MATHEMATICS · GRADES 10-12

Systems with infinitely many solutions

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you spot when two equations are really the same rule in disguise, like two different orders that give the same total price, so every point on the line is an answer and there is no single one. The two equations look different, but one is just the other multiplied or rearranged, so they describe the same line. That means every pair that works for one works for the other, and there are endless answers, not just one. Spotting this saves you from hunting for a single answer that does not exist.



Rule

Systems with infinitely many solutions: when two equations describe the same line, every point on that line is a solution.

A system like this is called dependent.

Solving gives a statement that is always true, like $0 = 0$.

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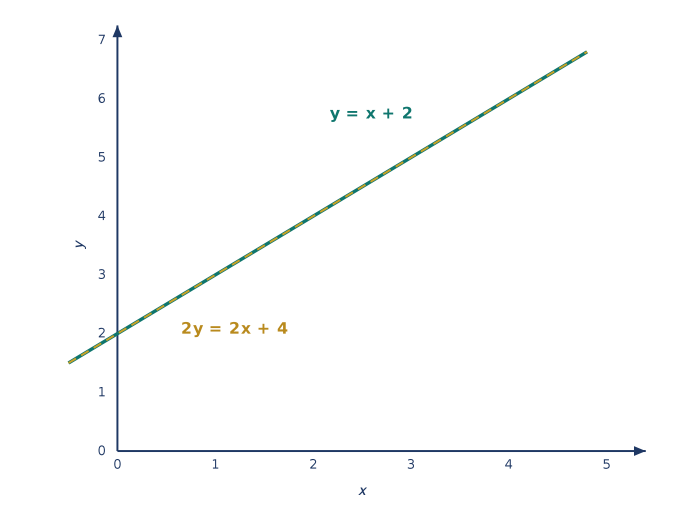
Worked examples

EXAMPLE 1

Q **Show that $y = x + 2$ and $2y = 2x + 4$ have infinitely many solutions.**



SOLUTION

Divide the second equation by 2: $y = x + 2$

It is the same equation as the first, so the lines lie exactly on top of each other.

Every point on $y = x + 2$ is a solution.

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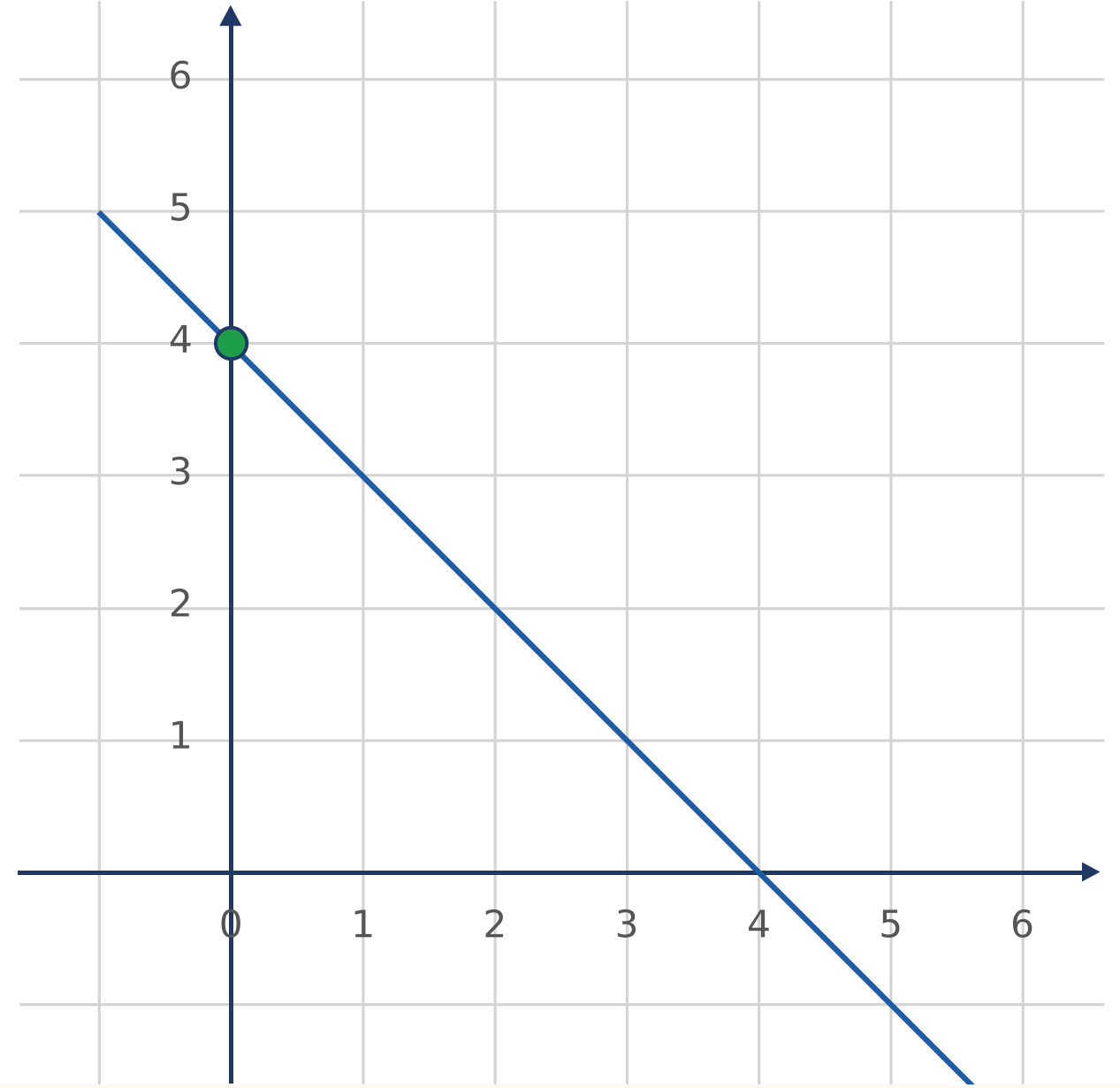
EXAMPLE 2

Q Solve $x + y = 4$ and $3x + 3y = 12$.



SOLUTION

Divide the second equation by 3: $x + y = 4$, the same as the first.

Solving gives $0 = 0$, which is always true.

Infinitely many solutions: any pair with $x + y = 4$, for example $(0, 4)$.

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Practice questions

1 Two recipes are really the same rule written two ways, and their graphs lie on top of each other. How many solutions does the system have?

- **A** Infinitely many
- **B** One
- **C** None
- **D** Two

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2 Solve $3x + y = 7$ and $6x + 2y = 14$. What does the working end with, and what does it mean?

- **A** $0 = 0$, so infinitely many solutions
- **B** $0 = 0$, so no solutions
- **C** $7 = 14$, so one solution
- **D** $x = 1$, so one solution

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3 The line $x + y = 5$ is given. Which pair (x, y) is on the line?

- **A** (1, 4)
- **B** (1, 5)
- **C** (5, 5)
- **D** (0, 0)

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4 The equations $x + 2y = 6$ and $2x + 4y = 12$ describe one line. Are there infinitely many solutions?

- **A** Yes
- **B** No

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5 When two equations describe the same line, what is the system called?

- A Dependent
- B Independent
- C Inconsistent
- D Parallel

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6 $y = x$ and $y = x + 1$ are two parallel lines. They never meet. How many solutions are there?

- A One
- B None
- C Infinitely many
- D Two

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7 A train fare rule says the cost y is 3 times the number of stops x, so $y = 3x$. Which pair fits the rule?

- **A** (3, 1)
- **B** (1, 3)
- **C** (2, 3)
- **D** (3, 6)

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8 The line $x + y = 5$ is given. Which equation together with it gives infinitely many solutions?

- **A** $2x + 2y = 10$
- **B** $x + y = 6$
- **C** $x - y = 5$
- **D** $2x + y = 10$

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9 **Consider the equations $2x + 2y = 8$ and $x + y = 4$. Do they give one solution, no solution, or infinitely many?**

- **A** No solution
- **B** Infinitely many

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10 **A student graphs a system and sees only one line. What does that tell them?**

- **A** The two lines lie on top of each other, so there are infinitely many solutions
- **B** The lines are parallel, so there are no solutions
- **C** The lines cross once, so there is one solution
- **D** The graph is wrong

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ANSWER KEY

1. Infinitely many

2. $0 = 0$, so infinitely many solutions

3. (1, 4)

4. Yes

5. Dependent

6. None

7. (1, 3)

8. $2x + 2y = 10$

9. Infinitely many

10. The two lines lie on top of each other, so there are infinitely many solutions

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