Graphic Communication (10.0399) T-chart

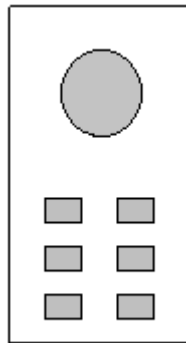| Determine image area to estimate ink	=	Apply geometric concepts to model and solve real-world problems

Program Task: Determine the image area on a sheet of printing paper to estimate ink needed.

PA Core Standard: CC2.3.HS.A.14
Description: Apply geometric concepts to model and solve real-world problems.

Program Associated Vocabulary:
AREA

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

Program Formulas and Procedures:
Estimating the surface area of an object being printed will help in estimating ink for the project.

Area = length x height

Example: In the 23" x 35" document below, the printed surface area consists of six 10" x 6" objects and a 20" diameter circle. The rest of the space will be printed in yellow. Your yellow cartridge covers 1000 sq.in. Will you have enough yellow ink?

Total area = 23 x 35 = 805 sq.in.

Area of each block = 10 x 6 = 60 sq.in.

Area of all blocks = 60 x 6 = 360 sq.in.

Area of circle = πr^2 = 3.14x10^2 = 314 sq.in

(radius = diameter ÷ 2)

Area of all images = 360 sq.in. + 314 sq.in. = 674 sq.in.

Area of all "yellow" areas = 805 sq.in. - 674 sq.in = 131 sq.in.

Yes, you will have enough yellow ink.

Formulas and Procedures:

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

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

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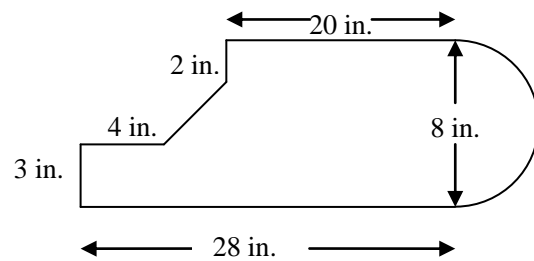   (Circumference = circle perimeter)

Triangle: $A = \dfrac{1}{2}bh$ $P = a + b + c$
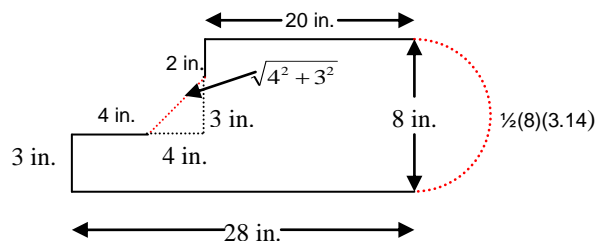
Pythagorean Theorem: $c^2 = a^2 + b^2$

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
The PA Common Core Standard does not include areas of basic figures, such as squares, rectangles, and circles. It does however include irregular shapes that are comprised of basic figures. Even a simple problem involving the area of a rectangle can become more complex when components must be either added or subtracted. In the example on the Graphic Communications side of the T-Chart, the student must be able to not only calculate the area of a rectangle and circle, but also must be able to combine areas (printed area) and subtract that from the total area.

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.

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.
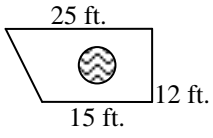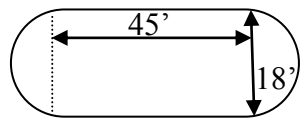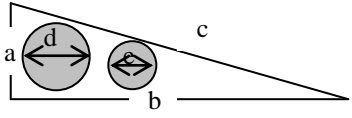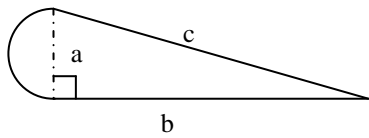
Perimeter calculations should <u>not</u> include inner edges: The perimeter of an irregular object should follow the outer edge of the figure. If you find the perimeter for basic shapes constructed within the irregularly shaped object, be sure to eliminate the auxiliary lines (inner edges) that don't follow the outside edge.
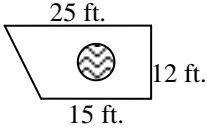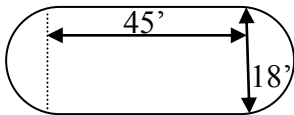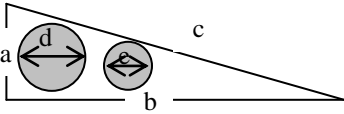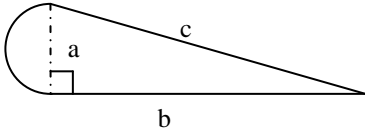
Be sure to find all missing lengths before calculating the perimeter.

CTE Instructor's Extended Discussion
Estimating the surface area of an object being printed will help in estimating ink for the project.

Graphic Communication (10.0399) T-chart

Problems	Career and Technical Math Concepts	Solutions
1. Find the printed area of (4) 2"x3" rectangular objects on a 23"x35" sheet of paper.		
2. Find the printed area of (2) 8" x 10" rectangular objects and a triangle with a base of 5" and a height of 6" on a 17"x2" sheet of paper.		
3. Find the area of white space if (8) 4" x 2" images and a 6" diameter circle are printed on a 20" x 24" sheet of paper.		

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)? 25 ft. 12 ft. 15 ft.		

Problems	PA Core Math Look	Solutions
7. Find the area of the figure pictured. 45' 18'		
8. Find the area of the unshaded area if a = 5, b = 18, d = 3, and e = 1. d a c b		
9. Find the perimeter of the figure if c = 37 and b = 24. c a b		

Problems	Career and Technical Math Concepts	Solutions

1.	Find the printed area of (4) 2" x 3" rectangular objects on a 23" x 35" sheet of paper	Area = L x W x number of rectangles Area = 2 x 3 x 4 = 24 sq.in.
2.	Find the printed area of (2) 8" x 10" rectangular objects and a triangle with a base of 5" and a height of 6" on a 17" x 22" sheet of paper	Area of Rectangles = L x W x number of rectangles = 2 x 3 x 4 = 24 sq.in. Area of Triangle = $\frac{1}{2}$ bh = $\frac{1}{2}$ (5)(6) = 15 sq.in. Total Area = 24 sq.in. + 15 sq.in. = 39 sq.in
3.	Find the area of white space if (8) 4" x 2" rectangular images and a 6" diameter circle are printed on a 20" x 24" sheet of paper.	Total Area = 20 x 24 = 280 sq.in. Area of Rectangles = L x W x number of rectangles = 4 x 2 x 8 = 64 sq.in. Area of Circle = πr^2 = 3.14(3)^2 = 28.26 sq.in. Total White Space = 280 sq.in. - 64 sq.in. - 28.26 sq.in. = 387.74 sq.in.

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 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?	You base your estimations on a semi-circle whose area is 200 sq. ft. (full circle size would be 400 sq. ft.) Formula to use: Diameter = (Sqrt.(Area/π)) x 2 Diameter = (Sqrt(400/3.14)) x 2 Diameter = Sqrt 127 x 2 Diameter = 11.27 x 2 Diameter = 22.5 feet
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)? 25 ft. 12 ft. 15 ft.	Area of patio = area of a trapezoid (patio shape) – area of the circle (hot tub shape) Area = $\frac{h(a+b)}{2}$ - πr^2 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. 45' 18'	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 unshaded area if a = 5, b = 18, d = 3, and e = 1. d a c b	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. c a b	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