PHYSICS 5A
Fall 2005
POSSIBLY USEFUL EQUATIONS

Conversions:
1 mile = 5280 feet
1 inch = 2.54 cm

Quadratic Formula:
If $ax^2 + bx + c = 0$,
$x = -b/(2a) \pm (1/2a)(b^2 - 4ac)^{1/2}$

Vectors:
$A = |\mathbf{A}| = (A_x^2 + A_y^2 + A_z^2)^{1/2}$

$\mathbf{A\cdot B} = AB\cos(\theta) = A_xB_x + A_yB_y + A_zB_z$

$$\mathbf{A}\times\mathbf{B} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

$|\mathbf{A}\times\mathbf{B}| = AB\sin(\theta)$, direction by right hand rule

Motion in 1-d with constant acceleration:
$x = x_0 + v_0t + (1/2)at^2$
$v = v_0 + at$
$v^2 = v_0^2 + 2a(x - x_0)$

Gravitational force near surface of the earth:
$|\mathbf{wt}| = mg$ ($g = 9.80\ m/s^2$), direction is down

Uniform circular motion:
$|\mathbf{a}| = v^2/r = 4\pi^2r/T^2$
direction is toward center of circle

Spring force:
$\mathbf{F} = -k\mathbf{\Delta s}$

Newton's First and Second Laws:
$\Sigma\mathbf{F} = m\mathbf{a}$

Newton's Third Law:
$\mathbf{F}_{A\ on\ B} = -\mathbf{F}_{B\ on\ A}$

Kinetic Energy:
$K_t = (1/2)mv^2$ (translational)
$K_r = (1/2)I\omega^2$ (rotational)

Potential Energy:
Gravity near surface of earth: $U_g = mgh$
Spring: $U_s = (1/2)k(\Delta x)^2$

Work & Energy:
$W = \mathbf{F}\cdot\mathbf{ds} = F\,ds\cos\theta$
$T = K + U$ (constant if forces are conservative)
$W_{(\text{non-conservative forces})} = \Delta T$
Power = Work/Time ($P = W/\Delta t$)

Momentum:
Impulse = $\mathbf{F}dt$
$\mathbf{p} = m\mathbf{v}$
$\Sigma\mathbf{p}$ = const if $\Sigma\mathbf{F}_{ext} = 0$
$\Sigma\mathbf{F}_{ext} = d(\Sigma\mathbf{p})/dt$

Definition of center of mass:
$\mathbf{r}_{cm} = (\Sigma m_i\mathbf{r}_i)/(\Sigma m_i)$

Motion of center of mass:
$\Sigma\mathbf{F}_{ext} = M\mathbf{a}_{CM}$

Rotational Motion:
$\omega = d\theta/dt$ $v_t = r\omega$
$\alpha = d\omega/dt$ $a_t = r\alpha$
$I = \Sigma m_ir_i^2$ $a_r = \omega^2r$
Parallel axis theorem: $I = I_{CM} + Mr^2_{CM}$

Torque:
$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$ $|\boldsymbol{\tau}| = rF\sin\theta$
$\Sigma\boldsymbol{\tau} = d\mathbf{L}/dt$

Rolling without slipping:
$v_{CM} = r\omega$

Equilibrium:
$\Sigma\mathbf{F} = 0$
$\Sigma\tau = 0$

Universal Gravitation:
$F = -GMm/r^2$
$U_G = -GMm/r$
($G = 6.67 \times 10^{-11}$ N-m^2/kg^2)

Angular momentum:
$\mathbf{L} = \mathbf{r} \times \mathbf{p}$
$L = I\omega$ (rotation about fixed axis)

Static Friction:
$F_{fmax} = \mu_s N$

Kinetic Friction:
$F_f = \mu_k N$

Collisions:
Elastic: ΣK = constant.
Elastic or Completely Inelastic:
Total momentum is conserved.