RESOURCES FOR FURTHER EXPLORATION

Continue the fun at home! Science happens all around us, all the time.
Check out these resources to learn more!

www.cosi.org
www.physics2005.org
www.fearofphysics.com
www.albert-einstein.org
www.physicsclassroom.com
www.physicscentral.com

COSI
EXPLORE SCIENCE. DISCOVER FUN!®

LASER TABLE → GADGETS

Inquiry Starters: Describe the light you see, but don't look directly into the path! What makes the light bounce? Why is mist coming out of the table? What seems to stop the light? What seems to make the light reflect? Can you make a triangle of light?

What's Going On: Laser is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. This means that light is increased in power by forcing the release of energy from atoms of a gas. The electrons in the gas are being excited by small particles of light, or photons. Light can then behave like a wave of energy, but also like a particle. This idea of "packets of light" is one of Einstein's great contributions to science that won him the Nobel Prize in Physics in 1921! The concentrated light has higher energy and can be used to do work. Here, the work is playing with reflections. Light travels in a straight line. The mist shows this as the light reflects off the small water droplets and reveals the straight lines. Mirrors cause the light waves to reflect. Warning: because laser light is so concentrated, it is never safe to look directly at a light coming from a laser! The light could cause damage to your eyes.

Fun Fact: If you had an infinite number of mirrors, you could reflect that one beam of concentrated light infinitely! Many optical illusions use this principle. While they do not employ an infinite number of mirrors, these illusions use enough mirrors to trick your brain to stop counting images and just assume they are countless.

UP UP AND AWAY! (Repulsion Coil) → GADGETS

Inquiry Starters: What happens to the ring when you press the green button? What force caused this? What is generated and released to cause the ring to move? Where does the energy come from? Why is it necessary to wait for the green button to light up in order for the ring to move again?

What's Going On: When the button is pressed, alternating current electricity starts to flow through the copper wire. Think of the current as sloshing back and forth, many times per second. Flowing electric current produces alternating magnetic fields. Think of the magnetic field as alternating up and down. The magnetic field flows into the aluminum ring. The current in the copper wire induces, or forces, an electric current to flow in the aluminum ring, called eddy currents, which causes its own magnetic field. Have you ever tried to place like poles of two magnets together? The two induced magnetic fields' poles are now pointing toward the original magnetic field created in the wire. The aluminum ring is repelled from the copper coil and the ring flies into the air.

Try This: Now that you have mastered induction, use this idea at the See The Light exhibit. A spin of the magnet creates a magnetic field and causes an electric current in the copper wire. Do you see any proof of the electric current? When electricity induces magnetism and magnetism induces electricity, motors and generators are set in motion, our lights light up, and our world moves!

little KIDSPACE®

ACTIVITIES FOR KINDERGARTEN AGE AND YOUNGER

Parents, below you will find fun questions to ask your child as they explore the little kidspace exhibition area.

FIND THE DOUBLE BALL RAMPS...

Do you have a lot of energy today? Start two balls at the top of the ramp, one on each track. Which one will reach the bottom first? Which ball seems to go faster? Did the curvy ramp make the ball speed up and slow down? How can you give the ball more energy?

Everything around us has energy associated with it, especially your children! Energy can be either kinetic or potential. While holding the balls at the top of the ramps, the balls have all potential energy because they are not moving. As your child lets go, the energy is converted to kinetic and the ball moves. On the curvy ramp, the balls gain potential energy as they travel on the uphill parts of the ramps. Does it make sense that when your children nap, they are building up their stores of potential energy?

FIND THE BIG LIGHT SWITCHES BY THE POWER PLANT...

What happens when you flip the switch to the "up" position? Did you see anything turn on? How did that happen? What else turns on with a button or a switch?

Children are fascinated with the cause and effect of switches and buttons. They can be entertained for hours by turning lights on and off. By giving your child the job of turning on a light when you enter a room together or letting them press the buttons, you encourage their learning and curiosity.

FIND THE BALLS FLOATING ABOVE THE FLOWER TUBE IN THE PARK...

Why is the ball up in the air above the tube? Why is the ball spinning? What happens when you place another ball at the bottom of the tube? Where does it go? How does it get there?

Playing peek-a-boo with people is something that children love to do, because they can predict that the other person will still be there. When an object flies out of sight without a child being able to see where it goes or how it got there, the child is amazed. If the weather is nice, head out to Big Science Park and find the Preposterous Ball Pipes with the colorful balls. Do the balls float at the top of these pipes?

TRY THIS... AT HOME!

Try this cool activity at home to learn even more about Physics. Work together, adults and kids, to learn and have fun. It's amazing how much science is in things that you have around your house!

OPTICAL MORPHER

MATERIALS NEEDED

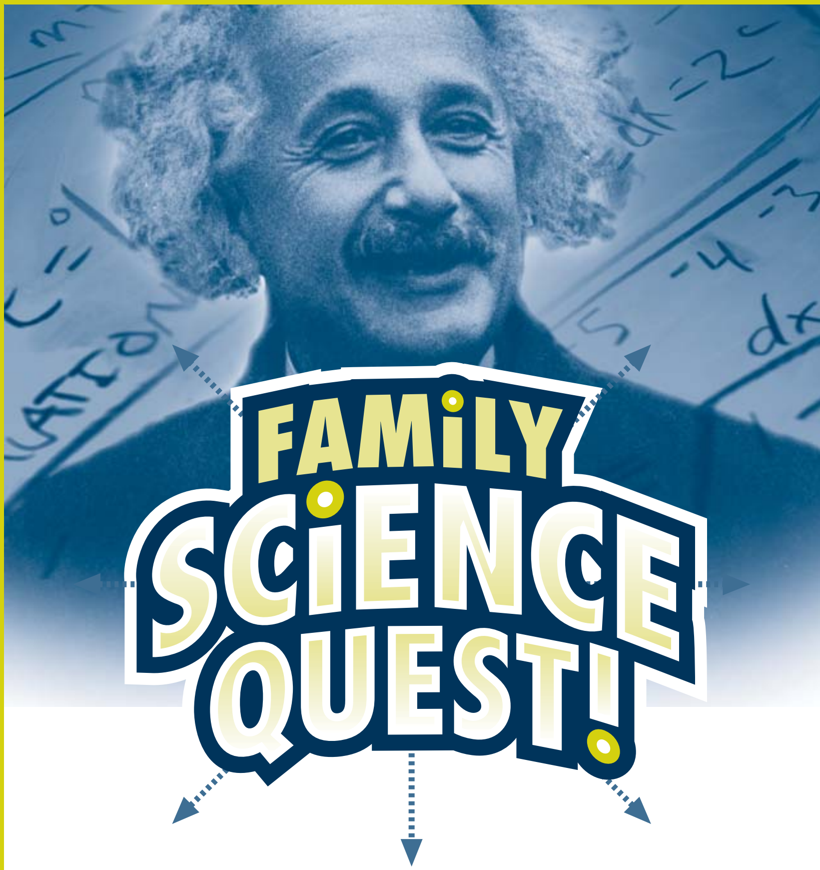
- Mylar balloon, medium or large size
- Dish or pan; flat, transparent, clear glass or plastic (like a pie plate)
- Ruler
- Clear tape
- Scissors

Carefully cut the Mylar balloon open near the bottom to release the gas inside without popping the balloon. Cut the balloon open along the seam so it resembles two flat circles. Cut thirty (30) strips of Mylar, 1/4 inch wide by 5 inches long. Using the tape and the ruler, attach 15 of the strips on one side of the glass dish, 1/4 inch apart, shiny side facing you. On the other side of the glass dish, attach the other 15 strips, shiny side facing you, directly opposite the first strips. The pattern should look like the illustration below, on both sides of the dish.

This device will help you observe an optical illusion. Your brain will think you are seeing something differently than it actually exists. Stand face to face with a friend. Hold the dish a few inches from your face so the reflective strips are horizontal. Line your eyes up with your friend's eyes by looking through a clear strip. Shift your eyes up to the mirrored strip above. What do you see? Can you make your friend's face appear to change into yours? How does this look different than what you observed at the You and Me exhibit in the Life exhibition area? Where is the light being transmitted? Where is the light being reflected?

THIS FAMILY SCIENCE QUEST WAS MADE POSSIBLE WITH FUNDING FROM:
GCAC GREATER COLUMBUS ARTS COUNCIL

P A R E N T ' S G U I D E



HOW TO USE THIS GUIDE

Experience COSI exhibits in a whole new way by using the questions, information and activities found in this guide.

Get more out of your visit by making hypotheses, asking questions and using all your senses to observe the exhibit. What is going on around it? What sounds do you hear? How does it feel? What is your reaction? Inside, you'll find starting questions (Inquiry Starters), information (What's Going On?) and suggested directions on where to go next (Try This). The "Try This At Home" activities will further engage all the members of your group to continue learning at home.

WHAT IS INQUIRY LEARNING?

Many of COSI's exhibits are designed according to the principles of inquiry. The inquiry method of learning engages the learner to ask questions, make observations and draw conclusions. This way, you truly learn the content and the processes of science.

Physics

is the science of matter and energy and how the two interact with each other.

There are many branches of physics, such as:

ACOUSTICS—sound

OPTICS—light and vision

MECHANICS—forces on matter

THERMODYNAMICS—heat and energy

ELECTROMAGNETISM—electricity and magnetism

Albert Einstein

Albert Einstein (1879 – 1955) was a pioneer in developing a better understanding of these branches of physics. His work, especially the work of his "Miracle Year," 1905, changed the way we view the world around us. In particular, three important papers he wrote have since influenced all of modern physics.

The first of Einstein's 1905 papers said that light behaves like a stream of particles with defined, discrete and measurable energies, called "quanta" (photo-electric effect). The second paper tested the kinetic theory of heat as heat affects the motion of small particles (Brownian motion). The third paper connects electromagnetism to ordinary motion (relativity), which was followed up with a shorter paper deriving one of science's most famous equations, $E=mc^2$. By several accounts, Einstein did not think his work ever would have any practical application! These papers have been described as revolutionary and have inspired studies in nuclear physics, cryogenics, solid-state physics, particle physics and plasma physics, to name a few.

Many people regard physics as a difficult science to comprehend. Principles of physics are easy to understand at a place like COSI. Use this guide to experience the really cool properties of physics presented in the exhibits. As you interact with them, consider how all the work of scientists like Albert Einstein contributed to our current understanding of matter and energy, and what a year he had in 1905!

STANDING WAVE TUBE → LEVEL ONE HALLWAY

Inquiry Starters: What happens to the beads in the tube when you turn the dial? Do you see patterns in the beads? Does a low sound produce a different pattern than a high sound? What would it take to make a flat pattern?

What's Going On: Pressing the button produces sound waves or vibrations at a particular frequency, or number of waves per period of time. Low sound waves and high sound waves have different wavelengths. These invisible sonic waves affect the very light foam beads in the tube and move them into a pattern with crests (tall points) and troughs (low valleys). By turning the knob, the wavelength changes and the bead pattern changes. Because we cannot "see" a sound wave propagating or moving through the air, we look to bounce sound waves off of barriers that will show the effect.

Try This: Head up the hall to Wired Voice. What happens when you change the frequency or wavelength of your own sound waves? Can you hear any patterns? How is your voice different than the sounds produced at the Standing Wave Tube?

SONIC FOUNTAINS → OCEAN

Inquiry Starters: Can you transfer energy to the bowl and make waves in the water? How does rubbing both handles make waves? Can you see any waves by rubbing only one handle? Do the waves look like waves on an ocean? What force do you need to apply and in what directions to get waves? What do the waves look like? Are there any spots along the bowl where there are no waves? Can you hear the waves? Can you feel the waves?

What's Going On: Energy can either be felt as heat (thermal energy) or observed as movement (kinetic energy). Moving your hands along the brass handles of the bowl transfers energy to the bowl and into the water because of friction. If you rub the handles at just the right frequency, the metal of the bowl will make sound waves and transfer the waves to anything the bowl touches, like the water and the floor. When two waves meet each other in the water, the waves can either cancel to produce no pattern (interference) or add to produce a larger pattern (big splashes!) Does the friction seem to heat up the handles? The two bowls are of different sizes. Does one bowl work better with slower or faster energy transfer?

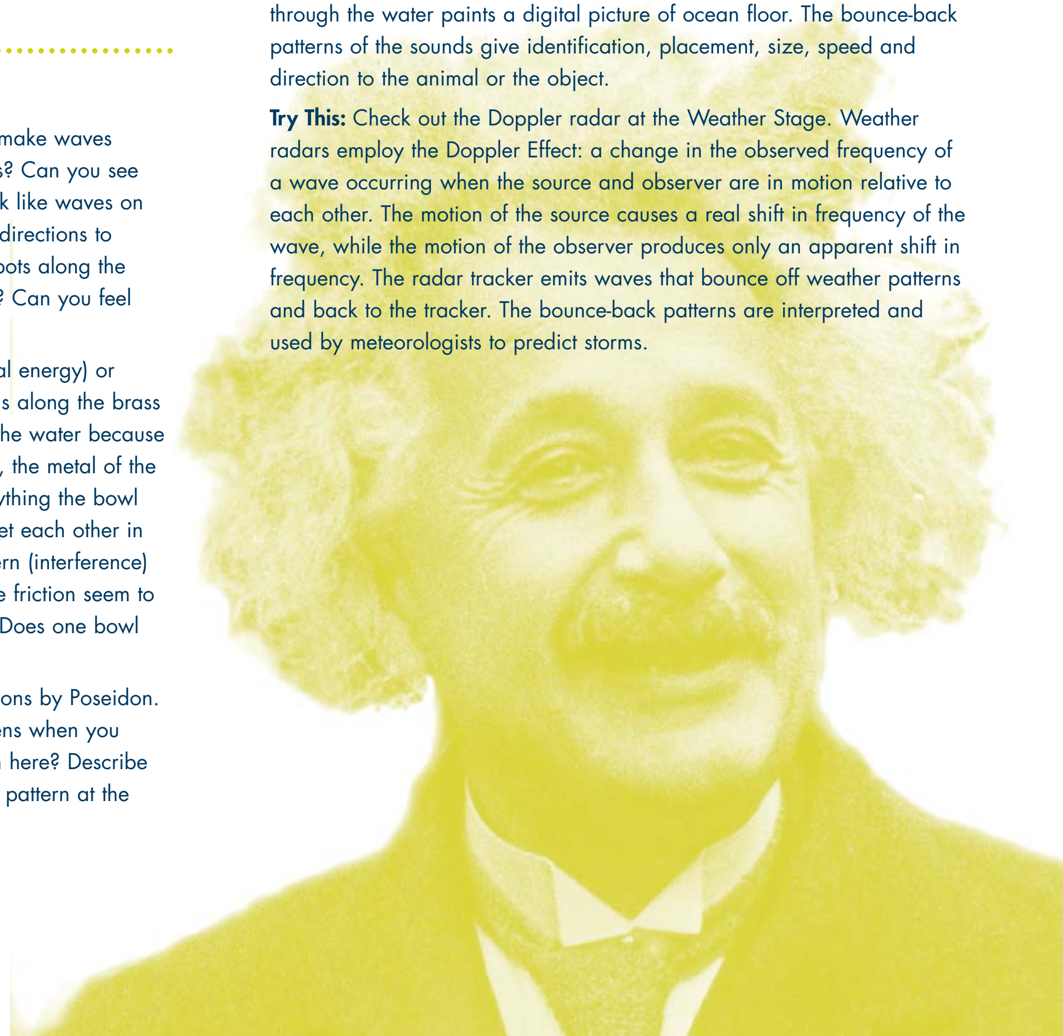
Try This: Observe the water coming out of the Water Cannons by Poseidon. Does the water seem to be coming in waves? What happens when you cross two streams of water? Is there an interference pattern here? Describe the shape of the pattern and compare it to the interference pattern at the Sonic Fountains.

ACOUSTIC SONAR AND SIDE SCAN SONAR → OCEAN

Inquiry Starters: Do you hear different sounds in the different oceans of the world? Do you hear different sounds at different depths? When you control the ship's sonar, what do you hear? Can you match a sample sound to a known sound? What can you see? Do these two types of sonar work the same way? Do sound waves behave differently in water than in air? Do sound waves behave differently through a solid?

What's Going On: Sonar is an acronym for **SO**und **N**avigation **A**nd **R**anging and uses sound waves to "see" where it is difficult to see. These two exhibits located in the Mechanical Room of the DSB Poseidon provide an opportunity to explore the ocean floor with sound waves. Acoustic sonar allows us to listen to sounds passing through the water of the ocean. Since water is much denser than air, sounds travel farther and faster through water than through air. Side scan sonar releases bursts of sounds and then waits for the echo to return. Knowing the speed at which the waves pass through the water paints a digital picture of ocean floor. The bounce-back patterns of the sounds give identification, placement, size, speed and direction to the animal or the object.

Try This: Check out the Doppler radar at the Weather Stage. Weather radars employ the Doppler Effect: a change in the observed frequency of a wave occurring when the source and observer are in motion relative to each other. The motion of the source causes a real shift in frequency of the wave, while the motion of the observer produces only an apparent shift in frequency. The radar tracker emits waves that bounce off weather patterns and back to the tracker. The bounce-back patterns are interpreted and used by meteorologists to predict storms.



ECHO FREE ROOM → LIFE

Inquiry Starters: What do you hear in this room? Is there any location that seems quieter than another location? Why are the walls shaped like peaks and valleys? Make a clapping sound in the room and observe what the echo sounds like. Exit the chamber and make a clapping sound just outside it. Compare the two echoes you heard. What causes an echo?

What's Going On: This room is an example of an anechoic chamber. Sound waves travel in straight lines from the source. These waves will travel until they contact a surface that reflects the waves in a straight line, but often in another direction. (Think about how a ball often bounces against the rail on a pool table at an angle.) An echo is a sound reflection that arrives at your ear after you no longer hear the original sound. The wedge-shaped projections on the walls and ceiling of the echo chamber absorb the sound waves so that no echo bounces back to your ears. Without an echo, your ears are unable to judge the direction or amplitude (loudness) of the sound waves. Often, this effect is more noticeable when you alternate being in and out of the room. The rest of the world seems louder and the chamber seems quieter. A fully enclosed anechoic chamber is so echo-proof, you can only hear the sounds of your own internal organs, like the beating of your heart!

Fun Fact: Many legends say that a duck's quack is the only sound that does not produce an echo. There has been a great deal of research among acoustic physicists to determine if this is true, including placing ducks in anechoic chambers like this exhibit and recording the sound of their quacks. Unfortunately for the myth, a quack does indeed produce an echo, although it is very quiet. Ducks just don't seem to quack near surfaces that reflect sound well!

YOU AND ME → LIFE

Inquiry Starters: Can you see your face in the mirror? What exactly are you seeing? How can you adjust the lighting so that you can see your friend's face? Can you get your two faces to merge in your field of vision?

What's Going On: Light waves move in all directions in straight lines from the source. Light can be reflected, transmitted or absorbed. We are able to see because light is transmitted from or through a source and the waves reflect off an object and into our eyes. By adjusting the amount of light on both sides of the exhibit, the amount of light transmitted through the glass changes. This causes the glass to act both as a mirror (reflector) and as a window (transmitter). How well can you match up faces through the window?

Try This: The You and Me exhibit shows a type of optical illusion by creating an image that tricks your brain. Check out the Tri-Zonal Space Warper in the Level 2 Hallway by the bridge to little kidspace. How does this spinning disk affect your vision? Are you seeing things?

Physics

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