Pythagorean Theorem

MCC8.G.6-8: Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

Essential ??

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- How can we use the Pythagorean Theorem to solve for a missing length of a right triangle.

Warm - Up

Solve for x

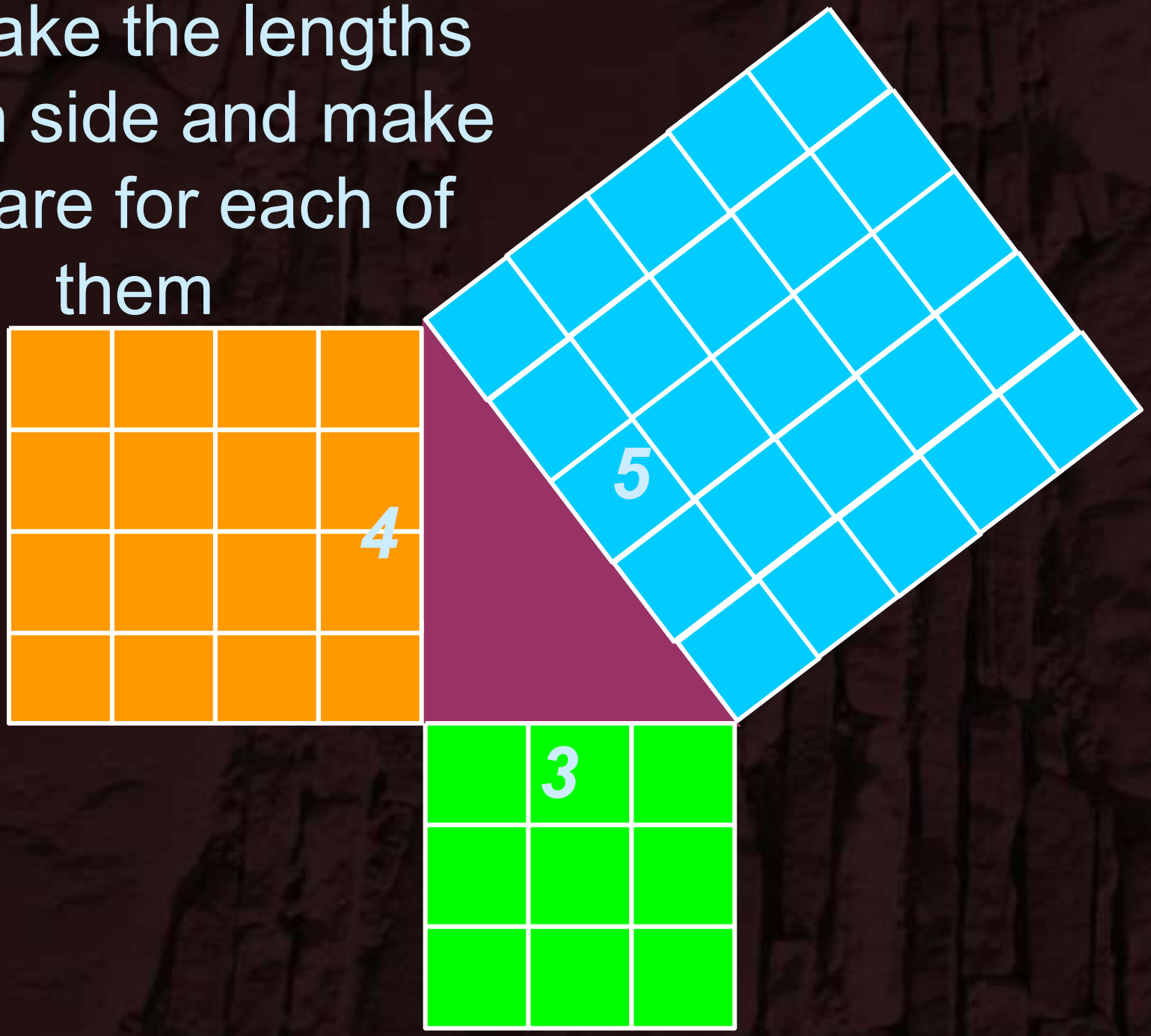
- $x^2+7=43$
- $64+x^2=164$

Evaluate for a = 12, b = 5, c = 13

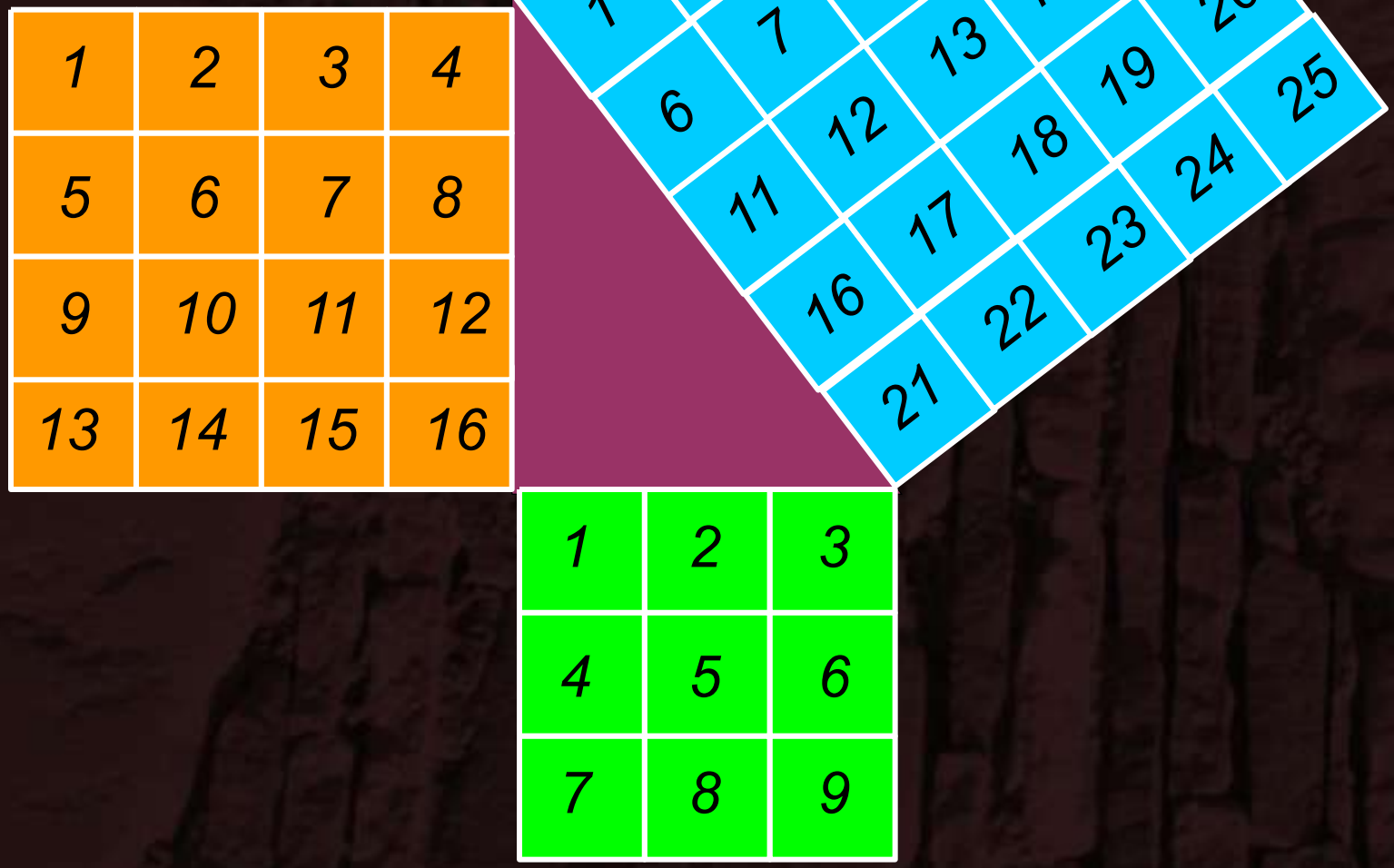
3. $a^2 + b^2$
4. $c^2 – b^2$

Here we have a triangle with the lengths of each of the three sides

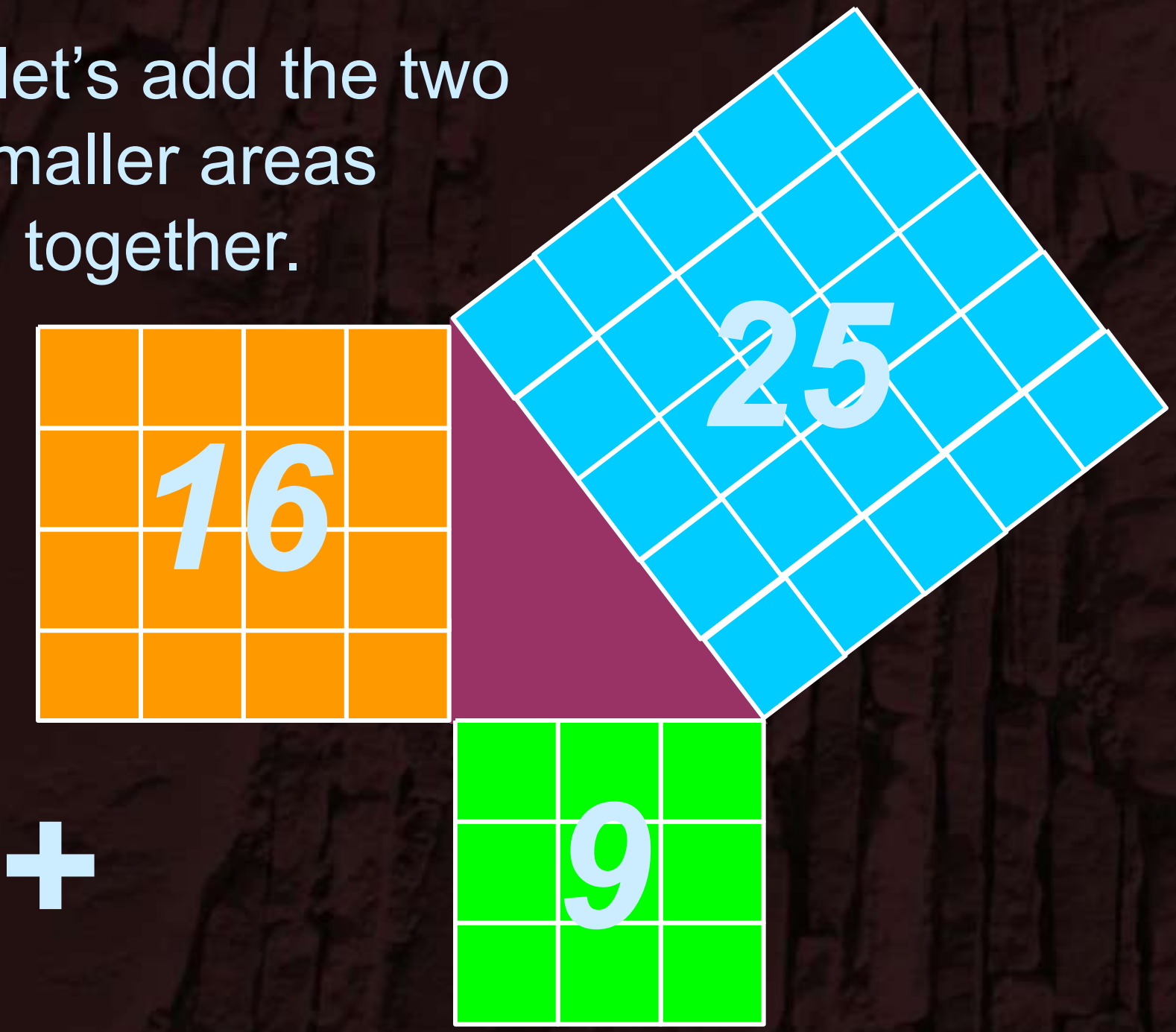
Let's take the lengths of each side and make a square for each of them



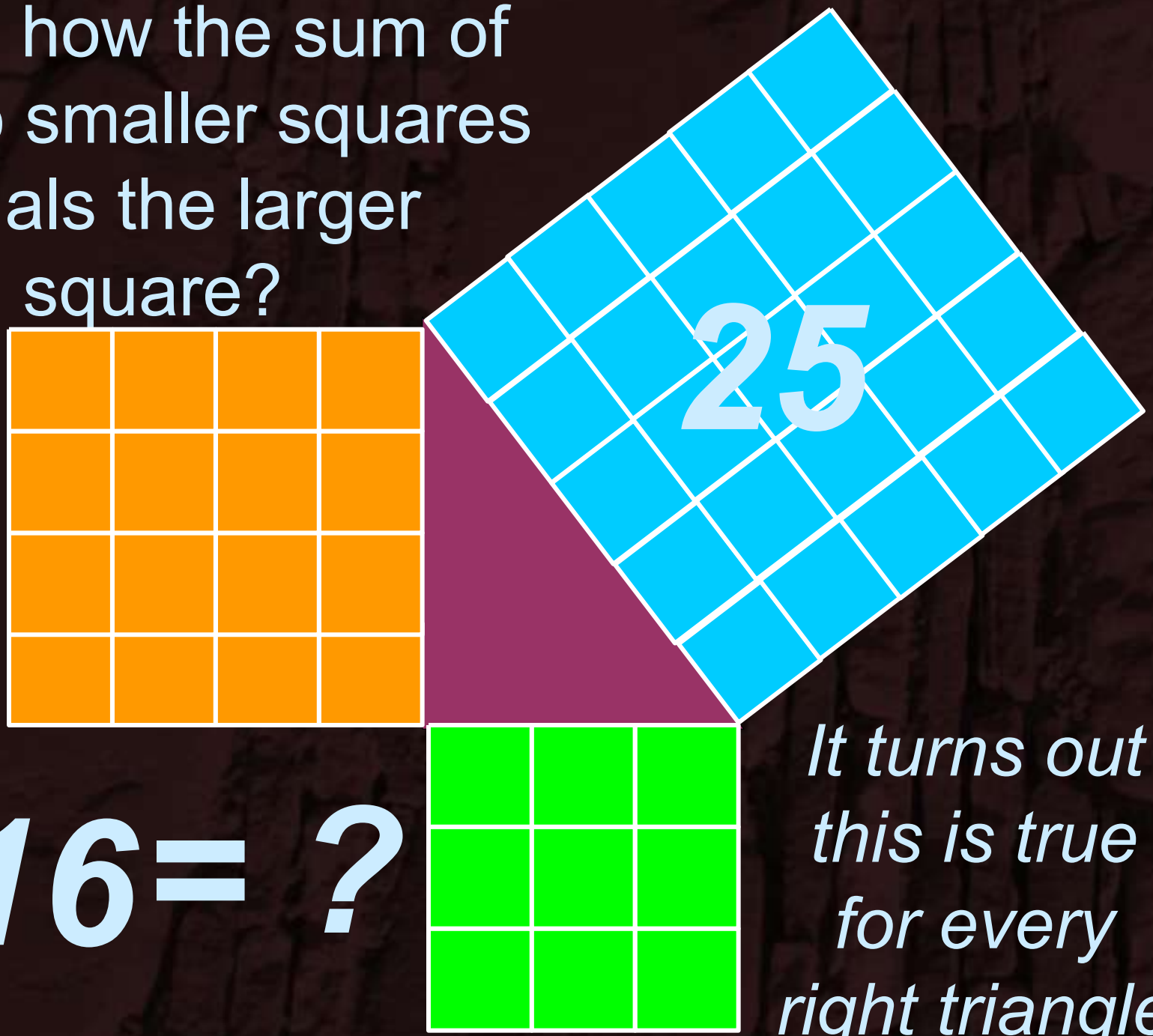
Let's find the area of each square?



Now, let's add the two smaller areas together.



Notice how the sum of the two smaller squares equals the larger square?



9+16= ?

It turns out this is true for every right triangle

The Pythagorean Theorem states: "The sum of the squares of the legs of a right triangle are equal to the square of the hypotenuse."

9+16= 25

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Pythagorean Theorem

- What is the Pythagorean Theorem in symbol form?

$$a^2 + b^2 = c^2$$

Which of these variables represent the hypotenuse? c

*Once you have figured out which is **c**, does it matter which leg is **a** and which is **b**?* *no*

TAKE NOTES

Steps to Solve for a missing side of a right triangle using the Pythagorean Theorem

The following are the basic steps for solving a Pythagorean Theorem Problem.

Step 1: Write the formula

Step 2: Substitute known values for the variables.

Step 3: Solve for the missing variable.

Lets break this down a little further…

Finding the missing side of a right triangle

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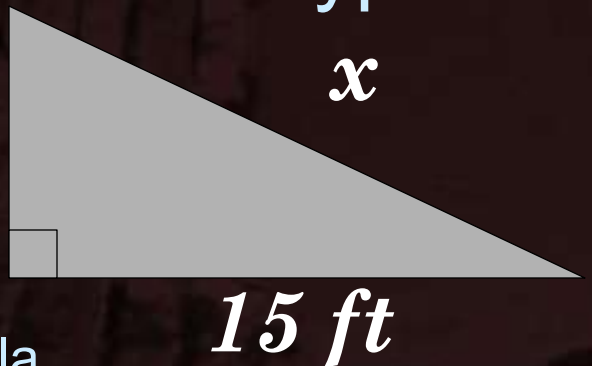
- Any time you are asked to find the missing side of a right triangle, the problem will generally boil down to 1 of 2 scenarios.
- Scenario 1: You have both legs and you have to find the hypotenuse
- Scenario 2: You have one leg and the hypotenuse, and you have to find the other leg.

Scenario 1: Need the hypotenuse

TAKE NOTES

Find x



- **Step 1:** Write the formula.

$$a^2 + b^2 = c^2$$

- ***Step 2:*** *Substitute or "Plug-in" the lengths of the legs into the Pythagorean Theorem for the "a" and "b" variables.*

$$8^2 + 15^2 = c^2$$

Step 3: *Simplify the side without the "c" by squaring the two numbers and adding them together.*

$$64 + 225 = c^2$$

We are not done yet…

$$289 = c^2$$

We have found c^2, but not just plain c.

Step 4: *Solve for c by using the square root.*

$$\sqrt{289} = \sqrt{c^2}$$

$$17 = c$$

We were told to solve for x, not c, so we should replace the c with an x.

$$x = 17$$

Scenario 1

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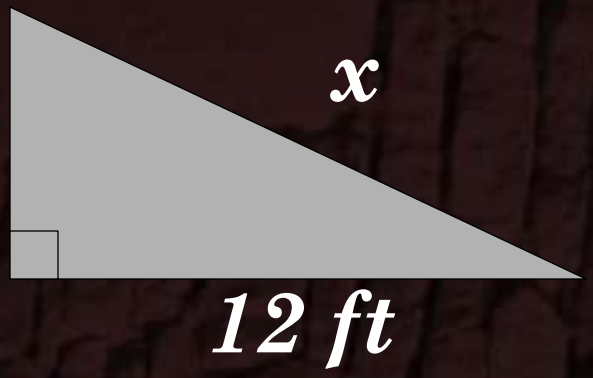
What does all of this boil down to?

- Square both legs.
- Add them together.
- Take the square root of the result.
- You have your hypotenuse.

You try this one in your notes.

TAKE NOTES

Find x



$$5^2 + 12^2 = x^2$$

$$25 + 144 = x^2$$

$$\sqrt{169} = \sqrt{x^2}$$

- Answer: $x = 13$

Scenario 2: Have Hypotenuse, need one leg

TAKE NOTES

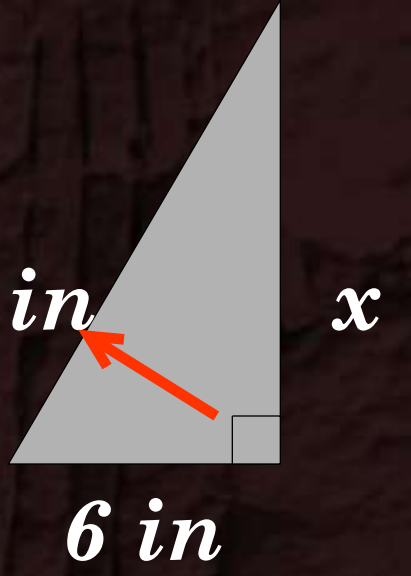
Find x.
Round to the nearest hundredth.

- Can we do this the same way we did the other example?
- Not exactly the same way, but similar.
- Let's start this one the same way we did the other ones and see what happens…

Scenario 2: Have Hypotenuse, need one leg

Find x.

Round to the nearest hundredth.



- ***Step 1:*** *Write the formula.* $a^2 + b^2 = c^2$
- ***Step 2:*** *Substitute or "Plug-in" the lengths of the legs … But we don't have both legs…*
- *Here is where we have to do something a little different. We have to plug in the hypotenuse and one of the legs.*

Which number goes where?

You need to identify the hypotenuse. It's the one opposite of the right angle.

The hypotenuse is always going to be c. So, the c = 14.

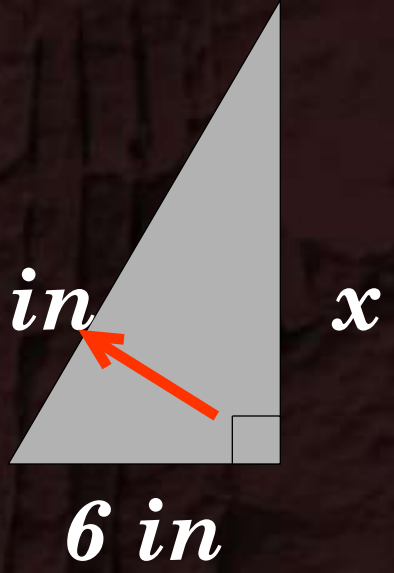
We need one more variable replaced in order to solve for the missing variable. So, we need to replace either a or b with the one leg length we have, which is 6.

Does it matter whether we use a = 6 or b = 6? No.

Let's set b = 6 and make a the missing length

Scenario 2: Have Hypotenuse, need one leg

Find x.
Round to the nearest hundredth.



- **Step 1:** *Write the formula.* $a^2 + b^2 = c^2$
- **Step 2:** *Identify the hypotenuse*
- **Step 3:** *Substitute or "Plug-in" the hypotenuse (14) for c and the other known measurement (6) for b.* $a^2 + 6^2 = 14^2$
- **Step 4:** *Simplify by squaring both the numbers.* $a^2 + 36 = 196$

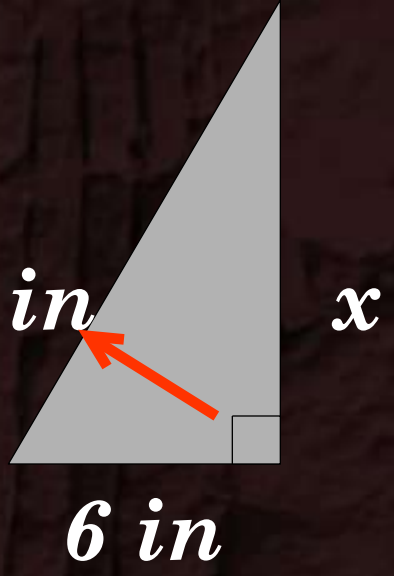
At this point, in the previous example, we added the two squares together. This time, the squares are on opposite sides of the equals sign. So, to combine them, we have to do the opposite operation.

- **Step 5:** *Subtract the smaller from the larger.*

$$\begin{array}{r} a^2 + 36 = 196 \\ -36 \quad -36 \\ \hline a^2 = 160 \end{array}$$

Scenario 2: Have Hypotenuse, need one leg

Find x.
Round to the nearest hundredth.



$$a^2 + b^2 = c^2$$

- **Step 1:** *Write the formula.*
- **Step 2:** *Identify the hypotenuse*
- **Step 3:** *Substitute or "Plug-in" the hypotenuse (14) for c and the other known measurement (6) for b.*

$$a^2 + 6^2 = 14^2$$

- **Step 4:** *Simplify by squaring both the numbers.*

$$a^2 + 36 = 196$$

- **Step 5:** *Subtract the smaller from the larger.*

$$a^2 + 36 = 196$$
$$-36 \quad -36$$
$$a^2 = 160$$

Step 6: *Solve for a by using the square root.*

$$\sqrt{a^2} = \sqrt{160}$$
$$a = 12.64911$$

$$a = 12.65$$

Scenario 2

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What does all of this boil down to?

- Square the hypotenuse and leg.
- Subtract the leg squared from the hypotenuse squared.
- Take the square root of the result.
- You have your missing leg.

What is the difference between the 2 scenarios?

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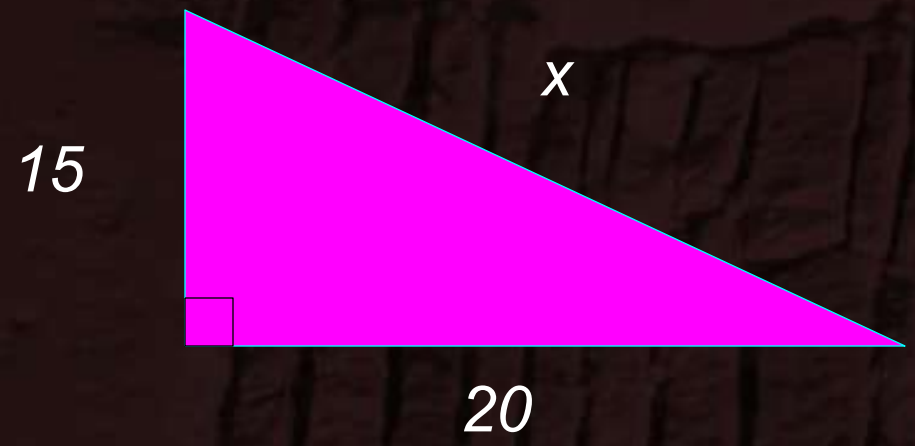
- Both have you squaring the given sides.
- Both have you using the square root at the end.
- The only difference is in the middle.
- Scenario 1 has you adding the numbers
- Scenario 2 has you subtracting the smaller from the larger.

What does this mean?

- When you have two sides of a right triangle, you can find the third using the Pythagorean Theorem.
- You can do this by squaring both of the measurements you have.
- Add or subtract the two numbers depending on whether or not you have the hypotenuse. (Subtract if you have it, add if you don't)
- Find the square root of the result and you have your missing side!

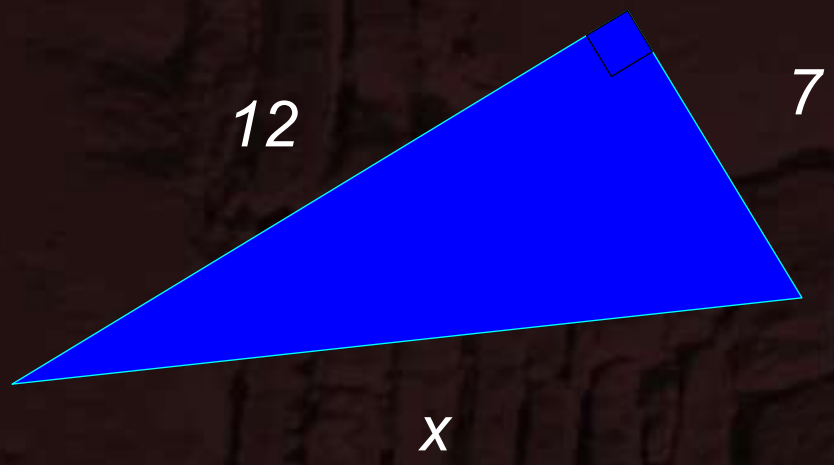
Try this one in your notes…



Solve for x.
Round your answer to the nearest hundredth if necessary.

Answer: 25

Try this one in your notes…



Solve for x.
Round your answer to the nearest hundredth if necessary.

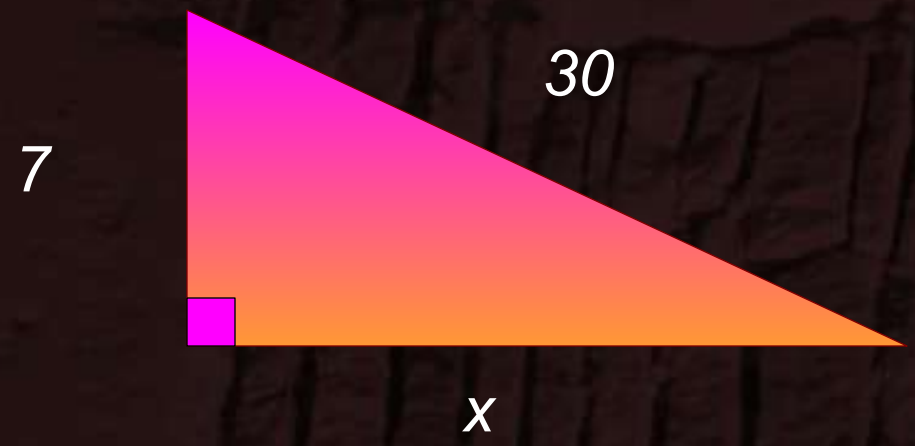
Answer: 13.89

Try this one in your notes…

Solve for x.
Round your answer to the nearest hundredth if necessary.

Answer: ***4***

Try this one in your notes…



Solve for x.
Round your answer to the nearest hundredth if necessary.

Answer: 29.17