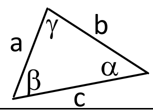
Cascarano **Formula Sheet** Physics 4A

Math Stuff		Constants	
Scalar Product	$\vec{A}\cdot\vec{B} = \lvert\vec{A}\rvert\lvert\vec{B}\rvert\cos\theta$	Acceleration of gravity	g = 9.80 m/s^2
Vector Product	$\vec{A}\times\vec{B} = \lvert\vec{A}\rvert\lvert\vec{B}\rvert\sin\theta$	Universal gravitation	G = 6.67x10^{-11} Nm^2/kg^2
Quadratic formula (ax^2+bx+c=0)	$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$	Mass of Earth Radius of Earth	$M_E = 5.97x10^{24}kg$ $R_E = 6.38x10^6 m$

Kinematics	Trig Identities	Newton's Laws / Friction / Circular motion	
$v_x = v_{ox} + a_x t$	Law of cosines:	2nd Law	$\sum\vec{F} = m\vec{a}$ or $\sum\vec{F} = \frac{d\vec{p}}{dt}$
$x = x_o + v_{ox}t + \frac{1}{2}a_x t^2$	$a^2 = b^2 + c^2 - 2bc\cos\alpha$	Gravitation	$F = \frac{Gm_1 m_2}{r^2}$
$v_x^2 = v_{ox}^2 + 2a_x(x - x_o)$	Law of sines:	Static friction	$f_s \le \mu_s n$
$x - x_o = \left(\frac{v_{ox} + v_x}{2}\right)t$	$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$	Kinetic friction	$f_k = \mu_k n$
Velocity Addition		Centripetal acceleration	$a_c = \frac{v^2}{r}$
$\vec{v}_{AB} = \vec{v}_{AC} + \vec{v}_{CB}$			

Work & Power		Energy	
Work by constant force	$W = \vec{F}\cdot\vec{s}$	Kinetic energy	$K = \frac{1}{2}mv^2$
Work by varying force	$W = \int_{x_1}^{x_2} F_x\,dx$	Gravitational potential energy	$U_g = mgy = -\frac{GmM}{r}$
Conservative forces	$W = -\Delta U$	Elastic potential energy	$U_{el} = \frac{1}{2}kx^2$
Non-conservative forces	$\Delta U_{int} = f_k d$	Hooke's Law	$F = kx$
Power	$P = \frac{dW}{dt}$	Force from potential energy	$F_x = -\frac{\partial U}{\partial x}$

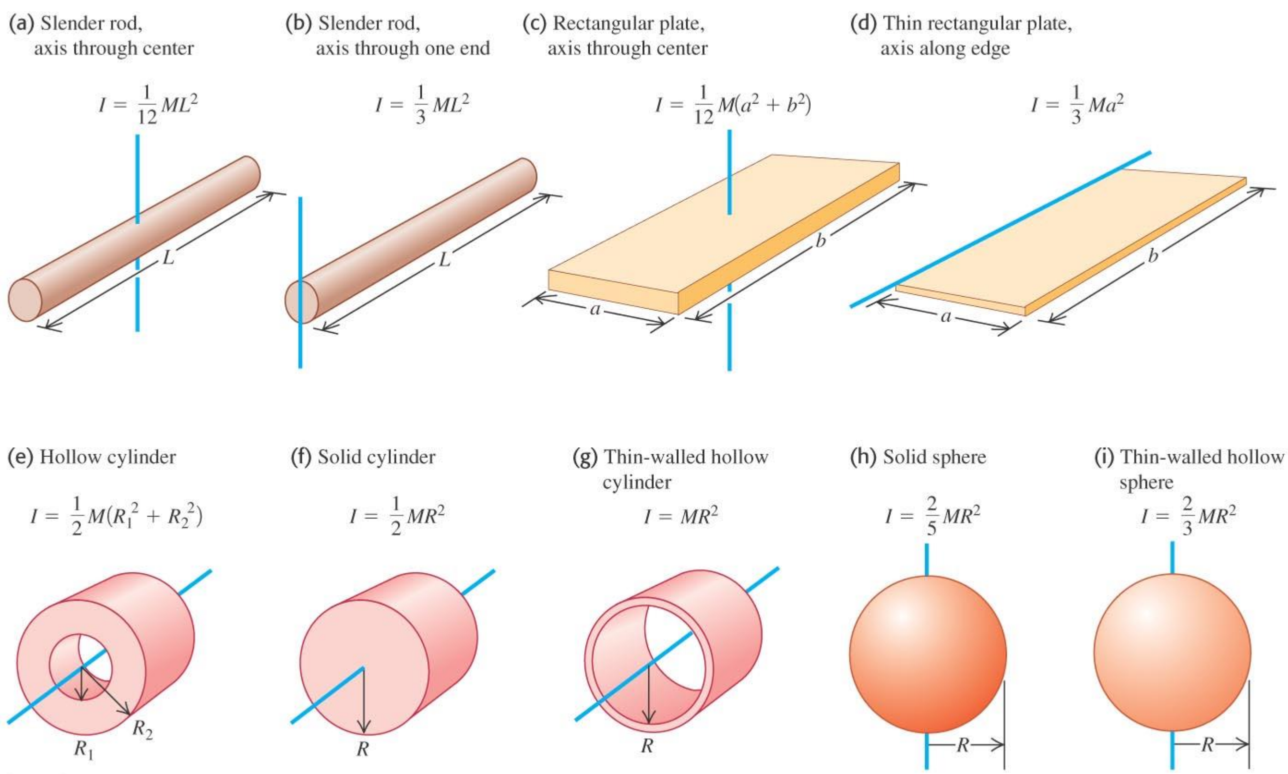
Impulse and Momentum		Center of Mass	
Linear momentum	$\vec{p} = m\vec{v}$	Center of mass (point objects)	$x_{CM} = \frac{\sum_n m_n x_n}{\sum_n m_n}$
Impulse	$\vec{J} = \int_{t_1}^{t_2}\sum\vec{F}dt = \left(\sum\vec{F}\right)_{ave}\Delta t$	Center of mass (solid objects)	$x_{CM} = \frac{\int x dm}{\int dm}$
Impulse - momentum	$\vec{J} = \Delta\vec{p}$	Total momentum	$\vec{p}_{total} = M_{total}\vec{v}_{CM}$ $\sum\vec{F}_{ext} = M_{total}\vec{a}_{CM}$

Rotational Kinematics	Linear / Angular	Rotational Inertia and Energy	
$\omega = \omega_o + \alpha t$	$s = r\theta$ $(\theta\ in\ radians)$	Rotational inertia (point objects)	$I = \sum_i m_i {r_i}^2$
$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$	$v = r\omega$	Rotational inertia (solid objects)	$I = \int r^2\,dm$
$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_o)$	$a_{tan} = r\alpha$	Parallel axis theorem	$I_P = I_{CM} + Md^2$
$\theta - \theta_o = \left(\frac{\omega_o + \omega}{2}\right)t$	$a_{rad} = \frac{v^2}{r}$	Rotational kinetic energy	$K = \frac{1}{2}I\omega^2$

Torque and Angular Momentum		Rotational Motion	
Torque	$\vec{\tau} = \vec{r}\times\vec{F} = rFsin\emptyset = Fl$	Newton's 2nd law	$\sum\vec{\tau} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$
Angular momentum	$\vec{L} = \vec{r}\times\vec{p} = mvrsin\emptyset = I\vec{\omega}$	Work	$W = \int_{\theta_1}^{\theta_2}\tau d\theta = \Delta K_{rot}$
		Power	$P = \tau\omega$

Cascarano **Formula Sheet** Physics 4A

Simple Harmonic Motion		Angular Frequency	
Displacement	$x(t) = Acos(\omega t + \emptyset)$	Mass on a spring	$\omega = \sqrt{\frac{k}{m}}$
Velocity	$v(t) = -\omega Asin(\omega t + \emptyset)$	Simple pendulum	$\omega = \sqrt{\frac{g}{l}}$
Period	$T = \frac{2\pi}{\omega}$	Frequency	$f = \frac{1}{T} = \frac{\omega}{2\pi}$



(j) Thin hoop rotating on axis through any diameter of the hoop:

$$I = \frac{1}{2}MR^2$$