

Reflecting Surfaces

Topic

Light reflected in a *plane mirror* demonstrates the law of reflection.

Introduction

Light behaves in a predictable way. Light striking and reflecting off a plane (flat) mirror obeys the law of reflection. The ray of light striking the mirror is called the *incident ray* (I) and the ray leaving the mirror is the *reflected ray* (R). A line perpendicular to the mirror, known as the *normal line* (N), can be drawn at the place where the ray strikes the mirror (see Figure 1). The normal line divides in half the angle created by the incidence ray and the reflected ray. The law of reflection defines the relationship between the two resulting angles.

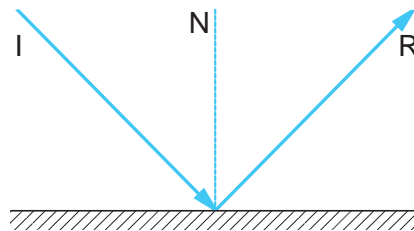


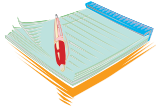
Figure 1

In this experiment, you will demonstrate how light acts when it strikes a plane mirror.



Time Required

55 minutes



Materials

- a plane mirror attached to a full soft drink can with double-sided tape (see Figure 2)

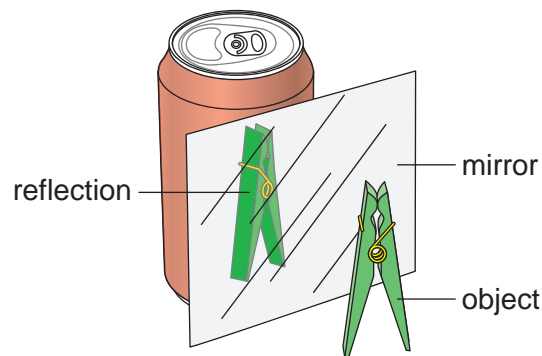


Figure 2

- protractor
- 1 sheet of graph paper (quadrille ruled is very convenient)
- objects to be reflected such as a clothespin standing vertically or a toy soldier
- 3 pushpins with flat tops (or thumbtacks)

Safety Note Take care when working with push pins and other objects that have sharp points. Please review and follow the safety guidelines.

Procedure

1. Place the mirror (attached to a soft drink can) on the edge of a piece of graph paper, with the mirror overlapping the paper a small amount.

2. Draw a line along the edge of the mirror.
3. On the paper, near the middle of the mirror, draw a straight line that is perpendicular to the surface of the mirror. This is the “normal” line.
4. Place two pushpins, with the points up, a little to one side of the normal line. Align the pins so that you can draw a straight line on the paper that connects the pins and extends to the mirror.
5. Without disturbing the pins, move to the opposite side of the mirror’s normal line and place a third pin so that it forms a straight line with the two pushpins reflected in the mirror from the other side. Now draw a straight line that connects the third pin and those reflected in the mirror.
6. Use the protractor to measure the angles formed by the two lines you just drew.
7. Do further exploration with the other items available. Describe your results in words and drawings.

Analysis

1. How do the angles formed by the pushpins compare? From your results, can you make a general statement about reflections or the direction that light travels?
2. Did the two lines meet exactly at the front of the mirror? If not, why not?
3. How far behind the mirror does the image of a pushpin appear to be compared to how far the actual pushpin is from the front of the mirror?
4. Describe the results of your further explorations.



What’s Going On?

This activity demonstrates the law of reflection: light travels in straight lines and the angle of incidence, created by the incident ray and normal line, is equal to the angle of reflection, which results from the reflected ray and the normal line. The mirrors that people use everyday are plane

mirrors. The images that result from reflections from plane mirrors are upright. In addition, the images and the viewed objects are the same size and the same distance from the mirror. The images produced are virtual images instead of real images. The light rays do not pass through the virtual image.

A common plane mirror is described as *back-silvered* because its reflective coating is behind the glass. The image is formed behind the piece of glass to which silvering has been applied. The thickness of the glass separates the line and its reflection. A more uncommon, more expensive, and more fragile *front-silvered* mirror does not display this phenomenon. In front-silvered mirrors, the reflective coating is on the front of the glass. Front-silvered mirrors produce more accurate reflections than back-silvered ones.

Want to Know More?

See Our Findings.

OUR FINDINGS

REFLECTING SURFACES

Suggestion for class discussion: Introduce the experiment by asking students what happens when they see their reflections in mirrors. Ask them if sound is reflected by a mirror in the same way that light is reflected; try to lead them to the understanding that sound waves and light waves have fundamental differences.

Analysis

1. The two angles should be equal. Answers will vary but should include that fact that light travels in straight lines.
2. Probably not. A back-silvered mirror forms images behind the glass. The thickness of the glass separates the line and its reflection. Front-silvered mirrors do not display this phenomenon.
3. The real pin and its image should be equal distances from the mirror. For example, if the pin is 10 grid squares in front of the mirror, the image of the pin should be 10 grid squares “into,” or behind, the mirror.
4. Answers will vary.

SAFETY PRECAUTIONS

Review Before Starting Any Experiment

Each experiment includes special safety precautions that are relevant to that particular project. These do not include all the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read and remain mindful of the General Safety Precautions that follow. Experimental science can be dangerous, and good laboratory procedure always includes following basic safety rules. Things can happen very quickly while you are performing an experiment. Materials can spill, break, or even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following the basic safety guidelines during the entire experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. For one reason, we want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical.

Read the safety precautions here and at the beginning of each experiment before performing each lab activity. It is difficult to remember a long set of general rules. By rereading these general precautions every time you set up an experiment, you will be reminding yourself that lab safety is critically important. In addition, use your good judgment and pay close attention when performing potentially dangerous procedures. Just because the book does not say “Be careful with hot liquids” or “Don’t cut yourself with a knife” does not mean that you can be careless when boiling water or using a knife to punch holes in plastic bottles. Notes in the text are special precautions to which you must pay special attention.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking an unnecessary risk can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to

check the individual experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone. When you are working off-site, keep in groups with a minimum of three students per groups, and follow school rules and state legal requirements for the number of supervisors required. Ask an adult supervisor with basic training in first aid to carry a small first-aid kit. Make sure everyone knows where this person will be during the experiment.

PREPARING

- Clear all surfaces before beginning experiments.
- Read the instructions before you start.
- Know the hazards of the experiments and anticipate dangers.

PROTECTING YOURSELF

- Follow the directions step by step.
- Do only one experiment at a time.
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eyewash, and first-aid kit.
- Make sure there is adequate ventilation.
- Do not horseplay.
- Keep floor and workspace neat, clean, and dry.
- Clean up spills immediately.
- If glassware breaks, do not clean it up; ask for teacher assistance.
- Tie back long hair.
- Never eat, drink, or smoke in the laboratory or workspace.
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult.

USING EQUIPMENT WITH CARE

- Set up apparatus far from the edge of the desk.
- Use knives or other sharp-pointed instruments with care.

- Pull plugs, not cords, when removing electrical plugs.
- Clean glassware before and after use.
- Check glassware for scratches, cracks, and sharp edges.
- Clean up broken glassware immediately.
- Do not use reflected sunlight to illuminate your microscope.
- Do not touch metal conductors.
- Use alcohol-filled thermometers, not mercury-filled thermometers.

USING CHEMICALS

- Never taste or inhale chemicals.
- Label all bottles and apparatus containing chemicals.
- Read labels carefully.
- Avoid chemical contact with skin and eyes (wear safety glasses, lab apron, and gloves).
- Do not touch chemical solutions.
- Wash hands before and after using solutions.
- Wipe up spills thoroughly.

HEATING SUBSTANCES

- Wear safety glasses, apron, and gloves when boiling water.
- Keep your face away from test tubes and beakers.
- Use test tubes, beakers, and other glassware made of Pyrex™ glass.
- Never leave apparatus unattended.
- Use safety tongs and heat-resistant gloves.
- If your laboratory does not have heat-proof workbenches, put your Bunsen burner on a heat-proof mat before lighting it.
- Take care when lighting your Bunsen burner; light it with the airhole closed, and use a Bunsen burner lighter in preference to wooden matches.

- Turn off hot plates, Bunsen burners, and gas when you are done.
- Keep flammable substances away from flames and other sources of heat.
- Have a fire extinguisher on hand.

FINISHING UP

- Thoroughly clean your work area and any glassware used.
- Wash your hands.
- Be careful not to return chemicals or contaminated reagents to the wrong containers.
- Do not dispose of materials in the sink unless instructed to do so.
- Clean up all residues and put them in proper containers for disposal.
- Dispose of all chemicals according to all local, state, and federal laws.

BE SAFETY CONSCIOUS AT ALL TIMES!