Formula Sheet For Calculus

Calculus Formulas

CASA
CENTER FOR ACADEMIC STUDENT ACHIEVEMENT

CALCULUS

Limits

Common Derivatives

$\lim_{x \to a} f(x) = L$ if

$\lim_{x \to a^+} f(x) = \lim_{x \to a^-} f(x) = L$

$\lim_{x \to a^-} f(x) \neq \lim_{x \to a^+} f(x)$ or

$\lim_{x \to a} f(x)$ Does Not Exist

L'Hospital's Rule

If $\lim_{x \to a} \frac{f(x)}{g(x)} = \frac{0}{0}$ or $\lim_{x \to a} \frac{f(x)}{g(x)} = \frac{\pm\infty}{\infty}$ then,

$\lim_{x \to a} \frac{f(x)}{g(x)} = \lim_{x \to a} \frac{f'(x)}{g'(x)}$ a is a number, ∞ or $-\infty$

Derivatives

Definition and Notation

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

Basic Properties and Formulas

$(fg)' = f'g + fg'$ – **Product Rule**

$\left(\frac{f}{g}\right)' = \frac{f'g - fg'}{g^2}$ – **Quotient Rule**

$\frac{d}{dx}\left(x^n\right) = nx^{n-1}$ – **Power Rule**

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

This is the Chain Rule

$\frac{d}{dx}(x) = 1$	$\frac{d}{dx}(\csc x) = -\csc x \cot x$
$\frac{d}{dx}(\sin x) = \cos x$	$\frac{d}{dx}(\cot x) = -\csc^2 x$
$\frac{d}{dx}(\cos x) = -\sin x$	$\frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$
$\frac{d}{dx}(\tan x) = \sec^2 x$	$\frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$
$\frac{d}{dx}(\sec x) = \sec x \tan x$	$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$

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

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

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

$\frac{d}{dx}\left(\ln|x|\right) = \frac{1}{x}, \quad x \neq 0$

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

Increasing/Decreasing

Concave Up/Concave Down

Critical Points

$x = c$ is a critical point of $f(x)$ provided either

1. $f'(c) = 0$ or 2. $f'(c)$ doesn't exist.

Increasing/Decreasing

1. If $f'(x) > 0$ for all x in an interval I then $f(x)$ is increasing on the interval I.
2. If $f'(x) < 0$ for all x in an interval I then $f(x)$ is decreasing on the interval I.
3. If $f'(x) = 0$ for all x in an interval I then $f(x)$ is constant on the interval I.

Concave Up/Concave Down

1. If $f''(x) > 0$ for all x in an interval I then $f(x)$ is concave up on the interval I.
2. If $f''(x) < 0$ for all x in an interval I then $f(x)$ is concave down on the interval I.

Inflection Points

$x = c$ is a inflection point of $f(x)$ if the concavity changes at $x = c$.

The information for this handout was compiled from the following sources: 1
Paul's Online Math Notes. (n.d.). Retrieved from http://tutorial.math.lamar.edu/cheat_table.aspx

Formula Sheet for Calculus is an essential resource for students and professionals alike, providing a concise summary of the key concepts, equations, and theorems that are fundamental to the study of calculus. Calculus is the branch of mathematics that deals with continuous change, and it is divided into two major parts: differential calculus and integral calculus. This comprehensive article serves as a formula sheet for both branches, offering a wide range of formulas, definitions, and theorems that can aid in problem-solving and understanding the subject matter.

1. Basic Concepts and Definitions

Before diving into the formulas, it's important to understand some basic concepts and definitions that underpin calculus.

1.1 Limits

- Definition: The limit of a function $f(x)$ as x approaches a value a is denoted as:
$$
\lim_{x \to a} f(x) = L
$$
- Properties:
- $\lim_{x \to a} c = c$, where c is a constant.
- $\lim_{x \to a} x = a$.
- $\lim_{x \to a} (f(x) + g(x)) = \lim_{x \to a} f(x) + \lim_{x \to a} g(x)$.

1.2 Continuity

- A function $f(x)$ is continuous at $x = a$ if:
1. $f(a)$ is defined.
2. $\lim_{x \to a} f(x)$ exists.
3. $\lim_{x \to a} f(x) = f(a)$.

1.3 Derivative

- Definition: The derivative of a function $f(x)$ at a point a is given by:
$$
f'(a) = \lim_{h \to 0} \frac{f(a+h) - f(a)}{h}
$$
- Notation: $f'(x)$, $\frac{dy}{dx}$, $Df(x)$.

1.4 Integral

- Definition: The integral of a function $f(x)$ from a to b is represented as:
$$
\int_{a}^{b} f(x) \, dx
$$
- Indefinite Integral:
$$
\int f(x) \, dx = F(x) + C
$$
where $F'(x) = f(x)$ and C is the constant of integration.

2. Derivatives

Derivatives are crucial in understanding how functions change. Below are some commonly

used derivative formulas.

2.1 Basic Derivative Formulas

1. $\frac{d}{dx}(c) = 0$ for any constant c.
2. $\frac{d}{dx}(x^n) = nx^{n-1}$ where n is any real number.
3. $\frac{d}{dx}(\sin x) = \cos x$
4. $\frac{d}{dx}(\cos x) = -\sin x$
5. $\frac{d}{dx}(\tan x) = \sec^2 x$
6. $\frac{d}{dx}(e^x) = e^x$
7. $\frac{d}{dx}(\ln x) = \frac{1}{x}$

2.2 Derivative Rules

- Product Rule: If $u(x)$ and $v(x)$ are functions, then:
$$
(uv)' = u'v + uv'
$$
- Quotient Rule: If $u(x)$ and $v(x)$ are functions, then:
$$
\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}
$$
- Chain Rule: If $g(x)$ is a function of $f(x)$, then:
$$
\frac{d}{dx}g(f(x)) = g'(f(x)) \cdot f'(x)
$$

2.3 Higher-Order Derivatives

- The n-th derivative of $f(x)$ is denoted as $f^{(n)}(x)$ and can be found by repeated differentiation.

3. Integrals

Integrals are used to find areas under curves and solve differential equations. Here are some essential integral formulas.

3.1 Basic Integral Formulas

1. $\int c \, dx = cx + C$
2. $\int x^n \, dx = \frac{x^{n+1}}{n+1} + C$ for $n \neq -1$

3. $\int e^x \, dx = e^x + C$
4. $\int \sin x \, dx = -\cos x + C$
5. $\int \cos x \, dx = \sin x + C$
6. $\int \sec^2 x \, dx = \tan x + C$
7. $\int \frac{1}{x} \, dx = \ln |x| + C$

3.2 Fundamental Theorem of Calculus

- If F is an antiderivative of f on the interval $[a, b]$, then:
$$
\int_{a}^{b} f(x) \, dx = F(b) - F(a)
$$

4. Applications of Derivatives and Integrals

Calculus has numerous applications in various fields, including physics, engineering, and economics.

4.1 Optimization

- To find the local maxima or minima of a function $f(x)$:
1. Compute the derivative: $f'(x)$.
2. Set $f'(x) = 0$ to find critical points.
3. Use the second derivative test:
- If $f''(x) > 0$, then $f(x)$ has a local minimum.
- If $f''(x) < 0$, then $f(x)$ has a local maximum.

4.2 Area Under a Curve

- The area A under the curve of a function $f(x)$ from a to b is given by:
$$
A = \int_{a}^{b} f(x) \, dx
$$

4.3 Volume of Revolution

- The volume V of a solid of revolution generated by rotating the curve $y = f(x)$ about the x-axis is given by:
$$
V = \pi \int_{a}^{b} [f(x)]^2 \, dx
$$

5. Advanced Topics

For those who delve deeper into calculus, several advanced concepts are worth noting.

5.1 Taylor Series

- The Taylor series expansion of a function $f(x)$ around the point a is given by:
$$
f(x) = f(a) + f'(a)(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \frac{f'''(a)}{3!}(x-a)^3 + \ldots
$$

5.2 Multivariable Calculus

- In multivariable calculus, derivatives and integrals extend to functions of two or more variables. The following are key concepts:
- Partial Derivatives: For a function $f(x, y)$:
$$
f_x = \frac{\partial f}{\partial x}, \quad f_y = \frac{\partial f}{\partial y}
$$
- Multiple Integrals: The double integral over a region R:
$$
\iint_{R} f(x, y) \, dA
$$

Conclusion

The formula sheet for calculus serves as a valuable guide for students and professionals who seek to understand and apply the principles of calculus. From limits and derivatives to integrals and their applications, this comprehensive overview encapsulates key formulas and concepts that are fundamental to the field. Mastery of these formulas will not only enhance problem-solving skills but also deepen the understanding of mathematical relationships that govern change and area, paving the way for more advanced studies in mathematics, physics, engineering, and beyond.

Frequently Asked Questions

What is a formula sheet for calculus?

A formula sheet for calculus is a concise reference document that contains essential formulas, theorems, and concepts used in calculus, such as derivatives, integrals, limits, and series.

Why is a formula sheet important for calculus students?

A formula sheet is important because it helps students quickly recall key formulas and concepts during exams or when solving problems, enhancing their efficiency and understanding of the subject.

What key topics should be included in a calculus formula sheet?

A calculus formula sheet should include topics like limits, derivatives, integrals, fundamental theorems of calculus, chain rule, product rule, quotient rule, and common derivative and integral formulas.

Can I create my own calculus formula sheet?

Yes, creating your own calculus formula sheet can be beneficial as it allows you to customize it according to your learning style and focus on the formulas that you find most challenging.

How can I effectively use a calculus formula sheet during practice?

To effectively use a formula sheet during practice, familiarize yourself with its layout, practice problems that require different formulas, and gradually reduce your reliance on it as you improve your understanding.

Are there any online resources for calculus formula sheets?

Yes, there are numerous online resources, including educational websites, online forums, and academic institutions, where you can find downloadable or printable calculus formula sheets.

Is it allowed to use a formula sheet during calculus exams?

Whether you can use a formula sheet during calculus exams depends on the specific exam rules set by the instructor or institution; always check the guidelines provided before the exam.

What are some tips for memorizing calculus formulas?

Some tips for memorizing calculus formulas include practicing problems regularly, using flashcards, grouping related formulas, and understanding the underlying concepts behind each formula instead of rote memorization.

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