



# DIVIDING POLYNOMIALS

*Using Long Division*

# Let's Review!

Divide the following using long division and explain the step-by-step process you used.

$$9 \overline{) 9421}$$

A handwritten long division problem on a piece of paper. The divisor is 9 and the dividend is 9421. The quotient is written as 1046 with a remainder of 7. The steps are as follows: 9 goes into 9 one time, 9 times 1 is 9, subtract 9 from 9 to get 0. Bring down the 4 to get 04. 9 goes into 04 zero times, 9 times 0 is 0, subtract 0 from 04 to get 4. Bring down the 2 to get 42. 9 goes into 42 four times, 9 times 4 is 36, subtract 36 from 42 to get 6. Bring down the 1 to get 61. 9 goes into 61 six times, 9 times 6 is 54, subtract 54 from 61 to get 7. The final remainder is 7. Colored arrows and lines indicate the movement of digits and the subtraction process.

$$\begin{array}{r} 1046 \text{ Remainder } 7 \\ 9 \overline{) 9421} \\ \underline{-9} \phantom{00} \phantom{00} \phantom{00} \\ 04 \phantom{00} \phantom{00} \phantom{00} \\ \underline{-0} \phantom{00} \phantom{00} \phantom{00} \\ 42 \phantom{00} \phantom{00} \phantom{00} \\ \underline{-36} \phantom{00} \phantom{00} \phantom{00} \\ 61 \phantom{00} \phantom{00} \phantom{00} \\ \underline{54} \phantom{00} \phantom{00} \phantom{00} \\ 7 \end{array}$$

# Let's Review!

Fill in the blank:

1.  $x^2 \cdot \underline{x} = x^3$

2.  $a \cdot \underline{a^3} = a^4$

3.  $y^3 \cdot \underline{y^2} = y^5$

4.  $z \cdot \underline{z^2} = z^3$

# Example 1

Divide the following using long division:  $x - 2 \overline{) 6x^3 - 19x^2 + 16x - 4}$

Handwritten long division showing the division of  $6x^3 - 19x^2 + 16x - 4$  by  $x - 2$ . The quotient is  $6x^2 - 7x + 2$  and the remainder is 0.

$$\begin{array}{r} \textcircled{x} - 2 \overline{) 6x^3 - 19x^2 + 16x - 4} \\ \underline{-6x^3 + 12x^2} \phantom{+ 16x - 4} \\ -7x^2 + 16x \phantom{- 4} \\ \underline{+7x^2 + 14x} \phantom{- 4} \\ 2x - 4 \\ \underline{2x - 4} \\ 0 \end{array}$$

# Example 2

Divide the following using long division:  $(2x^4 + 2x^3 + x^2 - x - 1) \div (x + 1)$

Handwritten long division showing the process:

$$\begin{array}{r} \textcircled{x+1} \overline{) 2x^4 + 2x^3 + x^2 - x - 1} \\ \underline{-2x^4 + 2x^3} \phantom{-1} \\ x^2 - x - 1 \\ \underline{-x^2 + x} \phantom{-1} \\ -2x - 1 \\ \underline{+2x + 2} \\ \phantom{-} 1 \end{array}$$

The final result is:

$$2x^3 + x - 2 + \frac{1}{x+1}$$

The remainder 1 is shown below the division line, with a vertical line indicating it is the remainder over the divisor  $(x+1)$ .

# On your own!

Divide the following using long division:  $(x^4 + 2x^3 - 5x^2 + 3x - 1) \div (x - 1)$

$$\begin{array}{r} x^3 + 3x^2 - 2x + 1 \\ \hline (x-1) \overline{) x^4 + 2x^3 - 5x^2 + 3x - 1} \\ \underline{-x^4 + x^3} \phantom{-5x^2 + 3x - 1} \\ 3x^3 - 5x^2 \phantom{+ 3x - 1} \\ \underline{-3x^3 + 3x^2} \phantom{+ 3x - 1} \\ -2x^2 + 3x \phantom{- 1} \\ \underline{+2x^2 + 2x} \phantom{- 1} \\ x - 1 \\ \underline{x - 1} \\ 0 \end{array}$$



# DIVIDING POLYNOMIALS

*Using Synthetic Division*

# Dividing Polynomials Using Synthetic Division

- **Synthetic Division** is a shortcut way to divide polynomials when the divisor is a binomial with a leading coefficient of 1. For example,

$$x - 5$$

- Note: Remember to write 0 for missing terms!

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



# Dividing Polynomials Using Synthetic Division

Steps:

1. Write the multiplier, which is the opposite of the number in the divisor.
2. Draw  $\frac{1}{2}$  of a box next to the multiplier.
3. Write the coefficients and constant of the dividend next to the multiplier.
4. Bring down the 1st coefficient below the line.
5. Multiply whatever is below the line by the multiplier.
6. Add the numbers in the 1st and 2nd rows together.
7. Write your answer below the line.
8. Repeat.
9. The bottom row is your answer. Insert the variables, beginning with the  $x$  term that is one less than the degree of the dividend. The last number is your remainder.

# Example 1

Divide the following using synthetic division:  $(x^5 - 1) \div (x - 1)$

$(x^5 - 1) \div (x - 1)$

Dividend Rewrite with 0 for missing terms! Divisor

$(1x^5 + 0x^4 + 0x^3 + 0x^2 + 0x - 1) \div (x - 1)$

Bring down the coefficients. Multiplier  
\* Change the sign \*

1	1	0	0	0	0	-1
	↓	+1	+1	+1	+1	+1
x						0

Rewrite with variables! Take the degree of the dividend

$|x^4 + |x^3 + |x^2 + |x + |$   $5 - 1 = 4$   
↳ degree of the quotient

Quotient  $x^4 + x^3 + x^2 + x + 1$

## Example 2

Divide the following using synthetic division:  $(2x^3 + 3x^2 - x + 1) \div (x + 2)$

The image shows handwritten work on grid paper for the synthetic division of  $(2x^3 + 3x^2 - x + 1) \div (x + 2)$ . The divisor is  $x + 2$ , so the synthetic division is performed using  $-2$ . The dividend coefficients are 2, 3, -1, and 1. The process involves multiplying the divisor's constant term by the coefficients and subtracting the results from the next coefficient. The final result is  $2x^2 - x + 1 - \frac{1}{x+2}$ , which is highlighted in a green box.

$$(2x^3 + 3x^2 - x + 1) \div (x + 2)$$

change the sign!

$$\begin{array}{r|rrrr} -2 & 2 & 3 & -1 & 1 \\ & \downarrow & -4 & +2 & -2 \\ \hline x & 2 & -1 & 1 & (-1) \text{ Remainder} \end{array}$$
$$2x^2 - x + 1 - \frac{1}{(x+2)} \rightarrow 2x^2 - x + 1 - \frac{1}{(x+2)}$$

# On your own!

Divide the following using synthetic division:  $(2x^3 - 3x^2 + 4x - 1) \div (x + 1)$

Handwritten work on graph paper showing synthetic division:

Problem:  $(2x^3 - 3x^2 + 4x - 1) \div (x + 1)$

Step 1: Write the divisor as 1 and the dividend coefficients: 2, -3, 4, -1.

Step 2: Synthetic division:

1	2	-3	4	-1
	↓	+2	-1	+3
x	2	-1	3	② Remainder

Step 3: Write the quotient and remainder:  $2x^2 - 1x + 3 + \frac{2}{(x+1)}$

Final Answer (boxed):  $2x^2 - x + 3 + \frac{2}{(x+1)}$



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