Physics I. Final Exam 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

$W = Fs\cos\theta$

$$W = \int_{r_1}^{r_2} \vec{F} \cdot d\vec{s}$$

$K_{trans} = (1/2)mv^2$; $K_{rot} = (1/2)I\omega^2$

$K_{tot} = (1/2)I_{CM}\omega^2 + (1/2)Mv_{CM}^2$

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

$r_{cm} = \Sigma m_i r_i / M$

$\Sigma F_{ext} = M a_{cm}$

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)

Misc Formulas:

Circumference of a circle = $2\pi R$

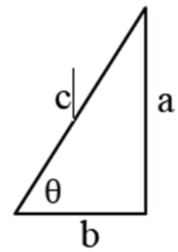
Area of a circle = πR^2

Surface Area of a Sphere = $4\pi R^2$

Volume of sphere = $(4/3)\pi R^3$

Volume of cylinder = $\pi R^2 L$

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:

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

Integration:

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

Acceleration due to gravity:

$g = 9.8\ m/s^2$ downward