Physics I Formula Sheet

Translational Motion
$\Delta x = x_2 - x_1$ (displacement)
$v_{average} = \Delta x/\Delta t$
$a_{average} = \Delta v/\Delta t$
Given x(t)
$v(t) = dx/dt$
$a(t) = dv/dt = d^2x/dt^2$

Kinematic eq-ns with const. Acc.:
$v(t) = v_{0x} + at$
$x(t) = x_0 + v_{0x}t + (1/2)\,at^2$
$v^2 = v_{0x}^2 + 2a(x - x_0)$

Newton 2nd law
$$\sum \vec{F} = m\vec{a}$$
$$\sum \vec{F} = \frac{d\vec{P}}{dt}$$

Frictional Forces:
$F_S \le \mu_S F_N$
$F_k = \mu_k F_N$

For springs:
$F = -kx$
$U(x) = (1/2)kx^2$

Linear Momentum and Impulse
$\vec{p} = m\vec{v}$
$\vec{J} = \int \vec{F}dt = \vec{F}_{av}\Delta t$

For elastic collision:
$\vec{p}_A + \vec{p}_B = \vec{p}'_A + \vec{p}'_B$
$\frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2 = \frac{1}{2}m_A v'^2_A + \frac{1}{2}m_B v'^2_B$

For 1-D elastic head-on collisions:
$v_A - v_B = -(v'_A - v'_B)$

Work and Kinetic Energy
$W = Fl\cos\theta$
$$W = \int_{r_1}^{r_2} \vec{F}\cdot d\vec{r}$$
$K_{trans} = (1/2)mv^2$; $K_{rot} = (1/2)I\omega^2$
$K_{tot} = (1/2)I_{CM}\omega^2 + (1/2)Mv_{CM}^2$

Work-Kinetic Energy principle
$W_{net} = \Delta K$

With non-conservative forces:
$\Delta K + \Delta U = W_{NC}$

Centripetal acceleration:
$a_R = v^2/R$; $a_R = \omega^2 R$

Rotational Motion
$\Delta\theta = \theta_2 - \theta_1$
$\omega = d\theta/dt$
$\alpha = d\omega/dt$
Given θ(t)
$\omega(t) = d\,\theta/dt$
$\alpha(t) = d\omega/dt = d^2\theta/dt^2$

Rotat. kinematic eq-ns with const. angular acceleration
$\omega(t) = \omega_0 + \alpha t$
$\theta(t) = \theta_0 + \omega_0 t + (1/2)\alpha t^2$
$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

Rotat. Newton 2nd law
$$\sum \vec{\tau} = I\vec{\alpha}$$
$$\sum \vec{\tau} = \frac{d\vec{L}}{dt}$$

Angular Momentum
$\vec{L} = \vec{r} \times \vec{p}$; $\vec{L} = I\vec{\omega}$
$I = \Sigma m_i R_i^2$

Torque
$\vec{\tau} = \vec{r} \times \vec{F}$; $\tau = r\,F\sin\theta$

Potential Energy
$$\Delta U = U(x) - U_0(x_0) = -\int_{x_0}^{x} F dx$$
$F(x) = -\,dU(x)/dx$

For gravity on earth's surface:
$F_g = mg$
$U(y) = mgy$

For gravity in general:
$F_g = -\,GmM_E/R^2$
$U(r) = -\,GmM_E/R$
g $= 9.8\ m/s^2$; **G** $= 6.67 \times 10^{-11}\ N.m^2/kg^2$

Total mechanical energy:
$E_{tot} = K + U$

Power
$P_{avg} = W/t$; $P = dW/dt$; $P = \vec{F}\bullet\vec{v}$

Equations connect. trans./rotat. motion
$v_{tan} = R\omega$
$a_{tan} = R\alpha$

Center of Mass

$\mathbf{r}_{cm} = \boldsymbol{\Sigma} m_i \mathbf{r}_i / M$

$\boldsymbol{\Sigma}\mathbf{F}_{ext} = M\mathbf{a}_{cm}$

Kepler's third law:

$T^2/R^3 = 4\pi^2/GM_{sun}$

Differentiation:

$dx^n/dx = nx^{n-1}$ $(n \neq 0)$

$d\cos(x)/dx = -\sin(x)$ (x in radians)

$d\sin(x)/dx = \cos(x)$ (x in radians)

Integration:

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C$$

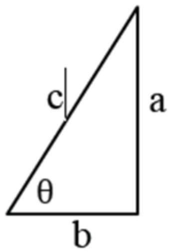
Right triangle:

$\sin\theta = a/c$

$\cos\theta = b/c$

$\tan\theta = a/b$

$c^2 = a^2 + b^2$



Quadratic Formula:

$Ax^2 + Bx + C = 0$ *has solutions:*

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$