MATHEMATICS · GRADES 10-12

Basic differentiation rules

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how scientists and engineers find how fast something is changing. A car's speed from its distance, or a population's growth rate, can be worked out piece by piece instead of starting from scratch each time. These rules are shortcuts that turn a long calculation into a quick one, and they are used in almost every calculus problem.



Rule

Basic differentiation rules: differentiate term by term.

The derivative of x^n is $n \times x^{(n-1)}$, and the derivative of a constant is 0. Working through a sum term by term like this is called the sum rule.

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Worked examples

EXAMPLE 1

Q Differentiate $f(x) = x^2 + 3x$.

SOLUTION

Differentiate each term separately: x^2 gives $2x$.

$3x$ gives 3.

So $f'(x) = 2x + 3$.

EXAMPLE 2

Q Differentiate $f(x) = 5x^3 - 2x + 7$.

SOLUTION

$5x^3$ gives $15x^2$.

$-2x$ gives -2, and 7 gives 0.

So $f'(x) = 15x^2 - 2$.

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Practice questions

1 Differentiate $x^2 + x$.

- **A** 2x
- **B** 2x + 1
- **C** x + 1
- **D** 2x - 1

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2 Differentiate $3x^2$

- **A** 3x
- **B** $6x^2$
- **C** 6x
- **D** 6

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3 A plant grows to a height of $x + 5$ cm after x weeks. Find the growth rate.

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4 A car's distance is $2x^3 + x$ metres after x seconds. Find its speed.

A. $6x^2 + 1$

B. $6x^2 - 1$

C. $2x^2 + 1$

D. $6x + 1$

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5 A tank holds a steady 7 litres. Find the rate of change of the volume.

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6 A rocket's height is $x^2 - 4x + 1$ metres after x seconds. Find its velocity.

- **A** $2x + 4$
- **B** $2x - 4$
- **C** $x - 4$
- **D** $2x^2 - 4$

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7 What rule lets you differentiate a sum term by term?

- **A** The product rule
- **B** The sum rule
- **C** The chain rule
- **D** The power rule

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8 A cyclist's distance is $4x^3 - x^2$ metres after x seconds. Find the speed.

- **A** $12x^2 - 2x$
- **B** $12x^2 + 2x$
- **C** $4x^2 - 2x$
- **D** $12x - 2$

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9 Differentiate $10x$.

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10 **A balloon's volume is $x^4 + 2x^2$ litres after x minutes. Find the rate of change of the volume.**

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

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ANSWER KEY

1. $2x + 1$

2. $6x$

3. 1

4. $6x^2 + 1$

5. 0

6. $2x - 4$

7. The sum rule

8. $12x^2 - 2x$

9. 10

10. $4x^3 + 4x$

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