MATHEMATICS · GRADES 10-12

Tangent lines

Difficulty level: Advanced

Mathematics: Grades 10-12

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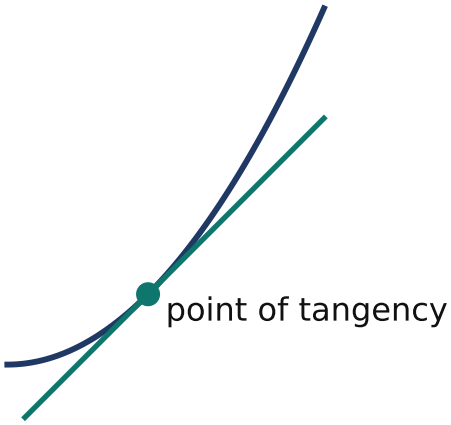
Overview of the concept

This is how you find the straight line that best matches a curve at one point, like the direction a roller coaster is heading at the top of a hill, to estimate what happens right there. A curve is always changing direction, but right at one point it is heading in one clear direction, and the tangent line is that direction drawn straight. That line tells you how fast things are changing just there, even though the curve bends away from it a moment later. Engineers and scientists use it to estimate speed, slope, or change at a single instant.



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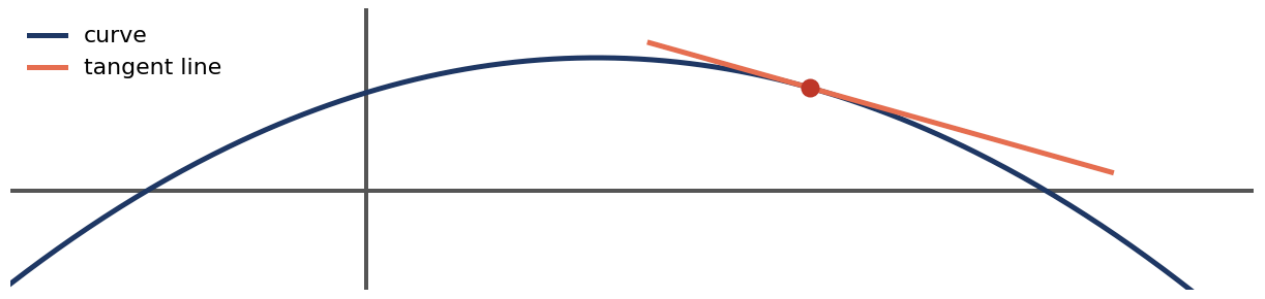
tangent line: touches once,
same slope as the curve there



Rule

Tangent lines: the tangent line to a curve at a point is the straight line through that point with slope equal to the derivative at that point.

It matches the curve's direction at that one point.

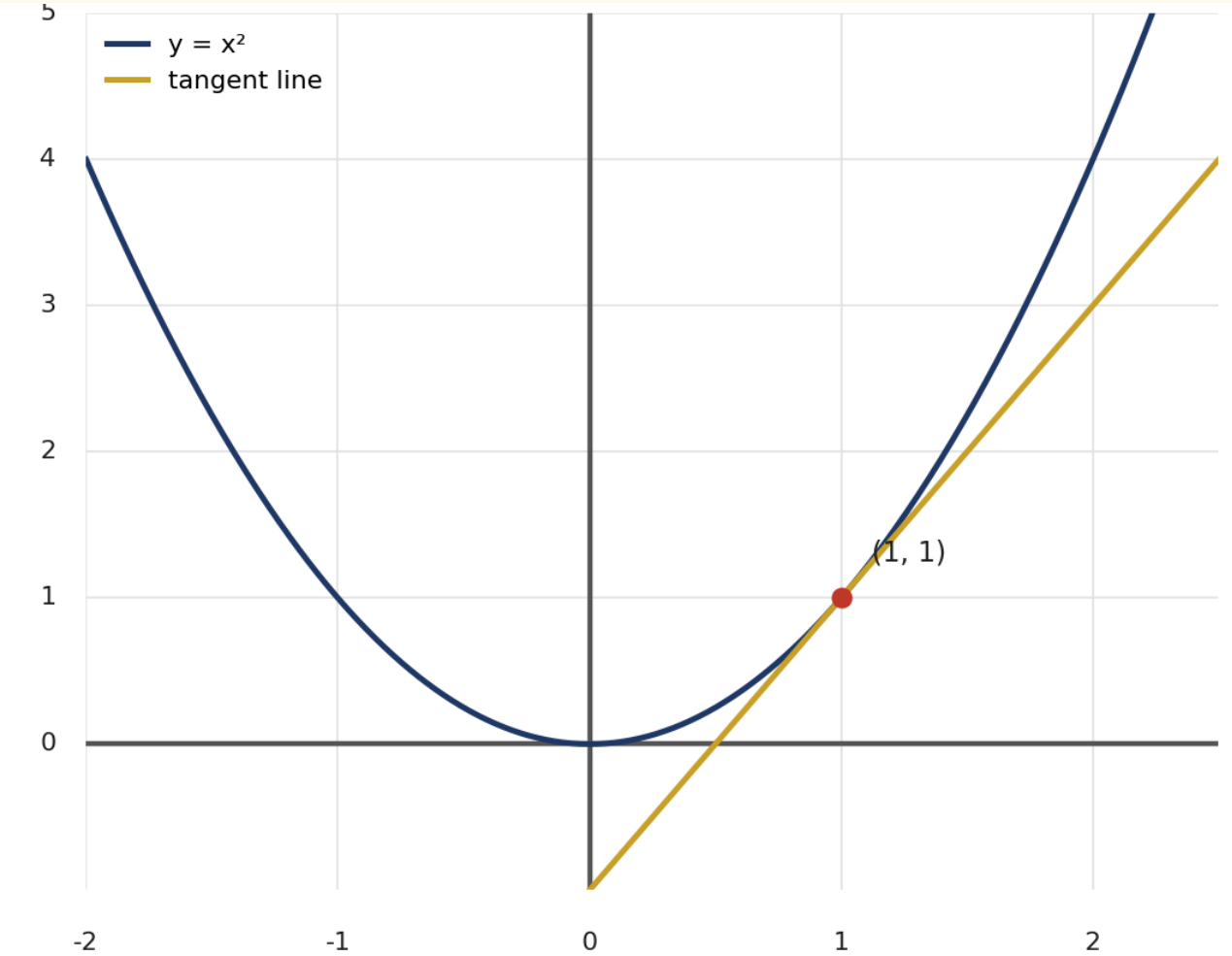


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Worked examples

EXAMPLE 1

Q Find the tangent line to $y = x^2$ at $x = 1$.



SOLUTION

Point: when $x = 1$, $y = 1$

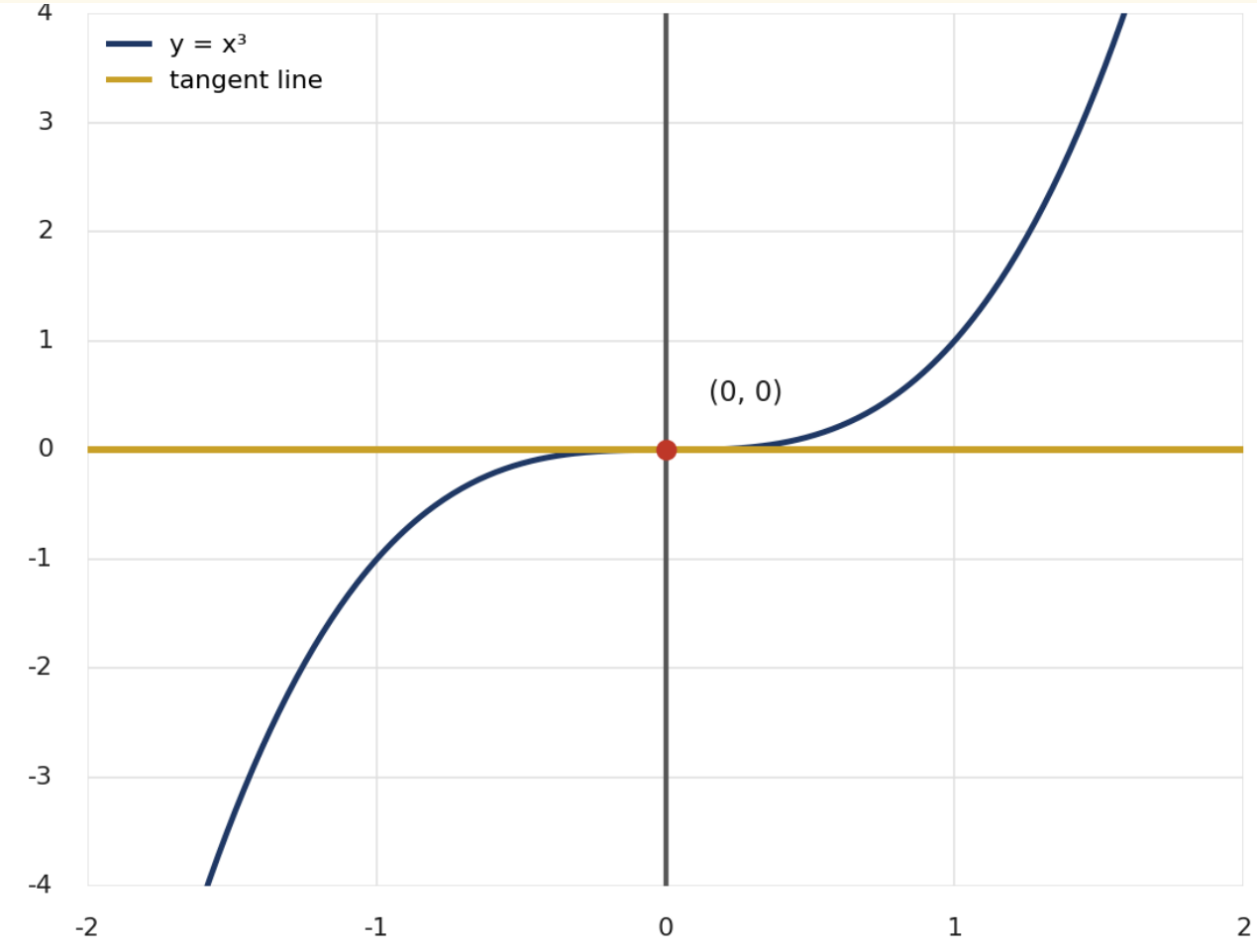
Slope: derivative $2x$ at $x = 1$ is 2.

Line: $y - 1 = 2(x - 1)$, so $y = 2x - 1$

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EXAMPLE 2

Q Find the tangent line to $y = x^3$ at $x = 0$.



SOLUTION

Point: (0, 0)

Slope: derivative $3x^2$ at $x = 0$ is 0.

Line: $y = 0$, the x-axis.

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Practice questions

1 $y = x^2$ at $x = 2$. Find the tangent line equation.

- **A** $y = 4x + 4$
- **B** $y = 5x - 4$
- **C** $y = 4x - 4$
- **D** $y = 3x - 4$

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2 For $y = x^2$ at $x = 2$, what is the slope of the tangent line?

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3 For $y = x^2$, the tangent line at $x = -1$ touches the curve at which point?

- **A** $(-1, 1)$
- **B** $(-1, -1)$
- **C** $(1, 1)$
- **D** $(-1, 0)$

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4 For $y = x^3$, at which value of x is the tangent line horizontal?

- **A** $x = 0$
- **B** $x = 1$
- **C** $x = -1$
- **D** $x = 3$

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5 The line $y = 2x + 1$ is already straight. What is its tangent line at $x = 3$?

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

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6 $y = x^2$. At $x = 0$. What is its equation?

- **A** $y = 1$
- **B** $y = -1$
- **C** $y = 2$
- **D** $y = 0$

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7 The tangent line to $y = x^2$ at $x = 3$ is $y = 6x - 9$. Use it to estimate the value of 3.1^2.

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8 The tangent line to $y = 1/x$ at $x = 1$ is $y = -x + 2$. Where does this tangent line cross the x-axis?

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9 A curve has tangent line $y = 3x + 1$ at $x = 2$. What is the value of the derivative at $x = 2$?

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10 The tangent line to a curve at $x = 1$ is $y = 4x - 3$. What is the value of the curve at $x = 1$?

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ANSWER KEY

1. $y = 4x - 4$

2. 12

3. $(-1, 1)$

4. $x = 0$

5. $y = 2x + 1$

6. $y = 0$

7. 9.6

8. 2

9. 3

10. 1

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