

What Are Roots?

1. What Is a Root?

A **root** (also called a **zero**) of a polynomial is a number that makes the polynomial equal to zero.

For example, if we have the polynomial:

$$f(x) = x - 3,$$

we can find the root by setting:

$$f(x) = 0 \Rightarrow x - 3 = 0 \Rightarrow x = 3.$$

So, $x = 3$ is a root of $f(x)$.

Roots are where the graph of a function crosses the x -axis. That means the output $y = 0$ at those points. In Scratch, you can graph this and look for where your curve hits $y = 0$.

2. The Zero Product Rule

If

$$(a)(b) = 0,$$

then either:

$$a = 0 \quad \text{or} \quad b = 0.$$

This is called the **zero product rule**, and it helps us solve equations that are **factored**.

Example:

$$(x - 2)(x + 5) = 0$$

Apply the zero product rule:

$$x - 2 = 0 \quad \text{or} \quad x + 5 = 0 \Rightarrow x = 2 \quad \text{or} \quad x = -5$$

So, the roots are $x = 2$ and $x = -5$.

3. Try It Yourself!

(a) What are the roots of $f(x) = (x - 4)(x + 1)$?

(b) What are the roots of $f(x) = x(x - 3)$?

(c) Factor and find the roots: $f(x) = x^2 - 9$

(d) Try a harder one: $f(x) = x^2 + 5x + 6$

4. Graphing Roots in Scratch

If you program a graphing calculator in Scratch, try this:

- Plot $f(x) = x^2 - 4$
- Watch where the graph crosses the x -axis
- The graph hits $y = 0$ at $x = -2$ and $x = 2$ — those are the **roots**.

Challenge: Make your Scratch calculator **highlight** the x -axis in red and show where the function equals 0.

5. Think About It...

- Why do some graphs cross the x -axis twice, once, or not at all?
- What does it mean when a root happens twice? Try $f(x) = (x - 2)^2$
- Can a function have *no real roots*? Try $f(x) = x^2 + 1$

6. Bonus Question (for Math Wizards)

What are the roots of:

$$f(x) = x^3 - 6x^2 + 11x - 6?$$

Hint: Try factoring it step by step!

Math is the art of finding patterns — and roots show us where patterns touch zero.