Advanced Math
Equations and Formulas

Pythagorean Identities:

$$\sin^2 x+\cos^2 x=1 \qquad 1+\tan^2 x=\sec^2 x \qquad \cot^2 x+1=\csc^2 x$$

Sum and Difference Formulas:

$$\sin(x\pm y)=\sin x\cos y\pm\sin y\cos x$$

$$\cos(x\pm y)=\cos x\cos y\mp\sin x\sin y$$

$$\tan(x\pm y)=\frac{\tan x\pm\tan y}{1\mp\tan x\tan y}$$

Double Angle Formulas:

$$\sin 2x=2\sin x\cos x$$

$$\cos 2x=\cos^2 x-\sin^2 x=2\cos^2 x-1=1-2\sin^2 x$$

$$\tan 2x=\frac{2\tan x}{1-\tan^2 x}$$

Half Angle Formulas:

$$\sin\frac{x}{2}=\pm\sqrt{\frac{1-\cos x}{2}} \qquad \cos\frac{x}{2}=\pm\sqrt{\frac{1+\cos x}{2}} \qquad \tan\frac{x}{2}=\frac{1-\cos x}{\sin x}=\frac{\sin x}{1+\cos x}=\pm\sqrt{\frac{1-\cos x}{1+\cos x}}$$

Power Reducing Formulas:

$$\sin^2 x=\frac{1-\cos 2x}{2} \qquad \cos^2 x=\frac{1+\cos 2x}{2} \qquad \tan^2 x=\frac{1-\cos 2x}{1+\cos 2x}$$

Product to Sum Formulas:

$$\sin x\sin y=\frac{1}{2}\left[\cos(x-y)-\cos(x+y)\right] \qquad \cos x\cos y=\frac{1}{2}\left[\cos(x-y)+\cos(x+y)\right]$$

$$\sin x\cos y=\frac{1}{2}\left[\sin(x+y)+\sin(x-y)\right] \qquad \cos x\sin y=\frac{1}{2}\left[\sin(x+y)-\sin(x-y)\right]$$

Sum to Product Formulas:

$$\sin x+\sin y=2\sin\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right) \qquad \sin x-\sin y=2\cos\left(\frac{x+y}{2}\right)\sin\left(\frac{x-y}{2}\right)$$

$$\cos x+\cos y=2\cos\left(\frac{x+y}{2}\right)\cos\left(\frac{x-y}{2}\right) \qquad \cos x-\cos y=-2\sin\left(\frac{x+y}{2}\right)\sin\left(\frac{x-y}{2}\right)$$

Odd and Even Identities:

$$\sin(-x)=-\sin(x) \qquad \cos(-x)=\cos(x) \qquad \tan(-x)=-\tan(x)$$

Law of Sines and Cosines:

$$\frac{a}{\sin A}=\frac{b}{\sin B}=\frac{c}{\sin C} \qquad a^2=b^2+c^2-2bc\cos A \qquad b^2=a^2+c^2-2ac\cos B$$

$$c^2=a^2+b^2-2ab\cos C$$

Triangle Area Formulas:

$$\sqrt{s(s-a)(s-b)(s-c)} \qquad s=\frac{1}{2}(a+b+c)$$

$$\frac{1}{2}ab\sin C \qquad \frac{1}{2}bc\sin A \qquad \frac{1}{2}ac\sin B$$

$$\frac{1}{2}c^2\frac{\sin A\sin B}{\sin C} \qquad \frac{1}{2}b^2\frac{\sin A\sin C}{\sin B} \qquad \frac{1}{2}a^2\frac{\sin B\sin C}{\sin A}$$

Sum and Difference of Cubes:

$$a^3+b^3=(a+b)(a^2-ab+b^2) \qquad a^3-b^3=(a-b)(a^2+ab+b^2)$$

Properties of Logarithms:

$$\log_b(xy)=\log_b x+\log_b y \qquad \log_b\left(\frac{x}{y}\right)=\log_b x-\log_b y \qquad \log_b x^a=a\log_b x$$

Exponential Applications:

$$f(x)=ae^{bx} \qquad A=P\left(1+\frac{r}{n}\right)^{nt}$$

Sequence and Series Formulas:

$$a_n=a_1+(n-1)d \qquad S_n=\frac{n}{2}(a_1+a_n) \qquad S_n=\frac{a_1(1-r^n)}{1-r} \qquad S_\infty=\frac{a_1}{1-r},|r|<1$$

$$a_n=a_1r^{n-1}$$

Binomial Theorem:

$$\sum_{r=0}^{n}\frac{n!}{(n-r)!r!}x^{n-r}y^r \qquad \sum_{n=0}^{r}{}_nC_r x^{n-r}y^r$$

Permutation and Combinations:

$${}_nC_r=\frac{n!}{(n-r)!r!} \qquad {}_nP_r=\frac{n!}{(n-r)!}$$

Derivative of a Function:

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

Distance:

$$\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

Midpoint:

$$\left(\frac{x_1+x_2}{2},\frac{y_1+y_2}{2}\right)$$

Polar/Rectangular Conversions:

$$x=r\cos\theta \qquad y=r\sin\theta \qquad r=\sqrt{x^2+y^2} \qquad \theta=\arctan\frac{y}{x},x>0$$