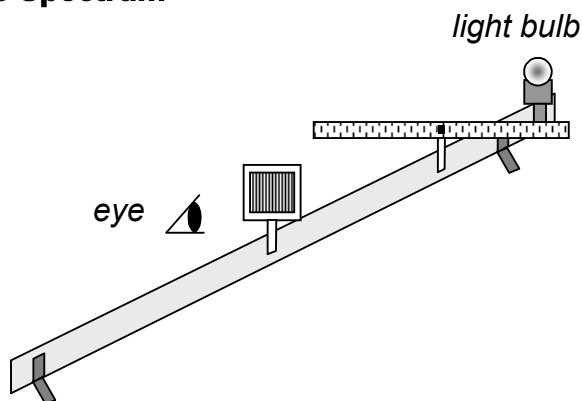
- 1) Assemble your apparatus as shown in the above diagram. Adjust the laser until its beam creates a central maximum (red dot) on the slit in the ruler. You should see at least three additional maxima to each side of the slit. Make sure that all of the red dots fall along the ruler. If not, adjust either the ruler or the position of the grating to suit.
- 2) Record the wavelength of the laser on your data sheet – it's written on the laser. Measure the distance  $L$  between the grating and the ruler and record it as well.
- 3) Measure the distance  $y$  from the slit to the first-order maximum on each side. Find the average  $y$  then use it and some trigonometry to calculate the angle  $\theta$  (see below). Record your results.



- 4) Repeat Step 3 for the second and third-order maxima.

- 5) Use the grating equation to calculate  $d$  for each maximum then find the average. Calculate the percent error. Record your results.

## PART II – The Visible Spectrum



- 1) Mount the light bulb holder at the edge of the meter stick just behind the ruler. If necessary, adjust the distance between the grating and the ruler so that at least two orders of the spectrum are visible, that is, *two rainbows to each side of the central rainbow are seen just above the ruler*. Don't forget to measure  $L$  again if you change this distance!
- 2) Measure the distance  $y_1$  from the slit to the first-order red line and the first-order violet line on each side. Find the average  $y_1$  for red and for violet then use these averages to calculate their respective angles  $\theta_1$ . Record your results.
- 3) Repeat Step 2 for the second-order red and violet lines.
- 4) Use the grating equation to calculate  $\lambda$  for first and second-order red and violet then find their averages. Calculate the percent errors. Record your results.

## PART III – The Helium Spectrum

- 1) Remove the light bulb holder and slide the ruler to the very end of the meter stick. Place the helium light source behind the slit and turn it on.
- 2) DO NOT TOUCH THE METAL TUBE HOLDERS WHILE THE LIGHT SOURCE IS ON! HANDLE WITH CAUTION – HIGH VOLTAGE.
- 3) Center the narrow section of the tube so that it shines brightly through the slit. If necessary, adjust the distance between the grating and the ruler so that at least two orders of the spectrum are visible. Don't forget to measure  $L$  again if you change this distance!
- 4) Do Steps 2–4 in Part II above for at least four different colors.

Accepted values of wavelengths:

|             |               |               |              |
|-------------|---------------|---------------|--------------|
| Red 650 nm  | Orange 590 nm | Yellow 570 nm | Green 510 nm |
| Blue 475 nm | Indigo 445 nm | Violet 400 nm |              |

### ASSIGNMENT:

Each group is required to submit a completed data sheet due by the end of the lab period.

Name \_\_\_\_\_ Date \_\_\_\_\_

Partners \_\_\_\_\_

**DIFFRACTION GRATING****PART I – Determining the Grating Spacing  $d$** Grating-ruler distance  $L =$  \_\_\_\_\_ mWavelength of laser  $\lambda =$  \_\_\_\_\_ m

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $d$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------|
| 1 <sup>st</sup> Order |              |               |             |                |         |
| 2 <sup>nd</sup> Order |              |               |             |                |         |
| 3 <sup>rd</sup> Order |              |               |             |                |         |

Average  $d =$  \_\_\_\_\_ m      % error = \_\_\_\_\_Accepted value of  $d = 3.00 \times 10^{-6}$  m**PART II – The Visible Spectrum**Grating-ruler distance  $L =$  \_\_\_\_\_ m

Red Line:

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $\lambda$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------------|
| 1 <sup>st</sup> Order |              |               |             |                |               |
| 2 <sup>nd</sup> Order |              |               |             |                |               |

Wavelength of red  $\lambda =$  \_\_\_\_\_ m      % error = \_\_\_\_\_

Violet Line:

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $\lambda$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------------|
| 1 <sup>st</sup> Order |              |               |             |                |               |
| 2 <sup>nd</sup> Order |              |               |             |                |               |

Wavelength of red  $\lambda =$  \_\_\_\_\_ m      % error = \_\_\_\_\_

**PART III – The Helium Spectrum**Grating-ruler distance  $L =$  \_\_\_\_\_ m

COLOR: \_\_\_\_\_

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $\lambda$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------------|
| 1 <sup>st</sup> Order |              |               |             |                |               |
| 2 <sup>nd</sup> Order |              |               |             |                |               |

Wavelength  $\lambda =$  \_\_\_\_\_ m      % error = \_\_\_\_\_

COLOR: \_\_\_\_\_

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $\lambda$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------------|
| 1 <sup>st</sup> Order |              |               |             |                |               |
| 2 <sup>nd</sup> Order |              |               |             |                |               |

Wavelength  $\lambda =$  \_\_\_\_\_ m      % error = \_\_\_\_\_

COLOR: \_\_\_\_\_

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $\lambda$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------------|
| 1 <sup>st</sup> Order |              |               |             |                |               |
| 2 <sup>nd</sup> Order |              |               |             |                |               |

Wavelength  $\lambda =$  \_\_\_\_\_ m      % error = \_\_\_\_\_

COLOR: \_\_\_\_\_

|                       | $y$ left [m] | $y$ right [m] | $y$ average | $\theta$ [deg] | $\lambda$ [m] |
|-----------------------|--------------|---------------|-------------|----------------|---------------|
| 1 <sup>st</sup> Order |              |               |             |                |               |
| 2 <sup>nd</sup> Order |              |               |             |                |               |

Wavelength  $\lambda =$  \_\_\_\_\_ m      % error = \_\_\_\_\_