13-1

Name _____ Date _____

Modeling Polynomials (Pages 560–564)

AF2.1

Mathematical expressions such as 1, x, and x^2 are examples of **monomials**. A monomial is a number, a variable, or a product of a number and one or more variables. Algebraic expressions that contain more than one monomial are called **polynomials**. A polynomial is the sum or difference of two or more monomials. You can model monomials and polynomials with algebra tiles.

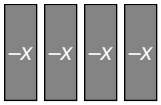
EXAMPLES

A Model the monomial 3 with algebra tiles.

Use white tiles for positive values, and shaded tiles for negative values. For the monomial 3, use three white positive 1-tiles.

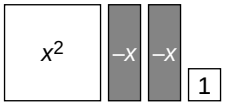
B Model the monomial $-4x$.

Use four shaded negative x-tiles for $-4x$.



C Model the polynomial $x^2 - 2x + 1$.

Use a white positive x^2-tile for x^2, two shaded negative x-tiles for $-2x$, and one white positive 1-tile for 1.



Try These Together

Write a monomial or polynomial for each model.

1. 

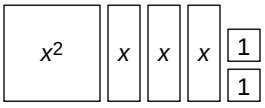
2. 

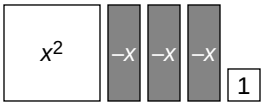
3. 

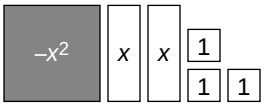
HINT: White tiles represent positive values, shaded tiles represent negative values.

PRACTICE

Write a monomial or polynomial for each model.

4. 

5. 

6. 

Model each monomial or polynomial using algebra tiles.

7. $-4x^2$ **8.** $3x$ **9.** $3x^2 + 2x$

10. $-5x + 2$ **11.** $2x^2 + 3x + 1$ **12.** $x^2 + 4x + 1$

13. $3x^2 + x - 2$ **14.** $-2x^2 - 2x - 2$ **15.** $2x^2 - 4$

16. **Standardized Test Practice** Write a monomial to express the surface area of a cube that has a side length of x.

A x^2 **B** $6x$ **C** $6x^2$ **D** x^3

Answers: 1. $2x$ 2. x^2 3. $-3x$ 4. $x^2 + 3x + 2$ 5. $x^2 - 3x + 1$ 6. $-x^2 + 2x + 3$ 7–15. See Answer Key. 16. C

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13-2 Simplifying Polynomials

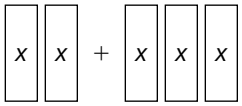
(Pages 565–569)

AF1.4, AF2.1

Each monomial in a polynomial is called a **term**. Monomials with the same variable to the same power, such as $2x$ and $3x$, are called **like terms**. You can recognize like terms when you are using algebra tiles because they have the same size and shape. You can simplify polynomials that have like terms. An expression that has no like terms is in **simplest form**.

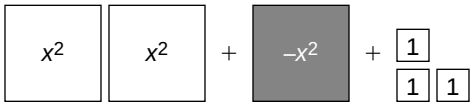
EXAMPLES

A Simplify $2x + 3x$.



With tiles you can see that there are 5 x-tiles. On paper, you add the like terms. So $2x + 3x = 5x$.

B Simplify $2x^2 - x^2 + 3$.



With the tiles, you can see that there are 2 positive x^2-tiles and one negative x^2-tile. Two positives plus one negative equals one positive. Or, on paper, $2x^2 - x^2 = x^2$. So the polynomial in simplest form is $x^2 + 3$.

Try These Together

Name the like terms in each list of terms.

1. $3, 2q^2, -3, q^2$ **2.** $4r^2, 2r^2, r$ **3.** $3z, 2y, -5x, 2$

HINT: Monomials with the same variable and power are like terms. All numbers without variables are like terms.

PRACTICE

Name the like terms in each list of terms.

4. $5a, 3b, 2a, 3b^2$ **5.** $6x, 3x, 4x$ **6.** $x^2, 3a, -4x$

7. m^4, m, m^2, m **8.** $-1, x^4, x^2, x, 5$ **9.** $y^3, -x^3, z^3$

10. $y^3, x^3, y^2, -3x^3$ **11.** $w, 1, 4w$ **12.** $5a^2, -18a^2, 7a^2$

Simplify each polynomial. Use drawings or algebra tiles if necessary.

13. $2b + 3 + 4b + 2$ **14.** $x^2 + 2x + 3x^2 + 4$ **15.** $2r^2 + 4r + 3r + r^2 + r$

16. $a - b + 3b - 1$ **17.** $2y + 2y^2 - 2y^2 + y$ **18.** $3a + 2a + a$

19. Money Matters Cesár put his \$50 cash birthday gift in a savings account. He also received \$50 last year and also put it in the account. Adding the interest x he made from his account, write an expression in simplest form that represents the amount of money in his account.

20. **Standardized Test Practice** Simplify the polynomial $x^2 + x + 2x^2 + 3$.

A $x^2 + 2x + 3$ **B** $4x^2 + 2x + 3$ **C** $3x^2 + x + 3$ **D** $2x^2 + x + 3$

Answers: 1. 3, -3; $2q^2$, q^2 2. $4r^2$, $2r^2$ 3. none 4. $5a$, $2a$ 5. $6x$, $3x$, $4x$ 6. none 7. m, m 8. -1, 5 9. none 10. x^3, $-3x^3$ 11. w, $4w$ 12. $5a^2$, $-18a^2$, $7a^2$ 13. $6b + 5$ 14. $4x^2 + 2x + 4$ 15. $3r^2 + 8r$ 16. $a + 2b - 1$ 17. $3y$ 18. $6a$ 19. $100 + x$ 20. C

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Adding Polynomials (Pages 570–572)

AF2.1

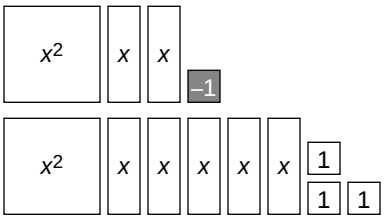
To add polynomials, add the like terms in each polynomial. You can use algebra tiles or pencil and paper to add polynomials.

EXAMPLES

Find each sum.

A $(x^2 + 2x - 1) + (x^2 + 5x + 3)$

Use algebra tiles to represent each polynomial.



Using the tiles, add like terms to find the sum, $2x^2 + 7x + 2$.

B $(2x^2 - x + 2) + (-x^2 + 3x + 2)$

Align the like terms in columns, then add.

$$\begin{array}{r} 2x^2 - x + 2 \\ +(-x^2) + 3x + 2 \\ \hline x^2 + 2x + 4 \end{array}$$

Try These Together

Find each sum.

1. $\begin{array}{r} y^2 + 2y + 1 \\ +\ y^2 - 3y - 2 \\ \hline \end{array}$

HINT: $2y + (-3y) = -y$

2. $\begin{array}{r} 3x^2 + y + 3 \\ +\ 2x^2 - 3y + 4 \\ \hline \end{array}$

HINT: $y + (-3y) = -2y$

3. $\begin{array}{r} 4m^2 + 2m + 5 \\ +\ 3m^2 + m - 4 \\ \hline \end{array}$

HINT: Like terms are in columns.

PRACTICE

Find each sum. Use drawings or algebra tiles if necessary.

4. $\begin{array}{r} 7x^2 - 6x - 2 \\ +\ 5x^2 + 3x - 4 \\ \hline \end{array}$

5. $\begin{array}{r} 10q^2 + 7q + 1 \\ +\ 8q^2 + 2q - 6 \\ \hline \end{array}$

6. $\begin{array}{r} 4a^2 + 4a + 4 \\ +\ (-3a^2) - 3a - 3 \\ \hline \end{array}$

Find each sum. Then evaluate if $x = 3$ and $y = 2$.

7. $(3x + 2y) + (2 + 3y)$

8. $(4x + y) + (-2x + 2y)$

9. $(-2x + 3y) + (3x - 4y)$

10. $(-4x - 3y) + (-x - y)$

11. $(5x + 3y) + (4x + 3y)$

12. $(x + y) + (y + x)$

13. **Standardized Test Practice** Find the sum. $\begin{array}{r} t^2 + 2t + 1 \\ +\ t^2 + 3t + 2 \\ \hline \end{array}$

A $t^2 + t + 3$ **B** $2t^2 + 5t + 3$ **C** $2t^2 + 5t^2 + 3$ **D** $t^2 + 5t + 3$

Answers: 1. $2y^2 - y - 1$ 2. $5x^2 - 2y + 7$ 3. $7m^2 + 3m + 1$ 4. $12x^2 - 3x - 6$ 5. $18q^2 + 9q - 5$ 6. $a^2 + a + 1$ 7. $3x + 5y + 2$; 21 8. $2x + 3y$; 12 9. $x - y$; 1 10. $-5x - 4y$; −23 11. $9x + 6y$; 39 12. $2x + 2y$; 10 13. B

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Subtracting Polynomials

(Pages 573–576)

AF2.1, MR2.8, MR3.1

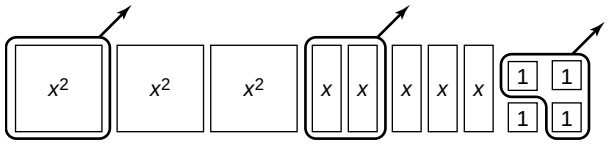
Subtracting polynomials is very similar to adding polynomials. You can use algebra tiles to subtract polynomials. You can also use paper and pencil. Since subtracting is the same as adding the opposite, use this procedure to subtract polynomials with paper and pencil.

EXAMPLES

Find each difference.

A $(3x^2 + 5x + 4) - (x^2 + 2x + 3)$

Use algebra tiles to represent the first polynomial.



To subtract, remove the tiles representing the second polynomial. The remaining tiles represent the difference, $2x^2 + 3x + 1$.

B $(2x^2 + 4x + 3) - (-x^2 + 3x + 2)$

Subtracting $-x^2 + 3x + 2$ is the same as adding the opposite, or $x^2 - 3x - 2$.

$$\begin{array}{r} 2x^2 + 4x + 3 \\ +\ x^2 - 3x - 2 \\ \hline 3x^2 + x + 1 \end{array}$$

Try These Together

Find each difference.

1. $\begin{array}{r} 4x + 4 \\ -\ (2x + 6) \\ \hline \end{array}$

HINT: The opposite of $2x + 6$ is $-2x - 6$.

2. $\begin{array}{r} 3x + 5 \\ -\ (x - 1) \\ \hline \end{array}$

HINT: The opposite of $x - 1$ is $-x + 1$.

3. $\begin{array}{r} 10x + 5 \\ -\ (5x + 1) \\ \hline \end{array}$

HINT: Add the opposite.

PRACTICE

Find each difference. Use drawings or algebra tiles if necessary.

4. $\begin{array}{r} 7y + 2 \\ -\ (4y + 3) \\ \hline \end{array}$

5. $\begin{array}{r} 8r^2 + 5a + 5 \\ -\ (6r^2 + 3a + 2) \\ \hline \end{array}$

6. $\begin{array}{r} 7a^2 + 4a + 4 \\ -\ (5a^2 + 2a + 2) \\ \hline \end{array}$

7. $(4b^2 + 4b + 4) - (-b^2 + b - 1)$

8. $(3b^2 + 3b + 3) - (2b^2 - 2b + 2)$

Find each difference and evaluate if $x = -3$ and $y = 4$.

9. $(6x + 3y) - (3x + 2y)$

10. $(5x + 5y) - (4x + 4y)$

11. **Standardized Test Practice** Find the difference $(5x + 3y) - (2x + 4y)$ and evaluate if $x = -2$ and $y = 5$.

A 13 **B** -29 **C** 6 **D** -11

Answers: 1. $2x - 2$ 2. $2x + 6$ 3. $5x + 4$ 4. $3y - 1$ 5. $2r^2 + 2a + 3$ 6. $2a^2 + 2a + 2$ 7. $5b^2 + 3b + 5$ 8. $b^2 + 5b + 1$ 9. $3x + y$; -5 10. $x + y$; 1 11. D

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13-5 Multiplying Monomials and Polynomials (Pages 578–581)

In order to multiply monomials and polynomials, you will multiply powers that have the same base.

Product of Powers	You can multiply powers that have the same base by adding their exponents. So, for any number a and integers m and n, $a^m \cdot a^n = a^{m+n}$.

EXAMPLES

Find each product.

A $5^5 \cdot 5^7$

$5^5 \cdot 5^7 = 5^{5+7}$ or 5^{12}

Check:

$5^5 \cdot 5^7 = (5 \cdot 5 \cdot 5 \cdot 5 \cdot 5)(5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5)$ or 5^{12}

B $x^3 \cdot x^5$

$x^3 \cdot x^5 = x^{3+5}$ or x^8

C $b \cdot b^4$

Remember, b is the same as b^1.

$b \cdot b^4 = b^1 \cdot b^4$ or b^5

D $g^3(g - 2)$

$g^3(g - 2) = g^3 \cdot g - g^3 \cdot 2$ Apply the distributive property.

$= g^4 - 2g^3$

Try These Together

Find each product. Express the answer in exponential form.

1. $2 \cdot 2$ **2.** $3^2 \cdot 3^2$ **3.** $x^2 \cdot x^3$

HINT: When you multiply powers, use the same base and use a new exponent that is the sum of the original ones. Bases with no exponent written have an understood exponent of 1.

PRACTICE

Find each product. Express the answer in exponential form.

4. $r^3 \cdot r^3$ **5.** $2r^2 \cdot r^2$ **6.** $3a \cdot a^5$

7. $2c \cdot c^4$ **8.** $x^5 \cdot x^{10}$ **9.** $y^7 \cdot y^9$

Find each product

10. $x(x + 2)$ **11.** $y(y - 3)$ **12.** $a(a + 4)$

13. $a^3(a - 3)$ **14.** $x^2(x^3 + 2)$ **15.** $r^3(r^5 - 5)$

16. $y^4(y^4 + 6)$ **17.** $2q^2(2q - 1)$ **18.** $3q^2(q^2 + 2)$

19. Geometry If a square has a side length of $7x$, what is the area of the square?

20. **Standardized Test Practice** Find the product $2x^6 \cdot x^{10}$.

A $2x^{16}$ **B** x^{16} **C** $2x^4$ **D** $2x^{60}$

Answers: 1. 2^2 2. 3^4 3. x^5 4. r^6 5. $2r^4$ 6. $3a^6$ 7. $2c^5$ 8. x^{15} 9. y^{16} 10. $x^2 + 2x$ 11. $y^2 - 3y$ 12. $a^2 + 4a$ 13. $a^4 - 3a^3$ 14. $x^5 + 2x^2$ 15. $r^8 - 5r^3$ 16. $y^8 + 6y^4$ 17. $4q^3 - 2q^2$ 18. $3q^4 + 6q^2$ 19. $49x^2$ 20. A

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13-6 Multiplying Binomials (Pages 583–585)

A **binomial** is a polynomial with two terms. Some examples of binomials are $x + 2$, $3y - 4$ and $r + s$. You can find the product of binomials by using algebra tiles or by using the distributive property.

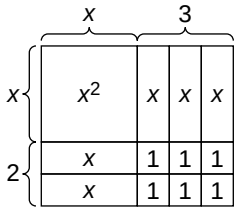
EXAMPLES

Find each product.

A $(x + 2)(x + 3)$

Use algebra tiles.

- *Make a rectangle with a width of $x + 2$ and a length of $x + 3$. Use algebra tiles to mark off the dimensions.*
- *Use the marks as a guide to fill in the rectangle with algebra tiles. The tiles represent the product $(x + 2)(x + 3) = x^2 + 5x + 6$.*



B $(x + 4)(x - 3)$

Use the distributive property.

$(x + 4)(x - 3) = x(x - 3) + 4(x - 3)$
$= x^2 - 3x + 4x - 12$
$= x^2 + x - 12$

Try These Together

Find each product. Use drawings or algebra tiles if necessary.

1. $(x + 3)(x + 4)$ **2.** $(y + 1)(y + 4)$ **3.** $(r + 2)(r + 2)$

HINT: Each product will have 3 terms.

PRACTICE

Find each product. Use drawings or algebra tiles if necessary.

4. $(x + 5)(x - 1)$ **5.** $(y - 2)(y + 2)$ **6.** $(a + 3)(a + 6)$

7. $(x + 5)(x - 5)$ **8.** $(2y + 2)(y + 4)$ **9.** $(3y - 4)(y + 1)$

10. $(2y + 5)(2y + 3)$ **11.** $(x - y)(x - y)$ **12.** $(a + b)(a + 2b)$

13. $(2x + y)(2x - 2y)$ **14.** $(2x + y)(2x + 2y)$ **15.** $(3b - 2c)(4b + c)$

16. Geometry The length and width of a rectangle are $4x + 2$ and $2x + 4$. What is the area of the rectangle?

17. **Standardized Test Practice** Find the product of $(x + 5)$ and $(x + 3)$.

A $x^2 + 8x + 8$ **B** $x^2 + 15x + 8$ **C** $x^2 + 8x + 15$ **D** $x^2 + 2x + 8$

Answers: 1. $x^2 + 7x + 12$ 2. $y^2 + 5y + 4$ 3. $r^2 + 4r + 4$ 4. $x^2 + 4x - 5$ 5. $y^2 - 4$ 6. $a^2 + 9a + 18$ 7. $x^2 - 25$
8. $2y^2 + 10y + 8$ 9. $3y^2 - y - 4$ 10. $4y^2 + 16y + 15$ 11. $x^2 - 2xy + y^2$ 12. $a^2 + 3ab + 2b^2$ 13. $4x^2 - 2xy - 2y^2$
14. $4x^2 + 6xy + 2y^2$ 15. $12b^2 - 5bc - 2c^2$ 16. $8x^2 + 20x + 8$ 17. C

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13-7 Factoring Polynomials (Pages 588–591)

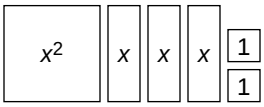
AF2.2

When you know a product but you want to find its factors, you use a process called **factoring**. You can use algebra tiles or pencil and paper to factor **trinomials**. A trinomial is a polynomial with three factors.

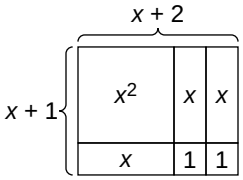
EXAMPLES

A Factor $x^2 + 3x + 2$.

Use algebra tiles to model the polynomial.



Try to form a rectangle with the tiles.



The rectangle has a width of $x + 1$ and a length of $x + 2$. Therefore, $x^2 + 3x + 2 = (x + 1)(x + 2)$.

B Factor $x^2 + 8x + 15$.

Use paper and pencil.

$x^2 + 8x + 15 = (x + \underline{?})(x + \underline{?})$

You know that there are two factors whose product is the polynomial.

Which two numbers have a sum of 8 and a product of 15? 3 and 5

So $x^2 + 8x + 15 = (x + 3)(x + 5)$.

Try These Together

Factor each polynomial.

1. $4x + 8$
HINT: One factor is 4.

2. $3r + 6$
HINT: One factor is $r + 2$.

3. $6x + 18$
HINT: The factors are a monomial and a binomial.

PRACTICE

Factor each polynomial.

4. $5x + 25$

5. $4y + 16$

6. $7a + 7$

7. $9q + 18$

8. $5x + 10$

9. $3x + 12$

If possible, factor each polynomial. Use drawings or algebra tiles if necessary.

10. $x^2 + 4x + 4$

11. $x^2 + 5x + 10$

12. $x^2 + 4x + 3$

13. $x^2 + 10x + 21$

14. $x^2 + 10x + 25$

15. $s^2 + 7s + 12$

16. For the polynomial $x^2 + 5x + \underline{?}$, write a positive integer in the blank that makes the polynomial factorable.

17. **Standardized Test Practice** If possible, factor the polynomial $x^2 + 4x + 5$.

A $(x + 4)(x + 1)$ **B** $(x + 1)(x + 4)$ **C** $(x + 3)(x + 2)$ **D** not possible

Answers: 1. $4(x + 2)$ 2. $3(r + 2)$ 3. $6(x + 3)$ 4. $5(x + 5)$ 5. $4(y + 4)$ 6. $7(a + 1)$ 7. $9(q + 2)$ 8. $5(x + 2)$ 9. $3(x + 4)$
10. $(x + 2)(x + 2)$ 11. not factorable 12. $(x + 1)(x + 3)$ 13. $(x + 3)(x + 7)$ 14. $(x + 5)(x + 5)$ 15. $(s + 3)(s + 4)$ 16. 4 or 6 17. D

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Chapter 13 Review

AF1.3, AF1.4

Rewind/Fast Forward

"Rewind" by factoring each polynomial completely. Then draw a line through the answer in the right column. "Fast forward" by multiplying your answer to check it. The letters that are left will spell the name of an animal.

Rewind.

1. $16x + 8$

2. $x^2 + 5x$

3. $x^2 + 6x + 8$

4. $x^2 + 6x + 9$

5. $x^2 + 7x + 12$

6. $x^2 + 8x + 12$

7. $x^2 + 3x + 2$

8. $2x + 6$

9. $x^2 + 7x + 6$

10. $x^2 + 5x + 6$

Fast Forward.

$x(2 + 5)$	E
$2(x + 3)$	A
$(x + 2)(x + 6)$	D
$(x + 3)(x + 3)$	Q
$x(x + 5)$	F
$(x + 1)(x + 6)$	I
$4(4x + 2)$	S
$(x + 2)(x + 10)$	H
$(x + 3)(x + 2)$	M
$(x + 4)(x + 2)$	N
$8(2x + 1)$	G
$(x + 4)(x + 12)$	O
$(x + 3)(x + 4)$	P
$(x + 8)(x - 8)$	R
$(x + 1)(x + 2)$	T

Answers are located on page 125.