MATHEMATICS · GRADES 10-12

Finding the vertex

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you find the highest or lowest point of a curved path. The peak of a thrown ball, or the lowest point of a valley on a roller coaster, is the vertex (see Vertex form), and it tells you the greatest height or the lowest dip. Every curved path has one, and it is usually the point you care about most. Finding it tells you the best or worst the situation can get.



Rule

Vertex: for a parabola $y = ax^2 + bx + c$, the x value of the vertex is $x = -\frac{b}{(2a)}$.

Put that x back into the equation to get the y value, and the vertex is the point (x, y).

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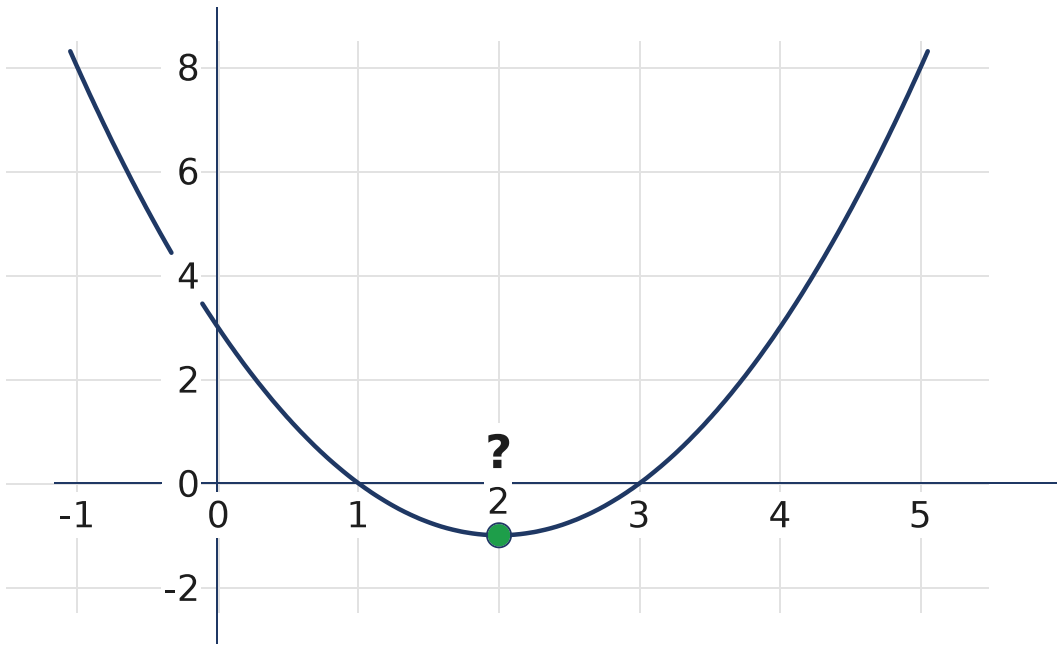
Worked examples

EXAMPLE 1

Q Find the vertex of $y = x^2 - 4x + 3$



SOLUTION

Use $x = -\frac{b}{(2a)}$: $x = \frac{-(-4)}{2} = \frac{4}{2} = 2$

Find y when x = 2: $2^2 - 4(2) + 3 = 4 - 8 + 3 = -1$

So the vertex is (2, -1)

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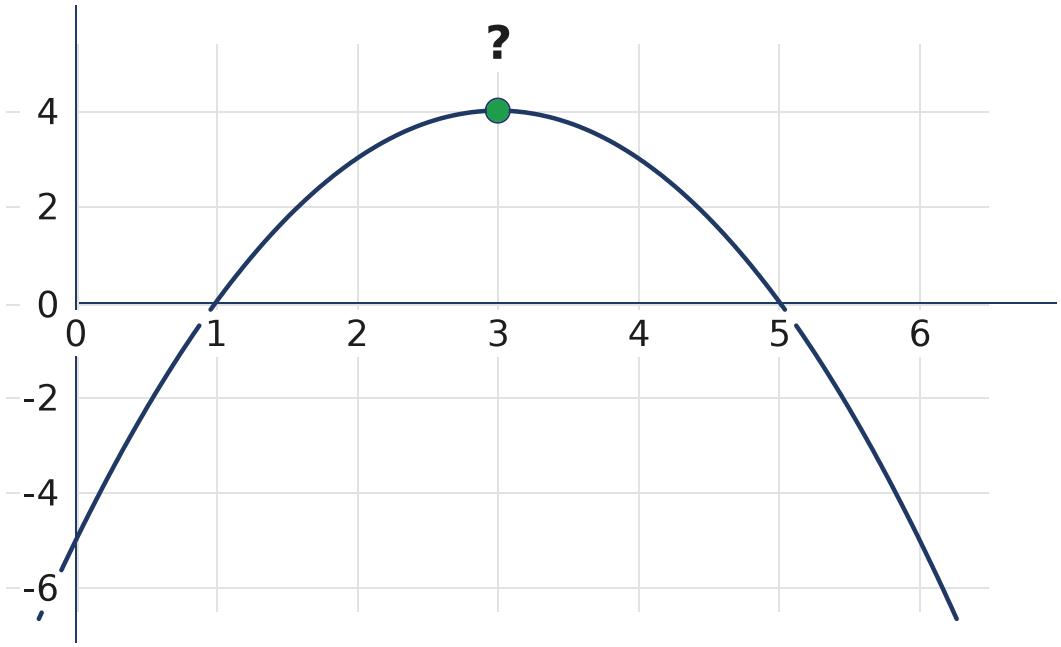
EXAMPLE 2

Q Find the vertex of $y = -x^2 + 6x - 5$



SOLUTION

Use $x = -\frac{b}{(2a)} : x = \frac{-6}{-2} = 3$

Find y when x = 3: $-(3^2) + 6(3) - 5 = -9 + 18 - 5 = 4$

So the vertex is (3, 4)

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Practice questions

1 What is the vertex of $y = x^2 + 2x - 3$?

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

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2 What is the vertex of $y = x^2 - 6x + 5$?

- **A** (-3, -4)
- **B** (3, 4)
- **C** (3, -4)
- **D** (-3, 4)

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3 What is the vertex of $y = -x^2 + 4x + 1$?

- **A** (-2, 5)
- **B** (2, 5)
- **C** (2, -5)
- **D** (-2, -5)

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4 What is the vertex of $y = x^2 + 8x + 12$?

- **A** (4, -4)
- **B** (-4, 4)
- **C** (4, 4)
- **D** (-4, -4)

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5 What is the vertex of $y = 2x^2 - 8x + 3$?

- **A** (2, 5)
- **B** (2, -5)
- **C** (-2, -5)
- **D** (-2, 5)

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6 What is the lowest point of $y = x^2 - 6x + 10$?

- **A** (3, 10)
- **B** (-3, 1)
- **C** (3, 1)
- **D** (3, -1)

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7 A parabola's vertex is (2, 3). Its equation is $y = x^2 + bx + c$. What is b?

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8 Sam finds the vertex of $y = x^2 + 4x + 3$. He says the axis is $x = 2$ and the vertex is (2, 15). What did he get wrong?

A. He used the wrong sign for b: the axis is x = -2, so the vertex is (-2, -1)

B. He used the wrong sign for b: the axis is x = -2, so the vertex is (2, -1)

C. He squared the wrong number: the vertex is (2, -1)

D. Nothing is wrong: x = 2 and (2, 15) are correct

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9 Find the vertex of $y = x^2 - 4x - 3$

- **A** (2, 7)
- **B** (-2, -7)
- **C** (2, -3)
- **D** (2, -7)

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10 One of these parabolas has its vertex on the x-axis. Which one?

- **A** $y = x^2 - 2x - 3$
- **B** $y = x^2 + 4x + 3$
- **C** $y = x^2 + 2x + 1$
- **D** $y = x^2 - 4x + 3$

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ANSWER KEY

1. (-1, -4)

2. (3, -4)

3. (2, 5)

4. (-4, -4)

5. (2, -5)

6. (3, 1)

7. -4

8. He used the wrong sign for b: the axis is x = -2, so the vertex is (-2, -1)

9. (2, -7)

10. $y = x^2 + 2x + 1$

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