

Lesson 5.4 Dividing Polynomials

Monday, February 10, 2025 8:13 PM

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MCA 5.4
Dividing P...



Exponents and Polynomials



5.4 Dividing Polynomials and Synthetic Division

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What You Will Learn

- ▶ Divide polynomials by monomials and write in simplest form.

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- ▶ Use long division to divide polynomials by polynomials.
- ▶ Use synthetic division to divide polynomials.
- ▶ Use division of polynomials to solve real-life problems.

Example 1 – Dividing a Polynomial by a Monomial

Perform the division and simplify.

$$\frac{12x^2 - 20x + 8}{4x}$$

Solution:

$$\frac{12x^2 - 20x + 8}{4x} = \frac{12x^2}{4x} - \frac{20x}{4x} + \frac{8}{4x}$$

Divide each term in the numerator by $4x$.

$$3x - 5 + \frac{2}{x}$$

Factor numerators.



Example 3 – Long Division Algorithm for Polynomials

Handwritten notes and diagrams for Example 3:

- Left:** A long division problem $3 \overline{) 95 \frac{2}{3}}$ is shown. The quotient is $31 \frac{7}{3}$ with a remainder of 2.
- Middle:** A polynomial long division diagram for $x-1 \overline{) x^2 + 2x + 4}$. The steps shown are:
 - $x^2 + 1x$ (with a note "Think $x^2/x = x$.")
 - $3x + 4$
 - $-3x + 3$ (with a note "Think $3x/x = 3$.")
 - The final remainder is 7.
- Right:** A diagram showing the multiplication of $x+3$ by $x-1$ to get $x^2 - x + 3x - 3 = x^2 + 2x - 3$. The result $x+3$ is circled in orange.



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Example 4 – Writing in Standard Form Before Dividing

Divide $-13x^3 + 10x^4 + 8x - 7x^2 + 4$ by $3 - 2x$.

Solution:

First write the divisor and dividend in standard polynomial form.

Handwritten notes and diagrams for Example 4:

- Left:** A long division problem $-2x+3 \overline{) 10x^4 - 13x^3 - 7x^2 + 8x + 4}$ is shown. The steps shown are:
 - $10x^4 + 15x^3$ (with a note "Think $10x^4/(-2x) = -5x^3$.")
 - $2x^3 - 7x^2$
 - $-2x^3 + 3x^2$
 - The final remainder is 7.
- Middle:** A diagram showing the multiplication of $-5x^3$ by $-2x+3$ to get $10x^4 - 15x^3$. The result $-5x^3$ is circled in orange.
- Right:** A diagram showing the multiplication of $-1x^2$ by $-2x+3$ to get $2x^3 - 3x^2$. The result $-1x^2$ is circled in orange.

$$\begin{array}{r} -2x^3 + 3x^2 \downarrow \\ -4x^2 + 8x \\ +4x^2 + 6x \end{array}$$

$$2x(-2x+7)$$



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Example 5 – Accounting for Missing Powers of x

Divide $x^3 - 2$ by $x - 1$.

Solution:

To account for the missing x^2 - and x -terms, insert $0x^2$ and $0x$.

$$\begin{array}{r} x^2 + 1x + 1 \\ x-1 \overline{) x^3 + 0x^2 + 0x - 2} \end{array}$$

$$\begin{array}{r} -x^3 + 1x^2 \\ -1x^2 + 0x \\ -1x^2 + 1x \\ -1x + 1 \end{array}$$



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Example 6 – A Second-Degree Divisor

Divide $x^4 + 6x^3 + 6x^2 - 10x - 3$ by $x^2 + 2x - 3$.

Solution:

$$\begin{array}{r} x^2 + 4x + 1 \\ x^2 + 2x - 3 \overline{) x^4 + 6x^3 + 6x^2 - 10x - 3} \end{array}$$

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

$$\begin{array}{r}
 (x^2 + 2x - 3) \div (x + 4x + 1) \\
 \underline{-(x^2 + 4x^3 + 3x^2)} \\
 4x^3 + 9x^2 - 10x \\
 \underline{-(4x^3 + 8x^2 + 12x)} \\
 1x^2 + 2x - 3 \\
 \underline{-(1x^2 + 4x + 1)} \\
 -2x - 4
 \end{array}$$

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



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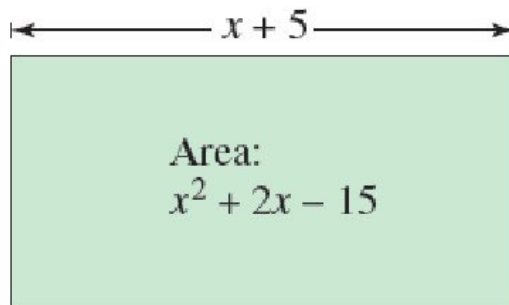


Example 8 – Geometry: Finding the Width of a Rectangle

The area of a rectangle is $(x^2 + 2x - 15)$ square feet and its length is $(x + 5)$ feet. Find the width of the rectangle.

Solution:

$$\frac{A}{L} = \frac{Lw}{L}$$



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Example 8 – Geometry: Finding the Width of a Rectangle cont'd

Example 8 – Geometry: Finding the Width of a Rectangle cont'd

Verbal Model: Area = Length \times Width

Labels: Area = $x^2 + 2x - 15$ (square feet)

Length = $x + 5$ (feet)

Equation: $x^2 + 2x - 15 = (x + 5)(\text{Width})$ \Rightarrow Width = $\frac{x^2 + 2x - 15}{x + 5}$

Handwritten polynomial long division:

$$\begin{array}{r} x+5 \overline{) x^2 + 2x - 15} \\ \underline{-(x^2 + 5x)} \\ -3x - 15 \\ \underline{+3x + 15} \\ 0 \end{array}$$

The quotient is $x - 3$.



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