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## Warm-Up

Find all zeros of:

1)  $x^4 + x^2 - 42 = 0$

Describe the End Behavior of:

2)  $x^3 + 8x^2 + 25x = \boxed{\phantom{0}} f(x)$

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## Objectives

Today we will...

- Divide Polynomials using Long Division
- Divide Polynomials using Synthetic Division

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## Big Picture

Find all Zeros of:

$$f(x) = x^3 + 10x^2 + 18x - 21$$

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## Long Division of Polynomials

Review of Long Division

$$7 \overline{)150}$$

$$3 \overline{)210}$$

$$\text{Ex. 1} \quad (x^3 + 10x^2 + 16x - 29) \div (x + 4)$$

$$\begin{array}{r} x^2 + 6x - 8 + \frac{3}{x+4} \\ \hline x+4 \overline{)x^3 + 10x^2 + 16x - 29} \\ - (x^3 + 4x^2) \\ \hline 6x^2 + 16x \\ - (6x^2 + 24x) \\ \hline -8x - 29 \\ - (-8x - 32) \\ \hline 3 \end{array}$$

**Ex. 2**  $x^4 + 2x^2 - x + 5 \div x^2 - x + 1$

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

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

$$\text{Ex. 3} \quad (4x^3 + 17x^2 - 3x - 25) \div (x + 4)$$

$$\begin{array}{r} 4x^2 + x - 7 + \frac{3}{x+4} \\ x+4 \overline{)4x^3 + 17x^2 - 3x - 25} \\ \underline{- (4x^3 + 16x^2)} \\ x^2 - 3x \\ \underline{- (x^2 + 4x)} \\ -7x - 25 \\ \underline{- (-7x - 28)} \\ 3 \end{array}$$

$$(x^3 - 13x^2 + 34x - 40) \div (x - 10)$$

$$\begin{array}{r} x^2 - 3x + 4 \\ x^2 - 3x + 4 \\ x-10 \overline{x^3 - 13x^2 + 34x - 40} \\ \underline{- (x^3 - 10x^2)} \\ -3x^2 + 34x \\ \underline{- (-3x^2 + 30x)} \\ 4x - 40 \\ \underline{- (4x - 40)} \\ 0 \end{array}$$

## Sythetic Division

- Alternate method for dividing polynomials
- Only works if divisor is in the form  $(x-K)$

$$\begin{cases} x+5 \\ x-7 \end{cases}$$

**Ex. 1**  $\underline{(x^3 + 6x^2 - 17x - 8)} \div \underline{(x + 8)}$

$$\begin{array}{r} -8 | & 1 & 6 & -17 & -8 \\ & & -8 & 16 & 8 \\ \hline & 1 & -2 & -1 & 0 \end{array}$$

$x^2 - 2x - 1$

**Ex. 2**  $(4x^3 - 8x^2 - 40x + 28) \div (x - 4)$

$$\begin{array}{r} 4 \\[-1ex] | \quad 4 \quad -8 \quad -40 \quad 28 \\ \quad 16 \quad 32 \quad -32 \\ \hline \quad 4 \quad 8 \quad -8 \quad \textcircled{-4} \quad R \\[1ex] 4x^2 + 8x - 8 - \frac{4}{x-4} \end{array}$$

Ex. 3  $(r^4 - 6r^3 + \cancel{2r} - 2) \div (r - 6)$

$$\begin{array}{r} 6 | 1 \quad -6 \quad 0 \quad 2 \quad -2 \\ \quad \quad 6 \quad 0 \quad 0 \quad 12 \\ \hline \quad 1 \quad 0 \quad 0 \quad 2 \quad 10 \end{array}$$

$r^3 + 2 + \frac{10}{r-6}$

**Ex. 4**  $(4n^3 + 15n^2 + 6n - 14) \div (n + 2)$

$$\begin{array}{r} \boxed{-2} & 4 & 15 & 6 & -14 \\ \hline & 4 & 7 & -8 & 2 \\ & 4 & 7 & -8 & 2 \end{array}$$
$$4n^2 + 7n - 8 + \frac{2}{n+2}$$

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**Ex. 5**  $(n^4 - 6n^2 - 2n + 7) \div (n - 2)$



