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Long Division of Polynomials.

Suppose I want to divide a trinomial by a polynomial, like this: $\frac{x^2-6x-12}{x+4}$. There are no factors of 12 that have a difference of 6, so the "reverse FOIL" method of factoring and cancelling factors won't work. We must do the long division. It's actually a lot like regular long division once you get the hang of it.

We can write the problem in a long division form like so: $x+4\overline{)x^2-6x-12}$.

Step 1. Divide the leading term into the leading term.

This step is essentially asking us to simplify this expression $\frac{x^2}{x}=x$ Put the result over the same term above the division bar like so: $\begin{array}{r} x \\ x+4\overline{)x^2-6x-12} \end{array}$

Step 2: Multiply this result by the divisor (in this case, that's x+4), and place it under the dividend (that's $x^2-6x-12$)

$x(x+4)=x^2+4x$ so we get: $\begin{array}{r} x \\ x+4\overline{)x^2-6x-12} \\ x^2+4x \end{array}$

Step 3: Subtract. $\begin{array}{r} x \\ x+4\overline{)x^2-6x-12} \\ \underline{-\left(x^2+4x\right)} \end{array} \longrightarrow \begin{array}{r} x \\ x+4\overline{)x^2-6x-12} \\ \underline{-x^2-4x} \\ -10x \end{array}$

Step 4: Bring down the next term and repeat until you run out of terms.

We will need to do this one more time.

Step 1: Leading term into leading term: Simplify $\frac{-10x}{x}=-10 \longrightarrow \begin{array}{r} x-10 \\ x+4\overline{)x^2-6x-12} \end{array}$

Step 2: Multiply the result by the divisor. -10(x+4) = -10x – 40

$$
\begin{array}{r}
x-10 \\
x+4\overline{)\,x^2-6x-12} \\
\underline{-x^2-4x} \\
-10x-12 \\
\underline{-10x-40} \\
\end{array}
$$

Step 3: Subtract

$$
\begin{array}{r}
x-10 \\
x+4\overline{)\,x^2-6x-12} \\
\underline{-x^2-4x} \\
-10x-12 \\
\underline{-(-10x-40)} \\
\end{array}
\quad\longrightarrow\quad
\begin{array}{r}
x-10 \\
x+4\overline{)\,x^2-6x-12} \\
\underline{-x^2-4x} \\
-10x-12 \\
\underline{10x+40} \\
28
\end{array}
$$

In this case, we ended up with a constant at the bottom, so there is a remainder of 28. We can't divide any more. In the nice cases we get a remainder of 0, but in those cases, we can factor (if we know how). In a case like the one above, this is the only way.