



8-2

Adding, Subtracting, and Multiplying Polynomials

TEKS FOCUS

TEKS (7)(B) Add, subtract, and multiply polynomials.

TEKS (1)(E) Create and use **representations** to organize, record, and communicate mathematical ideas.

VOCABULARY

- **Representation** – a way to display or describe information. You can use a representation to present mathematical ideas and data.

ESSENTIAL UNDERSTANDING

You can add, subtract, and multiply two polynomials. The result is always another polynomial, so the set of polynomials is closed under addition, subtraction, and multiplication. In this respect polynomials are like the integers, which share the same closure properties.



Problem 1

Plan

What methods can you use to add polynomials?

You can add vertically or horizontally by grouping like terms. Then add the coefficients. These sums are the coefficients of the resulting polynomial.

Adding Polynomials

What is the sum of $7x^3 - 4x^2 + 5x$ and $3x^3 - 11x + 2$?

Method 1 Add vertically.

$$\begin{array}{r}
 7x^3 - 4x^2 + 5x \\
 + 3x^3 \quad - 11x + 2 \\
 \hline
 10x^3 - 4x^2 - 6x + 2
 \end{array}$$

Line up like terms.
Combine like terms.

Method 2 Add horizontally.

$$\begin{aligned}
 (7x^3 - 4x^2 + 5x) + (3x^3 - 11x + 2) \\
 = (7x^3 + 3x^3) + (-4x^2) + (5x - 11x) + 2 & \text{Group like terms.} \\
 = 10x^3 - 4x^2 - 6x + 2 & \text{Combine like terms.}
 \end{aligned}$$



Problem 2

TEKS Process Standard (1)(E)

Think

How do you subtract each term of the second polynomial?

To group like terms, you can line them up vertically. Then find the differences of the coefficients. These differences are the coefficients of the resulting polynomial.

Subtracting Polynomials

What is the difference $(6x^4 - 2x^2 + 3x) - (4x^4 - 9x^2 + 7)$?

Method 1 Subtract vertically.

$$\begin{array}{r}
 6x^4 - 2x^2 + 3x \\
 -(4x^4 - 9x^2 + 7) \\
 \hline
 6x^4 - 2x^2 + 3x \\
 -4x^4 + 9x^2 \quad - 7 \\
 \hline
 2x^4 + 7x^2 + 3x - 7
 \end{array}$$

Line up like terms.
Combine like terms.

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Problem 2 *continued***Method 2** Subtract horizontally.

$$\begin{aligned}
& (6x^4 - 2x^2 + 3x) - (4x^4 - 9x^2 + 7) \\
&= (6x^4 - 2x^2 + 3x) - 4x^4 + 9x^2 - 7 \\
&= (6x^4 - 4x^4) + (-2x^2 + 9x^2) + (3x) - 7 \\
&= 2x^4 + 7x^2 + 3x - 7
\end{aligned}$$

Write the opposite of each term of the second polynomial.

Combine like terms.

Combine like terms.

**Problem 3****Multiplying Polynomials****A** What is the product $(2x + 3y)(7x - 4y)$?

$$\begin{aligned}
(2x + 3y)(7x - 4y) &= 14x^2 - 8xy + 21xy - 12y^2 \\
&= 14x^2 + 13xy - 12y^2
\end{aligned}$$

Use the FOIL method.

Combine like terms.

B What is the product $(x - 5)(4x^2 + 9x - 1)$?

$$\begin{aligned}
(x - 5)(4x^2 + 9x - 1) \\
&= x(4x^2 + 9x - 1) - 5(4x^2 + 9x - 1) \\
&= 4x^3 + 9x^2 - x - 20x^2 - 45x + 5 \\
&= 4x^3 - 11x^2 - 46x + 5
\end{aligned}$$

Distributive Property

Combine like terms.

C What is the product $(c^2 + 2)(c - 3)(2c + 1)$?

$$\begin{aligned}
& (c^2 + 2)(c - 3)(2c + 1) \\
&= (c^2 + 2)(2c^2 - 5c - 3) \\
&= c^2(2c^2 - 5c - 3) + 2(2c^2 - 5c - 3) \\
&= 2c^4 - 5c^3 - 3c^2 + 4c^2 - 10c - 6 \\
&= 2c^4 - 5c^3 + c^2 - 10c - 6
\end{aligned}$$

Multiply $(c - 3)$ and $(2c + 1)$.

Distributive Property

Combine like terms.

Think**What technique can you use to multiply polynomials?**

Since all polynomial multiplication is performed by distributing one factor to all terms of a second factor, you can use the Distributive Property.

**PRACTICE and APPLICATION EXERCISES**

Scan page for a Virtual Nerd™ tutorial video.

For additional support when completing your homework, go to PearsonTEXAS.com.**Find each sum.**

1. $(9x^2 - 7x + 12) + (-5x^2 + 2x)$

2. $(6x^2 + 8x - 2) + (3x^2 - 9x - 4)$

Find each difference.

3. $(4x^3 + 3x^2 + 5x) - (8x^2 - x + 11)$

4. $(-x^2 - 10x + 7) - (-2x^2 + 3x - 1)$

Find each product.

5. $(x - 6)(x + 2)$

6. $(x + 4)(2x^2 - x + 8)$

PearsonTEXAS.com

7. Apply Mathematics (1)(A) The length of a rectangle is 12 feet longer than the width. Write an expression to show the area of a rectangle.

8. Apply Mathematics (1)(A) Ryan planted flowers in a rectangular garden. The width of the garden is $(x - 5)$ feet and the length of the garden is 2 feet longer than the width. Write an expression for the area of the garden.

9. Apply Mathematics (1)(A) The cost of running a company last year was $4x^2 - 6x + 35,000$, where x is the number of widgets produced. The amount of revenue the company made last year was $9x^2 - 12x + 104,500$, where x is the number of widgets produced. Write an expression for the profit the company made last year for producing x widgets.

10. Explain Mathematical Ideas (1)(G) Is the difference of two polynomials P_1 and P_2 always a polynomial? Explain.

Simplify each expression.

11. $(-x^2 - 12x - 29) + (5x^3 + 4x - 7x^2 + 6)$

12. $(-7x + 3) + (-x^2 + 9x - 1) - (-4x^2 + 12x - 2)$

13. $(x + 3)(x - 7) + (6x^2 - 7x - 12)$

14. $(x - 5)(3x^2 + 4x - 1) - (-x^3 + 7x^2 - 6)$

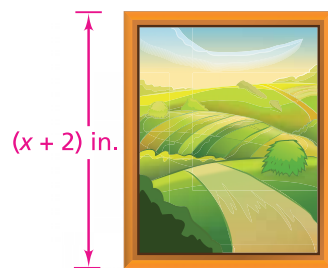
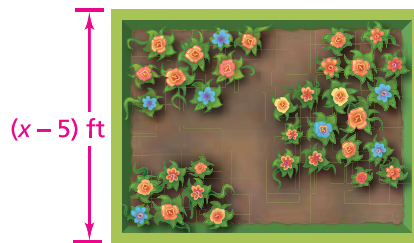
15. $(x + 3)(x - 8)(x + 1)$

16. $(2x + 4y)(x - 2y)(3x + y)$

17. Apply Mathematics (1)(A) Edith has a rectangular picture frame. The length of the frame is $(x + 2)$ inches, and the width of the frame is 5 inches shorter than the length. Write an expression for the perimeter of the picture frame.

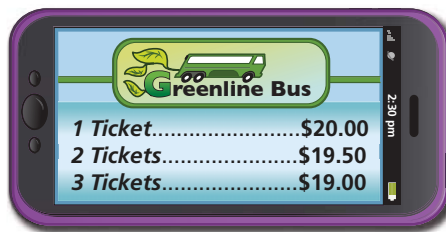
18. Evaluate Reasonableness (1)(B) Describe and correct the error at the right in determining the sum of the expressions.

$$\begin{aligned} & \cancel{(9x^2 + x - 4) + (2 - x^2 - 16x)} \\ & = \cancel{(9x^2 + x^2) + (x - 16x) + (-4 + 2)} \\ & = \cancel{10x^2 - 15x - 2} \end{aligned}$$



19. **Apply Mathematics (1)(A)** A bus station charges \$20.00 if a customer buys one ticket. If a customer buys two tickets, the cost of each ticket is \$19.50. If a customer buys three tickets, the cost of each ticket is \$19.00.

- Explain what happens to the price as the number of tickets sold increases.
- Write an expression for the cost of buying x tickets.
- Simplify the expression.



Greenline Bus	
1 Ticket.....	\$20.00
2 Tickets.....	\$19.50
3 Tickets.....	\$19.00

20. **Apply Mathematics (1)(A)** Jackie is mailing packages to 100 customers. The cost of materials to ship all of the packages is \$50.00. The rates for shipping are \$15.75 per out-of-state package and \$5.50 per in-state package. Write a simplified polynomial to express the total cost to mail the packages if x packages are shipped in state and the rest are shipped out of state.



TEXAS Test Practice

21. A savings account earns 4.62% annual interest, compounded continuously. After approximately how many years will a principal of \$500 double?

- A. 2 years B. 10 years C. 15 years D. 44 years

22. What is the inverse of the function $f(x) = \sqrt{x-4}$?

- F. $f^{-1}(x) = x^2 - 4, x \geq 0$ H. $f^{-1}(x) = \sqrt{x+4}$
 G. $f^{-1}(x) = x^2 + 4, x \geq 0$ J. $f^{-1}(x) = \frac{\sqrt{x-4}}{x-4}$

In Exercises 23 and 24, let $f(x) = x^2 - 4$ and $g(x) = \frac{1}{x+4}$.

23. What is $(g \circ f)(x)$?

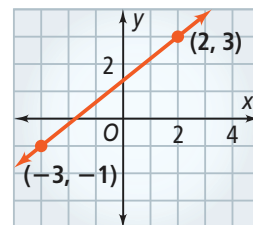
- A. $\frac{1}{x^2}$ C. $\frac{x^2-4}{x+4}$
 B. $\frac{1}{x^2-8x+16} - 4$ D. $x-4$

24. What is $(f \circ f)(3)$?

- F. 1 G. 5 H. 21 J. 77

25. What is the equation of the line shown at the right?

- A. $y = -\frac{4}{5}x + 2$ C. $-4x + 5y = 7$
 B. $y = \frac{5}{4}x - 2$ D. $4x - 5y = 15$



26. How much should you invest in an account that pays 6% annual interest compounded continuously if you want exactly \$8000 after four years? Show your work.

