Objective: Divide Polynomials using Long Division

Concept

Steps to Divide Polynomials Using Long Division

1. Set up the problem, adding zeros for missing terms in the dividend.
2. Divide the first terms in the divisor and dividend.
3. Multiply (distribute to the divisor).
4. Subtract (add the opposite of all terms) and combine.
5. Bring down the next term.
6. Repeat, as needed. (The remainder will have a degree less than the divisor.)
7. Write the quotient with any remainder as a ratio over the divisor.

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Ex) Divide using Long Division.

$$\underbrace{\left(4x^3+3x+4\right)}_{\text{dividend}}\div\underbrace{\left(2x-1\right)}_{\text{divisor}}$$

$$\boxed{2x^2 + x + 2 + \frac{6}{2x-1}}$$

$$2x-1 \,\big)\, 4x^3 + 0x^2 + 3x + 4$$

$$+\left(\cancel{-4x^3} + 2x^2\right)$$

$$2x^2 + 3x$$

$$+\left(\cancel{-2x^2} + 1x\right)$$

$$4x + 4$$

$$+\left(\cancel{-4x} + 2\right)$$

$$6$$

$2x^2(2x-1)$

$x(2x-1)$

$2(2x-1)$

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Ex) Divide using Long Division.

$$\underbrace{\left(2x^3 - 15x^2 + 18x - 15\right)}_{\text{dividend}} \div \underbrace{(x-5)}_{\text{divisor}}$$

$$\boxed{2x^2 - 5x - 7 + \frac{-50}{x-5}}$$

$x - 5 \overline{) \; 2x^3 - 15x^2 + 18x - 15}$

$+ \left(-2x^3 + 10x^2\right)$

$-5x^2 + 18x$

$+ \left(+5x^2 - 25x\right)$

$-7x - 15$

$+ \left(+7x - 35\right)$

-50

$2x^2(x-5)$

$-5x(x-5)$

$-7(x-5)$

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Ex) Divide using Long Division.

$$\underbrace{\left(15x^3+8x-12\right)}_{\text{dividend}}\div\underbrace{\left(3x^2+6x+1\right)}_{\text{divisor}}$$

$$\boxed{5x-10+\frac{63x-2}{3x^2+6x+1}}$$

$$
\begin{array}{r|l}
 & 15\cancel{x}^3 + 0x^2 + 8x - 12 \\
3x^2+6x+1 & +\left(-1\cancel{5}x^3 - 30x^2 - 5x\right) \\
 & -30\cancel{x}^2 + 3x - 12 \\
 & +\left(+\cancel{3}0x^2 + 60x + 10\right) \\
 & 63x - 2
\end{array}
$$

$5x(3x^2+6x+1)$

$-10(3x^2+6x+1)$

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Ex) Divide using Long Division.

$$\underbrace{(9x^4 + x^3 + 140x^2 - 4)}_{\text{dividend}} \div \underbrace{(x^2 + 16)}_{\text{divisor}}$$

$$\boxed{9x^2 + x - 4 + \frac{-16x + 60}{x^2 + 16}}$$

$x^2 + 16 \overline{) 9x^4 + x^3 + 140x^2 + 0x - 4}$

$9x^2(x^2+16)$: $+(-\cancel{9x^4} - 144x^2)$

$\cancel{x^3} - 4x^2 + 0x$

$x(x^2+16)$: $+(-\cancel{x^3} - 16x)$

$-\cancel{4x^2} - 16x - 4$

$-4(x^2+16)$: $+(+\cancel{4x^2} + 64)$

$-16x + 60$

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Ex) Divide using Long Division.

$$\frac{3x^4 - 8x^3 - 9x^2 + 8}{x}$$

dividend

divisor

monomial

preferred way

1

$$\frac{3x^4}{x} + \frac{-8x^3}{x} + \frac{-9x^2}{x} + \frac{8}{x}$$

$$3x^{4-1} \quad -8x^{3-1} \quad -9x^{2-1}$$

$$\boxed{3x^3 - 8x^2 - 9x + \frac{8}{x}}$$

or

2

$$\boxed{3x^3 - 8x^2 - 9x + \frac{8}{x}}$$

$$x \overline{)\, 3x^4 - 8x^3 - 9x^2 + 0x + 8}$$

$$-\cancel{3x^4}$$

$$-\cancel{8x^3}$$

$$+ \; +\cancel{8x^3}$$

$$-\cancel{9x^2}$$

$$+ \; (+\cancel{9x^2})$$

$$8$$

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Closure

How can you tell if you are finished with a polynomial division problem?

The remainder has a degree less than the degree of the divisor, or has degree 0 (is a constant).