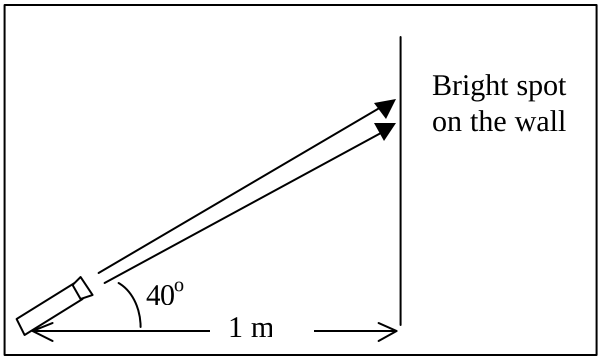
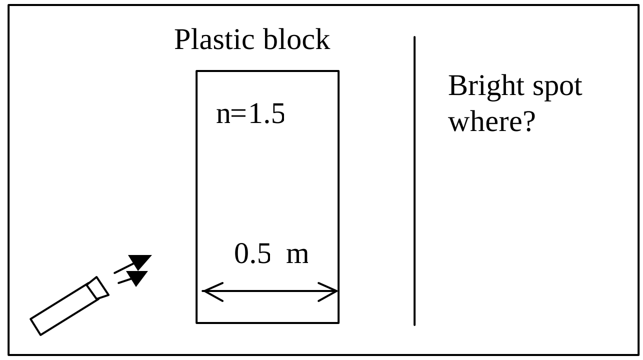
Physics 122, sections 502-4 and 8101 **Assignment 10**
Laura Lising **Due May 1 , start of class**

1) Revisiting the last question from the problem set before. Suppose you have a flashlight or a laser and you hold it at some angle and shine it on the wall, observing a bright spot at some height.

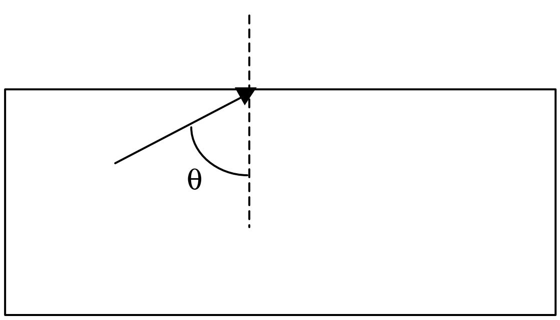




a) Suppose you know put a clear plastic block between the flashlight and the wall. You should have found that the bright spot was lower. How much lower is it? Tell me the original and final heights of the bright spots. I've given you the distances, indices of refraction, and angles you need (assume n of air is 1.) I haven't given you the exact location of the block from the wall because you don't need to know it. (Can you figure out why?)

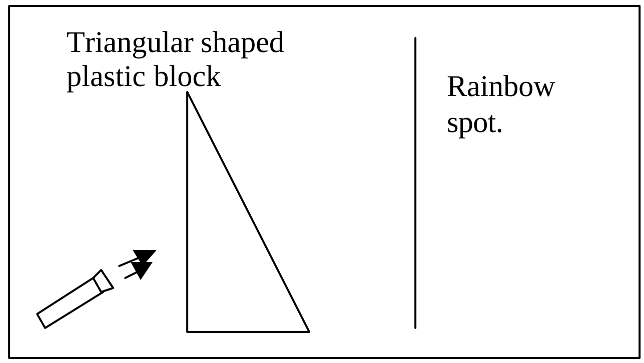
2) Suppose you have a ray of light traveling inside a plastic block with index of refraction 1. 5 (assume air has n=1.) The ray of light will bend at the surface.

a) If q is 30 degrees what direction will the reflected and refracted light rays go? Calculate the angles and draw the rays.
b) b) If q is 40 degrees, what direction will the reflected and refracted light rays go? Calculate the angles and draw the rays.
c) If q is 60 degrees, what direction will the reflected and refracted light rays go? Calculate the angles and draw the rays. If you got a funny result, how might you interpret this?



c) It turns out that any time you can't actually solve the equation for Snell's Law, it means that there is no refracted light - all the light gets reflected internally. This is called total internal reflection. Think of at least one application for this and describe how it might work.

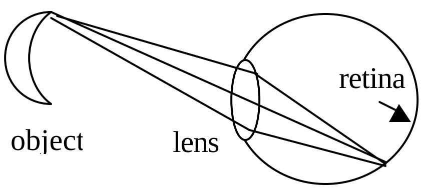
3) Think again about the triangular shaped plastic block in between the flashlight and the wall. If you tried this at home, what you would see is a bright spot much lower than with out the block, but instead of being a white spot, if your flashlight beam is very narrow you may actually get a rainbow spot. A triangle shaped block is also called a "prism."



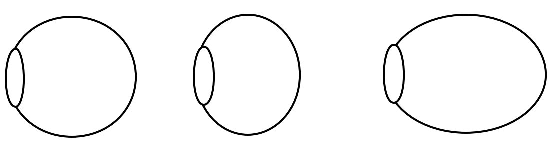
a) If I told you that most things actually have a different index of refraction for different colors, would this explain what you see? How?
b) If I told you that the index of refraction was higher for red than for blue, is the red on top of the rainbow spot on the wall or at the lower point?

4) In your eye, you have a converging lens that focused the light from objects onto your retina. (Actually you have two lenses, your cornea and the lens inside. Both are converging and work together.)

a) The lens inside is made up of flexible material that allows it to be stretched by muscles around it, effectively changing it's shape. The muscles can make it flatter, for instance. Why is this necessary?

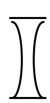


b) People with poor vision actually have eyeballs that are a little too long or too short.



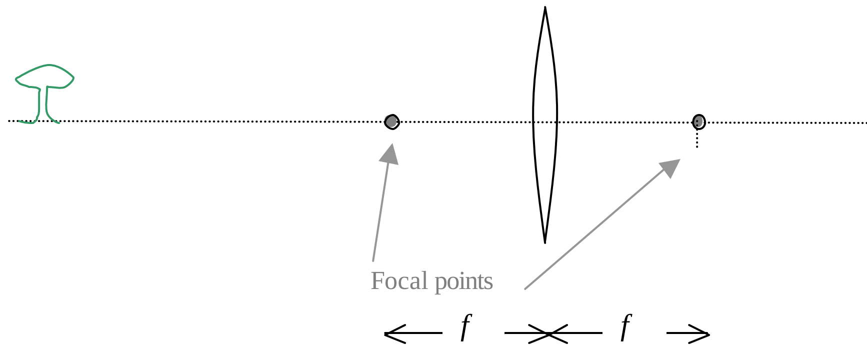
Good vision Poorer vision

Explain why this makes the vision blurry without glasses.

c) Eyeglasses are made of either diverging () or converging () lenses. Which do you need for which type of vision problem? Does the diverging lens go with the shorter eyeball or the longer one, and which does the converging lens go with, or is there a single lens that works for both and which is it?

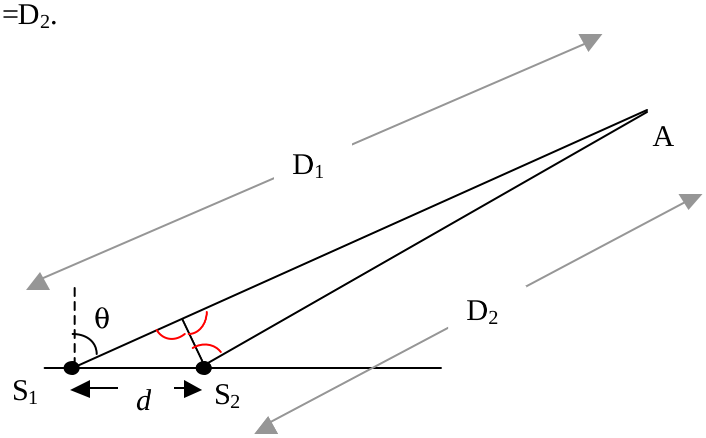
5) You have a tree and a thin converging lens with focal points as shown.

a) Find the image location for the tree. Is the image real or virtual? Is it magnified or reduced?



b) The distance from the lens to the focal points is called the focal length, f. Call the distance from the object (the tree) to the lens d_o, and the distance from the lens to the image d_i. Come up with a formula for the relationship between the image distance and object distances.

6) Consider a point A very far away from two sources of waves (both in-phase with wavelength λ, like two sources in the ripple tank) separated by a distance d. The distance from one source (S_1) to the point A is D_1 and from S_2 to A is the distance D_2. To figure out whether the two waves will interfere constructively or destructively at point A, we need to know the difference in the two distances $\Delta D = D_1 = D_2$.



a) Three angles are shown in the drawing (in red), but not labeled. (A fourth angle is labeled θ.) If the point A is very far away from the sources, these three angles all become right angles. In this limit, find an expression for ΔD in terms of the angle θ and the source separation d. (Hint look at the triangle that's a right triangle with hypotenuse d. One of the angles in that triangle is θ. Which one?)

b) For what values of ΔD (in terms of λ) will there be maximum constructive interference? Complete destructive interference?