# 2.2 Solve One-Step Equations


**Before** You solved equations using mental math.

**Now** You will solve one-step equations using algebra.

**Why?** So you can determine a weight limit, as in Ex. 56.

## Key Vocabulary

- **inverse operations**
- **equivalent equations**
- **reciprocal**

**Inverse operations** are two operations that undo each other, such as addition and subtraction. When you perform the same inverse operation on each side of an equation, you produce an *equivalent equation*. **Equivalent equations** are equations that have the same solution(s).

**KEY CONCEPT** *For Your Notebook*

### Addition Property of Equality

**Words** Adding the same number to each side of an equation produces an equivalent equation.

**Algebra** If $x - a = b$, then $x - a + a = b + a$, or $x = b + a$.

### Subtraction Property of Equality

**Words** Subtracting the same number from each side of an equation produces an equivalent equation.

**Algebra** If $x + a = b$, then $x + a - a = b - a$, or $x = b - a$.

$-3 \quad x + 3 = 7 \quad -3$

$x = 4$

**MULTIPLICATION AND DIVISION EQUATIONS** Multiplication and division are inverse operations. So, the multiplication property of equality can be used to solve equations involving division, and the division property of equality can be used to solve equations involving multiplication.

## KEY CONCEPT — For Your Notebook

### Multiplication Property of Equality

**Words** Multiplying each side of an equation by the same nonzero number produces an equivalent equation.

**Algebra** If $\frac{x}{a} = b$ and $a \neq 0$, then $a \cdot \frac{x}{a} = a \cdot b$, or $x = ab$.

### Division Property of Equality

**Words** Dividing each side of an equation by the same nonzero number produces an equivalent equation.

**Algebra** If $ax = b$ and $a \neq 0$, then $\frac{ax}{a} = \frac{b}{a}$, or $x = \frac{b}{a}$.

$\frac{Ax}{A} = \frac{B}{A}$

$\frac{x}{5} = 7$ $\quad 5 \cdot \frac{x}{5} = 7 \cdot 5$ $\quad x = 35$

$\frac{1}{A} Ax = B \cdot \frac{1}{A}$ $\quad x = \frac{B}{A}$

LESSON 2.2

# Practice A

*For use with the lesson "Solve One-Step Equations"*

**State the inverse operation.**

**1.** Add 23.

(SUBtract 23)

ADD -23

**2.** Subtract −18.

**3.** Add −50.

ADD 50

**Check whether the given number is a solution of the equation.**

**4.** $x - 8 = 11; 19$ **5.** $x + 4 = 7; 11$ **6.** $x - 5 = 13; 18$

$X + 4 = 7$

$11 + 4 = 7$

$15 = 7$

NO

**Solve the equation.**

**7.** $x + 6 = 14$ **8.** $n + 3 = 8$ **9.** $15 = w + 4$

$-6 + x + 6 = 14 - 6$ $15 - 4 = w + 4 - 4$

$x = 8$ $11 = w$

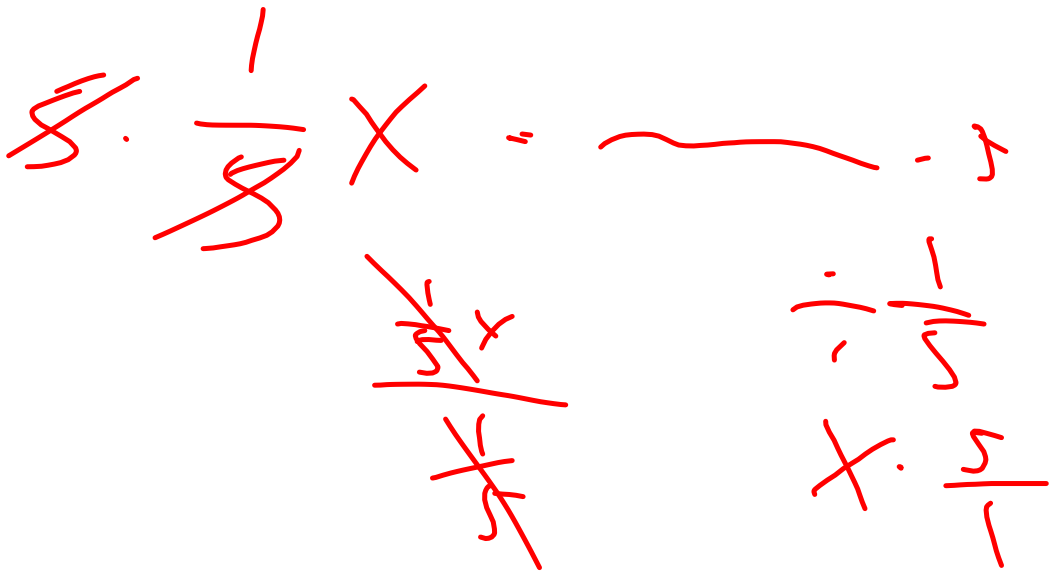
**10.** $y - 7 = 12$ **11.** $a - 2 = 10$ **12.** $22 = 8 + m$

$2 + A - 2 = 10 + 2$

$A = 12$

**Complete the sentence.**

**13.** To isolate the variable in $\frac{1}{5}x$, multiply by ___?___ or divide by ___?___.



**14.** To isolate the variable in $4x$, multiply by __?__ or divide by __?__.

**15.** To isolate the variable in $-\frac{2}{3}x$, multiply by __?__ or divide by __?__.

$-\frac{3}{2}$

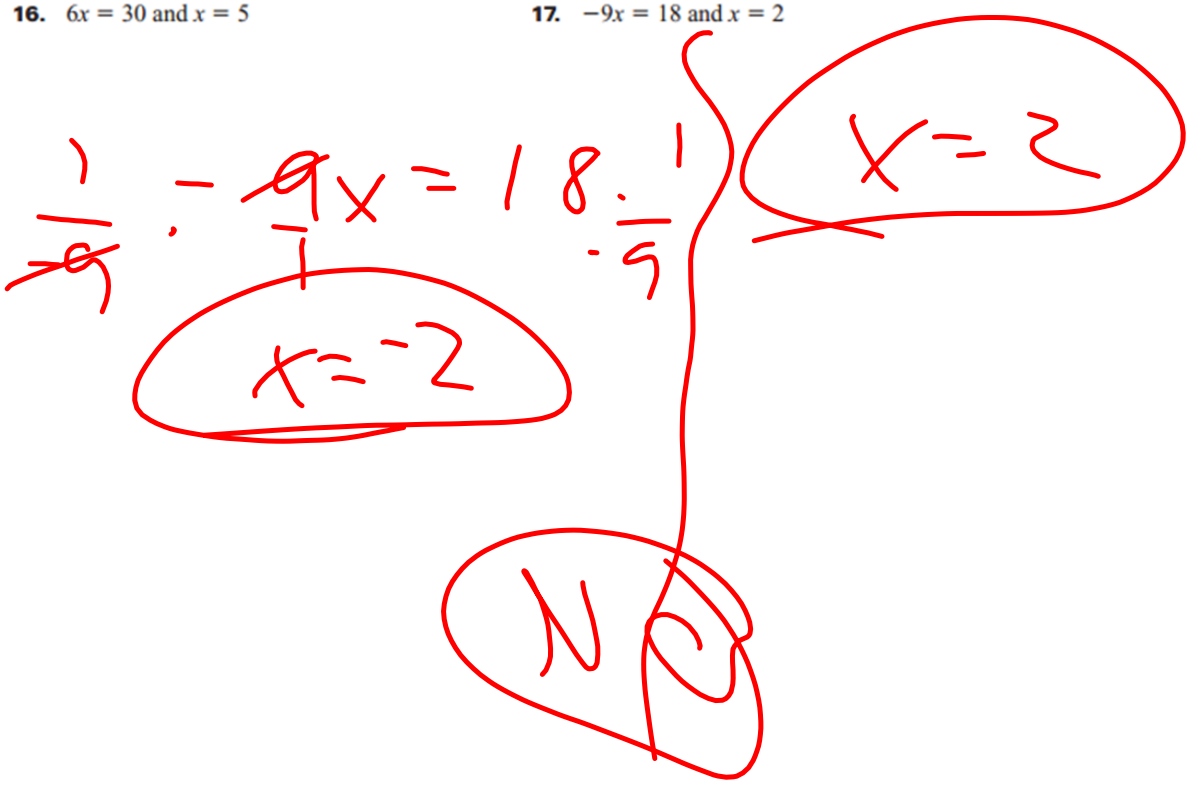
$\frac{-3}{2} \cdot -\frac{2}{3}x$

$x$

**Tell whether the equations are equivalent.**

**16.** $6x = 30$ and $x = 5$

**17.** $-9x = 18$ and $x = 2$



**Solve the equation.**

**18.** $8x = 40$ **19.** $-3b = 21$ **20.** $12 = 2m$

$$\frac{1}{-3} \cdot -3B = 21 \cdot \frac{1}{-3}$$

$$B = -7$$

**21.** $-34 = 2y$ **22.** $\frac{1}{2}n = 13$ **23.** $-\frac{1}{7}a = 5$

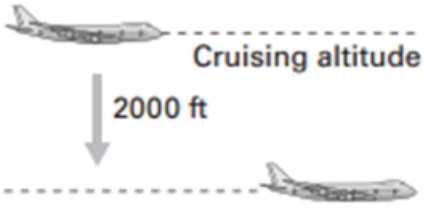
$\frac{1}{2} \cdot -34 = 2y \cdot \frac{1}{2}$

$-17 = y$

$\frac{-1}{7} \cdot \frac{-7}{1} A = 5 \cdot \frac{-7}{1}$

$A = -35$

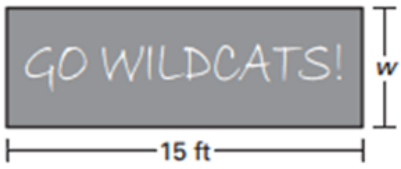
**24. Altitude** An airplane was at a cruising altitude, then descended 2000 feet. If the airplane is at 18,000 feet now, what was the cruising altitude?




$-2000 + C + 2000 = 18000 + 2000$

$C = 20000$

**25. Banner** You are working on a banner for Friday's pep rally. The length of the banner is 3 times the width. The length is 15 feet. What is the width?




$\frac{1}{3} 3w = 15 \cdot \frac{1}{3}$

$w = 5$

**26. Exercising** Every week, you run for cardiovascular fitness and lift weights for strength training. You spend about $\frac{1}{3}$ of your weekly exercising time lifting weights. You exercise 12 hours a week. How much time do you spend lifting weights?

**Practice Level A**

**1.** Subtract 23. **2.** Add $-18$. **3.** Subtract $-50$.

**4.** yes **5.** no **6.** yes **7.** $x = 8$ **8.** $n = 5$

**9.** $w = 11$ **10.** $y = 19$ **11.** $a = 12$

**12.** $m = 14$ **13.** $5; \frac{1}{5}$ **14.** $\frac{1}{4}; 4$ **15.** $-\frac{3}{2}; -\frac{2}{3}$

## *Lesson 2.2 Solve One-Step Equations, continued*

**16.** yes **17.** no **18.** $x = 5$ **19.** $b = -7$

**20.** $m = 6$ **21.** $y = -17$ **22.** $n = 26$

**23.** $a = -35$ **24.** 20,000 ft **25.** 5 ft **26.** 4 h

LESSON 2.2

# Practice B

*For use with the lesson "Solve One-Step Equations"*

**Solve the equation.**

**1.** $x + 16 = 25$

**2.** $n - 9 = 17$

**3.** $-30 = w + 8$

**4.** $y + 5 = -13$

**5.** $a - 17 = -10$

**6.** $41 = 52 + m$

**7.** $c - 2.4 = 1.8$

**8.** $z + 4.1 = 9.6$

**9.** $-3.2 = 4.5 + p$

**10.** $9x = 54$

**11.** $-5b = 55$

**12.** $-42 = 3m$

**13.** $-52 = -4y$

**14.** $\frac{1}{3}n = 36$

**15.** $-\frac{3}{4}a = 12$

**16.** $0.5y = 17$

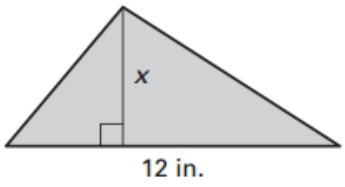
**17.** $-1.4a = 2.8$

**18.** $-6.5 = -1.3m$

**The rectangle or triangle has area *A*. Write and solve an equation to find the value of *x*.**

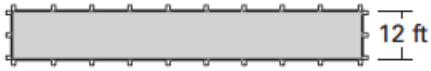
**19.** $A = 70$ in.$^2$


**20.** $A = 30$ in.$^2$



**21.** **Caves** Cumberland Caverns in Tennessee is 44.4 kilometers long. This cave is 10.9 kilometers longer than Carlsbad Caverns in New Mexico. How long is Carlsbad Caverns?

**22.** **Bocce** Bocce is a lawn bowling game that originated in Italy. The bocce court below has an area of 1032 square feet. The width of the court is 12 feet. What is the length of the court?




**23.** **Speedskating** In the 2002 Winter Olympics, Cartriona LeMay Doan won the 500-meter race. Her winning time was 74.75 seconds. Find her average speed to the nearest tenth of a meter per second.

**24.** **Part-Time Job** You work at a grocery store part-time. You estimate that you spend $\frac{3}{5}$ of your time stocking shelves. You work 20 hours each week. How many hours of your work week do you spend stocking shelves?

**Practice Level B**

**1.** $x = 9$ **2.** $n = 26$ **3.** $w = -38$ **4.** $y = -18$
**5.** $a = 7$ **6.** $m = -11$ **7.** $c = 4.2$ **8.** $z = 5.5$
**9.** $p = -7.7$ **10.** $x = 6$ **11.** $b = -11$
**12.** $m = -14$ **13.** $y = 13$ **14.** $n = 108$
**15.** $a = -16$ **16.** $y = 34$ **17.** $a = -2$
**18.** $m = 5$ **19.** $10x = 70$; $x = 7$ in.
**20.** $\frac{1}{2}(12x) = 30$; $x = 5$ in. **21.** 33.5 km
**22.** 86 ft **23.** 6.7 m/sec **24.** 12 h

## EXAMPLE 1 Solve an equation using subtraction

**Solve $x + 7 = 4$.**

$$x + 7 = 4$$ Write original equation.

$$x + 7 - 7 = 4 - 7$$ Use subtraction property of equality: Subtract 7 from each side.

$$x = -3$$ Simplify.

▶ The solution is $-3$.

**AVOID ERRORS**
To obtain an equivalent equation, be sure to subtract the same number from each side.

***CHECK*** Substitute $-3$ for $x$ in the original equation.

$$x + 7 = 4$$ Write original equation.

$$-3 + 7 \stackrel{?}{=} 4$$ Substitute $-3$ for $x$.

$$4 = 4 \checkmark$$ Simplify. Solution checks.

## EXAMPLE 2

**Solve $x - 12 = 3$.**

**Horizontal format**

| | |
|---|---|
| $x - 12 = 3$ | **Write original equation.** |
| $x - 12 + 12 = 3 + 12$ | **Add 12 to each side.** |
| $x = 15$ | **Simplify.** |

## EXAMPLE 3 Solve an equation using division

**Solve $-6x = 48$.**

$-6x = 48$ — Write original equation.

$\frac{-6x}{-6} = \frac{48}{-6}$ — Divide each side by $-6$.

$x = -8$ — Simplify.

## GUIDED PRACTICE for Examples 1, 2, and 3

**Solve the equation. Check your solution.**

**1.** $y + 7 = 10$ **3**

**2.** $x - 5 = 3$ **8**

**3.** $q - 11 = -5$ **6**

**4.** $6 = t - 2$ **8**

**5.** $4x = 48$ **12**

**6.** $-65 = -5y$ **13**

**7.** $6w = -54$ **−9**

**8.** $24 = -8n$ **−3**

## EXAMPLE 4 Solve an equation using multiplication

**Solve $\frac{x}{4} = 5$.**

**Solution**

$\frac{x}{4} = 5$ — Write original equation.

$4 \cdot \frac{x}{4} = 4 \cdot 5$ — Multiply each side by 4.

$x = 20$ — Simplify.

## GUIDED PRACTICE for Example 4

**Solve the equation. Check your solution.**

**9.** $\frac{t}{-3} = 9$ **−27**

**10.** $6 = \frac{c}{7}$ **42**

**11.** $13 = \frac{z}{-2}$ **−26**

**12.** $\frac{a}{5} = -11$ **−55**

## EXAMPLE 5 Solve an equation by multiplying by a reciprocal

**Solve $-\frac{2}{7}x = 4$.**

**Solution**

The coefficient of $x$ is $-\frac{2}{7}$. The reciprocal of $-\frac{2}{7}$ is $-\frac{7}{2}$.

$$-\frac{2}{7}x = 4 \qquad \text{Write original equation.}$$

$$-\frac{7}{2}\left(-\frac{2}{7}x\right) = -\frac{7}{2}(4) \qquad \text{Multiply each side by the reciprocal, } -\frac{7}{2}.$$

$$x = -14 \qquad \text{Simplify.}$$

The solution is $-14$. Check by substituting $-14$ for $x$ in the original equation.

**CHECK**

$$-\frac{2}{7}x = 4 \qquad \text{Write original equation.}$$

$$-\frac{2}{7}(-14) \stackrel{?}{=} 4 \qquad \text{Substitute } -14 \text{ for } x.$$

$$4 = 4 \checkmark \qquad \text{Simplify. Solution checks.}$$

## GUIDED PRACTICE for Example 5

**Solve the equation. Check your solution.**

**13.** $\frac{5}{6}w = 10$ 12 **14.** $\frac{2}{3}p = 14$ 21 **15.** $9 = -\frac{3}{4}m$ −12 **16.** $-8 = -\frac{4}{5}v$ 10

## EXAMPLE 6 Write and solve an equation

**OLYMPICS** In the 2004 Olympics, Shawn Crawford won the 200 meter dash. His winning time was 19.79 seconds. Find his average speed to the nearest tenth of a meter per second.


### Solution

Let $r$ represent Crawford's speed in meters per second. Write a verbal model. Then write and solve an equation.

| Distance (meters) | = | Rate (meters/second) | · | Time (seconds) |
|---|---|---|---|---|
| ↓ | | ↓ | | ↓ |
| **200** | = | $r$ | · | **19.79** |

$$\frac{200}{19.79} = \frac{19.79r}{19.79}$$

$$10.1 \approx r$$

▶ Crawford's average speed was about 10.1 meters per second.

## GUIDED PRACTICE for Example 6

**17. WHAT IF?** In Example 6, suppose Shawn Crawford ran 100 meters at the same average speed he ran the 200 meters. How long would it take him to run 100 meters? Round your answer to the nearest tenth of a second. **9.9 sec**