1. Given the following document recording system (not drawn with a common scale), designed to record an image of handwritten information on a small card:

Assume:
1. the light bulb is a point source radiating into 4π steradians
2. the card is a Lambertian reflector.
3. the card is far enough away from the camera to be considered at infinity and it is big enough to fill the field-of-view of the camera, i.e. the full image frame.

The camera has f/numbers of 2, 2.4, 3.5, 4, 5.6, 8, 11, 16 and 22 available. If the camera detector (film or CCD) requires at least $3 \times 10^{-5}$ W-cm$^{-2}$ to successfully record the image of the center of the card, what f/number(s) $N$ can you use? (40%)

2. Two lenses, $f_a = +8$ and $f_b = +8$, are placed 16 units apart along a common optical axis. An object, +4 units high, is placed 40 units to the left of lens a. (40%)

(a) Find the location and height of the final image formed by the two lenses, using both versions of Gauss' formula. Is the image real or virtual?

(b) Do a ray trace to confirm your answers in part (a).
3. Given an equilateral (all sides have same length) prism, illuminated by white light as follows:

The indexes of refraction of the prism are:

\[ n_{\text{red}} = 1.3 \]
\[ n_{\text{blue}} = 1.5 \]

Find the angle \( \alpha \) between the red and blue rays. (20%)