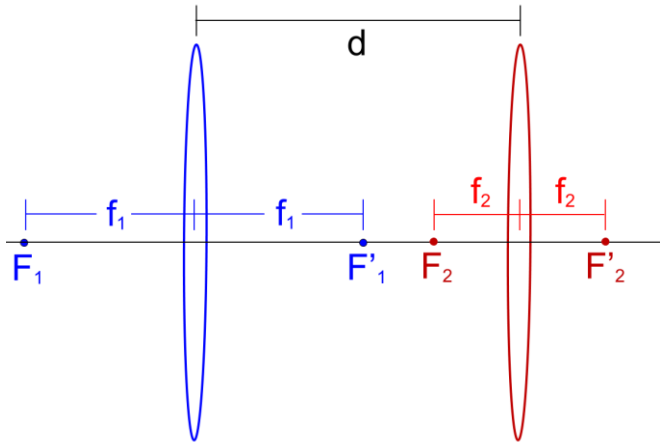
A thick lens has two places of refraction, the front surface and the rear surface. In a thin lens there are still technically two places of refraction because all lenses have two surfaces. But when we do the thin-lens approximation, we essentially replace the lens with a vertical line obeying the formula

$$\frac{1}{s_o}+\frac{1}{s_i}=\frac{1}{f}.$$

So, in this approximation, we can consider one effective refraction occurring at the location of the very thin lens. In such an approximation a two-thin-lens system has two effective places of refraction, one at each lens. Therefore, the formulas we developed in our text for thick lenses can be adapted to analyze such two-lens systems.

This assignment is pure theoretical physics all the way and all the relevant formulas and steps are found in the book. You need to adapt these formulas as you work out the steps for this assignment.



HW-F1. The Front and Back Focal Lengths. Start with

$$\frac{1}{f_1}=\frac{1}{s_{o1}}+\frac{1}{s_{i1}} \qquad \frac{1}{f_2}=\frac{1}{s_{o2}}+\frac{1}{s_{i2}} \qquad s_{o2}=d-s_{i1}$$

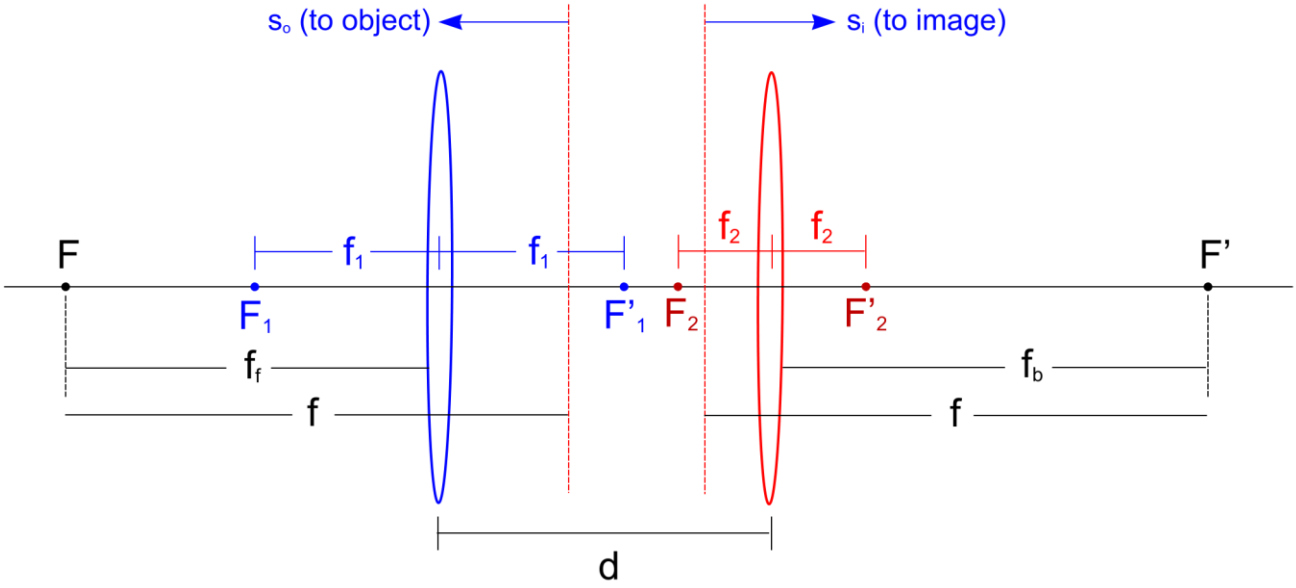
and show all steps to derive the following formulas for the front f_f and back f_b focal lengths for the above two-thin-lens system.

$$f_f=\frac{f_1(d-f_2)}{d-f_1-f_2} \qquad f_b=\frac{f_2(d-f_1)}{d-f_1-f_2}$$

How do these formulas compare to the results for a thick lens found in our text? Why?

[Grading: Start by giving the above diagram that defines the parameters. Then start with the first three above equations. Clearly show all steps and add words when necessary so that you are communicating effectively. And always work out your calculation on scrap paper first. Then transfer neatly to your homework paper to turn in.]

HW-F2. Effective Focal Length.



Start with the following formulas.

$$\frac{1}{s_o}+\frac{1}{s_i}=\frac{1}{f} \qquad M=-\frac{s_i}{s_o}$$

$$\frac{1}{s_{o1}}+\frac{1}{s_{i1}}=\frac{1}{f_1} \qquad \frac{1}{s_{o2}}+\frac{1}{s_{i2}}=\frac{1}{f_2}$$

$$M_1=-\frac{s_{i1}}{s_{o1}} \qquad M_2=-\frac{s_{i2}}{s_{o2}}$$

$$M=M_1M_2=\left[-\frac{s_{i1}}{s_{o1}}\right]\left[-\frac{s_{i2}}{s_{o2}}\right]=\frac{s_{i1}}{s_{o1}}\frac{s_{i2}}{s_{o2}} \text{ must match } M=-\frac{s_i}{s_o}.$$

First show that $s_{i1}=\dfrac{f_1 s_{o1}}{s_{o1}-f_1}$ and $s_{i2}=\dfrac{f_2 s_{o2}}{s_{o2}-f_2}$

Then proceed to show that $f=\dfrac{f_1 f_2}{f_1+f_2-d}$ and $\dfrac{1}{f}=\dfrac{1}{f_1}+\dfrac{1}{f_2}-\dfrac{d}{f_1 f_2}$.

Hint: The steps we did for the thick lens are very similar and can serve as your guide.

[Grading: Start by giving the above diagram that defines the parameters. Then start with the above equations. Clearly show all steps and add words when necessary so that you are communicating effectively. And always work out your calculation on scrap paper first. Then transfer neatly to your homework paper to turn in.]