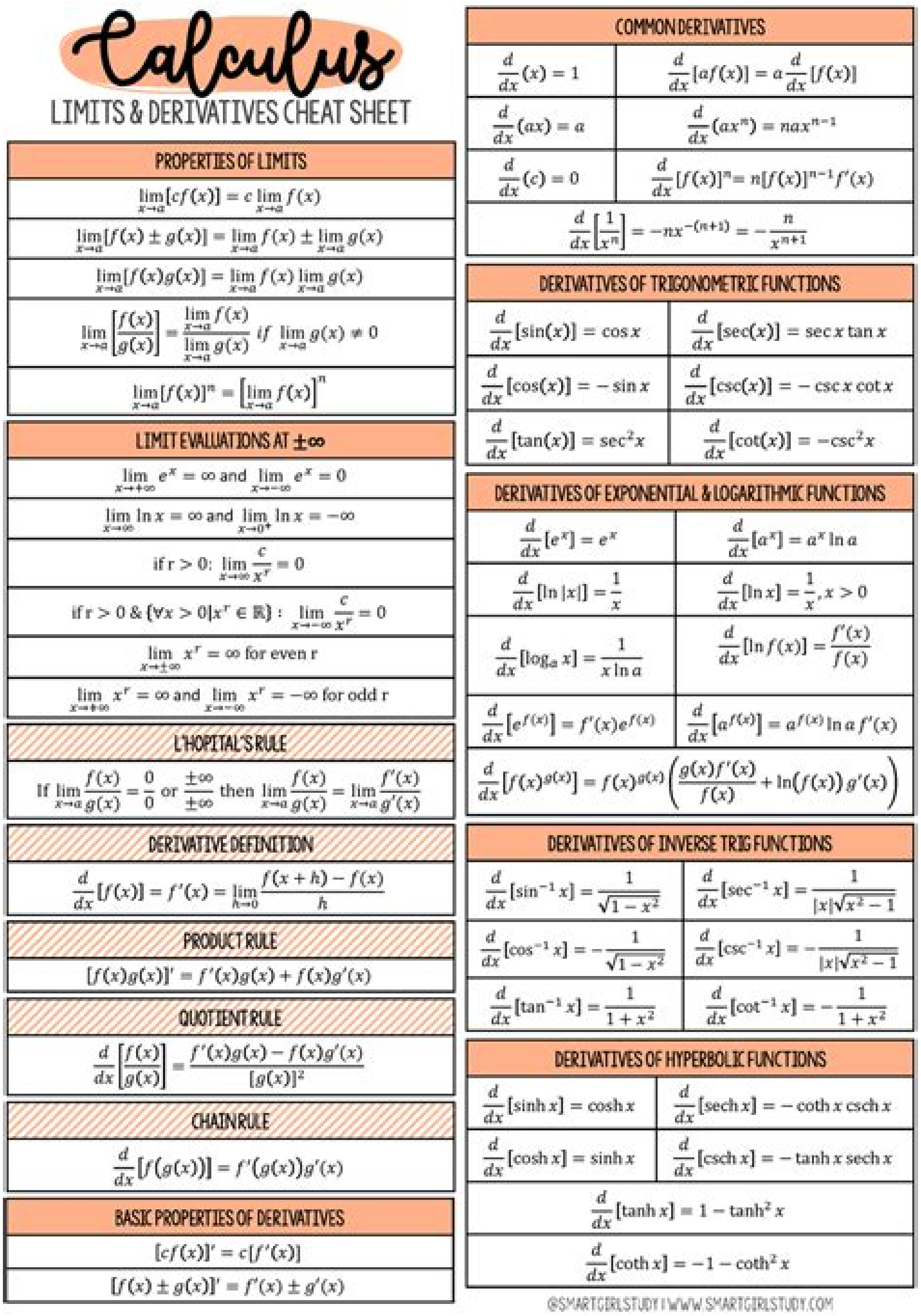
Calculus Rules Cheat Sheet



Calculus

LIMITS & DERIVATIVES CHEAT SHEET

PROPERTIES OF LIMITS

$$\lim_{x\to a}[cf(x)] = c\lim_{x\to a} f(x)$$

$$\lim_{x\to a}[f(x) \pm g(x)] = \lim_{x\to a} f(x) \pm \lim_{x\to a} g(x)$$

$$\lim_{x\to a}[f(x)g(x)] = \lim_{x\to a} f(x) \lim_{x\to a} g(x)$$

$$\lim_{x\to a}\left[\frac{f(x)}{g(x)}\right] = \frac{\lim_{x\to a} f(x)}{\lim_{x\to a} g(x)} \; if \; \lim_{x\to a} g(x) \neq 0$$

$$\lim_{x\to a}[f(x)]^n = \left[\lim_{x\to a} f(x)\right]^n$$

LIMIT EVALUATIONS AT ±∞

$$\lim_{x\to+\infty} e^x = \infty \text{ and } \lim_{x\to-\infty} e^x = 0$$

$$\lim_{x\to\infty} \ln x = \infty \text{ and } \lim_{x\to 0^+} \ln x = -\infty$$

$$\text{if r} > 0\text{:} \; \lim_{x\to\infty} \frac{c}{x^r} = 0$$

$$\text{if r} > 0 \;\&\; \{\forall x > 0 | x^r \in \mathbb{R}\} : \; \lim_{x\to-\infty} \frac{c}{x^r} = 0$$

$$\lim_{x\to\pm\infty} x^r = \infty \text{ for even r}$$

$$\lim_{x\to+\infty} x^r = \infty \text{ and } \lim_{x\to-\infty} x^r = -\infty \text{ for odd r}$$

L'HOPITAL'S RULE

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

DERIVATIVE DEFINITION

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

PRODUCT RULE

$$[f(x)g(x)]' = f'(x)g(x) + f(x)g'(x)$$

QUOTIENT RULE

$$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{f'(x)g(x) - f(x)g'(x)}{[g(x)]^2}$$

CHAIN RULE

$$\frac{d}{dx}[f(g(x))] = f'(g(x))g'(x)$$

BASIC PROPERTIES OF DERIVATIVES

$$[cf(x)]' = c[f'(x)]$$

$$[f(x) \pm g(x)]' = f'(x) \pm g'(x)$$

COMMON DERIVATIVES

$$\frac{d}{dx}(x) = 1 \qquad \frac{d}{dx}[af(x)] = a\frac{d}{dx}[f(x)]$$

$$\frac{d}{dx}(ax) = a \qquad \frac{d}{dx}(ax^n) = nax^{n-1}$$

$$\frac{d}{dx}(c) = 0 \qquad \frac{d}{dx}[f(x)]^n = n[f(x)]^{n-1}f'(x)$$

$$\frac{d}{dx}\left[\frac{1}{x^n}\right] = -nx^{-(n+1)} = -\frac{n}{x^{n+1}}$$

DERIVATIVES OF TRIGONOMETRIC FUNCTIONS

$$\frac{d}{dx}[\sin(x)] = \cos x \qquad \frac{d}{dx}[\sec(x)] = \sec x \tan x$$

$$\frac{d}{dx}[\cos(x)] = -\sin x \qquad \frac{d}{dx}[\csc(x)] = -\csc x \cot x$$

$$\frac{d}{dx}[\tan(x)] = \sec^2 x \qquad \frac{d}{dx}[\cot(x)] = -\csc^2 x$$

DERIVATIVES OF EXPONENTIAL & LOGARITHMIC FUNCTIONS

$$\frac{d}{dx}[e^x] = e^x \qquad \frac{d}{dx}[a^x] = a^x \ln a$$

$$\frac{d}{dx}[\ln|x|] = \frac{1}{x} \qquad \frac{d}{dx}[\ln x] = \frac{1}{x}, x > 0$$

$$\frac{d}{dx}[\log_a x] = \frac{1}{x\ln a} \qquad \frac{d}{dx}[\ln f(x)] = \frac{f'(x)}{f(x)}$$

$$\frac{d}{dx}[e^{f(x)}] = f'(x)e^{f(x)} \qquad \frac{d}{dx}[a^{f(x)}] = a^{f(x)}\ln a\, f'(x)$$

$$\frac{d}{dx}[f(x)^{g(x)}] = f(x)^{g(x)}\left(\frac{g(x)f'(x)}{f(x)} + \ln(f(x))g'(x)\right)$$

DERIVATIVES OF INVERSE TRIG FUNCTIONS

$$\frac{d}{dx}[\sin^{-1}x] = \frac{1}{\sqrt{1-x^2}} \qquad \frac{d}{dx}[\sec^{-1}x] = \frac{1}{|x|\sqrt{x^2-1}}$$

$$\frac{d}{dx}[\cos^{-1}x] = -\frac{1}{\sqrt{1-x^2}} \qquad \frac{d}{dx}[\csc^{-1}x] = -\frac{1}{|x|\sqrt{x^2-1}}$$

$$\frac{d}{dx}[\tan^{-1}x] = \frac{1}{1+x^2} \qquad \frac{d}{dx}[\cot^{-1}x] = -\frac{1}{1+x^2}$$

DERIVATIVES OF HYPERBOLIC FUNCTIONS

$$\frac{d}{dx}[\sinh x] = \cosh x \qquad \frac{d}{dx}[\operatorname{sech} x] = -\coth x \operatorname{csch} x$$

$$\frac{d}{dx}[\cosh x] = \sinh x \qquad \frac{d}{dx}[\operatorname{csch} x] = -\tanh x \operatorname{sech} x$$

$$\frac{d}{dx}[\tanh x] = 1 - \tanh^2 x$$

$$\frac{d}{dx}[\coth x] = -1 - \coth^2 x$$

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Calculus rules cheat sheet can be an invaluable resource for students and professionals alike who are navigating through the complexities of calculus. Whether you're a high school student preparing for advanced placement exams, a college student tackling introductory calculus courses, or a professional in fields that require mathematical precision, having a quick reference guide can streamline your study process and enhance your understanding of calculus concepts. This article will provide a comprehensive overview of essential calculus rules, organized in a structured manner for easy reference.

What is Calculus?

Calculus is a branch of mathematics that studies continuous change. It is divided into two main areas: differential calculus and integral calculus. Differential calculus focuses on the concept of a derivative, which represents the rate of change of a function. Integral calculus, on the other hand, is concerned with the accumulation of quantities, such as areas under curves.

Why Use a Calculus Rules Cheat Sheet?

A calculus rules cheat sheet is beneficial for several reasons:

- **Quick Reference:** It provides a quick way to look up important formulas and rules.
- **Study Aid:** It serves as a useful tool during study sessions and exam preparation.
- **Memory Aid:** Helps reinforce learning by summarizing key concepts.
- **Efficiency:** Saves time when working through complex problems.

Essential Calculus Rules

This section will outline the fundamental rules of calculus, divided into categories for easier navigation.

Differentiation Rules

Differentiation is the process of finding the derivative of a function. Here are some key differentiation rules:

1. **Power Rule:** If \(f(x) = x^n \), then \(f'(x) = n \cdot x^{n-1} \).
2. **Constant Rule:** If \(f(x) = c \) (where \(c \) is a constant), then \(f'(x) = 0 \).
3. **Sum Rule:** If \(f(x) = u(x) + v(x) \), then \(f'(x) = u'(x) + v'(x) \).
4. **Difference Rule:** If \(f(x) = u(x) - v(x) \), then \(f'(x) = u'(x) - v'(x) \).
5. **Product Rule:** If \(f(x) = u(x) \cdot v(x) \), then \(f'(x) = u'(x)v(x) + u(x)v'(x) \).
6. **Quotient Rule:** If \(f(x) = \frac{u(x)}{v(x)} \), then \(f'(x) =

\frac{u'(x)v(x) - u(x)v'(x)}{(v(x))^2} \).

7. **Chain Rule:** If \(f(g(x)) \) is a composite function, then \(f'(g(x)) \cdot g'(x) \).

Common Derivatives

Some functions have derivatives that are frequently used. Here's a list of common derivatives to remember:

- \(\frac{d}{dx}(c) = 0 \)
- \(\frac{d}{dx}(x^n) = nx^{n-1} \)
- \(\frac{d}{dx}(\sin x) = \cos x \)
- \(\frac{d}{dx}(\cos x) = -\sin x \)
- \(\frac{d}{dx}(\tan x) = \sec^2 x \)
- \(\frac{d}{dx}(e^x) = e^x \)
- \(\frac{d}{dx}(\ln x) = \frac{1}{x} \)
- \(\frac{d}{dx}(a^x) = a^x \ln a \)

Integration Rules

Integration is the reverse process of differentiation. Here are key integration rules:

1. **Power Rule for Integration:** If \(\int x^n \, dx = \frac{x^{n+1}}{n+1} + C \) (where \(n \neq -1 \)).
2. **Constant Multiple Rule:** If \(\int c \cdot f(x) \, dx = c \int f(x) \, dx \).
3. **Sum Rule for Integration:** If \(\int (u + v) \, dx = \int u \, dx + \int v \, dx \).

Common Integrals

Familiarizing yourself with common integrals can significantly aid in solving calculus problems:

- $\int c \, dx = cx + C$
- $\int x^n \, dx = \frac{x^{n+1}}{n+1} + C$ (where $n \neq -1$)
- $\int e^x \, dx = e^x + C$
- $\int \sin x \, dx = -\cos x + C$
- $\int \cos x \, dx = \sin x + C$
- $\int \sec^2 x \, dx = \tan x + C$
- $\int \frac{1}{x} \, dx = \ln |x| + C$

Fundamental Theorem of Calculus

The Fundamental Theorem of Calculus links the concept of differentiation and integration. It consists of two parts:

1. **Part 1:** If f is continuous on $[a, b]$, and F is an antiderivative of f on $[a, b]$, then:
$$\int_a^b f(x) \, dx = F(b) - F(a)$$
2. **Part 2:** If f is a continuous function, then the function F defined by:
$$F(x) = \int_a^x f(t) \, dt$$
is continuous on $[a, b]$ and differentiable on (a, b) with $F'(x) = f(x)$.

Tips for Using a Calculus Rules Cheat Sheet

To maximize the effectiveness of your calculus rules cheat sheet, consider the following tips:

- **Familiarize Yourself:** Spend time studying the cheat sheet to understand how and when to apply each rule.
- **Practice Problems:** Use the cheat sheet while solving calculus problems to reinforce learning.
- **Highlight Key Formulas:** Use different colors to highlight formulas that you find particularly challenging.
- **Update Regularly:** As you progress in your studies, update your cheat sheet to reflect new concepts you learn.

Conclusion

Having a **calculus rules cheat sheet** can be a game-changer for anyone studying calculus. By summarizing the essential differentiation and integration rules, common derivatives and integrals, as well as the Fundamental Theorem of Calculus, this guide serves as a compact reference tool for students and professionals alike. Remember to practice regularly and keep your cheat sheet updated to ensure you are always prepared for any calculus challenge that comes your way!

Frequently Asked Questions

What are the essential derivatives to include in a calculus rules cheat sheet?

Essential derivatives to include are the power rule, product rule, quotient rule, and chain rule, along with derivatives of common functions such as trigonometric, exponential, and logarithmic functions.

How can a calculus rules cheat sheet help in exam preparation?

A calculus rules cheat sheet can provide quick reference to key formulas and rules, helping students save time during exams and ensuring they remember important concepts and procedures.

What is the difference between a derivative rule and an integral rule in a cheat sheet?

Derivative rules focus on finding the rate of change of functions, while integral rules deal with finding the area under curves or the accumulation of quantities.

Should a calculus rules cheat sheet include examples?

Yes, including examples for each rule can enhance understanding and provide context, making it easier for students to apply the rules correctly during problem-solving.

Is it beneficial to create a personalized calculus rules cheat sheet?

Absolutely! Creating a personalized cheat sheet allows students to focus on the specific rules and formulas they find most challenging, tailoring the content to their individual learning needs.

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Calculus Rules Cheat Sheet

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