Equation Sheet For Physics 133: Midterm I (Schumacher)

Simple Harmonic Motion

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

Spring-mass oscillator: $\omega = \sqrt{k/m}$
$E = U_s(t) + K(t) = \frac{1}{2} k x_m^2$ $U_s(t) = \frac{1}{2} k x^2(t)$ $K(t) = \frac{1}{2} m v^2(t)$

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

Transverse Waves

$y(x,t) = y_m \sin(kx - \omega t + \phi_o)$
$v_T(x,t) = -\omega y_m \cos(kx - \omega t + \phi_o)$
$a_T(x,t) = -\omega^2 y_m \sin(kx - \omega t + \phi_o)$

String waves

$v = \sqrt{\tau/\mu}$ $P_{ave} = \frac{1}{2} \mu v \omega^2 y_m^2$

Sound Waves (Longitudinal Waves)

$s(x,t) = s_m \cos(kx - \omega t + \phi_o)$ $\Delta p(x,t) = \Delta p_m \sin(kx - \omega t + \phi_o)$ $\Delta p_m = (v\rho\omega) s_m$
$v = \sqrt{B/\rho}$ $v = 343$ m/s (in air)

Intensity

$I = P/A$ $I = P/(4\pi r^2)$ $I = \frac{1}{2} \rho v \omega^2 s_m^2$
$\beta = 10 \log I/I_o$ w/ $I_o = 10^{-12}$ W/m^2

Doppler Effect: $f' = f \dfrac{v \pm v_D}{v \pm v_S}$

Waves – General Relationships

$v = \omega/k = \lambda f = \lambda/T$

Superposition

$y_1(x,t) = y_m \sin(kx - \omega t)$ $y_2(x,t) = y_m \sin(kx - \omega t + \phi_o)$
$y'(x,t) = [2 y_m \cos\frac{1}{2}\phi_o] \sin(kx - \omega t + \frac{1}{2}\phi_o)$

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

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

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

Interference

$\Delta\phi = n\, 2\pi$ (fully constructive) $\Delta\phi = (n+\frac{1}{2})\, 2\pi$ (fully destructive)
$\Delta\phi = 2\pi \Delta L/\lambda$ $\Delta\phi = 2\pi \Delta t/T$
$f_{beat} = |f_1 - f_2|$