PBS Lesson Series

Math: Grade 6, Lesson 19, Area of Regular Polygons

Lesson Focus: Find the area of regular polygons
Practice Focus: Students will focus on finding the area of regular polygons by decomposing into triangles.
Objective: Students will decompose the regular polygon into triangles. Then use the formula, $A=\frac{1}{2}$ b x h, to find the area of triangles.
Key Vocabulary: area, regular polygon, irregular polygon, decompose, triangle, base, height, congruent
TN Standards: 6.G.A.1
Teacher Materials:

- White board and markers or smart board
- Projector, if possible, for geometric shapes
- Student Practice Packet

Student Materials:

- Paper and a pencil, and a surface to write on
- Calculator, optional

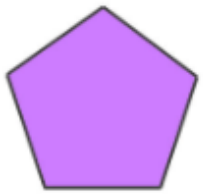
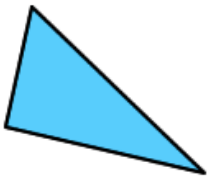
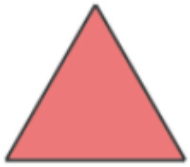
Teacher Do	Student Do
Opening (1 min) **Hello! Welcome to Tennessee's At Home Learning Series for math! Today's lesson is for all our 6th graders out there, though all children are welcome to tune in. This lesson is the nineteenth in our series.** **My name is ____ and I'm a ____ grade teacher in Tennessee schools! I'm so excited to be your teacher for this lesson! Welcome to my virtual classroom!** **If you didn't see our previous lesson, you can find it on the TN Department of Education's website at www.tn.gov/education. You can still tune in to today's lesson if you haven't see any of our others. But, it might be more fun if you first go back and watch our other lessons since we'll be talking about things we learned previously.** **Today we will be learning about the area of triangles in mathematics! Before we get started, to participate fully in our lesson today, you will need:** • **Paper and a pencil, and a surface to write on** • **Calculator is optional (you can even use one on a phone)** **Ok, let's begin!**	Students get materials ready for the lesson.
Intro (4 min) [This introduction will connect to the previous knowledge of working with triangles. It will also connect to 6.EE.A.2c, where	Students will begin by using previous knowledge to find the area of triangles. This will allow the

students evaluate expressions including expressions that arise from formulas used in real-world problems.] **Let's get our brains engaged with our first problem. In previous lessons, we have found the area of a triangle.** [Write or display the problem on the board as you read it.] **What is the area of a triangle with a height of 5 cm and a base of 12 cm?** [Pause for students to solve.] **What is the area of the triangle?** [Pause] **I heard 60 sq. cm and 30 sq cm. Let's dive into how to find the area of a triangle. How do you find the area of a triangle?** [Pause] **That's right! The area of a triangle is equal to the half the product of base and height.** [Write the formula A= $\frac{1}{2}$ bh on the board.] **So, what is the base?** [Pause and write under the formula on the board.] **That's right, the base is 12cm What's the height?** [Pause, then write under the formula on the board.] **Correct, the height is 5 cm.** **A= $\frac{1}{2}$ bh** **A= $\frac{1}{2}$ x 12 x 5** **Now, let's solve the equation.** **$\frac{1}{2}$ x 12 equals 6, then 6 times 5 equals 30.** **So, our answer is 30 sq. centimeters.** **The other answer I heard was 60 square centimeters. How do you think someone got that answer?** [Pause] **That's right! They found the area of the rectangle, not the area of a triangle. Remember, the area of a triangle is half of the area of the rectangle or parallelogram.** **Let's take it a little bit further, if there were five of these triangles, how would I find the total area?** [Pause] **That's right! We could find the sum of the areas or multiply the area of one triangle by 5. What would the total area be?** [Pause**]** **Exactly, it would be 150 sq. cm because 30 + 30 + 30 + 30 + 30 equals 150 or 30 x 5 equals 150. If we have 5 of these triangles, the total area would be 150 sq. centimeters.** **We're going to use this knowledge to connect to how we can find the area of special polygons!**	teacher to use this connection in the lesson.
<u>Teacher Model</u> (12 minutes) Objective 1: Understanding regular polygons	Objective #1:

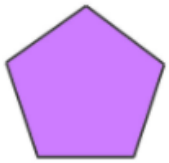
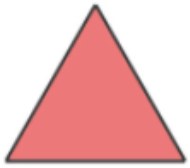
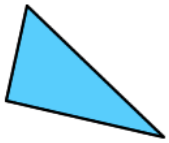
Our goal today is to find the area of regular polygons. Using what you know about the words regular and polygon, what do you think a regular polygon is? [Pause and write the regular polygon on the board.] **That's right! I heard someone say a regular polygon is a polygon in which all sides have the same length and all angles have the same measure.** [Write the definition on the board, then display the picture of a soccer ball or show a soccer ball.] **Let's look at an example.** 	Students will be learning what a regular polygon is and be able to identify them. Students respond.
This soccer ball is made up of regular polygons. Look at the purple polygon. What is it called? [Pause] **That made you think back to 3rd grade math, but you're correct. It's a pentagon because it has five sides. What are the yellow polygons called?** [Pause] **You remembered. It's a hexagon because it has six sides. If a polygon isn't regular, then it is irregular.** [Write irregular polygon on the board.] **What do you think an irregular polygon is?** [Pause] **I heard someone say that the prefix ir means not, so not regular. Way to make connections! I also heard someone say that an irregular polygon has side and angle that doesn't have the same measure. I'm going to display some polygons. I want you to sort them into regular and irregular polygons. Make a t-chart on your paper like the one I'm making on the board.**	Students respond. Students respond. Students respond. Students make a t-chart on their paper.

Regular Polygon	**Irregular Polygon**

[Display or draw the following shapes.] **Sort the polygons into regular and irregular. You can use the letter to identify the polygon.** [Pause 1-2 minutes for students to sort.]	Students sort the polygons.
Great work! Let's see how your sorted them. Let's talk through each one quickly. [As you talk through each place, place the letter in the correct column.] [The completed chart with correct answers is below.] **Where did you place shape A?** [Pause] **It's a regular pentagon. Why it is a regular polygon?** [Pause] **That's right. It is a regular polygon because all of the sides and angles are the same. What about B?** [Pause] **It's an irregular polygon. Why?** [Pause] **That's right! It is a rectangle, and even though**	Students respond. Students respond.

A 	**B** 	**C** 
D 	**E** 	**F** 
G 	**H** 	**I** 

all of the angles are equal all of the sides are not equal. For it to be a regular polygon you must satisfy both conditions. What about C? [Pause] **It is also an irregular polygon since the sides aren't the same. The angles in this shape are also not the same measure. What about D?** [Pause] **You're getting the this! It's an irregular polygon because the sides and angles aren't all the same size or measure. What about E?** [Pause] **You're right! It is a regular polygon. It is a square that by definition has four equal sides and four 90° angles. Let's look at F and G at the same time so we can compare? One of them is regular and the other one is irregular. What letter do you think is regular?** [Pause] **That's right! G is regular. All of the sides and angles are the same. H is an irregular polygon since none of the sides or angles are equal. We're almost done sorting. H is an irregular polygon because the sides and angles aren't equal, and we'll finish with I being a regular polygon. It's a 7- sided shape. Anybody remember what it's called?** [Pause] **I heard it – it's a heptagon.**	Students respond. Students respond. Students respond. Students respond.

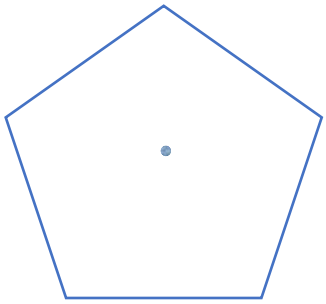
Regular Polygon	**Irregular Polygon**
A  **E**  **G**  **I**	**B**  **C**  **D**  **F**  **H**

To review, for a polygon to be regular, all of the sides and angles must be the same.

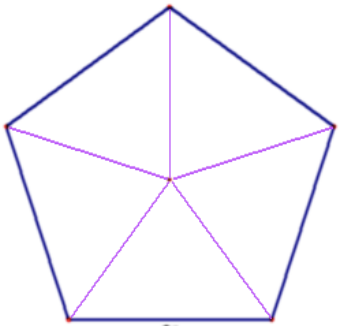
Now, let's work with regular polygons.

Objective #2: Finding the area of regular polygons

[Display or draw the image.]



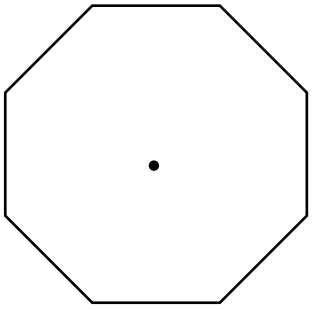
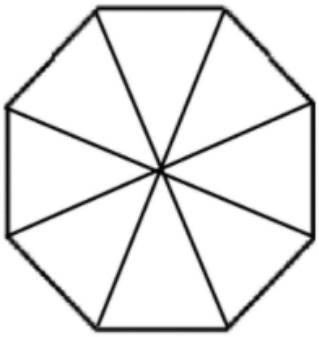
Let's look at the regular pentagon we saw in the soccer ball. Into how many congruent triangles can we divide the pentagon using the center as a vertex? Remember, congruent means that they have the same size and shape. [Pause] **How many did you get?** [Pause] **That's right. We can divide it into 5 equal triangles**

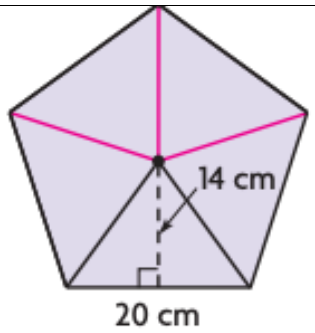
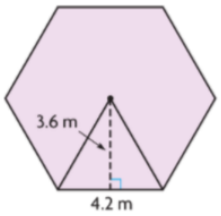


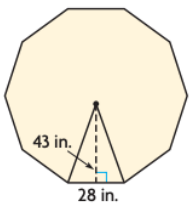
Let's try another one. [Display or draw a regular octagon.] **In how many congruent triangles, can you divide the octagon using the center as a vertex?** [Pause]

Objective #2:
Students will divide a regular polygon into congruent triangles, then use knowledge about finding the area of a triangle to find the area of regular polygons.

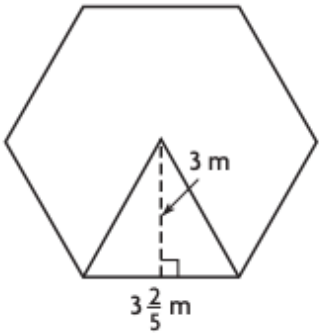
Students respond.

 **How many congruent triangles did you find?** [Pause] **That's correct. I heard you say 8.** [Draw or show the shape with the divided triangles.]  **Do you see a pattern for how many congruent triangles we can divide a shape?** [Pause] **Awesome! I heard someone say you could count the vertices of the shape to determine the number of triangles. Since segments are drawn from the center to each vertex, the number of congruent triangles will be the same as the number of vertices. Someone else said they counted the number of sides. That's works too.** **Let's see how this connects to finding the area of a regular polygon.** [Display or write the problem on the board.] Problem 1 **Emory is making a patch for his soccer ball using a regular pentagon. Emory needs to find the area of a piece of material shaped like a pentagon.** **Emory's soccer ball looks like the pentagon we looked at earlier in the lesson. Let's draw line segments to each vertex to divide it into five congruent triangles.**	Students respond. Students respond. Students respond.

 **How can we find the area of one of the triangles?** [Pause] **Correct. We can find the area if we know the base and height. Let's find the area of one triangle. How do we find the area of a triangle?** [Pause] **Yes, A = $\frac{1}{2}$ bh.** [Write the formula on the board.]	Students respond. Students respond.
A= $\frac{1}{2}$ bh **A= $\frac{1}{2}$ x 20 x 14** **A = 10x 14** **A=140 sq. cm**	
So, the area of one triangle is 140 sq. centimeters. How can we find the total area of the patch? [Pause] **I heard Shelby say we need to multiply 140 x 5 since each triangle is 140 sq. centimeters. I heard Daniel say he could add 140 + 140 + 140 + 140 + 140. Both of them are correct. We could do it either way.** **140 x 5 = 700 sq. cm** **140 + 140 + 140 + 140 + 140 = 700 sq. cm** **Let's work another problem.** [Write or display the problem on the board.] Problem 2 **Find the area of the regular hexagon.**	Students respond.
 **What do we need to do first?** [Pause] **I heard Misty say she wanted to find the area of the triangle first. So, let's do that. How do we find the area of a triangle?** [Pause] **That's right!**	Students respond. Students respond.

A=$\frac{1}{2}$ bh [Write the formula on the board. Then write b = __ and h = ___] **What is the base?** [Pause**] Yes, the base is 4.2m.** [Write that on the board] **What is the height?** [Pause] **Yes, the height is 3.6 m.** [Write that on the board.] **A=$\frac{1}{2}$bh** **A = $\frac{1}{2}$ x 4.2 x 3.6** **A = 2.1 x 3.6** **A= 7.56 sq. cm** **Is this the total area of the hexagon?** [Pause] **No, what do we need to do?** [Pause] **Excellent! We need to multiply the area of the one triangle by 6. How did you get six?** [Pause] **Perfect! I heard two different answers, and they are both correct. We will multiply by 6 since there are six sides. I also heard we will multiply by 6 since there are 6 vertices.** **7.56 x 6** **45.36 sq. cm** **You could have also found the total by using the sum of the triangles** **7.56 + 7.56 + 7.56 + 7.56 + 7.56 +7.56** **45.36 sq cm** Tying the learning together: **Today we learned that regular polygons are polygons that have equal sides and their angles have equal measures. Since they are congruent, we can divide them into triangles to find their area.**	Students respond. Students respond. Tying the learning together: Students listen as the teacher reviews the key connections.
<u>Guided Practice</u> (8 minutes) **Let's work a couple problems together. You're doing great!** **Problem 1** [Write or display the problem on the board as you read it.] **Find the area of the regular polygon.**  **What do we need to do to find the area of this regular polygon?** [Pause] **That's right! We need to find the area of the triangle, then find the total area of the polygon. Let's set it up together. How do we find the area of a triangle?** [Pause]	Students will be working on the problems independently. The first problem will gradually release the ownership to the student. After the student works the problems, discuss the answers. Students draw the parallelogram and label the base and height. Students respond.

Yes, A= $\frac{1}{2}$ bh. Take a minute and find the area of one triangle. Then we'll go over it. [Pause]	Students solve the problem.
Let's see how you did. **A= $\frac{1}{2}$ bh** [Write the formula on the board and fill it in as you ask the students.]	Students write the problem.
What is the base? [Pause] **Yes, it is 28. What is the height?** [Pause] **Yes, it is 43.**	Students find the area of one triangle.
A= $\frac{1}{2}$ x 28 x 43 **A= 14 x 43** **A= 602 sq. in.**	
What do we need to do next? [Pause] **That's correct! We need to figure out how many triangles are in the polygon. How many triangles are in the polygon?** [Pause] **That's right! There are 10 triangles in this polygon. I heard someone say 9. How could we double check?** [Pause] **Yes, that's right! You can count the number of sides or the number of vertices. So, let's multiply by 10.**	Students solve the problem. Students respond.
602 x 10 **6,020 sq. in.**	Students respond. Students respond.
What is a 10-sided polygon called? [Pause] **You're doing great! It is a decagon. The decagon's area is 6,020 sq. inches.**	
Let's work one more problem. I'm going to get you started, but I want to let you work it on your own, then we'll check it together.	
Problem 2 [Display or write the problem on the board as you read it.]	Students respond.
Sarah Beth is making a stained-glass window in the shape of a regular pentagon. The pentagon can be divided into congruent triangles, each with a base of 8.7 inches and a height of 6 inches. What is the area of the window?	Students solve this problem on their own, and the teacher will discuss the answer.
What do we know? [Pause] **That's right! We know what the base and height are. I also heard you say we know that it is a pentagon. Good work! See if you can find the area of the window.** [Pause]	
Let's see how you did. What is the area of one triangle? [Pause] **26.1 sq. cm Let's see how you got that. What is the**	Students respond.

area of a triangle? [Pause] **That's right! A= $\frac{1}{2}$ bh** [Write the formula on the board.] **Can someone tell me where the $\frac{1}{2}$ comes from?** [Pause] **That's correct! I heard Melanie say that a triangle's area is half the area of a parallelogram, and I heard Brooks say that a triangle's area is half the area of a rectangle. Both of them are correct! Now's let's solve this! What is the base?** [Pause] **That's right!** [Write b= 8.7.] **What is the height?** [Pause] **Yes, it is 6** [Write h=6.]	Students respond.
A= $\frac{1}{2}$ bh	Students respond.
A = $\frac{1}{2}$ x 8.7 x 6	Students respond.
A= 4.35 x 6	Students respond.
A = 26. 1 sq. cm	
The window is a pentagon. How many triangles are in a pentagon? [Pause] **That's it! There are 5 because there are 5 sides. I also heard Sammy say he knew 5 since there are 5 vertices in a pentagon. Great work!**	
Let's find the total area.	Students respond.
26.1 x 5	
130 sq. cm	
The window has an area of 130 sq. cm.	
Additional problems (if needed): 1. Find the area of the regular polygon. (Answer is $30\ \frac{3}{5} m^2$)  2. A regular 7-sided figure is divided into 7 congruent triangles, each with a base of 12 inches and a height of 12.5 inches. What is the area of the 7-sided figure? (Answer is 525 in^2)	
Independent Practice (1 min) **Woo hoo! We made it! Today, we reviewed finding the area of regular polygons by decomposing them into triangles. You**	

sure did a great job! After the video, you will have some problems to practice on your own. I will show you the independent practice problems now, or you can find them in the student practice for this lesson posted on our website, www.tn.gov/education. [Teacher shows student practice page under document camera or camera zooms in on student practice page.] **Good luck and do your best!**	
Closing (1 min) **I enjoyed reviewing the area of the regular polygons with you! Thank you for inviting me into your home. I look forward to seeing you in our next lesson in Tennessee's At Home Learning Series! Bye!**	