Section 2.1: The Pythagorean Theorem

The Pythagorean Theorem is a formula that gives a relationship between the sides of a right triangle   The Pythagorean Theorem only applies to RIGHT triangles. A RIGHT triangle is a triangle with a 90 degree angle. The 90 degree angle in a right triangle is often depicted with a square.
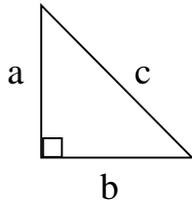

Pythagorean Theorem: $a^2 + b^2 = c^2$

NOTE: The side "c" is always the side opposite the right angle. Side "c" is called the hypotenuse.

The sides adjacent to the right angle are named "a" and "b".

There is no choice when selecting a side to be named "c", but the sides you choose to call "a" and "b" are interchangeable.

Example: Name each side of the triangle below. That is name one side a, one b and the hypotenuse c.
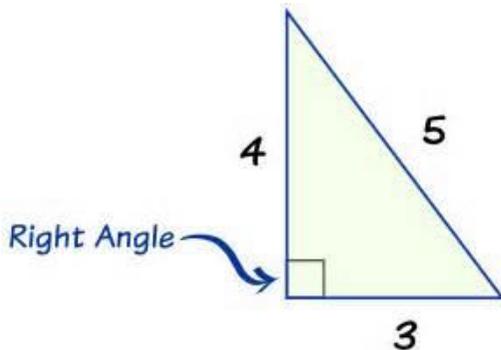
The c is the side opposite the right angle. There is no flexibility when it comes to choosing the side we name c.

The sides a, b are adjacent to the right angle and we have flexibility when naming them.

Each of these is a correct answer.

Answer 1: a = 3, b = 4 and c = 5

Answer 2: a = 4, b = 3, and c = 5

Example: Find the length of the missing side. Round to 2 decimals. Make sure to use the proper units in your answer.
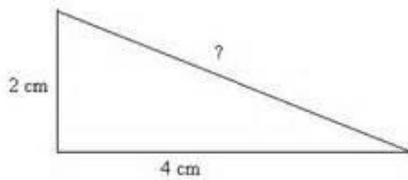
Step 1: Name each side. (It isn't necessary to use the units (cm) until I write my answer.)

The side with the question mark is opposite the right angle. It needs to be called c.
The 2 and the 4 are the sides that need to be labeled a and b. I have a bit of flexibility. It would be correct to call:
a = 2 and b = 4   or   a = 4 and b = 2

I will pick a = 2 and b = 4

Step 2: put the values into the $a^2 + b^2 = c^2$ formula and do the algebra to solve for the missing side.

$2^2 + 4^2 = c^2$
$4 + 16 = c^2$
$20 = c^2$
$\sqrt{20} = c$

Answer: c = 4.47 cm

Example: Find the length of the missing side. Make sure to use proper units in your answer.
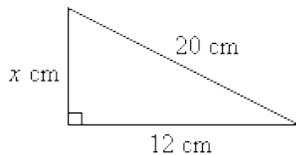
Step 1: Name each side. (It isn't necessary to use the units (cm) until I write my answer.)

The side opposite the right angle is called c. c = 20
The side with the x and the 12 are the "a" and "b" for this problem. I will call a = 12 and b = x

Step 2: Put the values into the $a^2 + b^2 = c^2$ formula and do the algebra to solve for the missing side.

$12^2 + x^2 = 20^2$
$144 + x^2 = 400$
$\underline{-144 \qquad -144}$
$x^2 = 256$
$x = \sqrt{256}$

Answer: x = 16 cm

Example: Find the length of the missing side (round your answer to 2 decimals). Be sure to include units in your answer.
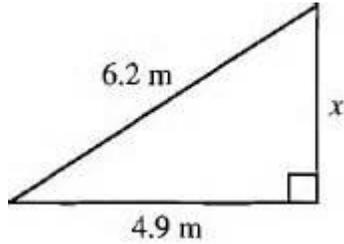
Step 1: Name each side.

The side opposite the right angle is called c. c = 6.2
The x and the 4.9 are the sides for "a" and "b" in this problem. I will call a = 4.9 and b = x

Step 2: put the values into the $a^2 + b^2 = c^2$ formula and do the algebra to solve for the missing side.

$$4.9^2 + x^2 = 6.2^2$$
$$24.01 + x^2 = 38.44$$
$$\underline{-24.01 \qquad\qquad -24.01}$$
$$x^2 = 14.43$$
$$x = \sqrt{14.43}$$
$$x = 3.798$$

Answer: x = 3.80 m

Example: Find x. Be sure to include units in your answer.
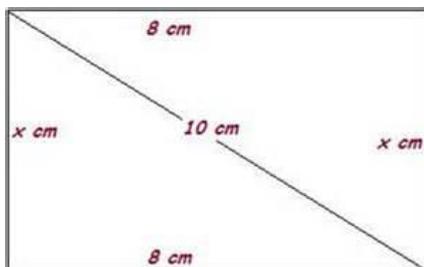
This is a Pythagorean Theorem problem in disguise. I can break this rectangle up into these two triangles.
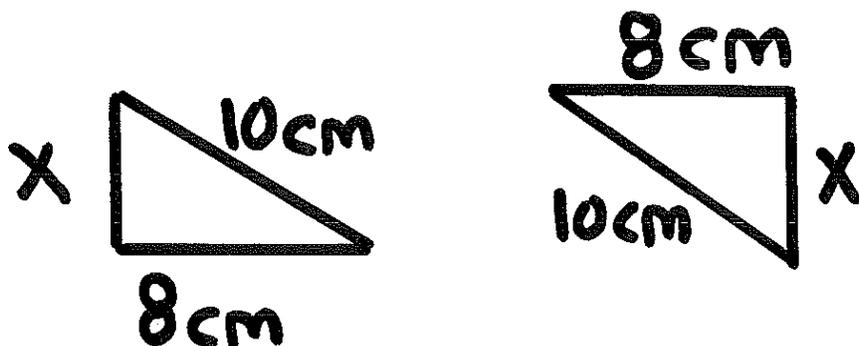
Now I just need to solve for x. Each of the triangles has the same three sides and will give the same answer regardless of the triangle I use when I solve for x.

Step 1: Name each side. I will use the left triangle.

The side opposite the right angle is called c. c = 10
The x and the 8 are the "a" and "b" for this problem. I will call a = 8 and b = x

Step 2: put the values into the $a^2 + b^2 = c^2$ formula and do the algebra to solve for the missing side.

$$8^2 + x^2 = 10^2$$
$$64 + x^2 = 100$$
$$\underline{-64 \qquad\qquad -64}$$
$$x^2 = 36$$
$$x = \sqrt{36}$$

Answer: x = 6 cm (I put my units back in at the end. I don't do my computations with the units in place as they don't affect my algebra.)

Example: Find the height of the triangle. That is, solve for h (round your answer to 2 decimal places.) Make sure to put units with your answer.
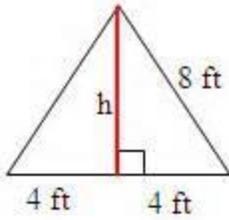
This is also a Pythagorean Theorem problem in disguise. I can break this triangle up into these two triangles.
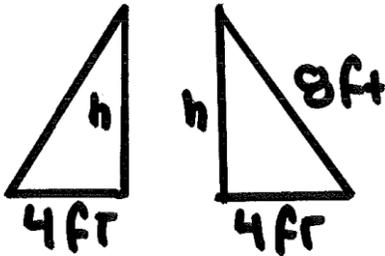
Now I just need to solve for h. I will use triangle on the right as it has all three sides labeled.

Step 1: Name each side.

The side opposite the right angle is called c.
c = 8
The h and the 4 are the "a" and "b" for this problem. I will call a = 4 and b = h

Step 2: Put the values into the $a^2 + b^2 = c^2$ formula and do the algebra to solve for the missing side.

$$4^2 + h^2 = 8^2$$
$$16 + h^2 = 64$$
$$\underline{-16 \qquad -16}$$
$$h^2 = 48$$
$$h = \sqrt{48}$$
$$h = 6.928$$

Answer: h = 6.93 ft (I put units in my answer as each number in the problem has units.)

Homework #1-20: Use the Pythagorean Theorem to find the missing length. Round to two decimal places when necessary. Make sure to use units in your answer when the lengths are given with units.

1)

A

5 cm

B   12 cm   C

2)

?

12 cm a   c

b

5 cm

3)

53cm

28cm

x

4)

60cm

x

48cm
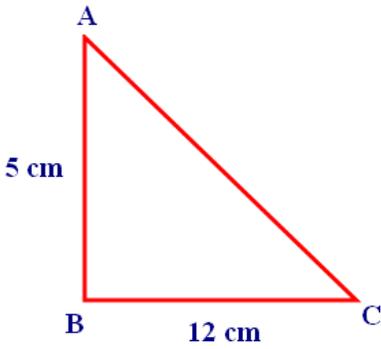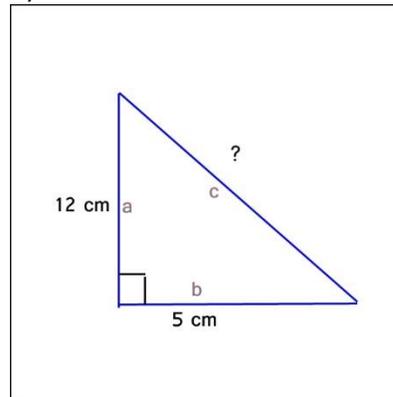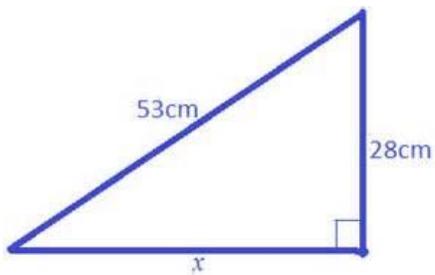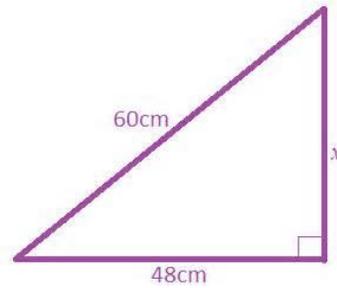
5) Round your answer to 2 decimals.

12 in.

8 in.

a in.

6)

8.5 cm

4.2 cm

a
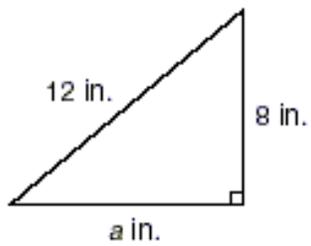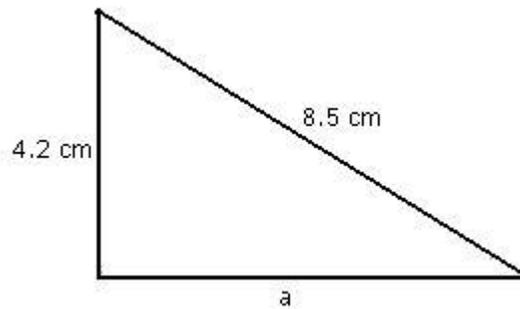
7) Find the length of the diagonal. Round your answer to 2 decimals.

D — 10m — C

10m ╲ 10m

A — 10m — B
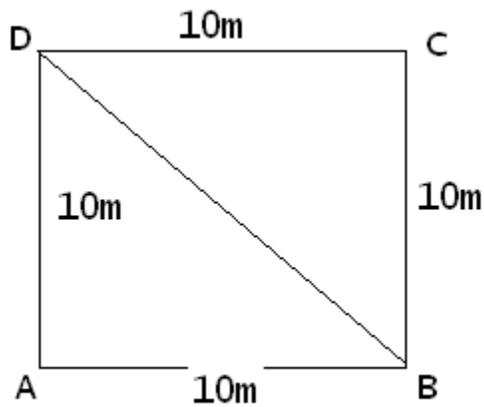
8) Find the length of the diagonal. Round to 2 decimals.

D C

8 cm
E

A .... B
15 cm

9) Find the length of the diagonal.

A ———————— D

x

18 m

B — 36 m — C
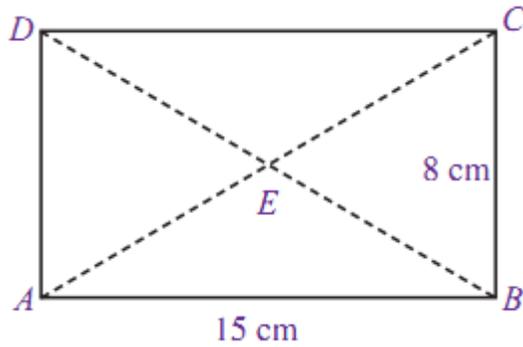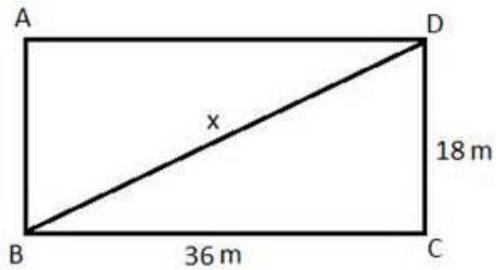
10) Find the length of the diagonal.

x

40 yards

30 yards
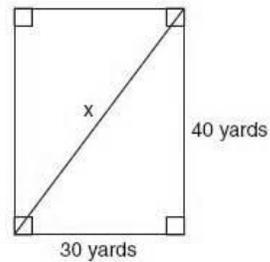
11) Solve for x. Assume the units are in meters. Round to 2 decimals.

12 | 12
x

⊢— 10 —⊣
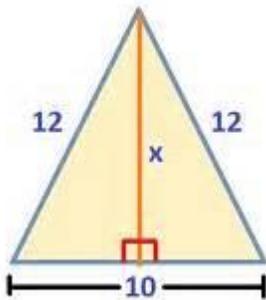
12) Find the height of the triangle. Assume the lengths are given in meters.

B

5

7 | 3

A

D   C
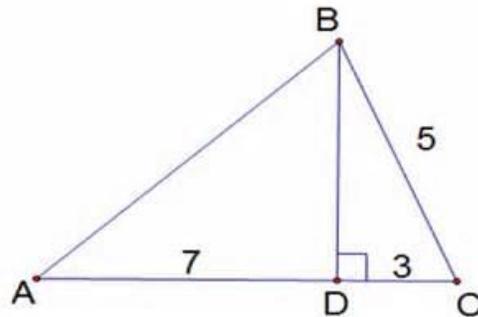
| 13) Find d and D. Round to 2 decimals. Hint the " ' " means the units are in feet.	14) Find the lengths of the dashed lines. Assume sides are measured in feet.
9' 9' D d 9'	A E F H 12 C 3 G D 4 B
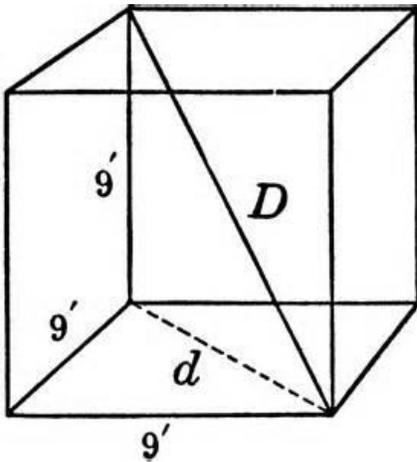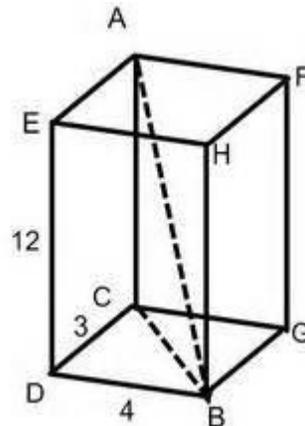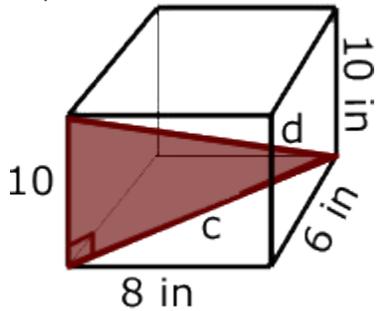
15) Solve for c and d.	16) Find d.
10 in 8 in 10 d c 6 in	12 in 10 in 8 in d
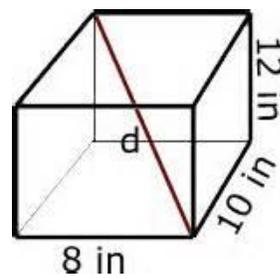
Answers:
1) 13 cm   3) x = 45 cm 5) a = 8.94 in 7) 14.14 m 9) 40.25 m 11) 10.91 m
13) d = 12.73' D = 15.59'   15) c = 10 in d = 14.14 in