3.3: Rules for Differentiation

RULE	FUNCTION	FUNCTION DERIVATIVE	EXAMPLE
Constant Rule (c is a constant)	f(x)=c y=c $\frac{d}{dx}(c)$	f'(x)=0 y'=0 $\frac{dc}{dx}=0$	$f(x)=3$ $f'(x)=0$ $f(x)=5$ $f'(x)=0$
Power Rule ✓ $2x^{1-1=0}$	$f(x)=x^n$ $y=x^n$ $\frac{d}{dx}(x^n)$	$f'(x)=nx^{n-1}$ $y'=nx^{n-1}$ $\frac{dx^{n-1}}{dx}=nx^{n-1}$	$y=\cancel{2}x^6$ $y'=6x^{6-1}$ $=6x^5$
*u and v are differentiable functions of x			
Constant Multiple Rule (c is a constant) ?	y=cf(x) y=cu $\frac{d}{dx}(cu)$	y'=cf'(x) y'=cu' $c\frac{du}{dx}=3\frac{d}{dx}x^2$ $=6x$	$\frac{d}{dx}(3x^2)$ $c=3$ $f(x)=x^2$ $f'(x)=2x$ $y'=(3)(2x)$ $=6x$ $=2x$ $f(x)=6x^3=18x^2$ $5x^4$
Sum and Difference Rule 2	f(x)± g(x) u ± v $\frac{d}{dx}(u \pm v)$	f'(x) ± g'(x) u' ± v' $\frac{du}{dx} \pm \frac{dv}{dx}$	$f(x)=3x^4+2x^3$ $f'(x)=(3)(4)x^{4-1}+(2)(3)x^{3-1}$ $=12x^3+6x^2$ $2x^5-4x^3+5$
Product Rule ✓	f(x) • g(x) ~~uv~~ pr $\frac{d}{dx}(uv)$	f'(x)g(x) + f(x)g'(x) ~~u'v+uv'~~ p'r + pr' $v\frac{du}{dx}+u\frac{dv}{dx}$	$y=(3x^2+2)(5x^3-2x+3)$ $f(x)=3x^2+2$ $f'(x)=6x$ $g(x)=5x^3-2x+3$ $g'(x)=15x^2-2$ $y'=(6x)(5x^3-2x+3)+(3x^2+2)($
Quotient Rule ✓ $\frac{dy}{dx}$	$\frac{f(x)}{g(x)}$ $\frac{q}{r}$ $\frac{d}{dx}\left(\frac{u}{v}\right)$	$\frac{f'(x)g(x)-f(x)g'(x)}{(g(x))^2}$ $\frac{q'r-r'q}{r^2}$ $\frac{v\frac{du}{dx}-u\frac{dv}{dx}}{v^2}$	$f(x)=\frac{x^2+5x-1}{x^2}$

FORMULAS FOR DERIVATIVES

1 $D_x c = 0$

2 $D_x (u + v) = D_x u + D_x v$

3 $D_x (uv) = u D_x v + v D_x u$

4 $D_x \left(\frac{u}{v}\right) = \frac{v D_x u - u D_x v}{v^2}$

5 $D_x f(g(x)) = f'(g(x))g'(x)$

6 $D_x u^n = nu^{n-1} D_x u$

7 $D_x e^u = e^u D_x u$

8 $D_x a^u = a^u \ln a D_x u$

9 $D_x \ln|u| = \frac{1}{u} D_x u$

10 $D_x \log_a |u| = \frac{1}{u \ln a} D_x u$

11 $D_x \sin u = \cos u D_x u$

12 $D_x \cos u = -\sin u D_x u$

13 $D_x \tan u = \sec^2 u D_x u$

14 $D_x \cot u = -\csc^2 u D_x u$

15 $D_x \sec u = \sec u \tan u D_x u$

16 $D_x \csc u = -\csc u \cot u D_x u$

17 $D_x \sin^{-1} u = \frac{1}{\sqrt{1 - u^2}} D_x u$

18 $D_x \cos^{-1} u = \frac{-1}{\sqrt{1 - u^2}} D_x u$

19 $D_x \tan^{-1} u = \frac{1}{1 + u^2} D_x u$

20 $D_x \sec^{-1} u = \frac{1}{u\sqrt{u^2 - 1}} D_x u$

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FORMULAS FOR INTEGRALS

1 $\int u\, dv = uv - \int v\, du$

2 $\int u^n\, du = \frac{1}{n+1} u^{n+1} + C, n \neq -1$

3 $\int \frac{1}{u}\, du = \ln|u| + C$

4 $\int e^u\, du = e^u + C$

5 $\int a^u\, du = \frac{1}{\ln a} a^u + C$

6 $\int \sin u\, du = -\cos u + C$

7 $\int \cos u\, du = \sin u + C$

8 $\int \sec^2 u\, du = \tan u + C$

9 $\int \csc^2 u\, du = -\cot u + C$

10 $\int \sec u \tan u\, du = \sec u + C$

11 $\int \csc u \cot u\, du = -\csc u + C$

12 $\int \tan u\, du = -\ln|\cos u| + C$

13 $\int \cot u\, du = \ln|\sin u| + C$

14 $\int \sec u\, du = \ln|\sec u + \tan u| + C$

15 $\int \csc u\, du = \ln|\csc u - \cot u| + C$

16 $\int \frac{1}{\sqrt{a^2 - u^2}}\, du = \sin^{-1} \frac{u}{a} + C$

17 $\int \frac{1}{a^2 + u^2}\, du = \frac{1}{a} \tan^{-1} \frac{u}{a} + C$

18 $\int \frac{1}{u\sqrt{u^2 - a^2}}\, du = \frac{1}{a} \sec^{-1} \frac{u}{a} + C$

19 $\int \frac{1}{a^2 - u^2}\, du = \frac{1}{2a} \ln\left|\frac{u + a}{u - a}\right| + C$

20 $\int \frac{1}{\sqrt{u^2 - a^2}}\, du = \ln\left|u + \sqrt{u^2 - a^2}\right| + C$