

Physics 101 Formula Sheet

Constant acceleration (2-12): $x = x_0 + v_0 t + \frac{1}{2} a t^2$, $v = v_0 + a t$, $v^2 = v_0^2 + 2a(x - x_0)$

Vector components (3-2, 3-3): $V_x = V \cos \theta$; $V_y = V \sin \theta$

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

Relative velocity (3-15): $\vec{v}_{BS} = \vec{v}_{BW} + \vec{v}_{WS}$

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

Newton's law of gravitation (6-1): $F = G \frac{m_1 m_2}{r^2}$; where $G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$

Dot (or scalar) product of two vectors (7-2, 7-4): $\vec{A} \cdot \vec{B} = AB \cos(\theta) = A_x B_x + A_y B_y + A_z B_z$

Work (7-3): $W = \vec{F} \cdot \vec{d} = Fd \cos(\theta)$

Kinetic Energy (7-10): $K = \frac{1}{2} m v^2$

Work energy principle (7-11): $W_{net} = \Delta K = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2$

Potential Energy: Gravity (universal) (8-17): $U(r) = -\frac{GmM}{r}$

Gravity (near surface of the earth) (8-3): $U = mgy$

Spring (8-5) $U = \frac{1}{2} kx^2$

Power (8-21): $P = \frac{W}{\Delta t} = \vec{F} \cdot \vec{v}$

Centre of mass (9-11): $x_{CM} = \frac{\sum m_i x_i}{M}$, $y_{CM} = \frac{\sum m_i y_i}{M}$, $z_{CM} = \frac{\sum m_i z_i}{M}$
 $v = R\omega$

Linear and angular quantities for rotation (10-4,5,6): $a_{tan} = R\alpha$
 $a_R = \omega^2 R$

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

Newton's 2nd law for rotation (10-14): $\Sigma \tau = I\alpha$

Total kinetics energy (10-23): $K = \frac{1}{2} M v_{MC}^2 + \frac{1}{2} I \omega^2$

Angular momentum of a rigid body (11-1): $L = I\omega$

Angular momentum of a moving particle: $L = r_{\perp} p = r p_{\perp} = r p \sin \theta$, where $p = mv$.

Static equilibrium (12-1,2): $\Sigma \vec{F} = 0$, $\Sigma \tau = 0$.

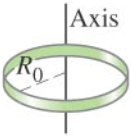
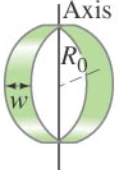
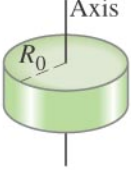
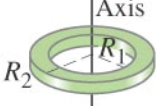
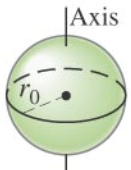
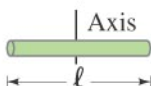
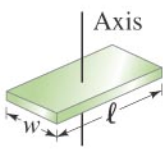
Pressure at a depth h in a liquid (13-3): $P = \rho gh$

Bernoulli's equation (13-8): $P_1 + \frac{1}{2} \rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g y_2$

Viscosity (13-11): $F = \eta A \frac{v}{l}$

Poiseuille's equation (13-12): $Q = \frac{\pi R^4 (P_1 - P_2)}{8\eta l}$

Moments of inertia (10-13): $I = \sum m_i R_i^2$

Object	Location of axis		Moment of inertia
(a) Thin hoop, radius R_0	Through center		MR_0^2
(b) Thin hoop, radius R_0 width w	Through central diameter		$\frac{1}{2}MR_0^2 + \frac{1}{12}Mw^2$
(c) Solid cylinder, radius R_0	Through center		$\frac{1}{2}MR_0^2$
(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_0	Through center		$\frac{2}{5}Mr_0^2$
(f) Long uniform rod, length ℓ	Through center		$\frac{1}{12}M\ell^2$
(g) Long uniform rod, length ℓ	Through end		$\frac{1}{3}M\ell^2$
(h) Rectangular thin plate, length ℓ , width w	Through center		$\frac{1}{12}M(\ell^2 + w^2)$