

Physical Science Investigations

Tom Hsu, Ph.D.

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CPO
science



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Question: What is magnification and how do you plot a reflected image?

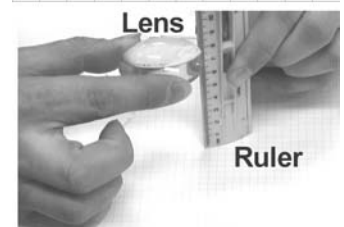
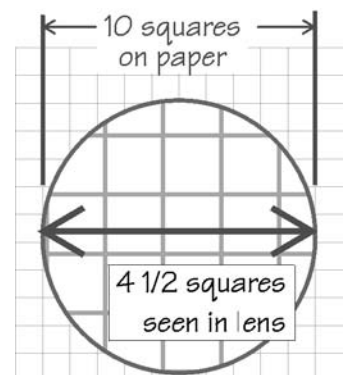
In this Investigation, you will:

1. Determine the magnification of a converging lens.
2. Trace incident and reflected rays from a mirror using a laser.
3. Learn how images are formed in optical systems.

We see **images** that are formed by the eye from light that comes from objects. Because light can be bent by lenses or mirrors, the image we see can be different from the object that produced it. With a magnifying lens, we can make an image seem larger than the object. The magnification is the ratio of image size to actual object size. In this Investigation, you will learn a shortcut method for finding the magnification of a single lens. Another way an image can be different from the object is in its orientation and location. For example, the image you see reflected in a mirror is reversed left-to-right and appears to be behind the mirror. In part 2 of this Investigation, you will learn how to predict where the image in a mirror appears by tracing the incident and reflected rays of light from a laser.

1 Finding the magnification of a lens

1. Set your lens directly on the graph paper and count the number of *unmagnified* squares that cross the diameter of the lens. In the example, the lens is 10 squares wide.
2. Next, examine a section of graph paper with your lens held above the paper. Move the lens closer and farther away until you have the biggest squares you can still see clearly in the lens.
3. Count the number of *magnified* squares that cross the diameter of the lens. For example, the picture shows 4 1/2 squares across the lens.
4. The magnification can be calculated by dividing the number of *unmagnified* squares by the number of *magnified* squares. In the example, you see 10 *unmagnified* squares and 4.5 *magnified* squares. The magnification is $10 \div 4.5$, or 2.22.
5. Try the experiment again using a ruler to measure the distance between the lens and the paper. Notice that the magnification changes with different distances.
6. Fill in the table by measuring the magnification of your lens for at least four different distances. The number of squares on the graph paper will be the same for all distances.



Measuring the distance from the lens to the paper

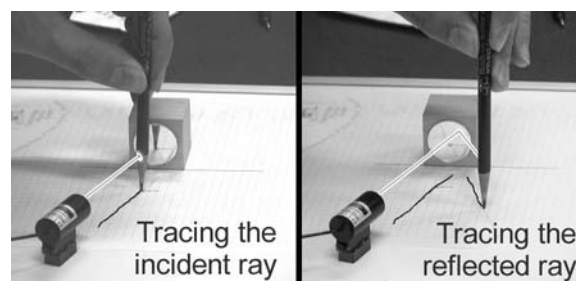
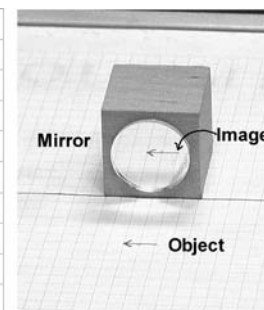
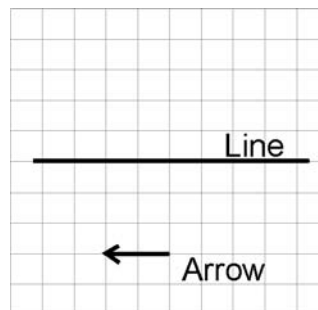
Table 1: Magnification of a lens

Distance to paper	# of squares on graph paper (unmagnified squares)	# of squares in lens (magnified squares)	Magnification

2

Reflections in a mirror

- Secure a sheet of graph paper to the optics table with the magnetic strips.
- Draw a line on the paper to mark where you will place a mirror. Place a mirror along this line.
- Draw a 1-centimeter-long arrow on the graph paper about 3 centimeters away from your line. The arrow should be parallel to the line.
- Move your head until you can see the reflection of the arrow in the mirror. The image of the arrow appears to be behind the mirror.
- Hold your pencil straight up with the point on the tip of your arrow. Use the pencil to set the laser beam so it passes right over the tip of your arrow, and hits the mirror.
- Trace the laser beam using your pencil as a guide. Trace the beam before it hits the mirror and after it hits the mirror.
- Move the laser so the beam passes over the tip of your arrow from a different angle, but still hits the mirror. Trace the beam with your pencil like you did in steps 5 and 6.
- The lines you drew represent rays of light before and after they hit the mirror. The **incident ray** shows the light before it hits the mirror. The **reflected ray** shows the path of the light after it bounces off the mirror.
- Remove the mirror and use a ruler to extend the two reflected rays. They should meet in a point on the other side of the line where the mirror was. This point is where you saw the image of the tip of the arrow. The image is where all rays that leave the same point on an object meet together again.

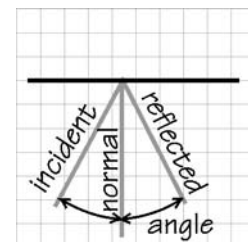


 **Safety Tip: NEVER look directly into a laser beam. Some lasers can cause permanent damage to your eyes.**

3

Thinking about what you observed

- Describe how the magnification changed as you changed the distance from the paper to the lens. Does the magnification get larger or smaller with distance?
- Could you adjust the distance between the paper and the lens to get any magnification you wanted, or was there a point where the lens could no longer create a sharp image?
- Describe why the image formed by a mirror appears to come from the place where the reflected rays meet. In your answer, refer to the fact that each point on an object is the source of many rays of light. You might want to include a sketch.
- Pick one pair of incident and reflected rays. Draw a straight line perpendicular to the point where the rays hit the mirror. This perpendicular line is called the **normal** in optics. Use a protractor to measure the angle between the incident ray and the normal, and between the reflected ray and the normal. From your angles, what can you say about the relationship between the direction of the incident ray and the direction of the reflected ray?



The cover is an evocative montage of historical and scientific achievements that demonstrate the incredible persistence of the human intellect. Around the border, daVinci's graphics reflect an evolving tapestry of conceptual thinking as they interweave with more contemporary themes. DaVinci's fantastical mechanisms become the modern bicycle, a quintessential machine, which rolls into a graphical interpretation of wavelength division multiplexing on a fiber optic. The images follow 500 years of scientific and technological innovation. The Earth and DNA symbolize the interdependence of the built world and the natural world. The exquisite blend of form and function revealed in the elegant geometry of the chambered nautilus folds into a spiral defined by the Golden Rectangle. The interplay of organic and architectural forms represents the balance we seek between the power of technology and the fragility of our lives and our world. I hope this colorful interplay of images will inspire interest and excitement about the discovery of science.

Bruce Holloway - Senior Creative Designer

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Cambridge Physics Outlet

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(800) 932-5227

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