USING MEASUREMENT AND GEOMETRY STANDARDS IN A REAL-LIFE SITUATION

To help you get the "big picture," following are seven Measurement and Geometry standards that are illustrated by an anchor problem called *Paving a Playground*; you might encounter problems such as this after high school. Even though the CAHSEE doesn't include problems with many calculations like this one, you might find it easier to remember one large problem (an "anchor problem"), in which many of the skills are combined, rather than trying to recall how to do each of the standards individually.

Try to do this problem before you look at its solution on the following pages.

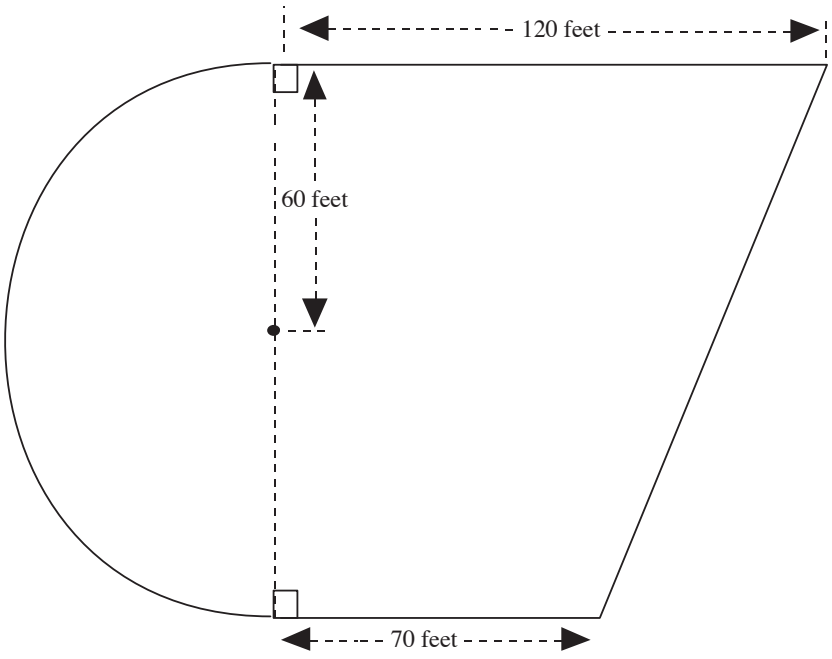
Paving a Playground

You work for a paving company and need to give a school a cost estimate for paving the playground and putting a concrete border around its perimeter. A scale drawing of the playground is shown below.

The cost (labor and materials) for the pavement is $54 per square yard.

The cost (labor and materials) for the concrete border is $18 per linear foot.

What's your estimate?

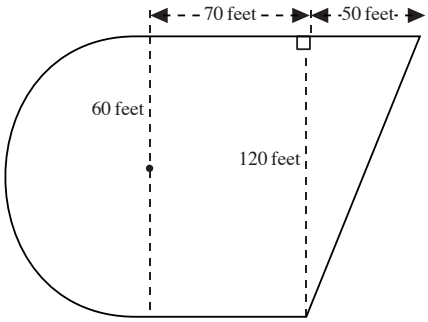


Paving a Playground Solution and Standards

7MG1.2 Construct and read drawings and models made to scale. [1 question]

To begin solving this problem, you'll first need to look at the diagram, read the lengths given, and make decisions about the missing lengths. Let's begin.

Do you see the semicircle, the rectangle, and the triangle? You can use what you know about these shapes plus the numbers given in the scale drawing to find the following lengths: the radius of the circle, and the length and width of the rectangle as shown:



7MG3.3 Know and understand the Pythagorean theorem and its converse and use it to find the length of the missing side of a right triangle and the lengths of other line segments and, in some situations, empirically verify the Pythagorean theorem by direct measurement. [2 questions]

Step 1: Determine the length of the playground's concrete border.
We can use the Pythagorean theorem to find the side of the triangle opposite the right angle (the hypotenuse). The Pythagorean theorem says that for a right triangle, the sum of the squares of the legs gives the square of the hypotenuse. In this figure, the legs are 50 and 120, so you would apply the theorem: $120^2 + 50^2 = 14{,}400 + 2{,}500 = 16{,}900$, which is the square of the hypotenuse. So the square root of 16,900 will be the length of the hypotenuse, 130 feet.

7MG2.1 Use formulas routinely for finding the perimeter and area of basic two-dimensional figures and the surface area and volume of basic three-dimensional figures, including rectangles, parallelograms, trapezoids, squares, triangles, circles, prisms and cylinders. [3 questions]

Next, you can find the length of the semicircular edge by using the formula for the circumference of a circle. A circle with a radius of 60 feet will have a circumference of $2\pi r$, where $\pi \approx 3.14$. $2\pi r = 2(3.14)60 = 376.8$ ft. But the playground's perimeter includes only half the circumference of the circle, which is 188.4 feet.

Now you can add up the pieces to find the length of the playground's entire perimeter:

$$50 + 130 + 188.4 + 70 + 70 = 508.4 \text{ feet}$$

Step 2: Find the area of the playground by calculating the areas of the triangle, rectangle, and semi-circle.

Area of triangle is $\frac{1}{2}(50)(120) = 3{,}000$ square feet.

Area of rectangle is $(70)(120) = 8{,}400$ square feet.

Area of semicircle is $\frac{1}{2}\pi(60)^2 = 5{,}652$ square feet.

The sum of these three areas is the total area of the playground to be paved, 17,052 square feet.

Step 3: Figure out the cost of the pavement.
Let's go back to the original problem. What are you asked to find? You need to estimate the cost of paving the playground and its concrete border. Do you see that the cost of pavement and the concrete border are given as rates per unit? Pavement is $54 per square yard, and the border is $18 per linear foot.

Although the cost of pavement is given per square yard, we have calculated the area in square feet! We need to change the square feet into square yards. To do this you will need to use the fact that it takes 9 square feet to make 1 square yard. The area in square feet (17,052) divided by 9 will give the converted area: 1,895 square yards. Finally, you have to multiply the 1,895 square yards by the cost of $54 per square yard to get the final cost of the pavement: $102,330.

7MG1.3 Use measures expressed as rates (e.g., speed, density) and measures expressed as products (e.g., person-days) to solve problems; check the units of the solutions; and use dimensional analysis to check the reasonableness of the answer. [2 questions]

7MG1.1 Compare weights capacities, geometric measures, times, and temperatures within and between measurement systems (e.g., miles per hour and feet per second, cubic inches to cubic centimeters). [2 questions]

Step 4: Figure out the cost of the border.
The only thing left to do is to find the cost of the border. You just need to multiply the perimeter, 508.4 feet, by $18 per linear foot.

$508.4(\$18) = \$9{,}151.$

7MG2.4 Relate the changes in measurement with a change of scale to the units used (e.g., square inches, cubic feet) and to conversions between units (1 square foot = 144 square inches or $[1\ ft^2] = [144\ in^2]$, 1 cubic inch is approximately 16.38 cubic centimeters. $[1\ in^3] = [16.38\ cm^3]$). [1 question]

Step 5: Determine the total cost estimate.
If you add the two money amounts together, $102,330 + $9,151, you will have a very good estimate for the work to be done by the paving company: $111,481 (nearest dollar).

Because this is an estimate, you may have rounded numbers off differently and found an estimate close to this. Did you get an estimate between $110,000 and $120,000?

7MG3.4 Demonstrate an understanding of conditions that indicate two geometrical figures are congruent and what congruence means about the relationships between the sides and angles of the two figures. [1 question]

Paving a Playground—Again!
Suppose your company must pave another playground like this one. Could you use the same cost estimate? You could if the two playgrounds were congruent—if both had exactly the same shape and same size.

In order to solve this big problem, you used the math in 7 of the Geometry and Measurement standards. Now you are ready to answer the questions in the next section and then check your answers using the answer key provided in the appendix at the back of this Study Guide.

(Note: The CAHSEE questions used as examples throughout this Study Guide and in the following sample questions were used on prior CAHSEEs. These items will not be used in future CAHSEEs.)