SUBTRACTING POLYNOMIALS To subtract a polynomial, add its opposite. To find the opposite of a polynomial, multiply each of its terms by −1.

EXAMPLE 4 Subtract polynomials

Find the difference.

a. $(4n^2 + 5) - (-2n^2 + 2n - 4)$ **b.** $(4x^2 - 3x + 5) - (3x^2 - x - 8)$

Solution

a.
$$\begin{array}{r} (4n^2 \quad + 5) \\ -(-2n^2 + 2n - 4) \\ \hline 6n^2 - 2n + 9 \end{array} \quad \rightarrow \quad \begin{array}{r} 4n^2 \quad + 5 \\ +\ 2n^2 - 2n + 4 \\ \hline 6n^2 - 2n + 9 \end{array}$$

AVOID ERRORS Remember to multiply *each* term in the polynomial by −1 when you write the subtraction as addition.

b. $(4x^2 - 3x + 5) - (3x^2 - x - 8) = 4x^2 - 3x + 5 - 3x^2 + x + 8$

$= (4x^2 - 3x^2) + (-3x + x) + (5 + 8)$

$= x^2 - 2x + 13$

EXAMPLE 5 Solve a multi-step problem

BASEBALL ATTENDANCE Major League Baseball teams are divided into two leagues. During the period 1995–2001, the attendance N and A (in thousands) at National and American League baseball games, respectively, can be modeled by

$N = -488t^2 + 5430t + 24{,}700$ and

$A = -318t^2 + 3040t + 25{,}600$

where t is the number of years since 1995. About how many people attended Major League Baseball games in 2001?

Solution

STEP 1 **Add** the models for the attendance in each league to find a model for M, the total attendance (in thousands).

$M = (-488t^2 + 5430t + 24{,}700) + (-318t^2 + 3040t + 25{,}600)$

$= (-488t^2 - 318t^2) + (5430t + 3040t) + (24{,}700 + 25{,}600)$

$= -806t^2 + 8470t + 50{,}300$

AVOID ERRORS Because a value of M represents *thousands* of people, $M \approx 72{,}100$ represents 72,100,000 people.

STEP 2 **Substitute** 6 for t in the model, because 2001 is 6 years after 1995.

$M = -806(6)^2 + 8470(6) + 50{,}300 \approx 72{,}100$

▶ About 72,100,000 people attended Major League Baseball games in 2001.

GUIDED PRACTICE for Examples 4 and 5

4. Find the difference $(4x^2 - 7x) - (5x^2 + 4x - 9)$. $-x^2 - 11x + 9$

5. **BASEBALL ATTENDANCE** Look back at Example 5. Find the difference in attendance at National and American League baseball games in 2001.

5. about 7,320,000 people

Extra Example 4

Find the difference.

a. $(2c^2 - 8) - (3c^2 - 4c + 1)$
$-c^2 + 4c - 9$

b. $(5y^2 + 2y - 4) - (-y^2 + 4y - 3)$
$6y^2 - 2y - 1$

Key Question to Ask for Example 4

- How do you group terms in the horizontal format for part (a)?
$(4n^2 - (-2n^2)) + (-2n) + (5 - (-4))$

Extra Example 5

During the period 1999–2005, the number of hours an individual person watched broadcast television B and cable and satellite television C can be modeled by $B = 2.8t^2 - 35t + 879$ and $C = -5t^2 + 80t + 712$ where t is the number of years since 1999. About how many hours did people watch television in 2002? about 1706 h

Closing the Lesson

Have students summarize the major points of the lesson and answer the Essential Question: How do you add and subtract polynomials?

- A polynomial is a monomial or the sum of monomials. The degree of a polynomial is the greatest degree of its terms.
- Use a vertical or horizontal format to add and subtract polynomials.

To use a vertical format, align like terms in columns. To use a horizontal format, group like terms and simplify. To add, add the terms. To subtract, add the opposite of each term of the subtracted polynomial.

Differentiated Instruction

Advanced Have students use the online U.S. Statistical Abstract to research a favorite sport or activity. Have them create a problem similar to **Example 5** using data that appear nonlinear. If necessary, they can review the Activity on page 342 on using the Abstract. They can enter data on a graphing calculator and use the quadratic and cubic regression option to find a best-fit equation. Students can discuss which equations best fit the data and exchange and solve each other's problems.

See also the *Algebra 1 Toolkit* for more strategies.

9.1 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS1 for Exs. 21 and 39

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 9, 10, 39, and 41

SKILL PRACTICE

A

1. **VOCABULARY** Copy and complete: A number, a variable, or the product of one or more variables is called a(n) _?_. monomial

2. ★ **WRITING** Is 6 a polynomial? *Explain* why or why not. Yes; a polynomial is a monomial or a sum of monomials, since 6 is a monomial, it is also a polynomial.

EXAMPLE 1 on p. 554 for Exs. 3–9

REWRITING POLYNOMIALS **Write the polynomial so that the exponents decrease from left to right. Identify the degree and leading coefficient of the polynomial.**

3. $9m^5$ $9m^5$; 5, 9
4. $2 - 6y$ $-6y + 2$; 1, -6
5. $2x^2y^2 - 8xy$ $2x^2y^2 - 8xy$; 4, 2
6. $5n^3 + 2n - 7$ $5n^3 + 2n - 7$; 3, 5
7. $5z + 2z^3 - z^2 + 3z^4$ $3z^4 + 2z^3 - z^2 + 5z$; 4, 3
8. $-2h^2 + 2h^4 - h^6$ $-h^6 + 2h^4 - 2h^2$; 6, -1

9. ★ **MULTIPLE CHOICE** What is the degree of $-4x^3 + 6x^4 - 1$? C

   (A) -4 (B) 3 (C) 4 (D) 6

EXAMPLE 2 on p. 555 for Exs. 10–16

10. ★ **MULTIPLE CHOICE** Which expression is *not* a monomial? D

    (A) $-5x^2$ (B) $0.2y^4$ (C) $3mn$ (D) $3s^{-2}$

IDENTIFYING AND CLASSIFYING POLYNOMIALS **Tell whether the expression is a polynomial. If it is a polynomial, find its degree and classify it by the number of its terms. Otherwise, tell why it is not a polynomial.**

11. -4^x not a polynomial; variable exponent
12. $w^{-3} + 1$ not a polynomial; negative exponent
13. $3x - 5$ 1 polynomial, binomial
14. $\frac{4}{5}f^2 - \frac{1}{2}f + \frac{2}{3}$ polynomial; 2, trinomial
15. $6 - n^2 + 5n^3$ polynomial; 3, trinomial
16. $10y^4 - 3y^2 + 11$ polynomial; 4, trinomial

EXAMPLES 3 and 4 on pp. 555–556 for Exs. 17–28

ADDING AND SUBTRACTING POLYNOMIALS **Find the sum or difference.**

17. $(5a^2 - 3) + (8a^2 - 1)$ $13a^2 - 4$
18. $(h^2 + 4h - 4) + (5h^2 - 8h + 2)$ $6h^2 - 4h - 2$
19. $(4m^2 - m + 2) + (-3m^2 + 10m + 7)$ $m^2 + 9m + 9$
20. $(7k^2 + 2k - 6) + (3k^2 - 11k - 8)$ $10k^2 - 9k - 14$
21. $(6c^2 + 3c + 9) - (3c - 5)$ $6c^2 + 14$
22. $(3x^2 - 8) - (4x^3 + x^2 - 15x + 1)$ $-4x^3 + 2x^2 + 15x - 9$
23. $(-n^2 + 2n) - (2n^3 - n^2 + n + 12)$ $-2n^3 + n - 12$
24. $(9b^3 - 13b^2 + b) - (-13b^2 - 5b + 14)$ $9b^3 + 6b - 14$
25. $(4d - 6d^3 + 3d^2) - (9d^3 + 7d - 2)$ $-15d^3 + 3d^2 - 3d + 2$
26. $(9p^2 - 6p^3 + 3 - 11p) + (7p^3 - 3p^2 + 4)$ $p^3 + 6p^2 - 11p + 7$

ERROR ANALYSIS ***Describe*** **and correct the error in finding the sum or difference of the polynomials.**

27.
$$\begin{array}{r} x^3 - 4x^2 + 3 \\ +\ -3x^3 + 8x - 2 \\ \hline -2x^3 + 4x^2 + 1 \end{array}$$


28.
$$(6x^2 - 5x) - (2x^2 + 3x - 2)$$
$$= (6x^2 - 2x^2) + (-5x + 3x) - 2$$
$$= 4x^2 - 2x - 2$$


27. Two unlike terms, $-4x^2$ and $8x$, were combined; $-2x^3 - 4x^2 + 8x + 1$.

28. When the subtraction was rewritten as addition, the last two terms of the second polynomial were not multiplied by -1; $(6x^2 - 2x^2) + (-5x - 3x) + 2$, $4x^2 - 8x + 2$.

B

29. **POLYNOMIAL FUNCTIONS** Find the sum $f(x) + g(x)$ and the difference $f(x) - g(x)$ for the functions $f(x) = 3x^2 + x - 7$ and $g(x) = -x^2 + 5x - 2$. $2x^2 + 6x - 9$, $4x^2 - 4x - 5$

Differentiated Instruction

English Learners Prefixes such as *mono-*, *bi-*, *tri-*, and *poly-* occur often in English. For example, the word *monotonous* means "one tone" and the word *bisect* means "cut into two." For some English learners, these prefixes do not occur in their native language, so the meanings of the terms *monomial*, *binomial*, *trinomial*, and *polynomial* may not be familiar. Try using more common language such as saying "one term" instead of monomial in classifying various polynomials.

See also the *Algebra 1 Toolkit* for more strategies.

4 PRACTICE AND APPLY

Assignment Guide

Answer Transparencies available for all exercises

Basic:
Day 1: pp. 557–559
Exs. 1, 2, 3–7 odd, 9, 10, 11–25 odd, 27–31, 37–40, 43–53 odd

Average:
Day 1: pp. 557–559
Exs. 1, 2, 6–10, 12–26 even, 27–34, 37–41, 44, 47, 50, 53

Advanced:
Day 1: pp. 557–559
Exs. 1, 2, 7–10, 14–16, 18–26 even, 29–42*, 48, 51, 54

Block:
pp. 557–559
Exs. 1, 2, 6–10, 12–26 even, 27–34, 37–41, 44, 47, 50, 53 (with 9.2)

Differentiated Instruction

See *Algebra 1 Best Practices Toolkit* for suggestions on addressing the needs of a diverse classroom.

Homework Check

For a quick check of student understanding of key concepts, go over the following exercises:

Basic: 4, 13, 17, 23, 37

Average: 6, 14, 18, 24, 38

Advanced: 8, 16, 20, 25, 39

Extra Practice

- Student Edition, p. 946
- Chapter 9 Resource Book: Practice levels A, B, C, pp. 7–9

Practice Worksheet

An easily-readable reduced practice page (with answers) for this lesson can be found on p. 552C.