1-4

Multiply and Divide Real Numbers

Objective To model multiplication of signed numbers on a number line
• To multiply and divide signed numbers

A diver descended into the ocean at a rate of 2.1 meters per minute over a 3-minute period. What signed number represents the diver's final depth at the end of the 3 minutes?

To find the diver's final depth, multiply: $3(-2.1)$

First estimate by rounding: $3(-2.1) \approx -6$
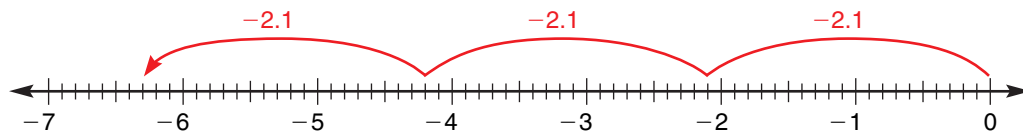
Think
$3(-2) = -6$

Then multiply the actual numbers.

Multiplying Decimals

To multiply signed decimals, multiply as you would with whole numbers, and then use the total number of decimal places in the factors for the number of decimal places in the product.

Multiply: $3(-2.1)$

Key Concept

Multiplying Two Signed Numbers
• If the factors have *like signs*, the product is *positive*.
• If the factors have *unlike signs*, the product is *negative*.

$3(-2.1) = -6.3$ ← Factors have *unlike signs*, so their product is negative.

1 decimal place   1 decimal place

So $3(-2.1) = -6.3$.

Think
-6.3 is close to the estimate of -6.
The answer is reasonable.

Multiplying Fractions or Mixed Numbers

Find the product: $\left(-1\frac{2}{3}\right)\left(-2\frac{1}{4}\right)$

First estimate by rounding: $\left(-1\frac{2}{3}\right)\left(-2\frac{1}{4}\right) \approx 4$

Think
$(-2)(-2) = 4$

Then multiply the actual numbers.

$\left|-1\frac{2}{3}\right| \cdot \left|-2\frac{1}{4}\right| = \frac{5}{3} \cdot \frac{9}{4}$ ← Multiply the absolute values of the numbers. Rename each factor as a fraction greater than 1.

$= \frac{5 \cdot \overset{3}{\cancel{9}}}{\underset{1}{\cancel{3}} \cdot 4} = \frac{15}{4}$ ← Divide by the GCF to simplify. Then multiply the numerators and then the denominators.

$= 3\frac{3}{4}$ ← Rename the product as a mixed number.

So $\left(-1\frac{2}{3}\right)\left(-2\frac{1}{4}\right) = 3\frac{3}{4}$ ← Factors have *like signs*. The product is positive.

Think
$3\frac{3}{4}$ is close to the estimate of 4.
The answer is reasonable.

Dividing Decimals

To divide signed decimals, divide as with whole numbers. Multiply both the dividend and the divisor by the power of ten that will make the divisor a whole number.

Find each quotient.

$$\frac{-0.0141}{-4.7}$$

> **Remember:** A fraction bar is a division symbol.

$|-0.0141| \div |-4.7| = 0.0414 \div 4.7$ ← Divide the absolute values of the numbers.

$$4.7\overline{)0.0141} \longrightarrow 47\overline{)0.141}^{\,0.003}$$ ← Write 2 zeros in the quotient as placeholders.

Multiply by 10. Move each decimal point 1 place to the right.

So $-0.0141 \div (-4.7) = 0.003$ ← The dividend and divisor have *like signs*, so the quotient is positive.

> ### Key Concept
> **Dividing Signed Numbers**
> • If the dividend and divisor have *like signs*, the quotient is *positive*.
> • If the dividend and divisor have *unlike signs*, the quotient is *negative*.

$2.2 \div (-0.055)$

$|2.2| \div |-0.055| = 2.2 \div 0.055$ ← Divide the absolute values of the numbers.

$$0.055\overline{)2.200.} \longrightarrow 55\overline{)2200.}^{\,40.}$$

Multiply by 1000. Move each decimal point 3 places to the right. Write 2 zeros in the dividend as placeholders.

So $2.2 \div (-0.055) = -40$ ← The dividend and divisor have *unlike signs*, so the quotient is negative.

Dividing Fractions or Mixed Numbers

When dividing with fractions, whole numbers, and mixed numbers, rename the whole numbers and mixed numbers as fractions.

Divide: $-3\frac{3}{5} \div \left(-\frac{3}{20}\right)$

$\left|-3\frac{3}{5}\right| \div \left|-\frac{3}{20}\right| = \frac{18}{5} \div \frac{3}{20}$ ← Rename as fractions greater than 1. Divide the absolute values.

$$= \frac{\overset{6}{\cancel{18}}}{\underset{1}{\cancel{5}}} \bullet \frac{\overset{4}{\cancel{20}}}{\underset{1}{\cancel{3}}}$$ ← Multiply by the reciprocal of $\frac{3}{20}$. Simplify using the GCF.

$$= \frac{24}{1} = 24$$ ← Rename the product as a whole number.

So $-3\frac{3}{5} \div \left(-\frac{3}{20}\right) = 24$ ← The dividend and divisor have *like signs*, so the quotient is positive.

> ### Key Concept
> **Dividing Fractions**
> • To divide real numbers as fractions, multiply by the reciprocal of the divisor.
> $$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \bullet \frac{d}{c}, \; b, c, d \neq 0$$
> reciprocals
> • $\frac{c}{d}\left(\frac{d}{c}\right) = 1$

Try These

Multiply or divide. Watch for the signs.

1. $0.9(-4.82)$ **2.** $\left(-\frac{1}{9}\right)\left(-\frac{3}{7}\right)$ **3.** $-4.8 \div (-0.5)$ **4.** $-0.45 \div \frac{3}{5}$ **5.** $1\frac{1}{2} \bullet 2\frac{3}{4}$

6. $0 \bullet (-171)$ **7.** $0 \div \left(-9\frac{1}{3}\right)$ **8.** $-12\frac{1}{2} \div \left(4\frac{1}{2}\right)$ **9.** $-8\frac{1}{2} \div 4$ **10.** $-\frac{3}{4} \div 0.5$

11. $-\frac{4}{5}\left(-1\frac{1}{4} \bullet \frac{5}{8}\right)$ **12.** $(3.564 \div 3) \div 0.5$ **13.** $-5\left(-\frac{3}{5} \div \frac{13}{20}\right)$

14. Discuss and Write Explain what steps you would take to multiply $4 \bullet -1\frac{1}{2}$.