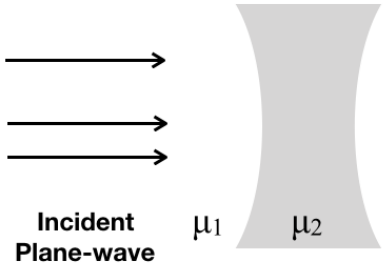
ASTR469: Homework #4.

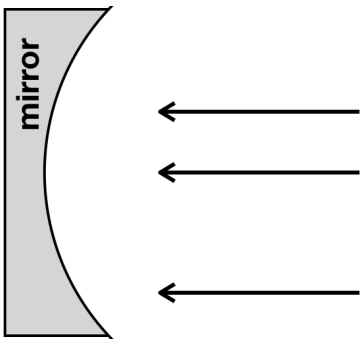
Due Feb. 10 at beginning of class.

1. (a-c, 1 pt each) Using the principles of refraction and reflection, draw a rough ray diagram for the following components of telescopes. What happens to the light within the component (in the case of the lens, at least) and then after it is passes through? Be at least conceptually precise (there is no need to use a protractor), and explain what should happen if you think your diagram is not clear. Assume all light is composed of plane waves.

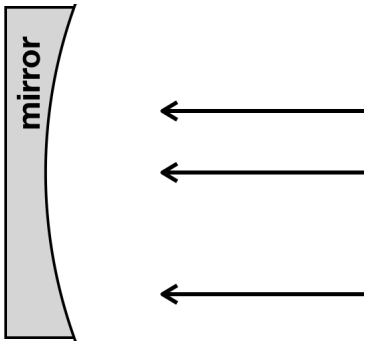
   (a)



   (b)



   (c)



   (d) (2 pt) Approximate the f-number of the mirrors in (b) and (c).

   (e) (2 pt) Assume a lens of 24-inch diameter with the same f-number as (c)'s mirror is used in conjunction with an eyepiece to allow people to view the sky. If you

wanted to achieve a magnification of 50x, what focal length would be required for your eyepiece? Express your answer in millimeters.

2. **a)** (3 pt) By what fraction does the number of photons received per second from a 10th magnitude star differ compared to that of a 9th magnitude star?
   b) (4 pt) Assume you have two different telescopes, each observing one of the two previous stars. To collect the same number of photons from each star per second, which star should the larger telescope be observing? How many times larger must the larger telescope be? *[Note: if you didn't get (a), just assume a ratio and use that to complete this question.]*

3. (3 pt) Most of the best optical telescope designs on Earth are seeing-limited. You're picking a telescope for an observing site that has a typical seeing of $1''$. Given that you'll be doing observations in the optical band, and you want to at least reach a resolution that matches your seeing limit, what is the biggest diameter you should make your primary mirror? Choose a representative wavelength in the middle of the optical band.

4. Compute the diffraction limit in arcseconds using the Rayleigh criterion for the following telescopes (1 pt each):
   (a) Hubble (2m diameter) telescope operating at 500nm
   (b) Chandra X-ray observatory (2m diameter) observing 1keV photons
   (c) GBT (100m diameter) observing at 1.4 GHz
   (d) Arecibo (300m diameter) observing at 5 GHz
   (e) James Webb Space Telescope (6m diameter, due to launch next year) observing at 2 microns
   (f) Comment on any trends you observe.