Homework 11, Chapter 16

Homework-11 chapter16 [7, 8, 22, 26, 44, 58, 62, 95]
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classical Physics - 1 (210)
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Q7] down = $y = y_0 + v_0 t_{down} + \frac{1}{2} a t^2_{down} \rightarrow h = \frac{1}{2} g t^2_{down}$

up = $h = V_{snd}\, t_{up} \rightarrow t_{up} = \frac{h}{V_{snd}}$

$h = \frac{1}{2} g t^2_{down} = \frac{1}{2} g (T - t_{up})^2 = \frac{1}{2} g (T - \frac{h}{V_{snd}})^2 \rightarrow$

$h^2 - 2V_{snd}\left(\frac{V_{snd}}{g} + T\right)h + T^2 V^2_{snd} = 0$

$\therefore$ This is the quadratic equation of the height

$h^2 - 2(343\,m/s)\left(\frac{343\,m/s}{9.80\,m/s^2} + 3.0s\right)h + (3.0)^2(343\,m/s)^2$

$= 0 \rightarrow h^2 - (26068\,m)h + 1.0588 \times 10^6 m^2 = 0 \rightarrow$

$h = 26068\,m, 41\,m$

$\rightarrow$ The larger root is impossible since it takes more than 3.0 sec so $\boxed{h = 41\,m}$

Q8] $d = V_{air} t_{air} = V_{concrete}\, t_{concrete} = V_{concrete}(t_{air} - 0.75) \rightarrow t_{air} = \frac{V_{concrete}}{V_{concrete} - V_{air}}\ 0.75s$

$d = V_{air} t_{air} = V_{air}\left(\frac{V_{concrete}}{V_{concrete} - V_{air}}\ 0.75s\right)$

Speed of the sound would be 3000m/s

$$d = (343\,m/s)\left(\frac{3000\,m/s}{3000\,m/s - 343\,m/s}(0.75s)\right)$$

$$= \boxed{290m}$$

22] $62dB = 10\log(I_{signal}/I_{noise})_{tape} \rightarrow$

$(I_{signal}/I_{noise})_{tape} = 10^{6.2} = \boxed{1.6\times10^{6}}$

$98dB = 10\log(I_{signal}/I_{noise})_{tape} \rightarrow$

$(I_{signal}/I_{noise})_{tape} = 10^{9.8} = \boxed{6.3\times10^{9}}$

26] a] $\beta = 130dB = 10\log\frac{I_{2.8m}}{I_0} \rightarrow I_{2.8m}$

$= 10^{13} I_0 = 10^{13}(1.0\times10^{-12}\,W/m^2) = 10W/m^2$

$P = IA = 4\pi r^2 I = 4\pi(2.2m)^2(10W/m^2)$

$= \boxed{608W \approx 610W}$

b] $\beta = 85dB = 10\log\frac{I}{I_0} \rightarrow I = 10^{8.5} I_0 =$

$(1.0\times10^{-12}\,W/m^2) = 3.16\times10^{-4}\,W/m^2$

$$P = 4\pi r^2 I \rightarrow r = \sqrt{\frac{P}{4\pi I}} = \sqrt{\frac{608W}{4\pi(3.16\times10^{-4}\,W/m^2)}}$$

$\boxed{= 390m}$

44] a] difference between successive overtones for this pipe is 176 Hz. Difference between overtones for an open pipe & each overtone is an integer multiple of the fundamental.

Since 264 Hz is not multiple of 176 Hz so pipe cannot be open. So its a $\boxed{\text{closed}}$ pipe.

b] The successive overtones differ by twice the fundamental frequency. So 176 Hz must be twice so fundamental is $\boxed{88\text{ Hz}}$. Because 264 Hz is 3 times the fundamental, 440 Hz is 5 times the fundamental & 616 Hz is 7 times.

58] a] $S_2 - S_1 - \frac{1}{2}\lambda \rightarrow \sqrt{(\frac{1}{2}D+x)^2+l^2} - \sqrt{(\frac{1}{2}D+x)^2+l^2}$
$= \frac{1}{2}\lambda \rightarrow \sqrt{(\frac{1}{2}D+x)^2+l^2} - \sqrt{\frac{1}{2}D-x)^2+l^2} \rightarrow (\frac{1}{2}D+x)^2+l^2$
$= \frac{1}{4}\lambda^2 + 2(\frac{1}{2}\lambda)\sqrt{(\frac{1}{2}D-x)^2+l^2} + (\frac{1}{2}D-x^2)+l^2 \rightarrow$
$2Dx - \frac{1}{4}\lambda^2 = \lambda\sqrt{(\frac{1}{2}D-x)^2+l^2} \rightarrow 4D^2x^2 - 2(2Dx)\frac{1}{4}\lambda^2 +$
$\frac{1}{16}\lambda^4 = \lambda^2[(\frac{1}{2}D-x)^2+l^2] \rightarrow x = \lambda\sqrt{\frac{(\frac{1}{4}D^2+l^2-\frac{1}{16}\lambda^2)}{(4D^2-\lambda^2)}}$

$D = 3.00\text{m}$, $l = 3.20\text{m}$, $\lambda = v/f = (343\text{m/s})/(494\text{Hz})$
$= 0.694\text{m}$

$$x = (0.694\text{m})\sqrt{\frac{\frac{1}{4}(3.00\text{m})^2 + (3.20\text{m})^2 - \frac{1}{16}(0.694\text{m})^2}{4(3.00\text{m})^2 - (0.694\text{m})^2}}$$

$= \boxed{0.411\text{m}}$

b] The maxima & minima will be interchanged
maxima are 0.411 m to the left or right of the midpoint and minimum is at the midpoint

62] The bat (the source) is stationary

$$f'_{object} = f_{bat}\left(1 - \frac{v_{object}}{v_{snd}}\right)$$

$$f''_{bat} = \frac{f'_{object}}{\left(1 + \frac{v_{object}}{v_{snd}}\right)} = f_{bat}\left(\frac{1 - \frac{v_{obj}}{v_{snd}}}{1 + \frac{v_{obj}}{v_{snd}}}\right)$$

$$= f_{bat}\frac{(v_{snd} - v_{object})}{(v_{snd} + v_{object})}$$

$$= (5.00 \times 10^4 Hz)\frac{343 m/s - 30.0 m/s}{343 m/s + 30.0 m/s}$$

$$= \boxed{4.20 \times 10^4 Hz}$$

95] $$f'_{approach} = f \Big/ \left(1 - \frac{v_{train}}{v_{snd}}\right)$$

$$f'_{recede} = f \Big/ \left(1 + \frac{v_{train}}{v_{snd}}\right)$$

$$f'_{approach}\left(1 - \frac{v_{train}}{v_{snd}}\right) = f'_{recede}\left(1 + \frac{v_{train}}{v_{snd}}\right) \rightarrow$$

$$v_{train} = v_{snd}\frac{(f'_{approach} - f'_{recede})}{(f'_{approach} + f'_{recede})}$$

$$= (343 m/s)\left(\frac{552 Hz - 486 Hz}{552 Hz + 486 Hz}\right)$$

$$= \boxed{22 m/s}$$