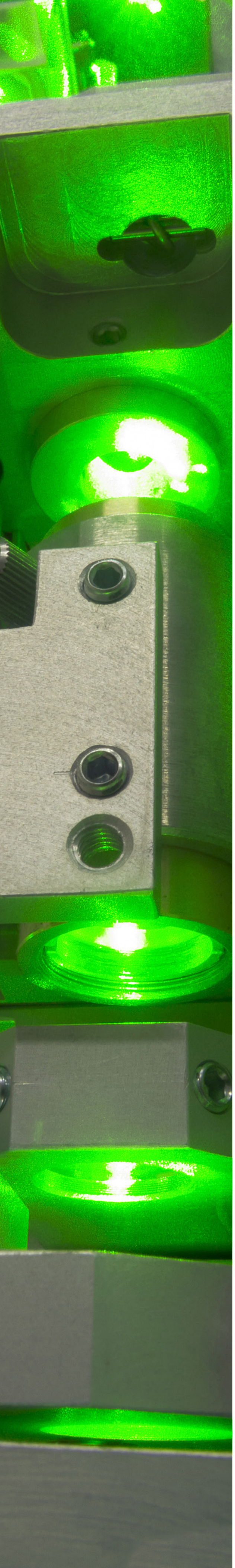
Grades
6–8, 9–12

15
minutes



LASER CHALLENGE

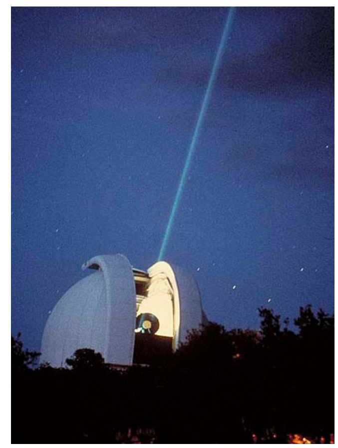
DESIGN CHALLENGE

Transmit music over a laser beam by manipulating mirrors.

SUPPLIES AND EQUIPMENT

Per whole group

- ◻ Music source (iPod, laptop, radio, etc.)
- ◻ 6–12 small square or rectangular plastic mirrors
- ◻ Modulated laser setup from Educational Innovations (teachersource.com/product/modulated-laser/light-color), about $60; or make your own setup with collected supplies for about $20 (the Educational Innovations product includes laser, electrical harness, audio cables, amplifier with attached photocell, and operation instructions)
- ◻ 2 AA batteries
- ◻ 10–20 wooden blocks, approximately 3" x 5"
- ◻ Clear tape
- ◻ Black cloth (enough to surround work area)



McDonal Observatory (USA) points a laser beam to a reflector stationed on the surface of the moon. Credit: McDonal Observatory.

GETTING READY

Assemble the modulated laser following the instructions supplied in the Educational Innovations kit. Use caution when handling the photoresistor (a.k.a. photocell); it is small and the wires are easily damaged. You may choose to mount the photoresistor on a piece of wood with glue or invisible tape to prevent damage. You may also wish to construct a device to hold the laser in place, or you can leave this to your participants.

As an alternative, you can make your own modulated laser to transmit audio signals. There are many good instructions for this online, but to follow them you should be comfortable working with electronics. *Make:* magazine provides clear instructions for an inexpensive modulated laser: makezine.com/projects/make-16/simple-laser-communicator.

Attach mirrors to the flat sides of wooden blocks.

Attach the laser pointer to the top of a wooden block so that when it is turned on, the laser beam is horizontal to the work surface.

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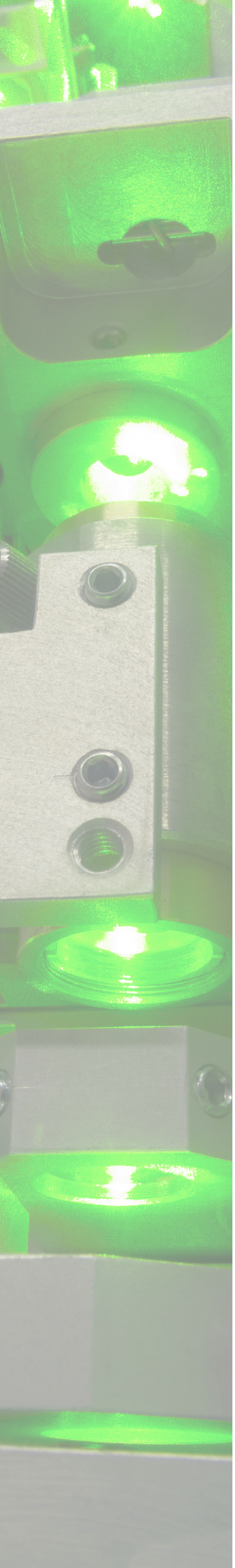

GETTING READY (CONTINUED)

Place the laser and photoresistor on opposite ends of a table, about 5–6 feet apart. Arrange wooden blocks or other obstacles in the middle.

Create a 1-foot-tall barrier around the outside of the work area using black cloth so that people can look down on the activity but can't get in the way of the laser beam. Cloth can be draped over boxes or strung along ropes.

Caution: Laser light can damage the retina. Never stare into a laser beam or shine a laser at people. Check state and local laws concerning the use of laser pointers before conducting this activity. Adult supervision is required.

INTRODUCTION

Get participants thinking about lasers and how we can manipulate them:

- What are some electronic devices that create light? (Flashlight, LED, lasers.)
- How can we alter the light coming from these devices? (Block it, refract it, pulse, filters.)
- How do we use lasers in our everyday lives? (Scan groceries, read data on CDs or DVDs, laser cutters, etc.)
- What happens when a laser strikes a mirror?

INSTRUCTIONS

Demonstrate the modulated laser:

- Turn on the speaker connected to the photoresistor. Connect the laser to a music source as illustrated in the modulated laser instructions and press Play. Aim the laser at the photoresistor and listen as music plays on the speaker.
- Most people will be fascinated and may ask questions. Quickly explain that the digital audio data is translated into a laser beam with brightness that varies in intensity through amplitude modulation. This laser signal strikes the photoresistor, which sends an electrical signal to the speaker to produce sound.
- Get to the hands-on portion as quickly as possible and let participant interest guide the discussion.

Introduce the design challenge. Using mirrors, participants direct a laser around obstacles to transmit a music signal. Music will play when the laser strikes the photoresistor.

Use a piece of tape to hold down the button on your laser.

Allow the participants to place mirrors on the table to direct the beam around the obstacles. Remember the law of reflection: the laser will reflect at the same angle it hits the mirror. Note that small movements to one mirror can lead to big changes in the laser's ultimate path.

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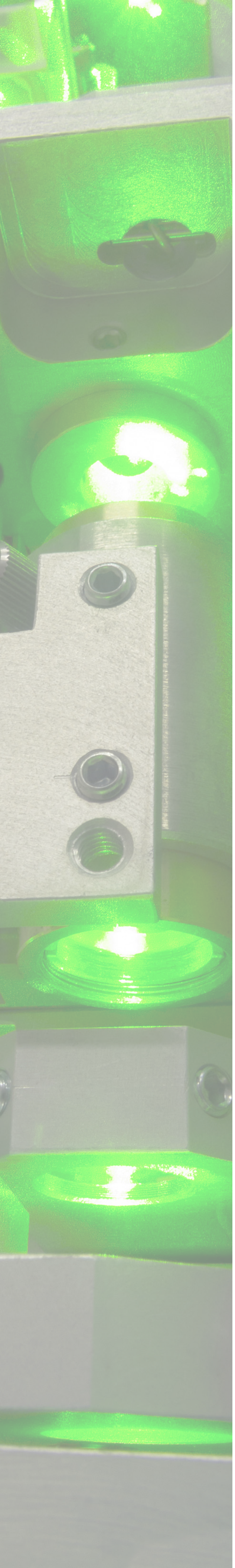


ACTIVITY VARIATIONS

Have a competition to see who can send the laser on the farthest path to the photoresistor.

TROUBLESHOOTING

If the laser doesn't work, make sure you have connected the positive wire to the laser's housing and the negative wire to the laser's spring. Also make sure the batteries are new and installed correctly.

RELEVANT TERMINOLOGY

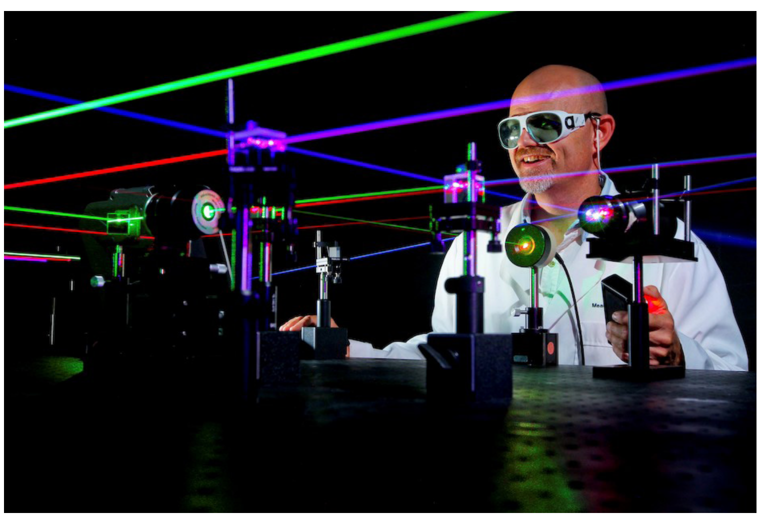
Innovation: A new method, product, or idea, or an improvement on an existing one.

Laser: A device that amplifies the energy of light by aligning the crests and troughs of the light waves. The term *laser* is an acronym that stands for "light amplification by stimulated emission of radiation."

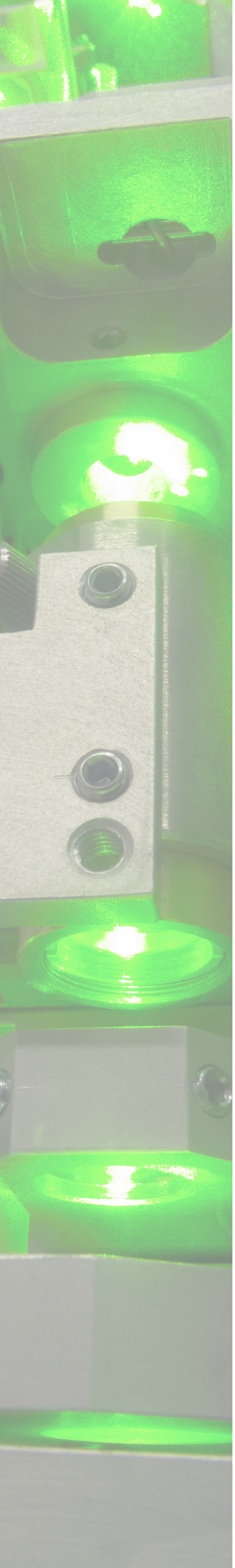
Law of reflection: States that the angle of the incident (incoming) light is equal to the angle of the reflected (outgoing) light.

Monochromatic light: Light that has only one wavelength so that it is only one color.

Photoresistor: An electrical device whose resistance to electrical flow through it decreases as the intensity of light shining on it increases.



Calibrating range finders for the US Navy. Laser range finders are used to calculate the distance to an object and in 3-D modeling. Credit: US Navy photo by Greg Vojtko.



GUIDANCE FOR PARTICIPANTS

QUESTIONS TO ASK AFTER THE ACTIVITY

- How many mirrors did you need to direct the laser to the photoresistor? Could you achieve the same results with fewer mirrors?
- Why do you think it is so important to keep the laser perfectly steady?
- What differences do you notice between laser light and ordinary light?
- After doing this activity, what ideas do you have for how we can use lasers in the future?

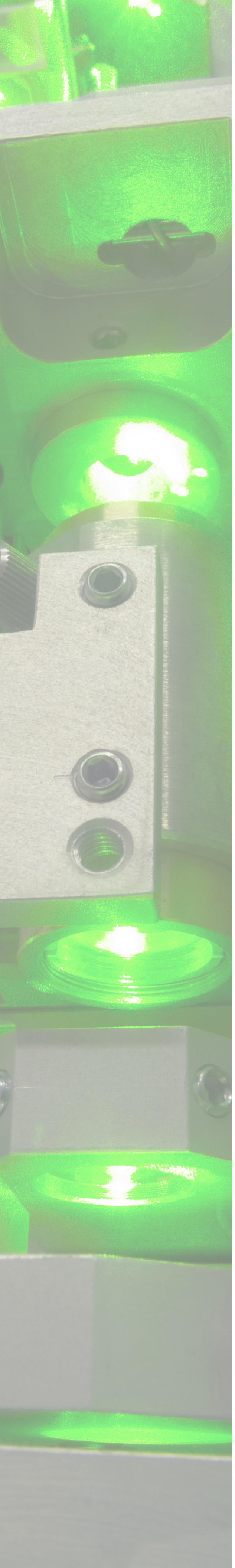
ENGINEERING CONNECTIONS

Engineers use lasers as a tool for building and design. Lasers can precisely cut and engrave materials such as leather, wood, fabric, and metal. Engineers also use lasers to solve health-related problems. Biomedical engineers combine engineering principles with medicine and biology in order to create life-saving machines and techniques. Lasers are often added to already existing technology to make it even better—a practice called innovation. For example, by combining lasers with a technology called fiber optics, engineers have found a way for doctors to see inside the body, examine organs, diagnose illnesses, and even deliver laser light to specific points in the body to help surgeons do surgery.

SCIENCE CONNECTIONS

Lasers create a very intense and powerful beam of light that is actually brighter than the sun. What makes lasers so powerful is the way light waves behave in a laser. Ordinary light is made up of many different wavelengths, but a laser beam is made up of waves with a single color or wavelength called monochromatic light. This allows the waves to line up “in phase,” meaning that the peaks of the wavelengths line up to create a super concentrated beam of light.

Light bounces off mirrors in a very predictable way, following the law of reflection. For example, if you shine a laser onto a mirror at 60 degrees, then the rays will reflect off of the mirror at 60 degrees as well. The angle at which light hits a mirror is called the angle of incidence, and when it bounces off it is called the angle of reflection. The law of reflection states that the angle of incidence is equal to the angle of reflection. By combining their knowledge of lasers and physical laws, engineers can use lasers in many ways when designing solutions.



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ACKNOWLEDGMENTS

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