Warm Up

Determine the zeros of each function.

1. $f(x) = x^2 - 4x + 4$

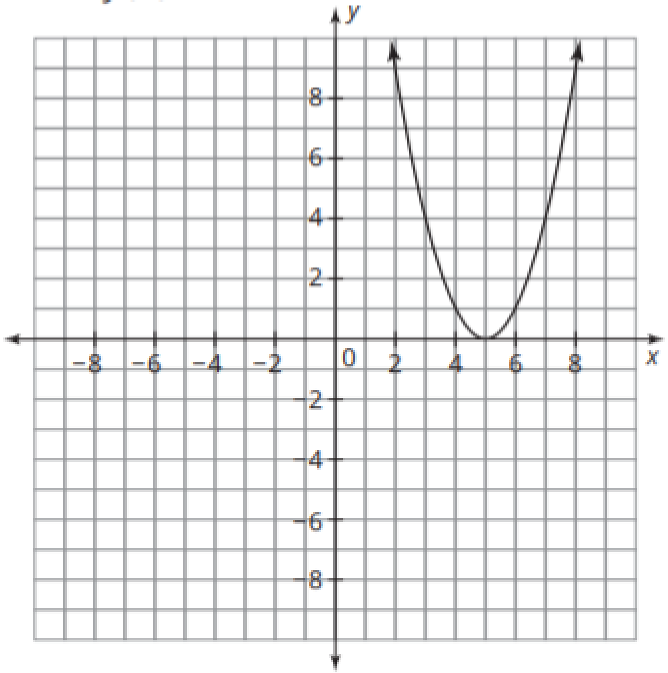
2. $g(x) = x^2 - 25$

3. $h(x) = (x - 1)^2 - 9$

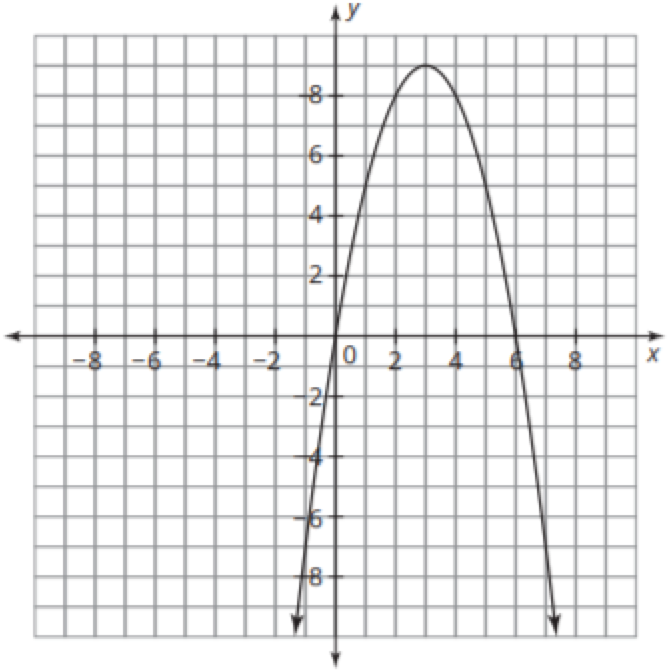
Did I Cross the Line?

1. Consider the quadratic functions and their graphs shown.

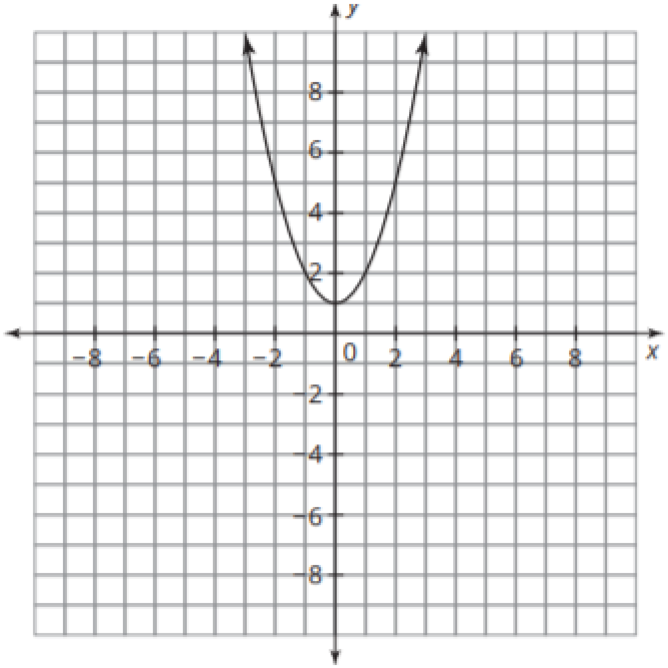
$f(x) = x^2 - 10x + 25$



$c(x) = -x^2 + 6x$



$p(x) = x^2 + 1$



Elena and Mark determined the zeros of the function.

Elena

$x^2 + 1 = 0$

$x^2 = -1$

$x = \pm\sqrt{-1}$

Mark

$x^2 + 1 = 0$

$x^2 = -1$

$x = \pm 1$

In order to calculate the square of any real number, there must be some way to calculate the square root of a negative number. That is, there must be a number such that when it is squared, it is equal to a negative number. For this reason, mathematicians defined what is called *the number i*.

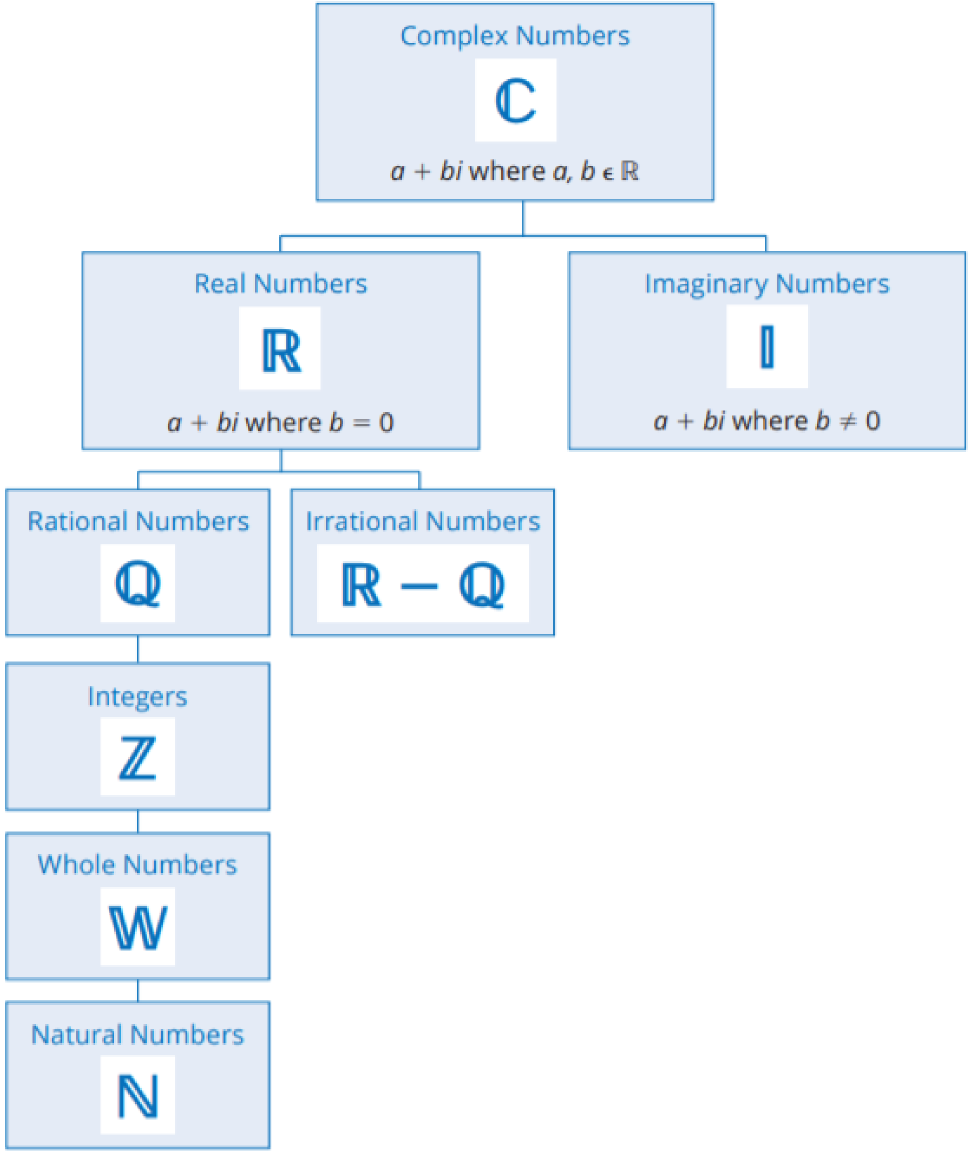
The number *i* is a number such that $i^2 = -1$. The number i is also called the imaginary identity.

3. If $i^2 = -1$, then what is the value of i?

4. Recall the function $p(x) = x^2 + 1$. Write the zeros of the function in terms of i.

Functions and equations that have solutions requiring *i* have **imaginary zeros** or **imaginary roots.**

5. **How can you tell from the graph of a quadratic equation whether or not it has real solutions or imaginary solutions?**



Complex Numbers
$\mathbb{C}$
$a + bi$ where $a, b \in \mathbb{R}$
Real Numbers
$\mathbb{R}$
$a + bi$ where $b = 0$
Imaginary Numbers
$\mathbb{I}$
$a + bi$ where $b \neq 0$
Rational Numbers
$\mathbb{Q}$
Irrational Numbers
$\mathbb{R} - \mathbb{Q}$
Integers
$\mathbb{Z}$
Whole Numbers
$\mathbb{W}$
Natural Numbers
$\mathbb{N}$

2. Use the diagram on the previous page to list *all* number sets that describe each given number.

a. 3 natural number, whole number, integer, rational number, real number, complex number

b. $\sqrt{7}$ irrational number, real number, complex number

c. $3i$ imaginary number, complex number

d. $5.\overline{45}$ rational number, real number, complex number

e. $\frac{7}{8}$ rational number, real number, complex number

f. $6 - i$ imaginary number, complex number

3. Rewrite each expression using *i*.

a. $\sqrt{-4}$

$2i$

b. $\sqrt{-12}$

$2\sqrt{3}i$

c. $5 + \sqrt{-50}$

$5 + 5\sqrt{2}i$

d. $\dfrac{6 - \sqrt{-8}}{2}$

$3 - \sqrt{2}i$

1. **Perform each operation. Show your work.**

a. $(3 + 2i) - (1 - 6i) =$

$2 + 8i$

b. $4i + 3 - 6 + i - 1 =$

$-4 + 5i$

c. $5i(3 - 2i) =$

$10 + 15i$

d. $(5 + 3i)(2 - 3i) =$

$19 - 9i$

2. Determine each product.

a. $(2 + i)(2 - i) =$

5

b. $(\frac{1}{2} + i)(\frac{1}{2} - i) =$

$\frac{5}{4}$

c. $(3 + 2i)(3 - 2i) =$

13

d. $(1 - 3i)(1 + 3i) =$

10

5. Consider the function $h(x) = x^2 - 2x + 2$.

a. What is the most efficient method to determine the zeros? Explain your reasoning.

b. Determine the discriminant of the function. How can you use the discriminant to know whether the solutions are real or imaginary?

Remember:

The discriminant of the function is $b^2 - 4ac$.

8. Use any method to solve each function.

a. $f(x) = -x^2 - 8x - 18$

$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4(-1)(-18)}}{2(-1)}$$

$$x = \frac{8 \pm \sqrt{64 - 72}}{-2}$$

$$x = \frac{8 \pm \sqrt{-8}}{-2}$$

$$x = \frac{8 \pm 2\sqrt{2}i}{-2}$$

$$x = -4 \pm \sqrt{2}i$$

b. $g(x) = 2x^2 - 2x + 3$

$$x = \frac{-(-2) \pm \sqrt{(-2)^2 - 4(2)(3)}}{2(2)}$$

$$x = \frac{2 \pm \sqrt{4 - 24}}{4}$$

$$x = \frac{2 \pm \sqrt{-20}}{4}$$

$$x = \frac{2 \pm 2\sqrt{5}i}{4}$$

$$x = \frac{1}{2} \pm \frac{1}{2}\sqrt{5}i$$