Equation Sheet For Physics 133: Midterm II (Schumacher)

Simple Harmonic Motion

$x(t) = x_m \cos(\omega t + \phi_o)$

$v(t) = -x_m\omega \sin(\omega t + \phi_o)$

$a(t) = -x_m\omega^2 \cos(\omega t + \phi_o)$

Spring-Block SHO

$E = U(t) + K(t) = ½\, k\, x_m^2$

$U_s(t) = ½\, k\, x^2(t)$

$K(t) = ½\, m\, v^2(t)$

SHO frequencies

$\omega = \sqrt{k/m}$

$\omega = \sqrt{g/L}$

Waves

$y(x,t) = y_m \sin(kx - \omega t + \phi_o)$ $\quad$ $s(x, t) = s_m \cos(kx - \omega t + \phi_o)$ $\quad$ $v = \omega/k = \lambda f$

Superposition

$y_1(x,t) = y_m \sin(kx - \omega t)$ $\quad$ $y_2(x,t) = y_m \sin(kx - \omega t + \phi_o)$ $\rightarrow$ $y'(x,t) = [2\, y_m \cos½\phi_o] \sin(kx - \omega t + ½\phi_o)$

$y_1(x,t) = y_m \sin(kx - \omega t)$ $\quad$ $y_2(x,t) = y_m \sin(kx + \omega t)$ $\rightarrow$ $y'(x,t) = [2\, y_m \sin kx] \cos\omega t$

Standing Wave Resonance (both ends nodes or antinodes, one end node)

$\lambda = 2L/n \; (n = 1,2,3\ldots)$ $\quad$ $\lambda = 4L/n \; (n = 1,3,5\ldots)$

Interference

$\Delta\phi = 2\pi\, \Delta x/\lambda$ $\quad$ $\Delta\phi = 2\pi\, \Delta t/T$ $\quad$ $f_{beat} = |f_1 - f_2|$

$\Delta\phi = n\, 2\pi$ (fully constructive) $\quad$ $\Delta\phi = (n+½)\, 2\pi$ (fully destructive)

Intensity

$I = P/A$ $\quad$ $I = P/(4\pi r^2)$

Doppler Effect (for waves in a mechanical medium only, so not for light): $f' = f\,\dfrac{v \pm v_D}{v \pm v_S}$

Specific Waves

String $\quad$ $v = \sqrt{\tau/\mu}$ $\quad$ $P_{ave} = ½\, \mu\, v\, \omega^2\, y_m^2$

Sound $\quad$ $v = \sqrt{B/\rho}$ = 343 m/s (in air) $\quad$ $I = ½\, \rho v\, \omega^2\, s_m^2$ $\quad$ $\beta = 10 \log(I/I_o)$ $\quad$ $I_o = 10^{-12}$ W/m^2

$\Delta p = \Delta p_m \sin(kx - \omega t + \phi_o)$ $\quad$ $\Delta p_m = (v\rho\omega)\, s_m$

Light $\quad$ $E = E_m \sin(kx - \omega t + \phi_o)$ $\quad$ $B = B_m \sin(kx - \omega t + \phi_o)$ $\quad$ $E = cB$ $\quad$ $I = (1/2c\mu_o)\, E_m^2$

$v = c/n$ $\quad$ $n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\quad$ $\sin\theta_c = n_2/n_1$

$c = 1\big/\sqrt{\mu_o \varepsilon_o}$ = 3.00 x 10^8 m/s $\quad$ ε_o = 8.854 x 10^{-12} F/m $\quad$ $\mu_o = 4\pi$ x 10^{-7} H/m

Images

$p = -i$ $\quad$ $1/f = 1/p + 1/i$ $\quad$ $m = -i/p$ $\quad$ $|m| = h'/h$

Young's Experiment and Diffraction

$d \sin\theta = m\lambda$ $\quad$ $d \sin\theta = (m+½)\, \lambda$ $\quad$ $m = 0,1,2,...$ $\quad$ $I = I_m \cos^2 \beta$ $\quad$ w/ $\beta = \dfrac{\pi\, d}{\lambda}\sin\theta$

$a \sin\theta = m\lambda$ $\quad$ $m = 1,2,3,\ldots$ $\quad$ $I = I_m\left(\dfrac{\sin\alpha}{\alpha}\right)^2$ $\quad$ w/ $\alpha = \dfrac{\pi\, a}{\lambda}\sin\theta$

$$I = I_m \cos^2\beta \left(\frac{\sin\alpha}{\alpha}\right)^2$$