MATHEMATICS · GRADES 10-12

Extraneous solutions in radical equations

Difficulty level: Advanced

Mathematics: Grades 10-12

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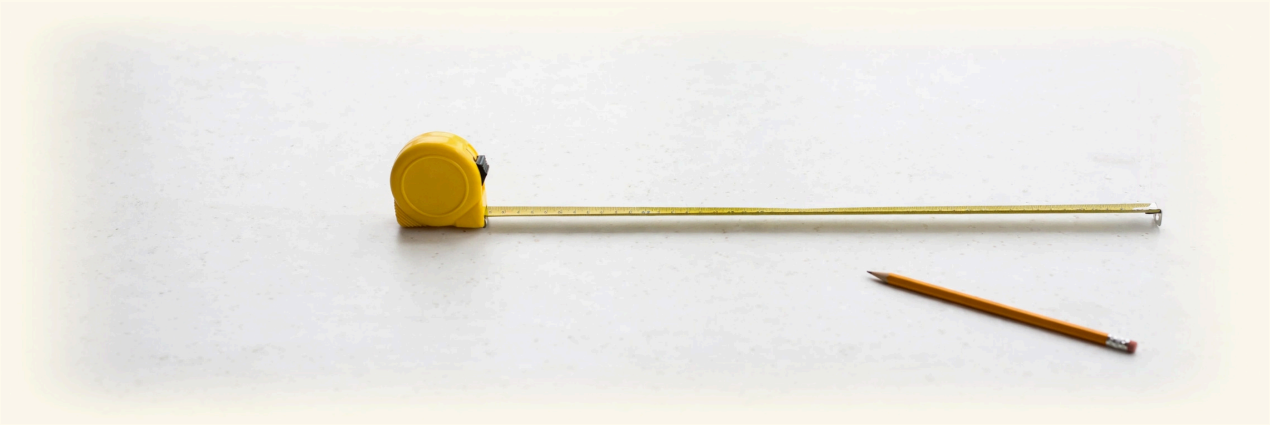
Overview of the concept

This is how you catch an answer that looks right after squaring but does not actually work. Squaring both sides can create an extra answer that never satisfied the original equation, like a measurement that fits the squared version but not the real one. Checking each answer back in the original equation catches the fake one. It is the same as double-checking a measurement before cutting an expensive piece of wood.



Rule

Extraneous solutions: squaring both sides of an equation can create answers that do not satisfy the original equation, so always check every answer in the original equation and reject any that fail.

A radical equation is an equation with a square root in it.

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Worked examples

EXAMPLE 1

Q Solve $\sqrt{(x+3)} = x - 3$

SOLUTION

Square both sides: $x + 3 = (x - 3)^2 = x^2 - 6x + 9$

Rearrange: $0 = x^2 - 7x + 6 = (x - 1)(x - 6)$, so $x = 1$ or $x = 6$

Check: for $x = 1$, $\sqrt{4} = 2$ but $1 - 3 = -2$, so reject 1. For $x = 6$, $\sqrt{9} = 3$ and $6 - 3 = 3$, so the only solution is $x = 6$

EXAMPLE 2

Q Solve $\sqrt{x} = x - 2$

SOLUTION

Square both sides: $x = (x - 2)^2 = x^2 - 4x + 4$

Rearrange: $0 = x^2 - 5x + 4 = (x - 1)(x - 4)$, so $x = 1$ or $x = 4$

Check: for $x = 1$, $\sqrt{1} = 1$ but $1 - 2 = -1$, so reject 1. For $x = 4$, $\sqrt{4} = 2$ and $4 - 2 = 2$, so the only solution is $x = 4$

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Practice questions

1 Solve $\sqrt{x} = x - 6$. State the valid solution.

- **A** $x = 4$
- **B** $x = 6$
- **C** $x = 9$
- **D** $x = 16$

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2 Solve $\sqrt{(2x+1)} = x - 1$. Which value is the extraneous solution?

- **A** $x = 0$
- **B** $x = 1$
- **C** $x = 4$
- **D** $x = 2$

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3 Solve $\sqrt{(x+1)} = x - 1$. How many valid solutions are there?

- **A** 0
- **B** 1
- **C** 2
- **D** 3

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4 After squaring $\sqrt{(x-2)} = x - 4$, you get $x = 3$ or $x = 6$. Which one is valid?

- **A** $x = 3$
- **B** $x = 6$
- **C** Both
- **D** Neither

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5 Solve $\sqrt{(x+5)} = \sqrt{(2x-1)}$. State the valid solution.

- **A** x = 3
- **B** x = 6
- **C** x = 9
- **D** x = 11

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6 Solve $\sqrt{(x+9)} = 5$ and state the valid solution.

- **A** x = 25
- **B** x = 9
- **C** x = 16
- **D** x = 34

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7 The valid solution is $x = 4$. Which equation has it?

- **A** $\sqrt{x} = x - 2$
- **B** $\sqrt{(x+1)} = x - 2$
- **C** $\sqrt{x} = x - 4$

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8 Why must you check your answers when you square both sides of a radical equation?

- **A** Squaring always gives the same answers as the original equation.
- **B** You only need to check answers that are negative.
- **C** Squaring can create an answer that does not satisfy the original equation.
- **D** Squaring removes the square root, so no check is needed.

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9 Which of these equations has no valid solution?

A $\sqrt{x} = x - 2$

B $\sqrt{(x+2)} = x$

C $\sqrt{x} = x + 1$

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10 Which one does not have a whole-number valid solution?

A $\sqrt{x} = x - 6$

B $\sqrt{x} = x - 2$

C $\sqrt{x} = x - 12$

D $\sqrt{x} = x - 4$

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ANSWER KEY

1. $x = 9$

2. $x = 0$

3. 1

4. $x = 6$

5. $x = 6$

6. $x = 16$

7. $\sqrt{x} = x - 2$

8. Squaring can create an answer that does not satisfy the original equation

9. $\sqrt{x} = x + 1$

10. $\sqrt{x} = x - 4$

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