Investigation 20A: Magnification of mirrors and lenses

Essential question: What kinds of images can be made by lenses and mirrors?

Mirrors change the direction of light through reflection. Lenses bend the direction of light through refraction. Both mirrors and lenses can create images. Images may be upside-down, right-side-up, larger or smaller. How the image appears usually depends on the geometry of the lens or mirror, and also on the location of the object and the observer. This investigation explores images formed by single lenses and mirrors.

Part 1: What mirrors or lenses magnify an object?

In the first part of the investigation, you will use three basic kinds of mirrors (flat, convex, and concave), two kinds of lenses (convex and concave), and a prism.

1. Look into the mirrors from different distances.
2. Hold the lenses and prism over the table at different heights and look at the table through them.

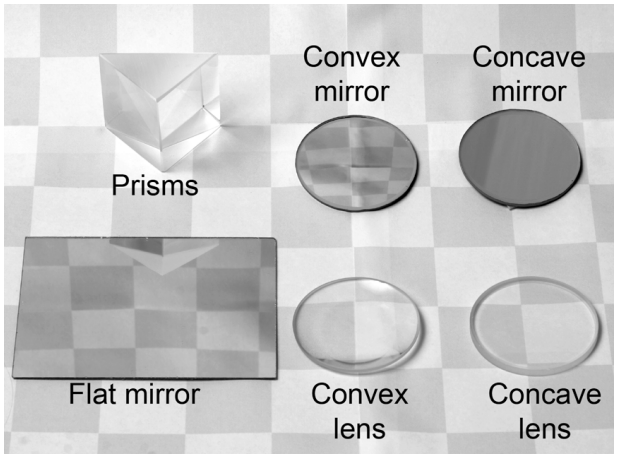

Table 1: Magnification and image orientation for optical devices

Optical device	Distance (close, far away, or all)	Magnification (enlarged, reduced, same size)	Image orientation (upright, inverted)
Flat mirror			
Triangular prism			
Concave mirror			
Convex mirror			
Concave lens			
Convex lens			

Questions

a. Which optical devices create magnifed images (either larger or smaller)?

b. Are there any optical devices that create *both* magnified and reduced size images? Under what conditions? (Include them in your table above.)

c. Do any of the devices create *inverted* (upside-down) images?

Part 2: Magnification of a convex lens

A magnifying glass is a commonly available optical device that is constructed using a convex lens.

1. Place a ruler flat on the table and look down at it from around 0.5 m.
2. Place a *convex lens* directly onto the ruler (distance $d_o = 0$) and record the diameter of the lens. Since the image fills the entire lens, this is the image size, h_i.
3. Use the markings on the ruler to measure *how much* of the object (the actual ruler) is visible through the lens. This is the object size, h_o.
4. Repeat these measurements with the lens held at three different distances above the ruler. For each trial, record the image size h_i, object size h_o, and the distance d between the ruler and lens.

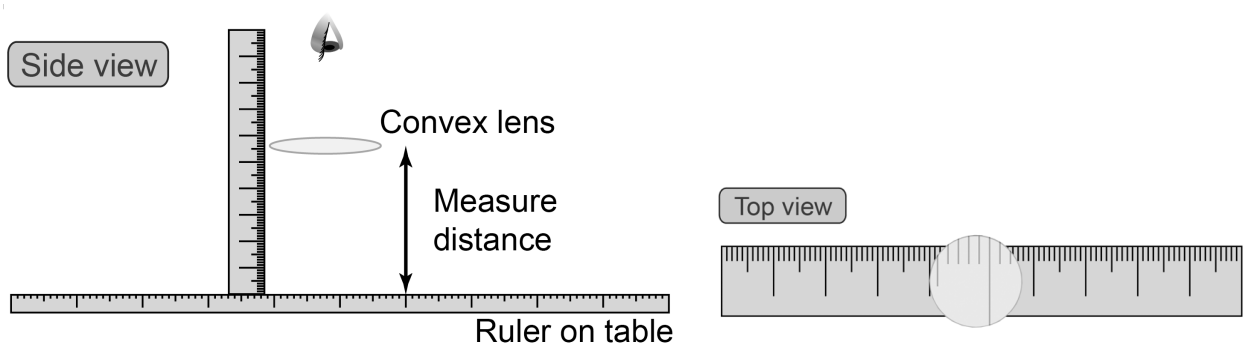

Table 2: Magnification

Distance, ***d*** (cm) (*from lens to ruler*)	Image size, $\boldsymbol{h_i}$ (cm) (*diameter of lens*)	Object size, $\boldsymbol{h_o}$ (cm) (*length of ruler seen through lens*)	Magnification, ***m*** $m = \frac{h_i}{h_o}$

Questions

a. Find the magnification of the lens for each trial by calculating $m = h_i/h_o$. Record your results in Table 2.

b. How does the magnification vary with the height of the lens above the ruler?

c. Does the appearance of the image change at any height?

Applying new knowledge

1. For each optical device below, state the method it uses to divert light.
   a. convex mirror
   b. prism
   c. convex lens

2. Why can no reflected image be seen on a surface that exhibits diffuse reflection?
   A. Light does not reflect off the surface.
   B. Light travels too fast to be reflected.
   C. Light can be reflected in any direction.
   D. Light changes direction as it passes through.

3. Are tinted windows on cars partially translucent or partially opaque?

4. Can a flat mirror produce magnified images?

5. Zing is 1.8 meters tall. His image in the fun house mirror is only 1.1 meters high. What is the magnification of the mirror?

6. Write a multiple-choice question that requires the reader to distinguish between optical devices that can magnify an image (larger or smaller), and those that cannot.