$\frac{d}{dx}(\ln|u|) = \frac{u'}{u}$

$\frac{d}{dx}(a^u) = (\ln a) \cdot a^u \cdot u'$

$\frac{d}{dx}\log_a u = \frac{u'}{u \cdot (\ln a)}$

Basic Integration Rules:

$\int x^n dx = \frac{1}{n+1}x^{n+1} + C, n \neq -1$

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

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

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

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

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

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

$\int e^u dx = e^u + C$

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

$\int \frac{u'}{u\sqrt{u^2 - a^2}} = \frac{1}{a}\sec^{-1}\frac{|u|}{a} + C$

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

Integration by Substitution:
$\int_a^b f(g(x))dx = \int_{g(a)}^{g(b)} f(u)du$, where $u = g(x)$ and $du = g'(x)dx$

L'Hopital's Rule: When taking a limit, if you get an indeterminate form i.e. $\frac{\pm\infty}{\pm\infty}, \frac{0}{0}$, then take the derivative of the top and bottom and evaluate the limit again.

Integration by Parts:
$\int u dv = uv - \int v du$, where $v = \int dv$

Trig Substitution:
If the integral contains the following root, use the given substitution and formula to convert into an integral involving trig functions.

$$\sqrt{a^2 - u^2} \Rightarrow u = a\sin\theta$$
$$\sqrt{u^2 - a^2} \Rightarrow u = a\sec\theta$$
$$\sqrt{a^2 + u^2} \Rightarrow u = a\tan\theta$$

Trig References:

$$\sin^2 x + \cos^2 x = 1$$
$$\sin 2x = 2\sin x\cos x$$
$$\cos 2x = \cos^2 x - \sin^2 x$$
$$\cos^2 x = \frac{1}{2}(1 + \cos 2x)$$
$$\sin^2 x = \frac{1}{2}(1 - \cos 2x)$$

Improper Integral:
Convergent: Limit exists as a finite number.
Divergent: Limit exists as either $\pm\infty$.

Arc Length:

$$s = \int_a^b \sqrt{1 + [f'(x)]^2}\, dx$$

Product and Quotients of Trig Functions:

a. $\int \sin^m x \cos^n x\, dx$
   1. n is odd: save one $\cos x$ and use $\cos^2 x = 1 - \sin^2 x$ to express the remaining factors in terms of sine.
   2. m is odd: save one $\sin x$ and use $\sin^2 x = 1 - \cos^2 x$ to express the remaining factors in terms of cosine.
   3. If both m and n are even, use the half angle identities.

b. $\int \tan^m x \sec^n x\, dx$
   1. m is odd: save one $\sec x \tan x$ and use $\tan^2 x = \sec^2 x - 1$ to express the remaining factors in terms of secant.
   2. n is even: save one $\sec^2 x$ and use $\sec^2 x = 1 + \tan^2 x$ to express the remaining factors in terms of tangent.

Integral of a Rational Function: $\int \frac{p(x)}{q(x)} dx$

If the degree of $p(x) \geq$ degree of $q(x)$, use long division.
If the degree of $p(x) <$ degree of $q(x)$, use partial fractions.

$\frac{d}{dx}(\ln|u|) = \frac{u'}{u}$

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$$\sin^2 x = \frac{1}{2}(1 - \cos 2x)$$

Improper Integral:
Convergent: Limit exists as a finite number.
Divergent: Limit exists as either $\pm\infty$.

Arc Length:

$$s = \int_a^b \sqrt{1 + [f'(x)]^2}\, dx$$

Product and Quotients of Trig Functions:

c. $\int \sin^m x \cos^n x\, dx$
   4. n is odd: save one $\cos x$ and use $\cos^2 x = 1 - \sin^2 x$ to express the remaining factors in terms of sine.
   5. m is odd: save one $\sin x$ and use $\sin^2 x = 1 - \cos^2 x$ to express the remaining factors in terms of cosine.
   6. If both m and n are even, use the half angle identities.

d. $\int \tan^m x \sec^n x\, dx$
   3. m is odd: save one $\sec x \tan x$ and use $\tan^2 x = \sec^2 x - 1$ to express the remaining factors in terms of secant.
   4. n is even: save one $\sec^2 x$ and use $\sec^2 x = 1 + \tan^2 x$ to express the remaining factors in terms of tangent.

Integral of a Rational Function: $\int \frac{p(x)}{q(x)} dx$

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