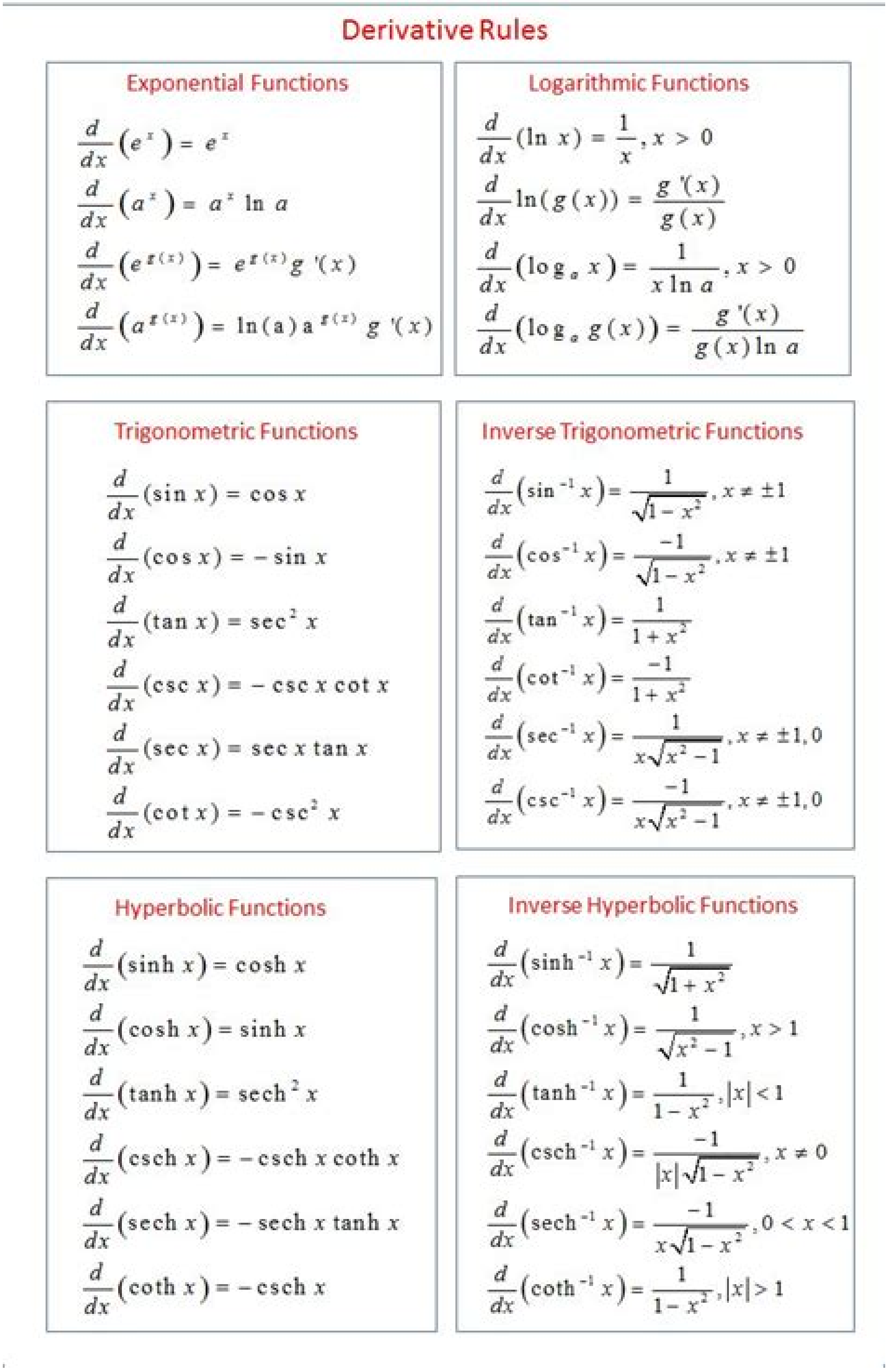
Differentiation Worksheet With Answers



Derivative Rules

Exponential Functions

$$\frac{d}{dx}\left(e^{x}\right) = e^{x}$$

$$\frac{d}{dx}\left(a^{x}\right) = a^{x}\ln a$$

$$\frac{d}{dx}\left(e^{g(x)}\right) = e^{g(x)}g'(x)$$

$$\frac{d}{dx}\left(a^{g(x)}\right) = \ln(a)\,a^{g(x)}\,g'(x)$$

Logarithmic Functions

$$\frac{d}{dx}(\ln x) = \frac{1}{x}, x > 0$$

$$\frac{d}{dx}\ln(g(x)) = \frac{g'(x)}{g(x)}$$

$$\frac{d}{dx}(\log_a x) = \frac{1}{x\ln a}, x > 0$$

$$\frac{d}{dx}(\log_a g(x)) = \frac{g'(x)}{g(x)\ln a}$$

Trigonometric Functions

$$\frac{d}{dx}(\sin x) = \cos x$$

$$\frac{d}{dx}(\cos x) = -\sin x$$

$$\frac{d}{dx}(\tan x) = \sec^2 x$$

$$\frac{d}{dx}(\csc x) = -\csc x\cot x$$

$$\frac{d}{dx}(\sec x) = \sec x\tan x$$

$$\frac{d}{dx}(\cot x) = -\csc^2 x$$

Inverse Trigonometric Functions

$$\frac{d}{dx}\left(\sin^{-1} x\right) = \frac{1}{\sqrt{1-x^2}}, x \neq \pm 1$$

$$\frac{d}{dx}\left(\cos^{-1} x\right) = \frac{-1}{\sqrt{1-x^2}}, x \neq \pm 1$$

$$\frac{d}{dx}\left(\tan^{-1} x\right) = \frac{1}{1+x^2}$$

$$\frac{d}{dx}\left(\cot^{-1} x\right) = \frac{-1}{1+x^2}$$

$$\frac{d}{dx}\left(\sec^{-1} x\right) = \frac{1}{x\sqrt{x^2-1}}, x \neq \pm 1, 0$$

$$\frac{d}{dx}\left(\csc^{-1} x\right) = \frac{-1}{x\sqrt{x^2-1}}, x \neq \pm 1, 0$$

Hyperbolic Functions

$$\frac{d}{dx}(\sinh x) = \cosh x$$

$$\frac{d}{dx}(\cosh x) = \sinh x$$

$$\frac{d}{dx}(\tanh x) = \operatorname{sech}^2 x$$

$$\frac{d}{dx}(\operatorname{csch} x) = -\operatorname{csch} x\coth x$$

$$\frac{d}{dx}(\operatorname{sech} x) = -\operatorname{sech} x\tanh x$$

$$\frac{d}{dx}(\coth x) = -\operatorname{csch} x$$

Inverse Hyperbolic Functions

$$\frac{d}{dx}\left(\sinh^{-1} x\right) = \frac{1}{\sqrt{1+x^2}}$$

$$\frac{d}{dx}\left(\cosh^{-1} x\right) = \frac{1}{\sqrt{x^2-1}}, x > 1$$

$$\frac{d}{dx}\left(\tanh^{-1} x\right) = \frac{1}{1-x^2}, |x| < 1$$

$$\frac{d}{dx}\left(\operatorname{csch}^{-1} x\right) = \frac{-1}{|x|\sqrt{1-x^2}}, x \neq 0$$

$$\frac{d}{dx}\left(\operatorname{sech}^{-1} x\right) = \frac{-1}{x\sqrt{1-x^2}}, 0 < x < 1$$

$$\frac{d}{dx}\left(\coth^{-1} x\right) = \frac{1}{1-x^2}, |x| > 1$$

Differentiation Worksheet with Answers is an essential tool for students and educators alike, particularly in the field of calculus. Differentiation, a fundamental concept in calculus, involves finding the rate at which a function is changing at any given point. Mastery of differentiation is crucial for students as it lays the foundation for advanced mathematical concepts and real-world applications. In this article, we will explore the various aspects of differentiation through a comprehensive worksheet, complete with solutions and explanations to guide learners in their understanding of this vital topic.

Understanding Differentiation

What is Differentiation?

Differentiation refers to the process of calculating the derivative of a function. The derivative is a measure of how a function changes as its input changes. It can be interpreted as the slope of the tangent line to the curve of the function at a specific point.

For example, if we have a function \(f(x) = x^2 \), the derivative, \(f'(x) \), represents how steep the curve is at any point \(x \). The derivative can be calculated using various rules, including the power rule, product rule, quotient rule, and chain rule.

Why is Differentiation Important?

Differentiation is crucial for several reasons:

- Understanding Rates of Change: It helps in understanding how quantities change in relation to one another, which is essential in fields like physics and engineering.
- Optimization: It is used to find maximum and minimum values of functions, which is vital in economics, business, and various scientific disciplines.
- Graph Analysis: It aids in sketching the graphs of functions by identifying critical points, inflection points, and behavior at infinity.

Differentiation Worksheet

Below is a sample differentiation worksheet designed to test knowledge and application of differentiation rules. The worksheet consists of a variety of functions to differentiate.

Problems

1. Differentiate the following functions:
- a) \(f(x) = 3x^4 - 5x^3 + 2x - 7 \)
- b) \(g(x) = \sin(x) + \cos(x) \)
- c) \(h(x) = e^{2x} + 5x^2 \)
- d) \(p(x) = \frac{1}{x^2} + \ln(x) \)
- e) \(q(x) = x^3 \cdot \sin(x) \)

2. Find the derivatives of the following functions using the chain rule:
- a) \(f(x) = (3x^2 + 4)^5 \)
- b) \(g(t) = \sqrt{2t + 1} \)

3. Determine the second derivative of the following function:

- a) $f(x) = 4x^3 - 2x^2 + x - 1$

Answers to the Worksheet

Now, let’s go through the solutions to the problems presented in the worksheet. We will provide step-by-step explanations to reinforce understanding.

Solutions

1. Differentiate the following functions:
- a) $f(x) = 3x^4 - 5x^3 + 2x - 7$
- Using the power rule:
- $f'(x) = 12x^3 - 15x^2 + 2$

- b) $g(x) = \sin(x) + \cos(x)$
- The derivative of sine is cosine and the derivative of cosine is negative sine:
- $g'(x) = \cos(x) - \sin(x)$

- c) $h(x) = e^{2x} + 5x^2$
- For the exponential function, use the chain rule:
- $h'(x) = 2e^{2x} + 10x$

- d) $p(x) = \frac{1}{x^2} + \ln(x)$
- Rewrite $\frac{1}{x^2}$ as x^{-2}:
- $p'(x) = -2x^{-3} + \frac{1}{x} = -\frac{2}{x^3} + \frac{1}{x}$

- e) $q(x) = x^3 \cdot \sin(x)$
- Use the product rule:
- $q'(x) = 3x^2 \sin(x) + x^3 \cos(x)$

2. Find the derivatives using the chain rule:
- a) $f(x) = (3x^2 + 4)^5$
- Let $u = 3x^2 + 4$, then $f(u) = u^5$:
- $f'(x) = 5u^4 \cdot \frac{du}{dx} = 5(3x^2 + 4)^4 \cdot 6x = 30x(3x^2 + 4)^4$

- b) $g(t) = \sqrt{2t + 1}$
- Rewrite as $(2t + 1)^{1/2}$:
- $g'(t) = \frac{1}{2}(2t + 1)^{-1/2} \cdot 2 = \frac{1}{\sqrt{2t + 1}}$

3. Determine the second derivative:
- a) $f(x) = 4x^3 - 2x^2 + x - 1$
- First derivative: $f'(x) = 12x^2 - 4x + 1$
- Second derivative: $f''(x) = 24x - 4$

Conclusion

In conclusion, the differentiation worksheet with answers serves not only as a practical exercise for students but also as a resource for teachers to assess understanding and proficiency in differentiation. By practicing the various types of differentiation problems outlined in the worksheet, students can solidify their grasp of the fundamental principles of calculus. Understanding differentiation is not just about knowing how to perform calculations; it’s about applying these concepts to solve real-world problems and develop critical thinking skills. Therefore, consistent practice and review of these topics are essential for success in calculus and beyond.

Frequently Asked Questions

What is a differentiation worksheet?

A differentiation worksheet is an educational resource that provides a variety of problems related to the concept of differentiation in calculus, allowing students to practice and improve their skills in finding derivatives of functions.

Where can I find differentiation worksheets with answers?

Differentiation worksheets with answers can be found on educational websites, math resource platforms, and online tutoring sites. Many teachers also provide these resources on their school or personal websites.

What types of problems are included in a differentiation worksheet?

A differentiation worksheet typically includes problems such as finding the derivative of polynomial, trigonometric, exponential, and logarithmic functions, as well as applying the product, quotient, and chain rules.

How can I use a differentiation worksheet effectively?

To use a differentiation worksheet effectively, start by reviewing the relevant rules of differentiation, practice solving the problems without looking at the answers, and then check your work against the provided answers to identify areas for improvement.

Are differentiation worksheets suitable for all skill levels?

Yes, differentiation worksheets can be tailored to various skill levels, from beginner to advanced. Teachers often provide different sets of problems to accommodate the learning needs of each student.

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