

We are going to begin our discussion of factoring higher-order polynomials with the grouping method. Hopefully this is review for some of you, or you have at least *seen* grouping in action before. It is very easy, as long as you remember how to find and factor the **greatest common factor (GCF)**.

You may remember factoring out the GCF. It is relatively straight-forward. For example, in the expression  $3x + 12$ , both terms have a common factor of 3. This means the expression can be written as  $3(x + 4)$ . Notice that we divided each of the terms by 3, and then wrote the 3 outside the parentheses, essentially inverting the Distribution Property.

A variable can also be part of the GCF. The factored form of the expression  $2x^2 + 12x$  is actually  $2x$ , because the GCF of 2 and 12 is 2, and the GCF of  $x^2$  and  $x$  is just  $x$ . Factor the expressions below by factoring out the GCF...

1.  $4x + 20$

2.  $2x^2 + 10x$

3.  $25 - 5x$

4.  $x^3 + 7x^2$

You will need to use your GCF skills when factoring by grouping, because **factoring by grouping is basically a 3 step process:**

- Correctly group related terms – look for patterns in the coefficients
- Factor out the GCF of each group
- Factor out the new GCF (this should be an expression, not just a number)

Here is an example of factoring by grouping...

$$\begin{aligned}
 & x^3 + 5x^2 - 4x - 20 \\
 &= (x^3 + 5x^2) + (-4x - 20) \quad \text{Correctly group related terms} \\
 &= x^2(x + 5) + (-4)(x + 5) \quad \text{Factor out the GCF of each group} \\
 &= (x + 5)(x^2 - 4)\dots \quad \text{Factor out the new GCF} \\
 &= (x + 5)(x - 2)(x + 2) \quad \text{Simplify any remaining factors if possible}
 \end{aligned}$$

Let's walk-through some more examples of factoring by grouping:

5.  $x^3 + 3x^2 - 4x - 12$

6.  $x^3 + 6x^2 - 9x - 54$

Solve for the roots of these functions by factoring. In some cases, it may help to factor out a GCF first.

7.  $x^3 - 7x^2 - 16x + 112 = f(x)$

8.  $x^3 - 4x^2 - 4x + 16 = f(x)$

9.  $3x^3 + 15x^2 - 12x - 60 = f(x)$

10.  $6x^4 + 30x^3 - 24x^2 - 120x = f(x)$

11.  $2x^3 - x^2 - 2x + 1 = f(x)$

12.  $4x^3 - 12x^2 - 36x + 108 = f(x)$

13.  $x^5 + 4x^4 - 5x^3 - 20x^2 + 4x + 16 = f(x)$

14.  $x^5 + x^4 - 3x^3 - 3x^2 - 4x - 4 = f(x)$

15.  $12x^3 - 9x^2 + 4x - 3 = f(x)$

16.  $2x^3 + 5x^2 + 6x + 15 = f(x)$

17.  $5x^3 - 10x^2 + 3x - 6 = f(x)$

18.  $12x^3 + 4x^2 + 3x + 1 = f(x)$