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Go to Grade 5 Everyday Mathematics Sample Lesson

Properties of Polygons

Objective To explore the geometric properties of polygons.

1 Teaching the Le	esson		materials
Key Activities Students sort geometric shapes properties of polygons by playir	s into sets according to various rung <i>Polygon Capture.</i>	ules. They identify geometric	 Math Journal 1, p. 80 Math Journals 1, Activity Sheets 3 and 4
[Geometry Goal 2]	ons.		 Student Reference Book, pp. 142 and 328 Study Link 3•6 Game Masters (<i>Math Masters</i>, pp. 494–496) See Advance Preparation
2 Ongoing Learni	ng & Practice		materials
Students practice and maintain	n skills through Math Boxes and	Study Link activities.	 Math Journal 1, p. 81 Study Link Master (Math Masters, p. 87)
3 Differentiation	Options		materials
READINESS Students sort attribute blocks by two properties at a time.	ENRICHMENT Students describe the polygons that are formed when diagonals are drawn in polygonal regions.	ELL SUPPORT Students sort shapes according to their attributes by playing <i>What's My</i> <i>Attribute Rule?</i>	 Game Masters (<i>Math Masters</i>, pp. 508 and 509) Teaching Master (<i>Math Masters</i>, p. 88) attribute blocks 1 six-sided die

0

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Getting Started

Mental Math and Reflexes

Survey the class for their definitions of parallel and perpendicular. Then ask them to stand beside their desks or in an area where there is enough room for them to stretch out their arms. Use the following instructions, alternating between degree measures and names for angles.

- Hold your arms so they are parallel to each other.
- Form a right angle (a 90° angle) with your arms.
- Form an acute angle (an angle between 0° and 90°) with your arms.
- Hold your arms so they are perpendicular to the floor.
- Hold your arms so they form a right angle and are parallel to each other. This cannot be done. Ask students to explain why this is impossible.

Math Message

Solve the problem on journal page 80.

Study Link 3-6 **Follow-Up**

Have students share where they found their angles. Discuss why there might be more (or fewer) of a given angle type.

Teaching the Lesson

Math Message Follow-Up

(Math Journal 1, p. 80)

WHOLE-CLASS DISCUSSION

NOTE Strictly speaking, a polygon consists of line segments. The interior (inside) of a polygon is not a part of the polygon. If the drawing of a polygon is cut out along its sides, the resulting shape consists of a polygon and its interior. This is a polygonal region, not a polygon. However, the distinction does not need to be stressed.

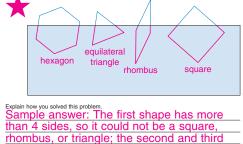
Student Page

3.7 Completing Partial Drawings of Polygons

Gina drew four shapes: equilateral triangle, square, rhombus, and hexago She covered up most of each figure, as shown below

Date

Can you tell which figure is which? Write the name below each figure. Then try to draw the rest of the figure.



rhombus, or triangle; the second and third shapes could not be a square because the angle shown was not 90

Math Journal 1, p. 80

For each of the shapes, ask students how they eliminated options. For example, the first shape has more than 4 sides, so it could not be a square, rhombus, or triangle, and the third shape could not be a square because the angle shown was not 90 degrees. Encourage students to use the terminology from the class definitions in their explanations. You can model this by restating student remarks, where necessary, without interrupting the flow of the discussion.

Constant Assessment: Recognizing Student Achievement Math Journal Page 80

Use journal page 80 to assess students' ability to recognize the relationships between sides and angles in polygons. Students are making adequate progress if they correctly draw and name the shapes and if their explanations refer to the angle and/or side attributes of the polygons.

[Geometry Goal 2]

Sorting Polygons by **Their Properties**



(Math Journal 1, Activity Sheet 3; Student Reference Book, p. 142; Math Masters, p. 494)

Spread the figures that you made from *Math Masters*, page 494 on the overhead projector. Ask students what these shapes are called. polygons Use follow-up questions to ask students how they know that these shapes are polygons, or simply ask why. Expect a variety of responses.

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Refer students to page 142 of the *Student Reference Book*. Have partners develop a definition for the term *polygon*. Circulate and assist.

Survey partners for their ideas and ask students to agree on a common definition for *polygon*. Record the class definition on the Class Data Pad.

Explain that students will work individually to sort the sixteen polygons into two or three different sets according to any rule that they choose. Demonstrate the activity by sorting the polygons on the overhead projector according to an unstated rule. Ask students to identify the rule. *Suggestions:*

- \triangleright At least two sides are parallel.
- \triangleright The polygons are convex.
- \triangleright The polygons are nonconvex.
- \triangleright At least one angle is greater than 90 degrees.

Allow students several minutes to formulate their rules and sort their polygons. Ask volunteers to show their sorting results on the overhead projector, and survey the class for the rules being demonstrated.

Playing Polygon Capture

(*Math Journal 1*, Activity Sheets 3 and 4; *Student Reference Book*, p. 328)

Students identify geometric properties of polygons by playing *Polygon Capture*. The game is played with two players or two teams of two players each.

Play a game or two against the class to help students learn the rules. Consider displaying a set of polygons on the overhead projector while students lay their polygons on their desks.

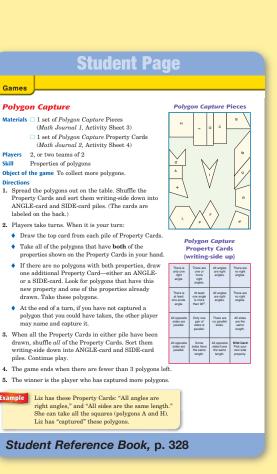


Ongoing Assessment: Informing Instruction

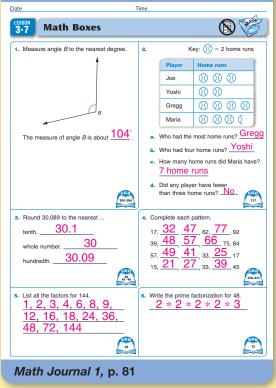
Watch for students who might not be correctly interpreting the properties. Show these students one of the following variations.

- During each turn, the player draws one Property Card and takes all polygons with this property. If no polygons match, the player loses the turn. Play continues until fewer than three polygons are left.
- During each turn, the player draws one Property Card and takes all the polygons with this property. Then the player draws another Property Card and puts back all the polygons he or she just captured that DO NOT have the property on the second card.

NOTE Use your established procedures to store the polygons and *Polygon Capture* Property Cards.



Student Page



2 Ongoing Learning & Practice

Math Boxes 3.7



(Math Journal 1, p. 81)



Mixed Practice Math Boxes in this lesson are paired with Math Boxes in Lesson 3-5. The skills in Problems 5 and 6 preview Unit 4 content.



Writing/Reasoning Have students write a response to the following: *Explain how you determined the first number pattern in Problem 4.* Sample answer: Subtract

17 from 62. There are 3 intervals between 17 and 62, so 62 - 17 = 45 and $45 \div 3 = 15$; 17 + 15 = 32; 32 + 15 = 47; 62 + 15 = 77.

Study Link 3.7



(Math Masters, p. 87)



Home Connection Students solve Odd Shape Out problems, in which they identify one shape that is different from others in a set and tell why it is different. Students then write their own Odd Shape Out problem.

3 Differentiation Options

READINESS

Sorting Attribute Blocks by Two Properties



To review geometric properties, have students work in groups and sort attribute blocks by two properties at a time. Each student takes an attribute block at random. Start with all students in the middle of the classroom. Ask students with blocks to go to one side of the room. (Every student should move.) Then ask students with a circle to go to the opposite side of the room. Tell students that when you say, "Spread Out!", the students with a thin block should move to one corner on their side of the room and the students with a thick block should move to the other corner on their side of the room. Students will need to negotiate to decide which corner is for thick and which is for the thin figures. If there is overwhelming confusion, answer questions and start over. A successful division of students will end up in four groups—thin polygons, thick polygons, thin circles, and thick circles.

ST	UDY LINK 3•7	Odd Shap	e Out			F
sh	ape and t	of shapes, there is tell why it doesn't b at's important is ha	elong. (There r	nay be more th	an one possible	517 14216 144
1.	\bigtriangleup	Sample :			ntagon is	the
		shape th				
2.	\bigotimes	_	Mn			
		Sample a pe that is			al is the o	nly
з.	\bowtie	\Box	\bigcirc	\bigcirc		
					ossed-out not conve	ex.
4.				\mathbf{X}		
					pezoid is t of parallel	
5.	Make up	o your own "Odd S	hape Out" probl	em on the bac	k of this page.	
6.	Practice 1,042 +		7,972	7. 9,062 -	_{3,718 =} <u>5,34</u>	4
8	9 109 *			9 58 ÷ 6 ·		

Study Link Master

Math Masters, p. 87

192

Each group should discuss the characteristics of their blocks and then share these characteristics with the class. Repeat the exercise, sorting the blocks by other properties (Attributes are polygons, circles, thick, thin, big, small, and colors.)



Connecting Vertices



(Math Masters, p. 88)

To apply students' understanding of the properties of polygons, have them draw and describe the properties of polygons within polygonal regions. Encourage students to use vocabulary from this unit. Have students read aloud the names of the new shapes and the properties for those shapes.

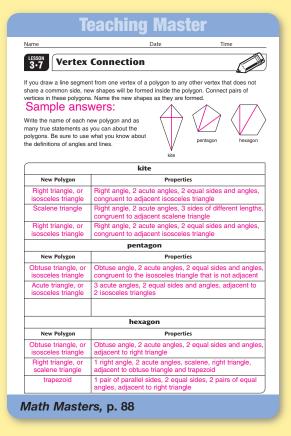


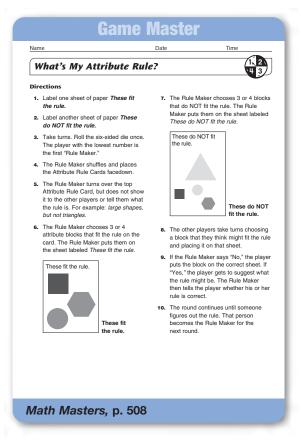
Attribute Rule?



(Math Masters, pp. 508 and 509)

To explore sorting shapes according to their attributes, have students play *What's My Attribute Rule?* When students have finished the game, have them discuss some of the difficult rules in the game. Encourage students to say the rules in more than one way. For example: *All Red Shapes* could also be *No Blue or Yellow Shapes*.





What's My A	ttribute Rul	Date e? Cards	
small blue shapes	large red shapes	large shapes, but not triangles	circles, but not red
blue and yellow shapes, but not circles	red and yellow small shapes	not triangles or squares	large triangles, but not yellow
large circles, but not red	large circles or squares		

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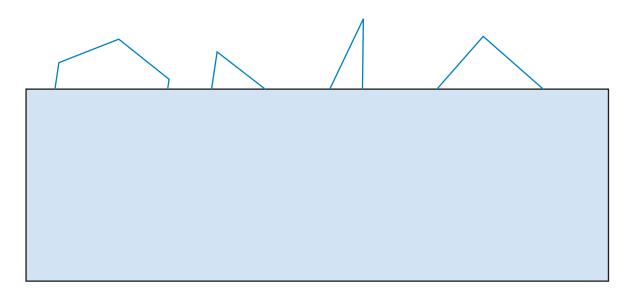
Date

Completing Partial Drawings of Polygons

Gina drew four shapes: equilateral triangle, square, rhombus, and hexagon.

She covered up most of each figure, as shown below.

Can you tell which figure is which? Write the name below each figure. Then try to draw the rest of the figure.



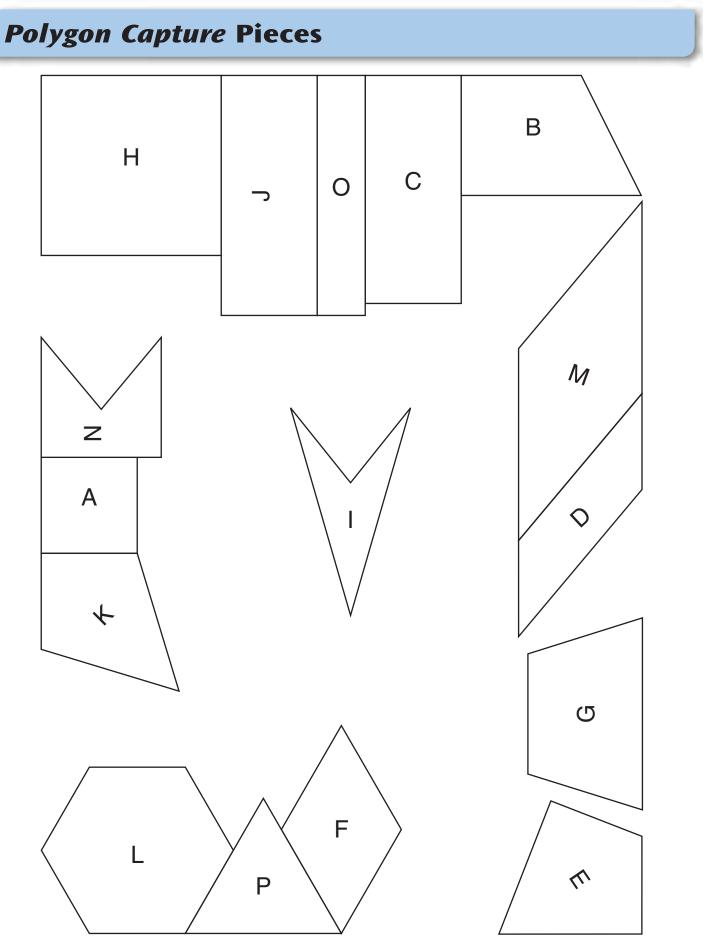
Explain how you solved this problem.

Date

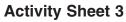
Time

Math Boxes			Co Canath
1. Measure angle <i>B</i> to the nearest degree.	2.	K	ey: \bigcirc = 2 home runs
↑		Player	Home runs
		Joe	$\bigcirc \bigcirc \bigcirc \bigcirc \bigcirc$
		Yoshi	\bigcirc \bigcirc
B		Gregg	$\bigcirc \bigcirc $
		Maria	$\bigcirc \bigcirc $
The measure of angle <i>B</i> is about	а.	Who had the	most home runs?
	b. '	Who had fou	Ir home runs?
	с.	How many h	ome runs did Maria have?
SRB 205-206			er have fewer ome runs?
 Round 30.089 to the nearest 	4. Cor	nplete each	pattern.
tenth.	17,	,	, 62,, 92
whole number	39,	,	,, 75, 84
hundredth.		,	, 33,, 17
SRB 30 45 46	15,	,	, 33,, 45
5. List all the factors for 144.	6. Writ	e the prime f	factorization for 48.
			SRB 12

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Polygon Capture Property Cards (Front)

NOTE: The backs of the first two row	s of cards are labeled "Angles."		
There is only one right angle.	There are one or more right angles.	All angles are right angles.	There are no right angles.
There is at least one acute angle.	At least one angle is more than 90°.	All angles are right angles.	There are no right angles.
All opposite sides are parallel.	Only one pair of sides is parallel.	There are no parallel sides.	All sides are the same length.
All opposite sides are parallel.	Some sides have the same length. s of cards are labeled "Sides."	All opposite sides have the same length.	Wild Card: Pick your own side property.

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Date

back to lesson Time



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Odd Shape Out

In each set of shapes, there is one shape that doesn't belong. Cross out that shape and tell why it doesn't belong. (There may be more than one possible reason. What's important is having a good reason for crossing out a shape.)





1.	\bigtriangleup		\bigcirc	\bigcirc	
	Reason:				
2.	Beason:	\bigcirc	Mn	X	
3.	\sum	\bigtriangledown	\bigcirc	\bigcirc	
	Reason:				
4.					
	Reason:				
5.	Make up you	r own "Odd Sh	ape Out" proble	m on the back of this page.	
	Duesties				

 Practice
 7. 9,062 - 3,718 = 9. $58 \div 6 \rightarrow$

 8. 9,109 * 9 = 9. $58 \div 6 \rightarrow$

Vertex Connection

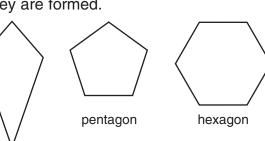
If you draw a line segment from one vertex of a polygon to any other vertex that does not share a common side, new shapes will be formed inside the polygon. Connect pairs of vertices in these polygons. Name the new shapes as they are formed.

Write the name of each new polygon and as many true statements as you can about the polygons. Be sure to use what you know about the definitions of angles and lines.

	kite
New Polygon	Properties
	nontagon
	pentagon
New Polygon	Properties
	hexagon
New Polygon	Properties

polygon and as can about the t you know about nes



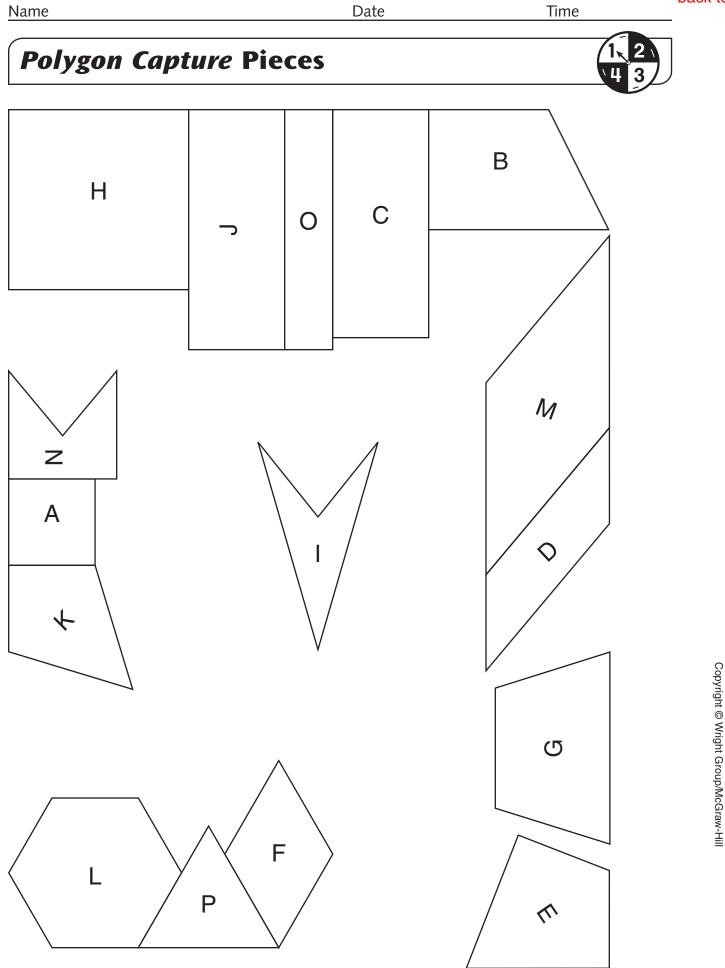


Time

LESSON

Date





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back to lesson Time

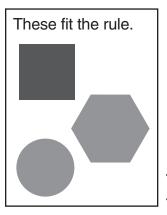
lame		Date	Time
Polygon CaptureProperty Cards1, 24 3			
OTE: The backs of the	e first two rows of cards	are labeled "Angles."	
There is only one right angle.	There are one or more right angles.	All angles are right angles.	There are no right angles.
There is at least one acute angle.	At least one angle is more than 90°.	All angles are right angles.	There are no right angles.
All opposite sides are parallel.	Only one pair of sides is parallel.	There are no parallel sides.	All sides are the same length.
All opposite sides are parallel.	Some sides have the same length.	All opposite sides have the same length.	Wild Card: Pick your own side property.

NOTE: The backs of the last two rows of cards are labeled "Sides."

What's My Attribute Rule?

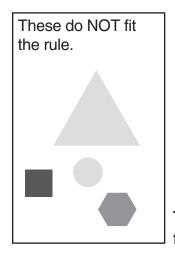
Directions

- 1. Label one sheet of paper *These fit the rule.*
- Label another sheet of paper These do NOT fit the rule.
- **3.** Take turns. Roll the six-sided die once. The player with the lowest number is the first "Rule Maker."
- **4.** The Rule Maker shuffles and places the Attribute Rule Cards facedown.
- 5. The Rule Maker turns over the top Attribute Rule Card, but does not show it to the other players or tell them what the rule is. For example: *large shapes, but not triangles.*
- 6. The Rule Maker chooses 3 or 4 attribute blocks that fit the rule on the card. The Rule Maker puts them on the sheet labeled *These fit the rule.*



These fit the rule.

 The Rule Maker chooses 3 or 4 blocks that do NOT fit the rule. The Rule Maker puts them on the sheet labeled *These do NOT fit the rule.*



These do NOT fit the rule.

- The other players take turns choosing a block that they think might fit the rule and placing it on that sheet.
- 9. If the Rule Maker says "No," the player puts the block on the correct sheet. If "Yes," the player gets to suggest what the rule might be. The Rule Maker then tells the player whether his or her rule is correct.
- **10.** The round continues until someone figures out the rule. That person becomes the Rule Maker for the next round.

Time

What's My Attribute Rule? Cards			
small blue shapes	large red shapes	large shapes, but not triangles	circles, but not red
blue and yellow shapes, but not circles	red and yellow small shapes	not triangles or squares	large triangles, but not yellow
large circles, but not red	large circles or squares		

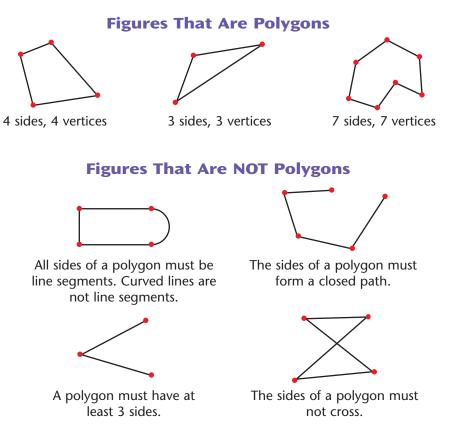
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Polygons

A **polygon** is a flat, 2-dimensional figure made up of line segments called **sides.** A polygon can have any number of sides, as long as it has at least three. The **interior** (inside) of a polygon is not part of the polygon.

- The sides of a polygon are connected end to end and make one closed path.
- The sides of a polygon do not cross.

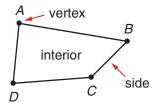
Each endpoint where two sides meet is called a **vertex**. The plural of vertex is **vertices**.



Polygons are named after the number of their sides. The prefix in a polygon's name tells the number of sides it has.

Prefixes			
tri-	3		
quad-	4		
penta-	5		
hexa-	6		
hepta-	7		
octa-	8		
nona-	9		
deca-	10		
dodeca-	12		





quadrangle (or quadrilateral)

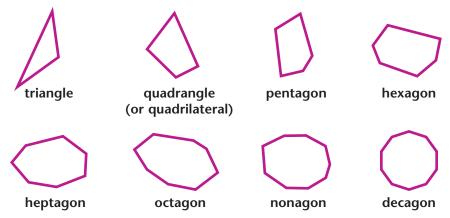
pentagon

hexagon

octagon

Convex Polygons

A **convex** polygon is a polygon in which all the sides are pushed outward. The polygons below are all convex.

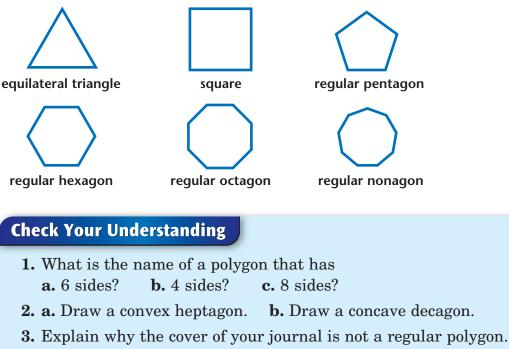


Nonconvex (Concave) Polygons

A **nonconvex**, or **concave**, polygon is a polygon in which at least two sides are pushed in. The polygons at the right are all nonconvex.

Regular Polygons

A polygon is a **regular polygon** if (1) the sides all have the same length; and (2) the angles inside the figure are all the same size. A regular polygon is always convex. The polygons below are all regular.



Check your answers on page 438.

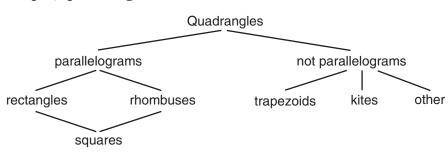


Geometry and Constructions

Special types of quadrangles have been given names. Some of these are parallelograms, others are not.

The tree diagram below shows how the different types of quadrangles are related. For example, quadrangles are divided

into two major groups— "parallelograms" and "not parallelograms." The special types of parallelograms include rectangles, rhombuses, and squares.



	Quadrangles That Are Parallelograms				
rectangle		Rectangles are parallelograms. A rectangle has 4 right angles (square corners). The sides do not all have to be the same length.			
rhombus		Rhombuses are parallelograms. A rhombus has 4 sides that are all the same length. The angles of a rhombus are usually not right angles, but they may be.			
square		Squares are parallelograms. A square has 4 right angles (square corners). Its 4 sides are all the same length. <i>All</i> squares are rectangles. <i>All</i> squares are also rhombuses.			

	Quadrangles That Are NOT Parallelograms				
trapezoid		Trapezoids have exactly 1 pair of parallel sides. The 4 sides of a trapezoid can all have different lengths.			
kite		A kite is a quadrangle with 2 pairs of equal sides. The equal sides are next to each other. The 4 sides cannot all have the same length. (A rhombus is not a kite.)			
other		Any polygon with 4 sides that is not a parallelogram, a trapezoid, or a kite.			

Check Your Understanding

What is the difference between the quadrangles in each pair below?

- 1. a square and a rectangle
- 2. a kite and rhombus
- 3. a trapezoid and a parallelogram

Check your answers on page 438.



one hundred forty-six

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Measuring an Angle with a Full-Circle Protractor

Think of the angle as a rotation of the minute hand of a clock. One side of the angle represents the minute hand at the beginning of a time interval. The other side of the angle represents the minute hand some time later.

Example

Example

Step 1: Place the center of the protractor over the vertex of the angle, point B.

Step 2: Line up the 0° mark on the protractor with BA.

Step 3: Read the degree measure where \overrightarrow{BC} crosses the edge of the protractor.

Example To measure reflex angle *EFG*:

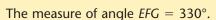
Step 1: Place the center of the protractor over point *F*.

Step 2: Line up the 0° mark on the protractor with \overrightarrow{FG} .

Step 3: Read the degree measure where \overrightarrow{FE} crosses the edge of the protractor.

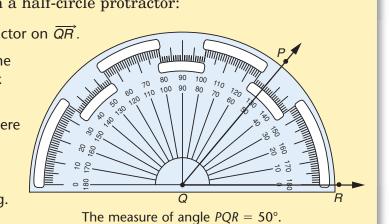


To measure angle PQR with a half-circle protractor: **Step 1:** Lay the baseline of the protractor on \overrightarrow{QR} . **Step 2:** Slide the protractor so that the center of the baseline is over the vertex 100 90 100 80 10 of the angle, point Q. **Step 3:** Read the degree measure where QP crosses the edge of the protractor. There are two scales on the protractor. Use the scale that makes sense for the size of the angle that you are measuring.



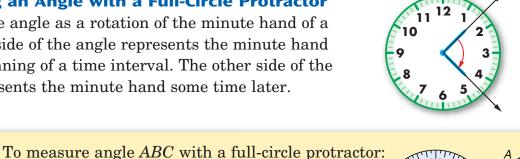
G

The measure of angle $ABC = 30^{\circ}$.



two hundred five

Measurement

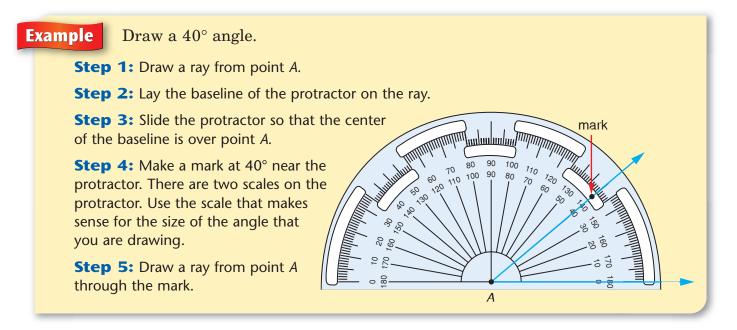


back to student page

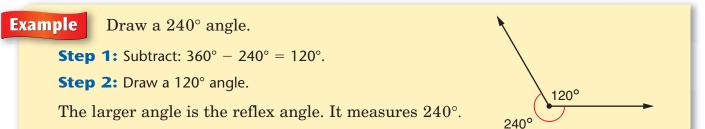


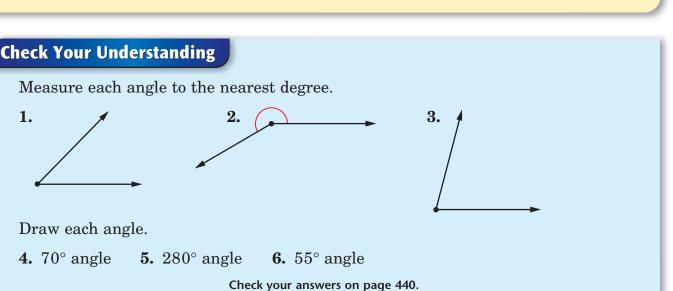
Measurement

Drawing an Angle with a Half-Circle Protractor



To draw a reflex angle using the half-circle protractor, subtract the measure of the reflex angle from 360°. Use this as the measure of the smaller angle.







back to lesson

Games

Polygon Capture

Materials □ 1 set of *Polygon Capture* Pieces (*Math Journal 1*, Activity Sheet 3)

□ 1 set of *Polygon Capture* Property Cards (*Math Journal 2*, Activity Sheet 4)

Players 2, or two teams of 2

Skill Properties of polygons

Object of the game To collect more polygons.

Directions

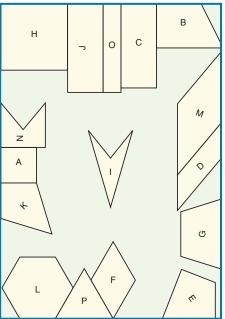
- 1. Spread the polygons out on the table. Shuffle the Property Cards and sort them writing-side down into ANGLE-card and SIDE-card piles. (The cards are labeled on the back.)
- 2. Players take turns. When it is your turn:
 - Draw the top card from each pile of Property Cards.
 - Take all of the polygons that have **both** of the properties shown on the Property Cards in your hand.
 - If there are no polygons with both properties, draw one additional Property Card—either an ANGLEor a SIDE-card. Look for polygons that have this new property and one of the properties already drawn. Take these polygons.
 - At the end of a turn, if you have not captured a polygon that you could have taken, the other player may name and capture it.
- **3.** When all the Property Cards in either pile have been drawn, shuffle *all* of the Property Cards. Sort them writing-side down into ANGLE-card and SIDE-card piles. Continue play.
- **4.** The game ends when there are fewer than 3 polygons left.
- 5. The winner is the player who has captured more polygons.

Example

Liz has these Property Cards: "All angles are right angles," and "All sides are the same length." She can take all the squares (polygons A and H). Liz has "captured" these polygons.



Polygon Capture Pieces



Polygon Capture Property Cards (writing-side up)

There is only one right angle.	There are one or more right angles.	All angles are right angles.	There are no right angles.
There is at least one acute angle.	At least one angle is more than 90°.	All angles are right angles.	There are no right angles.
All opposite sides are parallel.	Only one pair of sides is parallel.	There are no parallel sides.	All sides are the same length.
All opposite sides are parallel.	Some sides have the same length.	All opposite sides have the same length.	Wild Card: Pick your own side property.