Math by Design
Windjammer Environmental Center Constructed Response Questions Answer Key
**Right Triangle Concepts**
The new tower has a height of 150 feet. Several cables have been used to help support the tower. The base of one cable is attached on the ground at a spot 30 feet from the center of the base of the tower.

Step A: What is the length of this cable?
The cable is about 152.971 feet long.

Step B: Use what you know about the Pythagorean Theorem to explain how you determined the length of the cable. Use words, numbers, and/or symbols in your explanation.


$$150^2 + 30^2 = x^2$$
$$23400 = x^2$$
$$152.971 \approx x$$
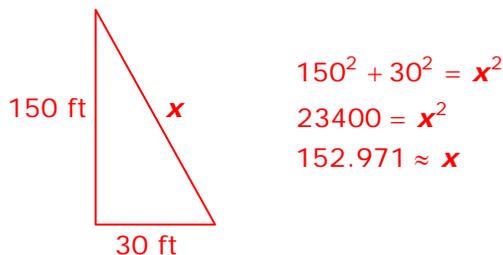
Transformations
A segment with endpoints located on a coordinate plane at (2, 5) and (7, 3) is rotated 90 degrees counterclockwise about the origin.

Step A: What are the coordinates of the endpoints of the segment after the rotation?
The endpoints of the rotated segment are located at (-5, 2) and (-3, 7).

Step B: Use what you know about rotations to explain how you determined the coordinates of the endpoints. Use words, numbers, and/or symbols in your explanation.
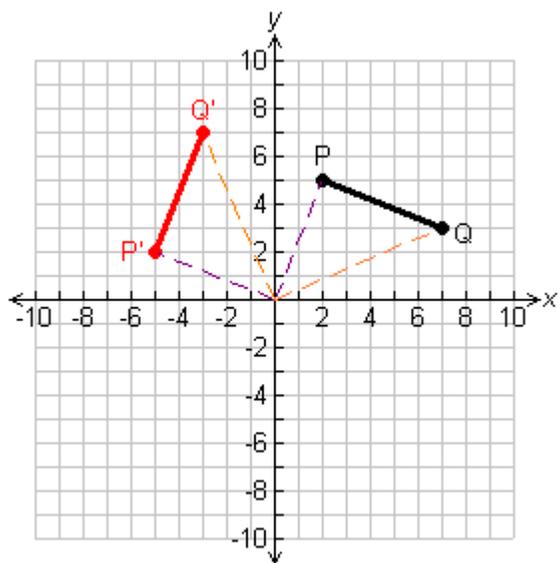
Point P is located by drawing the first side of a right angle from the origin to point P and the second side begins at the origin and is 90 degrees counterclockwise from the first side. (See the purple angle on the graph.) Then the image of point P is located on the second side of the angle the same distance from the origin as point P is from the origin on the first side of the angle.
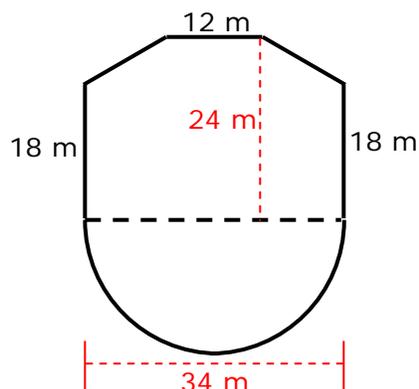Point Q is located similarly.

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Area of a Composite Figure
The figure shows the floor plan for the new theater.

Step A: What is the total area of the theater?
The area of the theater is approximately 1203.96 m^2.

Step B: Use what you know about finding the area of a composite figure to explain how you determined the area of the theater. Use words, numbers, and/or symbols in your explanation.
Answers may vary. One method is shown.

Separate the region into two trapezoids, labeled A and B, a rectangle, labeled C, and a semicircle, labeled D.

The height of each trapezoid is 11 meters. The entire width of the theater is 34m, and the middle section is 12m. The difference is 22m, so each trapezoid has a height of half of 22m, or 11m.

Area of A = $\frac{1}{2}(11\,\text{m})(18\,\text{m}+24\,\text{m})$

Area of A = $231\,\text{m}^2$

Area of B = $231\,\text{m}^2$

Area of C = $(24\,\text{m})(12\,\text{m})$ Area of D = $\frac{1}{2}\pi(17\,\text{m})^2$
Area of C = $288\,\text{m}^2$ Area of D $\approx 453.960\,\text{m}^2$

Total Area $\approx 231\,\text{m}^2 + 231\,\text{m}^2 + 288\,\text{m}^2 + 453.960\,\text{m}^2$
Total Area $\approx 1203.960\,\text{m}^2$

Note: Using 3.14 as the value for π, the area of D is 453.73 m^2 and the total area is 1203.73 m^2.
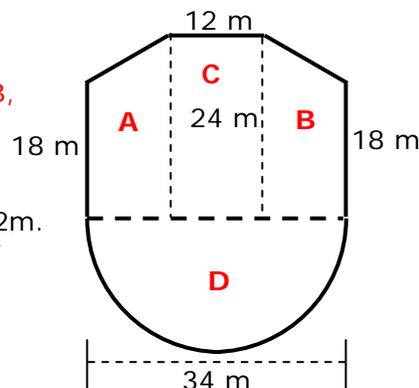
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Volume of a Cylinder
The cake designer is making a round layer cake for an event with 50 people. A layer of cake has a height of 4 inches. The designer can make a cake with a 10-inch diameter or a cake with a 12-inch diameter.   He needs at least 8 in^3 of cake per person.

Step A: Which of the sizes of cake should the designer use in order to have enough cake for all 50 people?
He should use the 12-inch layer cake.

Step B: Use what you know about finding the volume of a cylinder to explain how you determined the correct size to use. Use words, numbers, and/or symbols in your explanation.
The volume of the 10-inch layer cake is about 314.159 in^3, which will serve about 39 people. The volume of the 12-inch cake is about 452.389 in^3, which will serve about 56 people.

10 inch layer cake:

$$V = \pi(5\,\text{in})^2(4\,\text{in})$$
$$V \approx 314.159\,\text{in}^3$$

$$\frac{314.159\,\text{in}^3}{8\,\text{in}^3\,/\,\text{serving}} \approx 39.270\,\text{servings}$$

12 inch layer cake:

$$V = \pi(6\,\text{in})^2(4\,\text{in})$$
$$V \approx 452.389\,\text{in}^3$$

$$\frac{452.389\,\text{in}^3}{8\,\text{in}^3\,/\,\text{serving}} \approx 56.549\,\text{servings}$$

Note: Using 3.14 as the value for π, the volume of the 10-inch layer cake is 314 in^3 which is 39.25 servings and the volume of the 12-inch layer cake is 452.16 in^3 which is 56.52 servings.

Proportional Reasoning

An artist is drawing a giraffe. She knows that a male giraffe is about 18 feet tall and that his shoulder is about 11.5 feet above the ground. In the picture, the height of the giraffe will be about 10 inches.

Step A: In the picture, what should be the height of the giraffe's shoulder above the ground?
The giraffe's shoulder should be about 6.4 inches above the ground.

Step B: Use what you know about proportional reasoning to explain how you determined the height of the giraffe's shoulder. Use words, numbers, and/or symbols in your explanation.

$$\frac{18\,\text{ft}}{10\,\text{in}} = \frac{11.5\,\text{ft}}{x\,\text{in}}$$
$$18x = 115$$
$$x = 6.3\overline{8}\,\text{ft}$$