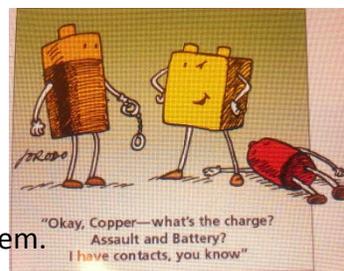


Dividing Polynomials

Who uses this?

Electricians can divide polynomials in order to find the voltage in an electrical system.



Polynomials long division is a method for dividing a polynomial by another polynomial of a lower degree. It is very similar to dividing numbers.

Arithmetic Long Division

$$\begin{array}{r} 173 \leftarrow \text{Quotient} \\ \text{Divisor} \rightarrow 4 \overline{)692} \leftarrow \text{Dividend} \\ \underline{-4} \\ 29 \\ \underline{-28} \\ 12 \\ \underline{-12} \\ 0 \leftarrow \text{Remainder} \end{array}$$

Polynomial Long Division

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

Example 1: Using Long Division to Divide Polynomials

Divide by using long division.

$$(4x^2 + 3x^3 + 10) \div (x - 2)$$

Step 1: Write the dividend in standard form, including terms with a coefficient of 0.

Step 2: Write division in the same way as you would when dividing numbers.

Step 3: Divide.

Step 4: Write the final answer.

Synthetic division is a shorthand method of dividing a polynomial by a linear binomial by using only the coefficients. For synthetic division to work, the polynomial must be written in standard form, using 0 as a coefficient for any missing terms, and the divisor must be in the form $(x - a)$.

Synthetic Division Method	
Divide $(2x^2 + 7x + 9) \div (x + 2)$ by using synthetic division.	
WORDS	NUMBERS
<p>Step 1 Write the coefficients of the dividend, 2, 7, and 9. In the upper left corner, write the value of a for the divisor $(x - a)$. So $a = -2$. Copy the first coefficient in the dividend below the horizontal bar.</p>	
<p>Step 2 Multiply the first coefficient by the divisor, and write the product under the next coefficient. Add the numbers in the new column.</p>	
<p>Repeat Step 2 until additions have been completed in all columns. Draw a box around the last sum.</p>	
<p>Step 3 The quotient is represented by the numbers below the horizontal bar. The boxed number is the remainder. The others are the coefficients of the polynomial quotient, in order of decreasing degree.</p>	$= 2x + 3 + \frac{\boxed{3}}{x + 2}$

Example 2: Using Synthetic Division to Divide by a Linear Binomial

Divide by using synthetic division.

A. $(4x^2 - 12x + 9) \div (x + \frac{1}{2})$

B. $(x^4 - 2x^3 + 3x + 1) \div (x - 3)$

You can use synthetic division to evaluate polynomials. This process is called synthetic substitution. The process of synthetic division, but the final answer is interpreted differently, as described by the Remainder Theorem.

Remainder Theorem	
THEOREM	EXAMPLE
<p>If the polynomial function $P(x)$ is divided by $x - a$, then the remainder r is $P(a)$.</p>	<p>Divide $x^3 - 4x^2 + 5x + 1$ by $x - 3$.</p> $ \begin{array}{r rrrr} \underline{3} & 1 & -4 & 5 & 1 \\ & & 3 & -3 & 6 \\ \hline & 1 & -1 & 2 & \underline{7} \end{array} $ <p>$P(3) = 7$</p>

Example 3: Using Synthetic Substitution

Using synthetic substitution to evaluate the polynomial for the given value.

A. $P(x) = x^3 - 4x^2 + 3x - 5$ for $x = 4$

B. $P(x) = 4x^4 + 2x^3 + 3x + 5$ for $x = -\frac{1}{2}$

Example 4: Physics Application

A Van de Graaff generator is a machine that produces very high voltages by using small, safe levels of electric current. One machine has a current that can be modeled by $I(t) = t + 2$, where $t > 0$ represents time in seconds. The power of the system can be modeled by $P(t) = 0.5t^3 + 6t^2 + 10t$. Write an expression that represents the voltage of the system.

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