

Determine office space layout = Apply geometric concepts to solve real-world problems

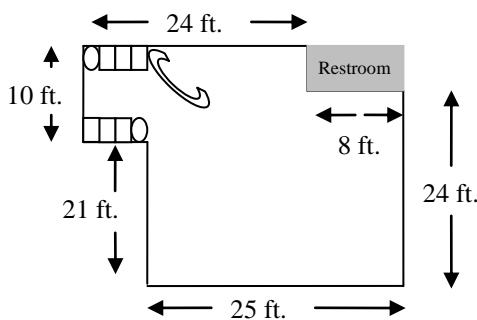
**Program Task:** Determine office space layout.

**Program Associated Vocabulary:**  
SQUARE FOOTAGE, LENGTH, WIDTH, AREA

**Program Formulas and Procedures:**

It is important for the dental assistant to know how to determine area. Many doctors need to update their office space to accommodate patients with disabilities or add new operatories as the office grows. The doctor will want input from the dental assistants regarding the new office layout.

**Example:** The doctor you are working for is moving into a new office and would like you, the dental assistant, to give input on the size and amount of operatories in the new building. It is important to understand how to calculate square footage. Excluding the restroom area, how many square feet of space does the doctor have to work with?



**Solution:**

Area of waiting room =  $10 \times 7 = 70$  sq. ft.  
 Area of other space incl. restroom =  $25 \times 31 = 775$  sq. ft.  
 Total area =  $70 + 775 = 845$  sq. ft.  
 Subtract the area of the restroom =  $7 \times 8 = 56$  sq. ft.  
 $845 - 56 = 789$  sq. ft.  
 The doctor has 789 sq. feet of space with which to work.

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

**Description:** Apply geometric concepts to 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  $\pi d$   
 (Circumference = circle perimeter)

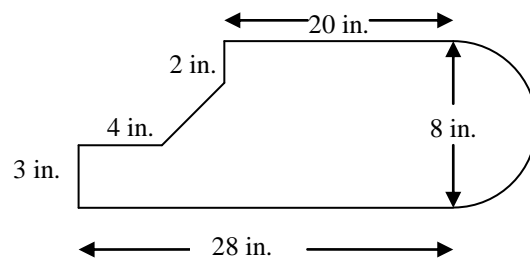
**Triangle:**  $A = \frac{1}{2}bh$        $P = a + b + c$

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

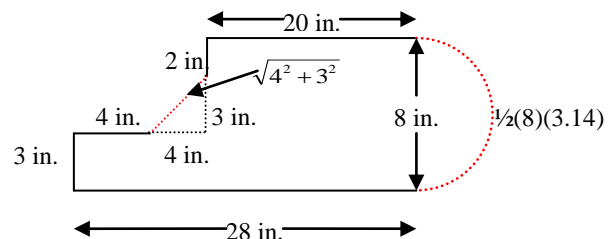
An irregular figure can be broken down into two or more regular shapes, such as triangles, circles, trapezoids or rectangles.

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 of 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**

Calculating areas of floor plans may not be routinely assigned to a dental assistant, but the ability to calculate areas of floor plans will build critical thinking skills. One could extend the dental problem on the first page by asking questions such as: If the doctor needed four operatories, what dimensions would they have to be in order to still maintain a reasonable waiting room, reception area and hallway?

Note: Answers to the problems on page 4 will be different if you are using 3.14 as  $\pi$ , rather than the  $\pi$  key on your calculator. Answers will be different, not by much, but enough that when some students are presented with the answer key they might not recognize that they did get the correct answers!

### **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 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 use perimeter formulas for basic shapes constructed within the irregular object, be sure to eliminate auxiliary lines (inner edges) that do not 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.

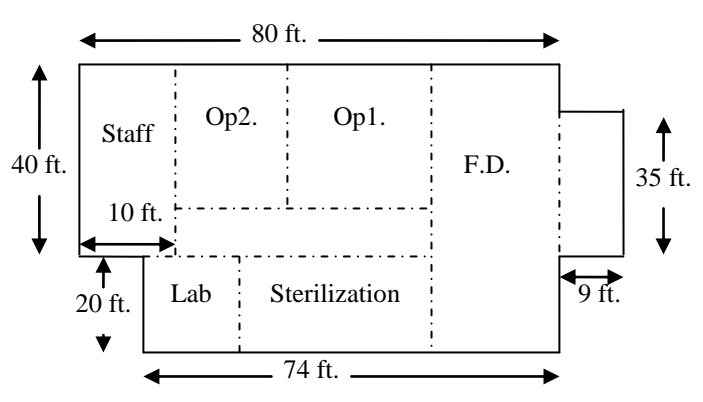
**Empty shapes in the figure require subtracting the area of the "hole:"** If your plan includes areas that create holes in the object, you will be subtracting out that area to get a final answer (e.g., a deck plan that has a spot for a hot tub).

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

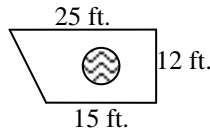
**Be sure to find all missing lengths before calculating the perimeter.**

### **CTE Instructor's Extended Discussion**

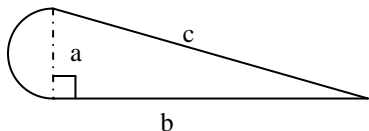
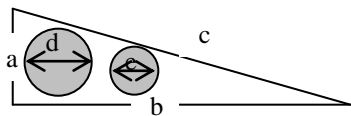
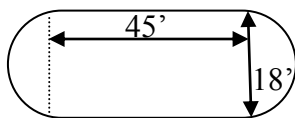
Give students parameters for different types of offices with different needs. Mix up types of operatories, sterilization areas and lab areas, and have them draw different floor plans to accommodate the needs of that office space.

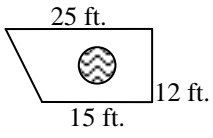
Problems	Career and Technical Math Concepts	Solutions
1. The dentist sketched a rough plan of the new office which she plans to build. What is the area of the new office?		
2. If the doctor decides to use half of the staff room for a handicap accessible bathroom, what would the square footage of the new handicap accessible bathroom be?		
3. Excluding the area for the staff room, what is the area of the office?		

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 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).		



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 $b = 24$ .		



Problems	Career and Technical Math Concepts	Solutions
1. The dentist sketched a rough plan of the new office which she plans to build. What is the area of the new office?		$(80 \times 60) + (35 \times 9) - (20 \times 6)$ $4,800 + 315 - 120 = 4995$ sq. ft. The total area is 4,995 sq. ft.
2. If the doctor decides to use half of the staff room for a handicap accessible bathroom, what would the square footage of the handicap accessible bathroom be?		Staff room area = $10 \times 40 = 400$ sq. ft. Half of the area = 200 sq. ft. The handicap accessible bathroom would be 200 sq. ft.
3. Excluding the area for the staff room, what is the area of the office?		$4995 - (10 \times 40) = 4995 - 400 = 4595$ sq. ft.
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 = $\pi (100 \times 100)$ Large circle area = $3.14 \times 10,000$ , or 31,400 ft <sup>2</sup> Small circle area = $3.14 \times 85 \times 85$ , or 22,687 ft <sup>2</sup> Area of the track = Large Circle Area (31,400) - Small Circle Area (22,687), or 8,718 ft <sup>2</sup>
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 $\pi$ . $r^2 = \frac{400}{\pi}$ $r = 11.28$ Diameter = $r (11.28) \times 2$ Double the radius to find the diameter. 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 a trapezoid (patio shape) – area of the circle (hot tub shape) $Area = \frac{h(a+b)}{2} - \pi r^2$ $A = \frac{12(15+25)}{2} - \pi 3^2$ $A = 240 - 28.26 = 211.74$ ft. <sup>2</sup>
		
Problems	PA Core Math Look	Solutions
7. Find the area of the figure pictured.		Area = Area Rectangle + Area one full circle $= lw + \pi r^2$ ( $l=45, w=18, r = \text{radius} = \frac{1}{2} \times 18 = 9$ ) $= (45)(18) + \pi(9)^2$ $= 810 + 254.3$ $= 1064.3$ ft. <sup>2</sup>
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 = $\frac{1}{2} \times 1 = 0.5$ ) $= \frac{1}{2} (18)(5) - \pi(1.5)^2 - \pi(0.5)^2$ $= 45 - 7.1 - .8$ $= 37.1$ units <sup>2</sup>
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 = $\frac{1}{2} d\pi = \frac{1}{2} (28.2)(3.14) = 44.3$ Total perimeter = $37 + 24 + 44.3 = 105.3$ units
	