# Inverse operations

In order to prepare to solve equations, we need to understand **inverse operations**, which are opposite operations that undo each other. For example, addition undoes subtraction and vice versa, and division undoes multiplication and vice versa.

## Defining inverse operations

For instance, because addition and subtraction are inverse operations,

- Addition is the inverse of subtraction
- Subtraction is the inverse of addition

adding and subtracting the same value from something won't change the value we started with. So let's say we start with $10$. If we both add and subtract $3$,

$$10 + 3 - 3$$

the addition and subtraction undo each other, and we're left with $10$, the same value we started with.

Similarly, because multiplication and division are inverse operations,

- Multiplication is the inverse of division
- Division in the inverse of multiplication

multiplying and dividing by the same value won't change the value we started with. If we start with $-4$ and both multiply and divide by $2$,

$$\frac{-4(2)}{2}$$

the multiplication and division undo each other, and we're left with $-4$, the same value we started with.

Finally, because exponents and roots are inverse operations,

- Exponents are the inverse of roots
- Roots are the inverse of exponents

raising something to a power and taking the root won't change the value we started with. If we start with $3$ and both raise it to the power of $2$ and take the square root,

$$\sqrt{3^2}$$

the exponent and root undo each other, and we're left with $3$, the same value we started with.

- An exponent of $2$ and a square root are inverses, $\sqrt{x^2}$
- An exponent of $3$ and a third root are inverses, $\sqrt[3]{x^3}$
- An exponent of $4$ and a fourth root are inverses, $\sqrt[4]{x^4}$
- ...

Let's do an example.

**Example**

What should replace the question mark to make the equation true?

$$2 + 7 \quad ? \quad = 2$$

Reading this equation from left to right, we can see that we're starting with $2$ on the left, and ending with $2$ on the right. Since the final value isn't different from the original value, we need to use an inverse operation that will undo the addition of $7$ that we see in the middle of the equation.

$$2 + 7 - 7 = 2$$

In other words, because we added $7$, we needed to subtract $7$. Those inverse operations undo each other, leaving us with a result that's unchanged from the value we started with.

The question mark should be replaced with $-7$.

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Let's try another example with inverse operations.

**Example**

What should replace the question mark to make the equation true?

$$4 \cdot 3 \quad ? \quad = 4$$

Because we're multiplying by $3$, we have to undo that operation by dividing by $3$. Multiplication and division are inverse operations, so dividing by $3$ will undo the multiplication by $3$.

$$4 \cdot 3 \div 3 = 4$$

The question mark should be replaced with $\div 3$.

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