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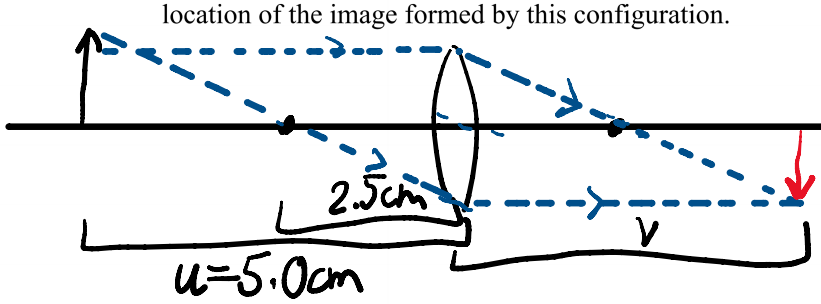
Due 9/13

Homework 1

Optics

1. An object is placed at a distance of 5.0 cm to the left (in front) of a convex lens with a focal length of 2.5 cm. Draw this system and, using the thin lens equation, determine the location of the image formed by this configuration.



$\frac{1}{v} = \frac{1}{2.5} + \frac{1}{5}$

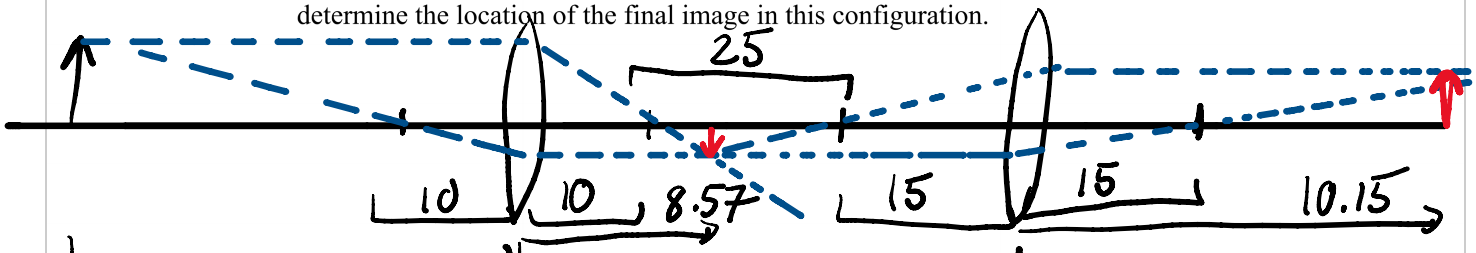
$v = \left(\frac{1}{2.5} + \frac{1}{5}\right)^{-1}$

$v = 1.67\text{cm}$

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{5} = \frac{1}{2.5}$

2. Two convex lenses, with the focal length f_1 = 10 cm and f_2 = 15 cm are placed 40 cm apart. An object is placed 60 cm in front of the first lens. Draw this optical system aand determine the location of the final image in this configuration.



$u_1 = 60\text{cm}$

$f_1 = 10\text{cm}$

$\frac{1}{v_1} = \frac{1}{10} + \frac{1}{60}$

$v_1 = 8.57\text{cm}$

40cm

$u_2 = 40 - 8.57$

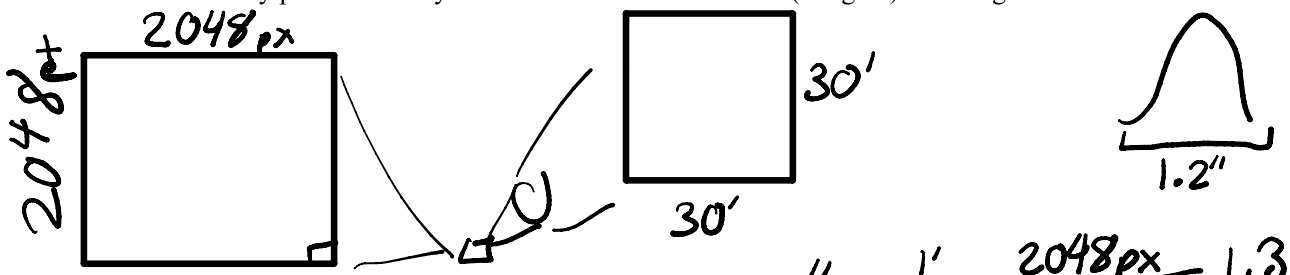
$u_2 = 31.43\text{ cm}$

$f_2 = 15\text{ cm}$

$\frac{1}{v_2} = \frac{1}{31.43} + \frac{1}{15}$

distance from lens 2
$v_2 = 10.15\text{cm}$
distance from origin
$d = 110.15\text{cm}$

3. A CCD chip with 2048x2048 pixels used with a certain telescope has a 30 arcminute by 30 arcminute field of view. What angle of the sky corresponds to 1 pixel? If the seeing (ie the Gaussian width of a point source) on a given observing night is 1.2 arcseconds, how many pixels should your radius be to extract 99.7% (3-sigma) of the light from the star?



$$\frac{30'}{2048\,px} = 0.015'/px$$

$$\frac{30'}{2048\,px} \cdot \frac{60''}{1'} = 0.878''/px$$

$$1.2'' \cdot \frac{1'}{60''} \cdot \frac{2048\,px}{30'} = 1.37\,px$$

$$1.37\,px \cdot 0.997$$

$$= \boxed{1.36\,px}$$

4. While observing at the telescope, partway through the night you notice a new speck of dust has landed on the filter wheel, and even worse it landed on a spot where your star is on the detector! What steps would you take either during the night or at the end of the night to mitigate the effect this might have on your data and subsequent analysis?

Take multiple flat fields throughout the night and then combine them later.