

# Literal Equations and Formulas

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## Quick Review

A **literal equation** is an equation with more than one variable — think formulas like  $d = rt$ ,  $A = \frac{1}{2}bh$ , or  $C = 2\pi r$ . “Solve for” a specific variable means rearrange the formula so that variable is alone on one side. Here’s the secret: treat every variable you’re *not* solving for like it’s a known number, and use the same inverse-operation moves as any other equation. The big advantage of solving for a variable up front: once you’ve done the algebra once, you can substitute different values without redoing the work. Solving  $d = rt$  for  $t$  gives  $t = \frac{d}{r}$ ; solving  $P = 2l + 2w$  for  $w$  gives  $w = \frac{P-2l}{2}$ .

## PRACTICE

Solve each formula for the indicated variable.

- Solve the distance formula  $d = rt$  for the rate  $r$ . \_\_\_\_\_
- $A = lw$ ; for  $w$  \_\_\_\_\_
- $P = 2l + 2w$ ; for  $l$  \_\_\_\_\_
- $V = lwh$ ; for  $h$  \_\_\_\_\_
- Solve the circumference formula  $C = 2\pi r$  for the radius  $r$ . \_\_\_\_\_
- $I = Prt$ ; for  $t$  \_\_\_\_\_
- $y = mx + b$ ; for  $x$  \_\_\_\_\_
- $ax + by = c$ ; for  $y$  \_\_\_\_\_
- $S = 2\pi r^2 + 2\pi rh$ ; for  $h$  \_\_\_\_\_
- Solve the simple-interest amount formula  $A = P(1 + rt)$  for the rate  $r$ . \_\_\_\_\_
- $V = \frac{1}{3}\pi r^2 h$ ; for  $h$  \_\_\_\_\_
- $E = mc^2$ ; for  $m$  \_\_\_\_\_
- $F = \frac{9}{5}C + 32$ ; for  $C$  \_\_\_\_\_
- $K = \frac{1}{2}mv^2$ ; for  $v^2$  \_\_\_\_\_
- $y - y_1 = m(x - x_1)$ ; for  $m$  \_\_\_\_\_
- $P = 2(l + w)$ ; for  $w$  \_\_\_\_\_
- $a = \frac{v - v_0}{t}$ ; for  $v$  \_\_\_\_\_
- $A = \frac{h}{2}(b_1 + b_2)$ ; for  $b_1$  \_\_\_\_\_
- $P = R - C$ ; for  $C$  \_\_\_\_\_
- Solve the formula  $S = \frac{a}{1 - r}$  for the rate  $r$ . \_\_\_\_\_

## Word Problems

- The perimeter of a rectangle is  $P = 2l + 2w$ . A garden has a perimeter of 56 ft and a length of 18 ft. First solve for  $w$ , then find the width.  
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- A car travels at a constant speed:  $d = rt$ . The car covers 210 miles in 3.5 hours. Solve the formula for  $r$  and find the speed.  
\_\_\_\_\_
- The area of a triangle is  $A = \frac{1}{2}bh$ . A triangle has area 30 in<sup>2</sup> and base 12 in. Solve for  $h$  and find the height.  
\_\_\_\_\_
- The formula  $C = \frac{5}{9}(F - 32)$  converts Fahrenheit to Celsius. Solve it for  $F$ , then use your formula to find  $F$  when  $C = 25^\circ\text{C}$ .  
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## Answer Keys

1.  $r = \frac{d}{t}$

2.  $w = \frac{A}{l}$

3.  $l = \frac{P - 2w}{2}$

4.  $h = \frac{V}{lw}$

5.  $r = \frac{C}{2\pi}$

6.  $t = \frac{I}{Pr}$

7.  $x = \frac{y - b}{m}$

8.  $y = \frac{c - ax}{b}$

9.  $h = \frac{S - 2\pi r^2}{2\pi r}$

10.  $r = \frac{A - P}{Pt}$

11.  $h = \frac{3V}{\pi r^2}$

12.  $m = \frac{E}{c^2}$

13.  $C = \frac{5(F - 32)}{9}$

14.  $v^2 = \frac{2K}{m}$

15.  $m = \frac{y - y_1}{x - x_1}$

16.  $w = \frac{P - 2l}{2}$

17.  $v = at + v_0$

18.  $b_1 = \frac{2A}{h} - b_2$

19.  $C = R - P$

20.  $r = 1 - \frac{a}{S}$

21.  $w = 10 \text{ ft}$

22.  $r = 60 \text{ mph}$

23.  $h = 5 \text{ in}$

24.  $F = 77^\circ \text{ F}$

## Step-by-Step Tutor Notes

- Work one inverse operation at a time and keep both sides balanced.  $r$  is multiplied by  $t$ . Divide both sides by  $t$ :  $r = \frac{d}{t}$ . After simplifying, the answer is  $r = \frac{d}{t}$ .
- Work one inverse operation at a time and keep both sides balanced. Divide both sides by  $l$ :  $w = \frac{A}{l}$ . After simplifying, the answer is  $w = \frac{A}{l}$ .
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Subtract  $2w$  from both sides:  $P - 2w = 2l$ . Divide by 2:  $l = \frac{P - 2w}{2}$ . After simplifying, the answer is  $l = \frac{P - 2w}{2}$ .
- Keep the order of operations in view, then simplify without skipping the sign check.  $h$  is multiplied by  $lw$ . Divide both sides by  $lw$ :  $h = \frac{V}{lw}$ . After simplifying, the answer is  $h = \frac{V}{lw}$ .
- Work one inverse operation at a time and keep both sides balanced.  $r$  is multiplied by  $2\pi$ . Divide both sides by  $2\pi$ :  $r = \frac{C}{2\pi}$ . After simplifying, the answer is  $r = \frac{C}{2\pi}$ .
- Work one inverse operation at a time and keep both sides balanced.  $t$  is multiplied by  $Pr$ . Divide both sides by  $Pr$ :  $t = \frac{I}{Pr}$ . After simplifying, the answer is  $t = \frac{I}{Pr}$ .
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Subtract  $b$ :  $y - b = mx$ . Divide by  $m$ :  $x = \frac{y - b}{m}$ . After simplifying, the answer is  $x = \frac{y - b}{m}$ .
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Subtract  $ax$ :  $by = c - ax$ . Divide by  $b$ :  $y = \frac{c - ax}{b}$ . After simplifying, the answer is  $y = \frac{c - ax}{b}$ .
- Subtract  $2\pi r^2$  from both sides:  $S - 2\pi r^2 = 2\pi r h$ . Divide by  $2\pi r$ :  $h = \frac{S - 2\pi r^2}{2\pi r}$ .
- Distribute or divide first — divide both sides by  $P$ :  $\frac{A}{P} = 1 + rt$ . Subtract 1:  $\frac{A}{P} - 1 = rt$ . Divide by  $t$ :  $r = \frac{A - P}{Pt}$  (after combining  $\frac{A}{P} - 1 = \frac{A - P}{P}$ ).
- Multiply both sides by 3 to clear the fraction:  $3V = \pi r^2 h$ . Divide by  $\pi r^2$ :  $h = \frac{3V}{\pi r^2}$ .
- Keep the order of operations in view, then simplify without skipping the sign check. Divide both sides by  $c^2$ :  $m = \frac{E}{c^2}$ . Famous formula, simple algebra. After simplifying, the answer is  $m = \frac{E}{c^2}$ .
- Subtract 32:  $F - 32 = \frac{9}{5}C$ . Multiply by  $\frac{5}{9}$ :  $C = \frac{5(F - 32)}{9}$ . (This converts Fahrenheit to Celsius).
- Multiply both sides by 2:  $2K = mv^2$ . Divide by  $m$ :  $v^2 = \frac{2K}{m}$ . (Solving for  $v^2$  stops short of taking the square root — only  $v^2$  is requested).
- Divide both sides by  $(x - x_1)$ :  $m = \frac{y - y_1}{x - x_1}$ . That's the slope formula — the rate of change between two points.
- Two ways: distribute first or divide first. Divide by 2:  $\frac{P}{2} = l + w$ . Subtract  $l$ :  $w = \frac{P}{2} - l$ , which equals  $\frac{P - 2l}{2}$ . Same answer either way.
- Multiply both sides by  $t$ :  $at = v - v_0$ . Add  $v_0$ :  $v = at + v_0$ . (Physics: this is the velocity-time formula.)
- Multiply both sides by  $\frac{2}{h}$ :  $\frac{2A}{h} = b_1 + b_2$ . Subtract  $b_2$ :  $b_1 = \frac{2A}{h} - b_2$ . (Trapezoid area, solved for one of the parallel bases.)
- Subtract  $R$  from both sides:  $P - R = -C$ . Multiply by  $-1$  (or just flip the sides):  $C = R - P$ . (Profit equals revenue minus cost — rearranged to solve for cost.)
- Multiply both sides by  $(1 - r)$ :  $S(1 - r) = a$ . Divide by  $S$ :  $1 - r = \frac{a}{S}$ . Subtract 1:  $-r = \frac{a}{S} - 1$ . Multiply by  $-1$ :  $r = 1 - \frac{a}{S}$ .
- Solve for  $w$ : subtract  $2l$ , then divide by 2 to get  $w = \frac{P - 2l}{2}$ . Substitute the garden's values:  $w = \frac{56 - 2(18)}{2} = \frac{56 - 36}{2} = \frac{20}{2} = 10$  feet.
- Divide both sides of  $d = rt$  by  $t$ :  $r = \frac{d}{t}$ . Use the trip's distance and time:  $r = \frac{210}{3.5} = 60$  miles per hour.
- Solve for  $h$ : multiply by 2 then divide by  $b$  to get  $h = \frac{2A}{b}$ . Substitute the area and base:  $h = \frac{2(30)}{12} = \frac{60}{12} = 5$  inches.
- Multiply both sides by  $\frac{9}{5}$ :  $\frac{9}{5}C = F - 32$ . Add 32:  $F = \frac{9}{5}C + 32$ .  $C = 25$ :  $F = \frac{9}{5}(25) + 32 = 45 + 32 = 77^\circ \text{ F}$ .



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