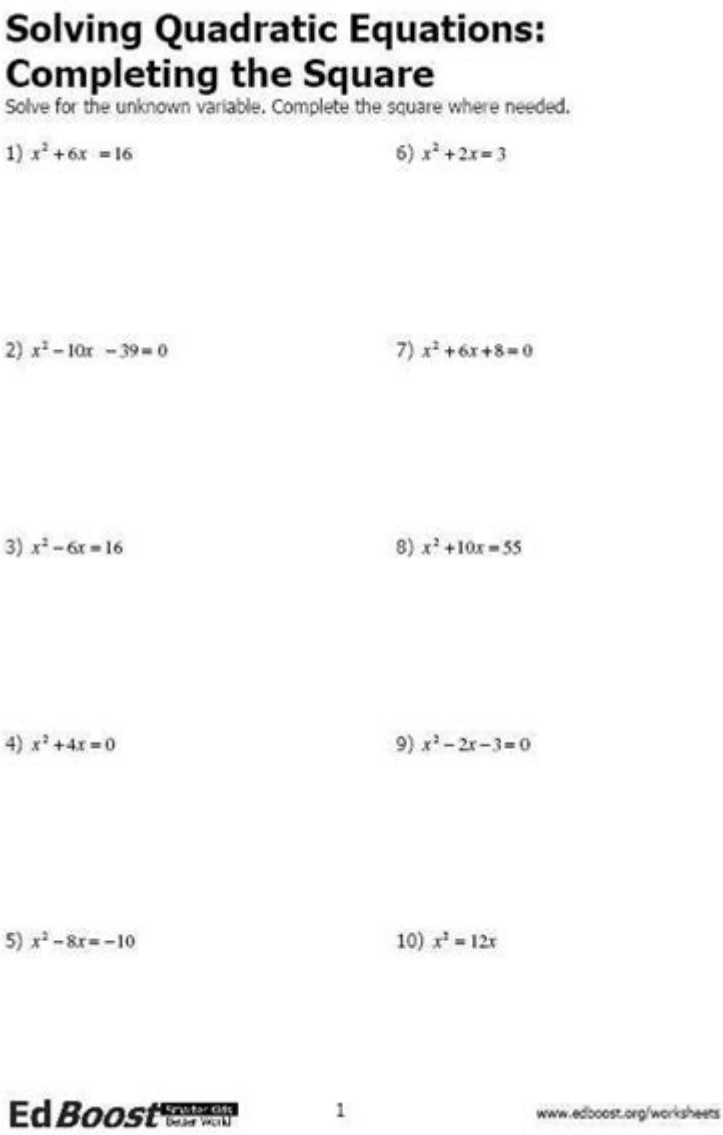
Quadratic Formula Word Problems Answer Key



Solving Quadratic Equations: Completing the Square

Solve for the unknown variable. Complete the square where needed.

1) $x^2+6x=16$

2) $x^2-10x-39=0$

3) $x^2-6x=16$

4) $x^2+4x=0$

5) $x^2-8x=-10$

6) $x^2+2x=3$

7) $x^2+6x+8=0$

8) $x^2+10x=55$

9) $x^2-2x-3=0$

10) $x^2=12x$

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Quadratic formula word problems answer key are essential tools for students and educators dealing with algebraic equations. These problems frequently arise in various real-world scenarios, making understanding and solving them crucial for mastering mathematics. The quadratic formula, which is $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, is used to find the roots of quadratic equations in the standard form $ax^2 + bx + c = 0$. This article will explore common types of word problems that can be solved using the quadratic formula, provide illustrative examples, and offer an answer key to facilitate learning.

Understanding the Quadratic Formula

To effectively solve word problems using the quadratic formula, it is vital first to understand what a quadratic equation is. A quadratic equation is a polynomial equation of degree two, typically expressed in the form $ax^2 + bx + c = 0$, where:

- a represents the coefficient of x^2 (and $a \neq 0$),
- b represents the coefficient of x,
- c is the constant term.

The solutions to these equations can be found using the quadratic formula, which provides the values of x that make the equation true.

Types of Word Problems

Quadratic formula word problems can be categorized into several types, including:

1. Projectile Motion Problems: These problems often involve calculating the height of an object at a given time or determining the time when an object reaches a certain height.

2. Area Problems: These problems may require finding the dimensions of a rectangular area given certain constraints or relationships.

3. Profit and Loss Problems: In business contexts, these problems can involve maximizing profit or minimizing loss based on quadratic relationships.

4. Geometry Problems: Problems involving the dimensions of geometric shapes can often be modeled using quadratic equations.

5. Rate Problems: These problems may involve speed, distance, and time relationships that yield quadratic equations.

Solving Word Problems Using the Quadratic Formula

To effectively tackle word problems, follow these steps:

1. Read the problem carefully to understand what is being asked.
2. Identify the variables and assign them to x.
3. Translate the problem into a quadratic equation in the form $ax^2 + bx + c = 0$.
4. Use the quadratic formula to solve for x.
5. Interpret the solutions in the context of the problem.

Example Problems and Solutions

Here are several illustrative problems using the quadratic formula, complete with solutions and explanations.

Example 1: Projectile Motion

A ball is thrown upwards from a height of 1.5 meters with an initial velocity of 20 meters per second. The height h of the ball after t seconds can be modeled by the equation:

$$
h(t) = -4.9t^2 + 20t + 1.5
$$

Question: When does the ball hit the ground?

Solution: To find when the ball hits the ground, we set $h(t) = 0$:

$$
-4.9t^2 + 20t + 1.5 = 0
$$

This translates to:

- $a = -4.9$
- $b = 20$
- $c = 1.5$

Using the quadratic formula:

$$
t = \frac{-20 \pm \sqrt{20^2 - 4 \times -4.9 \times 1.5}}{2 \times -4.9}
$$

Calculating the discriminant:

$$
20^2 - 4 \times -4.9 \times 1.5 = 400 + 29.4 = 429.4
$$

Now substituting back:

$$
t = \frac{-20 \pm \sqrt{429.4}}{-9.8}
$$

Calculating the square root and values:

$$
t \approx \frac{-20 \pm 20.7}{-9.8}
$$

Calculating both roots:

1. $t \approx \frac{0.7}{-9.8}$ (not valid, as time cannot be negative)
2. $t \approx \frac{-40.7}{-9.8} \approx 4.14$

Thus, the ball hits the ground approximately 4.14 seconds after being thrown.

Example 2: Area Problem

A rectangular garden has a length that is 3 meters longer than its width. If the area of the garden is 70 square meters, what are the dimensions of the garden?

Solution: Let the width be x meters. Then the length is $x + 3$.

The area A can be expressed as:

$$
A = x(x + 3) = 70
$$

Rearranging gives:

$$
x^2 + 3x - 70 = 0
$$

Identifying coefficients:

- $a = 1$
- $b = 3$
- $c = -70$

Using the quadratic formula:

$$
x = \frac{-3 \pm \sqrt{3^2 - 4 \times 1 \times -70}}{2 \times 1}
$$

Calculating the discriminant:

$$
9 + 280 = 289
$$

Substituting back:

$$
x = \frac{-3 \pm 17}{2}
$$

Calculating both roots:

1. $x = \frac{14}{2} = 7$ (valid width)
2. $x = \frac{-20}{2} = -10$ (not valid)

Thus, the width is 7 meters, and the length is 10 meters (7 + 3).

Example 3: Profit Problem

A company finds that its profit P in dollars from selling x units of a product is given by:

$$
P(x) = -5x^2 + 150x - 200
$$

Question: How many units should the company sell to maximize profit?

Solution: To find the maximum profit, we need to determine the vertex of the quadratic equation given by $P(x)$.

The formula for the vertex x is:

$$
x = \frac{-b}{2a}
$$

Where $a = -5$ and $b = 150$:

$$
x = \frac{-150}{2 \times -5} = \frac{150}{10} = 15
$$

Thus, the company should sell 15 units to maximize profit.

Answer Key Summary

Here’s a concise answer key for the example problems discussed:

1. Projectile Motion: The ball hits the ground after 4.14 seconds.
2. Area Problem: The dimensions of the garden are 7 meters (width) and 10 meters (length).
3. Profit Problem: The company should sell 15 units to maximize profit.

Conclusion

In conclusion, quadratic formula word problems answer key not only provide solutions but also enhance comprehension of quadratic equations and their applications in real-life situations. By learning to identify and set up these equations, students can effectively solve a variety of problems in areas such as physics, business, and geometry. The examples provided are just a starting point for mastering this essential algebraic tool. With practice, students will become adept at recognizing and solving quadratic equations in diverse contexts.

Frequently Asked Questions

What is the quadratic formula used for solving word problems?

The quadratic formula is used to find the solutions for a quadratic equation in the form ax^2 + bx + c = 0, and is given by x = (-b ± √(b² - 4ac)) / (2a).

How do you identify when to use the quadratic formula in a word problem?

You should use the quadratic formula when the problem involves a scenario that can be modeled by a quadratic equation, typically when a situation involves areas, projectile motion, or profit maximization.

Can you provide an example of a word problem that requires the quadratic formula?

A classic example is: 'A rectangular garden has a length that is 3 meters longer than its width. If the area of the garden is 40 square meters, what are the dimensions of the garden?' This can be set up as a quadratic equation.

What steps should be followed to solve a quadratic word problem?

1. Read the problem carefully and identify the variables. 2. Write down the equation in standard form (ax^2 + bx + c = 0). 3. Identify coefficients a, b, and c. 4. Apply the quadratic formula. 5. Interpret the solutions in the context of the problem.

What are common mistakes to avoid when solving quadratic formula word problems?

Common mistakes include misidentifying a, b, c from the word problem, forgetting to consider both possible solutions, and not interpreting the answers correctly in the context of the problem.

How can I check if my answer to a quadratic word problem is correct?

You can check your answer by substituting it back into the original equation to see if it satisfies the conditions of the problem, or by verifying if the dimensions or values make sense in the context of the problem.

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