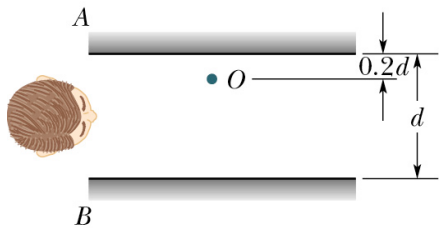
Read Unit O – chapters 1-5, and review lab manual chapters 6-7. You may work in groups and turn in one assignment per group, but no more than 3 people per group. Due via e-mail Friday, October 21st at 2:00 pm. Also due – corrections to lab #1.

Questions:

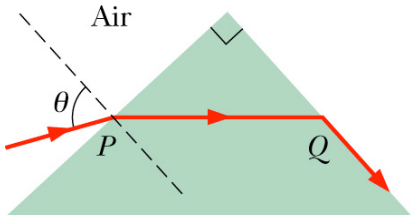
1. O1 #3
2. In the figure at right, you look into a system of two vertical parallel mirrors *A* and *B* separated by distance *d*. A grinning gargoyle is perched at point *O*, a distance 0.2*d* from mirror *A*. Each mirror produces a *first* (least deep) image of the gargoyle. Then each mirror produces a *second* image with the object for that image being the first image in the opposite mirror. Then, each mirror produces a *third* image with the object for that image being the second image in the opposite mirror, and so on – you might see hundreds of grinning gargoyle images. How deep behind mirror *A* are the first, second, and third images in mirror *A*?



3. You produce an image of the Sun on a screen, using a thin lens with focal length 20.0 cm. What is the diameter of the image?
4. An illuminated slide is held 44 cm from a screen. How far from the slide must a lens of focal length 11 cm be placed to form an image of the slide's picture on the screen?
5. O5 #3

Problems:

1. In the figure below, light enters a 90° triangular prism at point *P* with incident angle θ and then some of it refracts at point *Q* with an angle of refraction of 90°. Hints: There are 2 refractions here, so you should have 2 equations. There is a nice geometric relationship between the angle of refraction on the left and the angle of incidence on the right. You can get rid of a sine and cosine by squaring and adding them.



   a. What is the index of refraction of the prism in terms of θ?
   b. What, numerically, is the maximum value that the index of refraction can have?
   c. Explain what happens to the light at *Q* if the incident angle at *Q* is increased slightly.
   d. Explain what happens to the light at *Q* if the incident angle at *Q* is decreased slightly.
2. A luminous point is moving at speed v_0 toward a spherical mirror with radius of curvature *r*, along the central axis of the mirror. Assume that the mirror is concave, with $r = 15$ cm, and let $v_0 = 5.0$ cm/s.
   a. Show that the image of this point is moving at speed $v_1 = -\frac{r^2}{(2p-r)^2} v_0$, where *p* is the distance of the luminous point from the mirror at any given time.
   b. Find the speed of the image when $p = 30$ cm (far outside the focal point).
   c. Find the speed of the image when $p = 8.0$ cm (very near the mirror).

3. (17 from lab 1) Parallel light from a distant object strikes a large, concave, spherical mirror with radius 5 m and is reflected by a small mirror that is 2 m from the large mirror (measured along the axis of the spherical mirror). The small mirror is also spherical. The light is focused on the vertex of the large mirror.
    a. What is the radius of curvature of the small mirror?
    b. Is it convex or concave?
4. A lens is made of glass having an index of refraction of 1.5. One side of the lens is flat, and the other is convex with a radius of curvature of -20 cm. Use the lens maker's equation $1/f = (n\text{-}1)(1/r_1\text{-}1/r_2)$ to:
    a. Find the focal length of the lens.
    b. If an object is placed 40 cm in front of the lens, where will the image be located?
5. Reproduce the following and fill it in. Note: if there is no sign, does not indicate positive.

	Lens Type	*f*	*S'*	*S*	*M*	Real image?	Inverted image?
A		+10		+20			
B		+10		+5			
C		10		+5	>1		
D		10		+5	<1		
E		30		+10			
F		-30		+10			
G		-120		+10			
H				+10	0.5		No
I				+10	-0.5		

6. Two converging lenses, each of focal length 10 cm, are separated by 35 cm. An object is 20 cm to the left of the first lens.
    a. Find the position of the final image using both a ray diagram and the thin-lens equation.
    b. Is the image real or virtual? Erect or inverted?
    c. What is the overall lateral magnification of the image?
7. An object is 15 cm in front of a positive lens of focal length 15 cm. A second positive lens of focal length 15 cm is 20 cm from the first lens. What is the location of the final image?