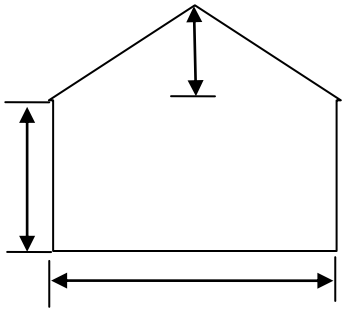
Carpentry (46.0201) T-Chart

Estimate area on a gable end	=	Apply geometric concepts to model and solve real world problems

Program Task: Estimate the area on the gable end of a house to order siding.

Program Associated Vocabulary:
DEPTH, DIMENSION, ESTIMATE, WIDTH, RISE, RUN, SPAN

Program Formulas and Procedures:
To install siding on a gable end, the carpenter must estimate how much material of siding is needed to complete the project. The carpenter will know the width of the building, the height of the wall and the total rise of the gable end. The carpenter will use the dimensions to estimate the area for the gable end.

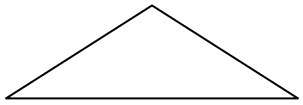


Width = 22'
Height = 10'
Total rise = 7'

Triangle: $A = \frac{1}{2}bh$

Rectangle: $A = lw$

To find the area of the gable end, the carpenter will separate the shape into a square and a triangle.



Area = $\frac{1}{2}(2)(7) = 77 sq.ft.$

Area= 22 × 10 = 220 sq. ft.

Total area for gable end = 77 sq. ft. + 220 sq. ft.
Total area = 297 sq. ft.

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

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

Math Associated Vocabulary:
LENGTH, HEIGHT, BASE, WIDTH, DIAMETER, RADIUS, HYPOTENUSE, AREA, PERIMETER, CIRCUMFERENCE

Formulas and Procedures:
Rectangle: A = lw P = 2l + 2w

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

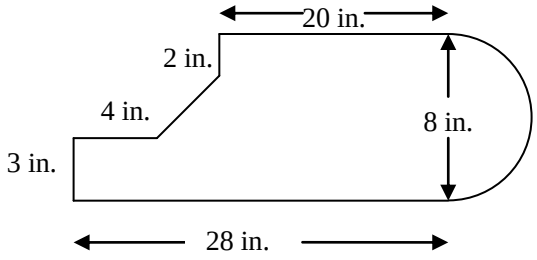
Circle: $A = \pi r^2$ $C = 2\pi r$ or πd
(Circumference = circle perimeter)

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

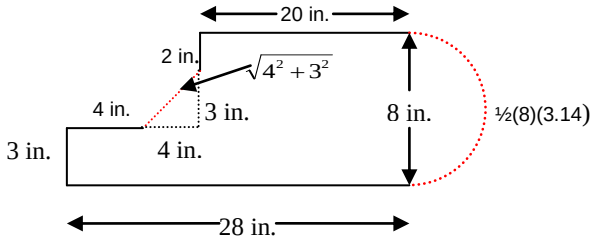
Pythagorean Theorem: $c^2 = a^2 + b^2$
An irregular figure can be broken down into two or more regular shapes, such as triangles, circles, trapezoids or rectangles.

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.

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.



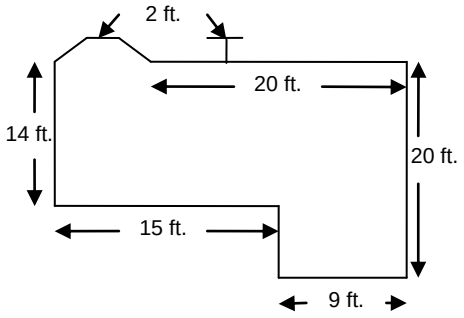
Example 2: To find the **perimeter** of the figure above, use the Pythagorean theorem and circumference formula to find the missing lengths:



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). Any figure may be irregular, meaning it is made up of part of a regular shape or more than one irregular shape. To make these problems more difficult, have a student estimate the area of a floor plan from a blueprint. Make the building layout so that it is not a basic rectangle. For instance, look at the floor plan shown below. The key skill required by this eligible content is the ability to break down complex shapes into simple shapes to find area and perimeter.



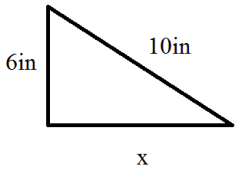
The ratio 3:4:5 is called a Pythagorean Triple. It is often used in Carpentry to find the sides of a right triangle.

Pythagorean Triple

$3 : 4 : 5$

$6\,\text{in.} : x : 10\,\text{in.}$

The missing side would be $8\,\text{in.}$



Pythagorean Theorem

$6^2 + x^2 = 10^2$

$36 + x^2 = 100$

$x^2 = 64$

$x = 8$

The Pythagorean Theorem must be used for triangles that do not follow the 3:4:5 ratio.

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 <u>not</u> 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).

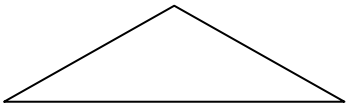
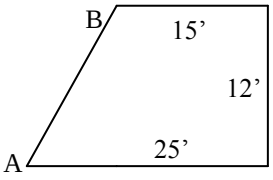
Final answer may include multiple parts: Don't forget to total all the various areas or perimeters to get your final answer.

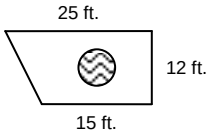
Be sure to find all missing lengths before calculating the perimeter.

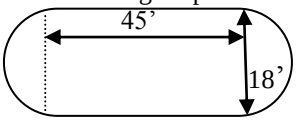
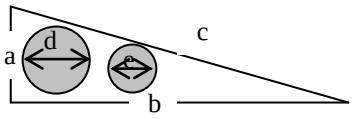
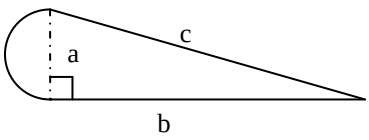
CTE Instructor's Extended Discussion

Carpenters like to build things plumb, square, level and **irregular**? Yes it is true; carpenters often build irregular shapes. Why? Because carpenters offer a service of skill, it is important that a carpenter can interpret a set of blueprints and estimate material. The carpenter must also understand the math to lay out walls that are not perpendicular or parallel to other walls. Understanding and knowing how to find the area and perimeter of irregular shapes will give a carpenter an advantage over other carpenters when a prospective client calls and ask for something irregular.

Carpentry (46.0201) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1. How many square feet of siding is needed to cover one gable end that has a span of 30' 6" and a total rise of 10'?		
2. A carpenter needs to replace the decking boards on an 8' hexagon shape deck. What is the total square feet of decking needed to complete the project? (Each side = 55.4")		
3. A customer would like you to seal their concrete patio; you need to determine how much sealer is needed. What is the area of the patio (in 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?		
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?		
6. The installer plans to build a new patio with a 6 ft. (d) round hot tub in the center. What is the area of material needed around the hot tub pictured in the patio below? 		

Problems	PA Core Math Look	Solutions
7. Find the area of the figure pictured. 		
8. Find the area of the unshaded area if a = 5, b = 18, d = 3, and e = 1. 		
9. Find the perimeter of the figure if c = 37 and b = 24. 		

Carpentry (46.0201) T-Chart

Problems	Occupational (Contextual) Math Concepts	Solutions
1. How many square feet of siding is needed to cover one gable end that has a span of 30' 6" and a total rise of 10'?		$A = \frac{1}{2}bh \quad A = \frac{1}{2}(30.5)(10) \quad A = \frac{1}{2}(305) = 152.5$ sq. ft.
2. A carpenter needs to replace the decking boards on an 8' hexagon shape deck. What is the total square feet of decking needed to complete the project? (Each side = 55.4")		$8' \times 12 = 96" \div 2 = 48"$ Area of one triangle $= 1/2 \times 48 \times 55.4 = 1329.6"$ $1329.6 \times 6 = 7977.6$ in.^{2} $7977.6 \div 144 = 55.4$ ft.^{2}
3. A customer would like you to seal their concrete patio; you need to determine how much sealer is needed. What is the area of the patio (in ft.^{2})?		Split diagram into triangle and rectangle: Triangle base = 25 – 15 = 10 ft. Area triangle = ½ bh = ½ × 10 × 12 = 60 ft.^{2} Area rectangle = lw = 15 × 12 = 180 ft^2 Total Area = 180 + 60 = 240 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 = π (100 x 100) Large circle area = 3.14 x 10,000, or 31,400 ft.^{2} Small circle area = 3.14 x 85 x 85, or 22,687 ft.^{2} Area of the track = Large Circle Area (31,400) - Small Circle Area (22,687), or 8,718 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?		Base your estimations on a semi-circle whose area is 200 sq. ft. A full circle size would be 400 sq. ft. Area of a semi-circle: $\frac{1}{2}\pi r^2 = 200$ $2 \times \frac{1}{2}\pi r^2 = 2 \times 200$ Multiple both sides by 2. $\pi r^2 = 400$ $\frac{\pi r^2}{\pi} = \frac{400}{\pi}$ Divide both sides by π. $r^2 = \frac{400}{\pi} \qquad \sqrt{r^2} = \sqrt{\frac{400}{\pi}}$ r = 11.28 Diameter = r (11.28) x 2 Double the radius to find the diameter. Diameter = 22.5'
6. The installer plans to build a new patio with a 6 ft. (d) round hot tub in the center. What is the area of material needed around the hot tub pictured in the patio below?		Area of patio = area of a trapezoid (patio shape) – area of the circle (hot tub shape) Area $= \frac{h(a+b)}{2} - \pi r^2 \qquad A = \frac{12(15+25)}{2} - \pi 3^2$ A= 240 – 28.26 = 211.74 ft.^{2}
Problems	**PA Core Math Look**	**Solutions**
7. Find the area of the figure pictured.		Area = Area Rectangle + Area one full circle = lw + πr^2 (l=45, w=18, r = radius = ½ × 18 = 9') = (45)(18) + π(9)^2 = 810 + 254.3 = 1064.3 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 = ½ bh – πr^2 - πr^2 (radius circle 1 = ½ × 3 = 1.5, radius circle 2 = ½ × 1 = 0.5) = ½ (18)(5) – π(1.5)^2 - π(0.5)^2 = 45 – 7.1 - .8 = 37.1 units^2
9. Find the perimeter of the figure if c = 37 and b = 24.		Perimeter = c + b + semicircle with diameter a. $a^2 + b^2 = c^2 \quad a^2 + 24^2 = 37^2 \quad a^2 + 576 = 1369$ $a^2 + 576 - 576 = 1369 - 576 \quad a^2 = 793 \quad \sqrt{a^2} = \sqrt{793}$ a = 28.2 = diameter of semicircle circumference of semicircle =1/2 dπ = ½ (28.2)(3.14) = 44.3 Total perimeter = 37 + 24 + 44.3 = 105.3 units