MATHEMATICS · GRADES 10-12

Definite integrals

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you add up lots of tiny amounts to get a real total. A car's distance over a trip is its speed added up moment by moment, and the water through a pipe over an hour is its flow added up the same way. Any time something changes a little bit at a time, adding up the little bits gives you the whole. That is how engineers work out totals they could never measure in one go.



Rule

Definite integral: the integral of f from a to b = F(b) - F(a), where F is an antiderivative of f (the function you get by undoing the derivative).

You find an antiderivative, work it out at the top end and at the bottom end, and subtract. The result is the total accumulated change from a to b.

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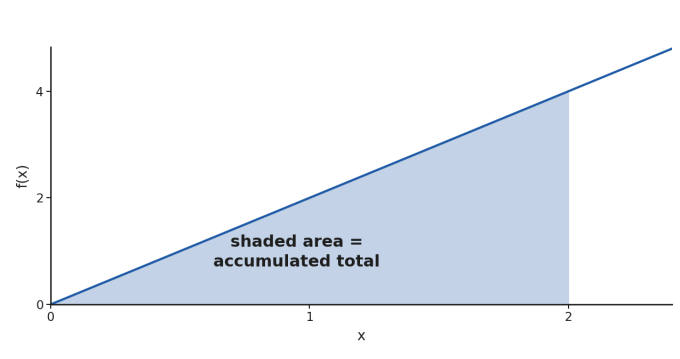
Worked examples

EXAMPLE 1

Q Evaluate the definite integral of 2x from 0 to 2.



SOLUTION

Antiderivative of 2x is x^2

Work the antiderivative out at each end: at the top end, x = 2, so it is $2^2 = 4$; at the bottom end, x = 0, so it is $0^2 = 0$

Subtract: 4 – 0 = 4

EXAMPLE 2

Q Evaluate the definite integral of 1 from 1 to 4.

SOLUTION

Antiderivative of 1 is x

At the top end, x = 4, so the antiderivative is 4. At the bottom end, x = 1, so it is 1

Subtract: 4 – 1 = 3

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Practice questions

1. Find the definite integral of $2x$ from 0 to 1.

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2. Find the definite integral of 1 from 0 to 5.

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3. Find the definite integral of $3x^2$ from 0 to 1.

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4 How is a definite integral different from an indefinite integral?

- **A** A definite integral gives a family of functions; an indefinite integral has limits and gives a number.
- **B** A definite integral has limits and gives a number; an indefinite integral gives a family of functions
- **C** Both a definite and an indefinite integral give a single number.
- **D** Both a definite and an indefinite integral give a family of functions.

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5 Find the area under $y = x$ from $x = 0$ to $x = 4$.

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6 Find the definite integral of 2 from 3 to 7.

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7 Find the area under $y = x^2$ from $x = 0$ to $x = 2$.

A. $8 \div 3$

B. $3 \div 8$

C. 8

D. $2 \div 3$

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8 On the integral sign, what do the two numbers tell you?

- **A** The area under the curve
- **B** The antiderivative of the function
- **C** The lower and upper limits of integration
- **D** The rate of change of the function

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9 Find the definite integral of 4x from 1 to 2.

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10 Find the definite integral of 0 from 0 to 10.

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ANSWER KEY

1. 1

2. 5

3. 1

4. A definite integral has limits and gives a number; an indefinite integral gives a family of functions

5. 8

6. 8

7. $8 \div 3$

8. The lower and upper limits of integration

9. 6

10. 0

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