Observational Astronomy

Problems: Set 3

1. What is the expected value of the Fried parameter at a wavelength of 5500 Å if the observed seeing is 0.6 arcsec? What is the corresponding value of r_0 at 1.6 microns in the infrared assuming Kolmogorov turbulence?

2. Which has a greater energy flux, 10 photons cm^{-2} s^{-1} at 10 Å or 10^5 photons cm^{-2} s^{-1} at 5000 Å?

3. It is often claimed that stellar magnitude errors can be taken as fractional errors of photometric accuracy. For example, if V=15.25±0.05 then one can claim that the photometric accuracy is ~5%.
   B=12.52±0.08 → ~8%
   R=19.3 ±0.1 → ~10%
   Although this is not quite correct but close to it. Prove it.

4. A star has a measured I-band magnitude of 22.0. How many photons per second are detected from **this star** by the William Herschel Telescope on La Palma (4.2 m diameter), assuming that the telescope and imaging optics have a throughput of 60%, the detector has a quantum efficiency of 80%, the sky has a brightness of 20 magnitudes per square arcsec, and the seeing is 1 arcsec .
   You can use the following information, for Vega, which has an I-band magnitude of m_I = 0.0:

Filter	λ_{eff} (Å)	$\Delta\lambda$(Å)	F (erg s^{-1} cm^{-2} $Å^{-1}$)
I	7980	1500	1.13×10^{-9}

   Estimate the exposure time required to detect the star at a signal-to-noise ratio of 20.

5. Calculate the flux F_λ of a star (in erg s^{-1} cm^{-2} $Å^{-1}$) having Vega magnitude R=15 and AB magnitude r=15 (λ_c = 6156 Å).

6. What fraction of the photons in the V band of a bright star would be absorbed by the atmosphere if one were to observe the star at an airmass of 2.5, and at the zenith ($X = 1$)?
   Assume that the atmospheric extinction k(λ) in the V band is 0.15 mag $airmass^{-1}$.

7. In making differential observations, explain why you should know the colors of the variable and comparison stars.