

**General College Physics I (PHY 103)**  
Equation Sheet

$x = x_0 + vt$	$\theta = \theta_0 + \omega t$
$v = v_0 + at$	$\omega = \omega_0 + \alpha t$
$x = x_0 + v_0 t + \frac{1}{2}at^2$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$v^2 = v_0^2 + 2a(x - x_0)$	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$
$F_{\text{net}} = ma$	$\tau_{\text{net}} = I\alpha$
$F_{\text{gravity}} = mg$	
$V_x = V \cos \theta$	$x = x_0 \cos \omega(t - t_0)$
$V_y = V \sin \theta$	$v = -\omega x_0 \sin \omega(t - t_0)$
$V = \sqrt{V_x^2 + V_y^2}$	$a = -\omega^2 x_0 \cos \omega(t - t_0)$
$\tan \theta = V_y/V_x$	$\omega = \sqrt{k/m}$
$a_R = v^2/r$	$a_{\text{tan}} = r\alpha$
$F = Gm_1 m_2/r^2$	$f = 1/T$
$F_{\text{fr}} = \mu_k F_N$	$\omega = 2\pi f$
$F_{\text{fr}} \leq \mu_s F_N$	$v = \lambda/T$
$W = F_{\parallel} d = F d_{\parallel} = F d \cos \theta$	$\tau = r F_{\perp} = r_{\perp} F = r F \sin \theta$
$\text{KE} = \frac{1}{2}mv^2$	$\text{KE} = \frac{1}{2}I\omega^2$
$W_{\text{net}} = \Delta\text{KE}$	
$\text{PE}_{\text{grav}} = mgy$	$\Delta E_{\text{th}} = mc\Delta T$
$\text{PE}_{\text{spring}} = \frac{1}{2}kx^2$	$F_{\text{spring}} = -kx$
$\text{ME} = \text{KE} + \text{PE}$	$s = r\theta$
$W_{\text{net,NC}} = \Delta\text{ME}$	$v = r\omega$
$\mathbf{p} = m\mathbf{v}$	$L = I\omega$
$\Delta\mathbf{P} = \mathbf{F}_{\text{net,ext}} \Delta t$	

$$g = 9.8 \text{ m/s}^2$$

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

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$C = 2\pi r$$

$$A = \pi r^2$$

Earth mass	$5.98 \times 10^{24}$ kg
Moon mass	$7.35 \times 10^{22}$ kg
Sun mass	$1.99 \times 10^{30}$ kg
Earth radius (mean)	$6.38 \times 10^6$ m
Moon radius (mean)	$1.74 \times 10^6$ m
Sun radius (mean)	$6.96 \times 10^8$ m
Earth-Moon distance (mean)	$3.84 \times 10^8$ m
Earth-Sun distance (mean)	$1.496 \times 10^{11}$ m

Substance	Specific Heat (J/kg·°C)
Aluminum	900
Copper	390
Iron or steel	450
Lead	130
Silver	230
Water	
Ice (-5°C)	2100
Liquid (15°C)	4186
Steam (110°C)	2010

Substance	Melting Point (°C)	Heat of Fusion (J/kg)	Boiling Point (°C)	Heat of Vaporization (J/kg)
Water	0	333,000	100	$2.26 \times 10^6$
Lead	327	25,000	1750	870,000

Object	Axis	Moment of Inertia
Solid cylinder	central axis	$I = \frac{1}{2}MR^2$
Cylindrical shell	central axis	$I = MR^2$
Solid ball	central axis	$I = \frac{2}{5}MR^2$
Rod	through center $\perp$ to rod	$I = \frac{1}{12}ML^2$
Rod	through end $\perp$ to rod	$I = \frac{1}{3}ML^2$