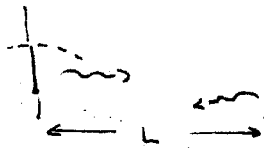
PHYS 195 WEEK 6 SOL'NS

(1.) (a) ECHO FROM DOOR



THE TIME FOR TRAVEL SHOULD BE

$t = \frac{2L}{v} \Rightarrow L = \frac{vt}{2} \simeq \frac{(343)(15)}{2}$

$\simeq 2.6$ km (!!) WAY BIG!

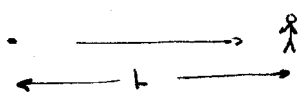
THIS IS FOR THE FIRST ECHO. SO THE LAST ECHO MUST BE THE nTH ($n \gg 1$).

(b) FOR n ~~REFLECTIONS~~ ECHOS $t = \frac{n2L}{v} \Rightarrow n = \frac{vt}{2L} = \frac{(343)(15)}{(2)(25.7\text{m})}$

$\cong 100$!

THE NUMBER OF REFLECTIONS IS ROUGHLY DOUBLE THIS. TO 2 SIG FIGS, 2.0×10^2.

(2.) EARTHQUAKE



FOR P WAVES $L = V_p t_p$ WHILE FOR S WAVES $L = V_s t_s$

$\Rightarrow \Delta t = t_s - t_p = \frac{L}{V_s} - \frac{L}{V_p} = L\,\frac{V_p - V_s}{V_p V_s}$ OR $\frac{\Delta t\, V_p V_s}{V_p - V_s} = L$

HENCE,

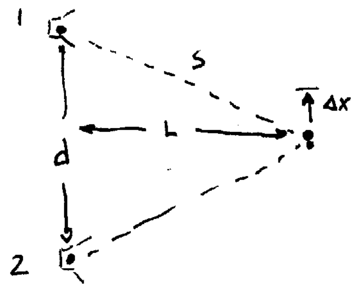
$$L = \frac{(3)(60)(8)(4.5)}{(8-4.5)}$$

$$\simeq 1851\text{ km} \simeq 1.8 \times 10^3\text{ km}$$

(3.) THE BEAT FREQUENCY IS $\Delta f = f_2 - f_1$ SO $f_2 = f_1 + \Delta f = 440 + 4 = 444$ Hz

SO THE PERIOD IS $\frac{1}{f} = 2.25 \times 10^{-3}$ s.

(4.) FOR SPEAKERS $d = 3.00\,m$ APART, EMITTING $f = 440\,Hz$ WE HAVE, AT $L = 3.20\,m$, AN INTENSITY MAXIMUM. SO



$$S = \sqrt{\left(\frac{d}{2}\right)^2 + L^2}$$

NOW WE SHIFT THE POSITION OF THE MIC BY Δx AND WE'RE LOOKING FOR AN INTENSITY MINIMA – A POINT OF DESTRUCTIVE INTERFERENCE. HENCE,

$$S_2 - S_1 = \frac{\lambda}{2} \qquad (1)$$

WITH $S_2 = \sqrt{\left(\frac{d}{2} + \Delta x\right)^2 + L^2}$ AND $S_1 = \sqrt{\left(\frac{d}{2} - \Delta x\right)^2 + L^2}$.

SQUARING EQU'N (1) GIVES

$$\left(\frac{d}{2} + \Delta x\right)^2 + L^2 + \left(\frac{d}{2} - \Delta x\right)^2 + L^2 - 2S_1S_2 = \frac{\lambda^2}{4}$$

OR

$$2 \cdot \frac{d^2}{4} + 2 \cdot \Delta x^2 + 2L^2 = \frac{\lambda^2}{4} + 2S_1S_2$$

$$\Rightarrow \left(L^2 + \Delta x^2 + \frac{d^2}{4} - \frac{\lambda^2}{8}\right) = S_1S_2$$

SQUARING AGAIN GIVES LOTS OF TERMS!

$$\cancel{L^4} + \cancel{2L^2\Delta x^2} + \cancel{\Delta x^4} + \cancel{2L^2\frac{d^2}{4}} + 2\frac{d^2}{4}\Delta x^2 + \cancel{\frac{d^4}{16}} + \frac{\lambda^4}{64} - \frac{2L^2\lambda^2}{8} - \frac{2\lambda^2}{8}\Delta x^2 - \frac{2\lambda^2}{8}\frac{d^2}{4}$$

$$= \cancel{\frac{d^4}{16}} + \cancel{\Delta x^4} - 2\frac{d^2}{4}\Delta x^2 + \cancel{L^4} + \cancel{2L^2\frac{d^2}{4}} + \cancel{2L^2\Delta x^2}$$

OR

$$\Delta x^2\left(d^2 - \frac{\lambda^2}{4}\right) = \lambda^2\left(\frac{L^2}{4} + \frac{d^2}{16} - \frac{\lambda^2}{64}\right)$$

$$\therefore \quad \Delta x^2 = \frac{\lambda^2\left(\frac{L^2}{4} + \frac{d^2}{16} - \frac{\lambda^2}{64}\right)}{d^2 - \frac{\lambda^2}{4}} = \frac{\lambda^2\left(L^2 + \frac{d^2}{4} - \frac{\lambda^2}{16}\right)}{4d^2 - \lambda^2}$$

WITH $\lambda = 343/440$ ~~I FIND~~ AND THE NUMBERS ABOVE

I FIND

$\Delta x = 0.46\text{m}$ PHEW!

(b.) WITH A π PHASE SHIFT THE INTENSITY MAX AND MIN WILL SHIFT. NOW THE MINIMUM IS AT THE CENTER ($\Delta x = 0$) WHILE THE MAX IS AT 0.46m.