Drafting & Design Technology/Technician (15.1301) T-Chart

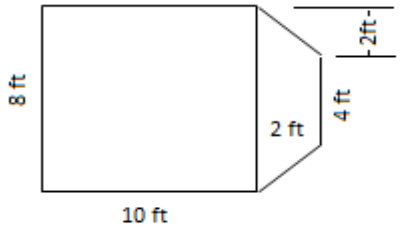
Calculate perimeter and area of irregular shapes	=	Apply geometric concepts to model and solve real-world problems

Program Task: Calculate the area in square feet for floor and/or ceiling tile; calculate perimeter of figure for base molding and/or wall trim.

Program Associated Vocabulary:
AREA, PERIMETER, COST ESTIMATING

Program Formulas and Procedures:
A drafter should be able to calculate perimeters and areas of spaces for several reasons: material requirements, cost comparisons, total costs and evaluating change orders.

Example: Using the diagram below, calculate the floor area and perimeter.



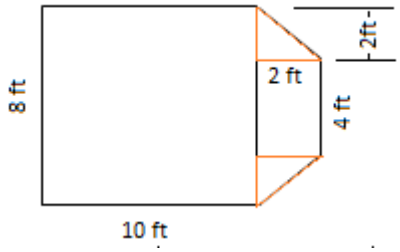
Calculation of floor area
Calculate the rectangle first: A = L x W
8 ft. x 10 ft. = 80 sq. ft.
Calculate the area of the trapezoid: $A=\frac{h(a+b)}{2}$

$$A = \frac{2(4+8)}{2}$$

$$A = 12\,\text{sq. ft.}$$

Then find the total area by adding the two smaller areas together: 80 sq. ft. + 12 sq. ft. = 92 sq. ft.

To find the perimeter we must add all of the outside lengths together. We first need to use the Pythagorean Theorem to find the diagonal length of each triangle (see picture below).



$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{2^2 + 2^2}$$

$$c = \sqrt{8}$$

$$c = 2.8\,\text{ft.}$$

Finally add all of the outside lengths together.
8 ft. + 10 ft. + 2.8 ft. + 4 ft. + 2.8 ft. + 10 ft. = 37.6 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)

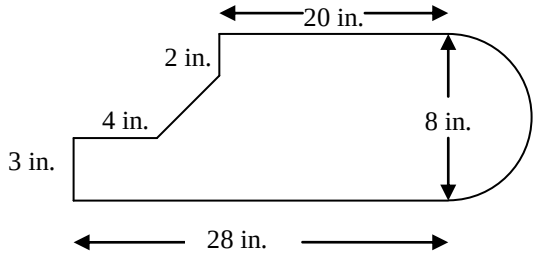
Triangle: $A = \frac{1}{2}bh$ P = a + b + c

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

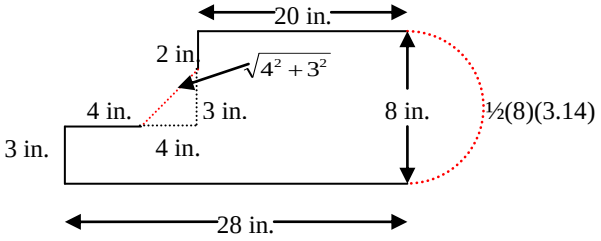
An irregular figure can be broken down into two or more regular shapes, such as triangles, circles, trapezoids or rectangles.

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.

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.



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
Drafting students must be able to find the area, perimeter and circumference of irregular figures represented in architectural drawings. Most floor plans are not represented by basic rectangles and the complexity of the architectural design affects the complexity of the shapes forming the irregular figure. Drafting students must also be able to differentiate between required dimensions for floor areas and perimeters and required dimensions for ceiling areas and perimeters.

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.

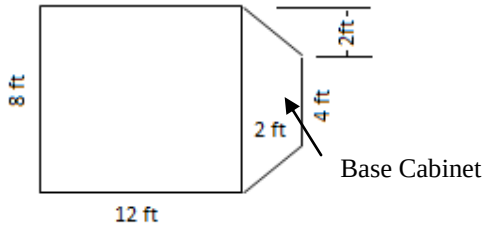
Empty shapes in the figure require subtracting the area of the "hole": If your plan includes areas that create holes in the object, you will be subtracting out that area to get a final answer (e.g., a deck plan that has a spot for a hot tub).

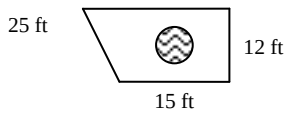
Final answer may include multiple parts: Don't forget to total all the various areas or perimeters to get your final answer.

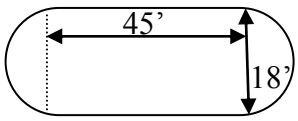
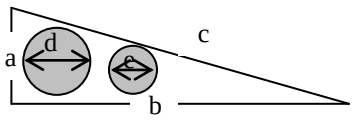
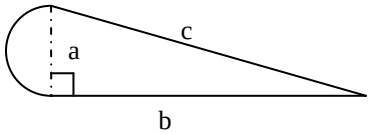
Be sure to find all missing lengths before calculating the perimeter.

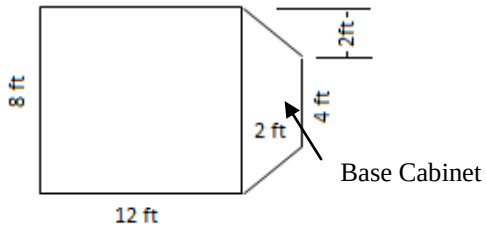
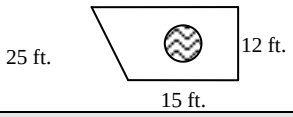
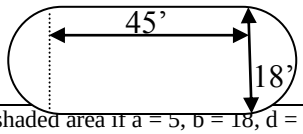
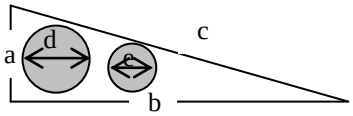
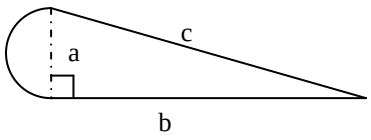
CTE Instructor's Extended Discussion
It is important for students to calculate areas and perimeters of irregular shapes. Since the majority of commercial buildings are unique designs, architects will often use irregular shapes for dramatic appeal. While irregular shapes will add costs to the project, they also inject the personal style of either the architect or client.

In addition, not all building lots are rectangular or square in shape. Since many lots are small, this sometimes forces the architect to utilize as much of the allowed building space as possible, while following irregular property lines.

Problems	Career and Technical Math Concepts	Solutions
1. Calculate the perimeter of the base cabinet section. 		
2. Calculate the perimeter of the entire space. (Use diagram above.)		
3. Calculate the area of the base cabinet section. (Use diagram above.)		

Problems	Related, Generic Math Concepts	Solutions
4. A health club has a circular jogging track with an outside diameter of 200 ft. and the track is 15 ft. 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. What is the area of the patio pictured if you install a 6 ft. (d) round hot tub in the center? 		

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

Problems	Career and Technical Math Concepts	Solutions
1. Calculate the perimeter of the base cabinet section.  Base Cabinet		Diagonals of base cabinet. $c = \sqrt{2^2 + 2^2} = \sqrt{8} = 2.8\,\text{ft.}$ Perimeter of base cabinets = 8 ft. + 2.8 ft. + 4.ft. + 2.8.ft. = 17.6 ft.
2. Calculate the perimeter of the entire space. (Use diagram above)		Diagonals of base cabinet. $c = \sqrt{2^2 + 2^2} = \sqrt{8} = 2.8\,\text{ft.}$ Perimeter of entire space = 8 ft. + 2.8 ft. + 4 ft. + 2.8 ft. +12 ft. + 12 ft. = 41.6 ft.
3. Calculate the area of the base cabinet section. (Use diagram above)		Area of trapezoid = $\frac{2(4+8)}{2} = \frac{24}{2} = 12\,\text{ft.}^2$
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 = 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 8,713 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. $r^2 = \frac{400}{\pi}$ $\sqrt{r^2} = \sqrt{400/\pi}$ Square root both sides. r = 11.28 Double the radius to find the diameter. Diameter = r (11.28) x 2 Diameter = 22.5’
6. What is the area of the patio pictured if you install a 6 ft. (d) round hot tub in the center? 		Area of patio = area of rectangle + area of triangle Area = 15(12) + ½ (12)(10) – (3.14)(3)(3) Area = 180 + 60 – 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) + $\pi(9)^2$ = 810 + 254.3 = 1064.3 $ft.^2$
8. Find the area of the un-shaded 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) – $\pi(1.5)^2$ $\pi(0.5)^2$ = 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. $a^2 + b^2 = c^2$ $a^2 + 24^2 = 37^2$ $a^2 + 576 = 1369$ $a^2 + 576 - 576 = 1369 - 576$ $a^2 = 793$ $\sqrt{a^2} = \sqrt{793}$ 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