

Determine perimeter or area of a custom part = Apply geometric concepts to model and solve real world problems

Program Task: Perform precision measurements.

PA Core Standard: CC.2.3.HS.A.14

Program Associated Vocabulary:

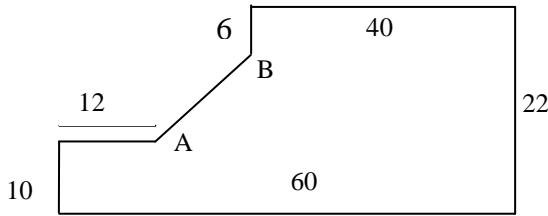
DEPTH, DIMENSION, ESTIMATE, WIDTH, HEIGHT, CIRCUMFERENCE

Description: Apply geometric concepts to model and solve real world problems.

Math Associated Vocabulary:

LENGTH, HEIGHT, BASE, WIDTH, DIAMETER, RADIUS, HYPOTENUSE, AREA, PERIMETER, CIRCUMFERENCE

Program Formulas and Procedures:



Formulas and Procedures:

Rectangle: $A = lw$ $P = 2l + 2w$

Trapezoid: $A = \frac{h(a+b)}{2}$

Circle: $A = \pi r^2$ $C = 2\pi r$ or πd
(Circumference = circle perimeter)

Triangle: $A = \frac{1}{2}bh$ $P = a + b + c$

Pythagorean Theorem: $c^2 = a^2 + b^2$

To correct a shimmy at 40 MPH and increase airflow over the AC condenser, a factory service bulletin (TSB) recommends fabricating a shim plate to fit between the transaxle and sub-frame. The TSB forgot to add the length for dimension AB on the diagram above. After fabricating the shim, the TSB states to add a foam rubber seal around the entire edge. What length foam rubber will you need to complete the job? Note: Illustration NOT to scale.

An irregular figure can be broken down into two or more regular shapes, such as triangles, circles, trapezoids or rectangles.

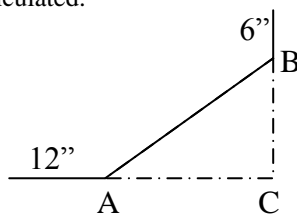
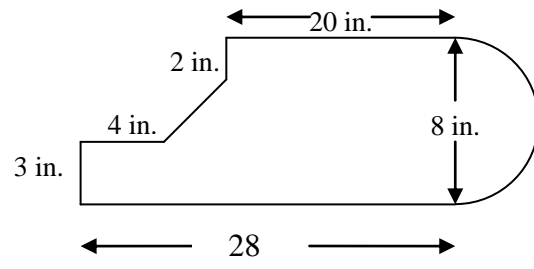
The lengths of all edges are known except for the length between A and B.

To find the **perimeter** around irregular figures, add the lengths of the sides. If the sides of the figures include circles, use the circumference formula to calculate the length of that portion of the figure and add it to the total of the other sides.

To estimate the distance between A and B, we need to identify a triangle that has AB as its long side:

Example 1: To find the **area** of an irregular figure, separate the figure into shapes for which you can calculate the area. The sum of the areas of each smaller figure is the area of the irregular figure.

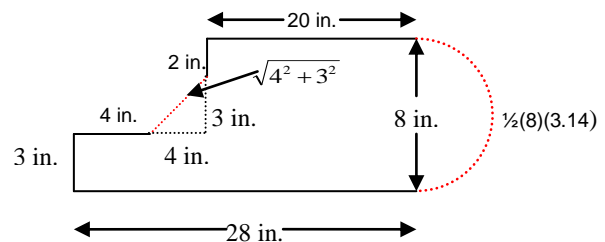
If the length of the other 2 sides of the triangle (BC, AC) are calculated, then AB can be calculated.



B to C = $22'' - 6'' - 10'' = 6''$
A to C = $60'' - 12'' - 40'' = 8''$

Example 2: To find the perimeter of the figure above, use the Pythagorean theorem and circumference formula to find the missing lengths:

Pythagorean Theorem: $AB^2 = 6^2 + 8^2$
 $AB^2 = 100$
 $AB = \sqrt{100}$
 $AB = 10$



Length of foam rubber is the perimeter of the figure:
 Perimeter = $10 + 6 + 40 + 22 + 60 + 10 + 12 = 160$ in.

To find the area of the same figure, divide the figure into one triangle, two rectangles, and one semi-circle.

Instructor’s Script – Comparing and Contrasting

Area is the total number of square units in a region.

Perimeter is the distance around the outside of a shape or figure (a circle’s perimeter is called a circumference).

Area, perimeter or circumference problems use a toolbox of formulas for basic shapes, but the critical step is to break down the irregular shape into these basic shapes (circle, rectangle, or triangle) and apply the correct formulas.

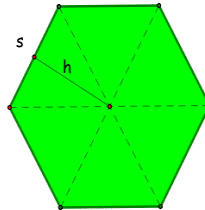
Whether trying to solve a trade application or a math problem, you should try to draw in new lines that create simple shapes within the complex shape and determine the dimensions of each simple shape.

To calculate irregular shapes with “holes”, calculate the area of the entire shape and then subtract out the area of the holes.

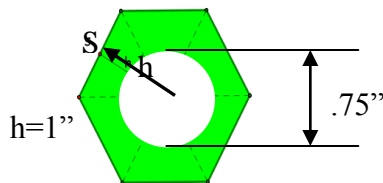
A regular hexagon consists of 6 similarly sized triangles.

$$A = 6 \times (\text{area of 1 triangle})$$

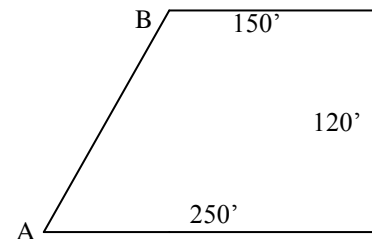
$$= 6 \times (\frac{1}{2} sh)$$



Use this diagram for question # 2 on page 3



Use this diagram for question # 3 on page 3



Common Mistakes Made By Students

Mixing perimeter and area formulas or calculations: Perimeter formulas calculate the length of the outside edge of an object, while area formulas calculate the space taken up by the shape. Areas and perimeters should not be compared (apples and oranges) because perimeter is measured as a unit length while area is that same unit squared.

Perimeter calculations should not include inner edges: The perimeter of an irregular object should follow the outer edge of the figure. If you find the perimeter for basic shapes constructed within the irregularly shaped object, be sure to eliminate the auxiliary lines (inner edges) that don’t follow the outside edge.

Finding basic shapes within irregular objects can be frustrating: Some irregular objects can be broken into basic shapes with only a couple of extra lines, while others seem to take a lot more. Don’t feel locked in to your first attempt if it is too messy.

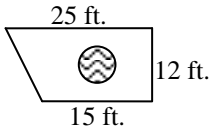
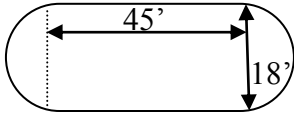
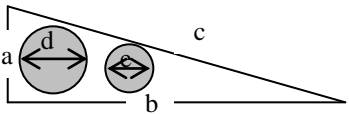
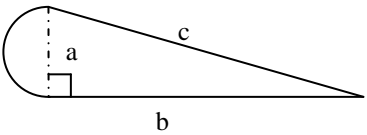
Empty shapes in the figure require subtracting the area of the “hole”: If your plan includes areas that create holes in the object, you will be subtracting out that area to get a final answer (e.g., a deck plan that has a spot for a hot tub).

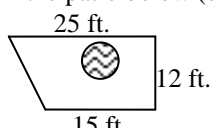
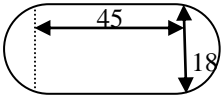
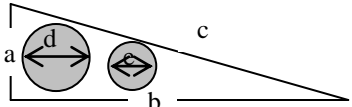
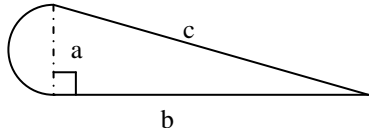
Final answer may include multiple parts: Don’t forget to total all the various areas or perimeters to get your final answer.

Be sure to find all missing lengths before calculating the perimeter.

CTE Instructor’s Extended Discussion

Technical tasks are usually not presented using this model. Therefore, it is important that technical instructors demonstrate to students how these math concepts link to and are relevant in their technical training and that the math is presented in a way which shows a relationship to the math which CTE students use in their academic school settings. Lab instructors can expand on these concepts. For example, how much of a tire’s tread contacts the road at any one time? Determine how much material you would need to recover a 60/40 split front seat. Use your imagination and you could easily develop several different related, relevant, rigorous math integration problems.

Problems	Career and Technical Math Concepts	Solutions
<p>1. A wheel has an outside $d = 16''$ and the outside of the tire has a $d = 22''$. What is the circumference of the wheel, circumference of the tire and the area of the sidewall?</p> <p>Use the formula: $A = \pi r_2^2 - \pi r_1^2$</p>		
<p>2. Please read the question carefully! It is a 3-part question. (1) What is the area of a lug nut that has $h = 1''$, $s = 1.125''$ & $d = 3/4''$ hole for the lug stud? (2) What is the area of the lug nut (1) without the hole for the lug stud? (3) What is the perimeter of the lug nut? Refer to the diagram on page two.</p>		
<p>3. By law the minimum size lot to build an auto repair shop is 20,000 sq. ft. Is the lot pictured large enough to build your shop on? Refer to the diagram on page two.</p>		
Problems	Related, Generic Math Concepts	Solutions
<p>4. A health club has a circular jogging track with an outside diameter of 200 feet and the track is 15 feet wide. What is the area of the track?</p>		
<p>5. Your goal is to paint a mural that depicts a large yellow image of the Sun, risen half-way above the eastern horizon. You buy a gallon of yellow paint and read that the manufacturer claims it will cover a 200 square foot wall. What is the diameter of the largest sun you can paint?</p>		
<p>6. The installer plans to build a new patio with a round hot tub in the center. What is the area of material needed around the hot tub pictured in the patio below (diameter of 6 feet)?</p> 		
Problems	PA Core Math Look	Solutions
<p>7. Find the area of the figure pictured.</p> 		
<p>8. Find the area of the unshaded area if $a = 5$, $b = 18$, $d = 3$, and $e = 1$.</p> 		
<p>9. Find the perimeter of the figure if $c = 37$ and $b = 24$.</p> 		

Problems	Career and Technical Math Concepts	Solutions
1. A wheel has an outside $d = 16''$ and the outside of the tire has a $d = 22''$. What is the circumference of the wheel, circumference of the tire and the area of the sidewall? Use the formula: $A = \pi r_2^2 - \pi r_1^2$	Sidewall Area (big circle - little circle) $A = \pi r_2^2 - \pi r_1^2$ where $r_2 =$ radius of tire $r_1 =$ radius of wheel $A = \pi 11^2 - \pi 8^2$ $A = 179.07 \text{ in.}^2$	
2. Please read the question carefully! It is a 3-part question. (1) What is the area of a lug nut that has $h = 1''$, $s = 1.125''$ & $d = 3/4''$ hole for the lug stud? (2) What is the area of the lug nut (1) without the hole for the lug stud? (3) What is the perimeter of the lug nut? Refer to the diagram on page two.	Area of lug nut without hole $A = 6(\frac{1}{2}sh)$ $A = 6(.5 \times 1.125 \times 1)$ $A = 6(.5625)$ $A = 3.375 \text{ in.}^2$ Area of hole $A = \pi \times 375^2 = .442$ Area of lug nut with hole for stud: $A = 3.375 - .442$ $A = 2.933 \text{ in.}^2$ Perimeter: $P = 6(1.125)$ $P = 6.75 \text{ in.}$	
3. By law the minimum size lot to build an auto repair shop is 20,000 sq. ft. Is the lot pictured large enough to build your shop on? Refer to the diagram on page two.	Triangle base = $250 - 150 = 100\text{ft}$ Area triangle = $\frac{1}{2}bh$ $.5 \times 100 \times 120 = 6000 \text{ ft.}^2$ Area rectangle = $lw = 120 \times 150 = 18000 \text{ ft.}^2$ $A = 6000 + 18000 = 24000 \text{ ft.}^2$	
Problems	Related, Generic Math Concepts	Solutions
4. A health club has a circular jogging track with an outside diameter of 200 feet and the track is 15 feet wide. What is the area of the track?	The diameter of the smaller circle is $(200 - (15 + 15))$ feet Large circle area = $\pi(100)^2 \approx 31400 \text{ ft.}^2$ Small circle area = $\pi(85)^2 \approx 22,687 \text{ ft.}^2$ Area of the track = $31400 - 22687$ or $8,713 \text{ ft.}^2$.	
5. Your goal is to paint a mural that depicts a large yellow image of the Sun, risen half-way above the eastern horizon. You buy a gallon of yellow paint and read that the manufacturer claims it will cover a 200 square foot wall. What is the diameter of the largest sun you can paint?	You base your estimations on a semi-circle whose area is 200 sq. ft. (full circle size would be 400 sq. ft.) $\text{Area} = \pi r^2$ $400 = \pi r^2$ divide both sides by π $127.32 = r^2$ take square root of both sides $\sqrt{127.32} = r$ $11.27 \approx r$ $11.27 \times 2 \approx 22.54 \text{ feet} = \text{diameter}$	
6. The installer plans to build a new patio with a round hot tub in the center. What is the area of material needed around the hot tub pictured in the patio below (diameter of 6 feet)? 	Area of patio = area of a trapezoid (patio shape) – area of the circle (hot tub shape) $\text{Area} = \frac{h(a+b)}{2} - \pi r^2$ $A = \frac{12(15+25)}{2} - \pi 3^2$ $A = 240 - 28.26 = 211.74 \text{ ft.}$	
Problems	PA Core Math Look	Solutions
7. Find the area of the figure pictured. 	Area = Area Rectangle + Area one full circle $= lw + \pi r^2$ ($l=45, w=18, r = \text{radius} = \frac{1}{2} \times 18 = 9$) $= (45)(18) + \pi(9)^2$ $\approx 810 + 254.5 \approx 1064.5 \text{ ft.}^2$	
8. Find the area of the unshaded area if $a = 5$, $b = 18$, $d = 3$, and $e = 1$. 	Area = Area triangle – Area circle 1 – Area circle 2 $= \frac{1}{2}bh - \pi r^2 - \pi r^2$ (radius circle 1 = $\frac{1}{2} \times 3 = 1.5$, radius circle 2 = $\frac{1}{2} \times 1 = 0.5$) $= \frac{1}{2}(18)(5) - \pi(1.5)^2 - \pi(0.5)^2$ $\approx 45 - 7.1 - .8 \approx 37.1 \text{ units}^2$	
9. Find the perimeter of the figure if $c = 37$ and $b = 24$. 	Perimeter = $c + b +$ semicircle with diameter a . $a^2 + b^2 = c^2 \rightarrow a^2 + 24^2 = 37^2 \rightarrow a^2 + 576 = 1369$ $a^2 + 576 - 576 = 1369 - 576 \rightarrow a^2 = 793 \rightarrow \sqrt{a^2} = \sqrt{793}$ $a = 28.2 = \text{diameter of semicircle}$ circumference of semicircle = $\frac{1}{2}d\pi = \frac{1}{2}(28.2)(3.14) = 44.3$ Total perimeter = $37 + 24 + 44.3 = 105.3 \text{ units}$	