The Pythagorean Theorem

Applications and design

Name _____ **Date** _____ **Score** _____ / 10

QUICK REVIEW

In a right triangle, $a^2 + b^2 = c^2$, where c is the hypotenuse opposite the right angle. For a missing leg, subtract: $a = \sqrt{c^2 - b^2}$. For a missing hypotenuse, add the leg squares. Use the positive root for a length. The converse tests whether three lengths form a right triangle; compare the longest-side square with the sum of the other squares.

Worked example

A right triangle has legs 5 and 7 units. Find its hypotenuse. Give an exact radical or integer; also round nonintegers to the nearest tenth.

1. The perpendicular legs are 5 units and 7 units, so $c^2 = 5^2 + 7^2$.
2. Evaluate the squares: $c^2 = 25 + 49 = 74$ square units. This is a squared length, not the side itself.
3. Take the positive root: $c = \sqrt{74} \approx 8.6$ units. It exceeds both legs; round only at the end.
Answer: $\sqrt{74} \approx 8.6$ units

Practice Problems

Show your thinking.

1. A 7 by 11 rectangular screen needs a diagonal brace. Find the brace length. Give an exact radical or integer; also round nonintegers to the nearest tenth.

2. A ladder 10 m long has its foot 3 m from a wall. Find its vertical reach in meters. Give an exact radical or integer; also round nonintegers to the nearest tenth.

3. A rectangular park is 12 m by 16 m. Find a straight diagonal path length in meters. Give an exact radical or integer; also round nonintegers to the nearest tenth.

4. A guy wire is attached 8 m up a pole and anchored 6 m from its base. Find the wire length in meters. Give an exact radical or integer; also round nonintegers to the nearest tenth.

5. A ramp rises 1.2 m over a horizontal run of 3.5 m. Find its sloping length in meters. Give an exact radical or integer; also round nonintegers to the nearest tenth.

6. A 6 m ladder reaches 5 m up a wall. Find the horizontal base distance in meters. Give an exact radical or integer; also round nonintegers to the nearest tenth.

7. A rectangular panel is 9 by 12 cm. A 14 cm rod must span its full diagonal. Is the rod long enough?

8. A builder measures triangular frame sides as $10, 24, 26$ cm. Is the angle opposite 26 cm a right angle?

9. Design a right-triangle brace with hypotenuse 20 cm and one leg 12 cm. Find its other leg and area.

10. A 5 by 8 m patio gets a diagonal cable plus 0.5 m extra at each end. Find total cable to the nearest tenth of a meter.

Answer Key

1. $\sqrt{170} \approx 13.0$ units
2. $\sqrt{91} \approx 9.5$ m
3. 20 m
4. 10 m
5. $\sqrt{13.69} \approx 3.7$ m
6. $\sqrt{11} \approx 3.3$ m
7. No; the diagonal is 15 cm.
8. Yes; a right triangle.
9. 16 cm; 96 cm^2.
10. 10.4 m

Step-by-Step Solutions

Follow each calculation, then check your own work.

Problem 1

1. The perpendicular legs are 7 units and 11 units, so $c^2 = 7^2 + 11^2$.
2. Evaluate the squares: $c^2 = 49 + 121 = 170$ square units. This is a squared length, not the side itself.
3. Take the positive root: $c = \sqrt{170} \approx 13.0$ units. It exceeds both legs; round only at the end.

Problem 2

1. The hypotenuse is 10 m; the known leg is 3 m. Thus $x^2 + 3^2 = 10^2$.
2. Subtract the known square: $x^2 = 100 - 9 = 91$ m^2. Adding would instead find a hypotenuse.
3. Take the positive root: $x = \sqrt{91} \approx 9.5$ m. It is shorter than the hypotenuse 10 m; round only at the end.

Problem 3

1. The perpendicular legs are 12 m and 16 m, so $c^2 = 12^2 + 16^2$.
2. Evaluate the squares: $c^2 = 144 + 256 = 400$ m^2. This is a squared length, not the side itself.
3. Take the positive root: $c = \sqrt{400} \approx 20.0$ m. It exceeds both legs; round only at the end.

Problem 4

1. The perpendicular legs are 8 m and 6 m, so $c^2 = 8^2 + 6^2$.
2. Evaluate the squares: $c^2 = 64 + 36 = 100$ m^2. This is a squared length, not the side itself.
3. Take the positive root: $c = \sqrt{100} \approx 10.0$ m. It exceeds both legs; round only at the end.

Problem 5

1. The perpendicular legs are 1.2 m and 3.5 m, so $c^2 = 1.2^2 + 3.5^2$.
2. Evaluate the squares: $c^2 = 1.44 + 12.25 = 13.69$ m^2. This is a squared length, not the side itself.
3. Take the positive root: $c = \sqrt{13.69} \approx 3.7$ m. It exceeds both legs; round only at the end.

Problem 6

1. The hypotenuse is 6 m; the known leg is 5 m. Thus $x^2 + 5^2 = 6^2$.
2. Subtract the known square: $x^2 = 36 - 25 = 11$ m^2. Adding would instead find a hypotenuse.
3. Take the positive root: $x = \sqrt{11} \approx 3.3$ m. It is shorter than the hypotenuse 6 m; round only at the end.

Problem 7

1. The diagonal square is $9^2 + 12^2 = 81 + 144 = 225$.
2. The required length is $\sqrt{225} = 15$ cm, but only 14 cm is available.
3. The rod is short by $15 - 14 = 1$ cm. Comparing to a side length alone would not check the diagonal constraint.

Problem 8

1. The longest side is 26, so it is the only possible hypotenuse. Compute $10^2 + 24^2 = 100 + 576 = 676$.
2. The longest-side square is $26^2 = 676$. The two values are 676 and 676, which are equal.
3. Thus $10^2 + 24^2 = 26^2$; the converse confirms a right triangle.

Problem 9

1. The missing leg satisfies $b^2 = 20^2 - 12^2 = 400 - 144 = 256$, so $b = 16$ cm.
2. The perpendicular legs are 12 and 16, giving area $\frac{1}{2}(12)(16) = 96$ cm^2.
3. The check $144 + 256 = 400$ verifies the brace dimensions. The hypotenuse is not the height in the area calculation.

Problem 10

1. The diagonal is $d = \sqrt{5^2 + 8^2} = \sqrt{89} \approx 9.434$ m.
2. The two end allowances add $0.5 + 0.5 = 1$ m, so total length is $\sqrt{89} + 1 \approx 10.434$ m.
3. Round the final total to 10.4 m. The allowance is added to the length, not to the squared diagonal.

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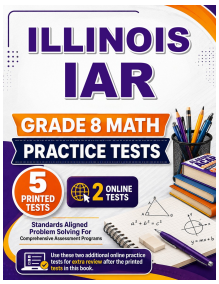

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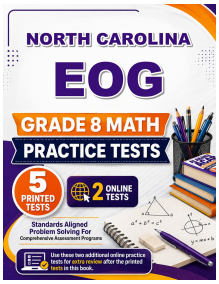

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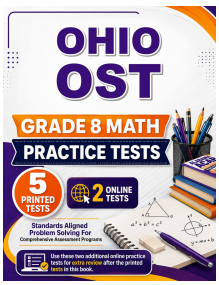

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