MATHEMATICS · GRADES 10-12

Derivatives of trigonometric functions

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you work out how fast something that swings back and forth is moving at any moment. A pendulum is fastest at the bottom of its swing and still for an instant at the top, and the derivative tells you its speed at any point in between. The same maths describes a wave at the beach or a vibrating guitar string. Any motion that repeats itself can be tracked this way.



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Worked examples

EXAMPLE 1

Q Differentiate sin(3x).

SOLUTION

This is a trig function with something other than x inside, so the chain rule applies: differentiate the outside, then multiply by the derivative of the inside.

The derivative of sin is cos, so the outside gives cos(3x), and the inside 3x gives 3.

So the derivative is 3cos(3x).

EXAMPLE 2

Q Differentiate x sin x.

SOLUTION

This is a product, x times sin x, so use the product rule.

The derivative of x is 1, and the derivative of sin x is cos x.

So the derivative is sin x + x cos x.

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Practice questions

1 Differentiate $\cos(2x)$.

- **A** $2\sin(2x)$
- **B** $-2\sin(2x)$
- **C** $-2\cos(2x)$
- **D** $2\cos(2x)$

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2 Differentiate $\tan(4x)$.

- **A** $\sec^2(4x)$
- **B** $4\sec^2(4x)$
- **C** $4\sec(4x)\tan(4x)$
- **D** $16\sec^2(4x)$

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3 Differentiate sec x.

A sec x tan x

B –sec x tan x

C $\sec^2 x$

D csc x cot x

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4 Differentiate csc x.

A csc x cot x

B –csc x cot x

C –sec x tan x

D $\csc^2 x$

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5 Differentiate $\sin^2 x$.

A $2 \sin x \cos x$

B $\cos^2 x$

C $2 \cos x$

D $\sin x \cos x$

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6 Differentiate $x \cos x$.

A $\cos x - x \sin x$

B $\cos x + x \sin x$

C $-x \sin x$

D $\cos x$

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7 Differentiate $\frac{\sin x}{x}$.

A $\frac{x \cos x - \sin x}{x^2}$

B $\frac{x \cos x + \sin x}{x^2}$

C $\frac{\cos x - \sin x}{x}$

D $\frac{x \cos x - \sin x}{x}$

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8 Find $f'(\frac{\pi}{4})$ for $f(x) = \sin x$.

A $\frac{\sqrt{2}}{2}$

B $-\frac{\sqrt{2}}{2}$

C $\frac{1}{2}$

D $\sqrt{2}$

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9 Find the second derivative of cos x.

A −cos x

B cos x

C −sin x

D sin x

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10 Simplify $\cos^2 x + \sin^2 x$ first, then differentiate.

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ANSWER KEY

1. $-2\sin(2x)$

2. $4\sec^2(4x)$

3. $\sec x \tan x$

4. $-\csc x \cot x$

5. $2\sin x \cos x$

6. $\cos x - x \sin x$

7. $\dfrac{x\cos x - \sin x}{x^2}$

8. $\dfrac{\sqrt{2}}{2}$

9. $-\cos x$

10. 0

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