PH2100 Formula Sheet

$$average\ speed = \frac{total\ distance}{total\ time}$$

$$\Delta x = x_f - x_i \qquad \Delta t = t_f - t_i$$

$$\bar{v}_x = \frac{\Delta x}{\Delta t}$$

$$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$$\bar{a}_x = \frac{\Delta v_x}{\Delta t}$$

$$a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt}$$

$$v_{xf} = v_{xi} + a_x \Delta t$$

$$x_f = x_i + v_{xi} \Delta t + \frac{1}{2} a_x (\Delta t)^2$$

$$v_{xf}^2 = v_{xi}^2 + 2a_x (x_f - x_i)$$

$$\Delta \vec{r} = \vec{r}_f - \vec{r}_i$$

$$\vec{v}_{ave} = \frac{\Delta \vec{r}}{\Delta t}$$

$$\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta \vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$$

$$\vec{a}_{ave} = \frac{\Delta \vec{v}}{\Delta t}$$

$$\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t}$$

$$\vec{v}_f = \vec{v}_i + \vec{a} \Delta t$$

$$\vec{r}_f = \vec{r}_i + \vec{v}_i \Delta t + \frac{1}{2} \vec{a} (\Delta t)^2$$

$$a_r = \frac{v_t^2}{r}, a_t = \frac{dv}{dt}$$

$$\vec{v}' = \vec{v} - \vec{v}_0$$

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

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$F_g = m g$$

$$F_k = \mu_k N$$

$$F_s \le \mu_s N$$

$$F_{spring} = -kx$$

$$\sum F_r = m a_r = \frac{m v^2}{r}$$

$$W = Fd \cos\theta$$

$$\vec{A} \cdot \vec{B} = AB \cos\theta = A_x B_x + A_y B_y + A_z B_z$$

$$W = \int_{x_i}^{x_f} F_x \, dx \quad ; \quad W = \int_{\vec{r}_i}^{\vec{r}_f} \vec{F} \cdot d\vec{r}$$

$$K = \tfrac{1}{2} m v^2$$

$$\sum W = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$\bar{P} = \frac{W}{\Delta t}$$

$$P = \lim_{\Delta t \to 0} \frac{W}{\Delta t} = \frac{dW}{dt}$$

$$P = \vec{F} \cdot \vec{v}$$

$$\Delta U = U_f - U_i = -\int_{x_i}^{x_f} F_x^c dx$$

$$U_g = mgh$$

$$U_s = \frac{1}{2} kx^2$$

$$F_x = -\frac{dU}{dx}$$

$$K_i + \sum U_i = K_f + \sum U_f$$

$$W = \Delta K + \Delta U$$

$$\vec{p} = m\vec{v}$$

$$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f}$$

$$\vec{I} = \int_{t_i}^{t_f} \vec{F} \, dt = \Delta \vec{p}$$

$$\vec{F}_{ave} = \frac{\vec{I}}{\Delta t} = \frac{\Delta \vec{p}}{\Delta t}$$

$$\vec{r}_{cm} = \frac{\sum m_i \vec{r}_i}{M}$$

$$\vec{v}_{cm} = \frac{\sum m_i \vec{v}_i}{M}$$

$$\sum \vec{F}_{ext} = M \vec{a}_{cm} = \frac{d\vec{p}_{tot}}{dt}$$

$$s = r\theta$$

$$\bar{\omega} = \frac{\Delta\theta}{\Delta t}$$

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$$

$$v = \omega r$$

$$\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$$

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$$

$$a_r = \frac{v^2}{r} = \omega^2 r$$

$$\omega_f = \omega_i + \alpha\,\Delta t$$

$$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha\,(\Delta t)^2$$

$$\omega_f^2 = \omega_i^2 + 2\alpha\,(\theta_f - \theta_i)$$

$$I = \sum m_i r_i^2$$

$$I = I_{CM} + MD^2$$

$$K_R = \frac{1}{2} I\omega^2$$

$$\tau = rF\sin\phi = Fd$$

$$\sum \tau_{ext} = I\alpha$$

$$P = \tau\omega$$

$$\sum W = \frac{1}{2} I\omega_f^2 - \frac{1}{2} I\omega_i^2$$

$$K = \frac{1}{2} I\omega^2 + \frac{1}{2} M v_{cm}^2$$

$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$

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

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\vec{L} = \vec{r} \times \vec{p}$$

$$L_z = I\omega$$

$$\sum \tau_{ext} = \frac{d\vec{L}}{dt}$$

$$\sum \tau_{ext} = 0 \quad \Rightarrow \quad \vec{L} = const$$

Constants:

$$g = 9.80\,m/s^2$$

$$G = 6.67 \times 10^{-11}\ N \cdot m^2/kg^2$$

$$I_0 = 1 \times 10^{-12}\ W/m^2$$

$$x = A\cos(\omega t + \phi)$$

$$f = \frac{\omega}{2\pi}$$

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

$$\omega = \sqrt{\frac{k}{m}} \qquad \omega = \sqrt{\frac{\kappa}{I}}$$

$$\omega = \sqrt{\frac{g}{l}} \qquad \omega = \sqrt{\frac{mgd}{I}}$$

$$E = \frac{1}{2} k\,A^2$$

$$F_g = \frac{Gm_1m_2}{r^2}$$

$$U_g = -\frac{Gm_1m_2}{r}$$

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

$$y = f(x \pm vt)$$

$$v = \sqrt{\frac{T}{\mu}}$$

$$y = A\sin(kx - \omega t)$$

$$v = \lambda f \qquad k = \frac{2\pi}{\lambda}$$

$$P = \frac{1}{2}\mu\omega^2 A^2 v$$

$$I = \frac{power}{area} = \frac{P_{ave}}{4\pi r^2}$$

$$\beta = 10\log(I/I_0)$$

$$f' = \left(\frac{v \pm v_0}{v \mp v_s}\right) f$$

$$f_n = \frac{n}{2L}\sqrt{\frac{T}{\mu}} = n\frac{v}{2L}$$

$$f_n = n\frac{v}{4L}$$

$$f_b = |f_1 - f_2|$$