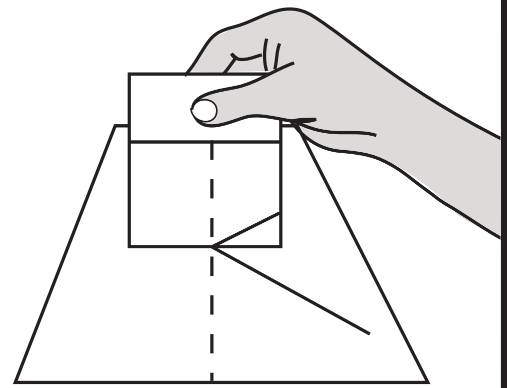
What's the Angle?

Light travels in a straight line, unless something is put in its path to cause it to either reflect (bounce) or refract (bend). Every object we can perceive with our eyes is reflecting light off its surface and into our eyes. Light reflects off an object at the same angle it strikes the surface of that object; this is called the angle of reflection. In the next activity students incorporate math and science skills to observe this phenomenon/property.

Materials (per student)
- 1 or more sheets of paper
- pencil
- small mirror
- ruler
- protractor

Procedure
- Use the ruler to draw a dotted line lengthwise down the center of the paper.
- Use the ruler to draw a continuous straight line at any angle leading out from the dotted line.
- Stand the mirror up at the point where the straight line and the dotted line meet. Adjust the mirror so that the dotted line is lined up with its reflection in the mirror as closely as possible.
- Line the edge of the ruler up with the reflection of the continuous line. Draw this line on the paper (it will appear as though you have drawn a line extending from the reflection in the mirror onto your paper). Try to make the line you are drawing keep in line with the reflection as closely as possible.
- Use the protractor to measure the angle between your first straight line and the dotted line.
- Use the protractor again to measure the angle between the dotted line and the continuous line you drew using the reflection in the mirror. This measurement will be the angle of reflection. Compare this with the angle of the first continuous line.



What's going on?
The angles of the two continuous lines should be the same. Light will bounce, or reflect, off an object at the same angle it strikes the reflecting surface. The light reflecting off of the line drawn on the paper hit the mirror at a certain angle. It should have been reflected back into your eyes at the same angle. Drawing an extension of the line you saw reflected in the mirror allowed you to use the protractor to measure the angle of reflection for yourself. Try repeating the experiment. Draw more lines leading away from the dotted line but at different angles. What do you notice?

Resources

Find these books at your local library or bookstore:

101 Physics Tricks, by Terry Cash, 1991

175 Science Experiments to Amuse and Amaze Your Friends, by Brenda Walpole, 1988

175 More Science Experiments to Amuse and Amaze Your Friends, by Terry Cash, Steve Parker and Barbara Taylor, 1989

200 Illustrated Science Experiments for Children, by Robert J. Brown, 1987

Light, by John and Dorothy Paull, 1982

Physics for Every Kid, by Janice VanCleave, 1991

Physics for Kids: 49 Easy Experiments with Electricity and Magnetism, by Robert W. Wood, 1990

Physics for Kids: 49 Easy Experiments with Optics, by Robert W. Wood, 1990

Physics for Kids: 49 Easy Experiments with Acoustics, by Robert W. Wood, 1991

Simple Mechanics, by John and Dorothy Paull, 1982

Simple Physics Experiments with Everyday Materials, by Judy Breckenridge, 1993

www.yucky.com

www.iknowthat.com/com/L3?Area=Science%20Lab

Science On Wheels website: www.pacificsciencecenter.org/education/sow

Credits

Science On Wheels Staff:
Laura Hamilton, Barbara Johnson
Zeta Strickland, Catherine Valiant

Graphic Designer: Katie Dresel

200 Second Avenue North • Seattle, WA 98109
206-443-2001 • pacificsciencecenter.org

Printed on 100% post-consumer recycled paper.

SCIENCE On WHEELS

POW!

Physics on Wheels

Dear Teacher,

Thank you for having the *Physics on Wheels* van visit your school. We hope you enjoyed investigating physics with your students during this Science On Wheels experience. This flier is intended to help continue the enthusiasm generated by our visit and extend your students' learning.

The following activities have been selected because they are straightforward, require few materials, and support state-adopted learning objectives. The one page insert is written for your students with activities you may choose to do as a class, or copy for home use.

Thank you again for having the *Physics on Wheels* van visit your classroom and remember, have fun!

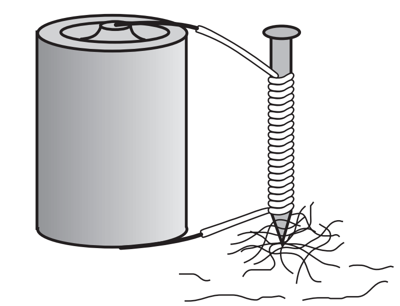
~Science On Wheels Teachers

Create an Electromagnet

Use electricity to magnetize an ordinary piece of steel!

Materials (per team)
- piece of insulated wire, 1 meter (3 feet) long
- size "D" battery
- large steel nail
- "steel wool" pot scrubber
- scissors
- white paper

Procedure
- Use scissors to trim off some steel wool onto a piece of white paper.
- Touch the nail to the steel wool shavings and observe what happens.
- Strip about ½ inch of insulation off each end of the wire.
- Wrap the rest of the wire around the nail as tightly as possible.
- Touch one of the stripped ends of the wire to the positive side of your battery and the other stripped end to the negative side of the battery. This will create a circuit so that the electricity from the battery will flow through the wire and around the nail.
- Keeping the nail and wire attached to the battery, touch the nail to the pile of steel wool. The shavings should now stick to the nail; the nail has become magnetic.
- Remove the shavings from the nail and unwrap the wire.
- Touch the unwrapped nail to the steel wool shavings to see if they still stick.



Challenge
Make the magnet stronger by using either more than one battery, or a larger one. Be sure batteries are lined up negative end to positive end to keep the electric current flowing. Try using more wire or winding it more tightly around the nail. Substitute a large piece of steel for the nail. Test nails made of other materials to see which metals can or cannot be magnetized.

What's going on?
This experiment turns a nail into a temporary magnet by forcing the electrons in the nail to line up in one direction. The nail will remain magnetized for a while even after being disconnected from the battery.

Note: Only a steel nail will remain magnetized. If an iron nail is used, it will only be magnetic while there is electricity from the battery flowing through it.

Pitch Paradox

The following activity presents an event which may appear contradictory until you discover what is vibrating to make the sound.

Materials
(for classroom demonstration)
- 8 identical glass bottles
- water
- pencil

Procedure
- Fill eight bottles with varying levels of water, so that a musical scale may be played when the bottles are tapped.
- Have a student come play a simple scale by tapping the bottles with a pencil.
- Have another student play the same scale, this time blowing over the bottles. The students should notice that the scales are now reversed.

Challenge
Try this activity with eight wine glasses, this time rubbing a wet finger around the rim of the glasses while holding the glass by the base with your other hand (dipping your fingers in water decreases the friction and will make it easier to get the glasses to "sing"). Also, while rubbing your finger around the glass, observe water waves produced by the vibrations.

Have students make a prediction about what will happen when the wine glasses are tapped. The scales stay the same this time! This surprising result happens because in both cases, the glass and water are vibrating, not the air over the water.

What's going on?
What causes sound? What is the relationship between the amount of water and the sound? What is vibrating in each case? When blowing, the air is vibrating; a larger column of air (i.e. an emptier bottle) produces a lower sound. When tapping the bottle, the bottle and its contents are vibrating; a fuller bottle produces a lower sound. In each case, the larger the mass vibrating, the lower the sound!

Let It Slide

A simple machine is something that helps us to do work. There are six basic types of simple machines: the screw, wheel and axle, wedge, inclined plane, lever, and pulley. The following activity demonstrates that simple machines make work easier.

Materials (per team)
- piece of string, about 30 cm (12 inches) long
- rubber band (a strong one)
- 2 books (one should be very thick)
- plastic bottle containing one liter of water
- ruler

Procedure
- Tie the string around the neck of the bottle, making a loop to which you can attach the rubber band. Attach the rubber band to the loop of string.
- Lay the thicker book flat on a desk or table top.
- Place the bottle of water on the table next to the book. One student should pull on the rubberband to lift the bottle until the bottom of the bottle is even with the top of the book. Hold the bottle even with the book.
- While one student holds the bottle in the air, the other student should use the ruler to measure the rubber band to see how far it has been stretched. Record this measurement.
- Next, rest the end of the second book on the edge of the first book to make a ramp. You have just built an inclined plane.
- Lay the bottle of water at the bottom of the inclined book; use the rubberband to pull the bottle to the top of the inclined book.
- One student should hold the book at the top of the ramp while the other measures the rubberband to see how far it stretched. Compare this to the first measurement.

What's going on?
The rubberband stretched more when the bottle was being lifted straight up because the person lifting was holding the entire weight of the bottle. When the bottle was pulled up the inclined plane, some of its weight was supported by the books, so it required less effort from the person pulling.

Physics Careers

Have you ever wondered why helium-filled balloons rise? Why water boils? Or how a big, heavy airplane can fly? If you have, you were wondering about physics!

Physics is the study of energy and matter. Physicists explore the physical world and try to explain how things like light, sound, electricity and magnetism work. Physics provides us with guidelines for how the world works. This allows us to predict how things around us will behave, which, of course, is very useful. The study of physics has led to the invention of everything from the telephone and the engines in our cars, to computers and the Space Shuttle.

A physicist can study everything from the individual parts that make up an atom to the makeup of the human body. And, while it takes a lot of hard work in school to become a physicist, it can be very exciting!

Careers in physics require a strong background in math and science. Someone who goes to college and wants to major in physics can begin in elementary school by observing the world and asking "What would happen if?" In high school a student can prepare by taking courses such as algebra, geometry, chemistry and physics.

Once in college, a physics major takes calculus and introductory physics classes. A physics major will also take classes like thermodynamics, electromagnetic theory, mechanics and much more. Physics is an exciting science, in part because it includes so many different fields. After earning a bachelor's degree in physics, some students decide to go on to earn a master's degree or a Ph.D.

A person who earns a college degree in physics can enter a variety of career fields. Some professional physicists focus on fields like astronomy and astrophysics. They may study distant stars and galaxies and try to discover how we can get there. Other traditional fields for physicists include electronics, geophysics and medical, nuclear or theoretical physics. A geophysicist, for example, studies our planet and the invisible forces within and around it. As a medical physicist, you could use radiation to treat diseases, or use it to look inside the body to make a diagnosis.

Besides the traditional physics fields, there are related fields that need people who have studied physics. Some of these include computer science, environmental science, oceanography, aerospace engineering, civil engineering, electrical engineering or even working at the Pacific Science Center. These are all careers where physics is used to make important discoveries all the time!

Some people combine their interest in physics with other studies and enter fields such as software development, patent law, sports science, or telecommunications. Almost any field you could imagine uses knowledge of physics.

It is surprising how often knowing something about physics can come in handy. Have your class try to figure out how a knowledge of physics would help in each of the following careers or hobbies:

- violin maker
- professional athlete or coach
- sculptor
- race car driver
- movie stunt person
- tight-rope walker
- snow boarder
- bungee jumper
- special effects designer
- magician
- baton twirler
- furniture mover
- elevator operator or repair person
- bicycle designer
- police officer