

Elementary Dynamics - Equation Sheet #1

Motion Tangent to Path:

$$s = s(t)$$

$$v = \frac{ds}{dt}$$

$$a = \frac{dv}{dt}$$

$$a = a(t)$$

$$\frac{dv}{dt} = a(t)$$

$$\int dv = \int a(t) dt$$

$$\int ds = \int v(t) dt$$

$$a = a(s)$$

$$v \frac{dv}{ds} = a(s)$$

$$\int v dv = \int a(s) ds$$

$$a = a(v)$$

$$\frac{dv}{dt} = a(v)$$

$$\int \frac{dv}{a(v)} = \int dt$$

$$\int ds = \int v(t) dt$$

$$a = a(v)$$

$$v \frac{dv}{ds} = a(v)$$

$$\int \frac{v dv}{a(v)} = \int ds$$

Normal & Tangential Components: (\underline{e}_n and \underline{e}_t)

Constant Acceleration:

$$a(t) = a_0 = \text{constant}$$

$$v(t) = v_0 + a_0 t$$

$$s(t) = s_0 + v_0 t + \frac{1}{2} a_0 t^2$$

$$v^2 = v_0^2 + 2a_0(s - s_0)$$

$$\underline{v} = v \underline{e}_t$$

$$\underline{a} = \dot{v} \underline{e}_t + \left(\frac{v^2}{\rho} \right) \underline{e}_n$$

$$v = \rho \dot{\theta}$$

$$\rho = \frac{[1 + (dy/dx)^2]^{3/2}}{|d^2y/dx^2|}$$

Helpful Integral

$$\int \left(\frac{f'(x)}{f(x)} \right) dx = \ln(f(x))$$

Cylindrical Components: (\underline{e}_r , \underline{e}_θ , and \underline{k})

$$\underline{r} = r \underline{e}_r + z \underline{k}$$

$$\underline{v} = \dot{r} \underline{e}_r + (r \dot{\theta}) \underline{e}_\theta + \dot{z} \underline{k}$$

$$\underline{a} = (\ddot{r} - r \dot{\theta}^2) \underline{e}_r + (r \ddot{\theta} + 2\dot{r} \dot{\theta}) \underline{e}_\theta + \ddot{z} \underline{k}$$

Circular Motion:

$$v = R \dot{\theta} = R \omega$$

$$a_t = a_\theta = R \ddot{\theta} = R \dot{\omega} = R \alpha$$

$$a_n = -a_r = \frac{v^2}{\rho} = R \dot{\theta}^2 = R \omega^2$$

Relative Motion

$$\underline{r}_{A/B} = \underline{r}_A - \underline{r}_B$$

$$\underline{v}_{A/B} = \underline{v}_A - \underline{v}_B$$

$$\underline{a}_{A/B} = \underline{a}_A - \underline{a}_B$$