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4–6 Multiplying Polynomials

Objective: To multiply polynomials.

Example 1 Multiply: $(2x - 3)(x^2 - 4x - 5)$

Solution You can find the product by arranging your work in vertical form. Each term of one polynomial must be multiplied by each term of the other polynomial.

Step 1: Multiply by $2x$.

$$\begin{array}{r} x^2 - 4x - 5 \\ \underline{2x - 3} \\ 2x^3 - 8x^2 - 10x \end{array}$$

Step 2: Multiply by -3.

$$\begin{array}{r} x^2 - 4x - 5 \\ \underline{2x - 3} \\ 2x^3 - 8x^2 - 10x \\ \quad - 3x^2 + 12x + 15 \end{array}$$

↑ ↑ Align similar terms.

Step 3: Add the results of Steps 1 and 2.

$$\begin{array}{r} x^2 - 4x - 5 \\ \underline{2x - 3} \\ 2x^3 - 8x^2 - 10x \\ \quad - 3x^2 + 12x + 15 \\ \hline 2x^3 - 11x^2 + 2x + 15 \end{array}$$

Multiply. Use the vertical form.

1. $2a + 1$, $a + 6$ → $\mathbf{2a^2 + 13a + 6}$
2. $3n + 6$, $2n - 5$ → $\mathbf{6n^2 - 3n - 30}$
3. $3x - 7$, $2x + 1$ → $\mathbf{6x^2 - 11x - 7}$
4. $4t - 1$, $3t - 2$ → $\mathbf{12t^2 - 11t + 2}$
5. $3x - 4y$, $5x - 2y$ → $\mathbf{15x^2 - 26xy + 8y^2}$
6. $2c - 5d$, $3c + d$ → $\mathbf{6c^2 - 13cd - 5d^2}$
7. $5c - 3d$, $2c + d$ → $\mathbf{10c^2 - cd - 3d^2}$
8. $3x^2 - x - 4$, $x + 4$ → $\mathbf{3x^3 + 11x^2 - 8x - 16}$
9. $a^2 - 5a - 7$, $3a + 2$ → $\mathbf{3a^3 - 13a^2 - 31a - 14}$
10. $4y^2 - 5y - 2$, $2y - 1$ → $\mathbf{8y^3 - 14y^2 + y + 2}$
11. $a^2 - ab + b^2$, $a + b$ → $\mathbf{a^3 + b^3}$
12. $2x^2 - xy + y^2$, $2x + y$ → $\mathbf{4x^3 + xy^2 + y^3}$

Example 2 Multiply: $(3x - 2)(2x + 5)$

Solution

$$\begin{aligned} (3x - 2)(2x + 5) &= (3x - 2)2x + (3x - 2)5 \quad \text{Use the distributive property.} \\ &= 6x^2 - 4x + 15x - 10 \\ &= 6x^2 + 11x - 10 \quad \text{Combine like terms.} \end{aligned}$$

Multiply. Use the horizontal form.

13. $(a + 2)(a + 3)$ $\mathbf{a^2 + 5a + 6}$
14. $(b + 4)(b + 5)$ $\mathbf{b^2 + 9b + 20}$
15. $(x - 3)(x + 8)$ $\mathbf{x^2 + 5x - 24}$
16. $(c + 1)(c - 4)$ $\mathbf{c^2 - 3c - 4}$
17. $(2a - 1)(a + 4)$ $\mathbf{2a^2 + 7a - 4}$
18. $(3a + 4)(a - 1)$ $\mathbf{3a^2 + a - 4}$
19. $(2a + 3)(5a - 1)$ $\mathbf{10a^2 + 13a - 3}$
20. $(4k - 5)(2k + 6)$ $\mathbf{8k^2 + 14k - 30}$
21. $(x - 1)(2x^2 + 3x + 4)$ $\mathbf{2x^3 + x^2 + x - 4}$
22. $(2a + 1)(a^2 + 2a + 5)$
23. $(t - 3)(3t^2 + 3t - 4)$
24. $(t - 2)(2t^2 - 3t - 4)$ $\mathbf{2t^3 - 7t^2 + 2t + 8}$
25. $(2x - 3)(3x^2 - 4x - 2)$

23. $\mathbf{3t^3 - 6t^2 - 13t + 12}$

25. $\mathbf{6x^3 - 17x^2 + 8x + 6}$

26. $(3x - 4)(2x^2 - x + 1)$

22. $\mathbf{2a^3 + 5a^2 + 12a + 5}$

26. $\mathbf{6x^3 - 11x^2 + 7x - 4}$

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4–6 Multiplying Polynomials *(continued)*

CAUTION It often is helpful to rearrange the terms of a polynomial so that the degrees of a particular variable are in either increasing order or decreasing order. For example:

In order of decreasing degree of x:

$$x^4 - 2x^3 - 5x + 6$$

In order of increasing degree of x:

$$6 - 5x - 2x^3 + x^4$$

In order of decreasing degree of x and increasing degree of y:

$$x^4 - 5x^3y + 3x^2y^2 - 6xy^3 + 9y^4$$

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

Solution

$$\begin{array}{r} x^3 - y^3 + 2x^2y + 3xy^2 \\ \underline{y + 3x} \end{array}$$

Rearrange in order of decreasing degree of x and increasing degree of y.

$$\begin{array}{r} x^3 + 2x^2y + 3xy^2 - y^3 \\ \underline{3x + y} \\ 3x^4 + 6x^3y + 9x^2y^2 - 3xy^3 \\ \quad x^3y + 2x^2y^2 + 3xy^3 - y^4 \\ \hline 3x^4 + 7x^3y + 11x^2y^2 \quad - y^4 \end{array}$$

Therefore $(y + 3x)(x^3 - y^3 + 2x^2y + 3xy^2) = 3x^4 + 7x^3y + 11x^2y^2 - y^4$.

Multiply using either the horizontal or vertical form. Arrange the terms in each factor in order of decreasing or increasing degree of one of the variables.

27. $(1 + y)(y^2 + 2y - 3)$ $\mathbf{y^3 + 3y^2 - y - 3}$
28. $(4 + x)(x^2 - 4x + 3)$ $\mathbf{x^3 - 13x + 12}$
29. $(2 + 3y)(3y - 5 + y^2)$
30. $(3y + 4)(y - 2y^2 + 5)$
31. $(3x + y)(x^2 + 4y^2 + 2xy)$
32. $(1 + 2a)(a^2 - 4 + a)$ $\mathbf{2a^3 + 3a^2 - 7a - 4}$
33. $(2x - y)(x^2 + 3y^2 - 4xy)$ $\mathbf{2x^3 - 9x^2y + 10xy^2 - 3y^3}$
34. $(y - 3x)(2x^2 + y^2 - 2xy)$ $\mathbf{-6x^3 + 8x^2y - 5xy^2 + y^3}$

30. $\mathbf{-6y^3 - 5y^2 + 19y + 20}$

Mixed Review Exercises

29. $\mathbf{3y^3 + 11y^2 - 9y - 10}$

31. $\mathbf{3x^3 + 7x^2y + 14xy^2 + 4y^3}$

Solve.

1. $2(x - 1) = 8$ $\{5\}$
2. $3(x - 2) - 2 = 7$ $\{5\}$
3. $4(2a + 3) = 5(a - 6)$ $\{-14\}$

Evaluate if $w = -1$, $x = 2$, and $y = 4$.

4. $x + |w| - y$ $\mathbf{-1}$
5. $w + x + y$ $\mathbf{5}$
6. $w - |y - x|$ $\mathbf{-3}$
7. $(x + y)^2$ $\mathbf{36}$
8. $(-x)^2x^2$ $\mathbf{16}$
9. wy^3 $\mathbf{-64}$