Dot Product

$$a \cdot b = |a||b| \cos\theta$$

Scalar Projection

$$\text{Comp}_a b = \frac{a \cdot b}{|a|}$$

Vector Projection

$$\text{Proj}_a b = \left(\frac{a \cdot b}{|a|}\right)\frac{a}{|a|} = \frac{a \cdot b}{|a|^2} a$$

$$a \times (b \times c) = (a \cdot c)b - (a \cdot b)c$$

Volume of a parallelopiped

$$V = |a \cdot (b \times c)|$$

Symmetric Equations

$$\frac{x - x_0}{a} = \frac{y - y_0}{b} = \frac{z - z_0}{c}$$

Vector Equation of a Line

$$n \cdot r = n \cdot r_0$$

Scalar Equation of a Plane

$$a(x - x_0) + b(y - y_0) + c(z - z_0) = 0$$

Distance From a Point to a Plane

$$D = |\text{comp}_n b| = \frac{|n \cdot b|}{|n|} = \frac{|ax_1 + by_1 + cz_1 + d|}{\sqrt{a^2 + b^2 + c^2}}$$

Unit Tangent Vector

$$\mathbf{T}(t) = \frac{r'(t)}{|r'(t)|}$$

Arclength

$$L = \int_a^b |r'(t)|\, dt$$

Unit Normal Vector

$$\mathbf{N}(t) = \frac{\mathbf{T}'(t)}{|\mathbf{T}'(t)|}$$

Binomial Vector

$$\mathbf{B}(t) = \mathbf{T}(t) \times \mathbf{N}(t)$$

Curvature

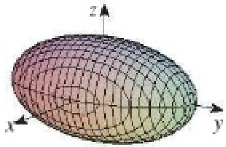
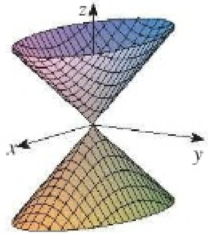
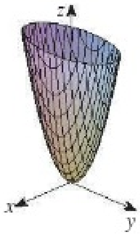
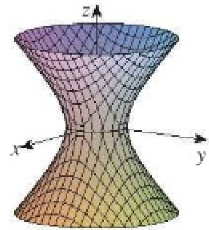
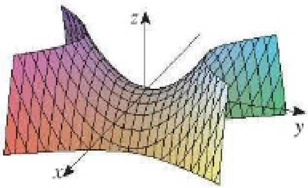
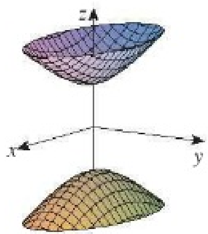
$$\kappa_t = \left|\frac{dT}{ds}\right| = \left|\frac{T'(t)}{r'(t)}\right| = \frac{|r'(t) \times r''(t)|}{|r'(t)|^3}$$

Acceleration

$$a = v'\mathbf{T} + \kappa v^2 \mathbf{N}$$

Torque

$$\tau = |r \times F| = |r||F| \sin\theta$$

Surface	Equation	Surface	Equation
Ellipsoid 	$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ All traces are ellipses. If $a = b = c$, the ellipsoid is a sphere.	Cone 	$\frac{z^2}{c^2} = \frac{x^2}{a^2} + \frac{y^2}{b^2}$ Horizontal traces are ellipses. Vertical traces in the planes $x = k$ and $y = k$ are hyperbolas if $k \neq 0$ but are pairs of lines if $k = 0$.
Elliptic Paraboloid 	$\frac{z}{c} = \frac{x^2}{a^2} + \frac{y^2}{b^2}$ Horizontal traces are ellipses. Vertical traces are parabolas. The variable raised to the first power indicates the axis of the paraboloid.	Hyperboloid of One Sheet 	$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{z^2}{c^2} = 1$ Horizontal traces are ellipses. Vertical traces are hyperbolas. The axis of symmetry corresponds to the variable whose coefficient is negative.
Hyperbolic Paraboloid 	$\frac{z}{c} = \frac{x^2}{a^2} - \frac{y^2}{b^2}$ Horizontal traces are hyperbolas. Vertical traces are parabolas. The case where $c < 0$ is illustrated.	Hyperboloid of Two Sheets 	$-\frac{x^2}{a^2} - \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ Horizontal traces in $z = k$ are ellipses if $k > c$ or $k < -c$. Vertical traces are hyperbolas. The two minus signs indicate two sheets.