B1) 8) No net Force applied. $\Rightarrow \vec{F}_{net} = 0$.

$$\vec{F}_{net} = m\vec{a}$$

$$0 = m\vec{a} \Rightarrow m\vec{a} = 0$$

$$m\vec{v} = 0$$

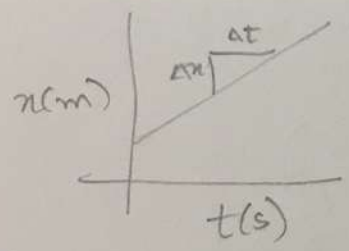
$$m\frac{dv}{dt} = 0$$

m cannot be zero so $\frac{dv}{dt} = 0$

$$\frac{dv}{dt} \cdot dt = 0 \cdot dt$$

$$\int dv = \int 0 \cdot dt \Rightarrow \boxed{v = \text{Constant}}$$

OBJECT is travelling at a constant velocity



When object is moving with constant velocity, it does not change direction nor speed.

17) Difference Power & Energy.

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

Energy = K.E., P.E.

Work = energy transfered

Energy = ~~Prop~~ Quantitative property of the object

Exercise: 12) P.E. of:

a) $m = 3\,Kg$, $h = 2\,m$

$$P.E. = \frac{1}{2} mgh \quad (J)$$

$$= \frac{1}{2}(3\,Kg)(2\,m)$$

$$= 3\,J$$

b) $K = 10^3\,N/m$. $x = 10\,cm = 10 \times 10^{-2}\,m$.

$$P.E = \frac{1}{2} K x^2$$

$$= \frac{1}{2}(10^3\,N/m) \times (10 \times 10^{-2}\,m)^2$$

$$= (10^3\,N/m) \times 100 \times 10^{-4}\,m^2 \times \frac{1}{2}$$

$$= (10^3 \times 10^2 \times 10^{-4})\,(N.m) \times \frac{1}{2}$$

$$= 10^{5-4}\,J \times \frac{1}{2}$$

$$= 10\,J \times \frac{1}{2} = 5\,J$$

c). $V = 1000\,cm^3$, $P_o = 10^5\,N/m^2$ (Atm. Pressure).

$P = 10^4\,N/m^2$

$$P.E. = \frac{1}{2} \frac{V}{P_o} P^2.$$

$$= \frac{1}{2} \frac{(10^{-3}\,m^3)}{10^5\,N/m^2} \times (10^4\,N/m^2)^2.$$

$$= \frac{1}{2} \frac{10^{-3}\,m^3}{10^5\,N/m^2} \times 10^8\,N^2/m^4$$

$$= \frac{1}{2}\,J$$

$$= 0.5\,J$$

$$\frac{V_{\ell_{10mm}}}{V_{\ell_{5mm}}} = \frac{(5mm)^2}{(10mm)^2}$$

$$= \frac{(5\times10^{-3}m)^2}{(10\times10^{-3}m)^2}$$

$$= \frac{5\times10^{-3}\times5\times10^{-3}m^2}{10\times10^{-3}\times10\times10^{-3}m^2}$$

$$\boxed{\frac{V_{\ell=10mm}}{V_{\ell=5mm}} = \frac{1}{4}}$$

6) $V_{air} = 331.3\ m/s \quad (T=0^\circ)$

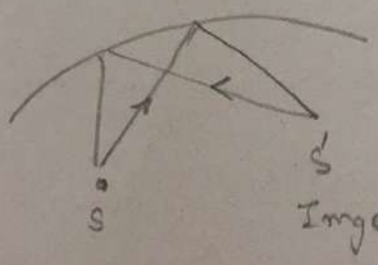
$V_{air} = 343\ m/s \quad (T=20^\circ C)$

$V_{steel} = 5100\ m/s.$

$V_{water} = 1,410\ m/s$

7) Chapter 23 Sec. 23.1, 23.2

Image sources.



Imge source

⇒ Each image source itself acts as a source & produces a wavefront.

4) Refraction (Pg 53)

Another Reason – Masking (Human Auditory System)

Ex) 4) a) 15 inches = 0.381 m = λ_1

b) 3 inches = 0.0762 m = λ_2

$$v = f \cdot \lambda$$

a) $f_a = \frac{v}{\lambda_1} = \frac{343 \text{ m/s}}{0.381 \text{ m}} = 900 \text{ Hz}$

b) $f_b = \frac{v}{\lambda_2} = \frac{343 \text{ m/s}}{0.0762 \text{ m/s}} = 4501 \text{ Hz}$

Ex 6) $50 \text{ Hz} \longleftrightarrow 15{,}000 \text{ Hz}$

$\lambda_1 = \frac{v}{50 \text{ Hz}}$, $\lambda_2 = \frac{v}{15{,}000 \text{ Hz}}$

$\lambda_1 = 6.86 \text{ m}$

$\lambda_2 = 0.022 \text{ m}$

$\lambda_2 = 2.2 \text{ cm}$

Range: $2.2 \text{ cm} \longleftrightarrow 6.86 \text{ m}$

Ex 9) Time difference between Thunderclap & Lightening = $t = 3 \text{ s}$.

Distance = ? , v = speed of sound.

Distance = $v \times t$

= $(343 \text{ m/s}) \times (3 \text{ s})$

= 1029 m (Around 1 Km)

$$f = \frac{7}{2\pi} \times \frac{1}{\sqrt{10}}$$

$$f \approx 0.35 \text{ Hz}$$

Ex 2) Write units (Use a graph paper).

Ex 4) $$f = \frac{v}{2\pi}\sqrt{\frac{a}{Vl}}$$

$v = 343 \text{ m/s}$ at $T = 20^\circ C$

$a = 0.02 \text{ m}^2$

$V = 0.5 \text{ m}^3$

$l = 0.05 \text{ m}$.

$$f = \frac{343 \text{ m/s}}{2\pi}\sqrt{\frac{0.02 \text{ m}^2}{(0.5 \text{ m}^3)(0.05 \text{ m})}}$$

$$f = 48.8 \text{ Hz}$$

B3) $$v = \sqrt{\frac{E}{\rho}}$$

$$v_{l=10mm} = \sqrt{\frac{E}{\pi\left(\frac{10mm}{4}\right)^2 \times l}} = A$$

$$v_{l=5mm} = \sqrt{\frac{E}{\pi\left(\frac{5mm}{4}\right)^2 \times l}} = B$$

$$\frac{v_{l=10mm}}{v_{l=5mm}} = \frac{A}{B}$$

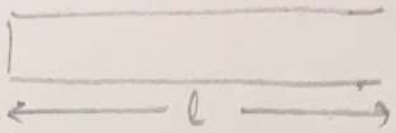
$$\rho = m/V.$$

$$\rho = \frac{m}{\pi r^2 \times l}$$

$$\rho = \frac{m}{\pi\left(\frac{d}{2}\right)^2 \times l}$$

$$\rho = \frac{m}{\frac{\pi d^2}{4} \times l}.$$

B4) c)



$f_0 = 200\ Hz$ (Fundamental)

$f_1 = \frac{v}{4l}$

→ $f_3 = 3f_1 = 3(200) = 600\ Hz$
(Third Harmonic)

→ $f_5 = 5f_1 = 5(200) = 1000\ Hz$
(Fifth Harmonic)

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8) $f \propto \sqrt{a}$ a = Area.
(For Helmholtz resonator

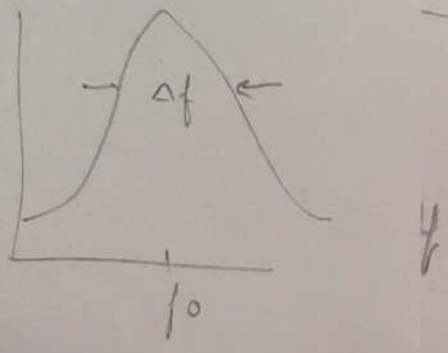
Ex 1) $f_0 = 440\ Hz$
$Q = 30$

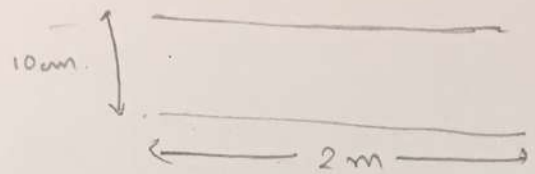
To Find: Linewidth = Δf

$Q = \frac{f_0}{\Delta f}$

$30 = \frac{440\ Hz}{\Delta f}$

$\Delta f = \frac{440\ Hz}{30} = 14.6\ Hz$





$l = 2\,m$ (Length)

$d = 10 \times 10^{-2}\,m$ (Diameter).

a) Without end correction:

$$f_1 = \frac{v}{2l}$$

$$= \frac{343\,m/s}{2 \times 2\,m}$$

$$f_1 = 85.8\,Hz$$

b) With end correction:

$$L = l + 2(0.61\,r)$$

$$L = 2m + 2(0.61 \times 5 \times 10^{-2}\,m)$$

$$L = 2m + 2(3.05 \times 10^{-2})$$

$$L = 2.061\,m$$

$$f_1' = \frac{v}{2L}$$

$$= \frac{343\,m/s}{2.061\,m}$$

$$f_1' = 166.4\,Hz$$