MULTIPLYING POLYNOMIALS

METHOD 1: Use the Distributive Property

3x(x +5)

= 3x⋅x + 3x ⋅ 5
= 3x^2 + 15x

Multiplying Binomials
(3x + 5)(2x – 1)

= (3x + 5)(2x) + (3x + 5)(-1)

= (3x)(2x) + (5)(2x) + (3x)(-1) + 5(-1)
= 6x^2 + 10x -3x - 5
Now combine like terms:
=6x^2 + 7x - 5

Multiplying a binomial and a trinomial
(2x + 1)(x^2 – 3x +5)

=(2x + 1)(x^2) + (2x+1)(-3x) + (2x+1)(5)
= 2x^3 + x^2 + (-6x^2) + (-3x) + 10x + 5
= 2x^3 -5x^2 + 7x + 5
Multiplying Larger Polynomials Using the Distributive Property

The Vertical Method of multiplication is sometimes more efficient.

\[(3x + 2)(x^2 - x + 4)\]

<table>
<thead>
<tr>
<th>x^2 - x + 4 \times 3x + 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x^2 - 2x + 8</td>
</tr>
<tr>
<td>3x^3 - 3x^2 + 12x</td>
</tr>
</tbody>
</table>

| 3x^3 - x^2 + 10x + 8      |

Just as you would in multiplying whole numbers, put the larger polynomial (the one with more terms) on top and the smaller polynomial on the bottom.

Multiply every term in the larger polynomial by 2 (the last term in the other polynomial).

Then on the next line multiply every term in the larger polynomial by the next term in the smaller polynomial (3x). Make sure to line up like terms.

Multiply:

\[(x^2 - 2x + 7)(x - 2)\]

<table>
<thead>
<tr>
<th>x^2 - 2x + 7 \times x - 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x^2 - 2x + 7)</td>
</tr>
<tr>
<td>(x - 2)</td>
</tr>
</tbody>
</table>
METHOD 2: FOIL (First, Outer, Inner, Last)
- This only works for multiplying binomials (polynomials with only 2 terms)

(3x + 5)(2x – 1)

The First terms in each of these binomials are 3x and 2x.
The Outer terms are the ones on the “outsides” of the binomials, 3x and -1.
The Inner terms are the ones in the middle, 5 and 2x.
The Last terms are the second terms of each binomial, 5 and -1.

FOIL = (3x)(2x) + (3x)(-1) + (5)(2x) + 5(-1)
= 6x^2 + -3x + 10x + -5
Now combine like terms:
=6x^2 + 7x - 5

(3x + 5)(2x – 1)
METHOD 3: **Box Method.** This method works for every problem!

Here’s how you do it.
Multiply \((3x - 5)(5x + 2)\)

Draw a box. Write a polynomial on the top and side of a box. It does not matter which goes where.

This will be modeled in the next problem along with FOIL.

<table>
<thead>
<tr>
<th>3x</th>
<th>-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>5x</td>
<td></td>
</tr>
<tr>
<td>+2</td>
<td></td>
</tr>
</tbody>
</table>
3) Multiply \((3x - 5)(5x + 2)\)

First terms: \(15x^2\)

Outer terms: \(+6x\)

Inner terms: \(-25x\)

Last terms: \(-10\)

Combine like terms.

\(15x^2 - 19x - 10\)

You have 3 techniques. Pick the one you like the best!
4) Multiply \((7p - 2)(3p - 4)\)

First terms: \(21p^2\)
Outer terms: \(-28p\)
Inner terms: \(-6p\)
Last terms: \(+8\)

Combine like terms.

\[21p^2 - 34p + 8\]
5) Multiply \((2x - 5)(x^2 - 5x + 4)\)

You cannot use FOIL because they are not BOTH binomials. You must use the distributive property or box method.

<table>
<thead>
<tr>
<th></th>
<th>(x^2)</th>
<th>-5x</th>
<th>+4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x</td>
<td>2x^3</td>
<td>-10x^2</td>
<td>+8x</td>
</tr>
<tr>
<td>-5</td>
<td>-5x^2</td>
<td>+25x</td>
<td>-20</td>
</tr>
</tbody>
</table>
5) Multiply \((2x - 5)(x^2 - 5x + 4)\)

Combine like terms!

\[
\begin{array}{|c|c|c|c|}
\hline
 & x^2 & -5x & +4 \\
\hline
2x & 2x^3 & -10x^2 & +8x \\
\hline
-5 & -5x^2 & +25x & -20 \\
\hline
\end{array}
\]

\[2x^3 - 15x^2 + 33x - 20\]
**Special Products of Binomials**

**CASE 1: The Sum and Difference of Two Terms**

\[(a + b)(a - b) = a^2 - b^2\]

**FOIL:**

\[a^2 + ab - ab - b^2\]

The inner terms and outer terms will always cancel each other out, so you are left with:

\[a^2 - b^2\]

**Examples:**

\[(x + 2)(x - 2) = x^2 + (2)(-2) = x^2 - 4\]

\[(2x + 3)(2x - 3) = (2x)^2 + (3)(-3) = 4x^2 - 9\]

**CASE 2: The Square of a Binomial**

\[(a + b)^2 = a^2 + 2ab + b^2\]

**Examples:**

\[(x + 3)^2 = x^2 + 2(3)(x) + 3^2 = x^2 + 6x + 9\]

\[(3x - 2)^2 = (3x)^2 + 2(3x)(-2) + (-2)^2 = 9x^2 - 12x + 4\]

**YOU TRY:** \((6x - y)^2\)