



## Lesson 4: Proving the Area of a Disk

### Student Outcomes

- Students use inscribed and circumscribed polygons for a circle (or disk) of radius  $r$  and circumference  $C$  to show that the area of a circle is  $\frac{1}{2}Cr$  or, as it is usually written,  $\pi r^2$ .

### Lesson Notes

In Grade 7, students studied an informal proof for the area of a circle. In this lesson, students use informal limit arguments to find the area of a circle using (1) a regular polygon inscribed within the circle and (2) a polygon similar to the inscribed polygon that circumscribes the circle (**G-GMD.A.1**). The goal is to show that the areas of the inscribed polygon and outer polygon act as upper and lower approximations for the area of the circle. As the number of sides of the regular polygon increases, each of these approximations approaches the area of the circle.

Question 6 of the Problem Set takes students through the steps of the informal proof of the circumference formula of a circle, which is another important aspect of **G-GMD.A.1**.

To plan this lesson over the course of two days, consider covering the Opening Exercise and the Example in the first day's lesson and completing the Discussion and Discussion Extension, or alternatively Problem Set 6 (derivation of circumference formula), during the second day's lesson.

### Classwork

#### Opening Exercise (7 minutes)

Students derive the area formula for a regular hexagon inscribed within a circle in terms of the side length and height provided in the image. Then, lead them through the steps that describe the area of any regular polygon inscribed within a circle in terms of the polygon's perimeter. This is used in the proof for the area formula of a circle.

#### Opening Exercise

The following image is of a regular hexagon inscribed in circle  $C$  with radius  $r$ . Find a formula for the area of the hexagon in terms of the length of a side,  $s$ , and the distance from the center to a side.



The area formula for each of the congruent triangles is  $\frac{1}{2}s \cdot h$ . The area of the entire regular hexagon, which consists of 6 such triangles, is represented by the formula  $3s \cdot h$ .

#### Scaffolding:

- Consider providing numeric dimensions for the hexagon (e.g.,  $s = 4$ ; therefore,  $h = 2\sqrt{3}$ ) to first find a numeric area (Area =  $24\sqrt{3}$  provided the values above) and to generalize to the formula using variables.
- Have students (1) sketch an image and (2) write an area expression for  $P_n$  when  $n = 4$  and  $n = 5$ .
- Example: Area( $P_3$ ) =  $2sh$



MP.2  
&  
MP.7

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