Phys 1402   2014-11-11

Spring Oscillator

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

$$T = 1/f$$

$$\text{Energy} = \frac{1}{2}kx^2$$

$$KE = \frac{1}{2}mv^2$$

HW5, #5   Given dist & time, first find speed.

String waves $v = \sqrt{F_T/\mu}$

$\mu = \frac{m}{L}$ m and L must be for the same bit of string.

#4

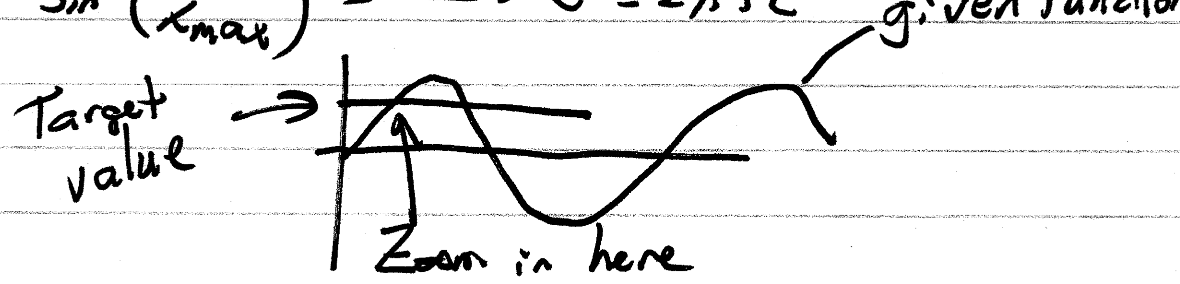
$$x = x_{max} \sin(2\pi f t)$$

when does $x = x_1$

$$x_1 = x_{max} \sin(2\pi f t)$$

$$\frac{x_1}{x_{max}} = \sin(\sim)$$

$$\sin^{-1}\left(\frac{x_1}{x_{max}}\right) = \sim = 2\pi f t$$



②

Sound Waves

- What are they?
- What is loudness?
- What is musical pitch?

Sound is pressure waves in air.
Air molecules vibrate a little bit along the direction of propagation.
"Longitudinal" waves
The speed is approx 340 m/s.

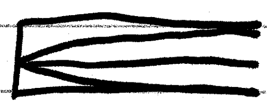
The pitch is the dominant frequency.

Ex: $f = 180\ Hz$ $\quad v = f\lambda$

$340\ m/s = (180\ Hz)\lambda$

$\lambda = 1.89\ m$

For open-closed tube $\lambda = \frac{4L}{i}$ (i = odd)



The above tube is ~0.47 m Long

For strings clamped @ both ends $\lambda = \frac{2L}{i}$ (i = int)

③

Ex: Musical notes: $f_A = 220$ Hz

$f_{A\#} = 233.08$ Hz

How fast would a person have to be moving to doppler shift an A into A#?

$\Delta f = 13.08$ Hz

$\frac{\Delta f}{f} = 0.0595 = 5.95\%$

$\frac{\Delta f}{f} = \frac{v_{rel}}{v_{wave}}$

$v_{rel} = (5.95\%)$ of 340 m/s

$= 20.2$ m/s

Doppler Radar uses radio waves

$v_w = c = 3 \times 10^8$ m/s

Reflection causes the doppler shift to happen twice.

④

Loudness - related to intensity

$$\text{Intensity} = \frac{\text{Power}}{\text{Area}}$$

Point Source - wave spreads equally in all directions.

$$I = \frac{P}{4\pi r^2}$$

Move 2 times further away, the intensity is 4 times less.

We hear intensity on a logarithmic scale. An increase by 2 times sounds like the same step size no matter how loud the initial sound was.

Sound Level β measured in dB (decibels).

10 dB is a 10 times increase.
Add/Subtract dB to mult/div intensity.

20 dB is a <u>100</u> times increase.
30 dB is 1000 X
35 dB is

$10 = 10^1$ $\quad$ $100 = 10^2$ $\quad$ $1000 = 10^3$

10 dB $\quad$ 20 dB $\quad$ 30 dB

35 dB $\Rightarrow$ 3100 $\quad$ more than 1000
less than 10 000

$$\text{factor} = 10^{\beta/10} \qquad \beta = \text{value in dB}$$

dB values are always relative.

For sound, we have a reference value.

$$I_0 = 10^{-12}\ W/m^2 \qquad 0\ dB$$

Loud Conversation

$$\text{factor} = 10^7 \qquad 70\ dB$$

$$I = (10^{-12}\ W/m^2)\,10^7 = 10^{-5}\ W/m^2$$

Pain $\quad$ factor $= 10^{12}$ $\quad$ ~120 dB

$$I = 10^{12}(I_0) = 1\ W/m^2$$