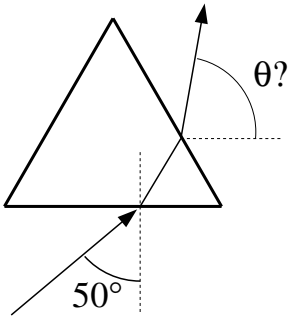
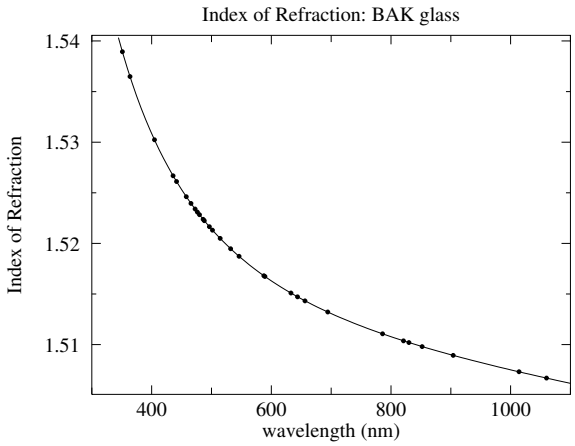
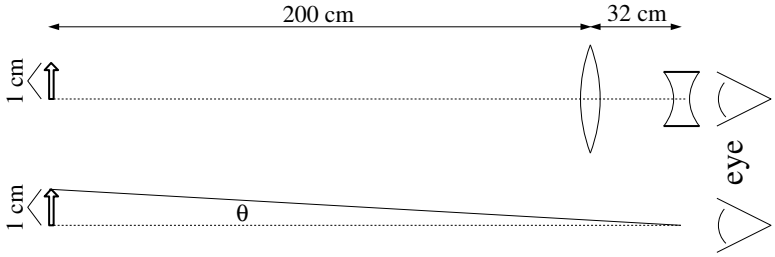
Answer **four** of the following five problems
'extra' answered problems will not contribute to your grade

1. As shown in the following diagram, light is incident at an angle of 50° on a equilateral (all angles 60°) prism made of BAK glass. The light is a mixture of wavelengths between 400 nm and 800 nm. The index of refraction of BAK glass as a function of wavelength is plotted below. Find the exit angle θ for 400 nm light. Do note that the exit angle θ is defined relative to the horizontal not the normal. (Retain 4 significant digits for this problem.) Would the exit angle for 800 nm light be more or less than you calculated for 400 nm light? Explain why briefly in words. Report the color of the 400 nm light and the color of the 800 nm light.





2. A 1 cm high object is 200 cm to the left of a converging lens with focal length 30 cm. A diverging lens with focal length −3 cm is 32 cm to the right of the converging lens. Where is the image? What is the magnification? Is the image virtual? Upright? As viewed by an unaided eye 232 cm from the object (i.e., the same distance as an eye next to the diverging lens), what angle would the object subtend? What angle does the image subtend as viewed through the lenses?

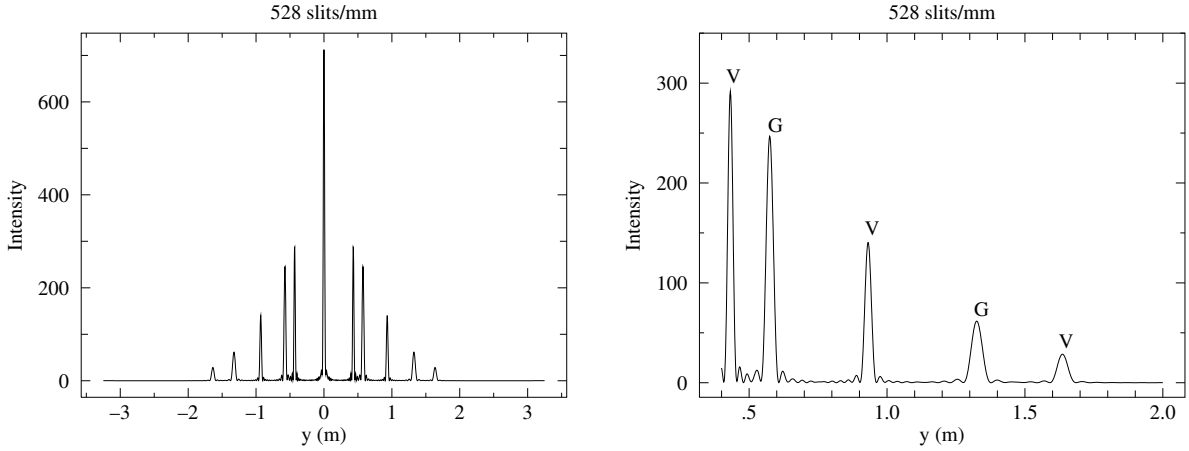


3. Consider normally incident light *exiting* glass coated for anti-reflection. Assume that the coating has an index of refraction intermediate between that of glass and air.

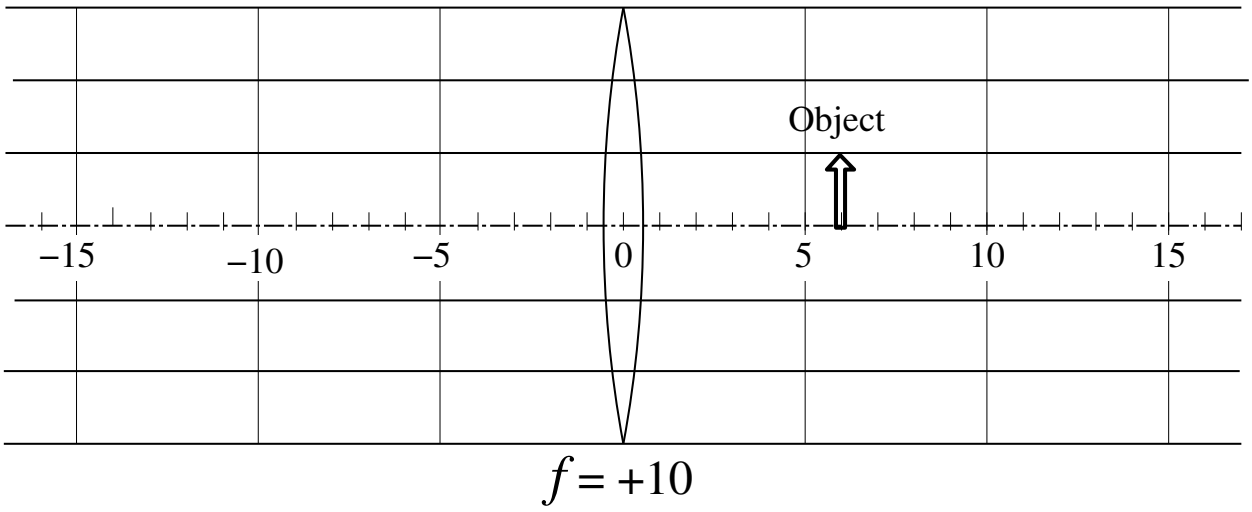
   (a) As the light leaves the glass (i.e., at the glass-coating interface), is the reflected light in phase with the light incident on the glass-coating interface? As the light leaves the coating (i.e., at the coating-air interface), is the reflected light in phase with the light incident on the coating-air interface?

   (b) If the glass-coating reflected light and the coating-air reflected light are to destructively interfere, write down the equation that reports how thick the coating should be. (Make sure you fully define any symbols you use in your equation.)

4. A beam of light, consisting of a mixture of two wavelengths (violet and green), is normally incident on a diffraction grating with 528 slits/mm. The light intensity on a screen $R = 2$ m from the slit is plotted below: the left plot shows both sides of the pattern; the right expands the $y > 0$ side of the left plot. (A) Calculate the two wavelengths of light. Directly on the below right plot, label each peak with its corresponding order m. (B) Notice on the below right plot that for $y > 0$ there are 5 big peaks: the peaks labeled V are violet colored and the peaks labeled G are green colored. Apparently the green partner of the rightmost V peaks is missing. Where should this partner have been? (C) Assuming that the missing peak has fallen on the zero of the single slit diffraction pattern, estimate the value of the slit width a.



5. An object sits 6 units from a $f = +10$ unit lens. Calculate the location and magnification of the image. Directly on the below diagram, accurately draw (using a ruler) the three principal rays and use those rays to locate the image. Draw the image at the proper location/size. Circle one of each: Is the image Real or Virtual? Upright or Inverted? Draw an eye located/oriented so that it could see the image. Compare the ray-based image size and location to your calculated values.



Physical Constants:
speed of light = $c = 2.9979 \times 10^8$ m/s
permittivity = $\varepsilon_0 = 8.8542 \times 10^{-12}$ C^2/(N $\cdot$ m^2)
permeability = $\mu_0 = 4\pi \times 10^{-7}$ T $\cdot$ m/A $= 1.2566 \times 10^{-6}$ N/A^2