Formula Sheet for Exam 3
PHYS 1110 Section 02

$x = r\cos\theta$; $\tan\theta = x/y$

$y = r\sin\theta$; $r^2 = x^2 + y^2$

$\vec{A}\cdot\vec{B} = AB\cos\theta$

$= A_xB_x + A_yB_y + A_zB_Z$

$\|\vec{A}\times\vec{B}\| = AB\sin\theta$

When $0 = ax^2 + bx + c$, $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$

Constant acceleration in one dimension:

$v = v_0 + at$ $x = x_0 + v_0t + 1/2\,at^2$

$x - x_0 = \frac{1}{2}(v_0 + v)t$

$v^2 - v_0^2 = 2a(x - x_0)$

Uniform circular motion

$f = 1/T = \omega/2\pi$

$v = 2\pi r/T = \omega r$

$a = v^2/r = \omega^2 r$

$= 4\pi^2 r/T^2 = 4\pi^2 f^2 r$

Friction: $f_s \le \mu_s N$ $f_k = \mu_k N$

Hooke's law: $F = -kx$; $U_{el} = ½\,kx^2$

Uniform gravity: $F_g = mg$; $U_g = mgh$

Newtonian gravity:

$F_g = G\frac{m_1m_2}{r^2}$ $U_g = -G\frac{m_1m_2}{r}$

$\vec{a} = \Sigma\vec{F}/m$

$W = \vec{F}\cdot\vec{s}$ $K = ½\,mv^2$

$\Sigma W = \Delta K$ $E_1 + W_N = E_2$

$\vec{J} = \vec{F}t$ $\vec{p} = m\vec{v}$

$\Sigma\vec{J} = \Delta\vec{p}$ $\vec{p}_1 = \vec{p}_2$

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

Totally inelastic collisions

$$v_f = \frac{m_1v_1 + m_2v_2}{m_1 + m_2}$$

Elastic collisions in one dimension

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_{1i} + \frac{2m_2}{m_1 + m_2}v_{2i};$$

$$v_{2f} = \frac{m_2 - m_1}{m_1 + m_2}v_{2i} + \frac{2m_1}{m_1 + m_2}v_{1i}$$

Rotational kinematics

$\omega = \Delta\theta/\Delta t = v/r$; $\alpha = \Delta\omega/\Delta t = a_{\parallel}/r$

$\omega = \omega_0 + \alpha t$; $\theta = \theta_0 + \omega_0 t + ½\,\alpha t^2$

$\omega^2 - \omega_0^2 = 2\alpha(\theta - \theta_0)$

Rotational dynamics

$K_r = ½\,I\omega^2$

$\vec{\tau} = \vec{r}\times\vec{F} = \Delta\vec{L}/\Delta t$

$\vec{L} = \vec{r}\times\vec{p} = I\omega$; $I_1\vec{\omega}_1 = I_2\vec{\omega}_2$

Moments of inertia about centers

Thin rod $I = 1/12\,ML^2$

Spherical shell $I = 2/3\,MR^2$

Solid sphere $I = 2/5\,MR^2$

Cylindrical shell $I = MR^2$

Solid cylinder $I = 1/2\,MR^2$

Simple harmonic motion

$x = \cos(\omega t)$; $v = -A\omega\sin(\omega t)$;

$a = -A\omega^2\cos(\omega t)$; $\omega^2 = k/m$

Simple pendulum $\omega^2 = g/L$

Wave motion

$x = A\cos(kx - \omega t + \varphi)$

$k = 2\pi/\lambda$; $\omega = 2\pi/T$

$u = \lambda/T = \lambda f = \omega/k = \sqrt{F/\mu}$

Sound intensity $I = {}^{P}/_{4\pi r^2}$

$\beta = (10\text{dB})\log_{10}(I/I_0)$

$\beta_2 - \beta_1 = (10\text{dB})\log_{10}(I_2/I_1)$

$= (20\text{dB})\log_{10}(r_1/r_2)$

Doppler shift $f_D = f_S\frac{v - v_D}{v - v_S}$