Formulas for Differentiation

1. **Power Rule.** For any real number k, $\dfrac{d}{dx}x^k = kx^{k-1}$.
2. **Derivative of a Constant Function.** If $F(x) = c$, then $F'(x) = 0$.
3. **Derivative of a Constant Times a Function.** If $F(x) = cf(x)$, then $F'(x) = cf'(x)$.
4. **Derivative of a Sum.** If $F(x) = f(x) + g(x)$, then $F'(x) = f'(x) + g'(x)$.
5. **Derivative of a Difference.** If $F(x) = f(x) - g(x)$, then $F'(x) = f'(x) - g'(x)$.
6. **Derivative of a Product.** If $F(x) = f(x)g(x)$, then $F'(x) = f(x)g'(x) + g(x)f'(x)$.
7. **Derivative of a Quotient.** If $F(x) = \dfrac{f(x)}{g(x)}$, then $F'(x) = \dfrac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$.
8. **Extended Power Rule.** If $F(x) = [g(x)]^k$, then $F'(x) = k[g(x)]^{k-1}g'(x)$.
9. **Chain Rule.** If $F(x) = f[g(x)]$, then $F'(x) = f'[g(x)]g'(x)$. Or, if $y = f(u)$ and $u = g(x)$, then $\dfrac{dy}{dx} = \dfrac{dy}{du} \cdot \dfrac{du}{dx}$.

Formulas for Differentiation
(*continued*)

10. $\dfrac{d}{dx} e^x = e^x$

11. $\dfrac{d}{dx} e^{f(x)} = e^{f(x)} \cdot f'(x)$

12. $\dfrac{d}{dx} \ln x = \dfrac{1}{x}, \quad x > 0$

13. $\dfrac{d}{dx} \ln f(x) = \dfrac{f'(x)}{f(x)}, \quad f(x) > 0$

14. $\dfrac{d}{dx} \ln |x| = \dfrac{1}{x}, \quad x \neq 0$

15. $\dfrac{d}{dx} \ln |f(x)| = \dfrac{f'(x)}{f(x)}, \quad f(x) \neq 0$

16. $\dfrac{d}{dx} a^x = (\ln a) a^x$

17. $\dfrac{d}{dx} \log_a x = \dfrac{1}{\ln a} \cdot \dfrac{1}{x}, \quad x > 0$

18. $\dfrac{d}{dx} \log_a |x| = \dfrac{1}{\ln a} \cdot \dfrac{1}{x}, \quad x \neq 0$

Table of Integrals

- **Antiderivative of a constant:** $\int k\,dx = kx + C$
- **Antiderivative of a constant times a function:** $\int k \cdot f(x)\,dx = k\int f(x)\,dx$
- **Sum/difference property of antidifferentiation:** $\int [f(x) \pm g(x)]\,dx = \int f(x)\,dx \pm \int g(x)\,dx$

1. $\int x^n dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$
2. $\int \frac{dx}{x} = \ln x + C, \quad x > 0$
3. $\int u\,dv = uv - \int v\,du$
4. $\int e^x dx = e^x + C$
5. $\int e^{ax} dx = \frac{1}{a} \cdot e^{ax} + C$

6. $\int xe^{ax} dx = \frac{1}{a^2} \cdot e^{ax}(ax - 1) + C$
7. $\int x^n e^{ax} dx = \frac{x^n e^{ax}}{a} - \frac{n}{a}\int x^{n-1} e^{ax} dx + C$
8. $\int \ln x\,dx = x \ln x - x + C$
9. $\int (\ln x)^n dx = x(\ln x)^n - n\int (\ln x)^{n-1} dx + C, \quad n \neq -1$
10. $\int x^n \ln x\,dx = x^{n+1}\left[\frac{\ln x}{n+1} - \frac{1}{(n+1)^2}\right] + C, \quad n \neq -1$
11. $\int a^x dx = \frac{a^x}{\ln a} + C, \quad a > 0, a \neq 1$
12. $\int \frac{1}{\sqrt{x^2 + a^2}} dx = \ln|x + \sqrt{x^2 + a^2}| + C$
13. $\int \frac{1}{\sqrt{x^2 - a^2}} dx = \ln|x + \sqrt{x^2 - a^2}| + C$
14. $\int \frac{1}{x^2 - a^2} dx = \frac{1}{2a} \ln\left|\frac{x - a}{x + a}\right| + C$
15. $\int \frac{1}{a^2 - x^2} dx = \frac{1}{2a} \ln\left|\frac{a + x}{a - x}\right| + C$
16. $\int \frac{1}{x\sqrt{a^2 + x^2}} dx = -\frac{1}{a} \ln\left|\frac{a + \sqrt{a^2 + x^2}}{x}\right| + C$
17. $\int \frac{1}{x\sqrt{a^2 - x^2}} dx = -\frac{1}{a} \ln\left|\frac{a + \sqrt{a^2 - x^2}}{x}\right| + C$
18. $\int \frac{x}{a + bx} dx = \frac{a}{b^2} + \frac{x}{b} - \frac{a}{b^2} \ln|a + bx| + C$
19. $\int \frac{x}{(a + bx)^2} dx = \frac{a}{b^2(a + bx)} + \frac{1}{b^2} \ln|a + bx| + C$
20. $\int \frac{1}{x(a + bx)} dx = \frac{1}{a} \ln\left|\frac{x}{a + bx}\right| + C$
21. $\int \frac{1}{x(a + bx)^2} dx = \frac{1}{a(a + bx)} + \frac{1}{a^2} \ln\left|\frac{x}{a + bx}\right| + C$
22. $\int \sqrt{x^2 \pm a^2}\,dx = \frac{1}{2}\left[x\sqrt{x^2 \pm a^2} \pm a^2 \ln|x + \sqrt{x^2 \pm a^2}|\right] + C$
23. $\int x\sqrt{a + bx}\,dx = \frac{2}{15b^2}(3bx - 2a)(a + bx)^{3/2} + C$
24. $\int x^2\sqrt{a + bx}\,dx = \frac{2}{105b^3}(15b^2x^2 - 12abx + 8a^2)(a + bx)^{3/2} + C$
25. $\int \frac{x\,dx}{\sqrt{a + bx}} = \frac{2}{3b^2}(bx - 2a)\sqrt{a + bx} + C$
26. $\int \frac{x^2 dx}{\sqrt{a + bx}} = \frac{2}{15b^3}(3b^2x^2 - 4abx + 8a^2)\sqrt{a + bx} + C$