

# 3.2

## Adding and Subtracting Linear Expressions



**Learning Target:** Find sums and differences of linear expressions.

- Success Criteria:**
- I can explain the difference between linear and nonlinear expressions.
  - I can find opposites of terms that include variables.
  - I can apply properties of operations to add and subtract linear expressions.

### Exploration 1 Using Algebra Tiles

	= +1
	= -1
	= variable
	= -variable

**Work with a partner.** You can use the algebra tiles shown at the left to find sums and differences of algebraic expressions.

- How can you use algebra tiles to model a sum of terms that equals 0? Explain your reasoning.
- Write each sum or difference modeled below. Then use the algebra tiles to simplify the expression.

$$\left( \begin{array}{c} \text{+} \\ \text{+} \\ \text{+} \\ \text{+} \\ \text{+} \\ \text{+} \end{array} \right) + \left( \begin{array}{c} \text{+} \\ \text{+} \\ \text{-} \\ \text{-} \\ \text{-} \end{array} \right)$$

$$\left( \begin{array}{c} \text{+} \\ \text{+} \\ \text{-} \\ \text{-} \\ \text{-} \\ \text{-} \\ \text{-} \end{array} \right) + \left( \begin{array}{c} \text{-} \\ \text{-} \\ \text{-} \\ \text{+} \\ \text{+} \\ \text{+} \end{array} \right)$$

$$\left( \text{+} \text{-} \text{-} \text{-} \text{-} \right) - \left( \text{+} \text{-} \text{-} \text{-} \right)$$

$$\left( \begin{array}{c} \text{-} \\ \text{-} \\ \text{+} \\ \text{+} \\ \text{+} \\ \text{+} \\ \text{+} \end{array} \right) - \left( \text{+} \text{-} \right)$$

- Write two algebraic expressions of the form  $ax + b$ , where  $a$  and  $b$  are rational numbers. Find the sum and difference of the expressions.

#### 4 MTR COMPARE METHODS

How is using integer counters to find sums and differences of integers similar to using algebra tiles to find sums and differences of algebraic expressions?

### Exploration 2 Using Properties of Operations

**Work with a partner.**

- Do algebraic expressions, such as  $2x$ ,  $-3y$ , and  $3z + 1$  have additive inverses? How do you know?
- How can you find the sums and differences modeled in Exploration 1 without using algebra tiles? Explain your reasoning.

#### Algebraic Reasoning

MA.7.AR.1.1 Apply properties of operations to add and subtract linear expressions with rational coefficients.



**Key Vocabulary**

linear expression, p. 110

A **linear expression** is an algebraic expression in which the exponent of each variable is 1.

<b>Linear Expressions</b>	$-4x$	$3x + 5y$	$5 - \frac{1}{6}x$
<b>Nonlinear Expressions</b>	$\frac{1}{2}x^2$	$-7x^3 + x$	$x^5 + 1$

You can use either a vertical or a horizontal method to add linear expressions.

**Example 1 Adding Linear Expressions**

Find each sum.

a.  $(x - 2) + (3x + 8)$

**Vertical method:** Align like terms vertically and add.

$$\begin{array}{r} x - 2 \\ + 3x + 8 \\ \hline 4x + 6 \end{array}$$

▶ The sum is  $4x + 6$ .

b.  $(-4y + 3) + (11y - 5)$

**Horizontal method:** Use properties of operations to group like terms and simplify.

$$\begin{aligned} (-4y + 3) + (11y - 5) &= -4y + 3 + 11y - 5 \\ &= -4y + 11y + 3 - 5 \\ &= (-4y + 11y) + (3 - 5) \\ &= 7y - 2 \end{aligned}$$

Rewrite the sum.

Commutative Property of Addition

Group like terms.

Combine like terms.

▶ The sum is  $7y - 2$ .

Linear expressions are usually written with the variable term first.

**Try It**

Find the sum.

1.  $(x + 3) + (2x - 1)$

2.  $(-8z + 4) + (8z - 7)$

3.  $(4.5 - n) + (-10n + 6.5)$

4.  $\left(\frac{1}{2}w - 3\right) + \left(\frac{1}{4}w + 3\right)$



To subtract one linear expression from another, add the opposite of each term in the expression. You can use a vertical or a horizontal method.

## Example 2 Subtracting Linear Expressions

Find each difference.

a.  $(5x + 6) - (-x + 6)$

**Vertical method:** Align like terms vertically and subtract.

$$\begin{array}{r} (5x + 6) \\ - (-x + 6) \\ \hline \end{array} \quad \text{Add the opposite.} \quad \begin{array}{r} 5x + 6 \\ + x - 6 \\ \hline 6x \end{array}$$

▶ The difference is  $6x$ .

b.  $(7.5y + 5) - (8.5y - 6)$

**Horizontal method:** Use properties of operations to group like terms and simplify.

$$\begin{aligned} (7.5y + 5) - (8.5y - 6) &= (7.5y + 5) + (-8.5y + 6) && \text{Add the opposite.} \\ &= 7.5y + (-8.5y) + 5 + 6 && \text{Commutative Property of Addition} \\ &= [7.5y + (-8.5y)] + (5 + 6) && \text{Group like terms.} \\ &= -y + 11 && \text{Combine like terms.} \end{aligned}$$

▶ The difference is  $-y + 11$ .

### Common Error

When subtracting an expression, make sure you add the opposite of each term in the expression, not just the first term.

### Try It

Find the difference.

5.  $(m - 3) - (-m + 12)$

6.  $(-2c + 5) - (6.3c + 20)$

### In-Class Practice

1

I don't understand yet.

2

I can do it with help.

3

I can do it on my own.

4

I can teach someone else.

7. **WRITING** Describe how to distinguish a linear expression from a nonlinear expression. Give an example of each.

4  
MTR

8. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find “both” answers.

What is  $x$  more than  $3x - 1$ ?

Find  $3x - 1$  decreased by  $x$ .

What is the difference of  $3x - 1$  and  $x$ ?

Subtract  $(x + 1)$  from  $3x$ .

GO DIGITAL



## Example 3 Modeling Real Life

7  
MTR

Skateboard kits cost  $d$  dollars, and you have a coupon for \$2 off each kit. You sell each assembled skateboard for  $(2d - 4)$  dollars. Find and interpret your profit on each skateboard sold.

Understand the problem.

You are given information about purchasing skateboard kits and selling the assembled skateboards. You are asked to find and interpret the profit made on each skateboard sold.

Make a plan.

Find the difference of the expressions representing the selling price and the purchase price. Then simplify and interpret the expression.

Solve and check.

You receive \$2 off of  $d$  dollars, so you pay  $(d - 2)$  dollars for each kit.

$$\begin{array}{l} \text{Profit} \\ \text{(dollars)} \end{array} = \begin{array}{l} \text{Selling price} \\ \text{(dollars)} \end{array} - \begin{array}{l} \text{Purchase price} \\ \text{(dollars)} \end{array}$$

$$= (2d - 4) - (d - 2) \quad \text{Write the difference.}$$

$$= (2d - 4) + (-d + 2) \quad \text{Add the opposite.}$$

$$= 2d - d - 4 + 2 \quad \text{Group like terms.}$$

$$= d - 2 \quad \text{Combine like terms.}$$

▶ Your profit on each skateboard sold is  $(d - 2)$  dollars. You pay  $(d - 2)$  dollars for each kit, so you are doubling your money.

**Look Back** Assume each kit is \$40. Verify that you double your money.

When  $d = 40$ : You pay  $d - 2 = 40 - 2 = \$38$ .

You sell it for  $2d - 4 = 2(40) - 4 = 80 - 4 = \$76$ .

Because  $\$38 \cdot 2 = \$76$ , you double your money. ✓



Jacksonville's Kona Skatepark is the longest-surviving private skatepark in the world.

### In-Class Practice

1 I don't understand yet.

2 I can do it with help.

3 I can do it on my own.

4 I can teach someone else.

- Dig Deeper** In a basketball game, the home team scores  $(2m + 39)$  points and the away team scores  $(3m + 40)$  points, where  $m$  is the number of minutes since halftime. Who wins the game? What is the difference in the scores  $m$  minutes after halftime? Explain.
- Electric guitar kits originally cost  $d$  dollars online. You buy the kits on sale for 50% of the original price, plus a shipping fee of \$4.50 per kit. After painting and assembly, you sell each guitar online for  $(1.5d + 4.5)$  dollars. Find and interpret your profit on each guitar sold.



## 3.2

## Practice WITH CalcChat® AND CalcView®

## Review &amp; Refresh

Simplify the expression.

1.  $4f + 11f$

2.  $b + 4b - 9b$

3.  $-4z - 6 - 7z + 3$

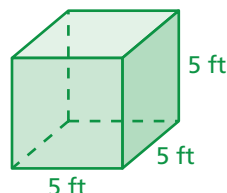
Evaluate the expression.

4.  $8 - 4^2 \cdot 3$

5.  $2^3 \cdot 7 - 14$

6.  $(-3^3 + 5^2) \cdot 6$

7. Find the surface area of the cube.



## Concepts, Skills, &amp; Problem Solving

**USING ALGEBRA TILES** Write the sum or difference modeled by the algebra tiles. Then use the algebra tiles to simplify the expression. (See Exploration 1.)

8. 
$$\left( \begin{array}{c} + \\ + \end{array} \begin{array}{ccc} - & - & - \\ - & - & - \end{array} \right) + \left( \begin{array}{c} + \\ + \\ + \\ + \\ + \\ + \end{array} \right)$$

9. 
$$\left( \begin{array}{c} + \\ + \end{array} \begin{array}{cccc} + & + & + & + \\ + & + & & \end{array} \right) - \left( \begin{array}{c} + \\ + \end{array} \begin{array}{cccc} - & - & - & - \end{array} \right)$$

**ADDING LINEAR EXPRESSIONS** Find the sum. (See Example 1.)

10.  $(n + 8) + (n - 12)$

▶ 11.  $(7 - b) + (3b + 2)$

12.  $(2w - 9) + (-4w - 5)$

13.  $(2x - 6) + (4x - 12)$

14.  $(-3.4k - 7) + (3k + 21)$

15.  $\left(-\frac{7}{2}z + 4\right) + \left(\frac{1}{5}z - 15\right)$

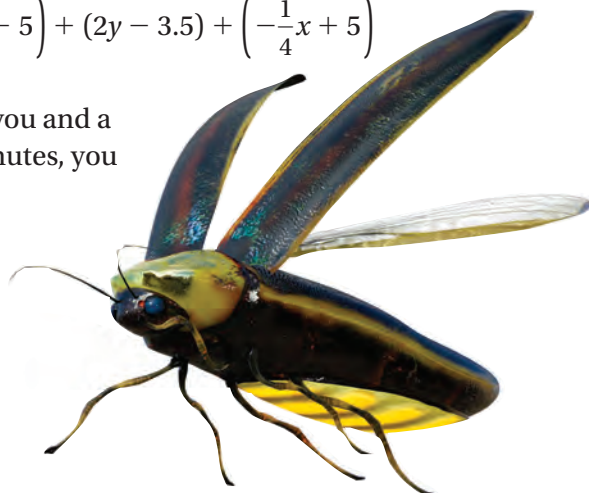
16.  $(6 - 2.7h) + (-1.3j - 4)$

17.  $\left(\frac{7}{4}x - 5\right) + (2y - 3.5) + \left(-\frac{1}{4}x + 5\right)$

7  
MTR

**18. MODELING REAL LIFE** While catching fireflies, you and a friend decide to have a competition. After  $m$  minutes, you have  $(3m + 13)$  fireflies and your friend has  $(4m + 6)$  fireflies.

- How many total fireflies do you and your friend catch? Explain your reasoning.
- The competition lasts 3 minutes. Who has more fireflies? Justify your answer.



**SUBTRACTING LINEAR EXPRESSIONS** Find the difference. (See Example 2.)

- ▶ 19.  $(-2g + 7) - (g + 11)$                       20.  $(6d + 5) - (2 - 3d)$
21.  $(4 - 5y) - (2y - 16)$                       22.  $(2n - 9) - (-2.4n + 4)$
23.  $\left(-\frac{1}{8}c + 16\right) - \left(\frac{3}{8} + 3c\right)$                       24.  $\left(\frac{9}{4}x + 6\right) - \left(-\frac{5}{4}x - 24\right)$
25.  $\left(\frac{1}{3} - 6m\right) - \left(\frac{1}{4}n - 8\right)$                       26.  $(1 - 5q) - (2.5s + 8) - (0.5q + 6)$

27. **B.E.S.T. Test Prep** Which expression is equivalent to  $(-5.2x + 8) - (3x - 5)$ ?

- Ⓐ  $-2.2x + 13$       Ⓑ  $-8.2x + 13$       Ⓒ  $2.2x + 3$       Ⓓ  $-8.2x + 3$



28. **YOU BE THE TEACHER** Your friend finds the difference  $(4m + 9) - (2m - 5)$ . Is your friend correct? Explain your reasoning.

$$\begin{aligned} (4m + 9) - (2m - 5) &= 4m + 9 - 2m - 5 \\ &= 4m - 2m + 9 - 5 \\ &= 2m + 4 \end{aligned}$$

29. **GEOMETRY** The expression  $1.7n + 1.1$  represents the perimeter of the triangle. What is the length of the third side? Explain your reasoning.



30. **MAKING AN ARGUMENT** Your friend says the sum of two linear expressions is always a linear expression. Is your friend correct? Explain.



31. **MODELING REAL LIFE** You burn 265 calories running and then 7 calories per minute swimming. Your friend burns 273 calories running and then 11 calories per minute swimming. You each swim for the same number of minutes. Find and interpret the difference in the amounts of calories burned by you and your friend. (See Example 3.)

32. **Dig Deeper** You start a new job. After  $w$  weeks, you have  $(10w + 120)$  dollars in your savings account and  $(45w + 25)$  dollars in your checking account.

- What is the total amount of money in the accounts? Explain.
- How much money did you have before you started your new job? How much money do you save each week?
- You want to buy a new phone for \$150, and still have \$500 left in your accounts afterward. Explain how to determine when you can buy the phone.

