Astronomy C2002: Problem Set 1

1. Show that if two lenses of focal lengths $f_1$ and $f_2$ can be considered to have zero physical separation, then the effective focal length of the combination of lenses is:

$$\frac{1}{f_{\text{eff}}} = \frac{1}{f_1} + \frac{1}{f_2}.$$  

[CO problem 6.4]

2. (a) Using the Rayleigh criterion, estimate the angular resolution limit of the human eye at 550 nm. Assume that the diameter of the pupil is 5 mm.

   (b) Compare your answer in part (a) to the angular diameters of the Moon and Jupiter (see the Appendix of your textbook for these values).

   (c) What can you conclude about the ability to resolve the moon’s disk and Jupiter’s disk with the unaided eye?

[CO problem 6.7]

3. Prove that the minimum separation between an object (on the left) of a thin lens with positive focal length $f$ and it’s real image (on the right) is $4f$.

4. A refracting telescope with a thin, convex lens generates an inverted (i.e. upside-down) image. This doesn’t bother us in astronomy. What about a mirror – does it also generate an inverted image? Answer this using a ray-diagram (try to use the three principle rays discussed in class).

NOTE: Solutions should be written clearly with a concise description of the calculation and an explanation of the steps taken (this makes it easier to award partial credit) If you use reference books or websites, please cite them where appropriate. Discussing the problems in groups is fine, but the final solution should be yours and yours alone.