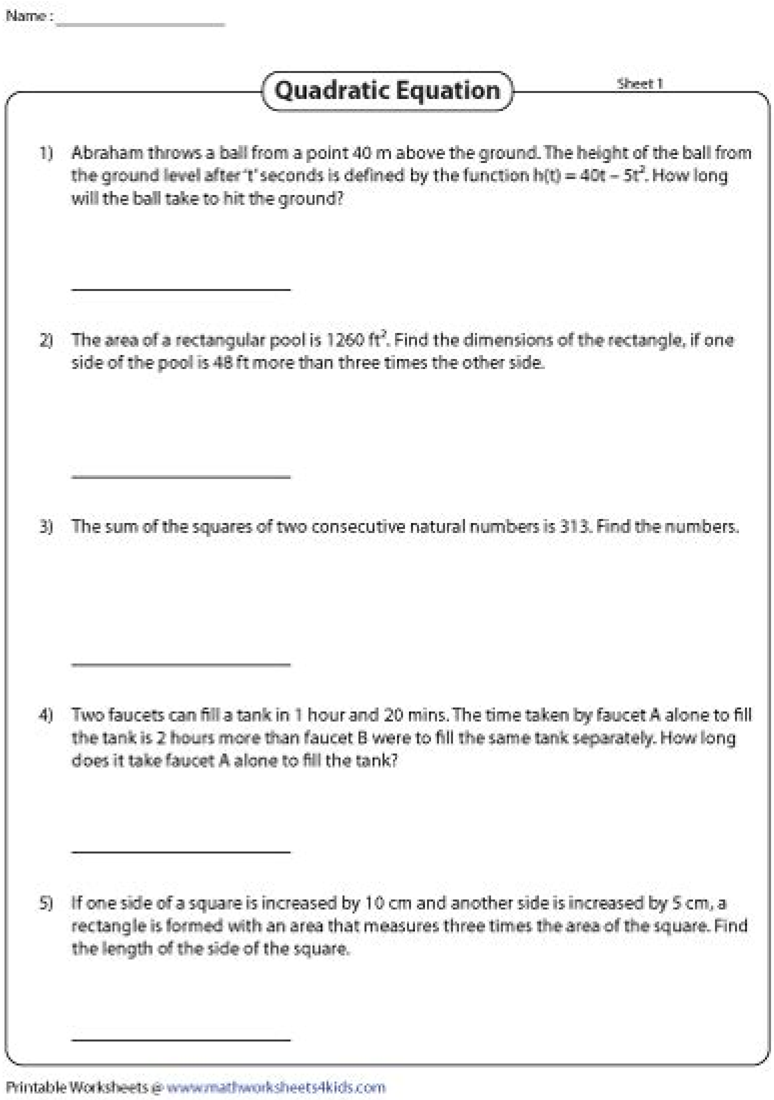
Quadratic Equation Word Problems And Answers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Quadratic Equation

Sheet 1

1) Abraham throws a ball from a point 40 m above the ground. The height of the ball from the ground level after 't' seconds is defined by the function $h(t) = 40t - 5t^2$. How long will the ball take to hit the ground?

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2) The area of a rectangular pool is 1260 ft^2. Find the dimensions of the rectangle, if one side of the pool is 48 ft more than three times the other side.

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3) The sum of the squares of two consecutive natural numbers is 313. Find the numbers.

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4) Two faucets can fill a tank in 1 hour and 20 mins. The time taken by faucet A alone to fill the tank is 2 hours more than faucet B were to fill the same tank separately. How long does it take faucet A alone to fill the tank?

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5) If one side of a square is increased by 10 cm and another side is increased by 5 cm, a rectangle is formed with an area that measures three times the area of the square. Find the length of the side of the square.

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Quadratic equation word problems and answers are a crucial aspect of algebra that help students and professionals alike understand practical applications of quadratic equations. A quadratic equation is typically expressed in the standard form \(ax^2 + bx + c = 0 \), where \(a \), \(b \), and \(c \) are constants and \(x \) represents an unknown variable. These equations can model a variety of real-world scenarios, including projectile motion, profit maximization, and area calculations. This article delves into the different types of quadratic equation word problems, provides examples, and explains how to solve them step by step.

Understanding Quadratic Equations

Quadratic equations can be solved using several methods, including:

- Factoring
- Completing the square
- Using the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Each method has its own advantages and is suitable for different types of problems. Understanding the context of a word problem is essential to determine the best approach to find the solution.

Types of Quadratic Equation Word Problems

Quadratic equations can arise in various contexts. Here are some common types of word problems that utilize quadratic equations:

1. Projectile Motion

Projectile motion problems often involve objects being thrown or projected into the air, where their height as a function of time can be modeled by a quadratic equation.

Example Problem:
A ball is thrown upward from a height of 5 feet with an initial velocity of 20 feet per second. The height h of the ball after t seconds can be modeled by the equation:
$$h(t) = -16t^2 + 20t + 5$$
How long will it take for the ball to hit the ground?

Solution:
To find when the ball hits the ground, we set $h(t) = 0$:
$$-16t^2 + 20t + 5 = 0$$

Using the quadratic formula:
$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
where $a = -16$, $b = 20$, and $c = 5$:
$$t = \frac{-20 \pm \sqrt{20^2 - 4(-16)(5)}}{2(-16)}$$
$$t = \frac{-20 \pm \sqrt{400 + 320}}{-32}$$
$$t = \frac{-20 \pm \sqrt{720}}{-32}$$
$$t = \frac{-20 \pm 26.83}{-32}$$

Calculating the two possible values:
1. $t = \frac{6.83}{-32}$ (not applicable since time cannot be negative)
2. $t = \frac{-46.83}{-32} = 1.46$ seconds (valid solution)

So, the ball will hit the ground after approximately 1.46 seconds.

2. Area Problems

Area problems often involve finding the dimensions of a rectangle or other shapes when certain conditions are known, leading to quadratic equations.

Example Problem:
A rectangle has a length that is 3 feet longer than its width. If the area of the rectangle is 54 square feet, what are the dimensions?

Solution:
Let the width be w feet. Then, the length is $w + 3$ feet. The area is given by:
$$w(w + 3) = 54$$
Expanding this:
$$w^2 + 3w - 54 = 0$$

Now, we can factor this quadratic equation:
$$(w + 9)(w - 6) = 0$$
Setting each factor to zero gives:
1. $w + 9 = 0$ → $w = -9$ (not valid for width)
2. $w - 6 = 0$ → $w = 6$

Thus, the width is 6 feet, and the length is:
$$6 + 3 = 9 \text{ feet}$$

3. Profit Maximization Problems

Profit maximization problems often use quadratic equations to determine the optimal production levels for maximum profit.

Example Problem:
A company finds that its profit P in dollars from producing and selling x units of a product can be modeled by the equation:
$$P(x) = -2x^2 + 40x - 100$$
How many units should the company produce to maximize its profit?

Solution:
To find the maximum profit, we need to locate the vertex of the parabola described by the quadratic equation. The x-coordinate of the vertex can be found using the formula:
$$x = -\frac{b}{2a}$$
Here, $a = -2$ and $b = 40$:
$$x = -\frac{40}{2(-2)} = \frac{40}{4} = 10$$

The company should produce 10 units to maximize its profit.

Practice Problems

To solidify your understanding of quadratic equation word problems, try solving the following practice problems:

1. A garden's length is twice its width. If the area of the garden is 200 square feet, what are the dimensions?
2. A ball is thrown from a height of 25 feet with an initial upward velocity of 15 feet per second. How long will it take for the ball to hit the ground?
3. The revenue R from selling x units of a product is modeled by the equation $R(x) = -3x^2 + 60x$. What quantity should be produced to maximize revenue?

Conclusion

Quadratic equation word problems are not only a significant aspect of mathematical education but also a practical tool in various fields such as physics, economics, and engineering. By understanding how to formulate and solve these problems, you can apply mathematical concepts to real-life situations effectively. Practice is key to mastering these types of problems, so take the time to work through various scenarios, and soon you'll be solving quadratic equations with confidence.

Frequently Asked Questions

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?

Let the width be x meters. Then the length is $x + 3$ meters. The equation is $x(x + 3) = 70$, which simplifies to $x^2 + 3x - 70 = 0$. Solving the quadratic equation, we find the width is 7 meters and the length is 10 meters.

A ball is thrown upward from a height of 1.5 meters with an initial velocity of 20 meters per second. How long will it take for the ball to hit the ground?

The height of the ball can be modeled by the equation $h(t) = -4.9t^2 + 20t + 1.5$. Setting $h(t) = 0$ and solving the quadratic equation $-4.9t^2 + 20t + 1.5 = 0$ gives $t \approx 4.1$ seconds.

The product of two consecutive integers is 306. What are the integers?

Let the integers be n and n + 1. The equation is n(n + 1) = 306, leading to n^2 + n - 306 = 0. Solving this gives n = 17 and n + 1 = 18.

A train leaves a station 30 minutes after another train that travels at a speed of 20 km/h. If the first train travels at a speed of 40 km/h, how far from the station will they meet?

Let the distance be d km. The first train travels for t hours, and the second for t - 0.5 hours. The equation is 40t = 20(t - 0.5), which simplifies to 20t + 10 = 0. Thus, t = 0.5 hours, and they meet 20 km from the station.

A projectile is launched from the ground with an initial velocity of 50 m/s. How high will it go before it starts to fall back down?

The height is modeled by h(t) = -4.9t^2 + 50t. To find the maximum height, calculate the vertex of the quadratic. The time at maximum height is t = 50/(24.9) ≈ 5.1 seconds. The maximum height is h(5.1) ≈ 127.5 meters.

The sum of the ages of a father and son is 66 years. In 6 years, the father's age will be twice the son's age. What are their current ages?

Let the son's age be x. Then, the father's age is 66 - x. In 6 years, the equation is 66 - x + 6 = 2(x + 6), leading to x^2 - 12x + 54 = 0. Solving gives the son's age as 30 and the father's age as 36.

A rectangular pool is 4 meters longer than it is wide. If the perimeter is 48 meters, what are the dimensions of the pool?

Let the width be x meters. Then the length is x + 4 meters. The equation for perimeter is 2(x + (x + 4)) = 48, simplifying to x^2 + 4x - 48 = 0. Solving gives the dimensions as width = 12 meters and length = 16 meters.

The area of a triangle is 84 square meters. If the base is 2 meters longer than the height, what are the dimensions of the triangle?

Let the height be h meters. Then the base is h + 2 meters. The area is given by (1/2) base height = 84, leading to h(h + 2) = 168, which simplifies to h^2 + 2h - 168 = 0. Solving gives height = 12 meters and base = 14 meters.

A car's value decreases by a fixed amount each year and is

modeled by the equation V(t) = -500t^2 + 6000. When will the car's value reach $0?

Setting V(t) = 0 gives the equation -500t^2 + 6000 = 0. Solving this yields t^2 = 12, so t = √12 ≈ 3.46 years. The car's value will reach $0 in approximately 3.46 years.

A farmer wants to create a rectangular field with an area of 100 square meters. If the length is 5 meters longer than the width, what are the dimensions of the field?

Let the width be x meters. Then the length is x + 5 meters. The equation is x(x + 5) = 100, simplifying to x^2 + 5x - 100 = 0. Solving this gives the width = 10 meters and the length = 15 meters.

Quadratic Equation Word Problems And Answers

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