Problem Set #4
PHY 300 Observational Astronomy
Throop / Booth

ASSIGNED: MONDAY 16-MAR-2015
DUE: MONDAY 23-MAR-2015, BEGINNING OF CLASS

** BECAUSE OF THE UPCOMING QUARTER TEST ON 25-MAR, I WILL POST THE SOLUTION SET IMMEDIATELY AFTER CLASS ON THE DUE DATE. THEREFORE, NO LATE ASSIGNMENTS CAN BE ACCEPTED.

1. **Telescope lengths**. You have a Galilean telescope with a 20-cm diameter primary and focal ratio f/10.

    a) Roughly how long is the telescope tube? You can ignore the eyepiece, which will add a few cm.

    b) Same problem as above, but for a Newtonian telescope?

    c) Same as above, but for a Cassegrain telescope?

    d) What is the magnification in each one? You can assume you have the same eyepiece on each telescope (a 5-mm eyepiece). What happens if you then switch to a 15-mm eyepiece?

    e) Roughly speaking, how does the brightness (that you see through the 5mm eyepiece) of each of these compare to each other?

2. **Eyepieces**. Why does a telescope need an eyepiece, while a magnifying glass does not? A diagram might be helpful to explain.

3. **Mirror Designs**. What are the pros and cons of parabolic vs. spherical optics?

4. **Minister of Telescopes**. You are the science minister for the Republic of Slobovia, a little-known province outside of Malawi. Your country has asked you to lead the way to develop a new observatory to put Slobovia at the forefront of modern astronomy. The president asks you to design a telescope that meets the following criteria:

Wavelength:	100 nm - 1 micron
Resolving power:	Able to resolve a solar system to a resolution of 1 AU, for a system 500 ly from the Sun.
Sky Visible:	Able to images targets through the entire sky (northern and southern hemispheres).
Purpose:	General purpose optical astronomy (some wide-angle, some narrow-angle studies).

    a) Describe the telescope that you propose she fund. Be sure to describe the diameter, the basic optical design and the rough focal ratio, and the location on Earth where it should be built. (You can ignore atmospheric effects — that is, assume that the telescope will resolve down to the diffraction limit.)

    b) Telescope construction cost scales roughly with the cube of the telescope diameter. Assuming it cost R1000 million to build the 10-meter Keck telescope, how much should you request for your telescope?

c) The minister comes back to you and says that she has located a 3-meter hyperbolic-surface mirror high in the mountains made by previous residents and abandoned. Is this of interest to you for use in this telescope? Why or why not?

5. **Observational Organization**. You are observing with your new telescope in Pretoria (lat 25 deg S). The local time is midnight, and the sun will rise at 6h00 local time. You look at your sidereal clock, and it says 03h15.

   You'd like to observe each of the following objects.

Jupiter	RA 03h15, Dec -20°
Constellation Cassiopeia	RA 5h, Dec +62°
The Carina nebula.	RA 11h, Dec -60°
Moon	RA 23h, Dec 0°

   For each of these, is it possible to observe tonight? If so, when should you do it? And where in the sky should you look? You don't need to be precise: "Look toward the north now" or "Look close to the zenith in two hours" is fine. If it's not possible to see, say why.

   ** The best time to observe something is typically when it is crossing the meridian, but for some of these that might not be possible due to the sun rising.

6. **Parallax Perspective**. You are observing your favorite distant star. You notice that its position changes slightly throughout the year, and you measure the amount of this shift as 0.1 arcseconds (0.1"). You assume (correctly) that this shift is due to parallax from the Earth's motion. How far away is your star?