# Factoring By Grouping

## Factoring by Grouping: More Examples & Applications

This worksheet will give you more examples of how to use the "Factoring by Grouping" trick, especially for polynomials with four terms. Pay close attention to the steps and the signs!

### Part 1: Basic Factoring by Grouping

Example 1: Factor $\boldsymbol{x^3 + 4x^2 + 5x + 20}$

1. Group the Terms: $(x^3 + 4x^2) + (5x + 20)$
2. Find GCF of Each Group:
   - For $(x^3 + 4x^2)$: GCF is $x^2$. So --> $x^2(x + 4)$
   - For $(5x + 20)$: GCF is 5. So --> $5(x + 4)$
3. Look for the Common Binomial:
   - Both parts have $(x + 4)$.
   - Now you have: $x^2(x + 4) + 5(x + 4)$
4. Factor Out the Common Binomial:
   - $(x + 4)(x^2 + 5)$

Example 2: Factor $\boldsymbol{2y^3 + 6y^2 + 7y + 21}$

1. Group the Terms: $(2y^3 + 6y^2) + (7y + 21)$
2. Find GCF of Each Group:
   - For $(2y^3 + 6y^2)$: GCF is $2y^2$. So --> $2y^2(y + 3)$
   - For $(7y + 21)$: GCF is 7. So --> $7(y + 3)$
3. Look for the Common Binomial:
   - Both parts have $(y + 3)$.
   - Now you have: $2y^2(y + 3) + 7(y + 3)$
4. Factor Out the Common Binomial:
   - $(y + 3)(2y^2 + 7)$

### Part 2: Factoring by Grouping with Negative Signs

Example 1: Factor $\boldsymbol{p^3 - 5p^2 - 6p + 30}$

1. Group the Terms: $(p^3 - 5p^2) + (-6p + 30)$

   *Notice the negative sign stays with the* 6p!
2. Find GCF of Each Group:

- For $(p^3 - 5p^2)$: GCF is $p^2$. So --> $p^2(p - 5)$
- For $(-6p + 30)$: We need to get $(p - 5)$. So, we factor out –6.
  - $-6p + 30$ becomes $-6(p - 5)$
  - Now you have: $p^2(p - 5) - 6(p - 5)$

3. Look for the Common Binomial:
   - Both parts have $(p - 5)$.
4. Factor Out the Common Binomial:
   - $(p - 5)(p^2 - 6)$

Example 2: Factor $\boldsymbol{m^3 + 3m^2 - 4m - 12}$

1. Group the Terms: $(m^3 + 3m^2) + (-4m - 12)$
2. Find GCF of Each Group:
   - For $(m^3 + 3m^2)$: GCF is $m^2$. So --> $m^2(m + 3)$
   - For $(-4m - 12)$: GCF is $-4$. So --> $-4(m + 3)$
3. Look for the Common Binomial:
   - Both parts have $(m + 3)$.
   - Now you have: $m^2(m + 3) - 4(m + 3)$
4. Factor Out the Common Binomial:
   - $(m + 3)(m^2 - 4)$

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## Part 3: When Terms Need Rearranging

Sometimes, the terms might not be in the "perfect" order for grouping right away. You might need to rearrange them first to find common factors within pairs.

RULE: Factor $\boldsymbol{ab + cd + ac + bd}$

If you group $(ab + cd) + (ac + bd)$, there's no common factor in the first pair, and no common factor in the second pair. And no common binomials!

Let's rearrange the terms:

- Try grouping terms that share a variable: $ab + ac + bd + cd$

1. Group the Terms: $(ab + ac) + (bd + cd)$
2. Find GCF of Each Group:
   - For $(ab + ac)$: GCF is a. So --> $a(b + c)$
   - For $(bd + cd)$: GCF is d. So --> $d(b + c)$
3. Look for the Common Binomial:
   - Both parts have $(b + c)$.
   - Now you have: $a(b + c) + d(b + c)$
4. Factor Out the Common Binomial:
   - $(b + c)(a + d)$

Example: Factor $\boldsymbol{2mx + 3ny + nx + 6my}$

- Try grouping terms that share a variable: --> $2mx + 6my + 3ny + nx$
- Group the Terms: $(2mx + 6my) + (nx + 3ny)$
- Group 1: $2mx + 6my$
- Group 2: $nx + 3ny$
- Factor Group 1 --> $2m(x + 3y)$
- Factor Group 2 --> $n(x + 3y)$
- Both parts have: $(x + 3y)$
- Factor Out the Common Binomial: $(x + 3y)(2m + n)$