

**12.3 Divide Polynomials** Goal • Divide polynomials.

**EXAMPLE 1:** Divide a polynomial by a monomial

Divide  $10x^3 - 25x^2 + 15x$  by  $5x$ .

Steps:

$$= \frac{10x^3 - 25x^2 + 15x}{5x}$$

Step 1: Write the division as a fraction.

$$= \frac{10x^3}{5x} + \frac{-25x^2}{5x} + \frac{15x}{5x}$$

← THIS IS A MENTAL STEP

Step 2: Divide each term by 5x.

$$= \frac{2x^2 - 5x + 3}{1}$$

Step 3: Simplify

**Step 4: Check**

To check your answer, multiply the quotient by the divisor.

$$5x \cdot (2x^2 - 5x + 3) = 10x^3 - 25x^2 + 15x$$

mentally check by multiplying

← MUST EQUAL

✓ **Checkpoint** Complete the following exercise.

1. Divide  $(12x^3 + 9x^2 - 3x)$  by  $-3x$

$$\frac{12x^3 + 9x^2 - 3x}{-3x} = -4x^2 - 3x + 1$$

← Mentally check multiply!

# Algebra 1 Notes...

## EXAMPLE 2: Divide a polynomial by a binomial

versus

### Review arithmetic long division

2a) Divide 81,536 by 32

$$\begin{array}{r}
 \underline{2548} \\
 32 \overline{) 81,536} \\
 \underline{-64} \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 175 \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 \underline{-160} \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 153 \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 \underline{-128} \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 256 \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 \underline{-256} \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 0 \phantom{0} \phantom{0} \phantom{0} \phantom{0} \\
 \rightarrow 0 \\
 \text{NO REMAINDER}
 \end{array}$$

How can you check?

$$32 \times 2,548 = 81,536 \checkmark$$

### Long division with variables

2b) Divide  $4x^2 - 4x - 3$  by  $2x + 1$

$$\begin{array}{r}
 \underline{2x-3} \\
 2x+1 \overline{) 4x^2-4x-3} \\
 \underline{+(4x^2+2x)} \phantom{-3} \\
 -6x-3 \\
 \underline{+(6x+3)} \\
 0 \\
 \text{No remainder} \rightarrow 0
 \end{array}$$

$\frac{4x^2-4x-3}{2x+1}$

**STEPS**  
 ① mult  
 ② subtract  
 ③ bring down

Tip: When you subtract Change the subtract sign to addition and take the opposite of what's in the ( )'s

How can you check?

$$\text{MULT } (2x-3)(2x+1) = 4x^2 - 4x - 3 \checkmark$$

## EXAMPLE 3: Divide a polynomial by a binomial with a remainder

Divide  $2x^2 + 9x + 12$  by  $x + 3$ .

$$\begin{array}{r}
 \underline{2x+3} \\
 x+3 \overline{) 2x^2+9x+12} \\
 \underline{+(2x^2+6x)} \phantom{+12} \\
 3x+12 \\
 \underline{+(3x+9)} \\
 3 \\
 \rightarrow 3 \\
 \text{Remainder}
 \end{array}$$

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

Check

$$\begin{array}{r}
 (x+3)(2x+3) = \\
 2x^2 + 9x + 9 \\
 \text{remainder} \rightarrow +3 \\
 \hline
 2x^2 + 9x + 12 \checkmark
 \end{array}$$

## Algebra 1 Notes...

### EXAMPLE 4: Rewrite polynomials

Divide  $2x - 1 + 3x^2$  by  $1 + x$ . ↗  
rewrite in  
descending order

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

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

Mentally check

$$(x+1)(3x-1) = 3x^2 + 2x - 1 \checkmark$$

### EXAMPLE 5: Insert missing terms for "place holders"

Divide  $-24 + 6x^2$  by  $-6 + 3x$ .

$$\frac{6x^2 - 24}{3x - 6}$$

NOTICE  
MISSING  
X TERM

(must add  
place  
holder  
"0x")

$$\begin{array}{r} \text{2x+4} \\ 3x-6 \overline{) 6x^2 + 0x - 24} \\ \underline{+ (6x^2 - 12x)} \phantom{-24} \\ 12x - 24 \\ \underline{-(12x - 24)} \\ 0 \end{array}$$

→ 0

No remainder

$$\boxed{2x + 4}$$

remember:  
mentally check  
 $(2x+4)(3x-6) =$   
 $6x^2 - 24 \checkmark$

**Algebra 1 Notes...**

✓ **Checkpoint Divide.**

2.  $(-8 - 2x + x^2) \div (2 + x)$

$$\begin{array}{r}
 x^2 - 2x - 8 \\
 \hline
 x + 2 \\
 \hline
 \end{array}$$

↙

$$\begin{array}{r}
 x + 2 \overline{) x^2 - 2x - 8} \\
 \underline{+(x^2 + 2x)} \phantom{- 8} \\
 -4x - 8 \\
 \underline{-(-4x - 8)} \\
 0
 \end{array}$$

↘

3.  $(x^3 + 125) \div (x + 5)$

$$\begin{array}{r}
 x^3 + 125 \\
 \hline
 x + 5 \\
 \hline
 \end{array}$$

↙

$$\begin{array}{r}
 x + 5 \overline{) x^3 + 0x^2 + 0x + 125} \\
 \underline{-(x^3 + 5x^2)} \phantom{+ 0x} \\
 -5x^2 + 0x \\
 \underline{-(-5x^2 - 25x)} \phantom{+ 125} \\
 25x + 125 \\
 \underline{-(25x + 125)} \\
 0
 \end{array}$$

↘