MATHEMATICS · GRADES 10-12

# Average rate of change

### Difficulty level: Advanced

### Mathematics: Grades 10-12

This document was made by AI and there may be mistakes. If a question or answer looks wrong, use the Flag a mistake button to let Brett know so he can fix it.

## *Overview of the concept*

This is how you work out an average speed over a whole trip, or an average price rise over a year, when the speed or price kept changing along the way. You take the total change and divide it by the total time, which gives you the steady rate that would have got you to the same place. It is the number you actually want when you ask how fast something went overall.



## *Rule*

$$\text{Average rate of change} = \frac{f(b) - f(a)}{b - a}.$$

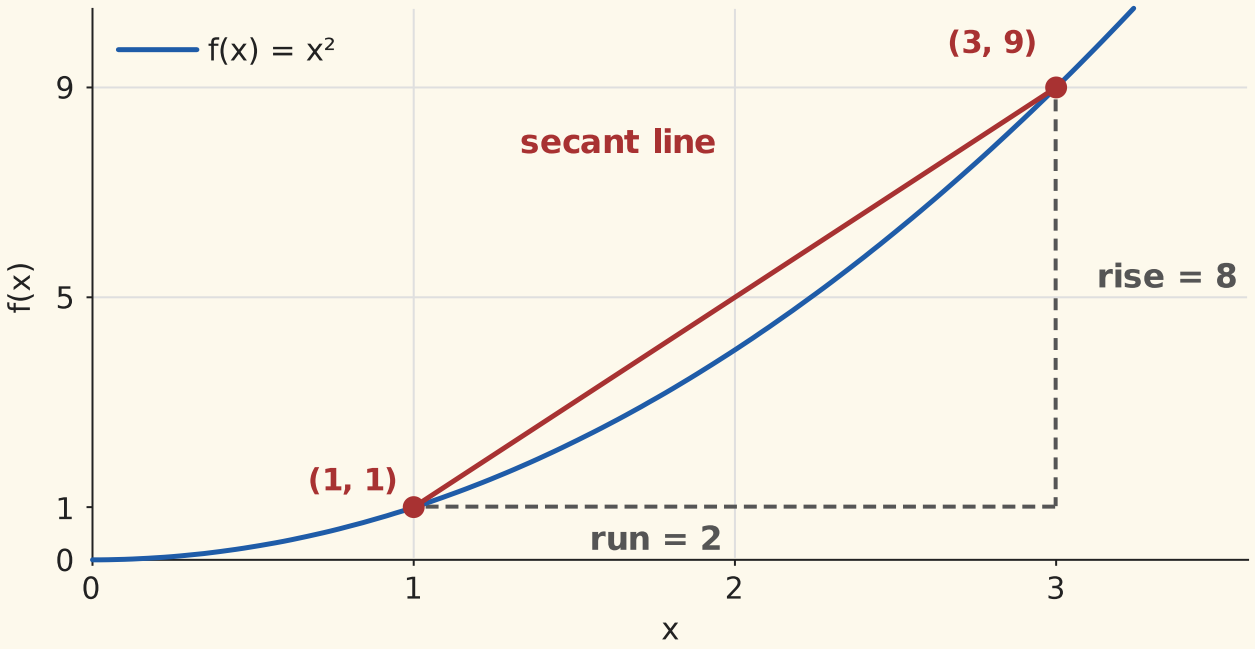
It is the average speed of the change over the interval, and on a graph it is the slope of the line joining the two points — called the secant line.

© 2026 Brett Robbins. All Rights Reserved.

## Worked examples

EXAMPLE 1

**Q** Find the average rate of change of $f(x) = x^2$ from $x = 1$ to $x = 3$.




### SOLUTION

Work out the values at the two ends: $f(1) = 1^2 = 1$ and $f(3) = 3^2 = 9$, the two points marked on the graph.

Change in f: $9 - 1 = 8$

Change in x: $3 - 1 = 2$

Average rate $= \frac{8}{2} = 4$

© 2026 Brett Robbins. All Rights Reserved.

EXAMPLE 2

**Q** Find the average rate of change of $f(x) = 2x + 1$ from $x = 0$ to $x = 4$.

**SOLUTION**

Work out the values at the two ends: $f(0) = 2 \times 0 + 1 = 1$ and $f(4) = 2 \times 4 + 1 = 9$

Change in f: $9 - 1 = 8$

Change in x: $4 - 0 = 4$

Average rate = $\frac{8}{4} = 2$, which is the slope of the line.

## Practice questions

**1** A walker covers $f(x) = x$ km in $x$ hours. What is the average rate of change from $x = 2$ to $x = 5$?

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

**2** A town's population is $f(x) = 3x$ thousand people after $x$ years. What is the average rate of change from $x = 1$ to $x = 4$, in thousand people per year?

- **A** 3 thousand people per year
- **B** 9 thousand people per year
- **C** 3 thousand people
- **D** 12 thousand people per year

Understand It with Pulse | Flag a mistake

**3** A stone's height is $f(x) = x^2$. What is the average rate of change from $x = 0$ to $x = 2$?

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

**4** What is the formula for the average rate of change of f from $x = a$ to $x = b$?

A $\frac{(f(b) - f(a))}{(b - a)}$

B $\frac{(f(b) + f(a))}{(b - a)}$

C $\frac{(f(b) - f(a))}{(b + a)}$

D $(f(b) - f(a)) * (b - a)$

Understand It with Pulse | Flag a mistake

**5** A lake's depth stays at $f(x) = 5$ m. What is the average rate of change from $x = 1$ to $x = 9$?

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

**6** A rocket's height is $f(x) = x^2 + 3x$ m. What is the average rate of change from $x = 1$ to $x = 3$?

Understand It with Pulse | Flag a mistake

**7** On a graph, the average rate of change is the slope of which line?

A. The slope of the secant line

B. The slope of the tangent line

C. The area under the graph

D. The value of the function

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

8 A tank drains as $f(x) = 10 - x$ litres after x minutes. What is the average rate of change from $x = 0$ to $x = 5$?

Understand It with Pulse | Flag a mistake

9 A cube's volume is $f(x) = x^3$. What is the average rate of change from $x = 0$ to $x = 1$?

Understand It with Pulse | Flag a mistake

10 A spring's force is $f(x) = 2x^2$. What is the average rate of change from $x = 1$ to $x = 2$?

Understand It with Pulse | Flag a mistake

© 2026 Brett Robbins. All Rights Reserved.

## ANSWER KEY

**1.** 1

**2.** 3 thousand people per year

**3.** 2

**4.** $\frac{(f(b) - f(a))}{(b - a)}$

**5.** 0

**6.** 7

**7.** The slope of the secant line

**8.** -1

**9.** 1

**10.** 6

© 2026 Brett Robbins. All Rights Reserved.