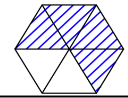
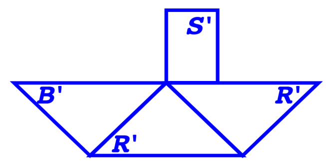
Most recent update: October 24, 2023

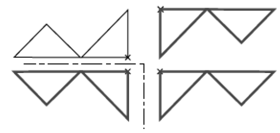
RightStart™ Mathematics

Corrections and Updates for Grade 6 Lessons and Worksheets, second edition

LESSON/WORKSHEET/SOLUTIONS			CHANGE DATE	CORRECTION OR UPDATE
Objectives			10/24/2023	Objectives were added to the Lesson book. See attached **PDF**.
Lesson 9			10/09/2018	Hexagram is a special six-point star based on a hexagon.
	Worksheet 10-3	Solutions 10-3	10/09/2018	Hexagram's definition is a closed six-point figure.
	Worksheet 15		10/10/2018	Measurements for the rectangles are off. See attached PDF.
	Worksheet 27-1		11/20/2018	Lengths for the lines to measure for Questions 6-10 are off slightly. See attached PDF.
	Worksheet 28		11/20/2018	Measurements of the rectangle and centimeter lines are off slightly. See attached PDF.
		Solutions 32	12/17/2019	The second equation for Problem 1B should be $4 \times 4 - 1 = 15$, not $4 \times 4 = 16$. The second equation for Problem 1C should be $5 \times 5 - 1 = 24$, not $5 \times 5 = 25$.
	Worksheet 33-2	Solutions 33-2	01/03/2019	Question 14 answer is Worksheet 32, not Worksheet 31. Question 15 has been added. See attached PDF.
Lesson 35			01/03/2019	The wording for the paragraph under Worksheet 35-1 has changed. It now reads, "This worksheet will have you measuring in hundredths. Your ruler only has markings for tenths, so you will be estimating the hundredths measurement. Use your best judgement to make your estimate. Complete the worksheet now."
	Worksheet 35-1		11/20/2018	Question 4 gives the wrong width measurement. It should be 2.493, not 2.927. See attached PDF.
		Solutions 35-1	01/03/2019	The second calculation in Problem 1 should be $A = 2 \times 1 = 2$ in^2, not $A = 3 \times 1 = 3$ in^2.
Lesson 37			01/03/2019	The list of materials needs to include the Casio Calculator fx-300MS.
Lesson 38			11/19/2018	In the first paragraph and the second to last paragrah, the worksheet referenced should be Worksheet 36, not 34 and 35.
	Worksheet 39-1	Solutions 39-1	03/27/2019	Changed some of the matching terms and Questions 10 and 11. See attached PDFs.
		Solutions 39-3	01/03/2019	Question 25 measurements should be 38 mm, not 39, and 48 mm, not 49. Area calculates to 1824 mm^2, not 1911 mm^2.
		Solutions 39-4	01/03/2019	Question 31-33 measurement should be 74 mm, not 73. Area calculates to 4921 mm^2, not 4854.5 mm^2.
	Worksheet 40-1	Solutions 40-1	08/01/2021	In Question 14, the figure is missing the marks indicating the two halves of the base of the triangle are the same. See attached pdf.
	Worksheet 40-1	Solutions 40-1	11/07/2022	Question 14, choice "a" has been changed to perpendicular, not line of symmetry. Answer is still circled. See attached pdf.

		Solutions 40-3	11/10/2022	Question 31 should have 4 of the 6 triangles of the hexagon shaded as shown here, not 5 triangles shaded. 
		Solutions 41-3	01/03/2019	Question 32 measurements should be 52 mm, not 53, 33 mm, not 32, and 29 mm, not 28. Perimeter calculates to 230 mm, not 229 mm. Question 34 measurements should be 2.0 in., not 2.1. Perimeter calculates to 7.3 cm, not 7.4 cm.
Lesson 44			11/25/2019	In the second heading, third paragraph should read "Using symbols, the area of the hexagon is twice the area…" not octagon.
		Solutions 44-2	11/25/2019	The last solution, #6, should read "*A* (rectangle)", not *A* (square).
	Worksheet 50-2	Solutions 50-2	01/03/2019	An additional question has been added. See attached PDFs.
	Worksheet 50-2		05/20/2020	The solutions, rather than the worksheet itself, was included in the worksheets book and document See attached PDF.
	Worksheet 53-1		01/03/2019	Changed the second definition listed to "quadrilateral with one and only one set of parallel lines", not "parallelogram with one and only one set of parallel lines. See attached PDF.
		Solutions 53-1	01/03/2019	Problem 10 measurement should be 2.4 in., not 2.5. Perimeter calculates to 6.1 in, not 6.2 in and 15.5 cm, not 15.7 cm.
		Solutions 53-2	01/03/2019	Problem 20 measurement should be 6.8 cm, not 6.9. Area calculates to 39.1 cm^2, not 39.6 cm^2.
Lesson 55			01/03/2019	The game for the day should use a target number of 180.
		Solutions 62	01/22/2019	Question 5 answer should read 3 mm, not 3 cm.
	Worksheet 71-1	Solutions 71-1	04/17/2020	In Problem 2, the size of the television has been updated from 18" by 14.4" to 48" by 41.8" to make the measurements more realistic. Calculated height changed from 10.8" to 23.6". Problem 3 final answer should be 13.92, not 13.97, which both round to 14.0.
	Worksheet 74-1	Solutions 74-1	04/17/2020	The definitions for Questions 1-8 had multiple errors. Wording as well as order have changed. See PDFs for the Worksheet as well as the Solutions.
	Worksheet 75-1	Solutions 75-1	04/17/2020	The definition for trapezoid should be a quadrilateral with one and only one set of parallel lines, not parallelogram.
		Solutions 76-2	02/28/2019	Question 21 answer should read 122º, not 58º.
	Worksheet 76-3	Solutions 76-3	04/04/2020	Problem 24 answer "a" should be 9.1, not 10.6 and answer "b" should be 10.6, not 9.1. The two answers were transposed. Question 31 should read "If the area of ΔTLG = 630 km^2, what is the area of ΔNGI? Answer is 1890 km^2. Question 32 should read "If line segments *GN* + *NA* = 25 mm, what is line segments *TN* + *NI*?" Answer is 50 mm. There were a few incorrect and/or illogical variations of this question and answer in some of the printings.
Lesson 80			02/08/2022	The 4-in-1 ruler should be listed as a needed material.
	Worksheet 87-1	Solutions 87-1	03/27/2019	Order of the matching terms has been changed. The circles used for Questions 11 and 12 were off and have been corrected. See attached PDF.
	Worksheet 90-2	Solutions 90-2	06/03/2019	Question 9 uses the information from Problem 7, not Problem 6.

		Solutions 98-2	03/25/2020	Problem 7 is missing some of the formula (in printings from April 2019 to March 2020). Second line for the area of the small circle should read: $A(\text{sm}) = \pi \times .9^2$. Also, r = 1.8 cm is missing.
		Solutions 99	04/17/2020	The perimeter for Problem 5 should be 41.1 m, not m^2.
		Solutions 102	04/04/2020	For Problem 2, the area for the 12" pizzas should be 113.1 in^2, not 113 in^2. The area for the 16" pizza should be 201.1 in^2, not 201 in^2. For Problem 7, the total cost for four 16" pizzas is $59.96, not $59.69.
	Worksheet 103-1	Solutions 103-1	04/10/2019	The third definition should read "formula for the perimeter of a rectange" not "formula for the perimeter of a parallellogram".
	Worksheet 103-2	Solutions 103-2	06/03/2019	The prices Problems 16 have been changed to MN 20 cm = $12.95, MN 25 cm = $13.55, ND 20 cm $12.53, and ND 25 cm $12.95. See attached PDFs.
		Solutions 104-1	04/04/2020	The answer for Question 8 should be 1:2, not 2:1. The answer for Question 9 should be 4:1, not 1:4. The second sentence in the second paragraph of the notes should say "The ratio of mdT to lgT, 1:2, is different than the ratio of lgT to mdT, 2:1."
	Worksheet 112	Solutions 112	04/28/2023	Problem 3c should read "Translate ΔBRG (3.5, 1.5) and rotate –90º about R'." not R". And directions for 3d should read "Translate ΔBRG (8, 3) and rotate 90° about R'." not R'". The solutions for the Problem 3 had mislabels. It should look like this: 
Lesson 113			04/22/2020	The figures in the middle of page were labeled wrong. The left figure is reflected vertically in place, not horizontally. The right figure is reflected horizontally in place, not vertically.
Lesson 120			10/10/2018	Under the Pool table game heading, second paragraph, the second sentence should read, "In the second and third figures, the ball is reflected at 30º, then at 60º."
		Solutions 121-2	06/03/2019	The answer for Question 20 Elipse for maximum number of lines of symmetry is ∞, not 2.
Lesson 122	Worksheet 122-2	Solutions 122-2	05/23/2023	Lessons: Two paragraphs regarding order of rotational symmetry of 1 have been added to the top of page 138. See attached pdf. Worksheets and Solutions: Question 7-10, the last figure's order of rotation symmetry should be 1, not none. The coloring of the figure is correct. See attached pdf for the worksheet.
	Worksheet 123-2	Solutions 123-2	05/23/2023	08/01/21: Question 6 asking about the relationship between point symmetry and the order of rotation is now Question 5. A bonus question has been added. See attached pdf. 05/23/23: Solutions have changes in Order of Rotation Symmetry and Degrees of Rotation columns. See attached pdf.
		Solutions 125-2	06/04/2022	Regarding Question 18, a note has been added: Remember from Worksheet 121-2, an ellipse is considered to have two lines of symmetry; however, in the case when an ellipse is a circle, it has infinitely many lines of symmetry.
	Worksheet 126-3	Solutions 126-3	06/05/2020	Question 42 has been changed from "If area ΔMES = 97 km^2, what is the area of ΔSNI?" to "…what is the area of ΔNDA?" Answer is changed from 194 km^2 to 291 km^2.
		Solutions 126-6	06/03/2019	The answer for Question 67 should be 19 mm, not 21 mm.

Solutions 126-8	01/22/2019	The graphic for Question 78 has an error in the top right drawing. It should be as shown here. 
Solutions 126-9	03/22/2020	Question 81 should read "What is the angle of rotation between…" rather tha "What is the angle of reflection between…"
Solutions 126-10	05/23/2023	Question 92, the last figure of the set, the quadrilateral, should have Order of Rot. Sym. answer of 1 with Degrees of Rotation of 360º, not 0 and 0º.
Solutions 127-2	06/03/2019	Question 23, identification of a rhombus, should be *ABJF* and *CDEJ*. The polygons *FKLE* and *KBCL* are not rhombuses because the four sides are not equal.
Worksheet 127-3 Solutions 127-3	06/05/2020	Question 42 has been changed from "If area ΔDIS = 82 cm^2, what is the area of ΔDSM?" to "…what is the area of ΔDMA?" Answer is changed from 164 cm^2 to 492 cm^2.
Solutions 127-10	05/23/2023	Question 91, the last figure of the set, the quadrilateral, should have Order of Rot. Sym. answer of 1 with Degrees of Rotation of 360º, not 0 and 0º.

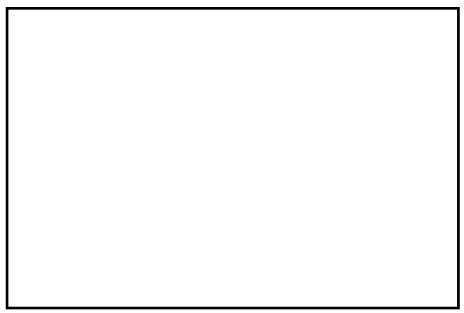
RIGHTSTART MATHEMATICS OBJECTIVES FOR LEVEL G

Name ______________________________ Year ____________

Objective	Trimester 1	Trimester 2	Trimester 3
Numeration			
Solves problems involving whole numbers, fractions, percents, and decimals using the four operations			
Interprets and computes problems with exponents and square roots			
Rounds and compares whole numbers, fractions, and decimals			
Identifies, evaluates and applies advanced patterns, including numerical and frieze patterns			
Solving Equations			
Writes, reads, evaluates, and solves equations with an unknown (sometimes called a variable)			
Applies order of operations to expressions with unknown numbers (sometimes called variables) and exponents			
Applies distributive property	N/A		
Finds and calculates the percent of a part or finds a whole when given a part			
Calculates perimeter and area of triangles, quadrilaterals, and polygons, both regular & irregular			
Problem Solving			
Solves multi-step real-world and mathematical problems involving rational numbers			
Uses reasoning to write and solve real-world problems			
Finds multiple ways to solve problems			
Ratios			
Understands, calculates, and applies ratios to lines, shapes, and related quantities or measurements			
Finds missing values in a table by using ratio reasoning			
Solves unit rate problems involving measurement and pricing	N/A		
Measurement			
Uses appropriate techniques and tools to accurately measure and draw lines and shapes			
Converts between metric and U.S. Customary systems			
Identifies and measures angles of existing shapes and draws shapes with specific angle measurements	N/A		
Understands and applies four properties of angles, i.e., complementary, supplementary, vertical angles, and intersecting parallel lines	N/A		
Coordinate System			
Draws polygons in a coordinate system	N/A	N/A	
Translates, rotates, and reflects shapes in a coordinate system	N/A	N/A	
Uses midpoints to find new coordinates of transformed shapes	N/A	N/A	
Understands and plots positive and negative numbers on a line or grid	N/A	N/A	
Statistics and Probability			
Collects and plots data on a number line or coordinate system			
Evaluates and summarizes data plotted on a number line or coordinate system			
Geometry			
Understands and uses formulas to calculate perimeter and area			
Learns, applies, and develops informal proofs of the Pythagorean theorem	N/A		
Identifies and applies translations, reflections, and rotations	N/A	N/A	
Identifies, understands, constructs lines of symmetry and produces shapes with line symmetry and rotational symmetry			
Identifies and classifies shapes by number of sides, side lengths, and angle measurements			
Demonstrates understanding of four triangle congruence theorems (SSS, SAS, ASA, AAA) by drawing samples of each type	N/A		
Understands and applies pi, π	N/A		
Identifies and calculates the center, radius, diameter, circumference, chords, and area of a circle	N/A		
Experiences the joy and beauty of geometry in daily life			
Study Skills			
Understands and can explain geometric and other mathematical terms			
Explores historic and cultural influences in math			
Develops independent learning skills			
Understands the importance of using available resources for independent learning			

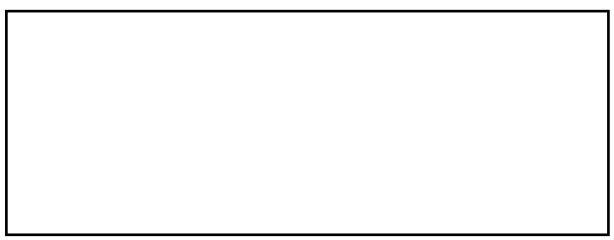
1. All these rectangles have the same area of 24 cm². Use a ruler to find the measurements of the sides.

2. Use a perimeter formula and your calculator to calculate the perimeters in cm. Show your work. Use each of the three formulas at least once.



3. Finding all the possible measurements of the rectangles should have reminded you of finding factors. List all the factors of 24.

____

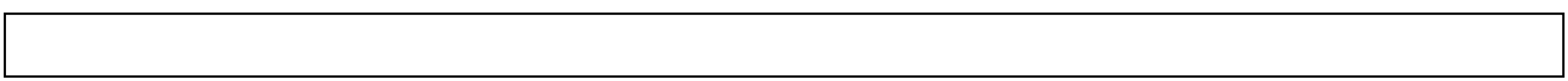


4. What pattern do you see in the perimeters as the rectangles become closer to a square?

____

5. What is a formula for the perimeter of a square ($h = w$)?

____



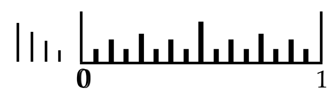
Name: ______________________________ *Worksheet 27-1, Review and Games 3*

Date: ______________________

1–4. Match the following terms with the correct definitions.

Hatching	the number of parts in a fraction
Numerator	shading used by engineers and designers to represent area
Denominator	the number in a fraction naming the size of the part
Unit fraction	fractions with a numerator of 1

5. Create a ruler below dividing it into sixteenths. Using your drawing tools, bisect the horizontal line below. At that point draw a vertical line the height of line *m*. Then bisect the two halves; draw lines the height of line *a*. Continue by bisecting the four fourths; draw lines the height of line *t*. Finally, bisect the eight eighths and draw those lines the height of line *h*.



Write the fraction for each line. Use your drawing tools to determine the length.

6. ________ ______________________

7. ________ ________

8. ________ ______________________________________

9. ________ ____

10. ________ ____

11–12. Using your drawing tools, draw a horizontal line the length indicated by the fraction. Use the ruler above as your guide.

$\frac{5}{8}$ ×

$\frac{5}{16}$ ×

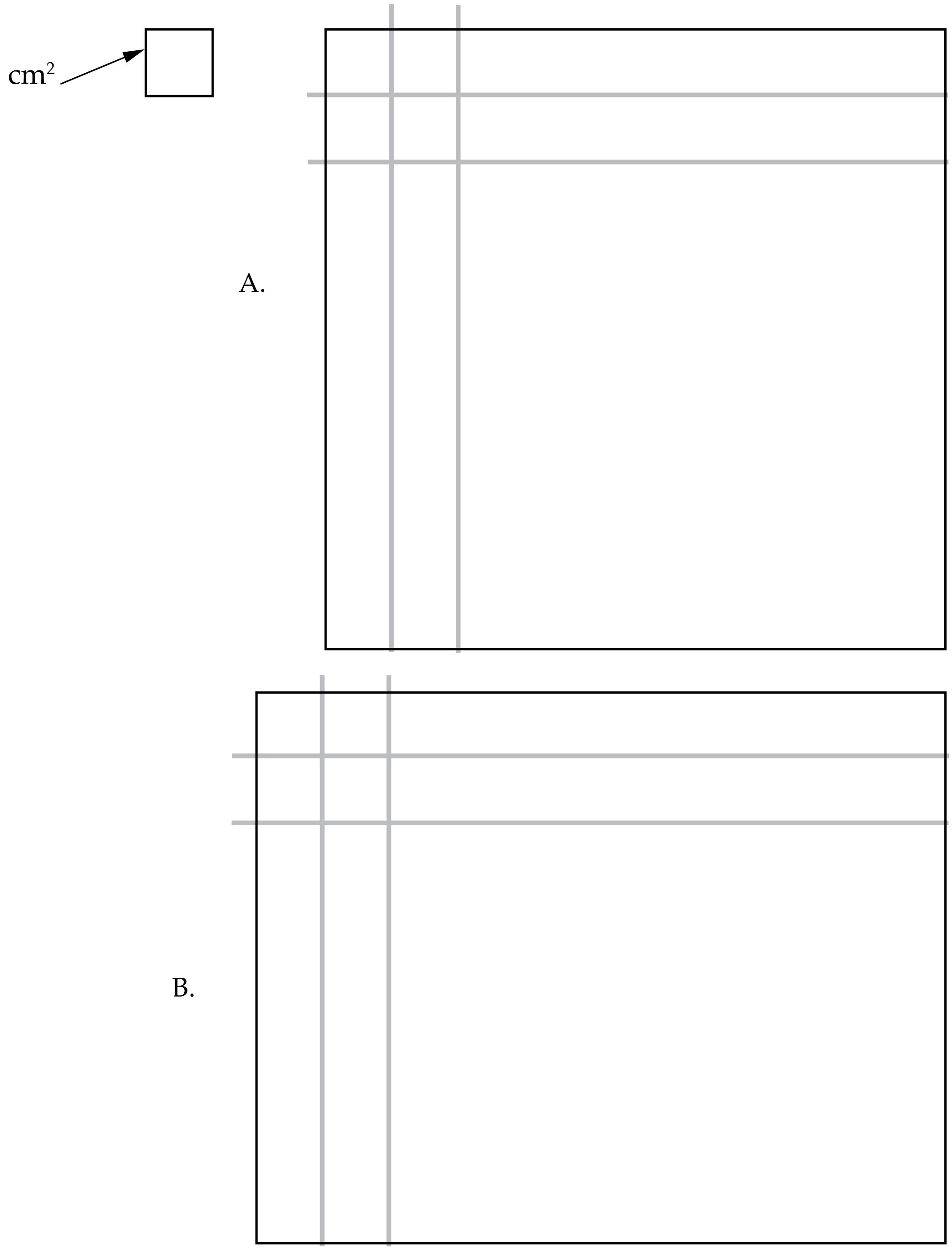
Name: ______________________________

Date: ______________________

Worksheet 28,
Square Centimeters

1. Before starting, guess which rectangle has the greater area. __________

2. Fill the two rectangles below by drawing square centimeters.



3. Which of the two rectangles, A or B, has the greater area? Explain you reasoning below.

____

____

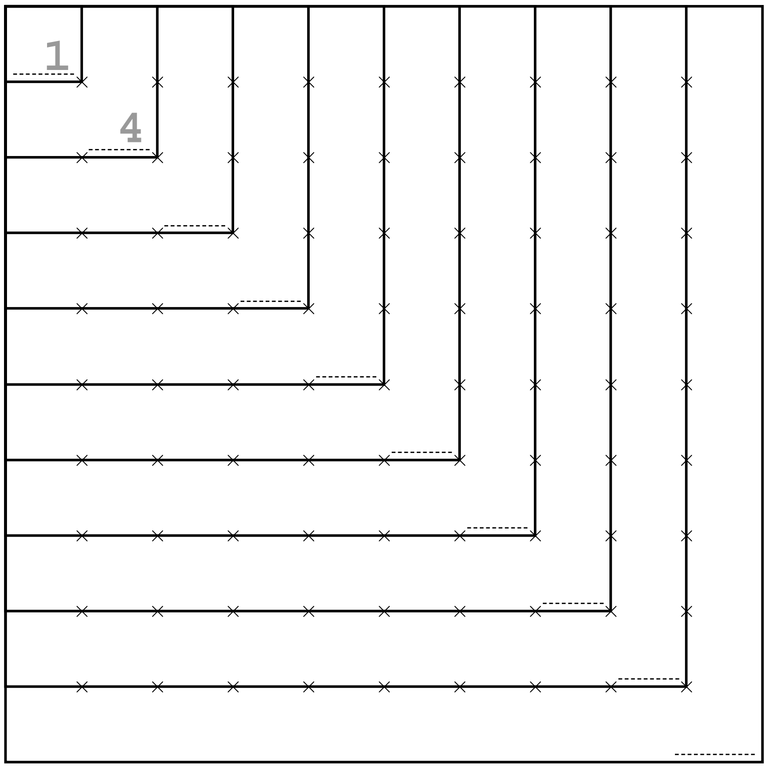
____

Name: ____________________

Date: ____________________

Worksheet 33-2, Area of Consecutive Squares

8. Below is a shortened version of the multiplication table. Find the area of each square and write the number on the dotted line.



9. What is special about the numbers? ____________________

10. Does the results from the previous worksheet apply? __________

11. Find the difference between each two consecutive numbers that you wrote in the multiplication table above.

3, 5, ____________________

12. Below is another version of the multiplication table. Fill in the shaded squares and circles.

1	2	3	4	5	6	7	8	9	10
2									
3									
4									
5									
6									
7									
8									
9									
10									

13. See the two numbers in circles next to a square. How are they related to the number in the square?

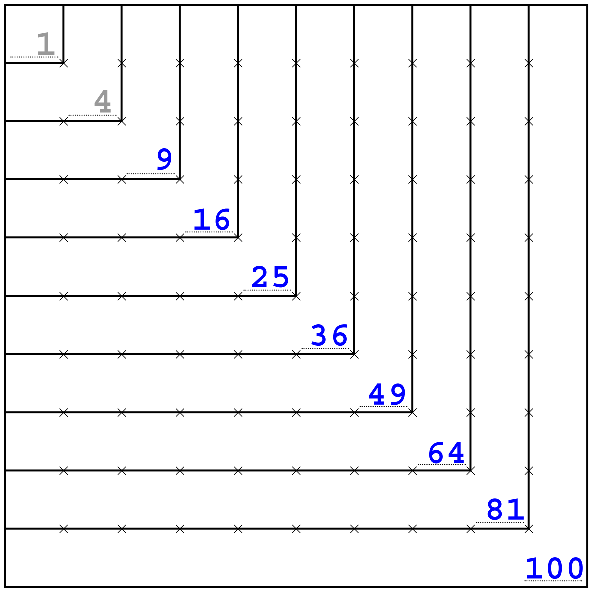
____

14. On what worksheet did you work with that relationship?

____

15. What is the formula? ____________________

8. Below is a shortened version of the multiplication table. Find the area of each square and write the number on the dotted line.



9. What is special about the numbers? They are squares.

10. Does the results from the previous worksheet apply? yes

11. Find the difference between each two consecutive numbers that you wrote in the multiplication table above.

3, 5, 7, 9, 11, 13, 15, 17, 19

12. Below is another version of the multiplication table. Fill in the shaded squares and circles.

1	2	3	4	5	6	7	8	9	10
2	4		8						
3		9		15					
4	8		16		24				
5		15		25		35			
6			24		36		48		
7				35		49		63	
8					48		64		80
9						63		81	
10							80		100

13. See the two numbers in circles next to a square. How are they related to the number in the square?

Equal & one less than the square.

14. On what worksheet did you work with that relationship?

32

15. What is the formula? $(n+1) \times (n-1) = n^2-1$

NOTES: Math is all about patterns. Being aware and able to find patterns will greatly help the student in their math education.

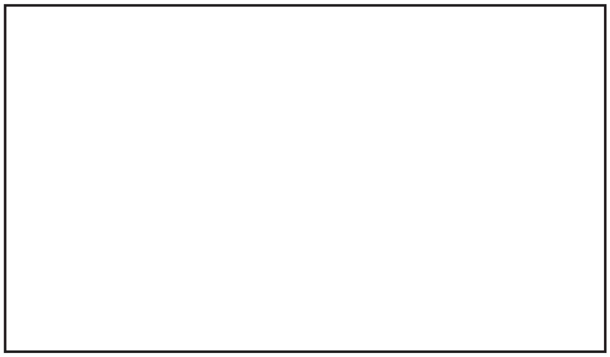
DICTIONARY TERMS: consecutive

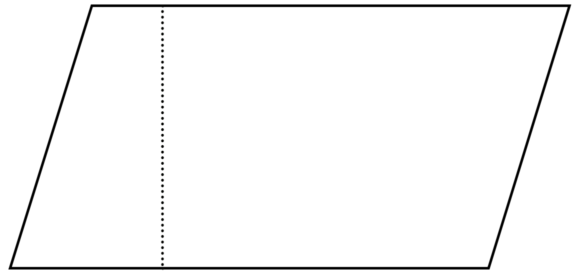
Name: ________________________________

Date: ______________________

Worksheet 35-1, Rounding

Use these two quadrilaterals for the next four problems. Pay attention to the precision requested with the measurements.





1. Calculate the area of both quadrilaterals. **Measure to the nearest whole number** using inches.

2. Calculate the area of both quadrilaterals. **Measure to the tenths** using inches. Round the answers to the tenths.

3. Calculate the area of both quadrilaterals. **Measure to the hundredths** using inches. Round the answers to the hundredths.

4. Calculate the area of both quadrilaterals. The rectangle measures 3.139 inches wide and 1.817 inches tall. The parallelogram measures 2.493 inches wide and 1.383 inches tall. Round the answers to the thousandths.

CONTINUE READING THE LESSON.

Name: ____

Date: ______________________________

1–7. Match the following terms with the correct definitions.

Formula	a general principle stated in mathematical symbols
Square inch	the number of units it takes to cover a surface
Altitude	a square measuring one inch by one inch used to measure area
Area	the line measured to give the height of a figure
Square millimeter	a square measuring one centimeter by one centimeter used to measure area
Square centimeter	a square measuring one millimeter by one millimeter used to measure area

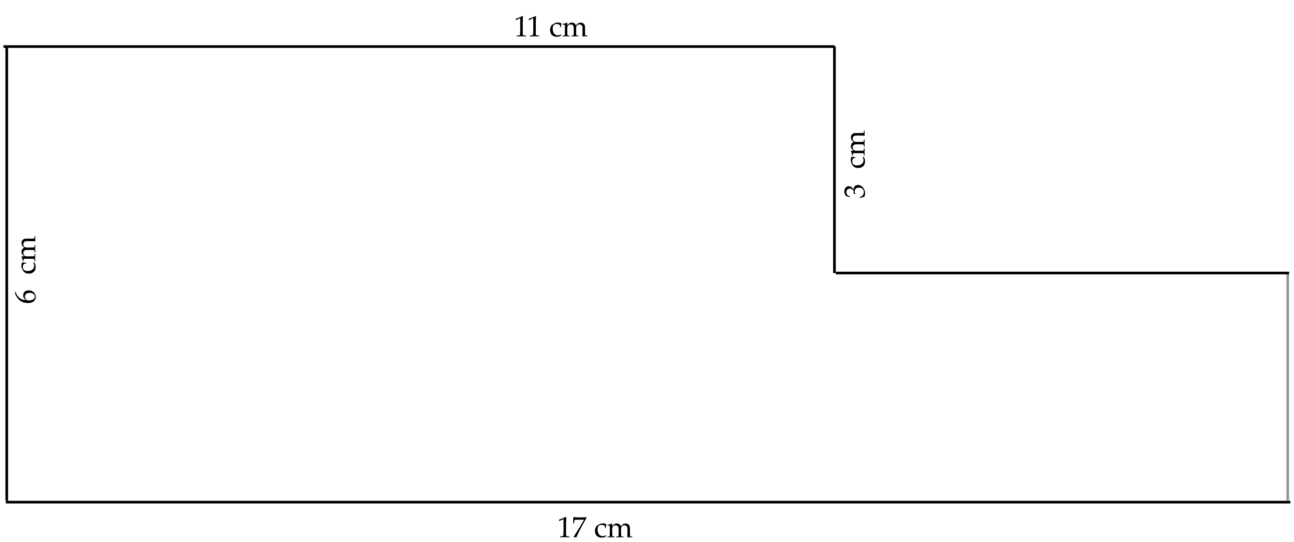
8. What is the symbol for square centimeters? ___________

9. What is the symbol for square inches? ___________

10. What is the formula for calculating area of a rectangle? ______________________________________

11. What is the formula for calculating perimeter of a rectangle? _________________________________

12. What is the area for the shape below? Show your work below.



1-7. Match the following terms with the correct definitions

Formula	a general principle stated in mathematical symbols
Square inch	the number of units it takes to cover a surface
Altitude	a square measuring one inch by one inch used to measure area
Area	the line measured to give the height of a figure
Square millimeter	a square measuring one centimeter by one centimeter used to measure area
Square centimeter	a square measuring one millimeter by one millimeter used to measure area

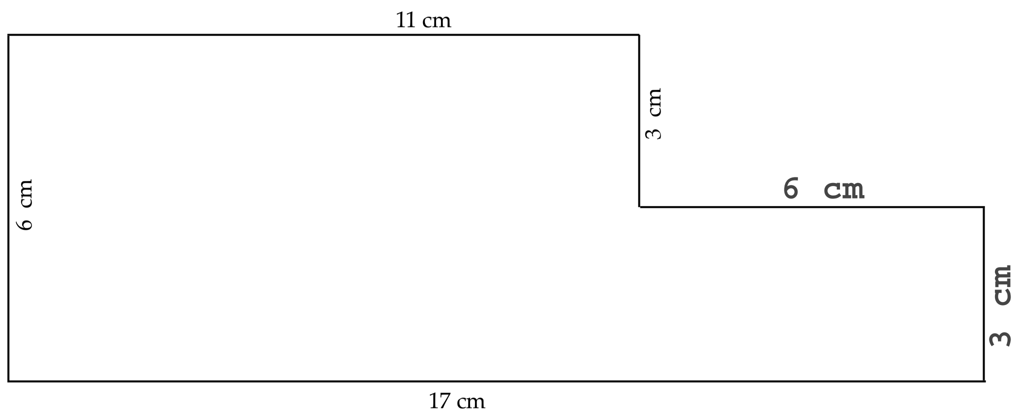
8. What is the symbol for square centimeters? $\underline{\text{cm}^2}$

9. What is the symbol for square inches? $\underline{\text{in}^2}$

10. What is the formula for calculating area of a rectangle? $\underline{A = w \times h \text{ or } A = wh}$

11. What is the formula for calculating perimeter of a rectangle? $\underline{P = 2(w + h) \text{ or}}$
$P = 2w + 2h$ or
$P = w + h + w + h$

12. What is the area for the shape below? Show your work below.



$A = 84 \text{ cm}^2$

[CALCULATION METHODS WILL VARY.]

NOTES: Problem 12 can be solved a number of different ways. If the shape is divided vertically into two rectangles, one 11 cm by 6 cm and the other 6 cm by 3 cm, the calculation will look like this:

$A = wh$ (left rectangle) + wh (right rectangle)
$A = 11 \times 6 + 6 \times 3$
$A = 66 + 18$
$A = 84 \text{ cm}^2$

If the shape is divided horizontally into two rectangles, one 11 cm by 3 ft cm the other 17 cm by 3 cm, the calculation will look like this:

$A = wh$ (upper rectangle) + wh (lower rectangle)
$A = 11 \times 3 + 17 \times 3$
$A = 33 + 51$
$A = 84 \text{ cm}^2$

Or, if the shape is made into a whole rectangle, then subtract the added rectangle, the calculation will look like this:

$A = wh$ (whole rectangle) – wh (added rectangle)
$A = 17 \times 6 - 6 \times 3$
$A = 102 - 18$
$A = 84 \text{ cm}^2$

Name: ________________________________

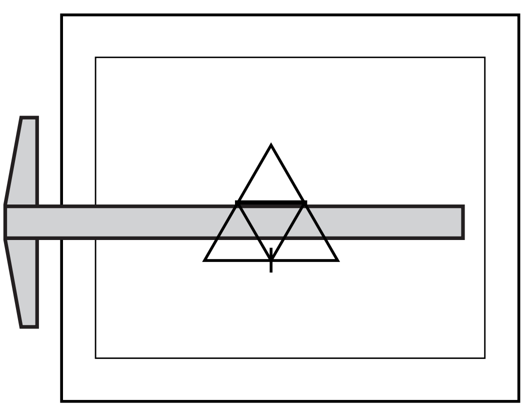
Date: __________________________

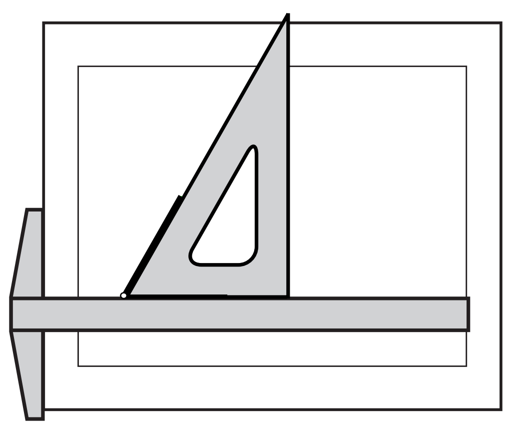
Worksheet 40-1,
Review for Assessment 1

1–11. Match the following terms with the correct definitions

Vertex	the distance around a figure
Midpoint	a point where the lines meet in a polygon
Perimeter	the number of units it takes to cover a surface
Area	middle
Numerator	a closed figure with straight line segments
Parallelogram	the number of parts in a fraction
Polygon	a quadrilateral with two sets of parallel lines
Altitude	the height of a figure
Square inch	the number in a fraction that names the sizes of the parts
Denominator	a square measuring one inch by one inch used to calculate area
Formula	a shortcut for stating a mathematical relationship using math symbols

12–13. What is wrong with these pictures?

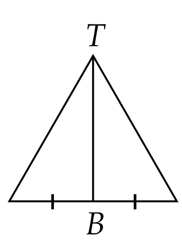




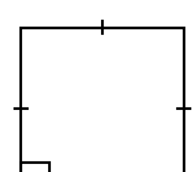
______________________________ ______________________________

______________________________ ______________________________

14. Circle all that describe the line *TB*.
   a. Perpendicular
   b. Horizontal
   c. Altitude of triangle
   d. Bisects the triangle

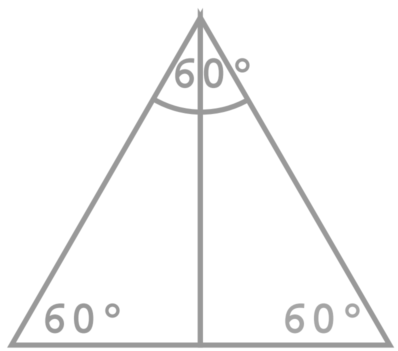


15. Circle all that describe the figure.
   a. Parallelogram
   b. Rectangle
   c. Quadrilateral
   d. Trapezoid



Use the two paper 30-60 triangles and arrange them to make the following figures. Then draw them with your drawing tools below. Make the shortest side of the 30-60 triangles 2.5 cm or 1 inch. For each figure, measure and write the angle of the vertices.

1. Equilateral triangle.



2. Isosceles triangle that is not equilateral.

3. Rectangle.

4–5. Two parallelograms that are neither rectangles nor mirror images of each other.

6. Quadrilateral that is not a parallelogram.

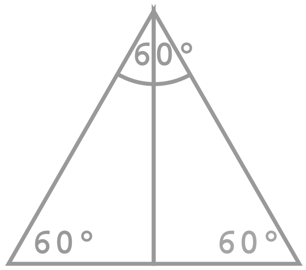
7. Which figure has the greatest area? ____________________

8. Which figures have the least perimeter? ____________________

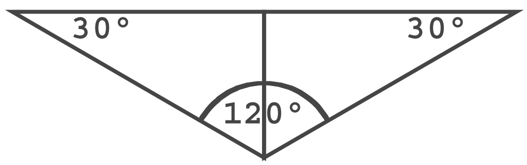
9. Which figures have the greatest perimeter? ____________________

Use the two paper 30-60 triangles and arrange them to make the following figures. Then draw them with your drawing tools below. Make the shortest side of the 30-60 triangles 2.5 cm or 1 inch. For each figure, measure and write the angle of the vertices.

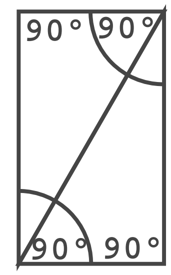
1. Equilateral triangle.



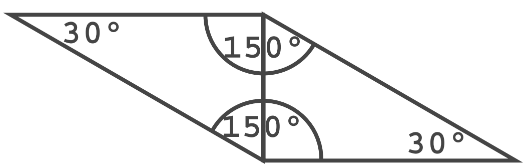
2. Isosceles triangle that is not equilateral.

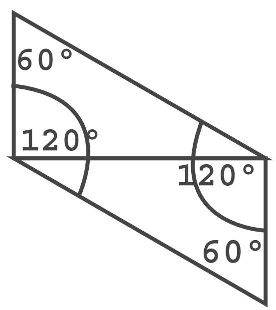


3. Rectangle.

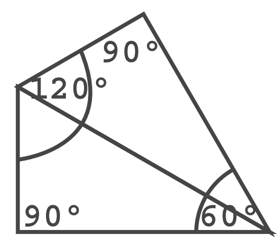


4–5. Two parallelograms that are neither rectangles nor mirror images of each other.





6. Quadrilateral that is not a parallelogram.



[ORIENTATIONS WILL VARY.]

7. Which figure has the greatest area? all the same

8. Which figures have the least perimeter? rectangle, quadrilateral

9. Which figures have the greatest perimeter? isosceles triangle, parallelogram with shortest sides of the triangle touching

NOTES: Some students may struggle creating the figures with their paper triangles. Help them realize that they can flip their triangles over as well as rotate the triangles. Once the figure is discovered with the paper triangles, drawing it is made easier.

Check that the shortest side of each 30-60 triangle drawn is 2.5 cm or 1 inch. One student, Draeke, chose to write "2.5 cm" on his paper triangles to help with the construction of the figures on the worksheet.

DICTIONARY TERMS: goniometer

Name: ______________________________

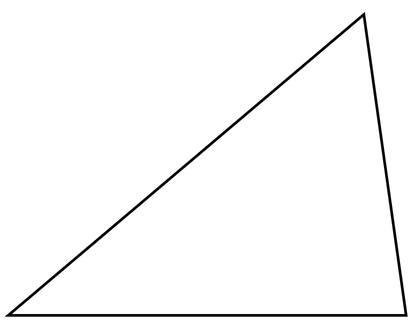
Date: ______________________

1–8. Match the following words with the correct definitions.

Straightedge	shape with four sides
Octagon	quadrilateral with one and only one set of parallel lines
Trapezoid	eight sided polygon
Quadrilateral	tool for drawing a straight line
Hexagon	polygon with six sides
Distributive Property	quadrilateral with two sets of parallel lines
Parallelogram	two equal sides
Isosceles	when multiplying or dividing some numbers all by the same number, you can add the numbers first and multiply the total

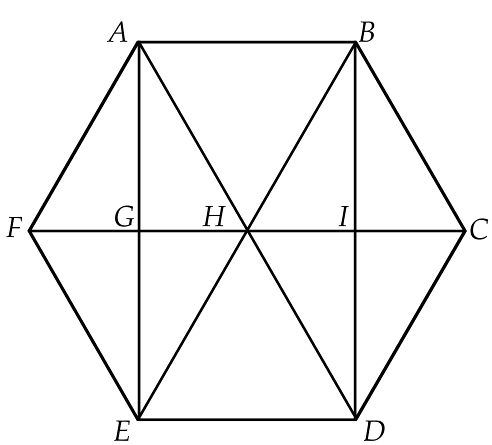
9. How many centimeters are in 1 inch? ____________

10. Find the perimeter of the triangle below to the nearest tenth of an inch.



11. Calculate the perimeter of the same triangle in centimeters using the calculator. $P =$ ______________

Use letters to identify the following shapes.



12. Two rhombuses: ______________________________

13. Three rectangles: ______________________________

14. Four trapezoids: ______________________________

15. Six equilateral triangles: ______________________________

____

16. Four isosceles triangles: ______________________________

17. Twelve right triangles: ______________________________

____

Name: ______________________________

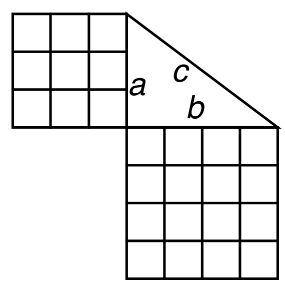
Date: ________________________

Worksheet 74-1,
Review and Games 7

1–8. Match the following terms with the correct definitions

Oblique	the side opposite the right angle of a triangle
Legs	a line that is not parallel or perpendicular
Perfect square	the two sides of a triangle opposite the hypotenuse
Hypotenuse	when the square root of a number is a whole number
Pythagorean theorem	a set of logical reasons for learning if a statement is true
Proof	a number multiplied by itself gives the quantity
Square root	the special relationship between the squares of the sides of a right triangle

9. In the triangle on the right, how many squares



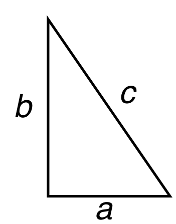
are on side a? ________

How many on side b? ________

How many on both sides? ________

How many squares will there be on the hypotenuse? ________

10. Draw the squares onto the sides of the triangle on the right using your drawing tools. Measure to the tenths of a cm, then give the answers to the hundredths.



a = ____________ a^2 = ______________

b = ____________ b^2 = ______________

c = 2.884 cm c^2 = ______________

11. Does $c^2 = a^2 + b^2$? ______________

NOTES: Make sure the student is understanding the difference between the measurements *a*, *b*, and *c* and the square of the numbers, a^2, b^2, and c^2.

1–8. Match the following terms with the correct definitions

Oblique	the side opposite the right angle of a triangle
Legs	a line that is not parallel or perpendicular
Perfect square	the two sides of a triangle opposite the hypotenuse
Hypotenuse	when the square root of a number is a whole number
Pythagorean theorem	a set of logical reasons for learning if a statement is true
Proof	a number multiplied by itself gives the quantity
Square root	the special relationship between the squares of the sides of a right triangle

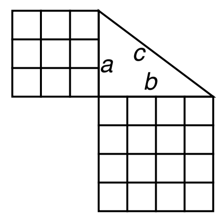
9. In the triangle on the right, how many squares

are on side *a*? 9

How many on side *b*? 16

How many on both sides? 25

How many squares will there be on the hypotenuse? 25

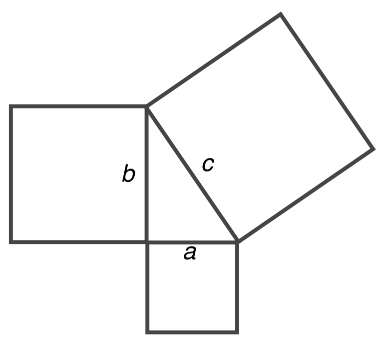


10. Draw the squares onto the sides of the triangle on the right using your drawing tools. Measure to the tenths of a cm, then give the answers to the hundredths.

a = 1.6 cm a^2 = 2.56 cm^2

b = 2.4 cm b^2 = 5.76 cm^2

c = 2.884 cm c^2 = 8.32 cm^2



11. Does $c^2 = a^2 + b^2$? yes

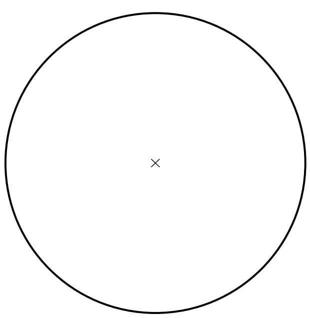
Name: ____________________________________

Date: ___________________________

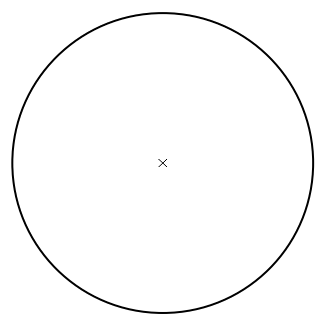
1–10. Match the following terms with the correct definitions

Circumference	when one circle is inside the other and they are tangent at the same point
Inscribed polygon	the distance around a circle
Tangent	when all of the vertices of a polygon lie on a circle
Internally tangent circles	the exact point where a line segment touches a circle
Line	a line measuring across the middle of a circle
Diameter	the ratio of the circumference to the diameter of a circle
Pi	a polygon drawn around a circle so that each of its sides is tangent to a circle
Circumscribed polygon	a path made by points that extends forever
Radius	an exact place, with no width, depth or height
Point	a line segment with one end at the center and the other on the circle

11. Using your drawing tools, draw an 8 sided inscribed regular polygon.



12. Using your drawing tools, draw an 8 sided circumscribed regular polygon.



13–14. For each polygon, measure the length of a side in millimeters. Find the perimeter. Calculate the ratio of P, the perimeter of the polygon, to *D*, the diameter of the circle. Complete the chart below.

Number of Sides	**Length, Side of Polygon in mm**	***P* (perimeter) of Polygon in mm**	***D* (diameter) of Circle in mm**	**Ratio of *P* to *D* (hundredths)**
8 Inscribed				
8 Circumscribed				

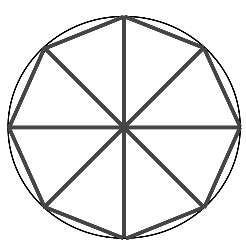
NOTES: On Problems 13 and 14, if needed remind the student that the ratio of *P*, perimeter, to *D*, diameter, is found by dividing the perimeter by the diameter, 120 ÷ 40 and 128 ÷ 40. If the student's measurements vary, check that their ratio is accurate.

If the student uses tickmarks, rather than line segments as shown in Problems 11 and 12, that is acceptable.

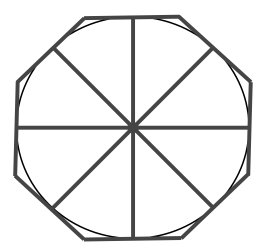
1–10. Match the following terms with the correct definitions

Circumference	when one circle is inside the other and they are tangent at the same point
Inscribed polygon	the distance around a circle
Tangent	when all of the vertices of a polygon lie on a circle
Internally tangent circles	the exact point where a line segment touches a circle
Line	a line measuring across the middle of a circle
Diameter	the ratio of the circumference to the diameter of a circle
Pi	a polygon drawn around a circle so that each of its sides is tangent to a circle
Circumscribed polygon	a path made by points that extends forever
Radius	an exact place, with no width, depth or height
Point	a line segment with one end at the center and the other on the circle

11. Using your drawing tools, draw an 8 sided inscribed regular polygon.



12. Using your drawing tools, draw an 8 sided circumscribed regular polygon.



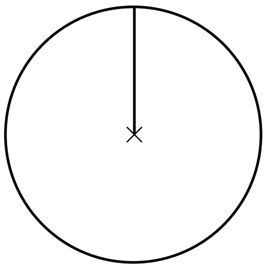
13–14. For each polygon, measure the length of a side in millimeters. Find the perimeter. Calculate the ratio of P, the perimeter of the polygon, to *D*, the diameter of the circle. Complete the chart below.

Number of Sides	Length, Side of Polygon in mm	*P* (perimeter) of Polygon in mm	*D* (diameter) of Circle in mm	Ratio of *P* to *D* (hundredths)
8 Inscribed	15 mm	120 mm	40 mm	3.00
8 Circumscribed	16 mm	128 mm	40 mm	3.20

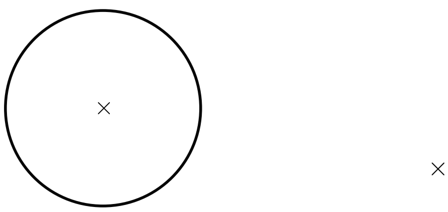
Name: ______________________________ *Worksheet 103-2, Review and Games 10*

Date: ______________________

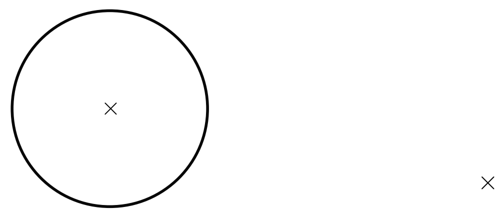
12. Draw a special square using the radius of this circle as one side. Find the perimeter and area of the square and then find the circumference and area of the circle.



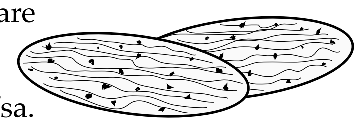
13. Find the radius of a circle that has twice the circumference of the circle below. Draw the circle.



14. Find the radius of a circle that has twice the area of the circle below. Draw the circle.



15. The Vikings had a favorite snack called lefsa. It is a soft tortilla made with potatoes, flour, butter, and cream. Find the area to the nearest tenth of a square cm for each size of lefsa in Minnesota and North Dakota. Fill in the chart.

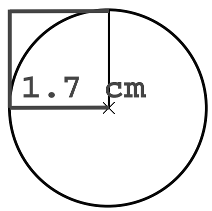


16. Find the price per square centimeter in tenths of a cent for each piece of lefsa.

Lefsa in Minnesota		
Size	20 cm	25 cm
Price	$12.95	$13.55
Area		
Price/cm²		

Lefsa in North Dakota		
Size	20 cm	25 cm
Price	$12.53	$12.95
Area		
Price/cm²		

12. Draw a special square using the radius of this circle as one side. Find the perimeter and area of the square and then find the circumference and area of the circle.



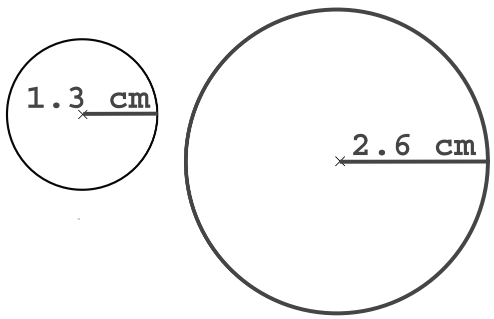
$P = 1.7 \times 4$
$P = 6.8$ cm

$C = 2\pi r$
$C = 2\pi \times 1.7$
$C \approx 10.7$ cm

$A(sq) = r^2$
$A(sq) = 1.7^2$
$A(sq) = 2.9$ cm²

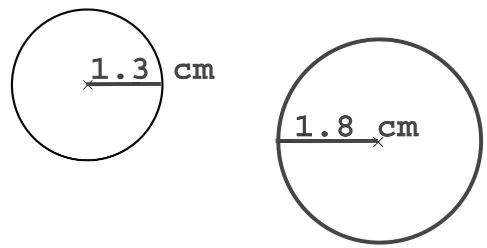
$A(cir) = \pi r^2$
$A(cir) = \pi \times 1.7^2$
$A(cir) \approx 9.1$ cm²

13. Find the radius of a circle that has twice the circumference of the circle below. Draw the circle.



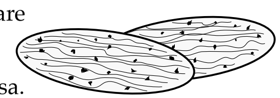
$C(sm) = 2\pi r$
$C(sm) = 2\pi \times 1.3$
$C(sm) = 8.2$ cm
$C(lg) = 8.2 \times 2$
$C(lg) = 16.4$ cm
$16.4 = 2\pi r$
$r(lg) = \frac{16.4}{2\pi} \approx 2.6$ cm

14. Find the radius of a circle that has twice the area of the circle below. Draw the circle.



$A(sm) = \pi r^2$
$A(sm) = \pi \times 1.3^2$
$A(sm) = 5.3$ cm²
$A(lg) = 5.3 \times 2$
$A(lg) = 10.6$
$10.6 = \pi r^2$
$\frac{10.6}{\pi} = r^2 \approx 3.37$
$r(lg) = 1.8$ cm

15. The Vikings had a favorite snack called lefsa. It is a soft tortilla made with potatoes, flour, butter, and cream. Find the area to the nearest tenth of a square cm for each size of lefsa in Minnesota and North Dakota. Fill in the chart.



16. Find the price per square centimeter in tenths of a cent for each piece of lefsa.

Lefsa in Minnesota		
Size	20 cm	25 cm
Price	$12.95	$13.55
Area	314.2	490.9
Price/cm²	4.1¢	2.8¢

Lefsa in North Dakota		
Size	20 cm	25 cm
Price	$12.53	$12.95
Area	314.2	490.9
Price/cm²	4.0¢	2.6¢

NOTES: On Question 16, the sizes given, 20 cm and 25 cm, is the diameter. Although it does not specifically say it is the diameter of the snack, using a radius measurement is not practical nor likely.

LESSON 122: ROTATIONAL SYMMETRY

OBJECTIVES:

1. To learn the terms *rotational symmetry*, *order of rotation symmetry*, and *point symmetry*
2. To apply rotational symmetry and point symmetry

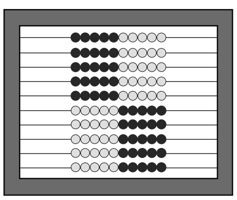
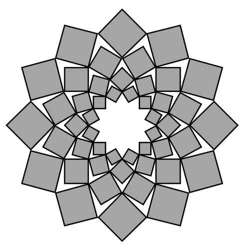
MATERIALS:

1. Math Dictionary
2. Worksheet 122, Rotational Symmetry
3. Tangrams
4. **Colored pencils, optional**
5. *Math Card Games* book

ACTIVITIES:

Rotational symmetry. Just as line symmetry refers to a line of symmetry within an object, *rotational symmetry* refers to rotation of an object. If a figure can be rotated and looks the same as before the rotation, it has rotational symmetry.

In the left figure below, the abacus has rotational symmetry; you can turn it 180° and it will look exactly as the original abacus.


In the center figure above, an image of the design (a logo) can be rotated 30° and still fit exactly on the original. Actually, it can be rotated for every multiple of 30° up to 360°, such as 30°, 60°, 90°, and so on, for a total of 12 times because 360 ÷ 30 = 12. When counting the number of rotations, we only go around once so do not count anything past 360°. The number of times it can be rotated is the *order of rotation symmetry.*

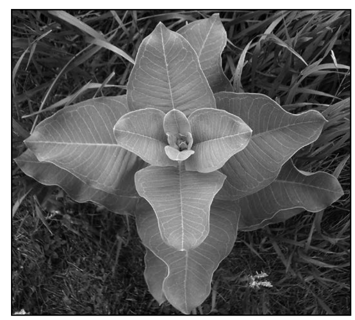
The car wheel above on the right can be rotated 72° (360 ÷ 5) and four more multiples of 72 and still look like the original.

The figures below show the five counterclockwise rotations. Notice the shadow. It will help you keep track as you observe the rotations. What is the order of rotation symmetry? Answer is below.

Sometimes rather than saying the order of rotation symmetry is 5, you will see the term "5-fold" or "12-fold" for the order of 12.

EXTRAS:

This lily demonstrates rotational symmetry.



The leaves on a milkweed plant rotate so they receive as much sunlight as possible.

The point of rotation is usually easy to find: it's the center of the figure.

LESSON CONTINUES ON THE NEXT PAGE.

Answer: 5

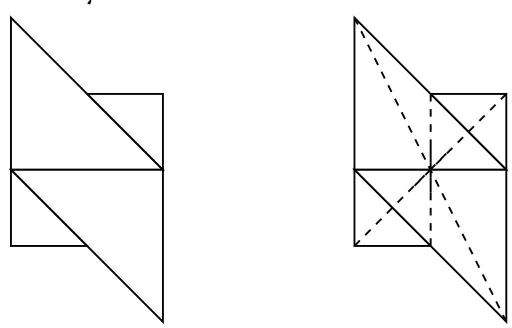
ACTIVITIES:

All objects have an order of rotational symmetry of 1 or more. Can you think why every object has at least an order of rotation of 1? Hint: what is 360 ÷ 360? It's 1!

So, in other words, you can always rotate an object completely around, 360°, and it will look the same. Therefore, everything has an order of rotation of 1 and sometimes more.

Point symmetry. A special case of rotational symmetry is *point symmetry*. An easy way to check for point symmetry is to rotate it 180°. If it looks the same, upside down as right side up, it has point symmetry.

To understand why it's called point symmetry, follow these steps. First construct this figure with your tangrams on top of a sheet of paper. Then rotate the paper 180° to see that the tangram design has point symmetry.



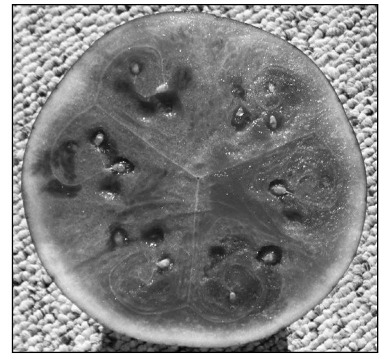
Next consider what happens if you connect the corresponding points. As you can see in the figure above on the right, the lines intersect at the center. The center also bisects each connecting line. It can be thought of as though each point is reflected through the center point. That's point symmetry.

Worksheet 122. The worksheet is a collection of problems applying symmetries.

Symmetry in logos, optional. Collect a dozen or so logos from magazines, the internet, or products. Analyze them for symmetry.

Today's game. Play your choice of math card game from the *Math Card Games* book.

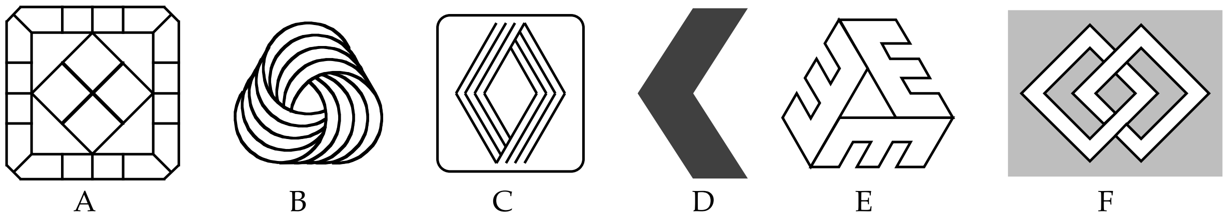
EXTRAS:

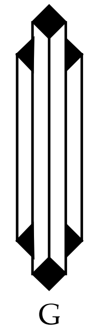


Watermelons also exhibit symmetry.

Name: ____

Date: ______________________________





1. Which of the figures above have line symmetry? ______________________________

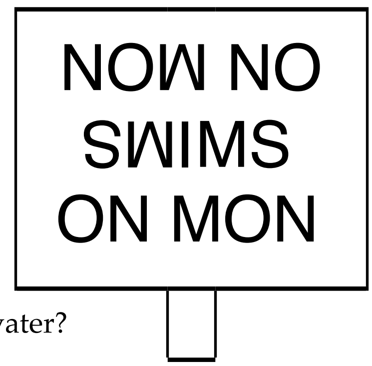
2. Which of the figures have rotational symmetry? Give the order of rotation symmetry.

____

3. Which of the figures have point symmetry? __________________________________

4. List the seven capital letters that have rotational symmetry.

____



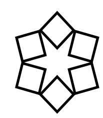
5. List the three digits that have rotational symmetry.

____

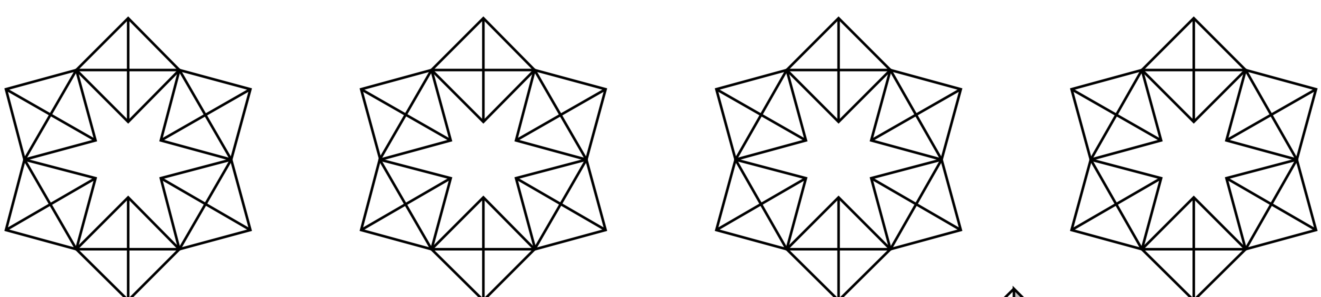
6. What did the diver read on the sign while traveling headfirst toward the water?

____

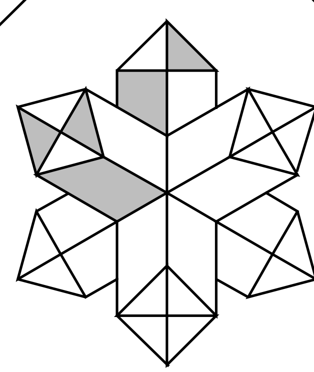
7–10. Color the squares in the figures below to show the order of rotation symmetry given.



2 3 6 1



11. Color the shaded part of the logo on the right. Then color the remaining part of the logo so it has rotational symmetry. What is the order of rotation symmetry? ____

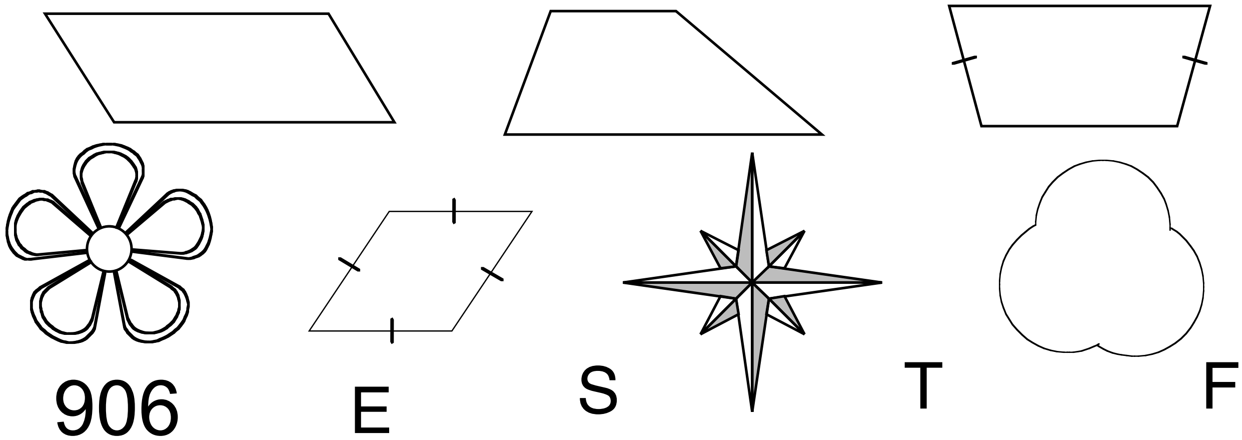


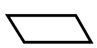
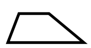
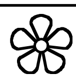
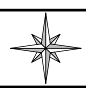
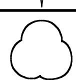
Name: ____

Date: _________________________________

Worksheet 123-2,
Symmetry Connections

4. Consider the symmetry of each figure and fill in the table below.



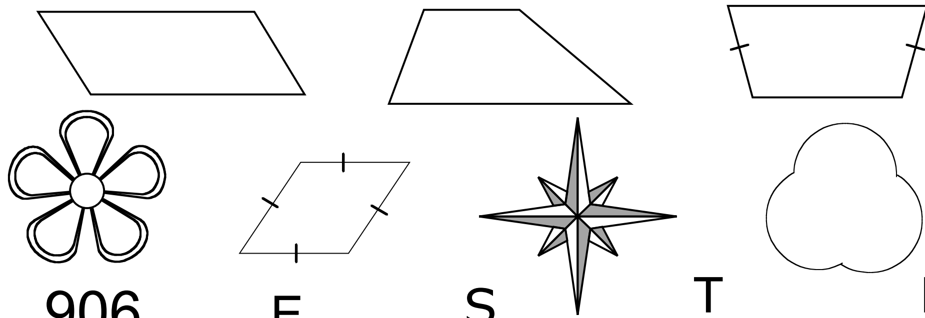
Shape	Line Symmetry?	Point Symmetry?	Rotational Symmetry?	Order of Rotation Symmetry	Degrees of Rotation
					
					
					
					
					
					
					
906					
E					
S					
T					
F					

5. What is the relationship between point symmetry and the order of rotation? ______________________

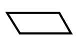
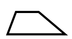
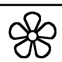
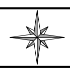
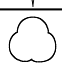
____

BONUS: Can you have rotational symmetry without line symmetry and point symmetry? ___________

4. Consider the symmetry of each figure and fill in the table below.



906 E S T F

Shape	Line Symmetry?	Point Symmetry?	Rotational Symmetry?	Order of Rotation Symmetry	Degrees of Rotation
	no	yes	yes	2	180°
	no	no	no	1	360°
	yes	no	no	1	360°
	yes	no	yes	5	72°
	yes	yes	yes	2	180°
	no	yes	yes	4	90°
	yes	no	yes	3	120°
906	no	yes	yes	2	180°
E	yes	no	no	1	360°
S	no	yes	yes	2	180°
T	yes	no	no	1	360°
F	no	no	no	1	360°

5. What is the relationship between point symmetry and the order of rotation? **Point symmetry only exists when order of rotation is even.**

BONUS: Can you have rotational symmetry without line symmetry and point symmetry? **yes**

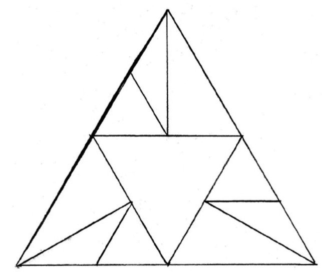
NOTES: Approaching this table systematically may be beneficial for some students. Considering line symmetry for all figures, then point symmetry, then rotational symmetry, etc, helps keep each definition straight.

The star is not symmetrical because of the shading.

An object having rotational symmetry with an order of 1 occurs when an object has symmetry about a point only when rotated by 360 ÷ 1, which is 360 degrees. In other words, the order of rotation symmetry of 1 happens with objects that have no symmetry less than 2. Rotational symmetry for these objects is trivial. Therefore, the simplest possible rotational symmetry is of order 2.

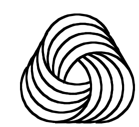
Question 5 can also reference the order of rotation being a multiple of 2.

For the bonus question, only looking to the chart's information, when neither line symmetry nor point symmetry exist, rotational symmetry does not appear to exist. The second quadrilateral and the letter F both have no line symmetry, no point symmetry, as well as no rotational symmetry.



Joshua Dill from St. Paul, MN, age 14, wondered about this. After some work, he shows that rotational symmetry can exist without point or line symmetry being present.

So the answer to the bonus question is "yes." Additionally, consider figure B from Worksheet 122 as shown here. It has rotational symmetry without line symmetry and point symmetry.



DICTIONARY TERMS: heptagon