Linear Equations

$$
\begin{aligned}
ax + bx &= c \\
y &= \alpha + \beta x \\
y - y_0 &= \beta(x - x_0)
\end{aligned}
$$

Quadratic Equations

$$
\begin{aligned}
y &= ax^2 + bx + c \\
y &= a(x-h)^2 + k \\
y &= a(x - r_1)(x - r_2) \\
r_1, r_2 &= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \\
h &= -\frac{b}{2a}, \quad k = -\frac{b^2 - 4ac}{4a^2}
\end{aligned}
$$

Completing the Square

$$
\begin{aligned}
y &= ax^2 + bx + c \\
&= a\left(x^2 + \frac{b}{a}x + \frac{c}{a}\right) \\
&= a\left[\left(x + \frac{b}{2a}\right)^2 - \left(\frac{b}{2a}\right)^2 + \frac{c}{a}\right] \\
&= a\left[\left(x + \frac{b}{2a}\right)^2 - \frac{b^2 - 4ac}{(2a)^2}\right] \\
&= a\left(x - \frac{-b - \sqrt{b^2 - 4ac}}{2a}\right)\left(x - \frac{-b + \sqrt{b^2 - 4ac}}{2a}\right)
\end{aligned}
$$

Ellipses

$$
\begin{aligned}
&\text{major axis:} && 2a = V_1V_2 \\
&\text{minor axis:} && 2b = coV_1coV_2 \\
&\text{focal distance:} && 2c = F_1F_2 \\
&a^2 = b^2 + c^2 \\
&\text{x-major:} && \frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1 \\
&\text{y-major:} && \frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{a^2} = 1
\end{aligned}
$$

Hyperbolas

$$\text{x-major:}\quad \frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1 \qquad \text{asymptotes:}\quad y = \pm\frac{b}{a}x$$
$$\text{y-major:}\quad \frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1 \qquad \text{asymptotes:}\quad y = \pm\frac{a}{b}x$$

Circles

$$(x-h)^2 + (y-k)^2 = r^2$$

Arithmetic Series

$$\begin{aligned} a_k &= a_1 + (k-1)d \\ &= a_n - (n-k)d \\ s_n &= na_1 + \frac{n(n-1)d}{2} \\ &= na_n - \frac{n(n-1)d}{2} \\ &= \frac{n(a_1+a_n)}{2} \\ 1+2+3+\ldots+n &= \frac{n(n+1)}{2} \end{aligned}$$

Geometric Series

$$a_n = a_1 r^{n-1}$$

$$s_n = a_1 \frac{1-r^{n+1}}{1-r} \qquad \longrightarrow \qquad s_\infty = \frac{a_1}{1-r}$$

Binomial Expansion

$$(a+b)^n = \binom{n}{0}a^n b^0 + \binom{n}{1}a^{n-1}b^1 + \binom{n}{2}a^{n-2}b^2 + \ldots + \binom{n}{n-1}a^1 b^{n-1} + \binom{n}{n}a^0 b^n$$

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

Law of Cosines

$$a^2 = b^2 + c^2 - 2bc\,\cos(\alpha)$$

Law of Sines

$$\frac{\sin(\alpha)}{a} = \frac{\sin(\beta)}{b}$$

Triangles

Area of a triangle with side lengths a, b, c:

$$\frac{1}{4}\sqrt{(2ab)^2 - \left(a^2 + b^2 - c^2\right)^2}$$