Projectile Motion

$$x = x_0 + (v_0 \cos\alpha)\, t \qquad y = y_0 + (v_0 \sin\alpha)\, t - \frac{1}{2} g t^2$$

Vector Functions

$$\mathbf{T}(t) = \frac{\mathbf{r}'(t)}{||\mathbf{r}'(t)||} \qquad \mathbf{N}(t) = \frac{\mathbf{T}'(t)}{||\mathbf{T}'(t)||} \qquad a_T = \mathbf{a}\cdot\mathbf{T} = \frac{d^2 s}{dt^2} = \frac{\mathbf{a}\cdot\mathbf{v}}{||\mathbf{v}||} \qquad a_N = \mathbf{a}\cdot\mathbf{N} = \kappa\left(\frac{ds}{dt}\right)^2 = \frac{||\mathbf{a}\times\mathbf{v}||}{||\mathbf{v}||}$$

Curvature

$$\kappa = \frac{|y''|}{[1+(y')^2]^{3/2}} \quad \text{or} \quad \frac{|x'y'' - x''y'|}{[(x')^2+(y')^2]^{3/2}} \quad \text{or} \quad \frac{||\mathbf{T}'(t)||}{||\mathbf{r}'(t)||} \quad \text{or} \quad \frac{||\mathbf{r}'(t)\times\mathbf{r}''(t)||}{||\mathbf{r}'(t)||^3} \quad \text{or} \quad \frac{|\mathbf{a}(t)\cdot\mathbf{N}(t)|}{||\mathbf{v}(t)||^2}$$

Polar Coordinates

$$x = r\cos\theta \qquad r = \sqrt{x^2+y^2}$$

$$y = r\sin\theta \qquad \tan\theta = \frac{y}{x} \qquad dA = r\,dr\,d\theta$$

Spherical Coordinates

$$x = \rho\sin\phi\cos\theta \qquad \rho = \sqrt{x^2+y^2+z^2}$$

$$y = \rho\sin\phi\sin\theta \qquad \cos\phi = \frac{z}{\sqrt{x^2+y^2+z^2}} \qquad dV = \rho^2\sin\phi\,d\rho\,d\phi\,d\theta$$

$$z = \rho\cos\phi \qquad \tan\theta = \frac{y}{x}$$

Vector Fields

$$\text{curl } \mathbf{F} = \nabla\times\mathbf{F} \qquad \text{div } \mathbf{F} = \nabla\cdot\mathbf{F}$$

Green's Theorem

$$\int_C \mathbf{F}\cdot d\mathbf{r} = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right) dA$$

Divergence Theorem

$$\iint_S \mathbf{F}\cdot\mathbf{N}\,dS = \iiint_Q \text{div}(\mathbf{F})\,dV$$

Stokes' Theorem

$$\int_C \mathbf{F}\cdot d\mathbf{r} = \iint_S \text{curl } (\mathbf{F})\cdot\mathbf{N}\,dS$$