# Factor by Grouping

***Factor by Grouping is another way of factoring polynomials that you learn in Algebra 1. It only works with polynomials that have 4 terms and it has to be able to factor into 2 binomials.***

There are steps that need to be followed to ensure that you are factoring correctly. We will use these steps when doing examples!

Examples:

$$x^3 - 5x^2 + 2x - 10$$

The first step is to "SPLIT" up this polynomial into binomials and finding the GCF within each binomial to factor out.

Let's focus on $x^3 - 5x^2$ first. Find the GCF in these 2 terms and factor it out (in this case, the GCF is $x^2$).

$$x^2 (x - 5)$$

Now do the same thing with 2x - 10. Find the GCF (in this case, 2) and factor it out.

$$2 (x - 5)$$

Write the 2 terms together to get:

$$x^2 (x - 5) + 2 (x - 5)$$

*Did you notice that the binomial x - 5 was there twice?* We can factor it out from both terms leading us with:

$$\mathbf{(x - 5)\,(x^2 + 2)}$$

*Why does this technique work?*

If you go back to when we were at the step

$$\mathbf{x^2\,(x - 5) + 2\,(x - 5)}$$

You might realize that this is the same as distributing x - 5 to each term in $x^2 + 2$. Again, this method only works with polynomials with 4 terms, but it is neat how this is related to the distributive property.

Let's try another example!

$$\mathbf{x^3 + 8x^2 - 8x - 64}$$

Remember to split this polynomial into 2 polynomials with 2 terms each ($x^3 + 8x^2$ and - 8x - 64), find the GCF of both polynomials ($x^2$ and -8, respectively), factor the GCF out of both polynomials and combine them together before pulling out the factor that is common in both terms.

You should get the following as your final answer:

$$\mathbf{(x + 8)\,(x^2 - 8)}$$

**Tips for Solving Problems:**

1. One way to check that you did your factoring correctly is to check whether the same factor appears in both terms after factoring out the GCF from the 2 polynomials that you "split" up the original polynomial into. If they are not the same, check to make sure you factored out the highest GCF possible between both terms.

2. Remember that this trick only works for certain polynomials with 4 terms. These polynomials, when the GCF is factored from each set of 2 terms, should have the same binomial, or you cannot use factor by grouping.

3. Remember when finding GCF's, factor out any negative signs that come along with factors (these negative signs can make the difference between the same factor in both terms matching or not).