

Physics and Chemistry Investigations

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CPO
science



Unit 1: Forces and Motion

1.1	Time and Distance	2
1.2	Investigations and Experiments	6
1.3	Speed	8
2.1	Using a Scientific Model to Predict Speed	10
2.2	Position and Time	12
2.3	Acceleration	14
3.1	Force, Mass, and Acceleration	16
3.2	Weight, Gravity, and Friction	20
3.3	Equilibrium, Action, and Reaction	22



Unit 2: Work and Energy

4.1	Forces in Machines	24
4.2	The Lever	26
5.1	Work	28
5.2	Energy Conservation	32
5.3	Energy Transformations	36



Unit 3: Electricity and Magnetism

6.1	What Is a Circuit?	38
6.2	Charge	40
7.1	Voltage	42
7.2	Current	44
7.3	Resistance	46
8.1	Ohm's Law	48
8.2	Work, Energy, and Power	50
9.1	More Electric Circuits	54
9.2	Series Circuits	56
9.3	Parallel Circuits	58
10.1	Permanent Magnets	60
10.2	Electromagnets	64



Unit 4: Sound and Waves

11.1	Harmonic Motion	66
11.2	Graphs of Harmonic Motion	70
11.3	Simple Mechanical Oscillators	72
12.1	Waves	74
12.2	Waves in Motion	76
12.3	Natural Frequency and Resonance	78
13.1	Sound	82
13.2	Properties of Sound	86
13.3	Music	90



Unit 5: Light and Optics

14.1	Introduction to Light	92
14.2	Color	96
15.1	Seeing an Image	98
15.2	The Human Eye	100
15.3	Optical Technology	104



Unit 6: Properties of Matter

16.1	Classifying Matter	106
16.2	Measuring Matter	108
16.3	States of Matter	110
17.1	Properties of Solids	112
17.2	Density of Fluids	116
17.3	Buoyancy of Fluids	118
17.4	Viscosity of Fluids	120
18.1	Atomic Structure	122
18.2	Comparing Atoms	124
18.3	The Periodic Table of Elements	128



Unit 7: Changes in Matter

19.1 Bonding and Molecules	132
19.2 Chemical Formulas	134
19.3 Comparing Molecules	136
20.1 Chemical Changes	138
20.2 Chemical Equations	140
20.3 Conservation of Mass	142
20.4 Using Equations	144
21.1 Classifying Reactions	148
21.2 Energy in Reactions	150
22.1 Nuclear Reactions	152
22.2 Carbon Reactions	154



Unit 8: Water and Solutions

23.1 What is a Solution?	156
23.2 Dissolving Rate	158
23.3 Solubility	160
24.1 Water	164
24.2 The Water Cycle	166
25.1 Acids, Bases, and pH	168
25.2 Acid Rain	170



Unit 9: Heating and Cooling

26.1 Temperature Scales	172
26.2 Measuring Changes in Heat	174
26.3 Specific Heat	178
27.1 Conduction	182
27.2 Convection	184
27.3 Radiation	186
28.1 Weather	188
28.2 Living Systems	190
28.3 Mechanical Systems	192



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

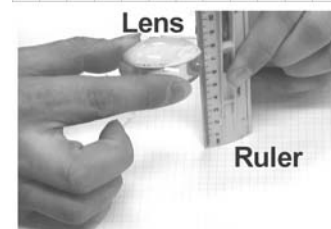
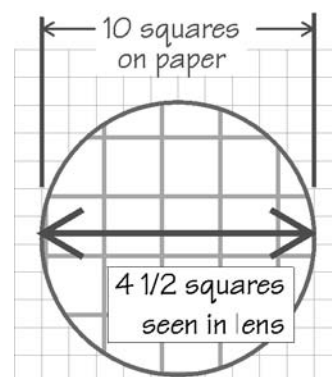
In this Investigation, you will:

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

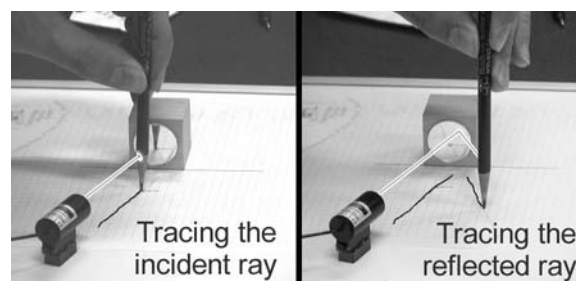
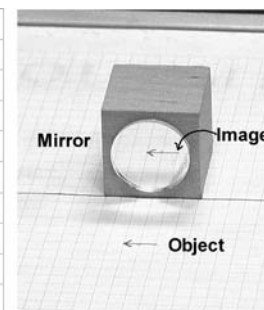
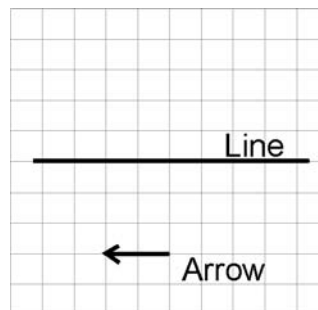
Table 1: Magnification of a lens

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.

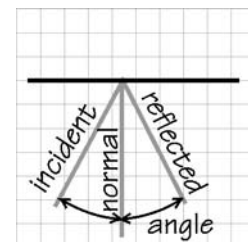


 **Safety Tip: NEVER look directly into a laser beam. Some lasers can cause permanent damage to your eyes.**

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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