Phys 1402 2017-11-09 Lec 20

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

Example Systems: $f = \frac{1}{2\pi}\sqrt{k/m}$ $f = \frac{1}{2\pi}\sqrt{g/l}$

Waves: $v = \frac{\lambda}{T}$ $\boxed{v = f\lambda}$

Example Waves: Sound $v \sim 340\ m/s$

Electromagnetic Waves $v = c = 3\times10^{8}\ m/s$

Wave on a String $v = \sqrt{F_T/\mu}$

μ = mass per Length

Generally, waves are started by an oscillator called the source.

The source frequency becomes the wave frequency.

Exception: Doppler Effect

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

Ex: Car horn Data

f_{source} $+\Delta f$ Initial freq: 4897 Hz } Both "observed" w/ Doppler

$-\Delta f$ Final Freq: 4513 Hz

$f_{source} = f_{avg} = 4705$ Hz

$\Delta f = 4897 - 4705 = 192$ Hz

$$\frac{192}{4705} = \frac{V}{340} \qquad V = 13.9\ m/s = 31\ MPH$$

Quirks in Doppler Calculations

Doppler Radar – ~~Wave~~ Wave propagates twice.

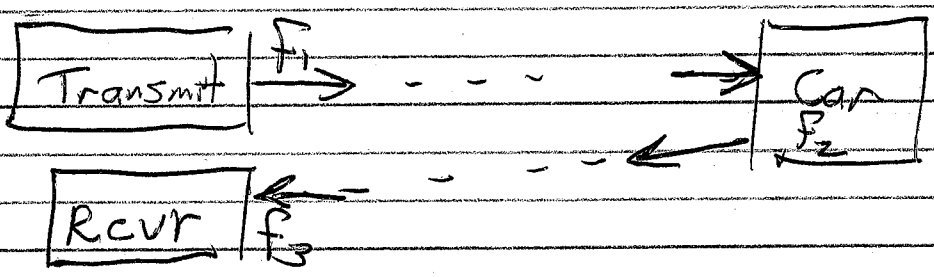
$$f_1 \rightarrow \frac{\Delta f}{f_1} = \frac{v}{c} \rightarrow f_2 \rightarrow \frac{\Delta f}{f_2} = \frac{v}{c} \rightarrow f_3$$

(v: car or rain; c: speed of light)

Between source (f_1) and receiver (f_3),

Doppler happens twice.

$$f_3 - f_1 = \Delta f \quad \text{(overall)} \qquad \text{use} \quad \frac{\Delta f}{f} = \frac{2v}{c}$$



Doppler shift is upward ⊕ on approach.

Standing Waves

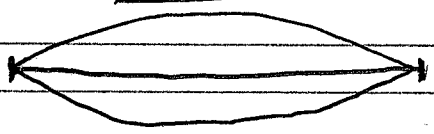
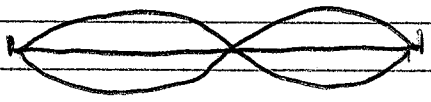
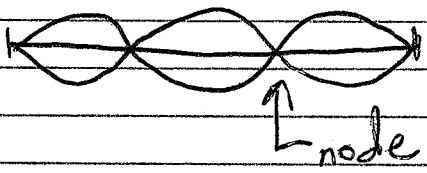
Two fixed Ends - pulse travels $2l$ to repeat itself.

If the next pulse starts exactly then, it will reinforce the previous pulse.

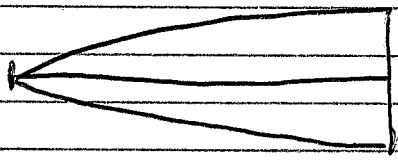
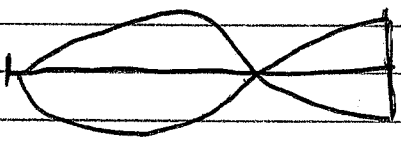
Condition for reinforcement

$m\lambda = 2l$ (m: any integer; l: length of string)

$v = f\lambda$ $\quad f = \frac{v}{\lambda}$

	m	λ_m	Picture	Frequency
Fundamental	1	$2l$		$f_1 = \frac{v}{2l}$
Harmonics	2	l		$f_2 = \frac{v}{l} = 2f_1$
	3	$\frac{2l}{3}$		$f_3 = 3f_1$

With an open end, repeat length is $4l$.

m	λ	Picture	f
1	$4l$		$f_1 = \frac{v}{4l}$
3	$\frac{4l}{3}$		$f_3 = 3f_1$
5			$f_5 = 5f_1$
⋮			