

## Phila-Gami: Philadelphia Themed Folding in the Math Classroom

### Abstract

This curriculum unit presents 4 discrete lessons integrating origami with math and the city of Philadelphia. The hope is for students to develop patience and perseverance in folding origami patterns while investigating mathematical properties and creating actual tangible products. Students will delve into Philadelphia history and give it an origami twist. The first lesson introduces the world of origami as an art medium and as a tool for mathematicians and scientists with a documentary entitled *Between the Folds*. Betsy Ross's story of the first flag will have students creating a one-cut 5-pointed star and then investigating its properties. Another lesson/project honors three generations of Alexander Calder sculptors in Philadelphia with the creation of a Calder themed origami mobile. Perhaps the easiest of the lessons is to create Pi Day cards using pop-up cutting and folding techniques.

Origami is creating a revolution in the arts and sciences with many real-world practical applications. In the mathematics classroom, origami allows creativity; not a word used often in conjunction with high school mathematics! Remember, mathematics is beautiful and fun; please give your students opportunities to see and believe this!

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**Seminar:** Origami Engineering

**Title:** Phila-Gami: Philadelphia Themed Folding in the Math Classroom

**Overview:**

One quick internet search will show you that there is no shortage of origami based math lessons and books available. Origami can be used to make mathematics fun and concrete – you can sneak that learning in. With this curriculum unit I am offering four discrete lessons that use origami with a Philadelphia slant to investigate various mathematical topics. The first lesson introduces the world of origami as an art medium and as a tool for mathematicians and scientists with a documentary entitled *Between the Folds*. Betsy Ross’s story of the first flag will have students creating a one-cut 5-pointed star and then investigating its properties. Another lesson/project honors three generations of Alexander Calder sculptors in Philadelphia with the creation of a Calder themed origami mobile. Perhaps the easiest of the lessons is to create Pi Day cards using pop-up cutting and folding techniques.

Origami is creating a revolution in the arts and sciences with many real-world practical applications. In the mathematics classroom, origami allows creativity; not a word used often in conjunction with high school mathematics! Even if this curriculum unit does nothing but provide a springboard for you to find and use other origami lessons, it will have served a purpose. Remember, mathematics is beautiful and fun; please give your students opportunities to see and believe this!

**Rationale:**

High School Mathematics has often been referred to as *abstract*. The higher level the mathematics class, the less concrete, and the more abstract it is. Typically, algebra introduces abstract reasoning, followed by geometry, which also expects students to be able to reason. Not all students are ready to make the transition to generalize, model and analyze mathematical situations, as NCTM describes, as one of the purposes of algebra.

Too often a Geometry classroom is filled with postulates, theorems and proofs; in that order. Who owns this plethora of If-Then statements? Euclid? The textbook author or publisher? The Common Core State Standards Initiative? The state’s department of education who restates the CCSS? The school district who creates the planning and scheduling timeline? The teacher? Wouldn’t it be amazing if the ownership was put on the students?

**Background:**

In the Common Core State Standards for Mathematics, the point is made that understanding mathematics is equally as important as being able to perform the

procedures. Where or when or how exactly is this understanding going to be developed? The Standards of Mathematical Practice encourage mathematical strategies that students can use to gain understanding of mathematical ideas. A teacher's job is to teach the students the strategies, so he/she can create meaning in each topic covered. One way a teacher can do this is to provide opportunities for students to observe, analyze and discover!

I am a believer in the pedagogical strategy of constructivism, an educational theory influenced by Jean Piaget, Maria Montessori, Lev Vgotsky, Jerome Bruner and other educational philosophers. Constructivism, specifically in mathematics, means students develop mathematical ideas and principles themselves, rather than being taught a number of formulas and rules. I believe student ownership in mathematics encourages reasoning and creates life-long learners and mathematicians. Using concrete models is one way for students to construct mathematical ideas. I propose using origami to do so. Because so many lessons for origami in mathematics already exist, I propose a Philadelphia theme to reach across the curricula to local sites, culture and history.

Philadelphia is an old city, among the first colonized by William Penn and the early founding fathers. We have a rich history and we remain a vibrant center for culture, art and academia. My hope is to use origami lessons to connect hands on learning to Philadelphia themes.

**Objectives:** This unit is intended for high school students. The lessons can be used separately and taught throughout the school year. Some appeal to direct Geometry or Algebra topics; others are geared to integrate Philadelphia history with origami folding while utilizing and enriching mathematical ideas.

The Objectives of the Lessons will include:

- Students will answer questions before, during and after watching the documentary *Between the Folds* by Vanessa Gould.
- Students will fold and with one cut, create a 5-pointed star to simulate its historical significance and examine the mathematics involved.
- Students will investigate the properties and characteristics of a pentagon and pentagram.
- Students will create an Alexander Calder themed origami mobile, write about the mathematics and the Calder inspired characters.
- Students will self-reflect on their Calder mobile project by answering questions.
- Students will create a pop-up greeting card to celebrate Pi Day.

**Strategies:**

- students will use hands-on paper folding activities to develop/increase patience and perseverance and attention to detail.
- students will work cooperatively to create origami objects.
- students will work cooperatively to discover geometric properties of polyhedral
- students will use a KWL chart to assess their knowledge of Betsy Ross and the first U.S. flag.
- students will research Alexander Calder Philadelphia themes in order to create a mobile.

### **Classroom Activities:**

Lesson 1: Introduction to Origami: Documentary *Between the Folds*.

*Learning Objective:* At the end of this lesson, students will be able to explain how origami connects with many fields of study, including mathematics. They will be able to list the roles and or purposes origami serves.

#### *Materials:*

- DVD or Stream *Between the Folds* (54 minutes)
- Discussion Questions (appendix 1)
- Origami Paper (I use deli Patty Paper which is readily available at our school)
- Directions for an easily folded origami object.

#### *Procedures:*

1. Before beginning the documentary, make sure students are familiar with what origami is. This could be a pre-viewing homework assignment or a Do Now.
2. Watch the documentary *Between the Folds* and answer/discuss questions. The questions could be answered by students as they watch the movie, or discussed as they watch, stopping at various points, or discussed after watching. Because the video is 54 minutes long, this may have to be done over two class periods or skip some of the movie.
3. Fold something for goodness sakes! Start with something easy a crane or a frog or a butterfly. This could be an exit ticket, a do now, or a homework assignment. Chances are there is at least one student who would be willing to demonstrate to the class or work with the student teams.

#### *Notes:*

- If a teacher does not have a DVD or is unable to stream the documentary, there is a trailer: <https://www.youtube.com/watch?v=tGxsvmJg18c> (5:34) and highlights (from website) <https://www.vanessagould.com/between-the-folds> (2:00) that provide some of the origami story and origami creations. At a minimum, either or both of these should be used to introduce the ever-growing world of origami.

- There is a more recent origami documentary released by NOVA, The Origami Revolution: <http://www.pbs.org/wgbh/nova/physics/origami-revolution.html>
- I use deli patty paper for most of the origami folding we do. It creases well and doesn't tear easily. It measures 5.5" by 5.5" and comes in boxes of 1000. It is available from many math supply companies and some restaurant supply stores

## Lesson 2: The Nation's First Flag

*Learning Objective:* At the end of the lesson, students will be able to fold and with one cut, create a five-pointed star. Students will be able to give the historical significance of Betsy Ross' storied contribution to our country's first flag. Students will be able to identify the properties and characteristics of a pentagon and pentagram.

### *Materials:*

- The story of George Washington and the secret committee of the Continental Congress who ordered the first flag from Betsy Ross.  
<http://www.ushistory.org/betsy/index.html>
- Erik Demaine's Folding and Unfolding: The Fold-and-Cut Problem  
<http://erikdemaine.org/foldcut/> (go to Try it out yourself by printing one of our several examples and print out the Fancy Star.) Appendix 2
- Pentagonam investigation questions. Appendix 3
- Origami Paper (I use Patty Paper which is readily available in our school).

### *Procedures:*

1. Begin the lesson by finding out what students know about the U.S.'s first flag. I suggest using a KWL. (I give each student a post it and have them write a K, W, and/or L and then post it on the KWL chart at the front of the room.)
2. Impart the story of Betsy Ross and the first flag. The teacher can give a detailed or peripheral account or can assign students via jigsaw to read the separate pages from ushitory.org and report back to their teams. A small writing assignment can be given to ensure students have learned the story.
3. Copy and distribute Erik Demaine's cut-and-fold Fancy Star. The reading *Folding and Unfolding: The Fold-and-Cut Problem*, can also be assigned. Students should fold and cut the star just as Betsy Ross did for George Washington.
4. Students will fold a pentagon <http://www.origami-instructions.com/origami-pentagon-base.html> and complete the investigation questions. This may be done on a second day. The internet investigations (#7 & #8) may be assigned for homework.

*Notes:*

- There are other methods for folding and cutting a 5-pointed star from a rectangular sheet and a square sheet. Search online or use those given at [ushistory.org](http://ushistory.org).
- The idea of history vs. story may be a new one to your students. Pursue this if
- There is a link to Erik Demaine's MIT lecture on The Fold-and-Cut Problem if you'd like to show that to the class or assign to individuals seeking enrichment.
- I use deli patty paper for most of the origami folding we do. It creases well and doesn't tear easily. It measures 5.5" by 5.5" and comes in boxes of 1000. It is available from many math supply companies and some restaurant supply stores.

Lesson 3: Three Generations of Calders in Philadelphia Art

*Lesson Objectives:* At the end of the lesson students will be able to describe the artistic contributions of Alexander Milne Calder, his son Alexander Stirling Calder, and his son Alexander "Sandy" Calder. Students will have made a mobile with origami pieces inspired by the work of any or all of the Calders.

*Materials:*

- Article: Generations of Alexander Calder Art a Trinity of Blessings for Philadelphia by Susie Perloff May 13, 2014 <https://why.org/articles/generations-of-alexander-calder-art-a-trinity-of-blessings-for-philadelphia/>
- Web article: Three Generations of Calders in Philadelphia (Adapted from *Public Art in Philadelphia* by Penny Balkin Bach (Temple University Press, Philadelphia, 1992). <http://www.associationforpublicart.org/apa-now/story/three-generations-of-calders-in-philadelphia/>
- Calder Mobil Project Guidelines (appendix 4)
- Calder Mobil Project Grading Rubric (appendix 5)
- Calder Mobil Project Self-Reflection Questions (appendix 6)
- Barbara Pearl's Instructions on how to make a mobile (appendix 7)
- Erik Demaine's Fold-and-Cut Swan (appendix 8)
- A completed mobile for display
- Materials for the mobile:
  - paper for the origami models (patty paper?)
  - needle
  - invisible thread or fishing line
  - glue
  - thin soft wire
  - wire cutters

*Procedures:*

1. Students will be introduced to the Alexander Calder Philadelphia legacy by reading the Susie Perloff Article: Generations of Alexander Calder Art; A Trinity of Blessings for Philadelphia and the Web Article: Three Generations of Calder in Philadelphia (Adapted from [Public Art in Philadelphia](#) by Penny Balkin Bach). You can use your choice of reading strategies or assign it for homework before you introduce the project.
2. Introduce the project to the class with the project guidelines. After going over the goals, expectations and requirements, answer any questions the students may have. Return to these guidelines throughout the project time period to ensure students are staying on task and understand the outcome. Distribute the project rubric and self-reflection questions and answer any questions students may have. Decide how long you will allow for the project and how many class periods students will have to work with you and/or their peers on the project. Also clarify which materials you will supply for the class and which materials the students will be responsible for themselves. It is advisable to have a finished mobile to show the class exactly what end result you expect.
3. Create check-in times for students to show you their progress and ask questions that may arise. Give advice to those students who are doing too much or too little. Allow students opportunity to discuss their projects among themselves as well.
4. On the due date, allow the students to present their mobiles to the class and share the mathematics they learned and their Calder connections.
5. Allow one or two days between the due date of the Calder mobile and the due date of the self-reflection questions. This will give students opportunity to compare their creative process with a classmate's.
6. Do your own reflection on the project. Will you do it again. What changes will you make? Record these now so you will remember for next time.

*Notes:*

- Some students/classes will need more guidance than others. Be prepared to make suggestions for Calder characters. Students can use swans, frogs or turtles from the Swann Memorial Fountain, they can use anything Shakespearean from the Shakespeare Memorial, they can use any of the zodiac symbols from the Zodiac Sundial, they can use any of the circus animals or performers from Sandy Calder's circus.
- Students may also need guidance when considering the mathematics they used for their Calder mobile. Did they have to consider weight and/or surface area when creating balance in their mobile? Were they able to scale their origami models by using different size paper? Were they interested in preserving orientation or symmetry when creating their mobile?
- I use deli patty paper for most of the origami folding we do. It creases well and doesn't tear easily. It measures 5.5" by 5.5" and comes in boxes of 1000. It is

- available from many math supply companies and some restaurant supply stores. It has no color and is semi-transparent, but students can decorate as they wish.
- This project can be done almost exclusively at home or in class or a mix of both. Perhaps use the shorter periods during standardized or before or after a break. It should be FUN!

#### Lesson 4: Pop-Up Pi

*Lesson Objectives:* At the end of the lesson, students will have created pop-up greeting cards to celebrate pi day, March 14.

*Materials:*

- Instructions for making pop-up cards <http://wp.robertsabuda.com/make-your-own-pop-ups/>
- Card stock or construction paper for greeting card.
- Scissors.
- Pencil, pen or marker.
- Decorating supplies.
- Pi and Pi Day designs, poems, etc.
- Sample card to show students.

*Procedures:*

1. Explain to class how popular pi day celebrations have become.
2. Do Now: Give a pi joke or a fact about pi.
3. Distribute directions, watch and/or demonstrate how to make a pop-up card <http://wp.robertsabuda.com/make-your-own-pop-ups/>
4. Distribute supplies.
5. Encourage creativity and reward Philadelphia based pi themes.

*Notes:*

- You can make your pop-up pi cards on Pi Day or before the actual day.
- You could make pop-up pi cards to sell to raise money for your math club.
- Students can work alone or with a partner.
- Celebrate Pi Day with other festivities such as pi recitation contests, pi jewelry and chains, a pi-throwing event with teachers as targets, or many other options.
- You can reward the best cards with pie!

#### **Annotated Bibliography/Works Cited/ Resources**

Brooks, Martin G, & Brooks, Jacqueline Brennon (1999) *The Courage to Be Constructivist*, ASCD Journal *Educational Leadership* November 1999 | Volume **57** | Number **3 The Constructivist Classroom** Pages 18-24

Gould, Vanessa (Director & Producer) (2009) *Independent Lens: Between the Folds* available to watch on Amazon Prime  
available to buy on shoppbs.org  
trailer: <https://www.youtube.com/watch?v=tGxsvmJg18c> (5:34)  
highlights (from website) <https://www.vanessagould.com/between-the-folds> (2:00)

Pearl, Barbara. (1994). *Math in Motion Origami in the Classroom*.  
[www.mathinmotion.com](http://www.mathinmotion.com).

Demaine, Erik, Demaine, Martin, & Lubiw, Anna (2016) *Erik Demaine's Folding and Unfolding, The Fold-and-Cut Problem*. Retrieved from <http://erikdemaine.org/foldcut/>

Balkin Bach, Penny (1992) *Three Generations of Calder's in Philadelphia* (Adapted from *Public Art in Philadelphia* by Penny Balkin Bach (Temple University Press, Philadelphia, 1992). Retrieved from <http://www.associationforpublicart.org/apanow/story/three-generations-of-calders-in-philadelphia/>

Perloff, Susie (2014) *Generations of Alexander Calder art a trinity of blessings for Philadelphia* by Susie Perloff May 13, 2014 Retrieved from <https://why.org/articles/generations-of-alexander-calder-art-a-trinity-of-blessings-for-philadelphia/>

Independence Hall Association (2018) *Betsy Ross and the American Flag*. Retrieved from <http://www.ushistory.org/betsy/index.html>

*Origami Pentagon Base* (2014) Retrieved from <http://www.origami-instructions.com/origami-pentagon-base.html>

Sabuda, Robert (2018) *Pop-Up Basics* Retrieved from <http://wp.robertsabuda.com/make-your-own-pop-ups/>

### **Annotated Bibliography Resources for Teachers:**

Origami Resources

<https://origamiusa.org/>

<https://www.origami-resource-center.com/money-origami-things.html>

Origami at the Philadelphia Airport based on work by Barbara Pearl, author of Math in Motion. <http://www.phl.org/Arts/Pages/Archivedexhibitions/origami.aspx>

Franco, Besty & Varner, Diane (1999) *Unfolding Mathematics with Unit Origami*. Emeryville, CA. Key Curriculum Press.

Hull, Thomas (2013) *Project Origami: Activities for Exploring Mathematics*. Boca Raton, FL. CRC Press.

The Effect of Origami-Based Instruction on Spatial Visualization, Geometry Achievement and Geometric Reasoning. International Journal of Science and Mathematics Education, Authors: Arici, S; Aslan-Tutak, F.

Montrell, John (2012) *Origami and Math, Simple to Complex*. New York, NY. Dover Publications, Inc.

Mitchell, David (2015) *Mathematical Origami: Geometrical Shapes by Paper Folding*. St Albans, Herts, UK. Tarquin Publications.

O'Rourke, Joseph (2011) *How to Fold It, The Mathematics of Linkages, Origami, and Polyhedra*. New York, NY. Cambridge University Press.

#### Betsy Ross Resources

dollar bill 5-pointed stars

<http://make-origami.com/money-5-pointed-star/>

#### Alexander Calder Resources

city hall virtual tour – sculpture by Alexander Milne Calder

[http://www.phila.gov/virtualch/virtual\\_tour.html](http://www.phila.gov/virtualch/virtual_tour.html)

Calder Foundation <http://www.calder.org/>

<http://www.theartstory.org/artist-calder-alexander.htm>

comedy & tragedy book fold! costs \$3.41

[https://www.etsy.com/listing/205058533/folded-book-art-tragedy-comedy-drama?ref=shop\\_home\\_active\\_4](https://www.etsy.com/listing/205058533/folded-book-art-tragedy-comedy-drama?ref=shop_home_active_4)

comedy & tragedy dollar bill fold

<https://www.pinterest.com/pin/484559241128280238/?lp=true>

## **Appendix/Content Standards**

### **CCSSI Mathematics High School Geometry**

#### **Understand congruence in terms of rigid motions**

6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

#### **Make geometric constructions**

12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).

#### **Visualize relationships between two-dimensional and three-dimensional objects**

4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

#### **Apply geometric concepts in modeling situations G-MG**

6. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).★□

7. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).★□

8. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).★□

#### **Mathematical Practices**

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.

3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

**Appendix Includes:**

1. *Between the Folds* discussion questions – Lesson 1
2. Erik Demaine’s cut-and-fold Fancy Star – Lesson 2
3. Pentagon/Pentagram Investigation Questions – Lesson 2
4. Alexander Calder Mobile Project Guidelines – Lesson 3
5. Alexander Calder Mobile Project Grading Rubric – Lesson 3
6. Alexander Calder Mobile Project Self-Reflection Questions – Lesson 3
7. Barbara Pearle’s How to Make an Origami Mobile – Lesson 3
8. Erik Demaine’s cut-and-fold Swan – Lesson

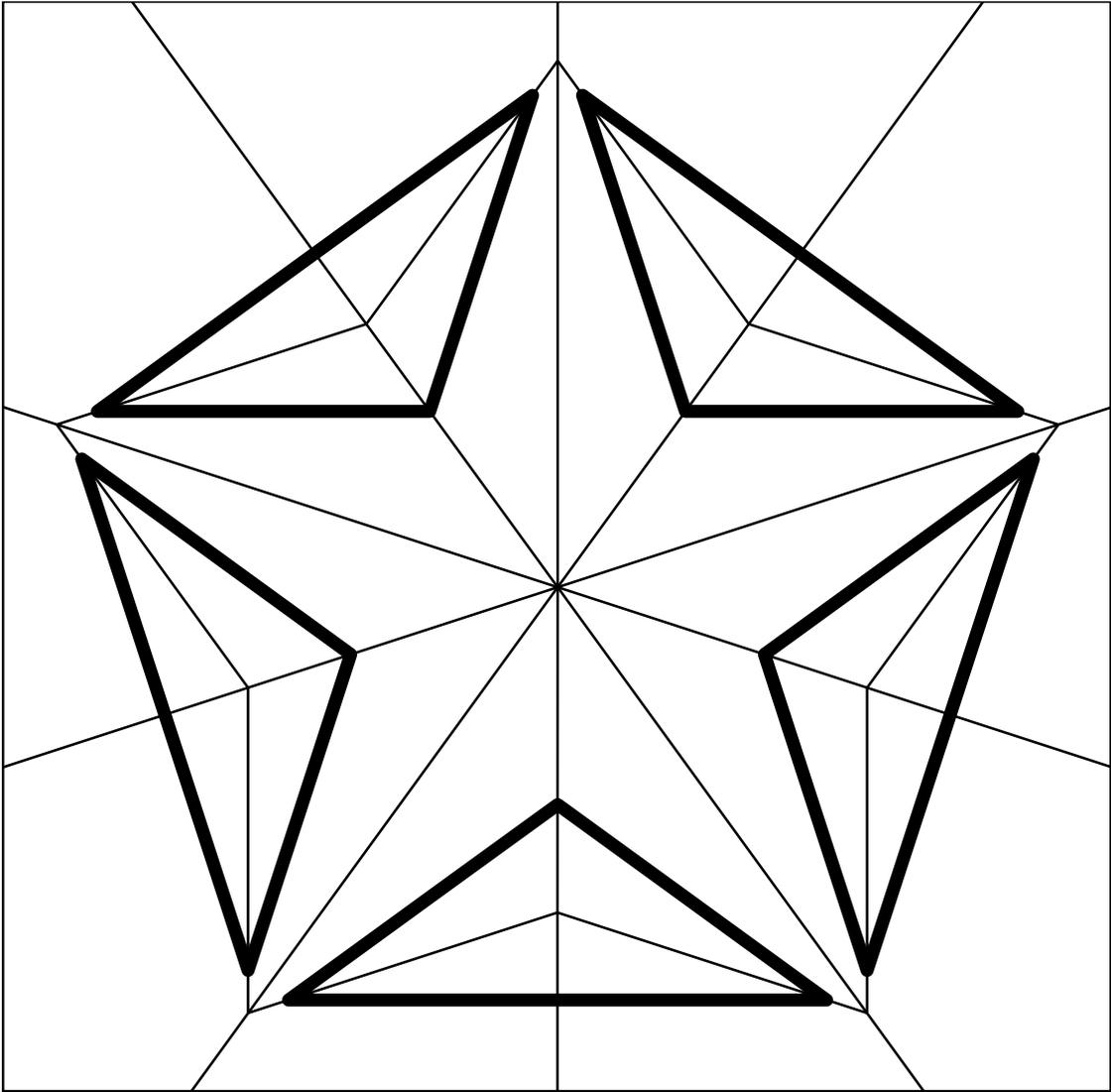
*Independent Lens: Between the Folds* by Vanessa Gould

Discussion Questions

Pre-Viewing Question: Explain or give examples of origami and any personal experience you may have with origami.

Questions from the film:

1. What are the basic rules of origami?
2. What is the "medium" for origami?
3. How do many origami artists and engineers use drawing or diagrams to assist in their folding?
4. Who is considered the father of origami? Give facts about him or his work.
5. What comparisons can one make between origami and music?
6. What else besides music do origami masters compare with their creative process and products?
7. Give two facts or questions you may have about origami creations that move or reconfigure.
8. What is origami and how is it used?
9. Name at least two practical applications of origami.
10. Name two of the origami masters in the film and what fascinates you about them (that can include their pieces).



## Pentagram/5-Pointed Star Investigation

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Pertinent Vocabulary:

Pentagram, pentagon, central angle of a circle, inscribed angle of a circle, diagonals of a polygon, golden ratio

?

Either before or after or in conjunction, use origami to fold a regular pentagon.

<http://www.origami-instructions.com/origami-pentagon-base.html>

?

Investigate the following:

?

1. Find the measure of each interior angle of the regular pentagon?

?

Connect each vertex of the pentagon to the center of the pentagon.

2. Find the measure of each "central angle".

?

Draw in all of the diagonals of the pentagon to create a pentagram.

??

3. What shape do the diagonals create in the center of the pentagram?

?

4. Find the measure of the interior angle at each point of the pentagram.

?

5. How many triangles are in the pentagram? (hint: there are more than 5)

?

6. What kind of triangles are these?

?

7. Investigate where the golden ratio appears in a pentagram.???

?

8. Investigate why it was thought that the pentagram had magical powers.

?

?

?

?

?

## Three Generations of Calder's in Philadelphia- Origami Mobile Project

**Project Start Date:** \_\_\_\_\_

**Project End Date:** \_\_\_\_\_

**Overview:** What do you know about William “Billy” Penn who sits atop City Hall? Did you learn how to use him as a marker for directions when you are in center city? Did you realize the statue is 37 feet tall and weighs over 26 tons? Have you seen him dressed in Eagles, Phillies, 76ers, or Flyers regalia?

The statue of William Penn was sculpted by artist Alexander Milne Calder, who immigrated from Scotland and lived in Philadelphia. Alexander’s son, Alexander Stirling Clader, was also an artist. He studied and taught at the Pennsylvania Academy of Fine Arts and carved many statues in and around Philadelphia that you may know. His son, Alexander “Sandy” Calder, also an artist is most famous for his large movable statues which Marcel Duchamp named “mobiles”.

For this project, you will create a mobile, using origami pieces inspired by work by any or all of the Alexander Calder's. You will have to research to find the objects you wish to include as well as how to make them by folding. You have many, many options.

### **Project Goals:**

- Students will research themes and elements of statues made by any or all of the Alexander Calder's.
- Students will choose at least 4 different characters from Calder themes to use in their mobiles.
- Students will find instructions to fold each of the selected characters.
- Students will fold at least 10 origami pieces.
- Students will construct a balanced mobile with at least 3 distinct levels.
- Students will write about the mathematics they used to create their mobile.
- Students will write about the selected characters and how they relate to Alexander Calder.
- Students will reflect on what they learned by making an Alexander Calder mobile.

### **Student Expectations:**

- Students are expected to be responsible for and participate fully in every aspect of the project and each task along the way.
- Students are expected to share the work equally and productively in their team.
- Students are expected to seek help or ask for clarifications from their team or teacher when needed.

### **Project Requirements:**

1. Student or student teams must create a mobile that is balanced.
2. The mobile must contain at 10 origami pieces.
3. The origami pieces must represent at least 4 different folds/characters.
4. The characters must represent figures inspired by works of Alexander Calder(s).
5. The mobile must have at least 3 distinct levels.
6. Students must write (individually even if she worked in a team) and describe the selection of each character and how and what piece of Calder art it was inspired by.
7. Students must write and describe the mathematics they used when creating the project.
8. Students must answer the project reflection questions.

Alexander Calder Mobile Project - Rubric

Name: \_\_\_\_\_ Worked with: \_\_\_\_\_ Date: \_\_\_\_\_

Mobile characters used: \_\_\_\_\_ Mobile levels: \_\_\_\_\_

Task	Points Possible	Points Earned
Mobile was turned in on time.	6	
Mobile is balanced and appears neat and pleasing	10	
Mobile contains at least 10 origami pieces	10	
Mobile contains at least 4 different characters	12	
Mobile contains at least 3 distinct levels	12	
Mobile characters are inspired by Calder art	10	
Mobile origami are accurately folded	10	
Written explanation of connections to Calder art	10	
Written explanation of mathematics used.	10	
Self –Reflection questions answered thoughtfully.	10	
<b>Total Project Points</b>	<b>100</b>	

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## Alexander Calder Mobile Project – Self-Reflection Questions

Please answer thoroughly and thoughtfully on lined paper.

For this project, you have created an Alexander Calder themed origami mobile, written about the mathematics involved and the inspiration for the origami pieces.

1. What new things did you learn about Philadelphia?
2. What new things did you learn about origami?
3. What new things did you learn about the Alexander Calders?
4. What new things did you learn about mathematics?
5. What part of this project or your learning surprised you? Why?
6. What new curiosities, questions or interests has this project inspired? Why?
7. What was your favorite part of this project? Why?
8. Compare your creative process with that of a peer. How were they the same? How were they different? Are the differences apparent in the outcome?
9. If you worked with your team throughout this whole project. How did your team work together? Is there anything that you, your team members or your teacher could have done to make this team process better?
10. What would you change about this project? What about the project worked or did not work? What would you add to enhance the project?

# How to Make an Origami Mobile

A mobile is a hanging ornament of parts that move.  
Origami makes a great mobile because it is lightweight and moves easily.

**Materials:** Several origami models, a needle, invisible thread, glue, thin soft wire, and wire cutters. These items can be purchased in an arts and crafts or a fabric store.

First, thread all your models.  
Vary the length of the thread to arrange the way you want each one to hang. (Fig.1)

Cut a piece of wire and tie a model to each end. Make a loop at the end of the wire to keep the thread from slipping off. Glue the knots in place.

Tie a thread to the middle of the wire and slide it back and forth to balance the models. Glue the knot to the wire. (Fig. 2)

Tie the pair of models to one end of a longer wire. Place one model or another pair at the other end. Tie a thread to the wire and balance. (Fig. 3)

Continue to work from the bottom upward and use longer wires to hang all your models. Make the wires long enough so that none of the models touch each other as they move around in circles. Finally, balance a thread to hang up the mobile. An origami mobile of bright colors can decorate a room or make a colorful gift for a new baby or a friend!

