Digital Lesson.com Presents

Marvelous Middle School Math

Geometry Activities

By Mark P. Tully

Mark Tully is a mathematics teacher at Oak Middle School in the Los Alamitos Unified School District, Los Alamitos, California. He has been teaching for about 25 years and during that time has served as Mathematics Department Chairman and as a Mathematics Mentor Teacher. He enjoys developing activities that are designed to present the prescribed mathematics curriculum and standards in a way that is active and engaging.

Mark's website, **www.DigitalLesson.com**, is designed to meet the needs of middle school math teachers. DigitalLesson.com specializes in providing instant downloads of engaging, hands-on math lessons and projects. These middle school math activities are designed to enhance the middle school math program. Also included on the site are other math resources tailored for the middle school math teacher.

Mark also publishes the ***Middle School Math Treasures*** newsletter. The newsletter includes resources, ideas, and activities for middle school math teachers. A subscription ***to Middle School Math Treasures*** is free! Sign up on the home page of Digital Lesson.com. Unsubscribe at any time. We will never rent or sell your e-mail address. Enjoy this great, free resource!

We would love to hear about your experiences using this book, *Geometry Activities*, in your classroom. Please e-mail us with any comments at digitallesson@yahoo.com.

A publication of Digital Lesson.com

Preface

Digital Lesson.com is dedicated to being a valuable resource for middle school math teachers who not only want to excel in the teaching of mathematics, but also want to deliver the mathematical curriculum in a manner that engages and involves students. The collection of lessons and projects in this book strive to place mathematics into an active context that is inherently interesting.

Instant

The lessons and projects at Digital Lesson.com are instantly available. Upon receipt of payment, your lesson or project is automatically sent to you via e-mail. Save your lesson file to your computer for later use. Then, just "Print and Present" your lesson. No more waiting for delivery and no shipping costs.

Engaging

Our math lessons and projects offer students an interesting way to connect to the mathematics prescribed by your required curriculum. Hands-on activities and contextual lessons heighten the sense of usefulness and purpose students find in their mathematics.

Teacher Friendly

All blackline masters for the math lessons and projects are included. We have seen far too many great ideas for lessons on the internet that would take hours of time and effort to format before actually being able to use them. All of our lessons come ready to implement in your classroom immediately. Just make a few copies and get ready to inspire your students!

Teacher Tips are provided with each lesson to eliminate as many of the "Oh, I'll do that differently next time," moments as possible. The goal of the *Teacher Tips* is to make you an expert in the lesson BEFORE you teach it, not after. Too many lesson plans and projects that we have seen and received over the years leave it up to teachers to use trial and error before they ever teach the lesson effectively. The tips will immediately empower the teacher to teach the lesson more effectively.

Standards Based

Finally, the math lessons and projects on Digital Lesson.com have been designed to specifically meet the NCTM math standards and state math standards that teachers are expected to teach. Our intent is to provide more engaging activities, while still covering the same mathematical standards as the textbook. The lessons are intended to be served a la carte, to fill in curriculum holes or just to infuse some excitement and activity into your classroom as you teach a familiar math standard.

Wishing you inspiration and motivation to be the best math teacher you can be!

Mark Tully

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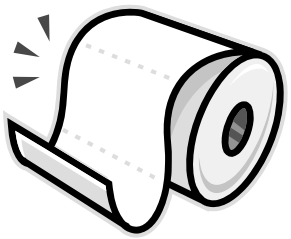


Toilet Paper Geometry

Toilet Paper Trivia

What did people use before toilet paper?

People of many cultures and social classes have used a number of different things in place of the rolls of toilet paper that we use today. Things they used include newsprint, straw, hay, grass, corn cobs, leaves, sand, pages from books, coconut shells, lace, rocks, a sponge on a stick, snow, and tundra moss.

Important Dates in Toilet Paper History

1391 - First toilet paper invented
1857 - First toilet tissue
1890 - First toilet paper on a roll
1942 - First soft toilet paper; two-ply

Toilet Paper Facts

Two-ply toilet paper is not twice as thick as one-ply toilet paper. One-ply is made of #13 thickness paper while two-ply is made of two layers of #10 thickness paper.

The size of a sheet of toilet paper can vary but the standard size is 4.5 inches by 4.5 inches. Some manufacturers have come out with "cheater sheets" that are as small as 4 inches by 3.8 inches and use about 15% less paper.

The average person uses 8.6 sheets of toilet paper per trip, 57 sheets per day, and 20,805 sheets per year. (I wonder how these statistics were compiled?)

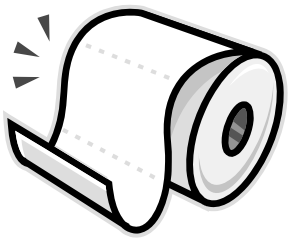
With over 6 billion people living on earth it is estimated that people need to produce 83,048,116 rolls of toilet paper each and every day, 30,600,000,000 rolls per year and 2.7 rolls per second.

Toilet paper may be quilted or rippled, perfumed, colored or patterned, medicated , include added aloe, and more. There are many different options available in a roll of toilet paper. Some toilet paper includes designs that range from cartoon characters to pictures of unpopular political leaders.

Differences in opinions on how to install a roll of toilet paper (with the toilet paper sheets hanging next to the wall or away from the wall) have caused disagreements in households.

When it comes to using toilet paper some people are "folders" and some are "scrunchers."

Resources used to compile this page:
www.toiletpaperworld.com
http://komar.cs.stthomas.edu/qm425/01s/Tollefsrud3.htm
http://en.wikipedia.org/wiki/Toilet_paper



Toilet Paper Geometry

Teacher Tips

(1 of 2)

Lesson Description: Toilet Paper Geometry is a math project that requires students to find the surface area and volume of a roll of toilet paper. Students unwind the roll of toilet paper, place it into the form of one or more rectangles, and calculate the total surface area of the roll. Then they determine how many rolls of toilet paper it would take to cover a basketball court, a football field, and a baseball diamond. Students also calculate the volume of the toilet paper in two different ways (by finding the volume of a cylinder and a rectangular prism) and compare their results.

Math Content: Surface Area**,** Area of Rectangles, Volume of Cylinders and Rectangular Prisms,

Time Required: 1-2 Class Periods

Toilet Paper Geometry includes:

* 2 Toilet Paper Geometry student worksheets
* 2 Toilet Paper Geometry student worksheet Answer Keys
* 1 Toilet Paper Geometry toilet paper trivia sheet
* 2 Toilet Paper Geometry Teacher Tips pages
* 1 Toilet Paper Geometry Cover Sheet **8 pages in all!**

Materials Needed: Rolls of toilet paper (with packaging information removed), rulers

Suggested Grade Level: 5th - 8th

Teacher Testimonial:

Toilet Paper Geometry is a chance for students to take an everyday household object (toilet paper) and have it become the basis for an interesting project involving surface area and volume. Middle school students are always telling stories about whose house got toilet papered over the weekend. Students have an inherent interest in toilet paper. Teachers can also take the opportunity to compare unit prices, number of sheets, etc. between toilet paper brands.

Teacher Tips:

* Keep the written packaging information in order to verify the accuracy of student area calculations. When I designed this lesson I used a roll of Kirkland Signature Quilted Bath Tissue, 2-ply, 425 sheets, 53.1 sq. ft. (4.9 sq. m.) per roll, with each sheet 4.5 in. x 4.0 in. (11.43 cm x 10.16 cm). The roll (from Costco) was individually wrapped and all of the above information was on the plastic wrap that covers the roll.
* Before distributing the rolls of toilet paper to each group be sure to write down which brand each group receives. Copy the vital measurements from the rolls beforehand. Do not pass out the toilet paper rolls with this information still on the packaging. You want the students to see how close they can get to the package information.
* Have students work in groups of two to four people on this project.
* You may want to have all students working on the exact same brand of toilet paper roll or you can have several different brands being worked on in each class.

The Royal

Reward

The Royal Reward

Group Geometry Project

King Euclid is a man who is very fond of geometry, especially polygons. After conquering the neighboring kingdom of Ignorance he decides to reward the greatest knights and ladies of his kingdom. He divides a large rectangular piece of land into smaller plots of land, shaped like polygons, and awards them to his top knights and a few prominent noble ladies.

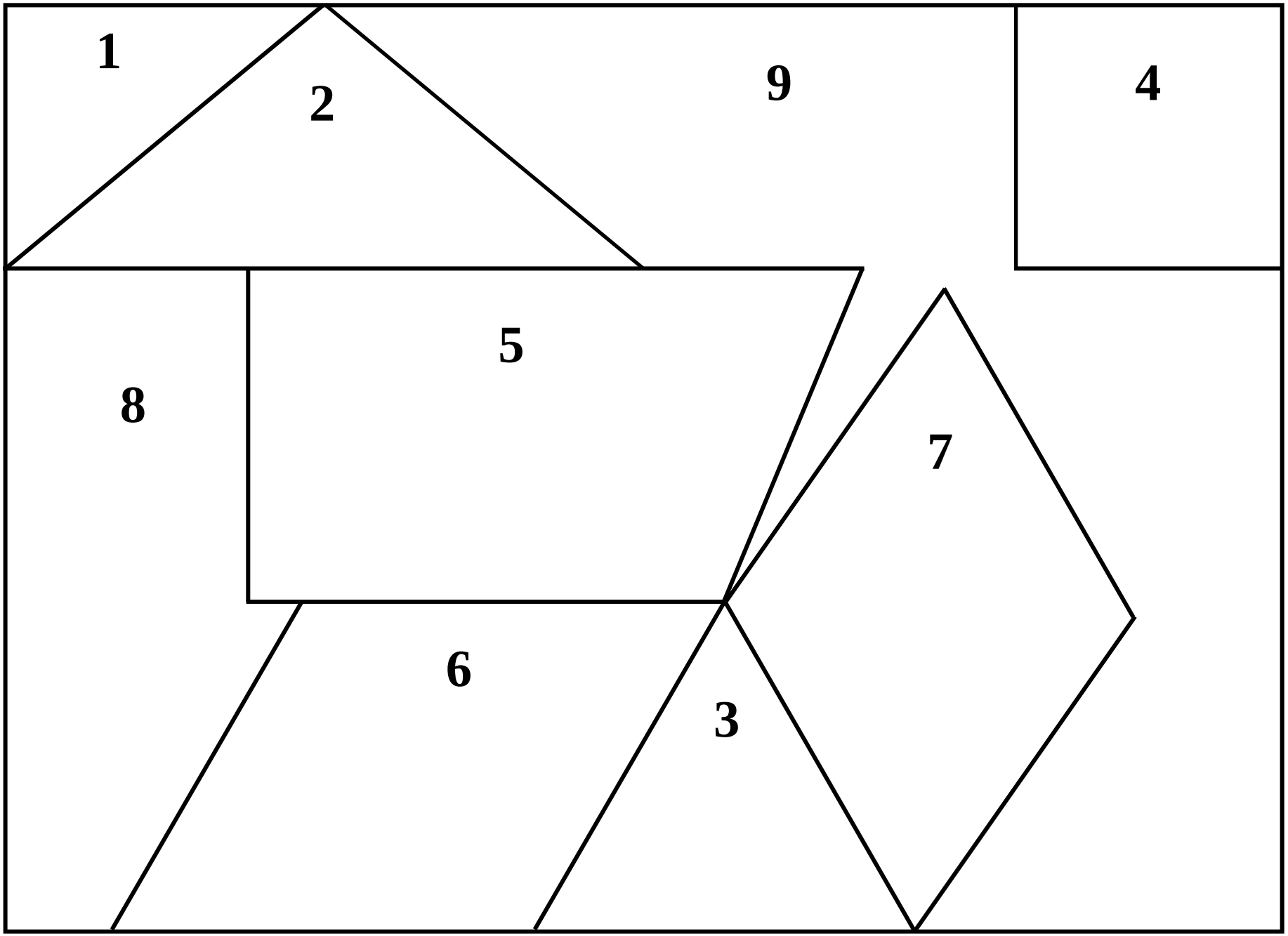
Those who are to receive land from the king for their support in the war against Ignorance include Sir Fibonacci, Lady Andrini, Sir Pascal, Sir Galileo, Sir Escher, Lady Burns, Sir Bernoulli, and Sir Pythagoras. The king decides to keep the largest plot of land. Before giving the remainder of the land to his loyal royal subjects King Euclid creates the Royal Reward Chart. Complete this chart and label the Royal Land Map in order to help the king to decide who will be the new owner for each piece of land.

If you are successful in this venture you will not only learn a great deal of geometry and become very wise, but King Euclid has promised to recommend that you receive three segments with three intersections. Of course he may recommend one segment and two arcs, a curve, one segment and one arc, or even the dreaded three segments with two intersections, depending upon the quality of your service.

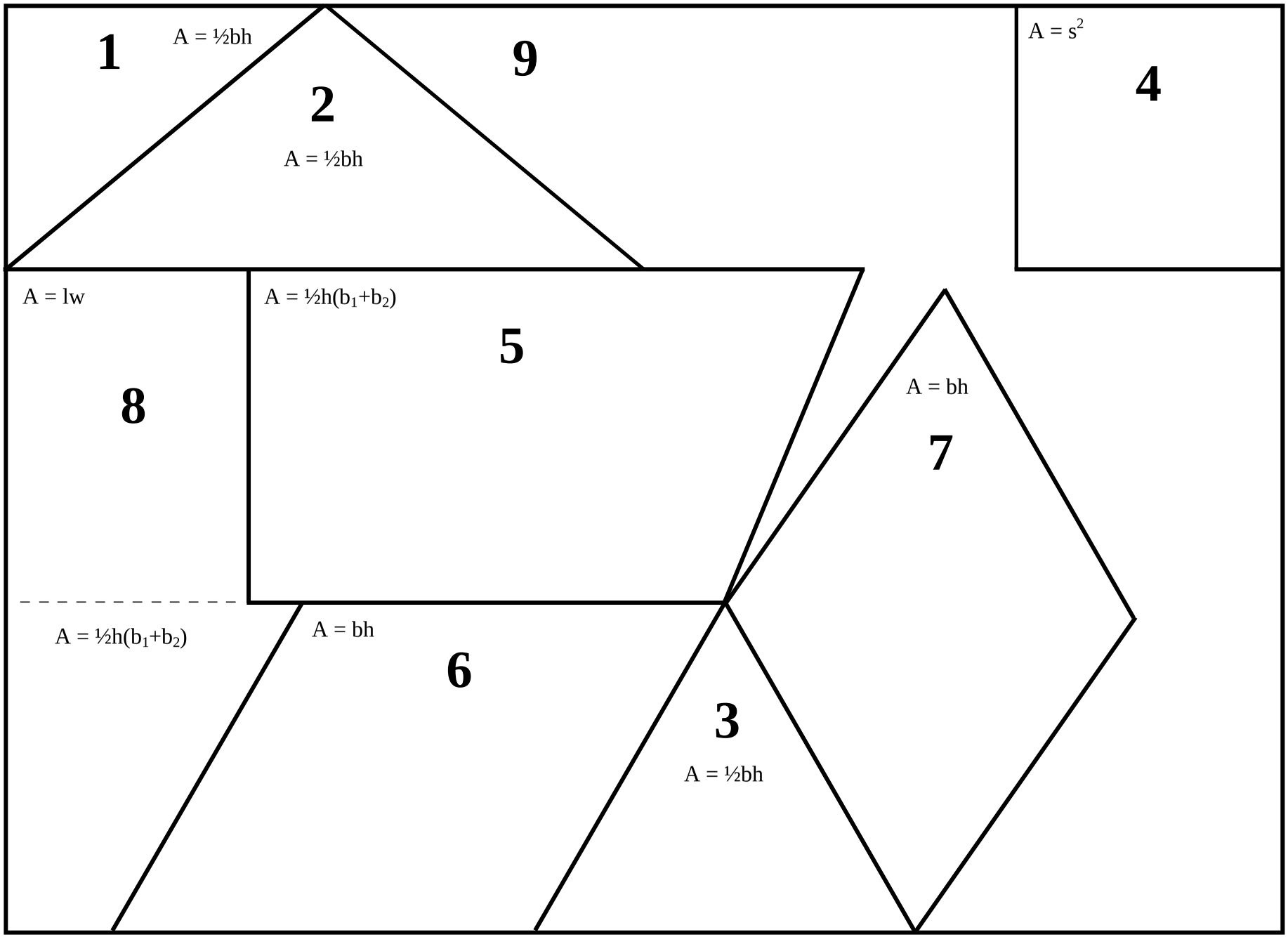
As you complete the chart and the map:

1. Measure and then label each of the angles for each piece of land on the Royal Land Map. Include this data on your chart.
2. Measure, and then label (in kilometers) each boundary line of each plot of land. The scale being used on the Royal Land Map is 1 centimeter (cm) = 1 kilometer (km). Place the boundary lengths on the inside of each polygon next to the corresponding segment. Measurements are only necessary on one side of a segment if two owners share the exact same length boundary. Include this data on your chart.
3. Label each piece of land with the name of the polygon that **best** describes it. Place the label a little below the center of the polygon (and in parentheses).
4. On your Royal Reward Chart calculate the sum of the angle measures and the perimeter of each piece of land. Pay attention to any patterns that you discover.
5. Use the Royal Land Map Area Worksheet and the area formulas given to find the approximate area of each piece of land. Record these area measurements on your chart.
6. After completing the Royal Reward Chart, King Euclid decides to reward the largest remaining piece of land to the noble that has served the king for the longest period of time. Each noble, in turn, will receive his or her piece of land according to the amount of time he or she has served the king. Using the **perimeter data** that has been collected, the king asks you to notify each noble and tell them which plot of land they have been given.
7. Lady Burns has served the king for the longest period of time, followed in order by Sir Fibonacci, Lady Andrini, Sir Pythagoras, Sir Escher, Sir Bernoulli, Sir Galileo, and finally Sir Pascal, who has only served the king for a very short period of time. On the Royal Land Map write the name of the noble that will receive each piece of land above the polygon label in the appropriate polygon.

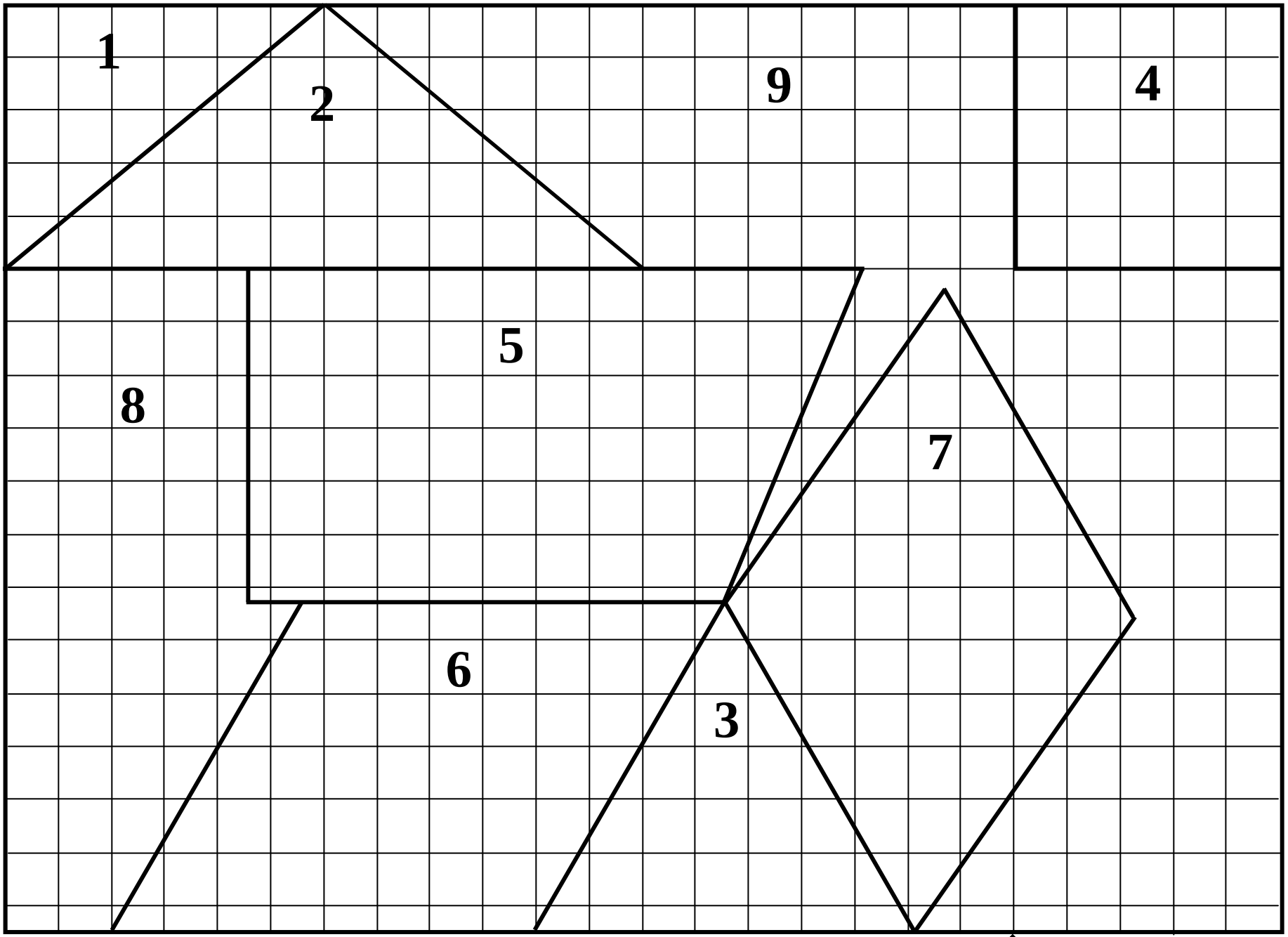
Royal Land Map



Royal Land Map Area Worksheet



Royal Land Map



The Royal Reward Chart

#	Polygon Name (specific)	Angle Measures (small to large)	Sum of Angle Measures (degrees)	Boundary Lengths (km) (small to large)	Perimeter (km)	Rank	Area (km^2)	Rank
1								
2								
3								
4								
5								
6								
7								
8								

The Royal Reward

Interior Angles of Polygons

King Euclid notices a pattern in the sum of the interior angles of a polygon. What pattern does he notice? You have already determined the sum of the interior angles of triangles, quadrilaterals, and hexagons. What will the sum of the interior angles of a pentagon be? An octagon? A nonagon? If you do not see the pattern, draw these polygons using straight line segments and measure their interior angles to determine the sum. Once you discover the pattern use it to develop a formula for finding the sum of the interior angles of a polygon with x sides. Then use this formula for the final three polygons!

Polygon	Number of Sides	Sum of Interior Angles
Triangle		
Quadrilateral		
Pentagon		
Hexagon		
Heptagon		
Octagon		
Nonagon		
Decagon		
Hendecagon		
Dodecagon		
Any Polygon	x	
Icosagon	20	
Pentacontagon	50	
Hectogon	100	

The Royal Reward

_____

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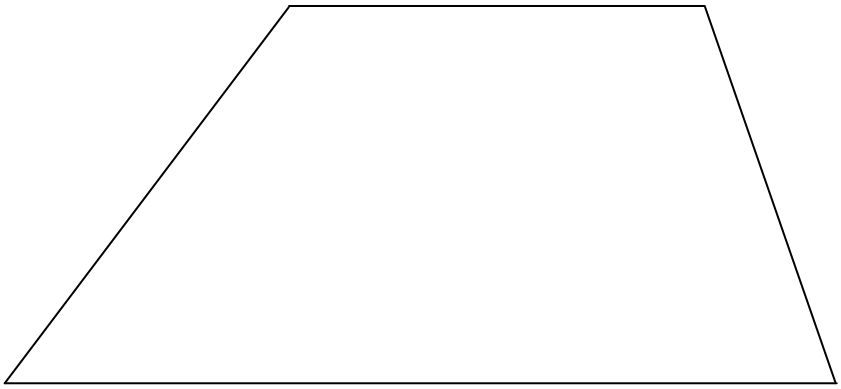
The Royal Reward - Quiz A

Use the scale map of a plot of land below to complete the quiz. Label the measures of the polygon and place the answers in the answer blanks below. The map scale is 1 cm = 1 km. Show all work for numbers 2, 4, and the extra credit problem. Use the back of the paper if necessary.



1) List the measures of the angles, in order, from least to greatest.

_____, _____, _____, _____

2) What is the sum of the interior angle measures of this polygon? _____

3) List the measures of each segment, in order, from least to greatest. Give answers in kilometers.

_____, _____, _____, _____

4) What is the perimeter of this polygon? _____

5) What is the area of this polygon (in square kilometers)? _____

6) What is the name of the polygon above? _____

Extra Credit: If the cost of fencing is 5.7 rolems per kilometer, how much would it cost to build a fence around this plot of land?

_____

The Royal Reward

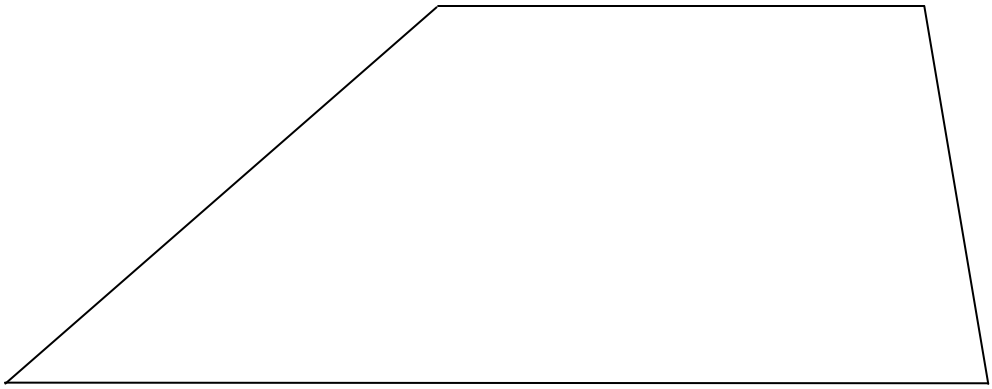
_____

_____

_____

The Royal Reward - Quiz B

Use the scale map of a plot of land below to complete the quiz. Label the measures of the polygon and place the answers in the answer blanks below. The map scale is 1 cm = 1 km. Show all work for numbers 2, 4, and the extra credit problem. Use the back of the paper if necessary.



1) List the measures of the angles, in order, from least to greatest.

_____, _____, _____, _____

2) What is the sum of the interior angle measures of this polygon? _____

3) List the measures of each segment, in order, from least to greatest. Give answers in kilometers.

_____, _____, _____, _____

4) What is the perimeter of this polygon? _____

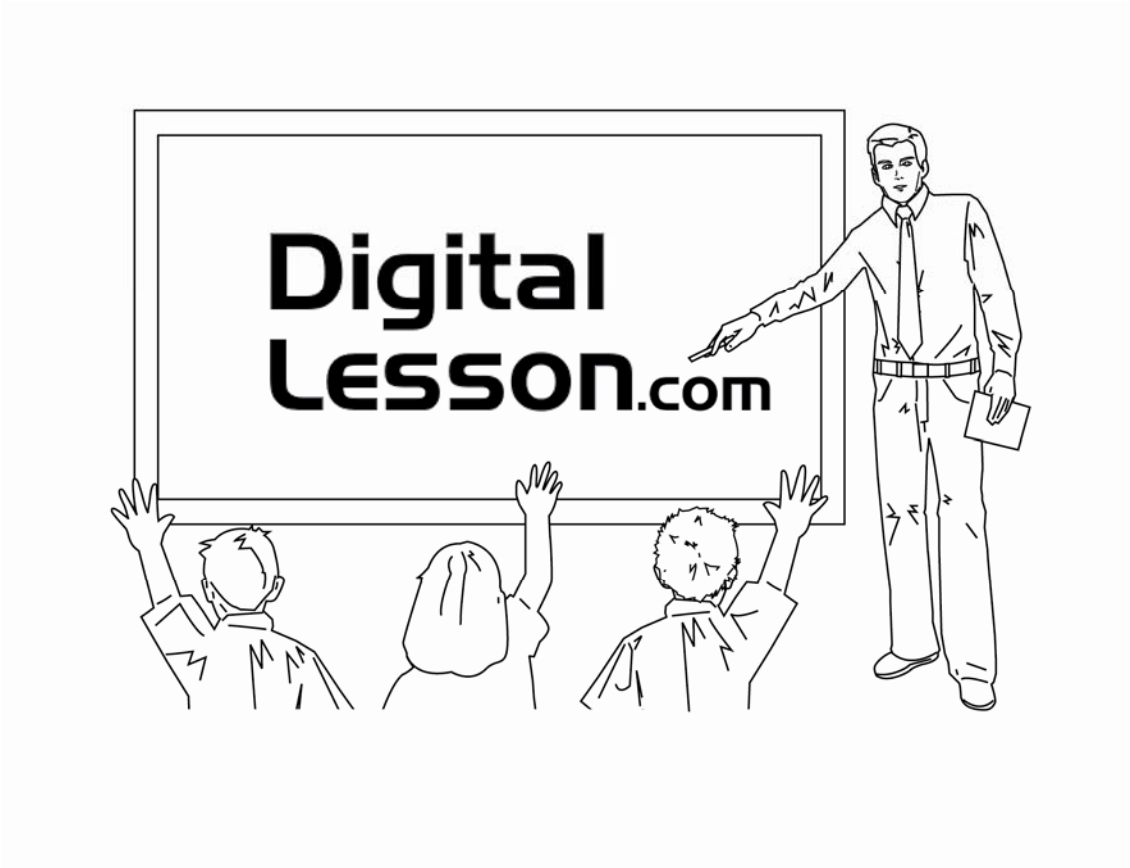
5) What is the area of this polygon (in square kilometers)? _____

6) What is the name of the polygon above? _____

Extra Credit: If the cost of fencing is 5.7 rolems per kilometer, how much would it cost to build a fence around this plot of land?

_____

Cereal Box



Surface Area

Cereal Box Surface Area

_____

_____

_____

Cereal Box Surface Area

Directions:

1. Calculate the area of each section of the box using the data on your cereal box net drawing and the table below. Let the longest side equal length. (Round area answers to the nearest hundredth.)
2. Label the area of each section on your cereal box and on the net on your worksheet.
3. Find the surface area of the entire box.

Section Number	Section Length	Section Width	Section Area
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
		Cereal Box Surface Area:	

Cereal Box Surface Area

_____

_____

_____

Cereal Box Volume and Weight

Cereal Box Volume

To find the volume of a box of cereal (also known as a rectangular prism) just multiply the area of the base (length times width) by the height. The formula is $V = l \cdot w \cdot h$.

Use your cereal box dimensions to find its volume. (Round the volume to the nearest hundredth.)

Length: _____ Width: _____ Height: _____ Volume = _____

Cereal Box Weight

Look on the cereal box to find the weight of the cereal in ounces. Weight = _____

Ratio of Cereal Weight to Volume in Comparison to Other Brands

	Cereal Brand	Weight	Volume	Ratio (weight/volume)
You	_____	_____	_____	_____

Now compare the data with that of four other groups in your classroom.

1)	_____	_____	_____	_____
2)	_____	_____	_____	_____
3)	_____	_____	_____	_____
4)	_____	_____	_____	_____

Cereal Box Mathematics Scavenger Hunt

Find at least three **other** examples of mathematics on your cereal box.

1. _____

2. _____

3. _____

Cereal Box Surface Area

Teacher Tips

(1 of 2)

Lesson Description: Cereal Box Surface Area is a group project in which students create a net of a rectangular prism from a cereal box and then use it to determine the surface area and volume of the box. Students also find the weight of the cereal and use it to determine weight to volume ratios. Finally, students complete a quick mathematical scavenger hunt on their cereal box. The finished cereal box projects are perfect for classroom display.

Math Content: Surface Area, Volume, Measurement, Ratios, Rectangular Prism, Fractions, Decimals, Net of a Rectangular Prism, Converting Fractions to Decimals

Time Required: 1-2 Class Periods

Cereal Box Surface Area includes:

* 3 Cereal Box Surface Area student worksheets
* 3 Cereal Box Surface Area student worksheet Answer Keys
* 2 Cereal Box Surface Area Teacher Tips pages
* 1 Cereal Box Surface Area Cover Sheet **9 pages in all!**

Materials Needed: Empty cereal boxes (one for each group), rulers, markers

Suggested Grade Level: 5th - 8th

Teacher Testimonial:

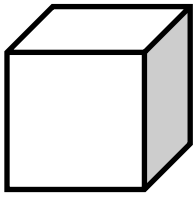
Cereal Box Surface Area is a group project that puts surface area and volume into a context that students can relate to. Whether it's Lucky Charms or Raisin Bran, virtually all students eat cereal. Breakfast will never be the same again! This project will help students see mathematics everywhere in the world around them. The project itself is packed with powerful math and will make the concepts of surface area and volume tangible for your students.

Teacher Tips:

* Have students display their work on the cereal box as well as their worksheets. One way to do this is shown on the answer key for the cereal box net. To show students the format you prefer you can either draw a diagram on the board or (if you like the model given) hand out the answer key as a sample page.
* If the inside of the box is printed, you can attach a sheet of paper with student work to the net.
* All flaps on the cereal box will not be perfect rectangles. Have students estimate the area of these sections by using a reasonable value for each length and width.
* As the teacher, you may choose to only complete the cereal box and the first two worksheets on calculating the surface area of the box. The third worksheet is optional.
* Cereal is not sold by volume but by weight. On the volume worksheet students find the ratio of weight to volume. Students can discuss what this ratio tells us. What factors might determine the weight to volume ratio? (one cereal is lighter, one box is smaller, etc.)

Squares

Project



SQUAREA

(Area and Volume)

_____

_____

_____

Note: All answers should include appropriate units such as square inches ($in.^2$) or cubic feet ($ft.^3$).

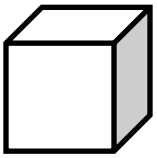
I. SQUARE FOOT

1. Cut out a square foot.
2. Draw square inches on your square foot.
3. How many square inches are in a square foot? _____

II. AREA TRACING/DRAWING

1. Trace or draw at least five objects on your square foot and color them.
2. Label each object and write its estimated area **on** your square foot.

Object	Area	Object	Area
A) _____	_____	D) _____	_____
B) _____	_____	E) _____	_____
C) _____	_____		

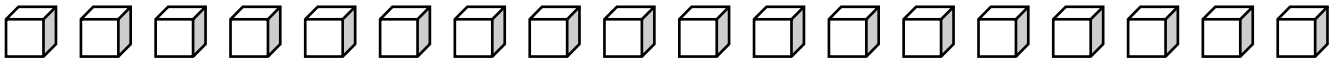


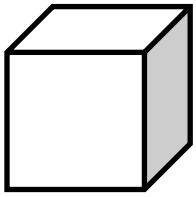
III. WHITE BOARD/CHALK BOARD

1. Use your square foot to estimate the area of one white board in square feet.
   L = _____ W = _____ A = _____
2. Estimate the area of the white board in square inches.
   Equation: _____ A = _____

IV. CLASSROOM FLOOR

1. Use your square foot to estimate the area of the classroom floor in square feet.
   L = _____ W = _____ A = _____
2. Estimate the area of the classroom floor in square yards.
   Equation: _____ A = _____
3. What would be the cost of carpeting the classroom at $25 per square yard?
   Equation: _____ C = _____





SQUAREA TEACHER TIPS

(Area and Volume)

Lesson Description: SQUAREA (a hybrid word I created which stands for "Square Area") is a hands on math project that helps students to discover area, volume, and surface area in a very concrete, visual manner. Students measure objects in a classroom, create square feet, draw square inches, construct cubic feet, construct square yards and cubic yards, and investigate the surface area of a cube.

Math Content: Area, Volume, and Surface Area **Time Required:** about 2 class periods

The SQUAREA Project includes:

* 2 SQUAREA Project worksheets
* 2 SQUAREA Project worksheet answer keys
* 1 SQUAREA Teacher Tips page

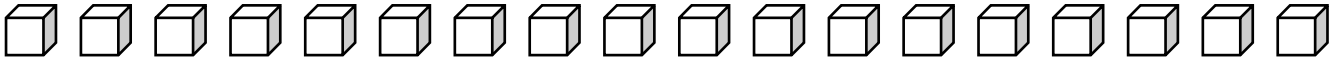
Materials Needed: Construction paper, tape **Suggested Grade Level:** 5^{th} - 8^{th}

Teacher Tips:

* Construction paper should be used for this project. Students need to carefully measure the paper, draw guide lines, and cut off enough in order to create their square.
* When students draw their square inches on their square feet I usually have them do this lightly in pencil first, using a ruler. Many later outline their square inches with a black marker and ruler.
* Have the students draw and color the objects on their square feet **over** the square inch markings. This contrast makes it easier for the students to count the square inches.
* Teach students to estimate the area of objects that include partial squares. I encourage students to draw or trace objects that are irregular in shape.
* I find it easier to collect and grade page 1 and the square foot before completing page 2.
* It will take 162 square feet in order to create 27 stackable cubic feet that can be used to create your cubic yard. If you do not have this many students you can either cut out extra square feet (that have not been divided into square inches) or just model the answer for the class.
* Use a lot of clear tape to tape the six square feet together to create your cubic feet. Have students put their names on the front of their square feet since they will be taped together.
* Stack 27 cubic feet together to create a cubic yard. You can place them on tables in the center of the room for a nice Open House visual.

Testimonial:

Since I developed this project I have used it several times with 6^{th} and 7^{th} grade students. The way in which it allows them to actively learn the concepts of area, volume, and surface area is truly remarkable. The students are able to visualize the concepts of a square inch, a square foot, and a square yard. They work cooperatively with others to incorporate their personal square foot with others to create a cubic foot. Then they combine these with the cubic feet from other classes to construct a cubic yard. I often have this cubic yard on display at Open House for the parents to see.

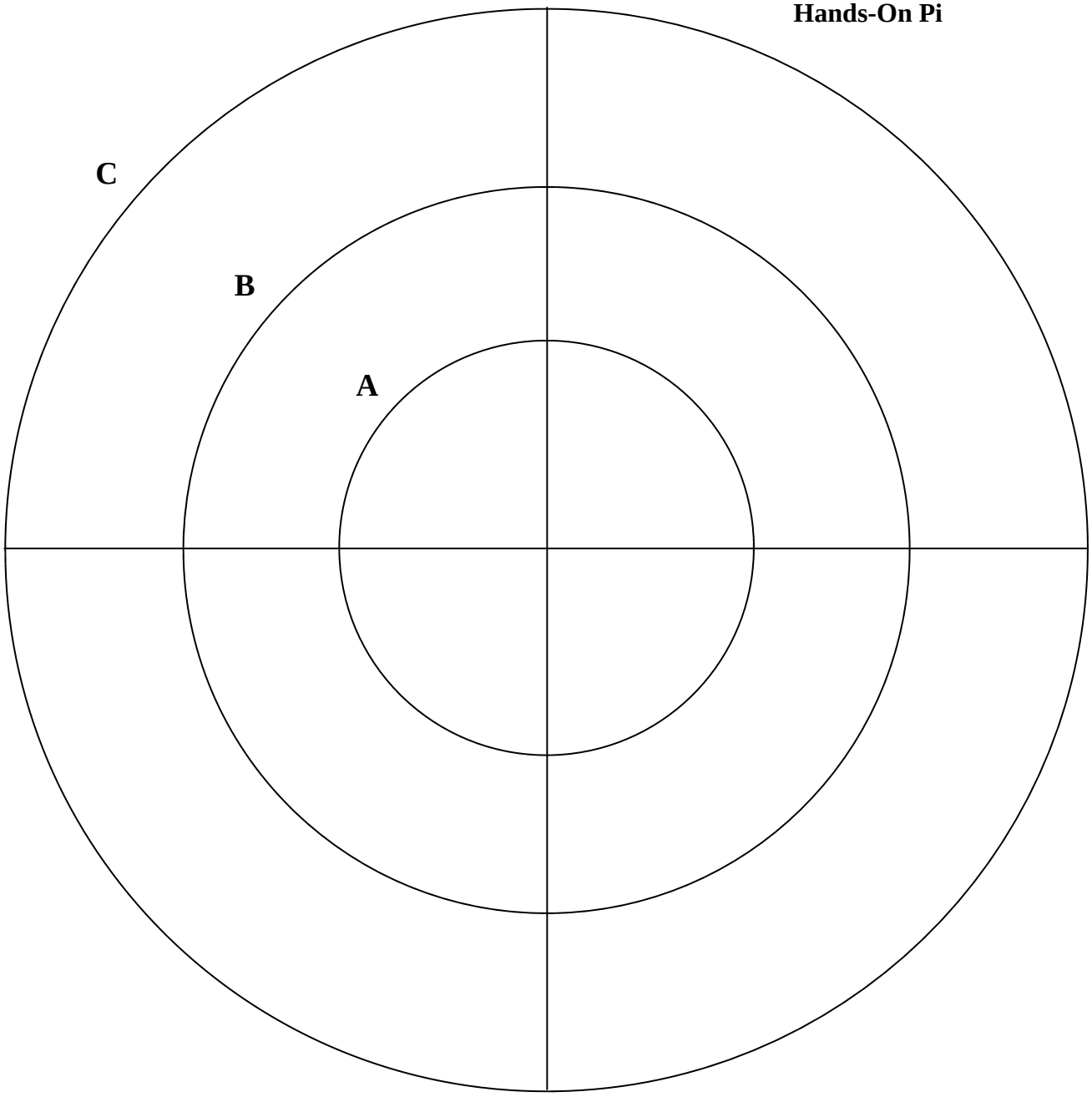


Discovering

Pi Day

Discovering Pi

Hands-On Pi



Use **string** and a **ruler** to measure in millimeters. Round the division answer to the **hundredths** place.

Circle A: Circumference: _____ Diameter: _____ Circumference ÷ Diameter = _____

Circle B: Circumference: _____ Diameter: _____ Circumference ÷ Diameter = _____

Circle C: Circumference: _____ Diameter: _____ Circumference ÷ Diameter = _____

π Discovering Pi

_____

_____

_____

Pi Basics

Pi is a number that expresses the constant ratio of the circumference of a circle to its diameter. The Greek letter π is used to represent this ratio. Pi is an infinite decimal. Since its digits never repeat in a pattern and never end it is called an irrational number. The decimal 3.14 and the fraction 22/7 are frequently used approximations of pi.

Ancient civilizations discovered the concept of pi thousands of years ago. Since then people have worked hard to calculate as many digits of pi as they were able. In the eighteenth and nineteenth centuries pi was successfully calculated to hundreds of digits. In the twentieth century, thanks to computers, pi has been calculated to billions and even trillions of digits.

Pi Day is often celebrated on March 14 (3.14) with some celebrations beginning at 1:59 (3.14159). On Pi Day students can participate in a number of pi-related activities. Enter "pi" or "Pi Day" into an internet search engine and you will find pi history, pi jokes, pi poems, pi facts, and other pi activities. Bring some in to share with your class!

One pi joke by John Evans goes like this:

Q: What do you get if you divide the circumference of a jack-o-lantern by its diameter?

A: _____

While it is interesting to know that the **circumference of a circle divided by its diameter always equals pi**, there are several practical uses for pi. Pi can be used to find the circumference and the area of a circle. It is also used in more advanced mathematical studies.

Pi is used to find the circumference of a circle. The formula for the circumference of a circle is $C=2\pi r$ or $C=\pi d$, where r is the radius of the circle and d is the diameter of the circle. These two formulas are similar since two times the radius is equal to the diameter. Using 3.14 for pi, what would be the approximate circumference of a circle with a diameter of 5 feet? Show your equation and answer on the line that follows.

_____

Pi is also used to find the area of a circle. The formula for the area of a circle is $A=\pi r^2$. Using 3.14 for pi, what is the approximate area of a circle with a radius of 4 inches? Show your equation and answer on the line that follows.

_____

The first 100 digits of pi are 3.14159 26535 89793 23846 26433 83279 50288 41971 69399 37510 58209 74944 59230 78164 06286 20899 86280 34825 34211 70679

Now that you've had a **piece of pi** you can share some with others! Share some of the pi jokes, songs, facts or history that you have found in your research of pi.

π

π Discovering Pi

Teacher Tips

(1 of 2)

Lesson Description: Discovering Pi is a lesson designed to give students a hands-on experience that will help them truly grasp the concept of pi. The students use string and a ruler to measure the circumference and diameter of three different circles. They then calculate the ratio of circumference to diameter, perhaps not realizing that they are really calculating pi. Students also read and complete the Pi Basics sheet. Finally, if you celebrate Pi Day on March 14th, have students share pi jokes, pi songs, pi facts, and pi history before EATING PIE. Of course students love this last part!!

Math Content: Pi, Area of a Circle, Circumference of a Circle, Millimeter Measurement

Time Required: 1-2 Class Periods (Celebrate Pi Day on March 14th!!)

Discovering Pi includes:

* 1 Discovering Pi Hands-On worksheet and 1 Hands-On answer key
* 1 Discovering Pi Basics sheet and 1 Basics answer key
* 2 Discovering Pi Teacher Tips pages
* 1 Discovering Pi Cover Page

Materials Needed: String, Metric Rulers, Pie (optional), and Pi Day research, jokes, songs, etc.

Suggested Grade Level: 5th - 8th

Teacher Testimonial:

Pi Day (March 14) was one of the biggest hits with my students last year! We learned about pi, told pi jokes, sang pi songs (that's a first in my math class!), and learned pi facts and pi history. Best of all, WE ATE PIE!! The students learned how to find the circumference and area of a circle. They also learned where pi comes from. Most importantly, we created a special day to have fun while we were learning. I believe that many of my students will remember March 14th in a special way from now on.

Teacher Tips:

* Have students complete the Hands-On Pi worksheet the day before Pi Day. Then have them do the Pi Basics worksheet for homework. Also, tell them in advance if you will give extra credit for Pi Day jokes, songs, facts, history, etc.
* Use string that does not fray or come apart if at all possible on the Hands-On Pi worksheet. Teach students to mark the string and then measure it using their ruler.
* Try the Hands-On Pi worksheet measurements yourself, ahead of time. You will be better prepared to help the students and to anticipate measurement questions. Make sure students understand that each centimeter on the ruler is actually 10 millimeters and that these measurements are done in millimeters. Help them to see that when they divide the circumference by the diameter they should have gotten close to pi (3.14). Discuss the fact that their calculations will not be exact, or even the same as another student's, since the measurements are not exact.

Paper

Portal

Paper Portal

Challenge - Teacher Notes

Portal Definition

When using this activity with your students it is important to explain to them the definition of the word portal. Dictionary.com defines portal as "a door, a gate, or entrance, esp. one of imposing appearance, as to a palace." The main idea is that a portal is a large opening to walk through.

Paper Portal Challenge

Paper Portal is an activity in which the teacher challenges the students to cut a hole in a single sheet of 8 ½" x 11" paper that is big enough to walk through.

Paper Portal Procedure

1. Introduce the challenge above. You might cut a small hole in a piece of paper to dramatize the difficulty of cutting a hole in the paper big enough to walk through.
2. Give students a period of time (possibly at home) to try to find a solution to the challenge.
3. Discuss any student solutions and whether or not they believe this challenge can be met.
4. Pass out the Paper Portal template and explain to students how to correctly cut the template.
5. Allow them to cut out their own Paper Portal.

Paper Portal Template Cutting Instructions

1. Fold the Paper Portal template in half along the longest line segment on the paper.
2. You will only be cutting along each solid line on the template except for where you see the arrows.
3. Cut **from the fold** to the end of each line segment without an arrow.
4. On the rays (line segments with arrows) cut **from the edges** of the folded paper to the endpoint of each ray. The arrows indicate that the paper should be cut from the edges. The arrows are used because the printer will not print all the way to the edge of the paper.
5. Finally, cut the solid black line along the fold. **Very Important**: Do not cut the fold on the very end of each side of the paper. This will ruin your paper portal. There is no black line segment in these locations.
6. Unfold the paper and you will have a portal opening big enough to walk through!!

Paper Portal

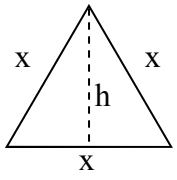
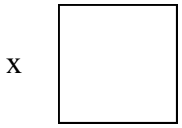
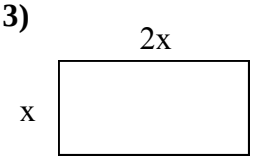
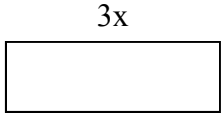
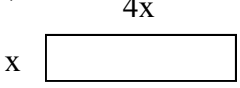
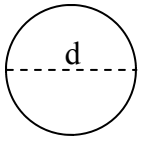
_____

_____

_____

Perimeter and Area

Use your Paper Portal, a tape measure, and mathematical reasoning to complete the chart below. First, identify the value of each variable. Then write equations for the perimeter and area of each polygon using variables. Use these equations to find the perimeter (or circumference) and area of each polygon (or circle). Finally, try to generalize a rule for finding the largest area when given a fixed perimeter. Round longer decimal answers to the nearest hundredth.

Polygon Dimensions (and circle)	Perimeter and Area Equations (using variables)	Perimeter of Polygons (and circle)	Area of Polygons (and circle)
1) 	x = ___ h = ___ P = _____ A = _____	P = _____	A = _____
2) 	x = _____ P = _____ A = _____	P = _____	A = _____
3) 	x = _____ P = _____ A = _____	P = _____	A = _____
4) 	x = _____ P = _____ A = _____	P = _____	A = _____
5) 	x = _____ P = _____ A = _____	P = _____	A = _____
6) 	d = ___ r = ___ C = π d A = π r^2	C = _____	A = _____

Paper Portal

Teacher Tips

(1 of 2)

Lesson Description: Paper Portal is a geometry lesson that begins with a fascinating challenge: Can students cut a hole in a single sheet of 8 ½" x 11" paper that is big enough to walk through? After students are shown the solution to this challenge the remainder of the lesson involves an investigation of the different polygon and circle areas that may be found using a fixed perimeter (the paper portal).

Math Content: Perimeter, Area, Measurement, Comparing the Areas of Different Figures with a Fixed Perimeter, Writing Perimeter and Area Equations with Variables

Time Required: 1 Class Period

Paper Portal includes:

* 1 Paper Portal Challenge Teacher Notes
* 1 Paper Portal Activity Template
* 1 Paper Portal Perimeter and Area worksheet
* 1 Paper Portal Perimeter and Area worksheet Answer Key
* 2 Paper Portal Teacher Tips pages
* 1 Paper Portal Cover Page

Materials Needed: scissors (1 per group), tape measures (1 per group)

Suggested Grade Level: 5th - 8th

Teacher Testimonial:

Paper Portal is an activity that begins with a fascinating challenge for your students. Can they cut a hole in a single sheet of paper big enough to walk through? After letting them work on this problem for a few days you can reveal the intriguing solution. Then students use their Paper Portal to conduct a hands-on investigation of the areas of different shapes that can be made with a fixed perimeter. Learning and fun come together in this activity!

Teacher Tips:

* Have the students work in groups of three or four to complete the Perimeter and Area worksheet. This way they can have a few students form (and hold) the figures and another student do the measuring.
* Make sure students understand that the value of x on each problem on the worksheet is different. Some students may assume that each x has the same value.
* Do not expect students to get the same answers that are on the answer key. **The answer key is intended as only as an approximate guide.** Student answers should be fairly close to the answers on the key, but will vary due to differences in measurement. However, the key relationship between fixed-perimeter figures and their respective areas should become apparent. **In general, the closer a fixed-perimeter figure gets to becoming a circle the bigger its area will be.**