MATHEMATICS · GRADES 10-12

The quadratic formula

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you solve any quadratic equation, like working out when a ball thrown in the air hits the ground or what size a garden can be for a given area, even when factoring does not work. Factoring only works when the numbers split neatly, and plenty of real problems do not split neatly at all. The quadratic formula works for every quadratic, neat or not, and gives you the answers directly. That makes it the fallback you can always rely on, whether you are timing a thrown ball or sizing a garden.



Rule

The quadratic formula: for $ax^2 + bx + c = 0$, $x = \frac{-b \pm \sqrt{(b^2-4ac)}}{2a}$.

Identify a, b, and c first, then substitute, and work out both values.

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Worked examples

EXAMPLE 1

Q Solve $x^2 + 4x + 1 = 0$ using the quadratic formula

SOLUTION

Identify $a = 1$, $b = 4$, $c = 1$.

Substitute: $x = \frac{-b \pm \sqrt{(b^2-4ac)}}{2a} = \frac{-4 \pm \sqrt{(4^2-4(1)(1))}}{2(1)}$

Simplify: $x = \frac{-4 \pm \sqrt{12}}{2} = \frac{-4 \pm 2\sqrt{3}}{2} = -2 \pm \sqrt{3}$

EXAMPLE 2

Q Solve $2x^2 - 3x - 2 = 0$ using the quadratic formula

SOLUTION

Identify $a = 2$, $b = -3$, $c = -2$.

Substitute: $x = \frac{3 \pm \sqrt{(9+16)}}{4} = \frac{3 \pm 5}{4}$

Work out both values: $x = 2$ or $x = -\frac{1}{2}$

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Practice questions

1 Solve $x^2 + 6x + 5 = 0$ using the quadratic formula.

- **A** x = -1 or x = -5
- **B** x = 1 or x = 5
- **C** x = -1 or x = 5
- **D** x = 1 or x = -5

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2 What are a, b, and c in $x^2 - 3x - 4 = 0$?

- **A** a = 1, b = –3, c = –4
- **B** a = 1, b = 3, c = 4
- **C** a = 1, b = –3, c = 4
- **D** a = –1, b = –3, c = –4

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3 Use the quadratic formula to find the discriminant ($b^2 - 4ac$) of $2x^2 + 5x - 3 = 0$.

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4 How many real solutions does $x^2 + 2x - 3 = 0$ have?

A None

B One

C Two

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5 Ria solves $3x^2 - 7x + 2 = 0$ and gets $x = 2$ or $x = 1/3$. Check $x = 2$ in the equation. What is the value of $3x^2 - 7x + 2$ when $x = 2$?

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6 $x^2 - 4x - 5 = 0$ has solutions $x = 5$ and $x = -1$. What is the sum of the solutions?

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7 The solutions are $x = 2$ or $x = -4$. Which equation has these solutions?

A $x^2 + 2x - 8 = 0$

B $x^2 - 2x - 8 = 0$

C $x^2 + 2x + 8 = 0$

D $x^2 - 2x + 8 = 0$

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8 Ria uses the quadratic formula on $x^2 + 5x + 6 = 0$ and writes $x = \frac{-5 + 1}{2} = -2$, then stops. What are the two solutions?

- **A** $x = -2$ or $x = -3$
- **B** $x = 2$ or $x = 3$
- **C** $x = -2$ or $x = 3$
- **D** $x = 2$ or $x = -3$

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9 A ball is thrown and its height is $h = -5t^2 + 20t$. It hits the ground when $h = 0$. After how many seconds does it hit the ground (other than at $t = 0$)?

- **A** 2 seconds
- **B** 4 seconds
- **C** 5 seconds
- **D** 20 seconds

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10 **Which equation does NOT have x = -1 as a solution:**

A $x^2 + 3x + 2 = 0$

B $x^2 + 4x + 3 = 0$

C $x^2 + 5x + 6 = 0$

D $x^2 + 6x + 5 = 0$

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ANSWER KEY

1. x = -1 or x = -5

2. a = 1, b = –3, c = –4

3. 49

4. Two

5. 0

6. 4

7. $x^2 + 2x - 8 = 0$

8. x = -2 or x = -3

9. 4 seconds

10. $x^2 + 5x + 6 = 0$

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