Ch 33 Lenses and Optical Instruments

More Practice with Thin Lenses

Objective:

Solve Level 2 and Level 3 problems that involve **thin lenses**

- ☐ By using the **lens equation** hand-in-hand with the **magnification equation**

$$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \quad \text{and} \quad m = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

and making sure to follow the **sign convention** so that our answer is consistent.

Content Review:

- NOTE: We have NOT covered **Refraction** in our LARC sessions yet.

- The **power** of a lens is given by

$$P = \frac{1}{f}$$

Remarks:

- The following statement holds ONLY for **single-lens systems**

Real images are inverted while virtual images are upright

we know that some **2-lens systems** can create images that are real AND upright.

- For a 2-lens system: the image of the 1st lens serves as the object of the 2nd lens.

Guided Practice (student - student) [10mins]

2-Lens System

Two lenses, one converging with focal length $20.0\,\mathrm{cm}$ and one diverging with focal length $10\,\mathrm{cm}$, are placed $25.0\,\mathrm{cm}$ apart. An object is placed $60.0\,\mathrm{cm}$ in front of the converging lens.

(a) Determine the position of the final image

(b) Determine the total magnification

Solution

(a) The final image is located $10\,\mathrm{cm}$ to the right of the 2nd lens.

(b) $m = -1.0$, the final image is inverted (upside-down)

NOTE: The image is real, because the image is on the opposite side of the incoming rays.

Group Activity (student - student) [15mins]

Old-School Projectors (picture)

Suppose an elderly couple wishes to see their old wedding photos. They bring out a slide projector to create a $98\,\mathrm{cm}$-tall upright image of themselves from a $2\,\mathrm{cm}$-tall slide. The screen is $3\,\mathrm{m}$ from the slide. Assuming the projector uses a thin lens,

(a) Would the image be real or virtual?

(a) What focal length does the lens need?

(b) How far should the lens be placed from the slide?

NOTE: The slides (photos) are placed upside-down into the projector so that the resulting image is upright!

Solution

(a) The image should be **real** since it appears behind the lens (opposite side of incoming light).

(b) $f = 5.9\,\mathrm{cm}$, converging lens

(c) $d_o = 6.0\,\mathrm{cm}$ in front of the lens