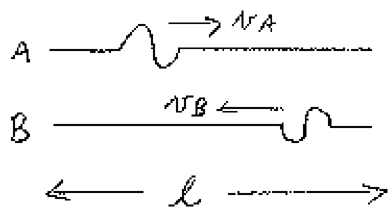
PROBLEM SET 8

CHAPTER 16 : 16, 40, 60, 78 [4 marks each]
CHAPTER 17 : 4

CHAPTER 16 #16



$\ell = 50.0$ m
$m/\ell = 0.020$ kg/m
$T_A = 6.00 \times 10^2$ N
$T_B = 3.00 \times 10^2$ N

$t = ?$

For wire A : $x_A = v_A t$ and $v_A = \sqrt{\dfrac{T_A}{m/\ell}}$

$$= \sqrt{\frac{T_A}{m/\ell}}\, t$$

For wire B : $x_B = v_B t = \sqrt{\dfrac{T_B}{m/\ell}}\, t$

The 2 pulses pass each other when $x_A + x_B = \ell$

$$\therefore \sqrt{\frac{T_A}{m/\ell}}\, t + \sqrt{\frac{T_B}{m/\ell}}\, t = \ell$$

$$t = \frac{\ell}{\sqrt{\frac{T_A}{m/\ell}} + \sqrt{\frac{T_B}{m/\ell}}} = \frac{\ell\sqrt{m/\ell}}{\sqrt{T_A} + \sqrt{T_B}}$$

$$= \frac{50\sqrt{0.02}}{(\sqrt{6} + \sqrt{3}) \times 10}$$

$$\boxed{t = 0.17 \text{ s}}$$

CHAPTER 16 # 40

$v_p = 8.0\ \text{km/s} = 8.0 \times 10^3\ \text{m/s}$

$v_s = 4.5\ \text{km/s} = 4.5 \times 10^3\ \text{m/s}$

$\Delta t = 78\ \text{s} \Rightarrow t_s = t_p + \Delta t$

$x = ?$

For P wave, $x = v_p t_p \Rightarrow t_p = \dfrac{x}{v_p}$

For S wave, $x = v_s t_s \Rightarrow t_s = \dfrac{x}{v_s}$

$$\therefore \frac{x}{v_s} = \frac{x}{v_p} + \Delta t$$

$$x v_p = x v_s + v_p v_s \Delta t$$

$$x = \frac{v_p v_s}{v_p - v_s} \Delta t$$

$$= \frac{8 \times 4.5 \times 10^6}{(8 - 4.5) \times 10^3} 78$$

$$x = 8.0 \times 10^5\ \text{m}$$

$$\boxed{x = 800\ \text{km}}$$

CHAPTER 16 #60

$\beta_{OUTSIDE} = \beta_{ROOM} + 44.0\,dB$

$I_{ROOM} = 1.20 \times 10^{-10}\ W/m^2$

$I_{OUTSIDE} = ?$

By definition $\beta = (10\,dB)\log\left(\frac{I}{I_0}\right)$

We could pick a reference intensity I_0 but this is not necessary

$$44.0\,dB = \beta_{OUTSIDE} - \beta_{ROOM}$$

$$= (10\,dB)\left[\log\left(\frac{I_{OUTSIDE}}{I_0}\right) - \log\left(\frac{I_{ROOM}}{I_0}\right)\right]$$

$$4.40\,dB = \log\left[\frac{I_{OUTSIDE}}{I_0}\ \frac{I_0}{I_{ROOM}}\right]$$

$$= \log\left[\frac{I_{OUTSIDE}}{I_{ROOM}}\right]$$

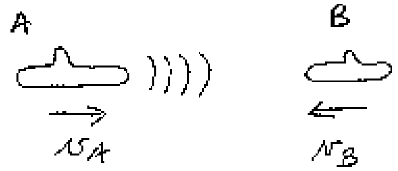
$$10^{4.40} = \frac{I_{OUTSIDE}}{I_{ROOM}}$$

$$I_{OUTSIDE} = 10^{4.4} \cdot I_{ROOM}$$

$$= 10^{4.4} \times 1.2 \times 10^{-10}$$

$$\boxed{I_{OUTSIDE} = 3.01 \times 10^{-6}\ W/m^2}$$

CHAPTER 16 # 78



$v_A = 12\,m/s$
$v_B = 8\,m/s$

$f_A = 1550\,Hz$
$v = 1522\,m/s$

(A) $f_B = ?$

Using the Doppler formula gives

$$f_B = f_A\left(\frac{1 + v_B/v}{1 - v_A/v}\right)$$

$$= 1550\left(\frac{1 + 8/1522}{1 - 12/1522}\right) = \underline{\underline{1570\,Hz}}$$

(B) $f_A' = ?$

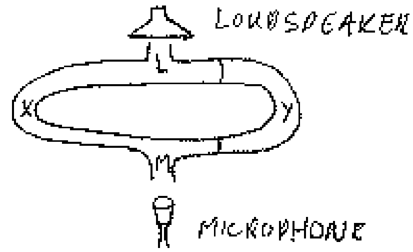
Using the Doppler formula a second time gives

$$f_A' = f_B\left(\frac{1 + v_A/v}{1 - v_B/v}\right) = f_A\left(\frac{1 + v_B/v}{1 - v_A/v}\right)\left(\frac{1 + v_A/v}{1 - v_B/v}\right)$$

$$= 1550\left(\frac{1 + 8/1522}{1 - 12/1522}\right)\left(\frac{1 + 12/1522}{1 - 8/1522}\right)$$

$$= \underline{\underline{1590\,Hz}}$$

CHAPTER 17 #4



$f = 12,000\,Hz$

$v = ?$

If the LYM section is pulled out by 0.020 m, the path-length of sound in this section increases by

$$2 \times 0.020\ m = 0.040\,m$$

Since this causes the sound to go from a minimum to a maximum

$$\frac{\lambda}{2} = 0.040\,m$$

Speed of sound $v = \lambda f$

$\therefore\ v = 2 \times 0.040 \times 12000$

$$\boxed{v = 960\ m/s}$$