PHYS 262 — **Homework 4 (Ch 17)** — Spring '03

1. (SB 1) d = distance between the lightning stroke and you

v_s = sound speed, t_s = time taken for the sound to reach you

c = light speed, t_ℓ = time taken for the light to reach you

$$d = v_s t_s = c t_\ell \Rightarrow t_\ell = \frac{v_s}{c} t_s$$

$$t_s - t_\ell = 16.2\,s \quad \text{(given)}$$

$$\therefore \quad t_s \left(1 - \frac{v_s}{c}\right) = 16.2\,s$$

Hence, $d = v_s t_s$

$$= \frac{v_s c}{c - v_s} (16.2\,s)$$

$$= 5.56\ km \ \#$$

<u>NOTE</u> $\because$ $c \gg v_s$, you will get the same answer (within the same accuracy, i.e. 3 sig. fig.) by:

$$d = v_s (16.2\,s)$$

2. (SB 6) Recall $v = f\lambda$,

smallest insect detected = wavelength of the chirp

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

$$= \frac{340\ ms^{-1}}{60.0\ kHz}$$

$$= 5.67 \times 10^{-3}\ m \ \# \ (\text{or } 5.67\ mm)$$

3. (SB 8) Using Eq. (17.4), $\Delta P_{max} = \rho v \omega S_{max}$ with

$$\Delta P_{max} = 4.00 \times 10^{-3}\ Pa$$
$$\rho = 1.20\ kgm^{-3}$$
$$v = 343\ ms^{-1}$$
$$\omega = 2\pi f = 2\pi(10.0\ kHz)$$

we get, $S_{max} = \dfrac{\Delta P_{max}}{\rho v \omega} = 1.55 \times 10^{-10}\ m \ \#$

4. (SB 9) $s(x,t) = (2.00\,\mu m) \cos[(15.7\,m^{-1})x - (858\,s^{-1})t]$

(a) amplitude, $A = 2.00\,\mu m$ #

wavelength, $\lambda = \dfrac{2\pi}{15.7\,m^{-1}} = 0.40\ m$ #

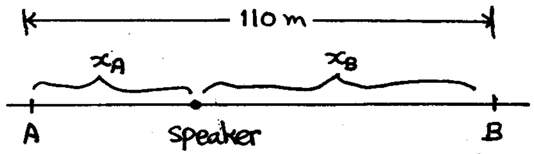
speed, $v = \dfrac{858\,s^{-1}}{15.7\,m^{-1}} = 54.6\ ms^{-1}$ #

(b) $s(x = 0.0500\,m,\ t = 3.00\,ms) = -0.433\,\mu m$ #

(remember to work in radian)

(c) max. speed $= (2.00\,\mu m)(858\,s^{-1}) = 1.72 \times 10^{-3}\ ms^{-1}$ #

5. (SB 24)



$\beta_A = 80.0\,\text{dB}$ $\qquad$ $\beta_B = 60.0\,\text{dB}$

Using Eq. (17.7), $\beta = 10 \log \frac{I}{I_0}$, we get

$$\beta_A - \beta_B = 10 \log \frac{I_A}{I_B}$$

Using Eq. (17.8), $I = \frac{P_{av}}{4\pi r^2}$

$$\beta_A - \beta_B = 10 \log \frac{x_B^2}{x_A^2} = 20 \log \frac{x_B}{x_A}$$

$\therefore \quad \log \frac{x_B}{x_A} = 1 \quad \Rightarrow \quad x_B = 10\,x_A$

Note that $x_A + x_B = 110\,\text{m}$

Hence, $\quad 11\,x_A = 110\,\text{m}$

$$\begin{cases} x_A = 10.0\,\text{m} \\ x_B = 100\,\text{m} \end{cases} \#$$

6. (SB 59) $I_0 = 1.00 \times 10^{-12}\,\text{Wm}^{-2}$

(a) threshold of pain, $I = 1.00\,\text{Wm}^{-2} = \frac{6.00\,\text{W}}{4\pi r^2}$

$$\Rightarrow r = 0.691\,\text{m} \#$$

(b) threshold of hearing, $I = 1.00 \times 10^{-12}\,\text{Wm}^{-2} = \frac{6.00\,\text{W}}{4\pi r^2}$

$$\Rightarrow r = 691\,\text{km} \#$$

7. (SB 34)

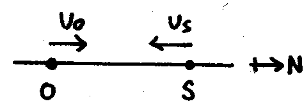
$$f' = \left(\frac{v \pm v_o}{v \mp v_s}\right) f$$

upper : toward
lower : away

$f = 2500\,\text{Hz}$
$v_o = 25.0\,\text{ms}^{-1}$
$v_s = 40.0\,\text{ms}^{-1}$
$v = 343\,\text{ms}^{-1}$

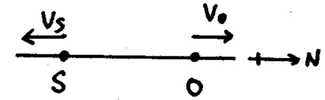
(a)

$$f' = \frac{v + v_o}{v - v_s} f = 3.04\,\text{kHz} \#$$



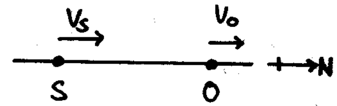
(b)

$$f' = \frac{v - v_o}{v + v_s} f = 2.08\,\text{kHz} \#$$



(c)

$$f' = \frac{v - v_o}{v - v_s} f = 2.62\,\text{kHz} \#$$



(d)

$$f' = \frac{v + v_o}{v + v_s} f = 2.40\,\text{kHz} \#$$