Lecture 41

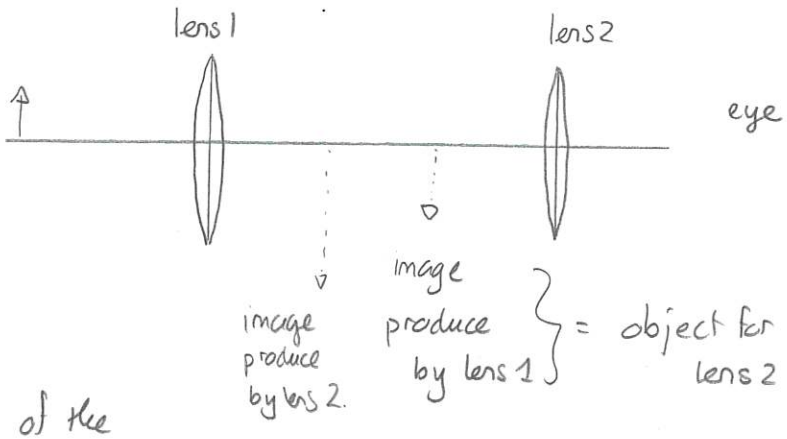
Weds: Ex 248, 249, 250, 251, 252, 253, 254

Thurs: Review

Final: Weds, May 18 at 10am

Multiple Lenses

Optical instruments such as telescopes or microscopes use multiple lenses to produce images. We can analyze these by tracing rays or repeatedly using the thin lens equation. When doing so the process is:

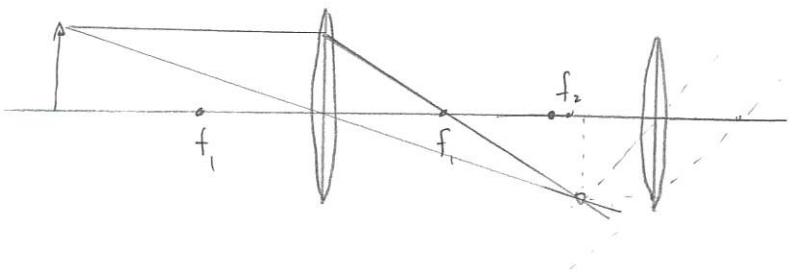


a) Lens 1 produces an image of the object - this acts as the object for lens 2

b) Lens 2 takes the intermediate image produced by lens 1 and treats it like and object. It makes an image from this.

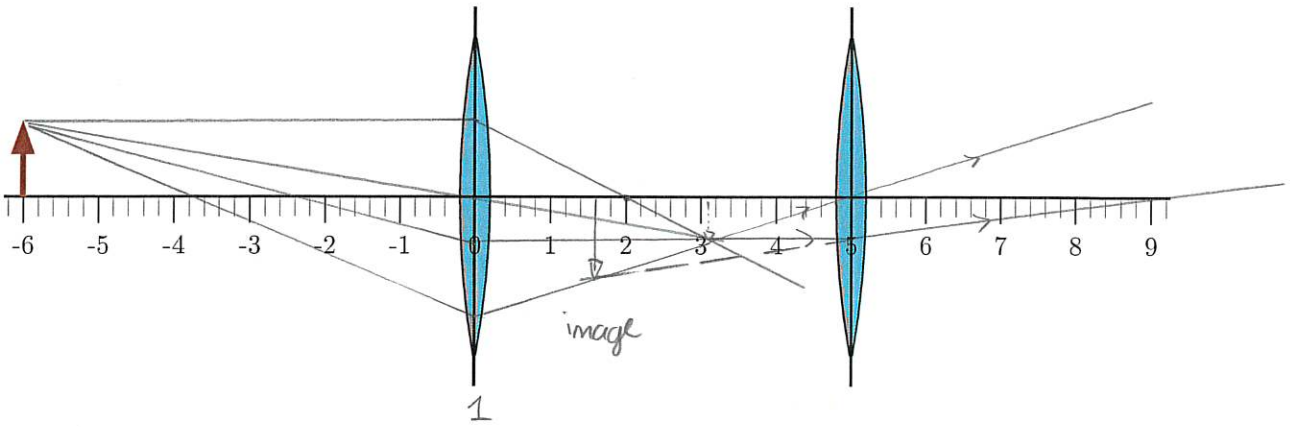
Quiz 1

- Moves real image closer to eyepiece
- Moves virtual " " " "



258 Image formation by two convex lenses

Two convex lenses are arranged as illustrated. The lens on the left has focal length 2.0 cm and the lens on the right has focal length 4.0 cm. The lenses are 5.0 cm apart. An arrow with height 1.0 cm is placed 6.0 cm left of the lens on the left.



a) Trace two rays from the tip of the arrow to determine the image produced by the lens combination.

b) Use equations to determine the location of the image produced by the lens combination.

c) Use equations to determine the height of the image produced by the lens combination.

b) Lens 1 produces an image at s_1' given by

$$\frac{1}{s}+\frac{1}{s_1'}=\frac{1}{f} \Rightarrow \frac{1}{s_1'}=\frac{1}{f}-\frac{1}{s}=\frac{1}{2}-\frac{1}{6}=\frac{3-1}{6}=\frac{2}{6} \Rightarrow s_1'=3\text{cm}.$$

This means that lens 2 sees an object 2cm to the left

$$\frac{1}{s}+\frac{1}{s_2'}=\frac{1}{f} \Rightarrow \frac{1}{2}+\frac{1}{s_2'}=\frac{1}{4} \Rightarrow \frac{1}{s_2'}=\frac{1}{4}-\frac{1}{2}=-\frac{1}{4} \Rightarrow s_2'=-4\text{cm}$$

So at the 1cm mark

c) $$M_{\text{both}}=M_1M_2=-\frac{s_1'}{s}\left(-\frac{s_2'}{s}\right)=-\frac{3}{6}\cdot\left(\frac{-(-4)}{2}\right)=-1$$

$$\Rightarrow h'=h(-1)=-1\text{cm}.$$

Show: Optics Slides – quick fact spectroscopy

Quiz 2

Diagnostic Test.