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> I. Model Problems. II. Practice III. Challenge Problems IV. Answer Key

Web Resources Different Methods for Solving Quadratic Equations Quadratic Equation Grapher Quadratic Formula Solver

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## Solving Quadratic Equations with the Quadratic Formula: Complex Solutions

For any quadratic equation  $ax^2 + bx + c = 0$ ,  $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ .

Complex numbers are written in the form a + bi where  $i^2 = -1$ ,  $i = \sqrt{-1}$ . Complex numbers include the set of Real and Imaginary numbers.

## I. Model Problems

In the following examples you will solve quadratic equations with the quadratic formula over the set complex numbers.

<i>Example 1:</i> Solve: $x^2 - 5x + 10 = 0$ . Write down the equation.	$x^2 - 5x + 10 = 0$
Identify the values of <i>a</i> , <i>b</i> , and <i>c</i> .	a = 1 $b = -5$ $c = 10$
Write down Quadratic Formula.	
white down Quadratic Formula.	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{\frac{2a}{2a}}$ $x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(10)}}{\frac{2(1)}{5 + \sqrt{25 - 40}}}$
Substitute.	$\frac{2a}{\sqrt{5}}$
Substitute.	$x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(10)}}{-(-5)^2 - 4(1)(10)}$
	2(1)
Simplify.	$x = \frac{5 \pm \sqrt{25 - 40}}{2}$
	$x = \frac{2}{2}$
	$x = \frac{5 \pm \sqrt{-15}}{2}$
	$x = \frac{2}{2}$
Simplify the radical and reduce.	$5\pm i\sqrt{15}$
	$x = \frac{5 \pm i\sqrt{15}}{2}$
The solution is:	$5 + i\sqrt{15}$
	$x = \frac{5 \pm i\sqrt{15}}{2}$
You can also write the answer as two separate	$x = \frac{5 - i\sqrt{15}}{2}, \frac{5 + i\sqrt{15}}{2}$
expressions.	$x = \frac{x^2 + x^2 + x^2}{2}, \frac{x^2 + x^2 + x^2}{2}$
	2 2
<i>Example 2:</i> Solve: $-2x^2 + 4x + 6 = 15$ . Write yo	our solutions as an exact answer(s).
Write down the equation.	$-2x^2 + 4x + 6 = 15$
Rearrange so the equation is equal to zero.	$-2x^2 + 4x - 9 = 0$
Identify the values of <i>a</i> , <i>b</i> , and <i>c</i> .	a = -2 $b = 4$ $c = -9$
Write down Quadratic Formula	$-b + \sqrt{b^2 - 4ac}$
	$x = \frac{2a}{2a}$
Substitute.	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $x = \frac{-(4) \pm \sqrt{(4)^2 - 4(-2)(-9)}}{2(-2)}$
	$x = \frac{(1) \pm \sqrt{(1)}}{2(-2)}$
Simplify	
Simplify.	$x = \frac{-4 \pm \sqrt{-56}}{-4}$
	-4
Simplify the radical and reduce. The solution is: $\emptyset$	$x = \frac{2 \pm i\sqrt{14}}{2}$
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II. Practice solving quadratics with the quadratic formula over the set of Complex numbers.

1. $x^2 - 4x + 5 = 0$	2. $x^2 + 6x + 13 = 0$
3. $x^2 + 6x + 12 = 0$	4. $x^2 + 4x + 2 = 0$
5. $a^2 - 5a + 8 = 0$	6. $x^2 - 3x + 10 = 0$
7. $b^2 - 7b - 3 = 0$	8. $-x^2 + 5x - 6 = 0$
9. $-c^2 - 6c + 8 = 0$	$10.\ 2a^2 - 6a - 3 = 0$
$11.\ 3d^2 - 5d + 6 = 0$	$12.\ 4x^2 + 11x = 3x - 10$
13. $14-3a^2 = 2a$	$14.7 - 8z^2 = 6z + 16$
$15. \ 3d - 2 = 5d^2$	$16.\ 5x^2 - 5x + 2 = 3x^2 - 3x$
$17.\ 10x^2 - 11x + 9 = 13x - 6x^2$	$18.\ 3t^2 + 8t + 5 = -2t^2$

## **III. Challenge Problems**

$19. x^4 + 13x^2 + 36 = 0$	$20. x^4 + 16x^2 - 225 = 0$
$21.\frac{1}{4}x^2 - \frac{1}{3}x + 1 = 0$	$22.\frac{2}{7}c^2 - \frac{1}{2}c - \frac{3}{14} = 0$

From the quadratic formula  $b^2 - 4ac$  is called the discriminant. The values of the discriminant tell us the nature of the solutions or roots of a quadratic equation,  $ax^2 + bx + c = 0$ 

- 23. What value(s) of the discriminant result in two unique real solutions?
- 24. What value(s) of the discriminant result in one unique real solution?
- 25. What value(s) of the discriminant result in two unique imaginary solutions?



## IV. Answer Key

1. 
$$x = 2 \pm i$$
  
2.  $x = -3 \pm 2i$   
3.  $x = -3 \pm i\sqrt{3}$   
4.  $x = -2 \pm \sqrt{2}$   
5.  $a = \frac{5 \pm i\sqrt{7}}{2}$   
6.  $x = \frac{3 \pm i\sqrt{31}}{2}$   
7.  $b = \frac{7 \pm \sqrt{61}}{2}$   
8.  $x = 2, 3$   
9.  $c = -3 \pm \sqrt{17}$   
10.  $a = \frac{3 \pm \sqrt{15}}{2}$   
11.  $d = \frac{5 \pm i\sqrt{47}}{6}$   
12.  $x = \frac{-2 \pm i\sqrt{6}}{2}$   
13.  $a = \frac{1 \pm \sqrt{43}}{3}$   
14.  $z = \frac{-3 \pm 3\sqrt{7}}{8}$   
15.  $d = \frac{3 \pm i\sqrt{31}}{10}$   
16.  $x = \frac{1 \pm i\sqrt{3}}{2}$   
17.  $x = \frac{3}{4}$   
18.  $t = \frac{-4 \pm 3i}{5}$   
19.  $x = \pm 3i, \pm 2i$   
20.  $x = \pm 3, \pm 5i$   
21.  $x = \frac{2 \pm 4i\sqrt{2}}{3}$   
22.  $c = \frac{7 \pm \sqrt{97}}{8}$ 

- 23. The discriminant is positive.
- 24. The discriminant is zero.
- 25. The discriminant is negative.

