2-3 Solving Equations by Using Multiplication and Division

Main Ideas

- Solve equations by using multiplication.
- Solve equations by using division.

GET READY for the Lesson

The diagram shows the distance between Earth and each star in the Big Dipper. Light travels at a rate of about 5,870 billion miles per year. The rate or speed at which something travels times the time equals the distance it travels. The following equation can be used to find the time it takes light from the closest star in the Big Dipper to reach Earth.

$$rt = d$$

$$5870t = 311{,}110$$

Source: National Geographic World

Solve Using Multiplication To solve equations such as the one above, you can use the **Multiplication Property of Equality**.

KEY CONCEPT *Multiplication Property of Equality*

Words If an equation is true and each side is multiplied by the same number, the resulting equation is true.

Symbols For any numbers a, b, and c, if $a = b$, then $ac = bc$.

Examples

$6 = 6$	$9 = 9$	$10 = 10$
$6 \times 2 = 6 \times 2$	$9 \times (-3) = 9 \times (-3)$	$10 \times \frac{1}{2} = 10 \times \frac{1}{2}$
$12 = 12$	$-27 = -27$	$5 = 5$

EXAMPLE **Solve Using Multiplication by a Positive Number**

1 Solve $\frac{t}{3} = 7$. Check your solution.

$\frac{t}{3} = 7$	Original equation
$3\left(\frac{t}{3}\right) = 3(7)$	Multiply each side by 3.
$t = 21$	$\frac{t}{3}(3) = t$ and $7(3) = 21$

CHECK

$\frac{t}{3} = 7$	Original equation
$\frac{21}{3} \stackrel{?}{=} 7$	Substitute 21 for t.
$7 = 7$ ✓	The solution is 21.

CHECK Your Progress

Solve each equation. Check your solution.

1A. $18 = \frac{w}{2}$ 36

1B. $\frac{n}{3} = -\frac{2}{5}$ $-1\frac{1}{5}$

EXAMPLE Solve Using Multiplication by a Fraction

2 Solve each equation.

a. $\left(2\frac{1}{4}\right)g = \frac{1}{2}$

$\left(2\frac{1}{4}\right)g = \frac{1}{2}$ Original equation

$\left(\frac{9}{4}\right)g = \frac{1}{2}$ Rewrite the mixed number as an improper fraction.

$\frac{4}{9}\left(\frac{9}{4}\right)g = \frac{4}{9}\left(\frac{1}{2}\right)$ Multiply each side by $\frac{4}{9}$, the reciprocal of $\frac{9}{4}$.

$g = \frac{2}{9}$ Check this result.

b. $42 = -6m$

$42 = -6m$ Original equation

$-\frac{1}{6}(42) = -\frac{1}{6}(-6m)$ Multiply each side by $-\frac{1}{6}$, the reciprocal of -6.

$-7 = m$ Check this result.

CHECK Your Progress

2A. $\frac{3}{5}k = 6$ **10**

2B. $-\frac{1}{4} = \frac{2}{3}b$ $-\frac{3}{8}$

Real-World EXAMPLE

Real-World Link

On July 20, 1969, Neil Armstrong stepped on the surface of the Moon. On the Moon, his suit and life-support backpacks weighed about 33 pounds.

Source: NASA

3 **SPACE TRAVEL** Refer to the information at the left. An item's weight on the Moon is about one sixth its weight on Earth. What was the weight of Neil Armstrong's suit and life-support backpacks on Earth?

Words	One sixth	times	the weight on Earth	equals	the weight on the Moon.
Variables	Let w = the weight on Earth.				
Equation	$\frac{1}{6}$	$\cdot$	w	$=$	33

$\frac{1}{6}w = 33$ Original equation

$6\left(\frac{1}{6}w\right) = 6(33)$ Multiply each side by 6.

$w = 198$ $\frac{1}{6}(6) = 1$ and $33(6) = 198$

Neil Armstrong's suit and backpacks were about 198 pounds on Earth.

CHECK Your Progress

3. SURVEYS In a recent survey of 13- to 15-year-old girls, 225, or about $\frac{9}{20}$ of those surveyed, said they talk on the telephone while they watch television. About how many girls were surveyed? **about 500**

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Solve Using Division In Example 2b, the equation $42 = -6m$ was solved by multiplying each side by $-\frac{1}{6}$. The same result could have been obtained by dividing each side by -6. This method uses the **Division Property of Equality**.

KEY CONCEPT — *Division Property of Equality*

Words If an equation is true and each side is divided by the same non-zero number, the resulting equation is true.

Symbols For any numbers a, b, and c with $c \neq 0$, if $a = b$, then $\frac{a}{c} = \frac{b}{c}$.

Examples

$15 = 15$ $\quad\quad$ $28 = 28$

$\frac{15}{3} = \frac{15}{3}$ $\quad\quad$ $\frac{28}{-7} = \frac{28}{-7}$

$5 = 5$ $\quad\quad$ $-4 = -4$

EXAMPLE Solve Using Division

1 **Solve each equation. Check your solution.**

a. $13s = 195$

$13s = 195$	Original equation
$\frac{13s}{13} = \frac{195}{13}$	Divide each side by 13.
$s = 15$	$\frac{13s}{13} = s$ and $\frac{195}{13} = 15$

CHECK

$13s = 195$	Original equation
$13(15) \stackrel{?}{=} 195$	Substitute 15 for s.
$195 = 195$ ✓	Multiply.

b. $-3x = 12$

$-3x = 12$	Original equation
$\frac{-3x}{-3} = \frac{12}{-3}$	Divide each side by -3.
$x = -4$	$\frac{-3x}{-3} = x$ and $\frac{12}{-3} = -4$

CHECK

$-3x = 12$	Original equation
$-3(-4) \stackrel{?}{=} 12$	Substitute -4 for x.
$12 = 12$ ✓	Multiply.

CHECK Your Progress

4A. $84 = 3b$ **28** $\quad\quad$ **4B.** $-42 = -3s$ **14**

Study Tip

Alternative Method

You can also solve equations like those in Examples 4 and 5 by using the Multiplication Property of Equality. For instance, in Example 4b, you could multiply each side by $-\frac{1}{3}$.

EXAMPLE Write and Solve an Equation Using Division

5 **Write an equation for the problem below. Then solve the equation.**

Negative eighteen times a number equals −198.

Negative eighteen	times	a number	equals	−198.
-18	$\times$	n	$=$	-198

$-18n = -198$	Original equation
$\frac{-18n}{-18} = \frac{-198}{-18}$	Divide each side by -18.
$n = 11$	Check this result.

CHECK Your Progress

5. Write an equation for the following problem. Then solve the equation.

Negative forty-two equals the product of six and a number. **$-42 = 6n$; -7**