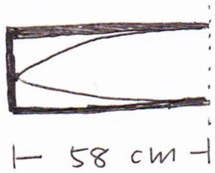
Ch 14 Assigned Questions

2014 Spring

PHYS 1Cb

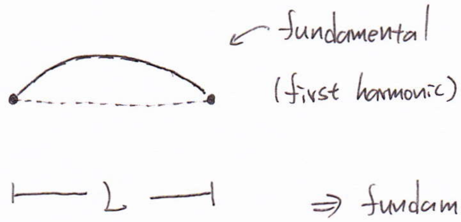
1. closed - open



$58\,cm = \frac{\lambda}{4} \Rightarrow \lambda = 232\,cm = 2.32\,m$

$\Rightarrow f = \frac{v}{\lambda} = \frac{343}{2.32} = 147.8\,Hz \approx 148\,Hz$ //

2.



$\frac{\lambda_{1st}}{2} = L \Rightarrow \lambda_{1st} = 2L$

$\Rightarrow$ fundamental frequency $f_{1st} = \frac{v}{\lambda_{1st}} = \frac{\sqrt{\frac{T}{\mu}}}{2L} = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$

(i) L is doubled : $\because f_{1st} \propto \frac{1}{L}$ $\therefore f_{1st}$ becomes $\frac{1}{2}$ (one-half as large) //

(ii) μ is doubled : $\because f_{1st} \propto \frac{1}{\sqrt{\mu}}$ $\therefore f_{1st}$ becomes $\frac{1}{\sqrt{2}}$ times as large //

(iii) T is doubled : $\because f_{1st} \propto \sqrt{T}$ $\therefore f_{1st}$ becomes $\sqrt{2}$ times as large //

3. wavelength of sound $\lambda = 0.8\,m$, original condition is that $|r_2 - r_1| = 0.8\,m$, but I don't know who is longer, r_1 or r_2 ...(?). Let's assume that $r_2 > r_1$ originally, $r_2 - r_1 = 0.8\,m$

(a) $r_2' = r_2 + 0.2 \Rightarrow r_2' - r_1 = r_2 + 0.2 - r_1 = 1\,m = \frac{5}{4}\lambda$ (b) $r_2'' = r_2 + 0.4 \Rightarrow r_2'' - r_1 = 1.2\,m = \frac{3}{2}\lambda$

(c) $r_2''' = r_2 + 0.6 \Rightarrow r_2''' - r_1 = 1.4\,m = \frac{7}{4}\lambda$ (d) $r_2'''' = r_2 + 0.8 \Rightarrow r_2'''' - r_1 = 1.6\,m = 2\lambda$

$\Rightarrow \phi_a = \frac{5}{4} \times 2\pi = \frac{5}{2}\pi$, $\phi_b = 3\pi$, $\phi_c = \frac{7}{2}\pi$, $\phi_d = 4\pi$ $\because$ Amplitude of resultant wave $= \left|2A\cos\left(\frac{\phi}{2}\right)\right|$

$\therefore$ (a) $\left|2A\cos\left(\frac{5}{4}\pi\right)\right| = \sqrt{2}A$, (b) $\left|2A\cos\left(\frac{3}{2}\pi\right)\right| = 0$ (destructive), (c) $\left|2A\cos\left(\frac{7}{4}\pi\right)\right| = \sqrt{2}A$

(d) $\left|2A\cos(2\pi)\right| = 2A$ (constructive) $\therefore$ (d) > (a) = (c) > (b)

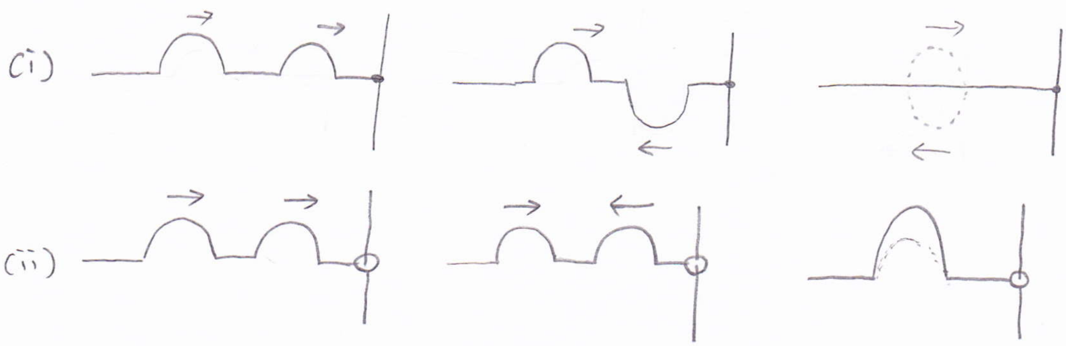
If $r_1 > r_2$ originally ($r_1 - r_2 = 0.8$), then (a) $r_1 - r_2' = 0.6\,m = \frac{3}{4}\lambda \rightarrow \phi_a = \frac{3}{2}\pi$

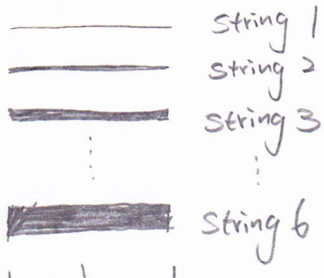
(b) $r_1 - r_2'' = 0.4\,m = \frac{1}{2}\lambda \rightarrow \phi_b = \pi$ (c) $r_1 - r_2''' = 0.2\,m = \frac{1}{4}\lambda \rightarrow \phi_c = \frac{\pi}{2}$

(d) $r_1 - r_2'''' = 0 \rightarrow \phi_d = 0$ Plugging into $\left|2A\cos\left(\frac{\phi}{2}\right)\right|$ we still obtain (d) > (a) = (c) > (b) //

4. (i) string is rigidly attached to the post ⇒ reflected pulses are inverted ∴ (e) 0

(ii) free end ⇒ reflected pulses are not inverted ⇒ ∴ (c) 0.2m



5. 

Ans. (b), (e)

(b) For all 6 strings, their fundamental wavelengths statisfy : $L = \frac{\lambda_{fundamental}}{2}$

⇒ $\lambda_{fundamental} = 2L$ have same value.

(d) speed of string wave depends on T and μ, thus they are different.

(a) fundamental frequency $= \frac{v_{on\ string}}{\lambda}$ ← different, ← same ∴ they are different.

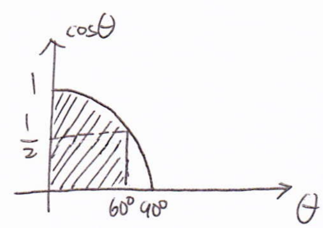
(c) fundamental wavelength of the sound $= \frac{v_{in\ air}}{f_{in\ air}}$ ← same, ← different ∴ they are different.

(e) the speed of the emitted sound is same for all 6 strings because the medium (the air) is same.

6. beat frequency $= f_b = |f_1 - f_2|$ ⇒ $|245 - f_2| = 5$ ∴ $f_2 = 240$ Hz or 250 Hz (e)

8. $y_1 = A\sin(kx - \omega t)$, $y_2 = A\sin(kx - \omega t + \phi)$: y_1 and y_2 have same amplitude (A), angular frequency (ω) and direction (→)

from textbook p.449, $y \equiv y_1 + y_2 = 2A\cos(\frac{\phi}{2})\sin(kx - \omega t + \frac{\phi}{2})$



∴ when $2A\cos(\frac{\phi}{2}) > A$ ⇒ $\cos(\frac{\phi}{2}) > \frac{1}{2}$ ⇒ $\frac{\phi}{2} < 60°$ ⇒ $\phi < 120°$ (d)

10. 4 beats per second ⇒ $f_b = 4Hz$ tuning fork (f_1) $|262 - f_2| = 4$ (string) ⇒ $f_2 = 266$ or 258 Hz

After taping the tines, it will lower the frequency of the tuning fork (f_1). Since lowing f_1 yields greater f_b, f_1 must be smaller than f_2 ⇒ ∴ $f_2 = 266$ Hz