

### Explain It!

The shapes below are used to show the relationship between each of the four equations in the same fact family.

$$8 \times 3 = 24 \quad \square \times \circ = \star$$

$$3 \times 8 = 24 \quad \circ \times \square = \star$$

$$24 \div 3 = 8 \quad \star \div \circ = \square$$

$$24 \div 8 = 3 \quad \star \div \square = \circ$$

**A.** Suppose the star represents  $-24$ . What values could the other shapes represent?

**B.** What do you know about the square and circle if the star represents a negative number?

**C.** What do you know about the square and circle both represent a negative number?

### Lesson 1-8

#### Divide Integers

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**I can...**  
divide integers.

#### Focus on math practices

**Use Structure** Suppose the square represents  $-8$  and the circle represents  $3$ . Use what you know about integer multiplication and the relationship between multiplication and division to write the complete fact family.

### Essential Question

How does dividing integers relate to multiplying integers?

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### EXAMPLE 1

#### Divide Integers with Different Signs

A machine drill is used to access water under the ground. If the machine drills the same distance each day, what is the change in the location of the bottom of the hole each day?

DAY 1  
DAY 2  
DAY 3  
DAY 4

water at 160 feet below ground level

Use a number line to represent the change each day.

Ground water  
-40  
-80  
-120  
-160  
Water

Each of the 4 parts is  $-40$ .

Divide the total distance into 4 equal parts to represent the 4 days of drilling.

The location of the bottom of the hole changed  $-40$  feet, or 40 feet lower each day.

Use the inverse relationship between multiplication and division.

$-160 \div 4 = ?$

Write a related multiplication equation.

$4 \cdot ? = -160$

$4 \cdot (-40) = -160$

So,  $-160 \div 4 = -40$ .

When dividing integers with different signs, the quotient will be negative.

The location of the bottom of the hole changed by  $-40$  feet, or decreased by 40 feet, each day.

**Try It!**

Suppose the machine drilled the same distance into the ground for 3 days and reached water at 84 feet below ground level. What was the change in the location of the bottom of the hole each day?

Each day, the location of the bottom of the hole changed by  feet, or decreased by  feet.

**Convince Me!** Explain why the quotient of two integers with different signs is negative.

$\div 3 = ?$

$3 \cdot ? =$

$3 \cdot$    $= -84$

So,   $\div 3 =$

0  
-84

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**EXAMPLE 2** Divide Integers with the Same Sign

Simplify  $-27 \div (-3)$ .

**ONE WAY** Use a related multiplication fact.

$-27 \div (-3) = ?$

$-3 \cdot 7 = -27$

$-3 \cdot 9 = -27$

So,  $-27 \div (-3) = 9$ .

Write division as a product with a missing factor.

When dividing integers with the same sign, the quotient will be positive.

**ANOTHER WAY** Write the division expression as a fraction and use properties of operations.

$\frac{-27}{-3}$

$= \frac{-1 \cdot 27}{-1 \cdot 3}$

$= \frac{-1 \cdot 27}{-1 \cdot 3}$

$= -1 \cdot 9$

$= 9$

So,  $-27 \div (-3) = 9$ .

Write negative numbers as a product, and then write as a product of fractions.

**Try It!**

Simplify.

a.  $-40 \div (-5)$

b.  $40 \div (-5)$

c.  $0 \div -40 = 0$

**EXAMPLE 3** Write Equivalent Quotients of Integers

Are the following quotients equivalent? Justify your answer.

$-\left(\frac{18}{4}\right)$

$-\frac{18}{4}$

$\frac{18}{4}$

$-\left(\frac{18}{4}\right) = -(18 \div 4)$

$= -(4.5)$

$= -4.5$

$-\frac{18}{4} = -18 \div 4$

$= -4.5$

$\frac{18}{4} = 18 \div 4$

$= 4.5$

$= 4.5$

Yes, each expression is equivalent to  $-4.5$ .

**Generalize** The value of  $-\left(\frac{p}{q}\right)$  is equivalent to  $-\frac{p}{q}$  and  $\frac{p}{-q}$ .

**Try It!**

Which of the following are equivalent to  $-5$ ?

$\frac{55}{11}$

$-\left(\frac{55}{11}\right)$

$-\frac{55}{11}$

$-\frac{55}{11}$

$-\frac{55}{11}$

$-\left(\frac{-55}{11}\right)$

**KEY CONCEPT**

The rules for dividing integers are related to the rules for multiplying integers.

If the signs of the dividend and the divisor are the same, the quotient is positive.

$24 \div 4 = 6$

$-24 \div (-4) = 6$

If the signs of the dividend and the divisor are different, the quotient is negative.

$-15 \div 3 = -5$

$15 \div (-3) = -5$

\* same rules as multiplication (divide instead)

**Do You Understand?**

1. **Essential Question** How does dividing integers relate to multiplying integers?

2. **Reasoning** Why is the quotient of two negative integers positive?

3. Helen wrote the following facts to try to show that division by 0 results in 0. Explain her error.

$0 \times (-7) = 0$   
So,  $(-7) \div 0 = 0$

\* cannot divide by 0  
"undefined"

**Do You Know How?**

4. Find each quotient.

a.  $-\frac{18}{3} \rightarrow -6$

b.  $\frac{-5}{-1} \rightarrow +5$

c.  $\frac{24}{-6} \rightarrow -4$

d.  $\frac{-10}{-1} \rightarrow +10$

e.  $\frac{25}{-5} \rightarrow -5$

f.  $\frac{-8}{2} \rightarrow -4$

5. A scuba diver descends 63 feet in 18 seconds. What integer represents the change in the diver's position in feet per second?

6. Which of the following are equivalent to  $-7$ ?

$-\frac{49}{7}$

$0$

$-7$

$\frac{49}{-7}$

$-\frac{21}{3}$

$\frac{21}{3}$

Name: \_\_\_\_\_

**Practice & Problem Solving**

**Leveled Practice** In 7-8, fill in the boxes to find each quotient.

7.  $-16 \div 4 = ?$   
 $4 \cdot 7 = \square$   
 $4 \cdot \square = \square$   
 So,  $-16 \div 4 = \square$

8.  $-56 \div -7 = ?$   
 $\square \cdot 7 = \square$   
 $\square \cdot \square = \square$   
 So,  $-56 \div -7 = \square$

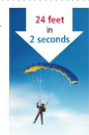
9. Classify the quotient  $-50 \div 5$  as positive, negative, zero, or undefined.

10. Is the expression  $\frac{42}{-3}$  undefined? If not, find the quotient.

11. A company loses \$780 as a result of a shipping delay. The 6 owners of the company must share the loss equally.  
 a. Write an expression to show the change in profit for each owner.  
 b. Evaluate the expression.

12. Which of the quotients are equivalent to 2.5? Select all that apply.  
  $\frac{10}{4}$       $\frac{5}{2}$   
  $\frac{10}{-4}$       $-\frac{5}{2}$   
  $-\frac{10}{4}$       $-\frac{5}{2}$

13. **Use Structure** The price of a stock steadily decreased by a total of \$127 over 15 months. Which expression shows the change in the stock's value?  
 A  $\frac{-\$127}{-15 \text{ months}}$      C  $\frac{-\$127}{15 \text{ months}}$   
 B  $\frac{\$127}{15 \text{ months}}$      D  $\frac{\$127}{127 \text{ months}}$

14. Zak goes parachuting and descends at the rate shown. If he maintains a steady descent, what integer represents Zak's change in elevation in feet per second?  


15. **Model with Math** Find each quotient and plot it on the number line. Which of the expressions are undefined?  
 $-8 \div 4$      $-21 \div 3$      $4 \div 0$      $-25 \div (-5)$      $\frac{36}{9}$      $0 \div (-8)$      $0 \div 0$

*Handwritten notes for problem 15:*  
 - A bracket groups  $4 \div 0$  and  $0 \div 0$  with the word "undefined" written above it.  
 - A star is drawn next to  $0 \div (-8)$ .  
 - A number line is shown below with points plotted at -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5.

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16. **Use Structure** The temperature in a town increased  $16^\circ\text{F}$  in 5 hours. The temperature decreased  $31^\circ\text{F}$  in the next 8 hours. Which of the expressions shows the rate of the total change in temperature?  
 A  $\frac{15^\circ\text{F}}{13 \text{ hours}}$   
 B  $\frac{47^\circ\text{F}}{13 \text{ hours}}$   
 C  $\frac{15^\circ\text{F}}{10 \text{ minutes}}$   
 D  $\frac{47^\circ\text{F}}{-13 \text{ hours}}$

17. Camille takes a rock-climbing class. On her first outing, she rappels down the side of a boulder in three equal descents. What integer represents Camille's change in altitude in feet each time she descends?



18. **Higher Order Thinking** If the fraction  $\frac{396}{x-10}$  is equivalent to  $-22$ , find the value of  $x$ . Show your work.

$d = 165 \div 3$

$$\begin{array}{r} 55 \\ 3 \overline{)165} \\ \underline{-15} \phantom{0} \\ 15 \\ \underline{-15} \\ 0 \end{array}$$

Camille descends 55 ft each time she rappels down the boulder.

**Assessment Practice**

19. Which of the quotients is equivalent to  $-\frac{5}{8}$ ? Select all that apply.  
  $-\frac{5}{8}$   
  $\frac{5}{8}$   
  $-\frac{5}{-8}$   
  $-\left(\frac{5}{-8}\right)$   
  $-\frac{5}{-8}$

20. Eva incorrectly classifies the quotient  $-\left(\frac{-81}{-9}\right)$  as positive.  
**PART A**  
 What is the correct quotient? Explain how you found your answer.

- PART B**  
 Explain what could have caused Eva's error.

