Name: _____

Geometry:
Mid-Year Bonus Projects

Directions:

Each unit project is worth **up to 8 bonus points**. You may decide to complete all, none or some of the unit projects. All completed projects must be turned in by the due date below.

Due Date:
April 7th 2015

UNIT 1: Introduction to Geometry

Beginning the Project:

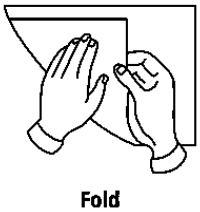
Some people look at a plain sheet of paper and see the hidden form of a swan or seashell waiting to be revealed. With a few meticulous folds, an origami artist can produce replicas of animals, flowers, buildings, vehicles, and even people. The ancient art of paper folding comes from Japan, where it has thrived since at least the twelfth century. Every time you made a paper airplane or a paper hat as a child, you were practicing the art of origami. In this unit project, you will use paper folding to explore geometric patterns. You will make origami models and use the language of geometry to tell others how to make them.

What You Need:

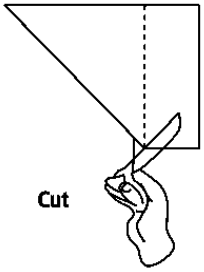
- Paper
- Scissors
- Ruler
- Pencil

Project Tips:

Read your directions carefully. As you work on the project, you will need several sheets of square paper. You can make these by folding and cutting 8½ x 11 sheets.



Fold



Cut

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Activity 1: Exploring

Most origami models are made by folding a square piece of paper. You can make patterns while you practice paper folding.

- Carefully fold a square piece of paper four times as shown.

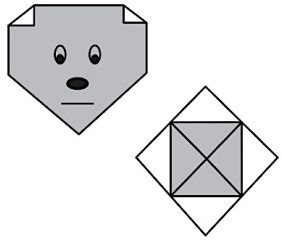
- Write your name on the resulting triangle. Then unfold the piece of paper until it is back in its original square shape.

- Try to duplicate your pattern of folds so that after four successive folds your name is visible on the outside of the triangle. If you wish, you may use a pencil to lightly label points or creases on the paper.

- **Brainstorm:** What instructions would you give to a friend to help them fold the piece of paper four times and still end up with your name visible on the outside of the triangle? What geometry vocabulary from this unit (or other units) could you use in your directions to help your friend understand?

Activity 2: Constructing

Some artists make origami by experimenting. They fold and unfold a piece of paper until they see a resemblance to something in the real world. Take your folded square from the previous activity. Use the existing creases to construct the dog and the flower pictured at the right. Now make your own origami figure, starting with a fresh square of paper.



Activity 3: Writing

To communicate the origami model that you designed in **Activity 2**, you can use the language of geometry. Use geometric terms and symbols along with sketches to write directions for the origami figure you made in **Activity 2**. Test your directions by having a friend or family member construct your model.

Finishing the Project:

Make sure you are ready to turn-in each of the following items:

- **Activity 1** origami figure
- **Activity 2** origami figure
- **Activity 3** instruction sheet

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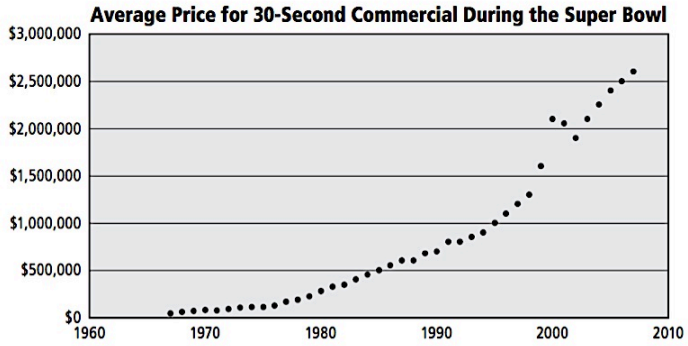
UNIT 2: Logic, Reasoning & Proof

Beginning the Project:

Hundreds of billions of dollars are spent on advertising each year in the United States. Advertising on television, in magazines and newspapers, on billboards, on the radio, and on the Internet bombard us with images and slogans designed to entice us to purchase products or services. For the annual Super Bowl broadcast, a company may spend as much as $2–$3 million for a thirty-second advertising spot that is designed to dazzle millions of viewers with the glories of its product.



In this unit project, you will analyze and generate advertising to explore logical reasoning.

Activity 1: Researching

Collect at least five ads in several different media. Consider radio, television, magazines, newspapers, the Internet and other media. For each ad that is not in print, write a description of the ad, including both visual and spoken messages.

Activity 2: Writing

Some advertisements use specific if-then conditional statements, and others use statements that can be written as conditionals. Still others only imply conditional statements. For each ad, identify at least one conditional statement that the ad states explicitly or implies.

Activity 3: Analyzing

Although an ad may only state or imply a conditional, the advertiser may want you to assume that the converse is true as well. Identify the converse of each of the conditionals you wrote for your ads. Analyze the truth-value for each of the conditionals and converses you wrote.

Activity 4: Generating

Choose a product or service on the market, or generate one of your own. Write a "good definition" of the product or service (See Problem 4 on p.100 of your textbook for examples of a "good definitions").

Finishing the Project:

Make sure you are ready to turn-in each of the following items:

- **Activity 1** five ads/descriptions
- **Activity 2** ad conditionals
- **Activity 3** converses & truth values
- **Activity 4** product & definition

UNIT 3: Parallel & Perpendicular Lines

Beginning the Project:

How do you show the three-dimensional world in a two-dimensional drawing? One technique is perspective. There is evidence that artists in ancient Greece and Rome used perspective, but that perspective was forgotten and then rediscovered during the Renaissance. In your project for this unit, you will investigate techniques of perspective and then use them to make a drawing of three-dimensional objects.

What You Need:

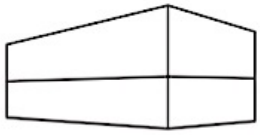
- Unlined Paper
- Straight Edge
- Pencil

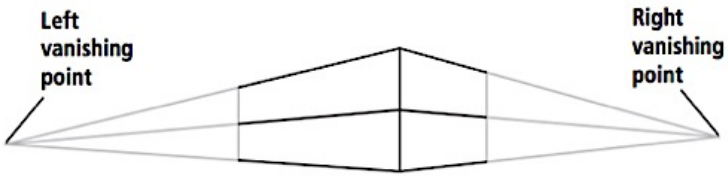
Project Tips:

Read your directions carefully. If a photo in **Activity 1** does not work out, choose another and try again. You may also wish to mark the photocopies in colored pencil. In **Activity 2,** take your time and use a light touch on the pencil so you can erase easily if necessary.

Activity 1: Exploring

Drawings are a great tool for studying perspective. Look at the drawing of the building below left. You know that floors in a building are in parallel planes. Are the segments for the floors parallel in the drawing? Below right you can see that if you extend these segments, they intersect. These points of intersection are called *vanishing points*.





Now look at the segments that represent the height of the building. Are these segments vertical? Are they parallel? Here they are both vertical and parallel, but in some drawings they might not be. Notice that because of perspective, the vertical segments are not the same length. The farther an object is from you, the smaller it appears.

Find three drawings or photos of buildings in books, magazines, or on the Internet. Using photocopies or printouts, show how parallel lines appear in perspective, and find the vanishing points. You may find examples of different kinds of perspective. Write a summary of your findings.

Activity 2: Drawing

Use what you have learned to make a perspective drawing of a building.

- Work in pencil and keep a ruler and eraser handy.
- To start, draw and label a horizon line near the middle of the page.
- Place a left vanishing point and a right vanishing point on the horizon.
- Draw a line parallel to and below the horizon. Label it "Ground."

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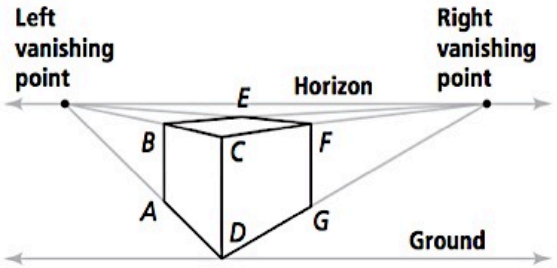
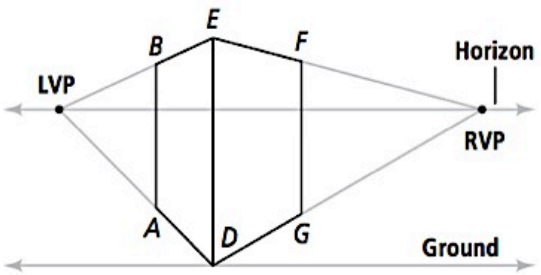
- Start your structure by drawing vertical segments perpendicular to the ground line. How long should you make each segment? Look at the buildings below and notice that if points B, E, and F are below the horizon, you will be able to see the roof of the building. If B, E, and F are above the horizon, the roof will be hidden.





Notice also that points A, D, and G do not lie on a line. If you extend DA to the left, it will pass through the left vanishing point. If you extend DG to the right, it will pass through the right vanishing point. Complete your building by deciding whether or not to place your points above or below the horizon, then connect your segments as shown.

- Add a second building to your drawing using the same procedure as above.
- Finish your drawing by adding a road that is in perspective with your buildings.

NOTE: You do not have to make a scale drawing. Your grade will be based only on correctly drawing lines in perspective.

Finishing the Project:

Make sure you are ready to turn-in each of the following items:

- **Activity 1** three drawings & summary
- **Activity 2** your drawing

UNIT 4: Transformations

Beginning the Project:

Ukrainian painted eggs, dollar bills, Native American pottery, Japanese kimonos, automobile tire treads, and African cloths are products of vastly diverse cultures, but all these things have something in common. They contain strips of repeating patterns, called frieze patterns. In this unit project, you will explore the underlying relationships among frieze patterns from around the world. You also will produce your own designs. You will see how distinct civilizations—separated by oceans and centuries—are linked by their use of geometry to express themselves and to beautify their world.

What You Need:

- Paper
- Graph Paper/Dot Paper (optional)
- Straight Edge
- Pencil

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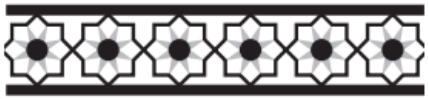
Activity 1: Exploring

A frieze pattern, or *strip pattern*, is a design that repeats itself along a straight line. Every frieze pattern can be mapped onto itself by a translation. Some patterns can also be mapped onto themselves by other transformations. Decide whether each frieze pattern can be mapped onto itself by a reflection, a rotation, a translation, or a glide reflection. Write your responses on a **separate sheet of paper**.

a) Nigerian design

b) Ancient Egyptian ornament

c) Arabian design

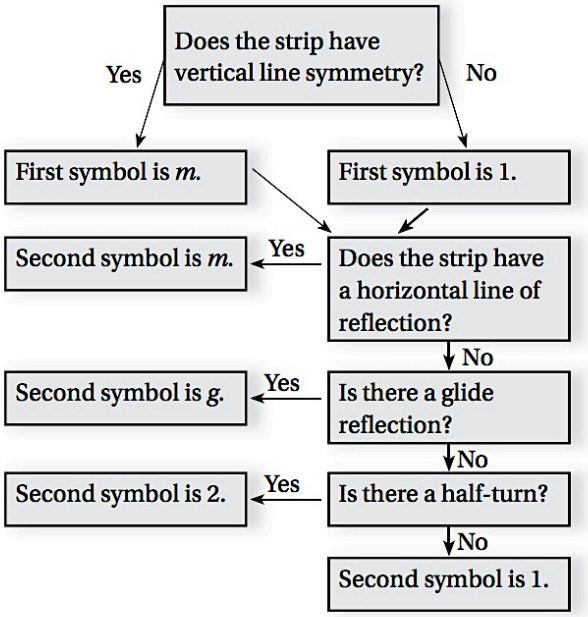


Activity 2: Classifying

It may surprise you to find out that when you classify frieze patterns by their symmetries, there are only seven different types. Each pattern is identified by a different two-character code: 11, 1g, m1, 12, mg, 1m, or mm. Use the flowchart below right to classify each frieze pattern below. Write your responses on a **separate sheet of paper**.

a) Caucasian rug design, Kazakh

b) French, Empire motif



Activity 3: Designing

In previous activities, you explored and classified frieze patterns from a variety of cultures. Now you can make your own. Use graph paper, dot paper, geometry or drawing software, or cutouts. Make at least one frieze pattern for each of the seven types summarized below.

The Seven Types of Frieze Patterns

Types	Symmetries	Examples						
11	T	P	P	P	P	P	P	P
12	T, H	Z	Z	Z	Z	Z	Z	Z
*m*1	T, RV	Y	Y	Y	Y	Y	Y	Y
1*g*	T, G	D	W	D	M	D	W	D
1*m*	T, RH, G	D	D	D	D	D	D	D
mg	T, H, RV, G	M	W	M	W	M	W	M
mm	T, H, RV, RH, G	I	I	I	I	I	I	I

Key to Symmetries:

T = Translation
H = Half-turn
RV = reflection in vertical line
RH = Reflection in horizontal line
G = Glide reflection

Finishing the Project:

Make sure you are ready to turn-in each of the following items:

- **Activity 1** three responses (a,b,c)
- **Activity 2** two responses (a,b)
- **Activity 3** seven frieze patterns

Name: _____

UNIT 5: Congruent Triangles

Beginning the Project:

Have you ever wondered how bridges stay up? How do such frail-looking frameworks stretch through the air without falling? How can they withstand the twisting forces of hurricane winds and the rumbling weight of trucks and trains? Part of the answer lies in the natural strength of triangles. In your project for this unit, you will explore how engineers use triangles to construct safe, strong, stable structures. You then will have a chance to apply these ideas as you design and build your own structure with toothpicks or craft sticks. You will see how a simple shape often can be the strongest one.

What You Need:

- Sheet of cardboard
- Scissors
- Stapler
- 100 toothpicks or 30 craft sticks
- Glue

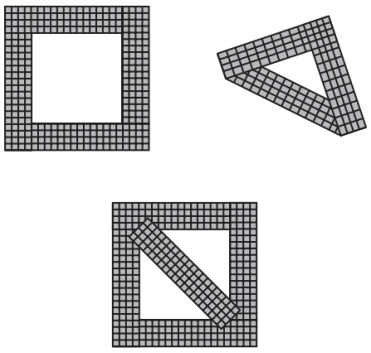
Project Tips:

Read your directions carefully. In **Activity 1**, push or pull the models only along the plane of the frame. In **Activity 2**, look for small design features that are used repeatedly. In **Activity 3**, use glue that is strong but quick-drying. In **Activity 4**, test small parts of your structure before building the entire structure. Also, decide in advance in what order you will assemble and glue the different sections.

Activity 1: Exploring (2D)

Many structures have straight beams that meet at joints. You can use models to explore ways to strengthen joints.

- Cut seven cardboard strips approximately 6 in. by ½ in. Make a square frame and a triangular frame. Staple across the joints as shown below right.



- With your fingertips, hold each model flat on a desk or table, and try to change its shape. Which shape is more stable?

- Cut another cardboard strip, and use it to form a brace for the square frame. Is it more rigid? Why does the brace work?

Write your responses to the questions above on a **separate sheet of paper**.

Activity 2: Observing

Visit (or research photographs of) local bridges, towers, or other structures that have exposed frameworks. Examine these structures for ideas you can use when you design and build a bridge later in **Activity 4**. Record your ideas. Sketch or take pictures of the structures. On the sketches or photos, show where triangles are used for stability.

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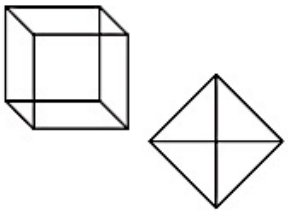
Activity 3: Exploring (3D)

In the first activity, you tested the strength of two-dimensional models. Now investigate the strength of three-dimensional models. Use toothpicks or craft sticks and glue to construct a cube and a tetrahedron (a triangular pyramid).

- Which model is stronger?
- Describe how you can strengthen the weaker model.

Write your responses to the questions above on a **separate sheet of paper**.



Activity 4: Creating

Use toothpicks or craft sticks and glue to construct a structure that can support the weight of your geometry book. Use what you discovered in **Activity 3** to make your structure as strong as possible.

Finishing the Project:

Make sure you are ready to turn in each of the following items:

- **Activity 1** square frame, triangular frame & question responses
- **Activity 2** sketches or photos
- **Activity 3** cube, tetrahedron & question responses
- **Activity 4** structure (or picture of structure)

UNIT 6: Relationships Within Triangles

Beginning the Project:

Pop-up cards and books, in which a flat piece of paper transforms into a three-dimensional creation, enchant children and adults alike. Other books and cards with movable parts offer things to spin or pull, or make a movement in some way. Surprisingly, "movable books" date back to the thirteenth century; however, pop-ups or movable parts were not used in children's books until late in the eighteenth century. In your project for this unit, you will explore the geometry of triangles by using pop-ups.

What You Need:

- 8½ x 11 paper
- Construction paper or cardstock
- Ruler
- Scissors
- Markers or colored pencils

Project Tips:

Read your directions carefully. For best results in **Activity 1**, use construction paper or other heavy paper for your final product. In **Activity 2**, always cut on the folded edge.

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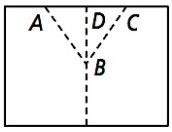
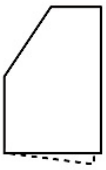
Name: _____

Activity 1: Building



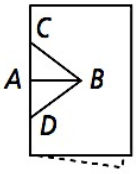
Follow the directions to make a triangle pop-up card.

- Fold two pieces of paper in half. Set one aside.
- Hold one paper with the fold on the left, and fold down the upper left corner, forming a triangle. Open up the paper to the inside, and label ΔABC and altitude $\overline{BD}$.
- What kind of triangle is ΔABC?
- In addition to being an altitude, what other word could describe $\overline{BD}$?
- Pull D toward you, and close the card so that ΔABC folds inside the card like the figure at the right. The folds along $\overline{AB}$ and $\overline{BD}$ must be reversed. When you open the card, ΔABC will pop up.
- Glue the other paper you folded in the first step to the outside of your card. Do not put glue on the pop-up triangle area.
- Decorate the card and pop-up. You can cut out a figure or an object, fold it vertically, and glue it along $\overline{BD}$, and it will pop up.



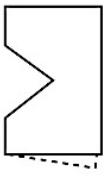
Write your responses to the questions above on a **separate sheet of paper**.

Activity 2: Experimenting



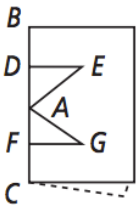
Follow the directions to make a "talking mouth" pop-up card.

- Fold two pieces of paper in half. Set one aside.
- Find the midpoint A of the folded side.
- Draw $\overline{AB}$ perpendicular to the fold.
- Draw isosceles ΔCBD, which has base $\overline{CD}$ on the fold and altitude $\overline{AB}$.
- Cut along $\overline{AB}$; fold on $\overline{BC}$ and $\overline{BD}$.
- Open the card, and pull each of the triangles to the inside of the card, as you did in the previous activity. When your card is closed, it should look like the figure at the right.



- When you open the card, the mouth should pop open.
- Experiment with a non-isosceles triangle ΔCBD.
- Finish your "talking mouth" card by gluing paper on the outside and decorating the card. Draw an animal around the talking mouth pop-up.

Activity 1: Building x2



Follow the directions to make a triangle pop-up card.

- Fold two pieces of paper in half. Set one aside.
- Label the fold $\overline{BC}$. Label the midpoint A of $\overline{BC}$.
- Draw the perpendicular bisectors of $\overline{AB}$ and $\overline{AC}$, labeling them $\overline{DE}$ and $\overline{FG}$, as in the figure at the right.
- Cut along $\overline{DE}$ and $\overline{FG}$.
- Fold on $\overline{\mathrm{AE}}$ and $\overline{\mathrm{AG}}$.
- Open the card, and pull the triangles to the inside. When your card is closed, it should look like the figure at the right.

- Glue paper on the outside, and decorate your card.

Finishing the Project: Make sure you are ready to turn-in all pop-ups and your responses for **Activity 1.**