EXPERIMENT 1

PURPOSE

To find the relationship between band gap energy and composition using LEDs that utilize the GaP_xAs_{1-x} ($0 \leq x \leq 1$) series of solid solutions.

PROCEDURE

1. Set up the apparatus as shown in Figure 1 below.

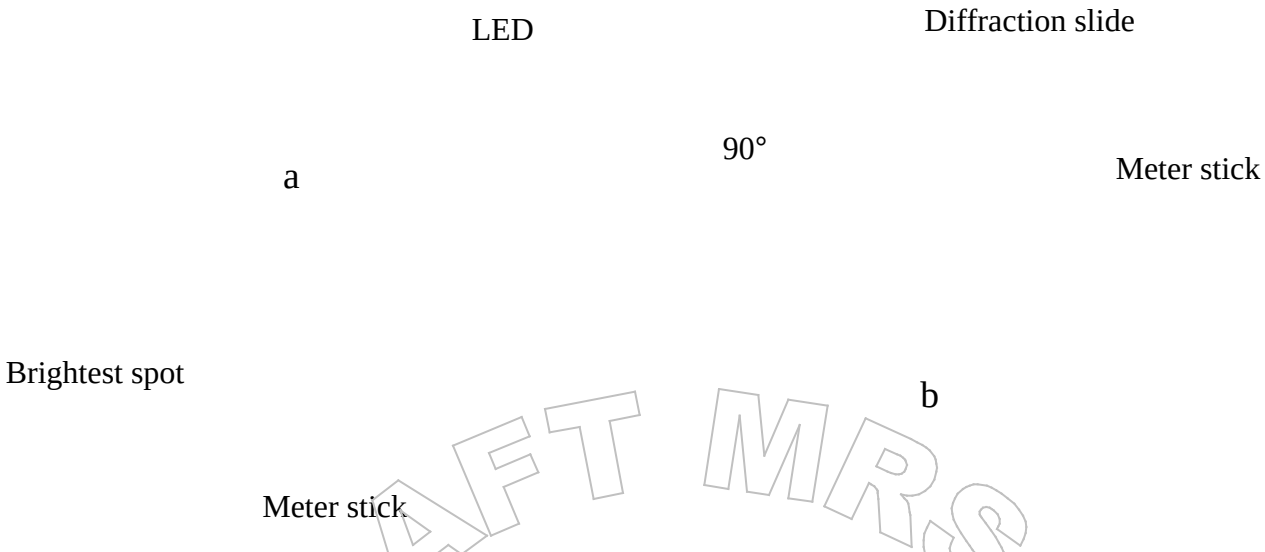

Figure 1.

2. One lab partner will position the LED directly behind the intersection of the two perpendicular meter sticks so that it is clearly visible to the other partner positioned at the end of the meter stick, directly opposite the LED. Once the team is ready, connect the LED to the battery and wait for the room lights to be turned off.

3. The partner with the diffraction grating will view the emission spectrum. The other partner will move a pencil slowly along the meter stick at the LED end of the apparatus away from the LED. The student viewing the spectrum should indicate when the pencil is at the brightest point of the spectrum on either side of the LED. At that point, measure the distance in cm from the LED to the brightest point and record as distance (X) in Data Table 1.

4. Repeat Step 3 for the other LEDs.

5. Disconnect all LEDs when you are finished.

Data Table 1

LED	COLOR	a (cm)	b (cm)	(x)
1	RED		100	0.40
2	ORANGE		100	0.65
3	YELLOW		100	0.85
4	GREEN		100	1.00

CALCULATIONS

Calculate the following and record in Data Table 2.

1. Find the distance (z) from the diffraction grating to the bright image in the spectrum for each LED. $\mathbf{c = \sqrt{(a^2 + b^2)}}$

2. Find the sine of angle θ for each LED. $\mathbf{\sin \theta = a/c.}$

3. Find the wavelength (λ) in cm: $\lambda = \mathbf{d} \sin \theta$ where d is the distance between the lines on the diffraction grating. (Ask your instructor for this value).

4. Using the relationship between wavelength and energy, find the energy E_g that corresponds to the wavelength for each LED.

Data Table 2

COLOR	c(cm)	SIN θ	λ (cm)	E_g (eV)
RED				
ORANGE				
YELLOW				
GREEN				

ANALYSIS

From the data in Tables 1 and 2 make a graph of E_g vs. x.

FOLLOW-UP QUESTIONS

1. What is the relationship between the band-gap energy and x in this GaP_xAs_{1-x} ($0 \leq x \leq 1$) series of LEDs?

2. The distance between the nuclei is one factor that determines how strongly an electron is held between covalently bonded atoms. As the size of the nuclei increase, the band gap energies decrease. Considering only size, would the LED made of GaP or GaAs be redder in color?