ANDREW ROSS
MALGORZATA ZAREBA HONORS GEOMETRY

Class Trip to The Museum of Mathematics

11 E 26th St, New York, NY 10010 • momath.org

PLANNING

Aim: How do we interpret geometric mathematical concepts with real world examples?

(Trip length – approximately 2–2.5 hours)

Focus Standards—

CCSS.Math.Practice.MP3: Construct viable arguments and critique the reasoning of others.

CCSS.Math.Practice.MP4: Model with mathematics.

CCSS.Math.Practice.MP1: Make sense of problems and persevere in solving them.

CCSS.Math.Practice.MP2: Reason abstractly and quantitatively.

Motivation and Application:

Provide students with a sensory experience of what mathematical abstractions look and behave like in real life, presenting concepts of rational interaction to the extreme limits of intuitive delight and visual wonder.

Objectives: SWBAT… *(Students Will Be Able To…)*

- construct viable arguments and critique the reasoning of others in regards to interactive museum exhibits of geometric concepts
- complete the handout using evidence from exhibits visited in the MoMath museum

Materials:

- handout (museum worksheet)

IMPLEMENTATION

Do Now:

Visit different exhibits at the museum and complete the handout.

Mini Lesson/At the MoMath Museum:

Students will be divided into pairs or threesomes depending on attendance. Each group will explore exhibits at the museum and complete the handout which consists of 25 differentiated questions. Part A of each question pertains to the specific exhibit at the museum, whereas part B promotes higher-order thinking and requires some prior knowledge of the particular topic. (Teachers may choose to have the class complete the entire sheet or finish either the set A or set B questions, depending on the students' level. This allows for maximum flexibility and differentiation.) Working in small groups promotes learning and offers immediate feedback that the peers provide to each other. During the museum visit the two supervising teachers will circle around and provide students with scaffolding to help them in the learning process. Students will be responsive in the process of scaffolding, using feedback and their own learning strategies in collaboration with the teacher's instruction.

Summary:

Before we leave the museum we will share experiences from different exhibits.

Homework:

Finish the handout and write one paragraph reflection about the museum visit.

STUDENT ACTIVITY GUIDE

A. Ross & M. Zareba

Name: _____ Date: _____

The Museum of Mathematics

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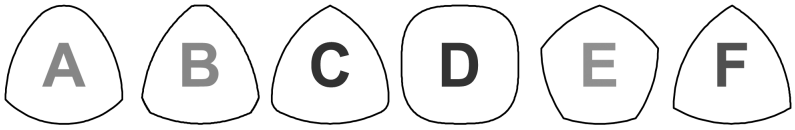
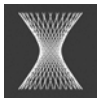
Have fun exploring the many exhibits throughout the museum. When viewing the monitors for more information, swipe through to the *In Depth* section. Use what you learn to answer the questions below.

1		**Coaster Rollers** **A.** What is unique about the shape of the rollers that allows the cart to move so freely? What are they called? **B.** Which of the shapes below has a constant width and would allow for a smooth ride? 
2		**Hyper Hyperboloid** **A.** What is hyperboloid? How can you describe it with a mathematical equation? **B.** How can you create a hyperboloid? Explain your reasoning.

3		**Light Grooves** **A.** How many etched plates make up this exhibit? **B.** What technique was used to get the images onto the plates?
4		**Mathenaeum** **A.** Use the formula you learned to determine the number of edges of a dodecahedron (12-faced polyhedron) **B.** How many ways can you cut a cube exactly in half with a flat mirror so that the two parts reflect onto each other?
5		**Pattern Mesh** **A.** Describe what happens when you put two like patterns together and start turning the one on the bottom? **B.** How can you explain the phenomenon in part A?
6		**Polypaint** **A.** Create wallpaper for your room. Try to predict the pattern you are about to get before each stroke of a paintbrush. **B.** Compare your prediction with the actual pattern that you achieved on your wallpaper in part A.

7		**Seeing Math** **A.** What is a minimal surface? **B.** What are fractals?
8		**Square-Wheeled Trike** **A.** The natural shape that a hanging chain makes is called a _____. **B.** What does the term "hyperbolic cosine" have to do with this exhibit?
9		**String Product** **A.** *Fill in the blank after viewing the monitor:* This exhibit is an example of a 3-dimensional _____, a graphical device used to solve certain types of equations and to perform rapid arithmetic calculations. **B.** Devise a formula and create your own three-column nomogram.

10

Structure Studio

A. Construct a tetrahedron (4 faces), a cube (6 faces), and an octahedron (8 faces).

Fill in the table below:

POLYHEDRON	V = number of vertices	E = number of edges	F = number of faces	V – E + F
Tetrahedron				
Cube				
Octahedron				

B. Make a Conjecture:
What do you think is true about the relationship between the number of vertices, edges, and faces of a polyhedron?

11

Enigma Café

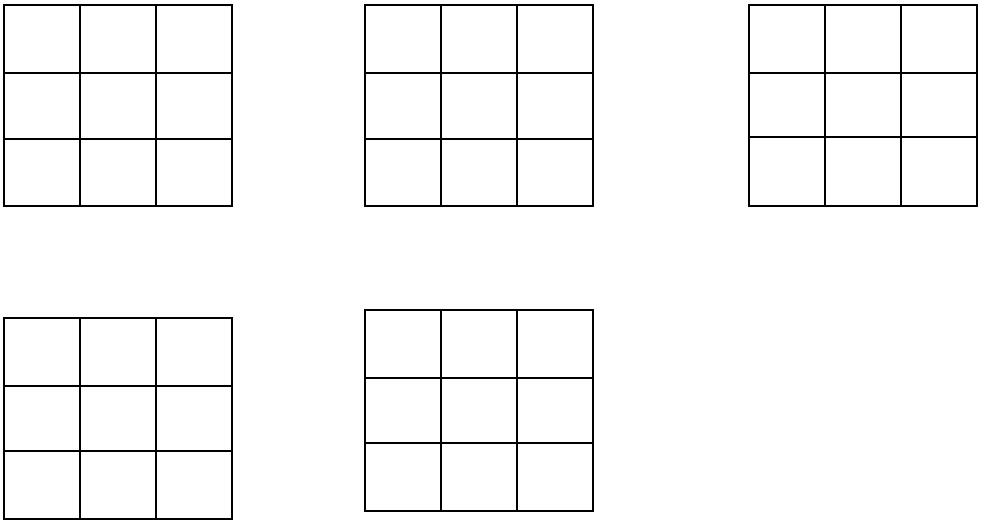
A. What is a pentomino? Describe it to your group-mate using your own words. How many pentominos are there in the Café ?

B. How can you create a 2x3x10 or 2x5x6 box using pentominos?

12

Finding Fifteen

A. Play 5 games of finding fifteen with your group-mate and copy the winning numbers. Are you noticing any patterns?



B. How do you know what constant number would work for a Magic Square 4 by 4, 5 by 5?

13

Funny Face

A. What is the original formula when you first snap your photo?

B. Does the photo stretch horizontally or vertically when you use the sliders with this type of formula: $x' = x + (-85) \sin(x)$?

14

Human Tree

A. How many copies of yourself did you use to create your "human tree?"

B. Explain what self-similarity is.

15

Math Square

A. What are the Voronoi Polygons? Why do you think they are convex polygons?

B. How are Voronoi Polygons and supermarkets related?

16

Monkey Around

A. How many red monkeys are there when the handle is spun to the left?

How many red monkeys are there when the handle is spun to the right?

B. The principal of "concealed distribution" dates back to the 1700s when it was first used for what?

17

Pythagoras Puzzler

A. Puzzle 1: Using the red tiles, fill in the a^2 and the b^2 squares. Then use those same tiles to fill in the c^2 square. Sketch out here how you arranged the pieces.

B. Puzzle 2: Using the white tiles, fill in the a^2 and the b^2 squares. Then use those same tiles to fill in the c^2 square. Sketch out here how you arranged the pieces.

18

Rhythms of Life

A. Write down the settings you used to create your 3-part rhythm section. (Remember, your fractions must add up to 1.)

B. What key mathematical concept are we using in this exhibit, when it comes to parts of a whole?

19

Sixth Sense

A. What characteristics are present in every combination of numbers in *Sixth Sense* that allow it to work successfully?

A. Can you think of a way to make your own version of *Sixth Sense*?

20

Tessellation Station

A. What is another word for *tessellation*?

B. Use two different types of polygon shapes to create a vertex star on the wall. Sketch a copy of your vertex star here.

21

Tile Factory

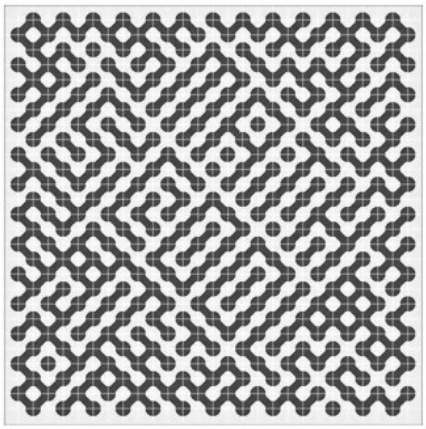
A. Why are the 12 tilings here called *isohedral* tilings?

B. Are there more Heesch labels or isohedral classes?

22

Time Tables

A. Can you decipher the message in this hidden image? If so, draw over the letters in a different colored pen or marker.



B. What hidden message did you reveal by using the Hagelin M-209 to decipher the code?

23

Twist 'n' Roll

A. Which solids will you have to twist to be able to follow the third path from the left?

B. How do you think the surface area of your solid played the role in your choice?

24

Wall of Fire

A. Use the Wall of Fire to explore different cross sections of the objects provided on the shelves beside the exhibit. Place each of the objects below into the light and write down what two-dimensional shapes you see. Depending where you "slice" the object you will encounter different answers.

1. cylinder
2. cube
3. pyramid
4. octahedron
5. dodecahedron

B. How many types of conic sections are there? Name them.

25

Water Frieze

A. What is a line of symmetry?

B. After visiting this exhibit, draw the line of symmetry on the following patterns.

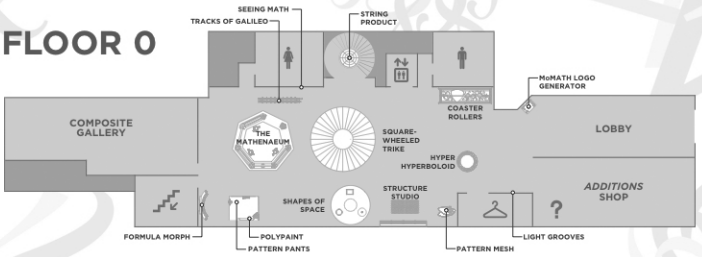
1.  2.  3.  4. 

26

Self-Reflection

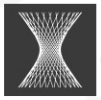
How did this visit help reinforce what we have been learning in geometry class this term? What was your favorite exhibit?

FLOOR 0



Coaster Rollers
Roll over the unusually shaped acorns and have a smooth ride due to their constant diameter.

Formula Morph
Bring formulas to life by exploring the multitude of unusual three-dimensional surfaces they can create.



Hyper Hyperboloid
Enter the cylindrical chamber and spin in the chair, creating a curved surface made entirely out of straight lines.

Light Grooves
Change the angle of the light to animate stunning stereographic images, created by precisely engraved reflective grooves in metal plates.

Logo Generator
Manipulate mathematical symbols symmetrically to create a unique MoMath-style logo.

Mathenaeum
Apply a palette of operations to transform basic shapes into unique three-dimensional sculptures.

Pattern Mesh
Rotate one pattern over another to create changing and surprising new patterns.

Pattern Pants
Dress yourself in a symmetrical pattern.

Polypaint
Use a paintbrush on the digital canvas to create intricate and colorful patterns that emerge from symmetry.

Seeing Math
Observe how math shows up in everyday scenes from the world around us.

Shapes of Space
Fit together shapes on differently curved surfaces and observe the differences among them.

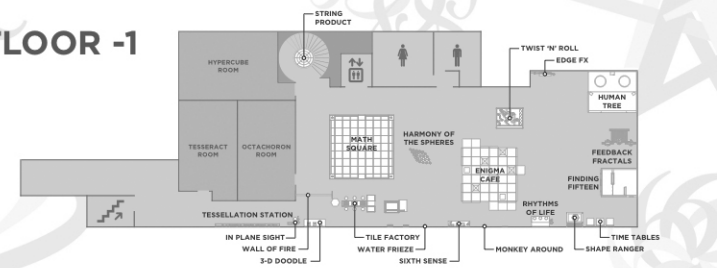
Square-Wheeled Trike
Take a smooth ride on square wheels.

String Product
Light up the line connecting two numbers on a special curve called a parabola, and see how it crosses the center pole exactly at the product of those two numbers.

Structure Studio
Make some cool mathematical structures with these uncommon construction toys.

Tracks of Galileo
Adjust the track and find the fastest path down to the bottom.

FLOOR -1



3-D Doodle
Fit two-dimensional cross-sections together to create three-dimensional forms.

Edge FX
Put a small bias into the bounce of each ball, and watch as your profits plummet or soar.

Enigma Café
Sit down and enjoy one of the many mathematical puzzles on the menu.

Feedback Fractals
Move the three cameras, zoom in and out, and apply different color filters to create an amazing variety of fractal pattern using a video feedback loop.

Finding Fifteen
Use simple arithmetic to find a winning strategy in this head-to-head game.

Harmony of the Spheres
Create a harmonic soundscape using this interactive musical sculpture, which takes its shape from the symmetries of the 12-tone musical scale.

Human Tree
See successively smaller copies of yourself combined to make a dynamic fractal tree that moves and sways in response to your motion.

In Plane Sight
Use cross-sections to figure out the shape of an invisible solid.

Math Square
Step into the world of mathematical games, controlled by the movement of your feet.

Monkey Around
Count the monkeys, turn the handle, and count again—what happened?

Rhythms of Life
Piece together fractions to fill circular disks, which you can play as musical rhythms using an unusual selection of sounds.

Shape Ranger
Arrange tile shapes inside various boundaries to try to set a MoMath record.

Sixth Sense
Choose six numbers and see how the machine predicted what their sum would be before the first number was even chosen.

Tessellation Station
Create tiling patterns called tessellations using unusual magnetic shapes.

Tile Factory
Bend and stretch the edges of polygons to create tessellating tiles.

Time Tables
Use a puzzle to prove the Pythagorean theorem, rotate a bird to explore geometric transformations, and decipher messages using a WWII-era encryption machine.

Twist 'n' Roll
Twist these shapes apart and change how they fit together to make dramatic changes in how they roll.

Wall of Fire
Highlight the sometimes-surprising cross-sections of different objects by using a plane of laser light to cut through their surfaces.

Water Frieze
Roll patterns across the wall to explore different symmetries.