



Teacher's Guide

Welcome to the Math Midway! A visit to the Midway will give you and your students a chance to be surprised and delighted by the breadth of mathematics. What follows are some tips and challenges to help you and your students get the most out of this exciting exhibition.

Roller Graphicoaster (primary content: curve of fastest descent) Have the students guess which path will get the car down the track fastest and try out several different tracks. They should discover that the cycloid is the fastest shape. The most important factor in the shape of the curve is having the steepest initial descent, which the cycloid has.



Ring of Fire (primary content: cross sections of 3D solids) Have the students find as many different polygonal cross sections in the different 3D solids as possible. For example, the tetrahedron has cross sections of triangles and quadrilaterals. If you can get all 6 faces of the cube to intersect with the laser plane, you will see a hexagon! With the dodecahedron, you can find polygons from triangles all the way to a decagon. You can also see conic sections within the shapes with curved sides.



Three Ring Circleous (primary content: solids of revolution) Have the students guess what shape is spinning before they hit the button to stop the motor. They can also imagine other shapes that would make the same spinning solid. For example, some other shapes that would make a cylinder are a straight vertical rod near the edge of the spinning disc or a spring shape.



The Mysterious Harmonograph (primary content: graphs of harmonic motion) Here the students will get to make and take home their own mathematical art. Have them test different configurations, like moving the weights and the cables on the pendulum as well as examining the differences between pictures made by placing pens in the various slots on the pendulum.



Universal Wheel of Chance (primary content: probability) Have your students tally whether their spins are odd or even numbers. You can compile the whole classroom's data and see how close they come to the theoretical half odd and half even. For example, you can expect that for 100 spins, you should be roughly within 10 spins of exactly 50 evens, because the square root of the number of trials is proportional to the variance.



Pirate X and Lady Y (primary content: algebra) Have the students set up equalities using one unknown piece and some of the number coins. Remember that moving the coins to the different numbered pegs acts like multiplying the number! See if they can solve for the unknown by moving coins around or replacing them with other equivalent coins. Also have them represent their equations using standard algebraic notation.



Magician and the Moon (primary content: geometry) Have your students solve the problem of covering the white circle with 5 smaller circles. For a hint, you can first tell them that the answer is not completely symmetric. As a second hint, note that the outer points where overlapping magnets touch each other all sit on the circumference of the big circle.



Mirror Morph (primary content: reflections) For a fun optics example at this exhibit, try moving closer and farther away from the mirrors in the corner of the booth and waving at yourself in the mirror with your right hand. With a concave mirror, the hand your reflection is waving with switches from the right hand to the left hand at different distances from the mirror! When the mirror is concave, light rays from the left and right sides can cross each other, and end up on the opposite sides, resulting in a reversed image. In a convex mirror, this can never happen.



Coffee Cup Curves (primary content: reflections) Students can experiment with creating interesting reflections using the bendable mirrors. There are blue curves drawn on the table. Students can bend the mirror to match these curves, and see that particularly attractive curves are generated. There is also a grey curve without a blue curve. The challenge for the student is to determine how to bend the mirror to create the curve.



Funny Face (primary content: transformations of graphs) Students will love adjusting the sliders to distort their photos at this exhibit. If they've learned content like sines and cosines, you can talk about how the graphs of these functions make waves, which is why the distorted image looks wavy when these functions are part of the transformation.



Pedal on the Petals (primary content: catenary curves) Students can ride the square wheeled tricycles and notice how smooth the ride is because of the specially curved track. Point out the hanging yellow chain around the exhibit and tell them that the curve of the hanging chain is the same shape as the bumps on the track, called a catenary.



Number Line Tightrope (primary content: number families) Students can watch the monkey roll back and forth on the number line and examine the different number families represented there. Pick a number family, for example the triangular numbers, and have students explain how each of the numbers with a triangle tag fits into that family.



Organ Function Grinder (primary content: composition of functions) Students can input numbers, choose which functions are applied, and hear music as their number is transformed into a new one. For a challenge, students can try to achieve 403 as the output of the function. (Answer: input 10, double it, square it, and add 3.)



Mathematical Monkey Mat (primary content: tessellations) If your students are familiar with rotational symmetry, have them point out the symmetries in the monkey mat. There is a twofold symmetry point where the monkeys' legs fit together, a threefold symmetry point where their elbows fit together, and a sixfold symmetry point where their upturned arms fit together.



Polyhedral Puzzle Plaza (primary content: geometry) A great challenge at this exhibit is to have teams of students put all 7 giant soma shapes together into a big cube. If they're having trouble, tell them to fit the most complicated shapes in the bottom layer and save the easier shapes to put in last. There are many different possible solutions for the cube, but it's still quite a challenge.



Miles of Tiles (primary content: geometry) Students will love making tile patterns here. One challenge is to tile the monkeys so that no two monkeys of the same color touch along any of the edges. Another challenge is to find a repeated tiling using hexagons, squares, and triangles.



A-Maze-ing Math (primary content: graph theory) If students are having a hard time solving the maze, give them this hint: Try to get to the small square at the center of the maze. Another hint is to think about working the maze backwards.



Plant the Daisy (primary content: harmonic motion) Have the students try to plant the daisy on the post while holding the stem at the section marked with red tape. Then have them hold the daisy at other points and observe that it's not as wobbly when it's not held at a node, one of which is marked by the red tape.



Math Unleashed (primary content: group theory) If the students correctly wind the ropes around the poles at these puzzles, removing pole A will allow the puppy to run free for both puzzles. You can help the students visualize the way the ropes will slide around the poles before removing one.



Traveling Carnival (primary content: graph theory) Students can try to plan the shortest route that visits all twelve cities in a loop, ending where they started. Using the surveyors' wheels, they then walk the route and measure the distance. There's no simple way to be sure you have the shortest distance, but you can swap the order of two cities and check the effect on total distance.



Amazing Acrobats (primary content: geometry) Students can build this collaborative sculpture with some help from museum staff. It's made of sixty pieces, where groups of five acrobats in a pentagon-like arrangement join together to form a solid in the pattern of a dodecahedron.

