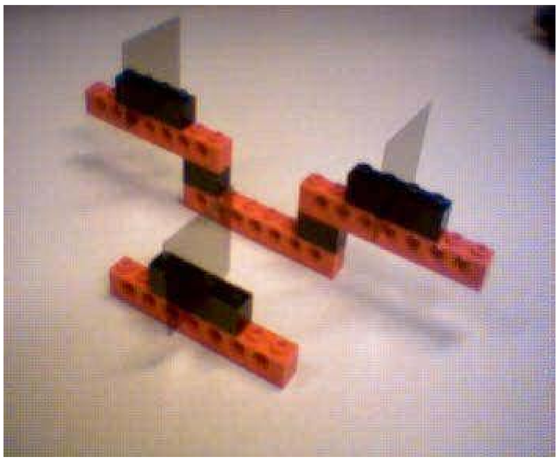
Group names:

LAB: LASER Beam Divergence, Etendue, and Polarizers

Part I: Exercises with Polarizers

You will be given three linear polarizers. Build a LEGO holder similar to what is shown in the images below.



Place one of the polarizers between your eyes and a light source, such as the sun or room lights or a flash light. What happens when you place the polarizer in front of your eyes? Why? What happens when you rotate the polarizer?

Place a second polarizer between your eyes and the light source. What happens as you rotate the second polarizer with respect to the first? Why?

Place the two polarizers so that you get **maximum** light through. Insert the third polarizer in the middle of the two polarizers. What happens as you rotate the middle polarizer? Why?

Place the two polarizers so that you get **minimum** light through. Insert the third polarizer in the middle of the two polarizers. What happens as you rotate the middle polarizer? Why?

Now repeat the steps using your diode laser as a source, and place a piece of paper on the other side of the polarizer to see how much light comes through. How is this different from the room light measurements?

Part II: Beam Divergence

Shine the laser to a spot on a white paper that is a known distance away from the laser (about 3 meters away). Measure the size of the spot that the laser forms at its exit and at the paper screen.

Size of spot at laser exit hole: __________mm (wide) __________mm (tall)

Size of spot at paper screen: __________mm (wide) __________mm (tall)

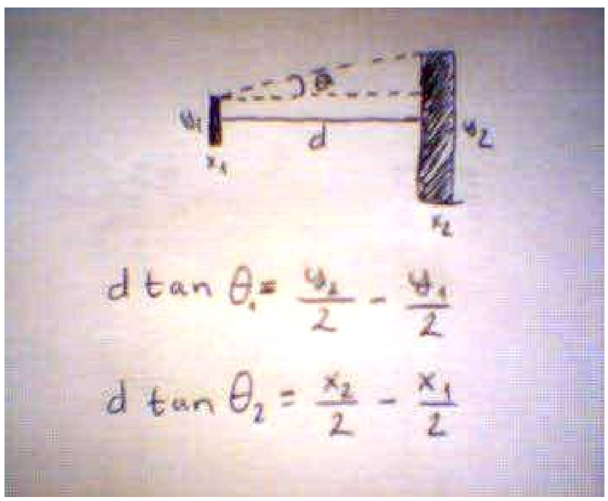
Distance between paper screen and laser: **d =** __________cm

Use the following relation and space below to calculate the divergence Θ of the beam in the height $\mathbf{\Theta_1}$ and width $\mathbf{\Theta_2}$ directions:

R = d tan(Θ)

Where:

R = distance the beam diverges from its initial size ($y_2/2 - y_1/2$) and ($x_2/2 - x_1/2$)
d = the distance between the laser and the spot
Θ = divergence



Height (y) divergence $\mathbf{\Theta_1}$ of you laser is: ________ degrees

Width (x) divergence $\mathbf{\Theta_2}$ of you laser is: ________ degrees

Theoretical divergence should be $\Theta = \lambda/D$, where D is the diameter of the beam as it emerges from the laser. What are the theoretical estimates for your Θ_1 and Θ_2? How close are your experimental values to your theoretical values?

Part III: Focusing Spot Size

In your book, the following equation indicates the smallest possible diameter of a spot that a lens can create for monochromatic laser light:

$$S = (f \lambda) / D$$

Where **S** = spot diameter
f = focal length of the lens
λ = wavelength of source light
D = diameter of the lens

I think there is a factor of two missing. So that,
$$S = 2*(f \lambda) / D$$

However, the diameter of the lens in this experiment (because you are not filling the lens with your beam) will be the diameter of your laser beam at the lens.

D = diameter of the laser beam at the lens

Measure the sizes of the spot created by shining a laser through the f=50mm convex lens:

D = Diameter of laser beam at the lens = ____________mm

Measured size spot for f=50mm lens = ___________mm

Measure the sizes of the spot created by shining a laser through the f=17cm convex lens:

D = Diameter of laser beam at the lens = ____________mm

Measured size spot for f=17cm lens = ____________mm

Use the spot size equation above to calculate the smallest spot diameters that the two convex lenses f=50mm and f=17cm can form. How do your measurements compare with the theoretical calculations?

Size spot for f=50mm lens = __________mm

Size spot for f=17cm lens = ___________mm