

4.5 Solving Quadratic Equations

Standard: A.A.FGR.5.5

Write and solve quadratic equations ... with real coefficients and use the solution to explain a mathematical, applicable situation.

Notes and Definitions

Remember that quadratic means of the form $ax^2 + bx + c$. To solve it to find the values of the variable that makes the equation true. Most commonly, there two real solutions to a quadratic equation though there could be one repeated real solution or two imaginary solutions as will be explained below.

There are several ways to solve a quadratic equation. The flow chart below summarizes these ways.



It is likely that you have encountered at least some of these methods before. Factoring was in the last section.

Graph Method

To solve a quadratic using the graph method, do the following:

(1) Type the equation as it into Desmos. (you would want to change the variable to x if not already an x .)

(2) Where the graph crosses the x -axis is/are the solution(s).

Note: if the graph doesn't cross the x -axis, the solutions are imaginary and you will likely have to use the quadratic formula.

Square Root Method

This method is used when there is no x term. To use it, do the following:

(1) Isolate x^2 .

(2) Take the square root of each side.

(3) Your solutions will be $x = \pm$

The purpose of the \pm is to bypass the fact that, by definition, $\sqrt{x^2} = |x| = \pm x$. When taking the square root of a squared variable, both the positive and negative root will make the equation true and are therefore both solutions.

Factoring Method

The factoring method involves getting everything to one side and getting $ax = 0$. This method takes advantage of the Zero Product Property which says if $ab = 0$ then $a = 0$ or $b = 0$. Do the following:

(1) Get everything to one side ($= 0$).

(2) Factor.

(3) Set each factor equal to 0.

(4) Solve.

Quadratic Formula

Like factoring, you need $ax = 0$. This is often seen as a "last resort", but has the advantage of working for any quadratic equation. Do the following:

(1) Get everything to one side ($= 0$)

(2) Determine a , b , c from $ax^2 + bx + c = 0$

(3) Insert into the formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

(4) Solve.

Note: make sure you have $ax = 0$ before declaring a , b , and c .

There is also a method called completing the square which is used to derive the Quadratic Formula and it used in future applications, but is most always not as efficient as other methods in solving.

Worked Out Examples

Solve the following quadratic equations. For Questions #1-3, no graph is available.

(1) $x^2 - 13 = 3$

Answer: Use the Square Root Method since there is no x term.

$$\begin{aligned} x^2 - 13 &= 3 \\ +13 &+13 \\ \hline x^2 &= 16 \\ \sqrt{x^2} &= \sqrt{16} \\ x &= \pm 4 \end{aligned}$$

(2) $x^2 = 9x - 20$

Answer: Since there is an x term we should set equal to zero.

$$\begin{aligned} x^2 &= 9x - 20 \\ -9x + 20 &-9x + 20 \\ \hline x^2 - 9x + 20 &= 0 \end{aligned}$$

Since this will easily factor, do so.

$$\begin{aligned} (x - 5)(x - 4) &= 0 \\ x - 5 &= 0 \text{ or } x - 4 = 0 \\ x &= 5 \text{ or } x = 4 \end{aligned}$$

(3) $4x^2 - 2x + 7 = 0$

Answer: This equation has an x term, so we can't take square roots. It is already set equal to 0 and is not easily factorable, so we resort to the Quadratic Formula.

$$\begin{aligned} a &= 4, b = -2, c = 7 \\ x &= \frac{2 \pm \sqrt{(-2)^2 - 4(4)(7)}}{2(4)} = \frac{2 \pm \sqrt{-108}}{8} = \frac{2 \pm 6\sqrt{3}}{8} \\ &= \frac{1 \pm 3\sqrt{3}}{4} \end{aligned}$$

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