4–5 Multiplying Polynomials by Monomials

Objective: To multiply a polynomial by a monomial.

Example 1 Multiply: $x(x + 4)$

Solution 1 $x(x + 4) = x(x) + x(4)$
$= x^2 + 4x$

Solution 2
$$\begin{array}{r} x + 4 \\ x \\ \hline x^2 + 4x \end{array}$$
Multiply each term by x.

Multiply.

1. $3(x - 2)$ $\mathbf{3x - 6}$
2. $-2(x + 3)$ $\mathbf{-2x - 6}$
3. $c(c - 4)$ $\mathbf{c^2 - 4c}$
4. $a(3 - 2a)$ $\mathbf{3a - 2a^2}$
5. $-2b(3 - 4b)$ $\mathbf{-6b + 8b^2}$
6. $-3c(4c + 1)$ $\mathbf{-12c^2 - 3c}$
7. $5y(y + 6)$ $\mathbf{5y^2 + 30y}$
8. $-z(4 - 5z)$ $\mathbf{-4z + 5z^2}$

Example 2 Multiply: $-2x(3x^2 - 2x + 1)$

Solution 1 Multiply each term of the polynomial $3x^2 - 2x + 1$ by the monomial $-2x$.

$-2x(3x^2 - 2x + 1) = -2x(3x^2) - 2x(-2x) - 2x(1)$
$= -6x^3 + 4x^2 - 2x$

Solution 2
$$\begin{array}{r} 3x^2 - 2x + 1 \\ -2x \\ \hline -6x^3 + 4x^2 - 2x \end{array}$$

Multiply.

9. $3x(x^2 - x - 2)$ $\mathbf{3x^3 - 3x^2 - 6x}$
10. $-2x(x^2 - 4x + 5)$ $\mathbf{-2x^3 + 8x^2 - 10x}$
11. $-4x(2x^2 - 3x - 7)$ $\mathbf{-8x^3 + 12x^2 + 28x}$
12. $5x^2(x^2 + x - 3)$ $\mathbf{5x^4 + 5x^3 - 15x^2}$
13. $-6x^2(x^2 - x - 12)$ $\mathbf{-6x^4 + 6x^3 + 72x^2}$
14. $4x^3(x^2 - 3x - 6)$ $\mathbf{4x^5 - 12x^4 - 24x^3}$
15. $\begin{array}{r} 3a^2 - 4a - 6 \\ 2a \\ \hline \mathbf{6a^3 - 8a^2 - 12a} \end{array}$
16. $\begin{array}{r} 4a^2 - 5a - 7 \\ 5a \\ \hline \mathbf{20a^3 - 25a^2 - 35a} \end{array}$
17. $\begin{array}{r} 5x^2 - x - 3 \\ 2x^2 \\ \hline \mathbf{10x^4 - 2x^3 - 6x^2} \end{array}$
18. $\begin{array}{r} 2k^2 - 3k - 5 \\ -4k^3 \\ \hline \mathbf{-8k^5 + 12k^4 + 20k^3} \end{array}$

Example 3 Multiply: $4x^2y(5x^2 - 3xy + 2y^2)$

Solution Multiply each term of the polynomial by $4x^2y$.

$4x^2y(5x^2 - 3xy + 2y^2) = 4x^2y(5x^2) + 4x^2y(-3xy) + 4x^2y(2y^2)$
$= 20x^4y - 12x^3y^2 + 8x^2y^3$

Multiply.

19. $3x^2y(4x^2 - 5xy - 2y^2)$ $\mathbf{12x^4y - 15x^3y^2 - 6x^2y^3}$
20. $xy^2(x^2 - 4xy - 5y^2)$ $\mathbf{x^3y^2 - 4x^2y^3 - 5xy^4}$
21. $-2xy(4x^2 - 3xy + y^2)$ $\mathbf{-8x^3y + 6x^2y^2 - 2xy^3}$
22. $\frac{1}{3}x^2y(6x^2 - 12xy + 9y^2)$ $\mathbf{2x^4y - 4x^3y^2 + 3x^2y^3}$

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4–5 Multiplying Polynomials by Monomials *(continued)*

Multiply. $\mathbf{6x^3y^2 - 14x^2y^3 - 4xy^4}$

23. $2xy^2(3x^2 - 7xy - 2y^2)$ $\mathbf{-4x^5y + 12x^4y^2 + 24x^3y^3}$
24. $-4x^3y(x^2 - 3xy - 6y^2)$
25. $5xy(2x^2 - 4xy + y^2)$ $\mathbf{10x^3y - 20x^2y^2 + 5xy^3}$
26. $\frac{1}{2}x^2y^2(6x^2 - 4xy - 8y^2)$ $\mathbf{3x^4y^2 - 2x^3y^3 - 4x^2y^4}$

Example 4 Simplify $3n(n + 2) + n(5 - n)$.

Solution
$3n(n + 2) + n(5 - n) = 3n(n) + 3n(2) + n(5) - n(n)$ — Use the distributive property.
$= 3n^2 + 6n + 5n - n^2$
$= 2n^2 + 11n$ — Combine similar terms.

Simplify.

27. $2x(x - 3) + 3x(x + 2)$ $\mathbf{5x^2}$
28. $4x(3 - 2x) + 5x(x - 1)$ $\mathbf{-3x^2 + 7x}$
29. $5x^2(2x - 1) - 2x(3x^2 - 4x)$ $\mathbf{4x^3 + 3x^2}$
30. $3y(4y^2 - 3y) - 2y^2(y + 1)$ $\mathbf{10y^3 - 11y^2}$
31. $2n^2(4n - 5) - 3n(2n^2 - 7n)$ $\mathbf{2n^3 + 11n^2}$
32. $2x(5x^2 - 3x) - x^2(x + 6)$ $\mathbf{9x^3 - 12x^2}$

Example 5 Solve $n(2 - 3n) + 3(n^2 - 4) = 0$.

Solution
$n(2 - 3n) + 3(n^2 - 4) = 0$ — Use the distributive property.
$2n - 3n^2 + 3n^2 - 12 = 0$ — Combine similar terms.
$2n - 12 = 0$
$2n = 12$ — To undo the subtraction of 12 from $2n$, add 12 to each side. To undo the multiplication of n by 2, divide each side by 2.
$n = 6$

The solution set is $\{6\}$.

Solve.

33. $2(x - 1) + 3 = 7$ $\{\mathbf{3}\}$
34. $3(y - 2) + 1 = 10$ $\{\mathbf{5}\}$
35. $2(2m - 3) - 3(2m - 1) = 9$ $\{\mathbf{-6}\}$
36. $4(3a - 1) - 5(1 - a) = 8$ $\{\mathbf{1}\}$
37. $y(3 - 2y) + 2(y^2 - 6) = 0$ $\{\mathbf{4}\}$
38. $0 = 3(1 - 2x) - 5(3 - x)$ $\{\mathbf{-12}\}$
39. $x(2 - 3x) + 3(x^2 - 6) = 0$ $\{\mathbf{9}\}$
40. $2x(1 - 3x) + 6(x^2 - 2) = 0$ $\{\mathbf{6}\}$

Mixed Review Exercises

Simplify.

1. $(2xy^2)^3$ $\mathbf{8x^3y^6}$
2. $(-4a^4b^3)^2$ $\mathbf{16a^8b^6}$
3. $(-2n)^4$ $\mathbf{16n^4}$
4. $(2a^2b)^2(3ab^2)^3$ $\mathbf{108a^7b^8}$
5. $(3x^2)(4x^3) + (2x^3)(5x^2)$ $\mathbf{22x^5}$
6. $(4n^3)n^2 - n^3(3n^2)$ $\mathbf{n^5}$
7. $(6p - 2q + 4) + (2p + 3q)$ $\mathbf{8p + q + 4}$
8. $(3x + y - 2) - (y - x - 3)$ $\mathbf{4x + 1}$
9. $(4x^3)^2(2x^2y)^3$ $\mathbf{128x^{12}y^3}$
10. $(7x^5)(2x) + (6x^4)(4x^2)$ $\mathbf{38x^6}$

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