DYNAMICS OF A PARTICLE

Newton's 2nd Law	Define Linear Momentum, **P** = m**v**. $\mathbf{F}=\frac{d\mathbf{P}}{dt}=\frac{d}{dt}(m\mathbf{v})$ If m is constant: $\mathbf{F}=m\frac{d\mathbf{v}}{dt}=m\mathbf{a}$
Moment and Angular Momentum	Define moment as $\mathbf{Mo}=\mathbf{r}\times\mathbf{F}$ $\mathbf{M_o}=\mathbf{r}\times\mathbf{F}=\mathbf{r}\times\frac{d}{dt}(m\mathbf{v})=\frac{d}{dt}(\mathbf{r}\times m\mathbf{v})$ Define angular momentum, $\mathbf{H_o}=\mathbf{r}\times m\mathbf{v}$ $\mathbf{M_o}=\frac{d}{dt}(\mathbf{H_o})$
Principle of Work and Kinetic Energy	Define Work, $W_{1\to 2}=\int_{r=r1}^{r=r2}\mathbf{F}\bullet d\mathbf{r}$ Define Kinetic Energy, $T=\frac{1}{2}mv^2$ $W_{1\to 2}=T_2-T_1$
Principle of Linear Impulse and Momentum	Define Linear Impulse, $\mathbf{I}=\int_{t=t1}^{t=t2}\mathbf{F}dt$ $\mathbf{I}=\mathbf{P}_2-\mathbf{P}_1$
Principle of Angular Impulse and Momentum	Define Angular Impulse, $\mathbf{A}=\int_{t=t1}^{t=t2}\mathbf{M}_o dt$ $\mathbf{A}=\mathbf{H}_{o2}-\mathbf{H}_{o1}$

DYNAMICS OF A SYSTEM OF PARTICLES

Location of Center of Mass	$\mathbf{R_{cm}} = \frac{\sum_{i=1}^{i=n} m_i \mathbf{r}_i}{\sum_{i=1}^{i=n} m_i} = \frac{\sum_{i=1}^{i=n} m_i \mathbf{r}_i}{M}$ where $M = \sum_{i=1}^{i=n} m_i$
Linear Acceleration of Center of Mass	Define System Linear Momentum, $\mathbf{P} = M\mathbf{v_{cm}}$. $\mathbf{F_{ext}} = \frac{d}{dt}(M\mathbf{v_{cm}}) = M\mathbf{a_{cm}}$
Moment about Center of Mass	Define Moment about Center of Mass: $\mathbf{M_{cm}} = \sum_{i=1}^{i=n} (\boldsymbol{\rho}_\mathbf{i} \times \mathbf{F_i})$ Define Angular Momentum about Center of Mass: $\mathbf{H_{cm}} = \sum_{i=1}^{i=n} \left(\boldsymbol{\rho}_\mathbf{i} \times m_i \frac{d}{dt} \boldsymbol{\rho}_\mathbf{i} \right)$ $\mathbf{M_{cm}} = \frac{d}{dt}(\mathbf{H_{cm}})$
Principle of Work and Kinetic Energy	Define Work, $\mathbf{W}_{1\to 2} = \int_{\rho 1}^{\rho 2} \sum_{i=1}^{i=n} \mathbf{F_i} \bullet d\boldsymbol{\rho}_\mathbf{i} + \int_{Rcm1}^{Rcm2} \mathbf{F_{ext}} \bullet d\mathbf{R_{cm}} + \int_{\rho 1}^{\rho 2} \sum_{i=1}^{i=n} \sum_{j=1}^{j=n} \mathbf{f_{ij}} \bullet d\boldsymbol{\rho}_\mathbf{i}$ Define Kinetic Energy, $\mathbf{T} = M \frac{v_{cm}^2}{2} + \sum_{i=1}^{i=n} \frac{m_i \left(\frac{d}{dt} \boldsymbol{\rho}_\mathbf{i} \right)^2}{2}$ $\mathbf{W}_{1\to 2} = \mathbf{T}_2 - \mathbf{T}_1$
Principle of Linear Impulse and Momentum	Define Linear Impulse, $\mathbf{I} = \int_{t=t1}^{t2} \mathbf{F}_{ext} dt$ $\mathbf{I} = \mathbf{P}_2 - \mathbf{P}_1$
Principle of Angular Impulse and Momentum	Define Angular Impulse, $\mathbf{A} = \int_{t1}^{t2} \mathbf{M}_{cm} dt$ $\mathbf{A} = \mathbf{H}_{cm2} - \mathbf{H}_{cm1}$

DYNAMICS OF A RIGID BODY: PLANE MOTION

Location of Center of Mass	$\mathbf{R}_{\mathbf{cm}} = \dfrac{\int_{mass} \mathbf{r}dm}{\int_{mass} dm} = \dfrac{\int_{mass} \mathbf{r}dm}{M}$ where $M = \int_{mass} dm$
Linear Acceleration of Center of Mass	Define System Linear Momentum, **P** = M$\mathbf{v}_{\mathbf{cm}}$. $\mathbf{F}_{\mathbf{ext}} = \dfrac{d}{dt}\left(M\mathbf{v}_{\mathbf{cm}}\right) = M\mathbf{a}_{\mathbf{cm}}$
Moment about Center of Mass	Define Angular Momentum about Center of Mass: $\mathbf{H}_{\mathbf{cm}} = \omega \int_{mass} \left(x^2 + y^2\right) dm = \omega\left(I_{xx} + I_{yy}\right) = \omega\left(I_{zz}\right)$ $\mathbf{M}_{\mathbf{cm}} = \dfrac{d}{dt}\left(\mathbf{H}_{\mathbf{cm}}\right)$
Principle of Work and Kinetic Energy	Define Work, $\mathbf{W}_{1\rightarrow 2} = \int_{\theta 1}^{\theta 2} \mathbf{M}_{\mathbf{cm}} \bullet d\theta + \int_{Rcm1}^{Rcm2} \mathbf{F}_{\mathbf{ext}} \bullet d\mathbf{R}_{\mathbf{cm}}$ Define Kinetic Energy, $\mathbf{T} = M\dfrac{v_{cm}^2}{2} + \dfrac{I_{zz}\omega^2}{2}$ $\mathbf{W}_{1\rightarrow 2} = \mathbf{T}_2 - \mathbf{T}_1$
Principle of Linear Impulse and Momentum	Define Linear Impulse, $\mathbf{I} = \int_{t=t1}^{t2} \mathbf{F}_{ext} dt$ $\mathbf{I} = \mathbf{P}_2 - \mathbf{P}_1$
Principle of Angular Impulse and Momentum	Define Angular Impulse, $\mathbf{A} = \int_{t1}^{t2} \mathbf{M}_{cm} dt$ $\mathbf{A} = \mathbf{H}_{cm2} - \mathbf{H}_{cm1}$