

Module 11 Homework

1. A convex lens is used to make an image of a 10 cm long arrow on a screen. The arrow sits 25 cm in front of the lens and the image that it creates is 20 mm long. What is the focal length of the lens?
2. A convex lens is used to create an image of an object that is 2 m in front of the lens on a white screen that is 15 cm behind the lens. For the sake of clarity in the description that follows, assume that the object, lens, and screen are on the x axis, the lens sits at the origin, and the object is in the positive x direction (so the object, lens, and screen are at $x = 2$ m, $x = 0.0$, and $x = -15$ cm respectively). A second lens is then placed in front of the first at $x = 5$ cm to create an image of an object located at $x = 5$ m on the screen.
 1. What is the focal length of the first lens?
 2. Is the second lens convex or concave?
 3. What is the focal length of the second lens?
 4. Before the second lens is placed in front of the first, the image of the object at $x = 5$ m exists, it is just not at the plane of the screen. Is this image in front of or behind the screen?
 5. How far is the image of the object at $x = 5$ m moved to place it on the screen?
3. A convex lens with a focal length of 55 mm is placed on the x axis at $x = 0$ cm. The lens creates an image of an apple placed at $x = -20$ cm, and the image is projected onto a frosted piece of glass. It is possible to move the lens such that an image of an object placed at $x = -35$ cm is brought into focus on the glass. How far must the lens be moved to do this?
4. A convex lens is made of a glass that has a refractive index $n = 1.5$. When an object is placed 15 cm in front of the lens while in air, the lens forms an image 7.5 cm behind the lens. The lens is then submerged in water and an object is placed 15 cm in front of it.
 1. Where will the image of the object be formed?
 2. What is the magnification of the image?
5. If you look at a mirror through a lens, the image that you see will be formed by rays that pass through the lens, reflect off of the mirror, and then pass through the lens again. Consider, an object is placed 1 m in front of a convex lens with an 80 cm focal length. A convex mirror is then placed 1 m behind the lens. The radius of curvature of the mirror is 50 cm.
 1. Where is the final image of the object (the image formed by light that has passed through the lens twice), with respect to the lens?
 2. What is the total magnification of the final image?
 3. Is the image right-side-up or inverted?

6. **Example Problem Write-up:** A symmetric convex lens made of glass ($n = 1.5$) is fixed a distance 25 cm in front of a screen. The lens surfaces both have a 5 cm radius of curvature (magnitude).

1. How far *from the screen* is the object that is in focus if the lens and screen are in air?
2. How far *from the screen* is the object that is in focus if the lens and screen are submerged under water?