Grades

3-5

Energy TEACHER GUIDE

How to Use your Field Trip Guide

Field Trip Guides provide structure and suggestions on a particular theme within COSI's exhibition areas. This will allow you, your students and your chaperones to be prepared to explore science and discover fun. We suggest you begin by selecting goals for your visit. These goals may include enhancing aspects of your science curriculum, understanding what it means to be a scientist, or showing your students that science learning can be cool and fun! If you have particular curriculum goals, use this Field Trip Guide to connect what you are doing in your classroom with our pre- or post visit activities. We recommend making copies of the Scavenger Hunt for each of your chaperones, so that they can guide the students through the exhibits and help record information. Our Scavenger Hunts are designed to be open-ended, and focus on process skills and scientific thinking. As a result, there may not be one right answer for each of the questions. This means you will NOT find an answer key for any of the scavenger hunts. Instead, you'll find descriptions the science concepts that we hope you'll experience. If you feel you need more clarification, you can always contact us at fieldtrips@mail.cosi.org.

COSI is a big place. As a result, you may not see everything in one day. Take your time-don't rush, and allow your students to explore the things that they find interesting. All too often kids are pulled away to the next area just as they start to get involved in an experience. Rather than trying to see it all, select just a few areas to spend your day. You will see less, but you will learn more.

Some COSI Exhibits related to Light, Sound & Energy

COSI is a great place to learn about the nature of energy, including light and sound. Explore the exhibition areas to find examples of reflection, refraction, waves, energy transfer, and energy conversion. You may also want to see the Gadgets LIVE Show on the Gadgets stage to learn about potential and kinetic energy. This show can be reserved for groups of up to 200 students.

Grades

3-5

Energy TEACHER GUIDE

GADGETS

Admired for their ability to change how we do things, gadgets are tangible proof of how creativity advances technology. The Gadgets exhibition area contains a variety of exhibits that allow guests to explore the building blocks of more complex gadgets: pulleys, gears, lasers, and electric circuits. Guests can examine the inner workings of everyday gadgets by taking them apart in the Gadgets Café. The café is an inventor's paradise that offers the tools necessary to investigate the gadgets we use daily. Energy exhibits include:

Magnetic Balancing Act - Touch a conductive target, strategically placed between two strong magnets, using your choice of a metal or a plastic wand. Materials which electrons move through easily are called conductors. Most metals make good conductors, which is why they are used to make wires for carrying electrical current. Materials that do not allow electrons to move easily through them are called insulators. Most plastics, rubber, and glass are good insulators. We use these materials to coat conductors to prevent ourselves form getting shocked by the electricity being carried.

Build-A-Circuit - Here you can manipulate circuit elements such as switches, light bulbs, resistors, capacitors, diodes, and LED's (light emitting diodes). The elements have magnets on each end. These can be joined together and attached to a power supply to create continuous electrical paths, known as circuits.

Current is the rate of the flow of electrons. Current electricity comes in different forms. There is direct current and alternating current. With direct current (DC), electricity flows in only one direction. This is the kind of electricity that is produced by a battery. With alternating current (AC) the direction of flow changes many times a second. This is the type of electricity that runs this exhibit and many of our appliances; it is the type of electricity that we plug into.

Bright Ideas - This is also known as the Hand-crank Generator. Guests alternately light fluorescent and incandescent bulbs by turning a handle and comparing the energy required to illuminate each. A hand lever allows guests to quickly switch from one light source to another. The incandescent bulb was invented by Thomas Edison. Inside an incandescent light bulb, there is a small-coiled wire called a filament. As the electrons pass through the filament, the wire is heated and begins to glow. It is the glowing of the wire that produces the light. The fluorescent bulb is fairly new to the world. This bulb is filled with a gas called Argon. Electrons are released into the bulb. As the electrons collide, they exert energy in the form of light (see Plasma Sphere), thus lighting the bulb.

Energy TEACHER GUIDE

Laser Table Laser technology is used in all sorts of gadgets, from CD players to telescopes. Guests manipulate semi-conductor lasers with lenses and mirrors. By changing the placement of the various components, guests can alter the path of the beams. The beams are revealed by fog emanating from diffusers within the table.

Laser is an acronym for Light Amplification by Stimulated Emission of Radiation. Light because its part of the light spectrum. Amplification because light is being amplified, or focused into a small beam. By Stimulated Emission of Radiation because electrons in the gas being used in the laser are excited by small particles of light called photons. Remember how we said light was a wave? This may seem like a contradiction, but is an accepted concept. Think of it as the duality of light. These particles of light if they all have the same energy level, or wavelength, will excite the electrons to a higher energy level. The electron does not tend to be in this state for long when it releases a photon in a random direction. We can, however, stimulate the electron to returning to its original state by bombarding it with an additional photon. When this happens it returns to its normal state and releases light as photon at the same energy level it was bombarded with. This process as said before focuses the light, thus we have a laser.

PROGRESS

Travel through time to the small Mid-western town of Progress, and discover the technology of 1898. Around the corner, find yourself a generation later in 1962 and see the changes progress makes. Take a look around Progress and make note of the types of energy being used to make the city work. These include electric lights above the town square, candlelight in the windows, and horse-powered carriages.

Telegraph - The electric telegraph translates mechanical action (dots and dashes from the telegraph key) into electrical pulses, and then back into mechanical action at the other end. It was all made possible by Hans Christain Oersted's 1820 discovery of the connection between electricity and magnetism.

Oersted discovered that a current-carrying wire forms a magnetic field around itself. By wrapping several coils of wire around an iron core, the iron becomes a magnet — but only as long as the electrical current continues in the wire. If the current is shut off at the other end, the electromagnet loses its pulling power. With a suitable transmitter, sending "on" and "off" electrical signals down a wire, an electromagnet attached to a spring and mounted above an iron plate can act as a receiver. When the current is "on," the electromagnet is pulled down to the plate. When the current is "off," the spring pushes the electromagnet up. The moving electromagnet makes the dots and dashes of Morse Code.

Grades

3-5

Energy TEACHER GUIDE

LIFE

Anechoic Chamber (Echo-free Room) - Step inside this room to discover a place without echoes. In most rooms, sound bounces all over the place and there are constant echoes, even if we don't really notice them. The way the walls in the anechoic chamber are shaped cause the reflected sound waves to hit each other instead of bouncing back to your ears. Clapping, snapping, singing, and shouting sound eerily quite in this room. This technology is used for automotive design, aerospace engineering, and testing sound equipment.

3D Audio - 3-dimensional audio creates an illusion that the events that make the sound you are hearing are truly happening in your immediate surroundings. With your eyes closed, it is especially hard to tell that the things are not there. Each set of headphones runs on a continuous loop and each is different. Under normal circumstances, our minds interpret where a sound is coming from depending on which ear hears it first and the lapse between that and the other ear hearing it. The reason this is able to confuse the mind is because these events were recorded using two microphones spaced as far apart as the average human ears, so the sound reaches the ears in the same way, as if, you were hearing it for real.

You and Me – Combine your reflections using a semi-reflective surface and two dimmer lights. Line up the reflection of your face with the another face . You should notice similarities and differences in your faces (if they are related, they may notice more similarities than they expected). Interesting fact: Humans and only a few other animals recognize themselves in a mirror. The mirror test is considered an important measure of self-identity. The reflective glass plays with your sense of self-identity by blending your image with another's.

Grades

3-5

Energy TEACHER GUIDE

OCEAN

Poseidon's realm takes two forms in this unique learning environment. On one side of the exhibition, Poseidon reigns majestic over a mythical playground, symbolizing the ancient means for understanding the sea. Here, you can explore the physical nature of water through laminar streams, eroding sand, and other activities, and at the same time being totally immersed in a theatrical recreation of the ocean's power. On the other side of Ocean, Poseidon is the namesake of an undersea research habitat, revealing the modern means for understanding the sea. Based on real ocean exploration technology, the "D.S.B. Poseidon" uses submersibles sonar to explore the scientific side of Ocean. Caution: It is likely that your students will get wet. Encourage them to take care not to get others wet in the process. Exhibits include:

The Sonic Fountains Energy is often felt as heat (thermal energy) or it can be observed as movement (kinetic energy). As wet hands move along the brass handles of the sonic fountain, friction occurs. This friction is transferred from the handles to the bowl and finally to the water in the bowl. The energy is able to transfer instead of dissipating as heat because the handles are attached to the bowl in such a way that vibration is possible.

As the water surface is observed it is noticed that some areas are calm while others move with vigor. This is called an interference pattern. Because of the circular shape of the bowl the waves hit each other. In some cases two wave crests hit, they add to each other, and become even taller. In other cases a wave crest will collide with a wave trough causing the waves to cancel each other out, leaving a smooth surface.

SONAR is a detection system based on the reflection of underwater sound waves. It listens with a sensitive microphone or hydrophone, for reflected pulses of submarines, obstacles, or marine animals. Acoustic oceanography is used to map the ocean floor and detect marine life. Side-scan sonar provides a different perspective on what the seafloor looks like. The equipment is usually attached to a "sled" that is towed behind a ship.

There are two types of acoustic sonar, active and passive. Active uses the same concept as side-scan, except it is attached to the submarine and emits acoustic energy out into open water, instead of, at the ocean floor. Active sonar is the familiar “pinging” sound you hear in submarine movies. Passive is where the sonar unit is placed under the sub and “waits” for sound to come to it, instead of, waiting for the reflections of sound it sent out. Sonar is an acronym standing for SOund Navigation And Ranging. It was first used in the 1920’s.

Grades

3-5

Energy TEACHER GUIDE

Vocabulary Words

Energy- The capacity of a physical system to do work.
Light- A small segment of the electromagnetic spectrum which creates illumination.
Sound- transmitted vibrations that stimulated the ear.
Reflection- When light bounces off a surface.
Refraction- When light bends in traveling from one medium to another.
Wavelength- the distance in which a wave repeats its pattern.

Standards

Grade 5 Physical Science Standards

3. Describe that electrical current in a circuit can transfer from one object to another by conduction.
4. Trace how an electrical current travels by creating a simple electrical circuit that will light a bulb.
5. Explore and summarize observations of the transmission, refraction and reflection of light.
6. Describe and summarize the absorption reflection and refraction of sound.

Process Skills are the actions that it takes to "do science." These are some of the scientific process skills that your students will be using as they explore the exhibits at COSI.

Observe - Use your senses to gather information.
Measure- Use tools and numbers to quantify objects or phenomena.
Categorize - Place objects into groups based on similarities or differences.
Communicate - Use words, pictures, graphs and diagrams to share your ideas.
Investigate - Follow a scientific method to formulate questions, conduct an experiment.
Apply - put the information you've gathered to use.
Infer – Make an assumption based on your observations.
Question– Wonder and ask about things and find ways to discover answers.
Predict - Decide what will happen in the future based on your observations.

Grades
3-5

Energy TEACHER GUIDE

Classroom Connections

Your visit to COSI should not a one day event, soon to be forgotten. Help your students make connections between the classroom lessons and your field trip by doing activities related to your visit. Before your visit, review the vocabulary words that the students will encounter, and brainstorm things they already know about technology or COSI in general. Give them descriptions of each of the areas and some of your expectations. If possible, review with the chaperones, so they know what to expect. After your visit, have your students draw pictures or write letters of stories about their experience, and list questions they still have that you could explore together.

Below are some lessons that you can use as pre-visit or post-visit activities to help connect your field trip to your classroom experiences and extend your students' learning. Consider doing one activity every day for a week before your visit.

Categorizing in the Classroom

Objective: Practice putting objects into categories.
Materials: Random objects from around the classroom, boxes or bins.
COSI Connections: What scientific themes can you find among the exhibits in Gadgets? Pick 3 exhibits and find something they have in common.
Procedure:

1. Split students up into partners or small groups.
2. Give each group a box of random objects from around the room that you have collected in advance, or give students the opportunity to go around the room collecting items.
3. Give each group a bin full of small objects. Observe the parts you collect. Are they all the same color? Shape? Size? What makes them different from each other? What similarities do they have?
4. Pick one property (or criterion) that can be used to categorize the parts. The criterion could be any property: size, shape, weight, or even smell. Think of two or three categories that the objects could be separated into. (For example: If your criterion is "Shape" you could have categories like Ball-Shaped, Box-Shaped, Pencil-Shaped)
5. Write the name of each category on the back of a sheet of paper, and place all of the objects on top of it.
6. Once all the categories have been made, groups should switch places with a nearby group and observe the categories that were made. Students should try to guess what categories were made by the previous team.

Grades
3-5

Energy TEACHER GUIDE

Flashlight Tag

Objective: Understand that light moves in a straight line.
Materials: One flashlight, a dark room (with some open space).
COSI Connections: Laser table in Gadgets
Procedure:
1. Select a student to be "it." This person gets the flashlight, and must remain in a middle section of the room designated by the teacher. All of the other students should spread out around the room.
2. When you say "go" the student with the flashlight must try to "tag" the other students by shining the flashlight on them. The light must hit a part of their body or clothing. Students can avoid getting tagged by moving out of the way or hiding behind other objects.
3. When a student is tagged, he or she becomes an obstacle frozen somewhere in the room. Other students can use these obstacles to hide behind.
4. As an alternative or extension activity, have students stay in one place, and use mirrors to reflect the light back and forth. The person who is "it" shines the light, and the rest of the students attempt to bounce the light from their mirrors to their classmates.

Discussion: What can you say about the light from the flashlight? How does it move? Does it bend around corners? Does it go through objects?

Coat Hanger Chimes

Objective: Understand sound & vibration.
Materials: metal coat hangers, string
COSI Connections: Sonic Fountains in Ocean and Anechoic Chamber in Life

Procedure:
1. Select several different metal coat hangers.
2. Cut two lengths of string about 3 feet long for each hanger, and tie them to different parts of the hanger.
3. Wrap the loose end of the strings around your index finger several times, and stick your fingers in your ears.
4. Bang the hanger up against a hard surface and listen. What do you hear? Were you surprised? Do different hangers make different sounds? What about different surfaces? Different lengths of string? What else could you change?

Grades
3-5

Energy TEACHER GUIDE

Creative Sounds

Objective: Combine language arts & science to describe sounds.
Materials: Containers with beans or seeds, rubber bands, CD of animal sounds, etc.
Procedure:

1. Ask your students to listen quietly to the sounds around them. What do they hear? Can they tell where those sounds are coming from? How?
2. Make a sound for everyone to hear, like shaking a rattle, banging a book, or playing an animal sound.
3. Ask the students to write down a word for that sound. For example, dropping a book might be "bang!, Smack!, or bap!" A barking dog may be "woof," "arf," or "rah." Do this with several different sounds, and have students write down a word for each one.
4. Ask students to read or write on the board the words that they came up with for each one. Are they all the same? What are some of the different sounds that people heard?
5. Continue the game by asking students close their eyes and listen. Tell students to make a loud or silly sound when you tap him or her on the shoulder. The rest of the students should write down a name for that sound, and guess what direction or which person the sound was coming from. At the end, everyone can make their sounds together for some crazy classroom music.

Why do we need Electricity?

Objective: Explain the reasons that electrical devices are important.
Materials: None
Procedure:

1. Each student chooses (but keeps secret) a particular electrical device. It could be anything from an electric hair dryer or toaster to an electric cable car or a photocopier.
2. Each student arranges her or his body to resemble the chosen device.
3. The teacher says, "Look at all of this junk! I need to get rid of some of it!" The student (we've discussed the rules of the game ahead of time) says, "No, you can't take me!" I reply, "Why not?" The student says, "Because without me. . ." (Here the student must come up with something bad that would happen if that particular device were not there. For example, a toaster might say, "Because without me you'd have to eat squishy soggy bread all the time." A photocopier might say, "Without me you'd get writer's cramp copying all those papers by hand." The idea here is that the students must come up with several real purposes for their objects.

Grades

3-5

Energy TEACHER GUIDE

Books to Check Out

<u>Sound</u>

· The Science Book of Sound by Neil Ardley. j534 121

· Experimenting with Sound by Robert Gardner. j534 403

· Using Sound by Sally and Adrian Morgan. j534 Morgan

· Sound FUNdamentals by Robert W. Wood. j534 Wood

· Sound by Terry Cash & Barbara Taylor. j534.076 207

· Sound Waves to Music by Neil Ardley. j534.078 Ardley

· Sound: A Creative, Hands-on Approach to Science by Wendy Baker & Andrew Haslam. j535.078 134

<u>Light</u>

· Bending Light: An Exploratorium Toolbook by Pat Murphy. j535.324078 Bending

Light and Color by Clarence Rainwater. j535 773

· Light by Brenda Walpole. j535 924

· Light by David Burnie. j535 Burnie

· The Super Science Book of Light by Graham Peacock and Terry Hudson. j535 Peacock

· Light Fantastic by Phillip Watson. j535.013 924

· Light by Robert Friedhoffer. j535.078 Friedhof

· Light FUNdamentals by Robert W. Wood. j535.078 Wood