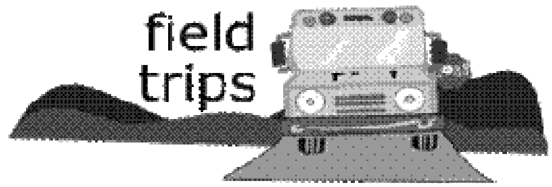

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How to Use your Field Trip Guide

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, the Foucault Pendulum, Life, and Space.

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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 exploring and understanding the sea.

Wave Tank Waves emerge in varying sizes and take on different shapes as they tumble towards shore. Try to predict the volume of water in one wave. For better accuracy, attempt to break the wave into parts so that you are estimating volumes of more familiar shapes then add them up at the end. Do you think that the wave will have a larger volume if its initial height is greater? Keep in mind that as the height increases the wavelength usually decreases.

Balancing Balls The ball within each water stream stays up because some water hits the ball and is deflected down. The ball is always off-center in the stream and will spin. Some water will stick to the spinning ball and be thrown off in the direction of spin; this reaction force is what pushes the ball sideways. Even if the ball begins to leave the stream the reaction force caused by the spray of the water is usually strong enough to pull it back in. How many degrees, using the stream of water as the norm, is the ball off-center? Does this measurement change with the height of the water stream?

Laminar Flow Many exhibits in Ocean demonstrate a special kind of fluid flow called laminar flow. Laminar flow occurs in a stream of water in which there is no turbulence and no air. Some characteristics include that all flowing water molecules are moving at the same velocity and fit comfortably in the space provided. Laminar flow depends on the number of water molecules and the amount of space they consume in a stream as well as the capacity of the stream. Relate these concepts to surface area and volume. Using these terms, when is laminar flow ideal?

Weather Center This exhibit displays the measurable aspects of weather, such as temperature, humidity, precipitation, Doppler radar, wind and pressure. Barometric pressure is a vital tool in weather forecasting. When pressure is rising, sunny weather is usually on the way. When pressure is falling, you can expect rain or snow. Since winds are often the result of pressure differences, the wind speed often picks up when pressure is changing. Using the information given on the Wind and Pressure board, predict what today's weather will be.

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FOUCAULT PENDULUM

COSI's Pendulum shows guests our recreation of French physicist Jean Foucault's experiment to prove the Earth's rotation on its axis. Knowing Newton's first law of motion, that an object that is free from all outside forces travels at a constant velocity along a straight line path, the only way for the pendulum to trace out the path along the circle is for the Earth to rotate under the pendulum. This pendulum knocks steel balls from their resting place as the pendulum sweeps out the circular path. The balls are set so that two will be struck about every fifteen minutes. Considering that the entire pendulum contains 144 balls, one eighth should hold 18 balls. If you divide 18 by 144 (or divide 1 by 8) you will find the percentage of the frame that one eighth represents. Multiply this percentage by 360 degrees to find the angle which holds this fraction of the balls.

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.

Why do we die? Staying alive takes energy. It also takes energy to make and care for offspring. Since there's a limited amount of energy available, a balance must be struck between these two competing needs. The lifespan of humans and mice as well as the number of offspring each produces are depicted. How many times longer is a human's lifespan than a mouse's? For each offspring that a human produces, how many will a mouse? Compare these ratios. What is the significance?

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Cancer Rates Compare the two charts, one showing cancer rates among males and the other among females in the US. The charts show the percentage of new cancers on the right hand side and the percentage of cancer deaths on the left hand side in 1999. What do these percentages mean? Are females more at risk for a certain kind of cancer? Is there a certain type of cancer that is more likely to affect only males?

Life Force Assess, diagnose, and cure various sick animals. This computer program leads guests through a menu of several animals each having numerous things medically wrong with it. After choosing an animal, guests can diagnose its condition using a variety of tests and tools. The guest can then apply one of several healing techniques. Be sure to make note of the many measurements and calculations you use as you diagnose and treat each ailment.

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.

Astronaut Selection This exhibit provides a glimpse into the types of tests astronauts underwent in the early days of the space program, and the tests they still undergo today. Guests are presented with two tests, a balance test and a heart monitoring station. See how your statistics compare to others and the normal to determine if you could be fit to be an astronaut.

Robot Commanders The robot commanders offer guests an opportunity to program the movement and activities of a team of unmanned robots as they explore an alien terrain. Using a keypad interface, write a custom program, directing these rovers to unearth and collect objects. Try to find the perfect path of movement and turns by using measurements and computations to complete your task. Robot arms, stationed at the perimeter of the terrain, can also be used to load the objects into the beds of the rovers.

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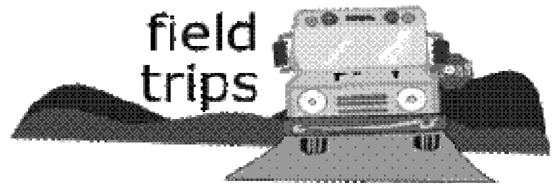
Rocket Launch Fuel up a rocket by charging a projectile with compressed air at this exhibit. Guests then perform their own countdown and release the miniature rocket. What goes up must come down. Well, not really, if you go up fast enough. Every planet has a certain speed called an escape velocity. If you reach that speed, you will never return! The escape velocity v for any planet is given by the equation: $v = \sqrt{2 \times gPlanet \times RPlanet}$.
On Earth, where g = 9.8 m/s^2 and R = 637,000 meters, this gives an escape velocity of slightly over 11,000 meters per second or just under seven miles per second.

Return to Space While learning about many amazing space capsules, observe how large the measurements of weight and thrust are. By converting these values to scientific notation, it is easier to understand them and put the concepts into perspective. After making a graph of the values written in scientific notation, the correlation between weight and thrust will be much more straightforward. How are the weight and the thrust of a capsule related? Which variable is dependent on the other?



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Vocabulary Words

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

Volume: The amount of space occupied by an object, measured in cubic units.
Surface Area: The total area of the surface of a three-dimensional object, measured in square units.
Pressure: The exertion of force upon a surface by an object, fluid, etc., in contact with it.
Ratio: The relationship in quantity, amount, or size between two or more things.
Percent: Measured or counted on the basis of a whole.
Scientific Notation: A way of writing very large or very small numbers using a number between 1 and 10 multiplied by a power of ten.
Degree: A unit for measuring the size of angles.

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 6 Number, Number Sense, and Operations
- 4. Describe what it means to find a specific percent of a number, using real-life examples.
- 14. Use proportional reasoning, ratios, and percents to represent problem situations and determines the reasonableness of solutions.

Grade 6 Measurement
- 1. Understand and describe the difference between surface area and volume.
- 3. Estimate perimeter or circumference and area for circles, triangles, and quadrilaterals, and surface area and volume for prisms and cylinders.

Grade 6 Patterns, Functions, and Algebra
- 1. Represent and analyze patterns, rules, and functions, using physical materials, tables, and graphs.
- 5. Produce and interpret graphs that represent the relationship between two variables.

Grade 7 Number, Number Sense, and Operations
- 8. Develop and analyze algorithms for computing with percents and integers, and demonstrate fluency in their use.

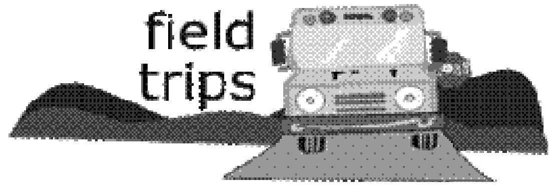
Grade 7 Measurement
- 8. Understand the difference between surface area and volume and demonstrate that two objects may have the same surface area, but different volumes or may have the same volume, but different surface areas.

Grade 7 Data Analysis and Probability
- 5. Compare data from two or more samples to determine how sample selection can influence results.

Grade 8 Number, Number Sense, and Operations
- 1. Use scientific notation to express large numbers and small numbers between 0 and 1.
- 5. Determine when an estimate is sufficient and when an exact answer is needed in problem situations, and evaluate estimates in relation to actual answers.
- 6. Estimate, compute, and solve problems involving rational numbers, including ratio, proportion, and percent, and judge the reasonableness of solutions.

Grade 8 Measurement
- 2. Use proportional relationships and formulas to convert units from one measurement system to another.
- 4. Derive formulas for surface area and volume and justify them using geometric models and common materials.

EXPLORE SCIENCE. DISCOVER FUN!



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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.

Baseball Geometry

http://www-tc.pbs.org/kenburns/baseball/teachers/pdf/lesson4.pdf

Objective: To apply various methods for finding volume and surface area of a sphere; to compare and contrast results among these methods.

Materials:

- Play-Doh
- Wax paper
- Baseballs
- Overhead transparency with square centimeter grid
- String or tape

Procedure:

1. Give every student a baseball for the activity (The local Little League coaches can help you out here by loaning the baseballs temporarily for the activity, suggesting a source for purchasing a class set at the best price.) You could get fewer baseballs and put the students in groups or you could just do the next few steps in front of the class yourself and pass around/display the results in the play-doh) Each student spreads out Play-Doh "pie crust style" on the wax paper.

2. Roll the baseball in the Play-Doh, make an impression of the "footprint" shape of the stitching pattern. (** This pattern might also be called a "peanut" shape. Mathematically, it is an "Oval of Cassini") Ask students if they realize the covering of the baseball is actually two of these "footprints" stitched together.

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3. Place the overhead transparency of the sq cm grid over this impression.
Count the number of whole squares completely interior to the footprint.
This is a lower bound to the area of the footprint (it is at least this much).
Take this number and add the number of whole squares that even just touch the footprint. This is an upper bound to the area of the footprint (it is at most this much). Average the upper and lower bounds to get a best estimate of the area of the footprint. Double this area to find the total surface area.

4. Check this work using another method.
Wrap a string or tape around the center of the baseball to find its circumference. Divide this circumference by $\pi = 3.14$ to find the diameter. Take half the diameter to find the radius.
Using r = radius and S = Surface Area, the formula for the SA of a sphere is
$S = 4\pi r^2$

5. Have the students get together discuss their results.

Follow-Up Questions:

1. Write down the formula for the circumference of a sphere, the surface area of a sphere and the volume of a sphere.

2. How can counting the number of whole cm squares that are completely inside the footprint and the number of whole cm squares that touch even a little bit of the footprint be used to calculate the surface area of a baseball?

3. Use twice the average of the lower bound for area and the upper bound for area to calculate the total surface area of a baseball.

4. Find the circumference of a baseball.

5. Calculate the radius of the baseball from measuring the circumference and use that radius in the formula to find surface area.

6. Compare the surface areas you calculated by the two methods of “Counting the Squares” and “Surface Area Formula”. Where are the sources of error in each method? Which method do you think is better? Why?

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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.

Missing Locker

Objective: solve problems using order of operations

Materials:

- Pencil
- Paper

You've been tripping over your shoes all day at COSI when you finally trip and fall over and decided that it was time to tie your shoes. As you were preparing to tie your shoes, you noticed a slip of paper on the ground that said:
"What you're looking for is in Locker # 8+6*5-1-8/2 on floor # 7 + (30+5)/5 – 6*2 - 1
Naturally being curious, you wonder what's inside this mysterious locker. Write an algorithm to solve each of these problems. To which locker should you head (remember to keep in mind order of operations) and on which floor?

Need Batteries!

Objective: Organize data to solve a problem. Use order of operations to solve a problem

Materials:

- Pencil
- Paper

Professor Smartley has been very busy in her lab. So busy, in fact, that she completely forgot to order more batteries for her experiments. If she doesn't place her order by 4pm today she won't be able to place an order for another month and would thus lose precious time for her research. It is now 3pm. Quickly Professor Smartley gathers her assistants, Sam, Cameron and Robin to figure out how many more batteries they'll need to order.

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"OK, we'll need 4 batteries for the first experiment and 6 batteries for the second experiment," said Sam.
"But we're going to do the first experiment 3 times, so we'll need three times as many batteries," said Robin.
"And we're running the second experiment 2 times, so we'll need twice the batteries for that one," said Cameron.
"Wait, that number's not right," said Professor Smartley, "We'll need 8 more batteries for the first experiment, so add on 8 to the original number of batteries, and don't forget to triple that number (since we're doing the experiment 3 times)," said Cameron.

How many batteries does the Professor need to order now?
Can your write a formula to solve this problem 2 ways?
A: 48 batteries 3(4+8) + 6*2 = 3*4 +3*8 + 6*2
"Oh, wait - we won't have time to do the first experiment so many times – let's just cut the number of experiments that we do in half," said the Professor.

Write down what the formula looks like now. How many batteries does she need to order for the first experiment only?
A: 3(4+8)/2 = 18 batteries

"And you said earlier that we'll need to order 7 batteries for the second experiment and we only have to do that experiment once," said Sam.
Using your formulas from above, write down how many batteries they need to do their experiments.
A: 2*(3+8)/2 + 7 = 11+7 = 18

"Ooh wait," said Cameron, "maybe we won't have to order all of them because I just found a box containing 6 batteries."
"And I found 3 more boxes with 6 batteries in each box. We won't have to buy as many as we thought!" exclaimed Robin.

"Wait, wait, wait - in each box there are 3 batteries labeled "don't use me"
So we'll have to order a few more," said Sam.

How many batteries have they found all together? How many did they find that work? Write down the formulas you used.
A: 4*6 = 24 batteries all together 4*(6-2) = 4*6 - 4*2 = 16 batteries that work

The final equation that our assistants came up with to find how many batteries to order was:
A: 2*(3+8)/2 + 7 – 4*(6-2) = (2*3 + 2*8)/2 + 7 – 4*6 – 4*2 =
(2*11)/2 + 7 – 4*4 = (6 + 16)/2 + 7 – 4*6 – 4*2 =
22/2 + 7 -16 = 22/2 + 7 – 24 + 8 =
11 + 7 – 16 = 11 +7 – 24 + 8 =
2 batteries! 2 batteries!