

MATH TOPICS ADDRESSED:

- Employing the Pythagorean theorem
- Using geometric shapes
- Seeing similar triangles

Building Trades

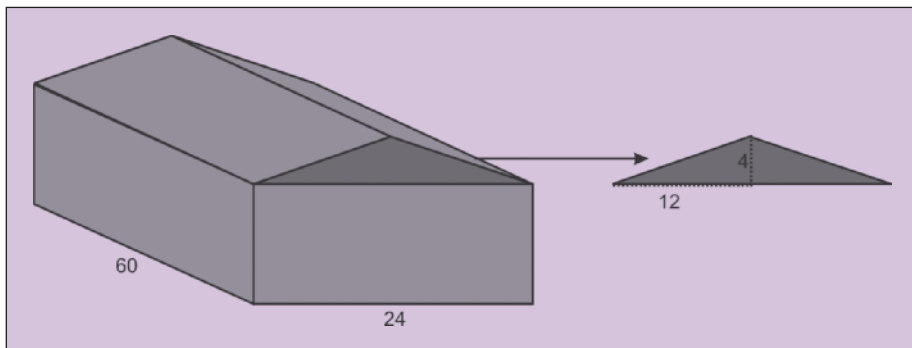
When building a home, it is critical for the walls to be at a 90° angle with the floor and with one another. Builders say the frame is *square* when these conditions are met. Otherwise, the structural integrity and safety of the house will be compromised. Builders use geometric properties to ensure that the walls and floor are square with one another.

PROBLEMS

1. Larry has a piece of rope that is 24 in. long. It is marked off in 1-in. increments. What possible right triangles could he create with this rope that have whole number lengths for all three sides?
2. Larry wants to check that 2 adjacent walls meet at a 90° angle (i.e., they are square with each other). How can he use his rope to check?
3. Larry needs to make sure that two walls are square with each other. Work with a partner and decide whether a 12-16-20 triangle or a 3-4-5 triangle will give a more accurate result. Explain your reasoning.
4. Larry expects that two dining room walls are square with each other. To verify, Larry measures 12 in. along one wall and 16 in. along the other wall. He then finds that the diagonal connecting these two locations is 21 in. long. Are the two walls at a 90° angle? Why, or why not?
5. Larry measures all 4 sides of a window frame. He finds that both pairs of opposite sides are the same length. Must the frame be a rectangle? Explain. If your answer is no, what other measurements could Larry make to ensure that the frame is a rectangle?

**CHALLENGE QUESTION**

6. Larry needs to estimate the roofing materials he needs for the home. The roof forms an isosceles triangle and has a 4:12 pitch (slope). The length of the base of the triangle (the short side of the house) is 24 ft. The long side of the house is 60 ft. (See the diagram at left.) Use these facts to estimate how much plywood in square feet he will need to cover the roof.



Edited by Erik Tillema, etillema@iupui.edu, who teaches at Indiana University in Indianapolis. This department highlights math concepts in the context of problem solving in the real world. Readers are encouraged to submit ideas or work with someone they know to create a manuscript. Submit your ideas to mtms@nctm.org.



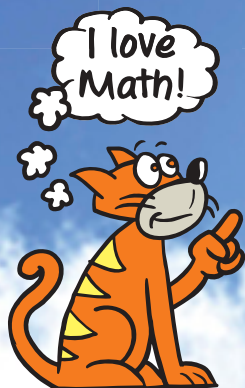
The solutions are appended to the online version of "Math for Real" at www.nctm.org/mtms.

1. One triangle can be 3 inches, 4 inches, and 5 inches, and another can be 6 inches, 8 inches, and 10 inches.
2. Larry can use one of the triangle combinations from problem 1 (i.e., 3 in., 4 in., 5 in. or 6 in., 8 in., 10 in.). He would put the two legs of the triangle in the corner, 3 inches and 4 inches or 6 inches and 8 inches, respectively. If the walls are square, the hypotenuse, or distance from the end of the rope back to the other end of the rope, should be 5 inches or 10 inches, respectively.
3. The 12-16-20 triangle would give the best results. As the sides of a triangle become longer, the measurement of the angles become more accurate.
4. No, these walls are not at a 90° angle. These three lengths, 12 inches, 16 inches, 21 inches, do not satisfy the Pythagorean theorem, namely,
5. Not necessarily. This shape could be a parallelogram. Larry could measure the diagonals. The diagonals must be the same length if the frame is a rectangle.
6. A 4:12 pitch indicates that for every 4 inches of rise, there is 12 inches of run. The short side of the house is 24 feet. The roof section of the house forms an isosceles triangle. Cutting the isosceles triangle from the peak of the roof forms a right triangle. The base of this triangle is 12 feet. By using the pitch and proportional reasoning, the height of this triangle must be 4 feet. By applying the Pythagorean theorem, the hypotenuse must be around 13 feet ($12^2 + 4^2 = 160$). The square root of 160 is approximately 13 feet (13 ft. $\times$ 60 ft. is about 780 square feet). Therefore, Larry will need about 800 square feet of plywood to cover one side of the roof, or about 1600 square feet for all of it.

$$12^2 + 16^2 \neq 21^2.$$

Three lengths must satisfy the Pythagorean theorem if they form a right triangle.

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