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Mathematics 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 of 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 everything, select just a few areas to spend your day. You will see less, but you will learn more.

COSI Exhibits related to Mathematics

COSI contains a wonderful atmosphere in which to demonstrate just how abundant math is in our daily lives. Mathematics helps us to understand the surrounding world, incorporating data, measurements, and scientific observations. Mathematics is universally applicable offering science both a standard for order and a basis of truth. You will find the proof of math's profusion as you explore Gadgets, Space, and Ocean.

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GADGETS

Gadgets solve problems, do work, and can be used to model and explain mathematics. Any machine or creation is usually a culmination of many pieces working together. The gadgets exhibition area contains a variety of exhibits that allow guests to explore the building blocks of more complex gadgets and observe how the pieces come together.

Build a Bridge At the bridge building exhibit, visitors can see how diversely shaped structures piece together into a larger more useful creation. See how many differently sized pieces can be used. Observe how varied the final structures can be.

Air Cannon Have some fun with the air cannon in the back of Gadgets. Toss a ball in and turn the handle to launch. Try shooting five or ten balls simultaneously. Observe the correlation between the number of balls shot and how many make it into the funnel. Is there an increasing probability of success when more balls are launched?

Magnetic Distortion Guests can distort a television screen picture by moving magnets near the screen. A television screen shows a picture when a stream of electrons hits the screen, causing the chemicals in the screen to light up in just the right places to produce a picture. Placing a magnet on the screen distorts this flow of electrons therefore distorting the picture and the color. Create a pattern with the magnet on the screen. What is changed? What colors do you see that were not there before?

Giant Engine It only takes teamwork and a little order to make this engine turn. The giant engine is a functioning engine that uses people to power its parts. Three people push pistons in sequence to power it. Follow the pattern of pushing each piston whenever its green light is lit and see how fast you can make the engine spin.

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SPACE

Once you enter the dizzying black hole of Space, you can ride in a space capsule, determine your weight on the moon, and maneuver a rover through a Martian landscape. While on your visit, study some of history's great space explorations and the technology that is used today. Observe how mathematics plays a role in the commands used to operate necessary machinery and in determining relative masses and pressures in outer space.

Animation Station Guests will create their own unique sci-fi, space movie frame by frame using the provided "props." Record, Play, and Erase buttons will guide them through the routine of setting up props, taking a picture, moving the props, and taking another picture. These steps will be repeated until the guests have created their own mini space movie. Animations are made of thousands of frames of film shown in rapid succession. There are usually 24 to 30 frames per second in film. Persistence of vision is the brain's ability to blend the rapidly changing frames into a single, moving picture. This is a result of the fact that a human eye retains an image for about one-twentieth of a second after seeing it.

Gravitational Comparison This interactive display demonstrates the weight of a single object affected by the gravity at three different locations. One tends to ask "How much do I weigh?" when what should be asked is "What is my mass?" Mass is a measure of the quantity of matter in an object. Your mass will remain the same from planet to planet; it's your weight that would change. Weight is the amount of gravitational pull on an object's mass, the higher the gravity, the more the weight.

Figure 8 Guests will release small balls into this unique double vortex to experiment with inter planetary gravity, trajectories, and angular momentum. The balls will follow a certain path as they approach the holes, this path should be recognized as a trajectory (figure 8). A free-return trajectory is the safest way to fly to the moon. The gravity of the moon would hurtle the spacecraft back towards earth if its engine was to fail.

Arm Chair Astronauts This exhibit offers an opportunity for guests to pilot three of NASA's most innovative and challenging creations: the Space Shuttle Orbiter, the Lunar Module, and the Manned Maneuvering Unit. Guests get to operate these creations and attempt to land them accordingly. Without being in control of the surrounding elements, can you land safely?

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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 and mathematical properties of water through laminar streams, eroding sand, and other activities, while 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, now symbolizing the modern means for understanding the sea.

Fountain of Poseidon This enormous fountain will be one of the first things noticed in Ocean. Play with the water guns and observe how when the gun is aimed at different angles, the distance the water shoots and the path it takes are changed. Is there an ideal way to position the gun so that the water shoots directly into one of the basins? Working together, can you make the water from the guns intercept each other's paths?

Ball Fountains The ball within each water stream stays up because some water hits the ball and is deflected downward. The ball is always off-center in the stream and will spin. See if the balls stay up for equal amounts of time on each of the spouts. Does the height of the spout have any effect? How long can a ball balance?

Erosion Table Whenever water flows to the sea, it transforms the land. Moving water carries with it the solids that are in its path. As more sand is removed, the flow of the water will increase. This abundance of water will take away more sand with it as it flows, creating erosion. How can the flow of the water be slowed? What do you think will happen when the water is blocked?

Build-A-Fountain At this exhibit, one can combine pipes, valves, and fountainheads in various ways. Visitors can combine all these pieces into a mechanism of their own and hypothesize where the water will flow next. The addition of fountainheads allows the explorer to observe what water does when forced through different openings.

COSI Submersible The COSI Submersible is a Cub class submarine. The Cub class was used throughout the sixties and early seventies. They were designed to hold two sailors and to dive for two to five hours. The crush depth of this class of sub is 500 ft though most would not dive deeper than 225 ft in it. However, on one of its missions it had to collect hydrogen bombs that were lost off the coast of Portugal and was responsible for finding one at 600 ft below the surface. Encourage students to crawl into the sub and examine all of the switches and controls. What do you think each one does?

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Vocabulary Words

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

Pattern: A repeated design or recurring sequence.
Mass: The quantity of matter in an object.
Distance: The amount of space between two points, lines, surfaces, or objects.
Flow: To glide or pass smoothly.
Increase: To get larger in size or number.
Decrease: To get smaller in size or number.
Units: A definite quantity used as a standard of measurement.
Order: To arrange according to a certain criterion.

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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Mathematics Standards

Kindergarten Number, Number Sense, and Operations
- 4. Determine "how many" in sets (groups) of 10 or fewer objects.
- 5. Relate, read, and write numerals for single-digit numbers (0 to 9).

Kindergarten Measurement
- 2. Compare and order objects of different lengths, areas, weights, and capacities; and use relative terms, such as longer, shorter, bigger, smaller, heavier, lighter, more and less.

Kindergarten Geometry and Spatial Sense
- 1. Identify and sort two-dimensional shapes and three-dimensional objects.

Kindergarten Data Analysis and Probability
- 1. Gather and sort data in response to questions posed by teacher and students.

Grade 1 Measurement
- 4. Estimate and measure lengths using non-standard and standard units.

Grade 1 Geometry and Spatial Sense
- 1. Identify, compare, and sort two-dimensional shapes.
- 2. Create new shapes by combining or cutting apart existing shapes.

Grade 1 Patterns, Functions, and Algebra
- 5. Describe orally and model a problem situation using words, objects, or number phrase or sentence.

Grade 1 Data Analysis and Probability
- 8. Describe the likelihood of simple events as possible/impossible and more likely/less likely.

Grade 2 Measurement
- 1. Identify and select appropriate units of measure for length, volume, weight, and time.

Grade 2 Geometry and Spatial Sense
- 2. Predict what new shapes will be formed by combining or cutting apart existing shapes.
- 3. Recognize two-dimensional shapes and three-dimensional objects from different positions.

Grade 2 Patterns Functions and Algebra
- 2. Use patterns to make generalizations and predictions.
- 3. Create new patterns with consistent rules or plans, and describe the rule or general plan of existing patterns.

Grade 2 Data Analysis and Probability
- 7. List some of the possible outcomes of a simple experiment, and predict whether given outcomes are more, less, or equally likely to occur.

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Classroom Connections

Your visit to COSI should not be 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.

Professor Pocket-Protector

Objective: Exercise your measuring skills by using standard and non-standard units.

Materials: String, twine or yarn, precut in lengths of 6", 12", 18", 24"
Enough rulers for one for each group
Enough coins for one for each group
Objects to measure/measure with found in the classroom or brought in from home (ex: pink rubber erasers, pen caps, coins, stamps)

You can ham this up and dress up as the Professor or pretend to be communicating with her on your cell phone. The great scientist, Professor Pocket-Protector, is in need of your help! For her latest experiment, how to make the perfect sugar-free bubble gum, she needs several pieces of string/twine/yarn exactly 18" long (she has lots of hair) to tie her hair back so it doesn't get in her face. (Her hair keeps getting in her face making it extremely difficult to do her experiments).

Procedure:
1. Break the students up into small groups. Give each group a piece of yarn 18" and 2 other pieces of yarn (6", 12", 24", etc).
2. Have the students measure each piece of yarn and write down the different lengths, making sure to set aside the 18" piece of yarn to give to the teacher to send to Professor Pocket-Protector.
3. Collect all the rulers and hide them.

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Thanks for finding the correct strings for the Professor; now she can do her experiments!
But, oh no! The Professor has another dilemma and she needs YOUR help. She wants to add the largest item first, but she's lost her rulers (and so have we!).

Procedure:
1. Break/Keep the students into/in their groups. Give each group a coin and something to measure (ex: a pink rubber eraser for elasticity, a picture of a flower or a pencil with flowers on it for color, etc). Have them write on the blackboard how long their item(s) is/are in measurements of the coin (ex: two pennies long). Try to arrange it so that two of the items of different lengths measure the same number of coins (ex: one measures 5 nickels and one measures 5 dimes).
2. Hold up the different coins (use 2 or 3 depending upon the class). Ask which coin is biggest and which is smallest.
3. Based upon that answer, do they think that (for example) the item with a measurement of three dimes will be larger than the item with a measurement of three nickels? Make a prediction as to which item you think will be longer.
4. Hold up the two items for comparison. Which one is longer? Did you guess correctly?

Congratulations on a job well done! Professor Pocket-Protector can now finish her experiment.

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Post-Visit Activities/Assessment

A few days after your visit to COSI, take some time to talk about what you saw and did. Encourage students to write a story or draw a picture about one of their favorite things. As a force & motion assessment, ask students to find examples of different forces around the room, school, or at home, and tell you about them. The COSI Team would love to hear about what you learned. Send stories or letters to: Field Trips, COSI Columbus, 333 W. Broad St., Columbus OH 43215.

Identifying Patterns

Objective: Learn how to identify patterns, find the rule (if applicable) and predict next items in the pattern.

Materials:

Paper
Pencil
Chalkboard/Whiteboard and writing utensils

Procedure:

1. Go over the definition of pattern and repetition.
2. Write a pattern on the board, for example:
   ▲ ● ● ▲ ● ● ▲ (rule: 1 triangle then 2 circles)
   (You can use other symbols too, such as flowers or smiley faces).
3. Which symbol do you predict will come next? Why? What is the pattern/rule?
4. Repeat with other non-numerical patterns (flowers or exclamation points), having the students predict the next 2 or 3 symbols in line
5. Now write a pattern with numbers. Ex:
   1 2 3 4 5 (rule: +1)
   2 4 6 8 10 (rule: +2)
   10 9 8 7 (rule: -1)

For more advanced classes:

1 1 2 3 5 8 (rule: each number is the sum of the two preceding numbers)

6. Which number do you predict will come next? Why? What is the pattern/rule?

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Tangrams

Objective: Identify 2-dimensional shapes and see what shapes are created when a shape is divided in half or when 2 shapes are put together.

Materials: Scissors
Copies of shape sheets (following), either pre-cut (please do not cut the circle and the square in half!) or not cut
Construction paper (or some other paper upon which to glue the shapes)
Glue or tape
Markers or crayons

Procedure:
1. If you haven't already, have the students cut the shapes out (do not cut the circle or the square in half yet.
2. Ask the students which each of the shapes are (one cutout at a time).
3. Have the students put all the shapes of each kind in a group.
4. Ask what do you think will happen if we put the 2 small squares together? What shape can be made?
5. Ask what do you think will happen when we cut the circle and the square in half? What shapes will be made?
6. Have the students regroup the shapes into the correct order.
7. Challenge the students to make the tangram of the house.
8. Have the students make a design out of the shapes (doesn't have to be anything definable). Glue the pieces on a separate piece of paper/construction paper and color it.

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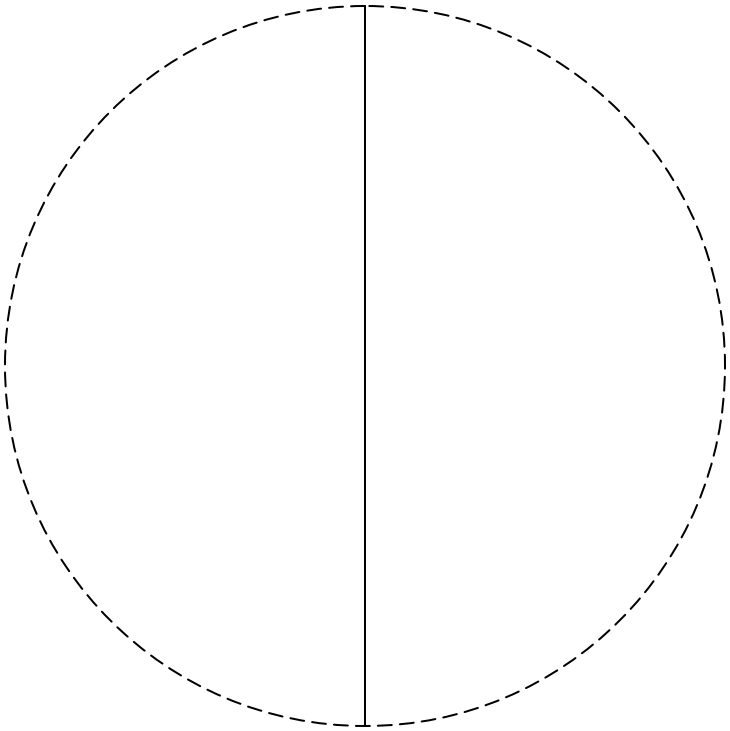
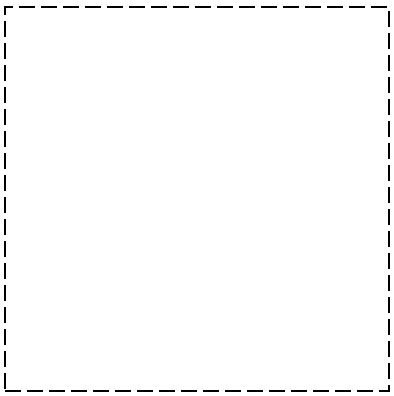
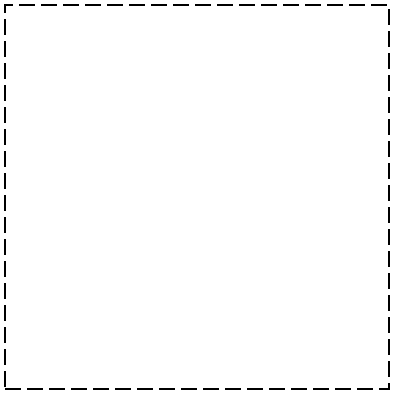
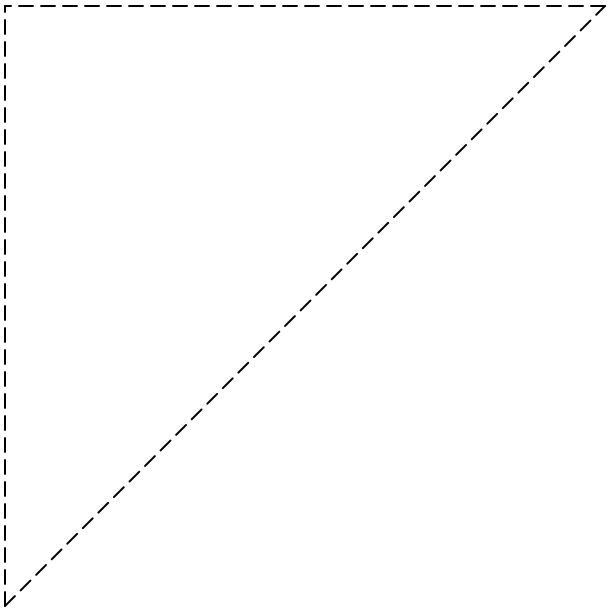
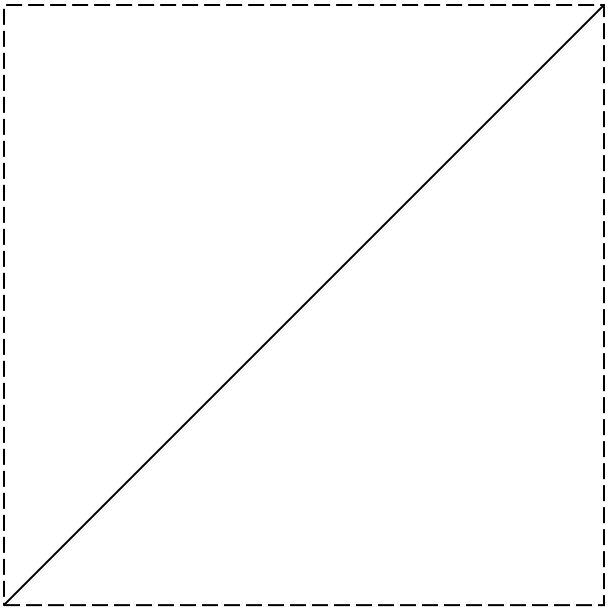
Cut along dotted lines only!











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