Physics 153 Section T0H - Week 2

Multiple Lenses

Rik Blok

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1 Review

Tutorial notes, solutions and comments are online at `http://www.physics.ubc.ca/~blok/phys153/`.

I will always *try* to have Friday's tutorial notes up on the web by Friday morning so you can bring them to class.

Tutorial assignments will not be returned.

Tutorial assignments receive either a *Pass* or *Fail* grade, based on effort.

Out of the 44 students who handed in Assignment #1, only 5 failed. I judged it by requiring at least 2 ray diagrams and a reasonable argument leading to some calculation for the index of refraction n.

Correction: Last week I had a sign error in the lens-maker's equation (doh!). The correct equation is

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right). \qquad (1)$$

2 Multiple Lenses

When dealing with multiple lenses remember that the light passes from the incident side to the transmission side through one lens at a time.

As it passes through each lens it forms an image which becomes the object for the next lens.

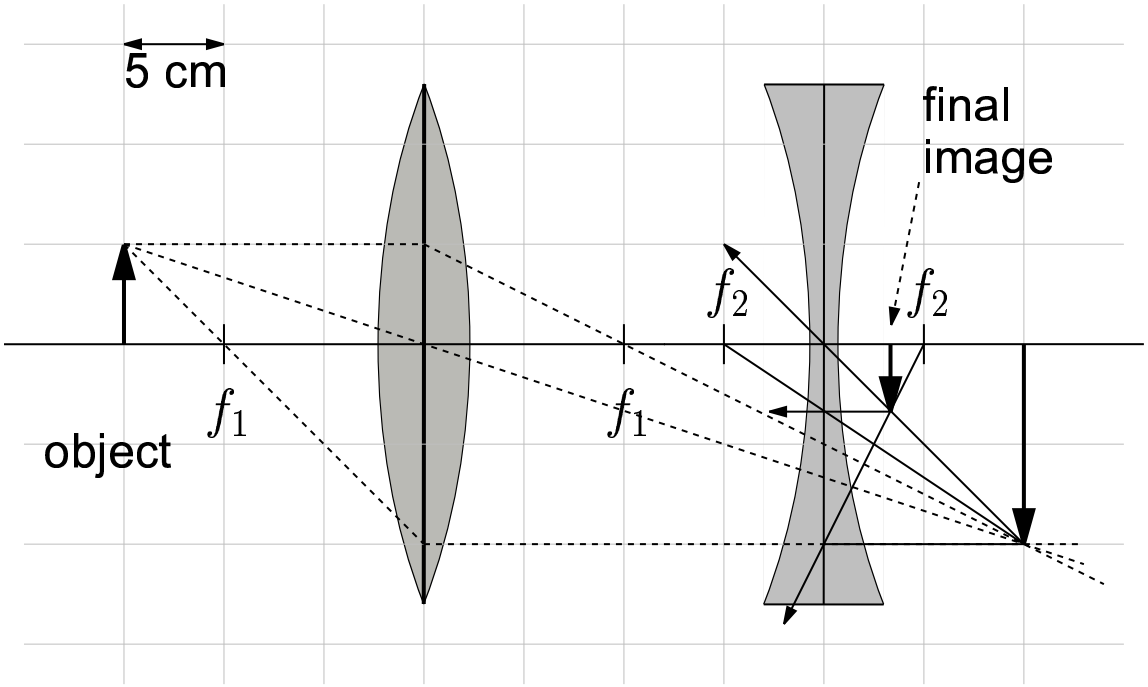
This is true regardless of whether the image is real or virtual.

Remember the three rays you need to trace: (1) paraxial/focus; (2) central; and (3) other focus/paraxial.

3 Sample Problem

A converging lens with $f_1 = +10\,\mathrm{cm}$ is $20\,\mathrm{cm}$ away from a diverging lens with $f_2 = -5\,\mathrm{cm}$. An object is placed $15\,\mathrm{cm}$ in front of the first lens. Draw a ray diagram for this system.

3.1 Solution



4 Assigned Problem

Two converging lenses with focal lengths $f_1 = 15\,\mathrm{cm}$ and $f_2 = 10\,\mathrm{cm}$ can be be positioned to form a simple refracting telescope by placing lens 1 $25\,\mathrm{cm}$ in front of lens 2. (*a*) Draw a ray diagram produced by an object $60\,\mathrm{cm}$ in front of lens 1 (the objective lens). The resultant image is inverted but it can be flipped by placing a second identical telescope with its objective $50\,\mathrm{cm}$ behind lens 2, producing an upright image. (*b*) Calculate the net magnification of the object. A clever TA thinks he can replace the first three of these lenses by a single lens to produce the exact same image. (*c*) Where must the lens be placed and what are the characteristics and focal length of the replacement lens? (*d*) What's wrong with this configuration? (*Hint:* try to draw the ray diagram.)