PHYS101 - Second Major - Formula Sheet

$$\vec{r}-\vec{r}_o=\vec{v}_o t+\frac{1}{2}\vec{a}t^2$$
$$\vec{v}=\vec{v}_o+\vec{a}t$$
$$v^2=v_o^2+2a(x-x_o)$$
$$x-x_o=\frac{1}{2}(v+v_o)t$$

$$\sum\vec{F}=m\vec{a}=\frac{d\vec{p}}{dt}; \qquad \vec{p}=m\vec{v}$$
$$f_k=\mu_k N$$
$$f_s\le\mu_s N$$
$$W=\int\vec{F}\cdot d\vec{r}$$
$$W=\vec{F}\cdot\vec{d} \quad \text{if } \vec{F} \text{ is a constant}$$

$$\vec{A}\cdot\vec{B}=A\,B\,\cos\theta$$
$$|\vec{A}\times\vec{B}|=A\,B\,\sin\theta$$

$$W_{net}=\Delta K=\frac{1}{2}mv_f^2-\frac{1}{2}mv_i^2$$
$$P_{avg}=\frac{W}{\Delta t}; \qquad P=\frac{dW}{dt}=\vec{F}\cdot\vec{v}$$
$$U_s=\frac{1}{2}kx^2, \qquad F_s=-kx$$
$$U_g=mgy$$
$$E_{mech}=K+U$$
$$\Delta U=-W \quad \text{for a conservative force}$$
$$\Delta K+\Delta U+\Delta E_{th}=W$$
$$\text{where} \quad \Delta E_{th}=f_k d$$

$$\vec{J}=\int\vec{F}\,dt=\vec{F}_{avg}\Delta t=\Delta\vec{p}$$
$$\vec{p}_{1i}+\vec{p}_{2i}=\vec{p}_{1f}+\vec{p}_{2f}$$
$$\sum\vec{F}_{ext}=M\vec{a}_{com}$$
$$\vec{r}_{com}=\frac{1}{M}\sum_{i=1}^{n}m_i\vec{r}_i=\frac{1}{M}\int\vec{r}\,dm$$
$$v_{1f}=\frac{m_1-m_2}{m_1+m_2}v_{1i}+\frac{2m_2}{m_1+m_2}v_{2i}$$
$$v_{2f}=\frac{2m_1}{m_1+m_2}v_{1i}+\frac{m_2-m_1}{m_1+m_2}v_{2i}$$

$$\omega=\frac{d\theta}{dt}; \qquad \alpha=\frac{d\omega}{dt}$$
$$s=r\theta, \qquad v=r\omega$$
$$a_t=r\alpha; \quad a_r=\frac{v^2}{r}=r\omega^2$$
$$\vec{a}=\vec{a}_t+\vec{a}_r; \qquad a=\sqrt{a_t^2+a_r^2}$$

If α is constant:
$$\omega=\omega_o+\alpha t$$
$$\theta-\theta_o=\omega_o t+\frac{1}{2}\alpha t^2$$
$$\omega^2=\omega_o^2+2\alpha(\theta-\theta_o)$$

$$I=\sum_i m_i r_i^2=\int r^2\,dm$$
$$I_p=I_{com}+Mh^2$$
$$\vec{\tau}=\vec{r}\times\vec{F}$$
$$\tau=rF\sin\theta=r_\perp F=rF_t$$
$$W=\int\tau\,d\theta$$
$$=\tau\Delta\theta \quad \text{if } \tau \text{ is constant}$$
$$\vec{l}=\vec{r}\times\vec{p}=m\vec{r}\times\vec{v}$$
$$l=mr_\perp v=mrv_\perp$$

For a solid rotating about a fixed axis:

$$K_{rot}=\frac{1}{2}I\omega^2, \qquad L_z=I\omega$$
$$\Delta K=\frac{1}{2}I(\omega_f^2-\omega_i^2)=W$$
$$P=\frac{dW}{dt}=\tau\omega$$
$$\vec{\tau}=\frac{d\vec{l}}{dt}$$
$$\sum\vec{\tau}_{ext}=\frac{d\vec{L}}{dt}=I\vec{\alpha}$$
$$a_{com}=\frac{-g\sin\theta}{1+\frac{I_{com}}{MR^2}}$$

$$\int x^n dx=\frac{x^{n+1}}{n+1}; \qquad \frac{d}{dt}(t^n)=nt^{n-1}$$
$$g=9.80\,m/s^2$$
$$I_{com}(\text{solid cylinder, disk})=\tfrac{1}{2}MR^2$$
$$I_{com}(\text{thin walled hollow cylinder})=MR^2$$
$$I_{com}(\text{solid sphere})=\tfrac{2}{5}MR^2$$
$$I_{com}(\text{thin walled hollow sphere})=\tfrac{2}{3}MR^2$$
$$I_{com}(\text{thin rod})=\tfrac{1}{12}ML^2$$
$$I_{com}(\text{thin hoop, about central axis})=MR^2$$
$$I_{com}(\text{ring, about central axis})=MR^2$$
$$I_{com}(\text{ring, about diameter})=\tfrac{1}{2}MR^2$$