Formulas for Physics 1A

$\alpha \equiv$ angular acceleration ($1/s^2$)
F $\equiv$ force ($N \equiv kg \bullet m/s^2$)
G $\equiv$ gravitational constant = $6.67 \times 10^{-11}\ m^3/(kg \bullet s^3)$
k $\equiv$ spring constant (kg/s^2)
$\mu \equiv$ coefficient of friction
N $\equiv$ normal force
P $\equiv$ pressure ($Pa \equiv kg/m \bullet s^2$)
$\tau \equiv$ torque ($N \bullet m \equiv kg \bullet m^2/s^2$)
$\theta \equiv$ angular displacement or rotation
$\omega \equiv$ angular velocity ($1/s$)
X $\equiv$ displacement (m)

A $\equiv$ acceleration (m/s^2)
g $\equiv$ gravitat. acceleration at Earths surface = $9.81\ m/s^2$
I $\equiv$ moment of inertia (kg/m^2)
L = angular momentum ($kg \bullet m^2/s$)
m $\equiv$ mass (kg)
P $\equiv$ momentum ($kg \bullet m/s$)
$\rho \equiv$ density (kg/m^3)
T $\equiv$ period of orbit
V $\equiv$ velocity (m/s)
W $\equiv$ work ($J = N \bullet m = kg \bullet m^2/s^2$)
Y $\equiv$ displacement (m)

Kinematics
For A = Constant: $V(t) = V_0 + A \bullet t$ and $X(t) = X_0 + V_0 \bullet t + (1/2) \bullet A \bullet t^2$
The above two equations lead to: $V^2(t) = V^2{}_0(t) + 2 \bullet A \bullet [X(t) - X_0]$

Forces
$F(t) = m(t) \bullet A(t)$ (where we explicitly note that both mass and acceleration can change with time)
$P(t) = m(t) \bullet V(t)$ (where $F = \Delta P/\Delta t$ or $\Delta P = F\Delta t$; the change in momentum ΔP is also referred to as impulse)

Friction models
$f_{static\ friction} \leq \mu_s \bullet N$ (opposes the direction of motion up to a maximum value of $\mu_s \bullet N$)
$f_{kinetic\ friction} = \mu_k \bullet N$ (opposes the direction of motion)

Rocket equation
$V = \mu_{exhaust} \bullet ln(M_{initial}/M_{final})$

Spring equation
$F(t) = k \bullet [x(t) - x_0]$

Gravitational formula
$F = (G \bullet M_1 \bullet M_2)/R^2{}_{12}$ (points radially inward)
$T^2 = [(4\pi^2)/(G \bullet M_{sun})] \bullet R^3$ (Kepler's third law, where $T = 2\pi/\omega$)

Rotational motion
For α = Constant $\omega(t) = \omega_0 + \alpha \bullet t$ and $\theta(t) = \theta_0 + \omega_0 \bullet t + (1/2) \bullet \alpha \bullet t^2$
$A_{tangent} = R \bullet \alpha$ and $V_{tangent}(t) = R \bullet \omega(t)$
$A_{centrifugal}(t) = R \bullet \omega^2(t) = V^2{}_{tangent}(t)/R$ (points radially inward)
$\tau(t) = R \bullet F(t) \bullet sin\theta$ (where the angle extends from the radius vector to the force vector)
$\tau(t) = I \bullet \alpha(t)$
$L(t) = I \bullet \omega(t)$ (where $\tau = \Delta L/\Delta t$)
$I \equiv \Sigma_i m_i r_i^2 = M \bullet R^2$ (point mass); $M \bullet R^2$ (thin cylindrical shell); $(2/3) \bullet M \bullet R^2$ (thin spherical shell); $(1/2) \bullet M \bullet R^2$ (solid cylinder rotated on axis); $(1/3) \bullet M \bullet L^2$ (rod rotated about end); $(1/5) \bullet M \bullet R^2$ (solid sphere); $(1/12) \bullet M \bullet L^2$ (rod rotated about center); where R is the radius and L is the length

Work and Energy
$W = F \bullet (X_{final} - X_{initial}) \bullet cos\theta$ (where the angle is between the force vector and the displacement vector)
Conservative forces: KE + PE = Constant
Nonconservative forces: KE + PE $\neq$ Constant
Translation: $KE = (1/2) \bullet m \bullet V^2$
Rotation: $KE = (1/2) \bullet I \bullet \omega^2$
Gravitational: $PE = -(G \bullet M_1 \bullet M_2)/R_{12}$
Spring: $PE = (1/2) \bullet k \bullet [X(t) - X_0]^2$

Fluids
Continuity: $A \bullet V = A' \bullet V'$
Bernouli: $P + \rho \bullet g \bullet Y + (1/2) \bullet \rho \bullet V^2$ = Constant