chapter 9

Q2

$l = 0.5 m$

$T = 270 N$

$f_0 = 150 Hz$

$$f_n = n \frac{c}{2l}$$

$$c = v = \sqrt{\frac{T}{\mu}}$$

$$f_0 = \frac{1}{2L} \sqrt{\frac{T}{\mu}}$$ ← mass per unit Length

$$150 = \frac{1}{2 * 0.5} * \sqrt{\frac{270}{\mu}}$$

$$\boxed{\mu = 0.012 \ kg/m}$$

b) $T = ??$ if $f = 440\,Hz$

$\mu = 0.012\ kg/m$

$$f_0 = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

$$440 = \frac{1}{2(2.5)}\sqrt{\frac{T}{0.12}}$$

$$\boxed{T = 2323.2N}$$

Q3

air $Z_{air} = 413$

Liquid Z

$\rho = 950 kg.m^{-3}$

$C = 750 m.s^{-1}$

a) the proportion of wave is reflected from the boundry

$Z_{lig} = \rho_{Liquid} * V_{Liquid}$

$= 950 * 750$

$= 712.5 \ kg.\frac{m^2}{s}$

$R = \frac{Z_{liq} - Z_{air}}{Z_{Liq} + Z_{air}}$

$= 0.998$

b) $T = 1 - R$

$= 1 - 0.998 = 0.0016$

Q4

$P = 1\ kpa$

$Z_{air} = 413$

(a) intensity of the sound?

$$I = \frac{P^2}{Z} = \frac{(1 \times 10^3)^2}{413}$$

$$= 2421.3\ \frac{W}{m^2}$$

(b) I in dB

$$dB = 10 \log\left(\frac{I}{I_0}\right)$$

$$= 10 \log\left(\frac{2421.3}{10^{-12}}\right)$$

$$\boxed{I = 153.84\ dB}$$

Q5
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whisper at 30 dB
loud shout at 110 dB
$A_{ear\ canal} = 1.54 \times 10^{-4} m^2$
$Z_{air} = 413$

(a) the opening of ear canal
$\beta = 30 dB$

$$\frac{30}{10} = \frac{10}{10} \log\left(\frac{I}{I_0}\right)$$

$$\log\left(\frac{I}{I_0}\right) = 3$$

$$\frac{I}{I_0} = 10^3$$

$$\boxed{\therefore I = 10^3 I_0}$$ $I_0 = 10^{-12}$

$$I = 10^3 \times 10^{-12} = 10^{-9} \frac{W}{m^2}$$

the power:

$$P_w = I \times A$$

$$= 10^{-9} \times 1.54 \times 10^{-4}$$

$$\boxed{P_w = 1.54 \times 10^{-13} \text{ watts}}$$

b shout $d\beta = 110 dB$

in the same steps of a

$$I = 10^{-1} \frac{W}{m^2}$$

$$P_L = I \times A$$

$$= 10^{-1} \times 1.54 \times 10^{-4}$$

$$= 1.54 \times 10^{-5} \text{ watts}$$

$$\boxed{10^{8} P_L = P_W}$$

Q6

$C_{air} = 343\, m/s$ $\quad f = 392\, Hz$

propagating velocity $v = 500\, m/s$
(bass)

obo ⟶ pipe "open at one end"

bass ⟶ string fixed at both end.

- what are the lengths of the bass string and the obo cavity in "fundamental mode"

$$f_n = n \frac{C}{4L_1} \quad \text{for obo}$$

$$f = \frac{C}{4L} \Rightarrow L = \frac{v_1}{4f}$$

$$= \frac{343}{4 \times 392}$$

for double bass

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$$f = \frac{nV}{2L}$$

$$f_0 = \frac{V}{2L}$$

$$L = \frac{V}{2f} = \frac{500}{2 * 392}$$

$$= 0.6378 \text{ m}$$

Q9.7

$f_{source} = 300\ Hz$

$V_D = 100\ km/h \approx 27.8\ m/s$

$C_{air} = 343\ m/s$

a) what is the freq you hear before you pass them

Stationary source

$$f' = \frac{C \pm V_D}{C \pm \cancel{V_{source}} \to 0} f$$

$$f' = \frac{C \pm V_D}{C} f$$

approaching (+) observer

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$$f' = \frac{c + V_D}{c} f$$

$$= 300\left(\frac{343 + 27.8}{343}\right)$$

$$= \frac{300(370.8)}{343}$$

$$\boxed{f' = 324\ Hz}$$

(b) The observe retreating

$$f' = f\ \frac{c - V_D}{c}$$

$$= 300\left(\frac{343 - 27.8}{343}\right)$$

$$\boxed{f' = 278\ Hz}$$