Find the length of $AB$. 

A

B
From the opening exercise we saw two ways of find the length of a line on the grid page.

**One way to find the length of a line.**

1. Find the length of the segment AB.

2. Make a square with side AB:

3. Find the area of the square:

\[
\text{Area} = \ _____
\]

4. Then find the length of the side by taking the square root.

\[
\text{AB} = \ _____
\]

**Another way (a shortcut to finding the area)**

5. Make a square with side AB.

6. Find the areas of P and Q.

\[
\text{Area P: } \ _____, \ \text{Area Q: } \ _____
\]

7. Then find the length of the side by taking the square root.

\[
\text{AB} = \ _____
\]

So the length of AB is the same as

\[
\text{AB} = \sqrt{\text{Area P} + \text{Area Q}}
\]

How do the areas relate to the area of R?

So the area of square R is the sum of the areas of P and Q.
The Pythagorean Theorem

In the previous exercises you saw how we use area to find the length of a line segment. The shortcut in step 6 is the key to what is called the Pythagorean Theorem, one of the oldest and most useful relationships in numbers. In order to describe it completely we need some definitions.

In a right triangle (a triangle with a 90° angle) the two sides that form the 90° angle are called the Legs.
The side opposite the 90° angle is called the Hypotenuse.

From the previous exercises we saw that the three sides of the right triangle are related by \( L_1^2 + L_2^2 = H^2 \)

The Pythagorean Theorem says that:
The area of the square made from the hypotenuse is equal to the sum of the areas of squares made from the two legs.

Equivalently, we take the three areas:
The area of the square made from the hypotenuse: __________
The area of the square made from one leg \( (a) \): __________
The area of the square made from the other leg \( (b) \): __________
and according to Pythagoras,

\[
\text{_________} + \text{_________} = \text{_________}
\]

Which means that the length of hypotenuse is \( c = \sqrt{\text{_________} + \text{_________}} \)

**Example:** Find the length of the hypotenuse of the triangle below.

\[
\begin{align*}
H^2 &= 5^2 + 12^2 \\
H^2 &= 25 + 144 \\
H^2 &= 169 \\
H &= \sqrt{169} \\
H &= 13
\end{align*}
\]

So the hypotenuse is 13.
Exercises

1. Find the length of the hypotenuse.
   \[ c = \phantom{0} \]

![Triangle 1](image1.png)

2. Find the length of the hypotenuse.
   \[ H = \phantom{0} \]

![Triangle 2](image2.png)

3. Find the length of the hypotenuse.
   \[ x = \phantom{0} \]

![Triangle 3](image3.png)

4. Find the length of the hypotenuse.
   \[ c = \phantom{0} \]

![Triangle 4](image4.png)

5. Find the perimeter of a right triangle if the legs are 8cm and 15cm long.

6. Find the perimeter of this triangle.

![Triangle 5](image5.png)