# Properties and Equations

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## Properties of Addition and Multiplication

Let $a$, $b$, and $c$ be real numbers.

| Property | Addition | Multiplication |
|---|---|---|
| **Closure** | $a + b$ is a real number. | $ab$ is a real number. |
| **Commutative** | $a + b = b + a$ | $ab = ba$ |
| **Associative** | $(a + b) + c = a + (b + c)$ | $(ab)c = a(bc)$ |
| **Identity** | $a + 0 = a, 0 + a = a$ | $a \cdot 1 = a, 1 \cdot a = a$ |
| **Inverse** | $a + (-a) = 0$ | $a \cdot \frac{1}{a} = 1, a \neq 0$ |

The following property involves both addition and multiplication.

**Distributive** $a(b + c) = ab + ac$ $(b + c)a = ba + ca$

**General steps for solving (simple) equations:**

1. Use the distributive property to remove parentheses.

   or

   Multiply each term by the least common denominator to remove fractions.
2. Combine like terms on each side of the equation.
3. "Move" all variable terms to one side of the equation.
4. "Move" all constant terms to the other side of the equation.
5. Divide both sides by the coefficient.
6. Check to see that the solution works in the original equation.

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## Equation Examples

1. $7p + 13 = 9p - 5$

$-7p \quad -7p$

$13 = 2p - 5$

$+5 \quad +5$

$\frac{18}{2} = \frac{2p}{2}$

$9 = p$

2. $\frac{2}{3}x - 7 = 5$

$+7 \quad +7$

$\frac{3}{2} \cdot \frac{2}{3}x = \frac{12}{1} \cdot \frac{3}{2}$

$x = \frac{18}{1} = 18$

3. $30\left[\frac{2}{5}k + \frac{1}{6} = \frac{3}{10}k + \frac{1}{3}\right]$

$\frac{6}{30} \cdot \frac{2}{5}k \rightarrow 12k$

$5\ 30 \cdot \frac{1}{6}$

$\frac{3}{30} \cdot \frac{3}{10}k \rightarrow 9k$

$30 \cdot \frac{1}{3}$

$10$

$12k + 5 = 9k + 10$

$-9k \quad -9k$

$3k + 5 = 10$

$-5 \quad -5$

$\frac{3k}{3} = \frac{5}{3}$

$k = \frac{5}{3}$

# Unit (Dimensional) Analysis

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Write each statement as a rate:

There are 5280 feet in a mile. $\frac{5280 \text{ feet}}{1 \text{ mile}}$

There are 60 seconds in a minute. $\frac{60 \text{ sec}}{1 \text{ min}}$

There are 60 minutes in an hour. $\frac{60 \text{ min}}{1 \text{ hour}}$

Use the rates to answer this question: If you a driving a car and you are travelling 50 feet per second, what is your rate in miles per hour?

$$\frac{50 \text{ ft}}{\text{sec}} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ hour}} = = \frac{\text{mi}}{\text{hour}}$$

$$34.1 \frac{\text{mi}}{\text{hour}} \qquad \frac{180{,}000}{5280}$$