Physics 101 Formula Sheet

Constant acceleration (2-11): $x = x_0 + v_0 t + \frac{1}{2}at^2$, $v = v_0 + at$, $v^2 = v_0{}^2 + 2a(x - x_0)$

Vector components (3-3, 3-4): $V_x = V\cos\theta;$ $V_y = V\sin\theta$

$$V = \sqrt{V_x^2 + V_y^2}; \qquad \tan\theta = \frac{V_y}{V_x}$$

Relative velocity (3-6): $\vec{v}_{BS} = \vec{v}_{BW} + \vec{v}_{WS}$

Circular motion (5-1): $a_R = \frac{v^2}{r}$, $v = \frac{2\pi r}{T}$, $T = \frac{1}{f}$

Newton's law of gravitation (5-4): $F = G\frac{m_1 m_2}{r^2}$; where $G = 6.67\times10^{-11} N\cdot m^2/kg^2$

Work (6-1): $W = \vec{F}\cdot\vec{d} = Fd\cos(\theta)$

Work energy principle (6-2, 6-4): $W_{net} = \Delta K = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

Potential Energy of a spring (6-9): $U = \frac{1}{2}kx^2$

Power (6-17): $P = \frac{W}{\Delta t} = \vec{F}\cdot\vec{v}$

Momentum (7-1): $\vec{p} = m\vec{v}$

Centre of mass (7-9): $\vec{r}_{CM} = \frac{\sum m_i \vec{r}_i}{M}$

Sine and Cosine Laws: $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$$c^2 = a^2 + b^2 - 2ab\cos C$$

Linear and angular quantities for rotation (8-4,5,6):

$$v = R\omega$$
$$a_{\tan} = R\alpha$$
$$a_R = \omega^2 R$$

Torque due to a force (8-10): $\tau = R_\perp F = RF_\perp = RF\sin\theta$

Moments of inertia (8-13): $I = \Sigma m_i R_i^2$

Newton's 2nd law for rotation (8-14): $\Sigma\tau = I\alpha$

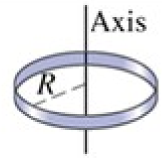
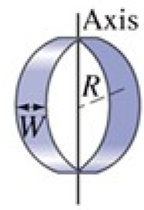
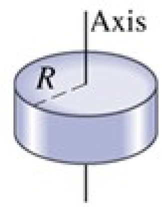
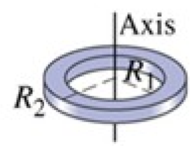
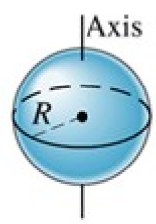
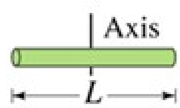
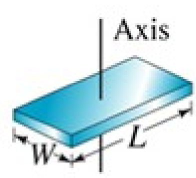
Total kinetics energy (8-16): $KE = \frac{1}{2}Mv_{MC}^2 + \frac{1}{2}I_{CM}\omega^2$

Angular momentum of a rigid body (8-18): $L = I\omega$

Angular momentum of a moving particle: $L = r_\perp p = rp_\perp = rp\sin\theta$, where $p = mv$.

Static equilibrium (9-1,2): $\Sigma\vec{F} = 0$, $\Sigma\tau = 0$.

Young's Modulus (9-4): $\Delta L = \frac{1}{E}\frac{F}{A}L_0$.

	Object	Location of axis		Moment of inertia
(a)	**Thin hoop,** radius R	Through center		MR^2
(b)	**Thin hoop,** radius R width W	Through central diameter		$\frac{1}{2}MR^2 + \frac{1}{12}MW^2$
(c)	**Solid cylinder,** radius R	Through center		$\frac{1}{2}MR^2$
(d)	**Hollow cylinder,** inner radius R_1 outer radius R_2	Through center		$\frac{1}{2}M(R_1^2 + R_2^2)$
(e)	**Uniform sphere,** radius R	Through center		$\frac{2}{5}MR^2$
(f)	**Long uniform rod,** length L	Through center		$\frac{1}{12}ML^2$
(g)	**Long uniform rod,** length L	Through end		$\frac{1}{3}ML^2$
(h)	**Rectangular thin plate,** length L, width W	Through center		$\frac{1}{12}M(L^2 + W^2)$

Liquid pressure at a depth *h* (10-3): $P = \rho g h$

Equation of continuity (10-4): $\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

Bernoulli's equation (10-5): $P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$

Poiseuille's equation (10-9): $Q = \frac{\pi R^4 (P_1 - P_2)}{8\eta l}$

Simple harmonic motion (SHM):

$$x = A\cos(\omega t + \phi)$$
$$v = -\omega A \sin(\omega t + \phi)$$
$$a = -\omega^2 A\cos(\omega t + \phi) = -\omega^2 x$$

Mass and spring (11–7): $\omega = 2\pi f = \sqrt{\frac{k}{m}}$

Simple pendulum (11–11): $\omega = 2\pi f = \sqrt{\frac{g}{l}}$

Wave velocity (11–12): $v = \lambda f$

Transverse wave velocity on a cord (11-13): $v = \sqrt{\frac{F_T}{m/l}}$

Longitudinal wave velocity in a rod (11-14a): $v = \sqrt{\frac{E}{\rho}}$

Longitudinal wave velocity in a fluid (11–14b): $v = \sqrt{\frac{B}{\rho}}$

Wave energy (11-17a): $E = 2\pi^2 \rho S v t f^2 A^2$

Wave power (11-17b): $P = \frac{E}{t}$

Wave intensity (11-18): $I = \frac{P}{S}$

Wave function: $D(x,t) = A\,sin\left[\left(\frac{2\pi}{\lambda}\right)(x - vt + \phi)\right] = A\,sin(kx - \omega t + \phi)$

Wave number: $k = \frac{2\pi}{\lambda}$

Standing wave (11-19): $\lambda_n = \frac{2l}{n}$

Sound level (12-1): $\beta = 10\,log\left(\frac{I}{I_0}\right)$, $\quad I_0 = 1.00 \times 10^{-12}\ W/m^2$

Doppler effect (12-4): $f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right)$