For A.C circuit with resistance only:

① $$\boxed{P_{avg} = \frac{e_0 I_0}{2} = \frac{e_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}} = e_{rms} I_{rms}}$$

$\cos\phi = 1$ $\phi = 0° \rightarrow$ same phase.

② $$\boxed{P_{avg} = I_{rms}^2 R = \frac{e_{rms}^2}{R}}$$

- EMF induced in a straight conductor in rotational motion about its end in a plane $\perp^{rd}$ to the $\vec{B}$.

① $e = Bf\pi l^2$

② $e = \frac{1}{2} B\omega l^2$

③ $e = BlI\sin\theta$

Frequency of D.C source is ZERO.

Moving coil galvanometer

$\tau_{applied} = \tau_{restoring}$ after twist ϕ

$NIBA\sin\theta = c\phi$

$I = \frac{c\phi}{NBA\sin\theta}$

$I \propto \frac{\phi}{\sin\theta}$

" To remove $\sin\theta$, we use Radial field"

$$\boxed{I = \frac{c\phi}{NBA}}$$

→ Current sensitivity

$$\boxed{\frac{\phi}{I} = \frac{NBA}{c}}$$

→ Voltage sensitivity

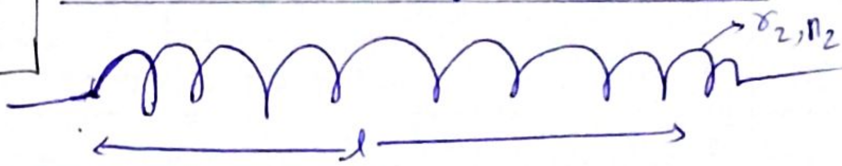
$$\boxed{\frac{V}{I} = \frac{NBA}{cR}}$$

Self inductance of a solenoid

$$\boxed{L = \mu_0 n^2 A l = \frac{\mu_0 N^2 A}{l}}$$

→ The core of any transformer is laminated so as to reduce the energy loss due to eddy currents.

Mutual inductance of a solenoid



$$\boxed{M = \mu_0 n_1 n_2 \pi r_2^2 l}$$

$$\boxed{M = \frac{\mu_0 N_1 N_2 A}{l}}$$

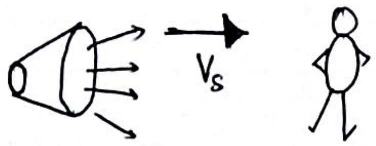
Doppler effect :

SDON → Source Denominator & ~~object~~ observer Numerator

$$n_a = \left(\frac{V \pm V_o}{V \mp V_s}\right) n$$

n_a = Apparent freq.
n = Actual freq
V = speed of sound
V_o = Velocity of observer
V_s = Velocity of source.

① O @ Rest ($V_o = 0$)



$$n_a = \left(\frac{V}{V - V_s}\right) n$$

$n_a > n$

② O @ Rest ($V_o = 0$)

$$n_a = \left(\frac{V}{V + V_s}\right) n$$

$n_a < n$

③ S @ REST ($V_s = 0$)

$$n_a = \left(\frac{V + V_o}{V}\right) n$$

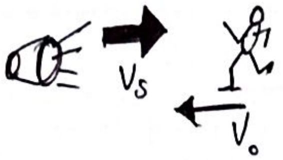
$n_a > n$

④ S @ REST ($V_s = 0$)

$$n_a = \left(\frac{V - V_o}{V}\right) n$$

$n_a < n$

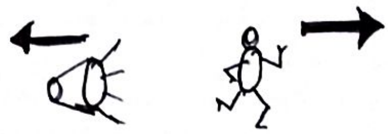
⑤ Both O & S ARE Moving TOWARS



$$n_a = \left(\frac{V + V_o}{V - V_s}\right) n$$

$n_a > n$

⑥ Both O & S ARE MOVING AWAY



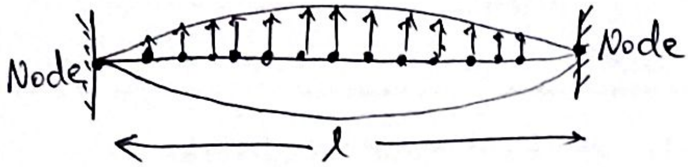
$$n_a = \left(\frac{V - V_o}{V + V_s}\right) n$$

$n_a < n$

Unison :- If two frequencies are equal, then the vibrating bodies are said to be in unison.

Standing waves on a string fixed at Both ends

① ~~At~~ Fundamental Mode / tone

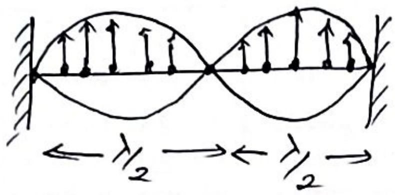


$$n = \frac{1}{\lambda}\sqrt{\frac{T}{\mu}} \qquad \because v = \sqrt{\frac{T}{\mu}}$$

$$\boxed{n_1 = \frac{1}{2l}\sqrt{\frac{T}{\mu}}}$$

② First overtone / second haromic freq.

$$\boxed{n_2 = 2n_1}$$



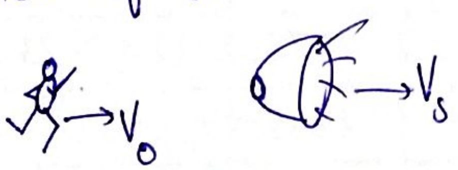
③ Second overtone / 3rd haromic freq.

$$\boxed{n_3 = 3n_1}$$

$$\boxed{(n-1)^{th} \text{ overtone} = n^{th} \text{ haromic}}$$

In short : $\boxed{n_n = n\,n_1}$

⑧ when both source & observer are moving in same direction & source is a head of observer



$$\boxed{n_a = n\left(\frac{V + V_o}{V + V_s}\right)}$$

⑨ when both source & observer are moving in same direction & observer is ahead of source

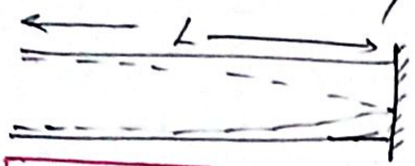
$$\boxed{n_a = n\left(\frac{V - V_o}{V - V_s}\right)}$$

Closed

Organ Pipe

(I) Closed organ Pipe

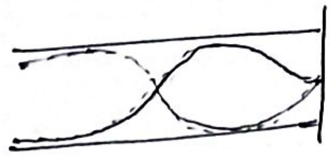
i) I^{st} harmonic / Fundamental tone



$$\boxed{n_1 = \frac{V}{4L}}$$

V = speed of air

ii) 3^{rd} harmonic / first overtone



$$\boxed{n_3 = 3n_1} = \frac{3V}{4L}$$

iii) Second overtone – 5^{th} harmonic

$$\boxed{n_5 = 5n_1 = \frac{5V}{4L}}$$

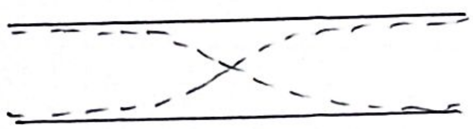
Note: ① In closed organ pipe Even harmonic are ABsent.

② $\boxed{n^{th} \text{ overtone} = (2n+1)^{th} \text{ Harmonic}}$

③ $\boxed{n_{(2n+1)} = (2n+1)\, n_1}$

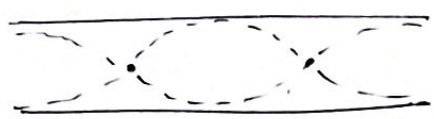
(II) OPEN organ PIPE:

i) I^{st} harmonic – fundamental tone



$$\boxed{n_1 = \frac{V}{2L}}$$

ii) 2^{nd} harmonic – first overtone.



$$\boxed{n_2 = 2n_1} = 2\frac{V}{2L}$$

iii) 3^{rd} harmonic – 2^{nd} overtone.

Note: ① All harmonic are Present

② n^{th} overtone $= (n+1)^{th}$ harmonic

③ $n_{(n+1)} = (n+1)\, n_1$

If a open pipe is half submerged in water, it will become a closed organ pipe of length which is half that of the open pipe.

Its fundamental frequency will become

$$n' = \frac{V}{4\left(\frac{L}{2}\right)} = \frac{V}{2L} = n_1 \qquad \boxed{\therefore n' = n_1}$$

i.e equal to that of open pipe ie frequency remains unchanged

---

(6) Resonance tube: $\quad V = 2n(l_2 - l_1)$

1) Velocity, $\boxed{V = 4n(l + 0.3d)}$

2) End Correction, $\boxed{e = \frac{l_2 - 3l_1}{2}}$

l_1 = length of air column for first resonance

l_2 = length of air column for second resonance.

Note: A set of 25 tuning forks is arranged in order of decreasing frequencies. Each fork, produces 3 beats with succeeding one.

$n_1 = N \quad n_2 = N-3 \quad n_3 = N-3\times2 \quad n_4 = N-3\times3 \quad \ldots \quad n_{15} = N-3\times14 \quad n_{25} = N-3\times24$

Velocity of wave: $\boxed{V = n\lambda = \frac{\lambda}{T} = \frac{\omega}{K}}$

If N toning forks are arranged in order of decreasing frequencies and any two successive forks produce X beats/sec, then frequency of last fork = frequency of first fork − (N − 1)X

$$\boxed{n_{last} = n_{first} - (N-1)X}$$

Laws of a vibrating string:

$$\boxed{n = \frac{1}{2l}\sqrt{\frac{T}{m}}}$$

$\mu/m \rightarrow$ mass per unit length

$\left(n \propto \frac{\sqrt{T}}{r L}\right)$ ...if density is same.

Conditions for Beat formation

① Two waves ⇒ slightly different freq.

② " ⇒ Amplitude equal or nearly eq.

③ " ⇒ Simultaneoulsy arrive at a point in medium

④ " ⇒ travel in same direction with same speed

#Note: ① $n_2 = 2n_1$

it means n_2 is octave higher than n_1 OR

n_1 is an octave lower than n_2

② $n_2 = 2^3 n_1$ it means n_2 is 3-octave higher than n_1

or n_1 is 3-octave lower than n_2

- Equation of simple harmonic progressive wave

$$\boxed{y = A\sin(\omega t - kx)} \qquad k = \frac{2\pi}{\lambda}, \quad \omega = 2\pi n$$

- Path difference :

$$\boxed{\Delta\phi = k\Delta x = \frac{2\pi\,\Delta x}{\lambda}}$$

$$\sqrt{X} \approx \frac{X+Y}{2\sqrt{Y}}$$

~~Y = Nearst no. have~~ root

$$\sqrt{23} = \frac{23+25}{2\sqrt{25}} = 4.8$$

Tuning fork:

$$\boxed{n_{Last} = n_{first} + (N-1)X}$$

$N \rightarrow$ No. of tuning fork

$X \rightarrow$ Beat frequency.

If N tuning forks are so arranged, that every fork gives X beats per second with the next then the frequency of last fork will be

in Increasing freq.