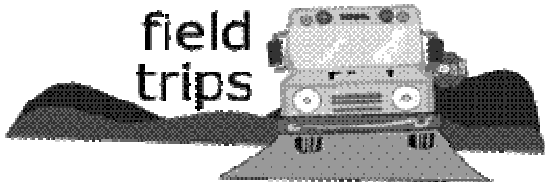


3-5 Force & Motion TEACHER GUIDE

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.

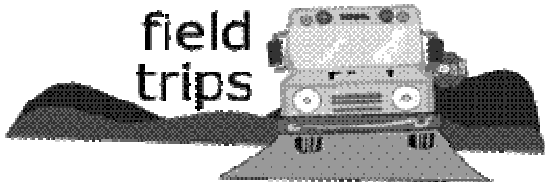
COSI is a big place. As a result, you may not see everything in one day. Take your time- don't rush, and allow your students to explore the things that they find interesting. All too often kids are pulled away to the next area just as they start to get involved in an experience. Rather than trying to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

Exhibits related to Force & Motion

COSI is a great place to learn about force and motion. Below are descriptions of exhibits related to force and motion. Push, pull, shove, roll and fly your way into science with these cool experiences. You will find them in Gadgets, Ocean, Big Science Park, Space, and the hallways. You may want to consider making a reservation for one of the following experiences to enhance your explorations of force & motion. All shows require 3 weeks advance notice.

The Gadgets LIVE Show – This dynamic demonstration includes potential and kinetic energy, force and motion, and explosions! Caution: Science can be LOUD! Reservation for up to 200 people at select times.

The Gadgets Café – Your group can spend some time in the Gadgets Café taking stuff apart or trying out our science menu. Reservations available for groups of 6 or less.



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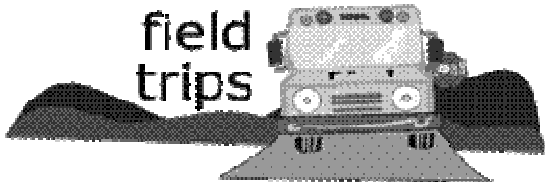
BIG SCIENCE PARK

Big Science Park is strictly Big Fun for your head and body as big experiments await your exploration. Big Science Park fosters the spirit of learning by putting you into the experiments, so you become a part of the science. As in all of the exhibition areas, there is no food, drink, or smoking in Big Science Park. Some great exhibits for your students to explore include:

- The Centripetal Generotor will allow you and your students to feel inertia, friction, gravity, and centripetal force in action. As the 'Rotor spins, your body is forced against the walls, so when the floor drops below you, your body remains suspended. Young children can focus on the idea of gravity, and a push or pull. This is experience is open weather permitting. Certain restrictions apply.

- The Granite Sphere - Are you strong enough to move a 2,500-pound object? Give the granite sphere a push and see how reducing friction can make things easier to move. The inch of water under the sphere allows for the sphere to roll easily than it would if it were in contact with the ground.

- The Giant Lever - Get a body-on understanding of simple machines as you lift a 2437-pound (1105.4 kg) 1961 Mercury Comet! This is a class-1 lever, with a fulcrum between the load and the effort. Try both ropes. Which one is easier? Which one takes longer?



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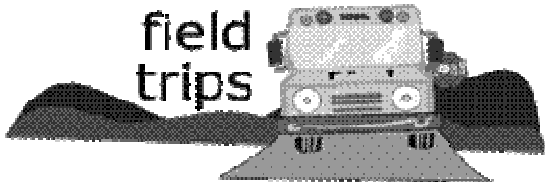
OCEAN

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 Cartesian Diver** Divers will sink when their density is greater than the water surrounding them. This is accomplished with a buoyancy compensator (BC) that they wear. As the air is removed, the BC will deflate. This decreases the divers overall volume, making him/her more dense than the surrounding water. Can you get COSI's diver to go up and down? How about remain neutrally buoyant (the middle)?
- **Erosion Table** As water is pulled by gravity to lower levels, it exerts a force of change upon the surface on which it travels. This force of change is called erosion. The erosion table demonstrates fluvial (water) erosion on landmass. Where does the sand go? Where is sand washed away faster? Slower? Why? Are there any areas that have no sand? Where? How would you explain this observation? What ideas do you have to stop the flow of water? What do you think will happen when the water is blocked? (Make and share predictions.) Have students construct a dam with the sand and compare their predictions with their observations about the dam.
- **Ball Fountains** You will notice that the ball is spinning. The moving water sticks to the bottom of the ball and then is thrown from the top of the ball. The thrown water moves in one direction, causing the ball to move in the other direction. This is an example of Newton's Third Law of Motion: For every action, there is an equal and opposite reaction.
- **Laminar Flow** The water coming out of the water cannons is an example of laminar flow. Notice that this water is much less turbulent than the water in your kitchen sink. Does if feel or look different than other streams of water you have seen? How is it different?
- **Water Jets** Notice water popping up from the floor. Pumps push the water up and gravity pulls it back down. What else doe you notice? Does the water spray out or stick together? What makes it do that?



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GADGETS

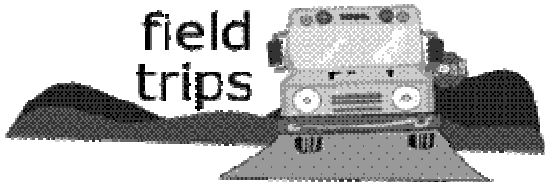
Admired for their ability to change how we do things, gadgets are tangible proof of how creativity advances technology. The Gadgets exhibition area contains a variety of exhibits that allow guests to explore the building blocks of more complex gadgets: pulleys, gears, lasers, and electric circuits. Guests 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. Force and motion exhibits include:

- **Pulley Chairs** - An example of a simple machine that makes life easier. Each chair has a different number of pulleys, so you can try them all and feel the difference. If there are more pulleys, you expend less effort.

- **Air Cannon** - Have some fun with the Air Cannon in the back of Gadgets. Toss a ball in and turn the handle to launch. Air from the compressor will push the ball. Try two or five or ten balls. What happens?

- **Flying Propellers** - Control the speed of the flying propellers, causing them to rise, fall, or hover on a pole that reaches the ceiling. The faster the propeller spins, the more air it pushes down, causing lift.

- **Newton's Nozzles** - Balance a ball inside a path of airflow. Air is pushing up on a ball. Since the ball is curved, the air travels over top of the ball. This action holds the ball in place. This is an excellent demonstration of Newton's third law: for every action there is an equal and opposite reaction.



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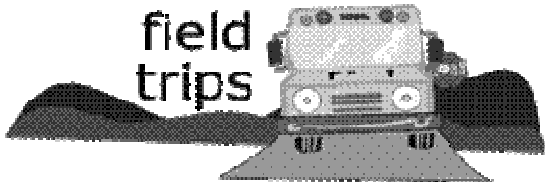
SPACE

How big is the universe? What drives humanity to the stars? These are questions that have piqued the curiosity of many, and whose answers change as we gain more information about the universe. Space offers opportunities to think about these questions while at the same time relive some of history's great space explorations. Enter the exhibit through the Black Hole, a cool spinning sensory experience, or sit in the Living Room and watch the history of space travel. Please ask students to use caution in the tunnel.

- Overhead Thrusters Listen for the hissing sound. This is the sound of air being pushed through the thruster's nozzles, causing thrust. Thrust is the primary means of acceleration in space. In space, propellant is pushed through a nozzle instead of air. Thrust from the air being forced through the nozzles causes the thruster to move. The thruster has inertia. Inertia refers to an object's tendency to keep moving or the resistance to changes in motion. Until an outside force (air resistance, friction, collision) acts upon the thruster, it will continue to move. These thrusters will eventually stop on their own due to drag. The primary forces are air resistance (drag) and friction. In space, however, there is little gas, which means, little drag. To stop a thruster here or in space, apply thrust in opposite direction. How do Newton's laws of motion relate to this exhibit? Newton's first law of motion (objects in motion tend to stay in motion) explains why the thruster continues to fly after the thrust is disengaged. The thruster will continue to fly until some force opposes that motion. Newton's second law (force = mass * acceleration) dictates the rate at which the thruster will accelerate when a force is applied either from thrust or air friction. Newton's third law (every action has an equal and opposite reaction) is demonstrated by the simultaneous push the thruster exerts on the fuel (air) and push the fuel exerts on the thruster.

- The Rocket Launch exhibit invites guests to "fuel up" a rocket by charging a projectile with compressed air. Guests then perform their own countdown and release the miniature rocket, watching it arc 25 feet up to the ceiling. Rockets go because of Newton's Third Law: For every action there is an equal and opposite reaction. Spent fuel escapes the rocket through a hole called the nozzle. This is the action. The rocket moves away from the spent fuel, in effect pushing against it. This is the reaction. The more spent fuel the rocket leaves behind, and the faster the spent fuel moves, the faster the rocket will fly. Notice that the rocket does not push against the launch pad, the air, or anything else except its own fuel. This is the reason rockets can work in outer space.



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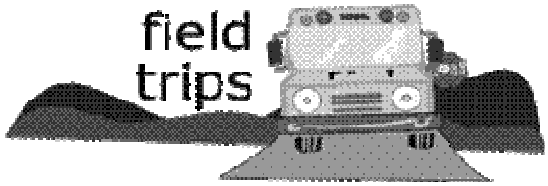
Vocabulary Words

These are some Force & Motion terms that you should be familiar with as you explore COSI with your students:

- Force: A push or pull on an object. You can observe a force when something flies, falls, spins, drops, rolls or stops.
- Gravity: The earth's pull on things.
- Mass: A measure of quantity of matter in an object.
- Newton's First Law of Motion- An object in motion will stay in motion unless acted upon by an outside force, or things will keep on doing what they are doing until something stops them. This is also known as inertia.
- Newton's Second Law of Motion: Force =Mass x acceleration, which translates to this: the more mass an object has, the more you have to push it. The harder you push an object, the farther it will go.
- Newton's Third Law of Motion: When you push on an object, it pushes back, and is often referred to as action and reaction. This is not the same as cause & effect.
- Speed: how far something goes in a certain amount of time.
- Velocity: How fast and in what direction something is going.
- Weight: The amount of gravitational pull on an object.

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.



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Standards

Grade 3 Physical Science

1. Describe an objects position by locating it relative to another object or the background.
2. Describe an object's motion by tracing and measuring its position over time.
3. Identify contact-non-contact forces that affect motion of an object (e.g) gravity, magnetism & collision.)
4. Predict the changes when an object experiences a force (e.g. push or pull, weight, friction.)

Grade 3 Scientific Inquiry

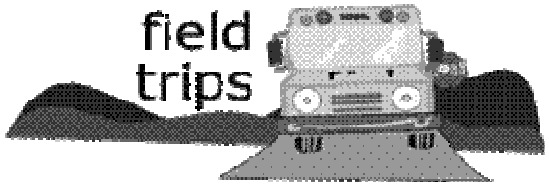
1. Select the appropriate tools and use relevant safety procedures to measure and record length and weight in metric and English units.
6. Communicate scientific finds through a variety of methods (e.g. pictures, written, oral and recorded observations.)

Grade 3 Science & Technology

4. Use a simple design process to solve a problem (e.g. identify a problem, identify possible solutions and design a solution.)
5. Describe possible solutions to a design problem (e.g. how to hold a paper down in the wind.)

Resources

http://www.kidsolr.com/science/index.html
Lots of excellent science links for kids.
www.howstuffworks.com - Just about everything you've ever wanted to know is described at this informative and understandable website.
www.physics4kids.com This website, although void of activities, has clear and accessible definitions of a variety of physics terminology such as energy, forces, and friction.
www.exploratorium.edu/snacks/iconmagnetism.html Some cool activities from the Exploratorium related to magnetism.
www.sciencenetlinks.com/lessons.cfm?BenchmarkID=4&DocID=405
A lesson on gravity and other forces related to the launch of an object.
www.mos.org/sln/Leonardo/InventorsToolbox.html
Description of simple machines



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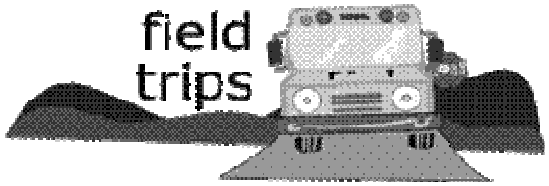
Classroom Connections

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.

Newton's in the Driver's Seat

Objective: To understand Newton's Laws of Motion.
Materials: 2 identical plastic toy cars, yardstick, science journal.
COSI Connections: Rockets & Thrusters in Space, Ball Launcher in Gadgets, Centripetal Generotor in Big Science Park
Procedure:
1. Place the two cars about 60 centimeters apart on a smooth flat surface.
2. Count down, then gently push the cars toward each other.
3. Note the point in which the cars make contact, and mark this spot, and write down any other observations you have made.
4. Measure the distance that each car travels and write this down.
5. Do at least three more trials, and record your findings.
6. Next, vary the experiment by changing the distance, speed, or amount of weight on the cars. Remember to change only one variable at a time.
7. What happens when the cars made contact? Did changing variable produce the results you expected?



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An Object in Motion

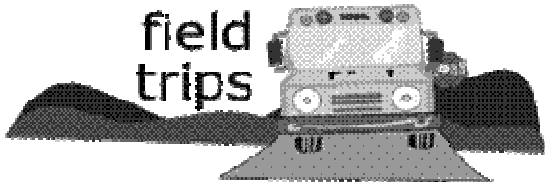
Objective: Demonstrate that an object continues to move due to inertia.
Materials: balloons, tape, straws, string
COSI Exhibit Connections: Rockets and thrusters in Space, Rocket in Gadgets Live Show
Procedure:
1. Cut a length of string 10 feet long and run the end of it through a plastic drinking straw.
2. Give each group of students a balloon and some tape.
3. Inflate the balloon (make sure only one person from the group does this) pinch it closed, and tape it to the straw. What happens when you release it? What is the action and what is the reaction? What can you change or add to make it go faster? Slower? Farther?

Paper Airplane Contest

Objective: Design the best paper airplane or helicopter
Materials: Sheets of paper, scissors, tape
Procedure:
1. Challenge students to design an airplane or helicopter that will fly the farthest or spend the most time in the air.
2. Test out your planes, make changes to your designs and test again. What works best?
3. Explain one change you made that had the biggest impact.

In the News

Objective: Understand a law of motion through writing.
Materials: Paper & pencil
Procedure:
1. Early scientists like Sir Isaac Newton, Albert Einstein and Galileo, made some fundamental discoveries of physical science. The fables tell us Newton noticed gravity when an apple fell from a tree. Pretend you are a reporter living along side one of these great scientists. Select one of their discoveries. Do some research on what it is, and write a story or newspaper article about the discovery of it. In your article, talk about how the scientist first made this discovery, what was done to prove it was true, and why it made him or her famous.
2. An alternate assignment is to pretend that YOU made the discovery, and write the article about how you found out that your force exists. You can even name it after yourself.



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After Your Visit/Assessment

Use the following activities to assess the impact of the visit to COSI on your students' knowledge, attitudes, and perceptions. Use a standard project rubric to assess the product of each of these projects. If you would like, send stories, pictures, or descriptions of your project to:
COSI c/o Field Trips, 333 W. Broad St., Columbus, OH 43215.

Make a Great Gravity Gizmo!

Objective: Use all of your understanding of force and motion to build a device that will cause an object to move all around your room (think of the game "Mousetrap," or a roller coaster).
Materials: Random objects brought in from home or around the classroom.
Procedure:
1. Work together to build the biggest, longest, craziest path you can. Some components you may want to include:
- A ramp made from cardboard tubes or pipe insulation
- A boat that sails across a sink full of water
- A catapult that launches the ball
- A rocket balloon that crosses a string
- A pulley that lifts a basket

2. Label components and forces along the way.
3. Test and revise your design as needed.
4. What forces did you notice? How many devices did you use? How many different ways did you make your marble move?

What is science?

Objective: Assess perceptions of science
Materials: pencil & paper
Procedure:
1. Ask students to write an essay or draw picture answering the question "What is science?"
2. Discuss some of the following: What is science? What are some of the benefits? The challenges? What are the best parts of science? The worst parts? What does a scientist look like? Are you a scientist?