1. (4pts) Sketch the main elements of a cassegrain reflecting telescope. Be sure to label the primary and secondary mirrors. Show the path of light rays through the telescope. Mark with an 'X' where you would put a CCD chip.

![Cassegrain Telescope Diagram]

2. (2pts) How many times larger is the light gathering power of the Keck I telescope (diameter = 10 m) compared to the human eye (diameter = 0.5 cm)? Be sure you use consistent units.

\[
\frac{LG_P}{LG_E} = \frac{D_k^2}{D_e^2} = \frac{1000\text{ cm}^2}{0.5\text{ cm}^2} = 4 \times 10^6
\]

3. (3pts) The replacement of the Hubble Space Telescope (diameter = 2.3 m) will be the James Webb Space Telescope (JWST). It will have a diameter of 8 m and collect visible light. What will be its resolution, \( \alpha \), in arc sec? Will JWST be able to separate two stars 0.02 arc sec apart in the sky?

\[
\alpha = \frac{11.6}{D} = \frac{11.6}{800\text{ cm}} = 0.015\text{ arc sec}
\]

Since the 2 stars are separated by 0.02 arc sec, which is greater than 0.015 arc sec, JWST will be able to resolve the stars.

4. (2pts) Betelgeuse has a surface temperature of about 3,000 K and Rigel has a surface temperature of about 12,000 K. How many times greater is the energy per second per square meter put out by Rigel compared to Betelgeuse?

\[
\frac{E_R}{E_B} = \frac{\sigma T_R^4}{\sigma T_B^4} = \frac{T_R^4}{T_B^4} = \left(\frac{12,000\text{ K}}{3,000\text{ K}}\right)^4 = 256
\]