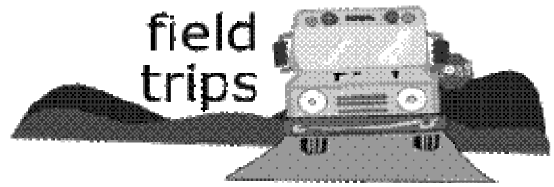

3-5 Mathematics TEACHER GUIDE

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 Ocean, the Weather Station, Life, Progress, and Gadgets.

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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 submersible's 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:

Pressure When using the pressure simulator one can feel how the pressure exerted on the body changes as one is submersed in water. Keep in mind that 1 atmosphere equals 33 feet which is equal to 14.7 pounds of pressure. Make note of the readings on the dials, one denoting the depth, the other the water pressure. Observe how the pressure felt changes with the depth. What happens when the depth increases? Do you think that there is a limit to how far one can sink before the pressure becomes unbearable?

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.

Submersibles The Cub class submarine was used throughout the sixties and early seventies. They were designed to accommodate 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 take it more than 225 ft below the surface. This submarine was previously used by the Air Force to retrieve target drones from a firing range over a lake. The Nautilus submersible allows explorers to travel deep in the ocean without suffering the extremes of pressure normally felt at those depths. They can dive to depths of 13,000 ft. Guests can climb into this submersible and settle in at one of the three view ports to observe a dive into the ocean abyss, feel the sub making its descent, and discover the mysterious worlds that exist miles below the sea's surface while listening to communications from the surface controllers.

Waves Waves have mathematical properties that can be analyzed to understand the motion of the ocean. Observe the many exhibits in Ocean that describe wave behavior. Try to determine the pattern and the shape that the waves follow and how it can be altered.

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Tornadoes The Mist Tornado uses vaporized water to show us the movement of a tornado's vortex. A vortex is the narrow column of spinning air, which makes up a tornado. Study the data posted on the wall and observe the average number of tornadoes occurring in each of the states per year. What does this average mean for the state of Ohio? Now look at the graph of the average number of strong tornadoes per year. Determine what the range (the possible y-values) is for this data. Next determine the mode (the most frequent y-value). What do these values mean in terms of the number of strong tornadoes occurring per year?

LIFE

We are curious about our bodies, awed by the power of our minds, and eager to probe the depths of our own human spirit. Life tells the story of you through three areas: Body, Mind, and Spirit. View surgery, see decomposition in action, age your face, and play tricks on your mind. The experiences are as real and personal as life itself.

Body Noises Guests can orchestrate a symphony of human body noises on this scaled keyboard. From coughs to vomit to sneezes, this humorous exhibit can be enjoyed by all ages. When guests press the "scale" button the piano tunes itself automatically and can be played as if it were a real piano; familiar tunes now sound completely different! Although the notes do not sound as they should, what patterns emerge in their sounds?

Anechoic Chamber (Echo-free Room) What would the world sound like without echoes? Step in side this room to find out. 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 even shouting sound eerily quiet in this room.

Praxinoscope Guests explore the phenomenon of persistence of vision through their artistic modeling of several moveable hands in this exhibit. Bend and shape all of the hands on the spinning wheel. What happens when the wheel is spun? The hands appear to move in a fluid motion and what are several hands appear to be one. Does changing each individual hand appear to change the motion of the hands when spun? Make note that you are watching the reflection of the hands, so that you are seeing the opposite of what you set up. Persistence of vision is a process by which the brain turns a set of static images into motion. This process is the basis for animation and modern film techniques.

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PROGESS

Travel through time and interact with the people of the small Mid-western town of Progress and the technology of their time in1898. Around the corner, find yourself a generation later in 1962 and see the changes Progress makes. Take a step into the past to explore topics like communication, transportation, and recreation while making meaningful calculations along your way.

-At the grocery store, weigh out different amounts of produce and record the results, be sure to include the units. Do you think these goods cost more or less today? By about how much do you think they differ?
-Compare the costs of objects at the drugstore in 1962 with the prices of today. For example a toothbrush that costs $.10 in 1962 now costs $1.50. Which objects have increased the most in price? How do you think we have been able to manage and pay these higher prices?

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 many mathematical properties. Throughout the exhibit one can work with linear and planar geometry, reflections, congruency, and angles.

Pulley Chairs Guests lift themselves off the ground using three different pulley systems: a 2-pulley, a 3-pulley, or a 4-pulley arrangement. Guests discover the relationship between the number of pulleys and the amount of force needed to pull and the length of rope needed to reach the top of the exhibit. Work = Force × Distance: This is the equation that describes the phenomenon. In the case of pulleys, a one pulley system means you will pull the length of a rope the same distance you are lifting an object. In a two pulley system, you will lift an object with half the effort (force) but you need to pull the rope twice as long. What do you think will happen in the three and the four pulley systems?

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Gear Table Guests can manipulate a variety of gears of different shapes, sizes, and colors at the gear table. You can construct complex gear chains in both vertical and horizontal planes. With gears, the equation Work = Force × Distance works as follows: Think of the distance as the distance around the outside of the gear. If two gears engage each other and are the same size, the amount of work is equal to the force. If one gear is one half the size of the other it will take twice as much effort to move the larger gear by turning the smaller gear; or you could say it would take the larger gear half as much force to move the smaller gear.

Laser Table Manipulate the direction of laser light and try to aim the laser's beams. See if you can get the laser to point in a certain direction by influencing its path with mirrors and prisms. After getting familiarized with the lasers, see if you can cause beams to be parallel, perpendicular, or intersect one another. What kind of tools do you need to use? What happens when the beams intersect?

Flying Propellers Guests can 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 the propeller to lift. The propeller will not fly if lift is less than the force of gravity, and it cannot hover unless the two forces are equal.

Tune Up Tune up allows us to realize the importance of the cylinders in a car's engine to fire in the proper order. In real life, if the cylinders do not fire properly your car will not run well if at all. See if you can fire each cylinder in order by stepping on the yellow cylinders of the engine block so that the distributor notes light up in order.

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Vocabulary Words

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

Angle: The amount of turning between two lines meeting at a common point.
Parallel: Lines that are the same distance apart.
Perpendicular: Lines that intersest at right angles to each other.
Reflection: An image produced by or as if by a mirror.
Congruent: Having the same size and shape.
Range: From the lowest score to the highest score in a graph.
Mode: The most frequent value of a set of values.
Pressure: The force exerted as a result of the weight of the atmosphere.

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

Grade 3 Number, Number Sense, and Operations

5. Represent fractions and mixed numbers using words, numerals, and physical models.
15. Evaluate the reasonableness of computations based upon operations and the numbers involved.

Grade 3 Patterns, Functions, and Algebra

3. Use patterns to make predictions, identify relationships, and solve problems.
4. Model problem situations using objects, pictures, tables, numbers, letters, and other symbols.

Grade 3 Data Analysis and Probability

1. Collect and organize data from an experiment, such as recording and classifying observations or measurements, in response to a question posed.
8. Identify the mode of a data set and describe the information it gives about a data set.

Grade 4 Geometry and Spatial Sense

1. Identify, describe, and model intersecting, parallel, and perpendicular lines and line segments.

Grade 4 Patterns, Functions, and Algebra

6. Describe how a change in one variable affects the value of a related variable.

Grade 4 Data Analysis

1. Create a plan for collecting data for a specific purpose.
5. Propose and explain interpretations and predictions based on data displayed in tables, charts, and graphs.
6. Describe the characteristics of a set of data based on a graphical representation, such as range of the data, clumps of data, and holes in the data.

Grade 5 Geometry and Spatial Sense

2. Use standard language to describe line, segment, ray, angle, skew, parallel, and perpendicular.
4. Describe and use properties of congruent figures to solve problems.
7. Understand that the measure of an angle is determined by the degree of rotation of an angle side rather than the length of either side.

Grade 5 Patterns, Functions, and Algebra

1. Justify a general rule for a pattern or a function by using physical materials, visual representations, words, tables, or graphs.
4. Create and interpret the meaning of equations and inequalities representing problem situations.
5. Model problems with physical materials and visual representations, and use models, graphs, and tables to draw conclusions and make predictions.

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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.

Silly Faces

Objective: Use collected data to organize data, create graphs and answer statistical questions.

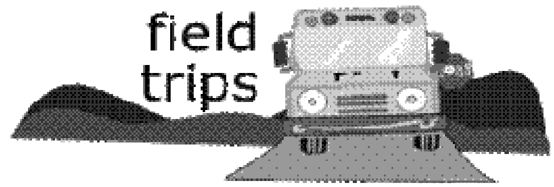
Materials:

- Pencil
- Ruler (if you want to connect the dots)

Sam's little sister has been bugging him all week. So Sam, being the scientist that he is, did an experiment. Every day for the past two weeks, he observed how many times a day she made faces at him. Here are his observations:

On the first week, she made 8 faces at him on Monday and Wednesday, 7 faces on Friday, 9 faces on Tuesday and Thursday, and 18 faces at him on Saturday and Sunday.

On the second week, she made 8 faces at him on Monday and Thursday, 7 faces on Friday, 9 faces on Tuesday, 10 on Wednesday, and 18 faces on Saturday and 19 on Sunday.



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Fill out the chart:

Day of the Week (Week 1)	How many times his sister made faces at him

Day of the Week (Week 2)	How many times his sister made faces at him

Label the two axes on the graph and plot the points (the first week on one graph and the second week on the other).

Which day(s) had the lowest number of making faces on Week 1? Week 2?
Which day(s) had the highest number of making faces on Week 1? Week 2:
What is the average number of times she made faces at him over both weeks?
What is the mode over both weeks?

On which days of the week did his sister make the most faces at him?
Make a prediction as to why she made the most faces on those days.

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Objective: Identify right angles, parallel and perpendicular lines.

Materials:

- Pencil
- Paper

Tonight Professor Knows-It-All is working in his lab late at night when he runs out of hydrochloric acid. At first he's very upset because it's important to him to finish tonight. Suddenly he remembers that he has a vial of HCl on the upper shelf in his closet. Unfortunately he is too short to reach it. The professor was sitting, trying to figure things out, when all of a sudden tiny creatures appear out of thin air! They are little mice.

"Professor," said one of the mice. "There is a ladder nearby and I think that my friends and I can retrieve it for you."

"That would be splendid!" said the professor.

"In return, we would like some cheese."

"Oh," said the professor, "I'm all out of cheese. I had a late-night snack."

"Hmmmm," said the mouse. "Maybe you can help us with our homework. It's about the ladder."

??? The professor didn't realize that mice had homework (especially about ladders!). But of course he agreed to help. The mice retrieved that ladder for the professor. It looked like this:

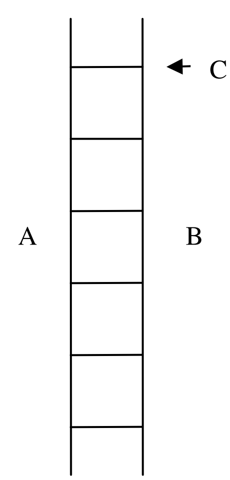
Here was the mice's homework:

A and B are the long sides of the ladder and C is the top rung. The angle between C and B (as well as C and A) is 90 degrees.

After looking at the homework, the professor said, "Why this is easy!"

And he quickly answered the first questions (his answers are in bold), but the last question stumped him.

Check over the professor's work.



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Please fill in the blanks:
A is parallel to B .

B is perpendicular to C .

A is parallel to C .

What kind of angle is formed by side B and C?

If A is perpendicular to C, then we can say that:
a) C is parallel to B
b) B is perpendicular to C
c) A is parallel to B

Is the professor correct? Do you think the mice should have retrieved the ladder for the professor? Can you figure out the last problem?

Venn Diagram
Objective: Use a Venn diagram to solve a problem

Materials:
- Pencil
- Paper

Professor McGee teaches math and science at a local middle school. She is an amazing professor. So amazing in fact, that almost everyone in her class loves math and/or science. As a bonus question to a quiz, she postulated the following problem:

I've taken a survey and in my classes, 40% of the students love math, 30% of the students love science (to teacher: please note that the previous two percentages are NOT exclusive – it doesn't say 40% of the students ONLY love math) and 15% of the students love math AND science. If 30 students love math AND science, how many love math only? (Please draw an accompanying Venn diagram).

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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.

Tessellations

Objective: Identify shapes (and for older students, parallel and perpendicular lines). Learn about and create tessellations

Materials:

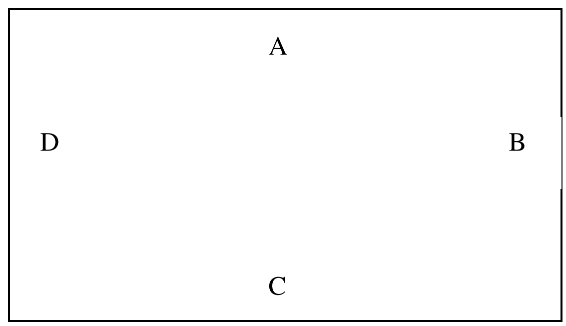
- 3" x 5" index cards
- Scissors
- Tape
- Paper upon which to glue the index cards
- Markers/crayons (optional)

Questions:

How many sides does your card have?

What type of shape is it?

(For older students) Label the sides of your index card, for example:



Find the parallel lines and list them here:

Find the perpendicular lines and list them here:

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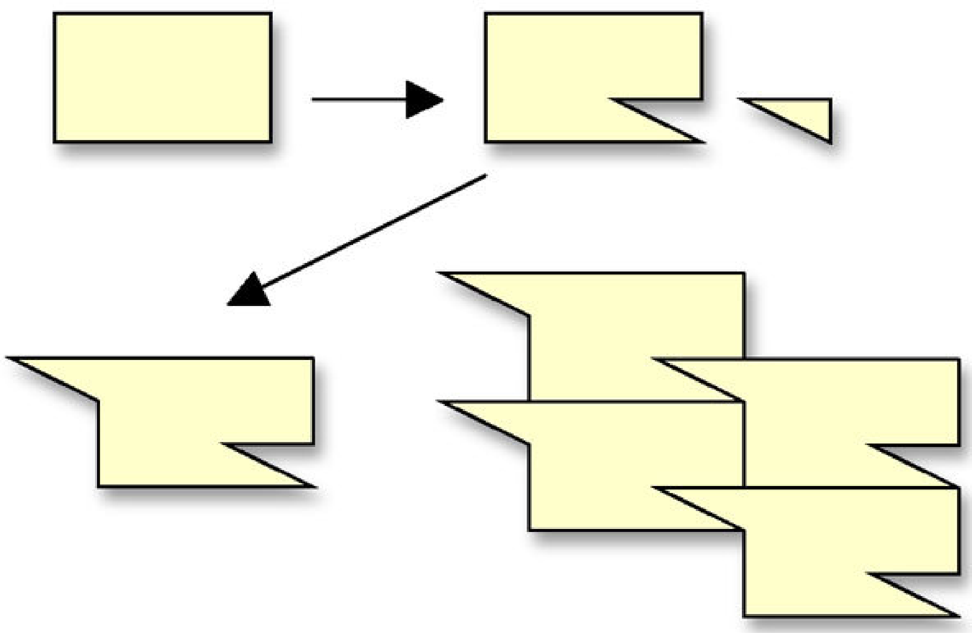
Discuss the definition of tessellation (defined as a repetitive pattern of polygons that covers (or tiles) a plane with no gaps and no overlaps (referenced by http://images.rbs.org/appendices/d_glossary_geometric.shtml).

Have students cut out a shape from one edge of the index card and then tape that shape onto the opposite edge of the card. This new shape will tessellate the plane. For example:



Reference:
http://images.rbs.org/activities_plans/activities.shtml#creating_tessellations

(After cutting and taping the one card) How many sides does your object have now?

(For older students for themselves, as each student may have different shapes) Are there any parallel lines? Perpendicular lines? Name them.

Give the students at least 4 other cards and have them create the same shape as the one they have now. You can have them color the cards if you like (2 cards one color and 2 a different color). Then have them glue their shapes so that they are tessellated, onto the paper.