EQUATIONS

$$\vec{v} = \dot{x}\hat{\imath} + \dot{y}\hat{\jmath}$$
$$= v\hat{e}_t$$
$$= \dot{r}\hat{e}_r + r\dot{\theta}\hat{e}_\theta$$

$$\vec{a} = \ddot{x}\hat{\imath} + \ddot{y}\hat{\jmath}$$
$$= \dot{v}\hat{e}_t + \frac{v^2}{\rho}\hat{e}_n$$
$$= \left(\ddot{r} - r\dot{\theta}^2\right)\hat{e}_r + \left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)\hat{e}_\theta$$

$$\vec{v}_B = \vec{v}_A + \vec{v}_{B/A}$$
$$= \vec{v}_A + \vec{\omega} \times \vec{r}_{B/A}$$
$$= \vec{v}_A + \left(\vec{v}_{B/A}\right)_{rel} + \vec{\omega} \times \vec{r}_{B/A}$$

$$\vec{a}_B = \vec{a}_A + \vec{a}_{B/A}$$
$$= \vec{a}_A + \vec{\alpha} \times \vec{r}_{B/A} - \omega^2 \vec{r}_{B/A}$$
$$= \vec{a}_A + \left(\vec{a}_{B/A}\right)_{rel} + \vec{\alpha} \times \vec{r}_{B/A} + 2\vec{\omega} \times \left(\vec{v}_{B/A}\right)_{rel} + \vec{\omega} \times \left(\vec{\omega} \times \vec{r}_{B/A}\right)$$

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

$$\sum \vec{F} = m\vec{a}$$

$$T_1 + V_1 + U_{1\to 2}^{(nc)} = T_2 + V_2$$

$$V_{gr} = mgh$$

$$V_{sp} = \frac{1}{2}k\Delta^2$$

$$T = \frac{1}{2}mv^2$$

$$U_{1\to 2}^{(nc)} = \int_1^2 \left(\sum \vec{F} \cdot \hat{e}_t\right) ds = \int_1^2 \left(F_x dx + F_y dy\right)$$

$$e = -\left(\frac{v_{Bn2} - v_{An2}}{v_{Bn1} - v_{An1}}\right)$$

$$\int_1^2 \sum \vec{F}_{ext}\, dt = \left(\sum_i m_i \vec{v}_i\right)_2 - \left(\sum_i m_i \vec{v}_i\right)_1$$

$$\int_1^2 \sum \vec{M}_O\, dt = \left(\sum_i \left(\vec{H}_O\right)_i\right)_2 - \left(\sum_i \left(\vec{H}_O\right)_i\right)_1$$

$$\left(\vec{H}_O\right)_i = \vec{r}_{i/O} \times (m_i \vec{v}_i)$$