Although many applications are modeled with a linear equation, there are many more that are not! One common equation type used in applications is called the quadratic equation. The solution(s) to the equation are also called roots(s).

**Quadratic Equations**

A quadratic equation in standard form appears as \( ax^2 + bx + c = 0 \) where \( a, b, c \) are real numbers and \( a \neq 0 \). The degree of the polynomial \( ax^2 + bx + c \) is _______.

To solve \( ax^2 + bx + c = 0 \), we introduce one very important theorem:

**Zero Product Theorem:** If \( ab = 0 \), then \( a = 0 \) or \( b = 0 \) where \( a, b \) are real numbers.

This theorem states that if the product of factors is 0, then at least one of the factors must equal 0.

**Note:** This theorem ONLY works if the product is 0.

**Example 1:** Solve the following:

a) \( (x - 4)(x + 3) = 0 \)

b) \( 2(x - 5)(x + 7) = 0 \)

c) \( x(2x - 1)(3x + 4) = 0 \)

We can use the zero-product theorem and factoring to solve some equations with polynomials. Remember that not all polynomials are factorable (some are prime), so if they are involved in equations we cannot use factoring to solve them. We will learn other methods of solving these equations in the future.

**To solve an equation by factoring:** \( 2x^2 + 4x = 6 \)

1. Write the equation in standard form so it is set equal to 0 (may have to remove parentheses, etc.)

2. Factor the polynomial completely.

3. Set each factor containing a variable equal to 0 and solve.

4. Check each solution in the original equation.
Example 2: Solve the following by factoring.

a) \(x^2 - 5x = 14\)

b) \((y - 5)(y - 2) = 28\)

c) \(x^2 = 4x\)

Example 3: Find a quadratic equation that has the roots \(x = 3\) and \(x = -5\).