LAKSHYA

MHTCET 2025

Physics

Lecture - 03

Superposition of Waves

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Topics *to be covered*

1. Vibration Of Air Column Closed At One End ✓
2. Vibration Of Air Column Open At Both Ends ✓
3. Vibration Produced In A String ✓
4. Harmonics And Overtones ✓

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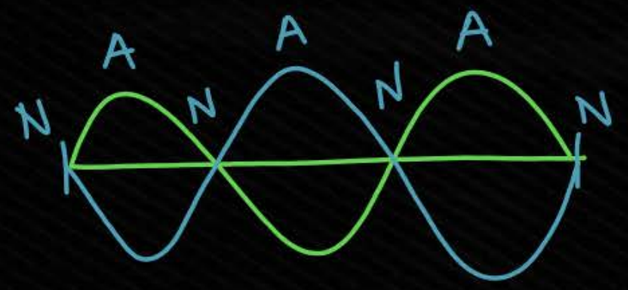
Revision :

1) Stationary Waves.



N - A = $\lambda/4$

N - N = $\lambda/2$

A - A = $\lambda/2$

Antinode = $0, \frac{\lambda}{2}, \lambda, \ldots$

Node = $\lambda/4, \frac{3\lambda}{4}, \frac{5\lambda}{4} \ldots$

Vibrations of air column in a pipe closed at one end

Here $L = (l + e)$ — length of air column.

l - length of pipe

e - end correction.

$$V = n\lambda$$

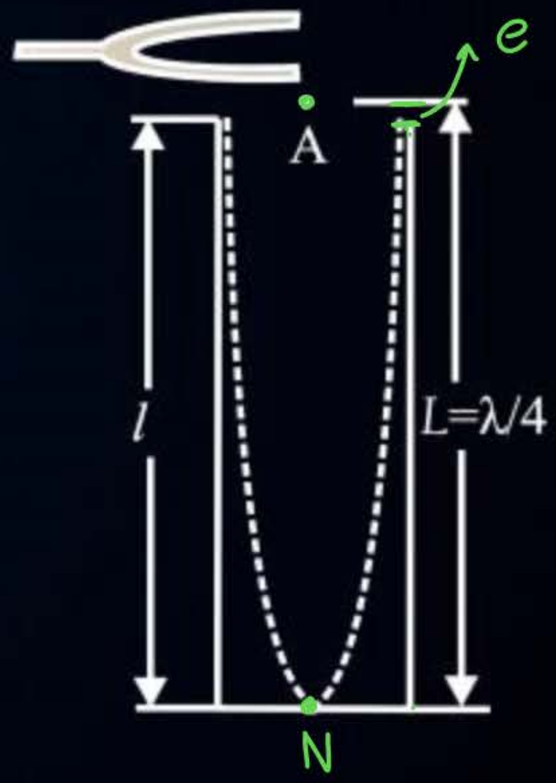
here $L = \lambda/4$

$\therefore \lambda = 4L$

$\therefore V = n.4L$

$$n = \frac{V}{4L}$$

$$n = \frac{V}{4(l+e)}$$



$$\eta = \frac{v}{4L} = \frac{v}{4(l+e)}$$

This simplest mode

& frequency is c/a

fundamental frequency :

Here, $L = l + e$

$$L = \frac{3\lambda_1}{4}$$

$$\lambda_1 = \frac{4L}{3}$$

$$v = n\lambda$$

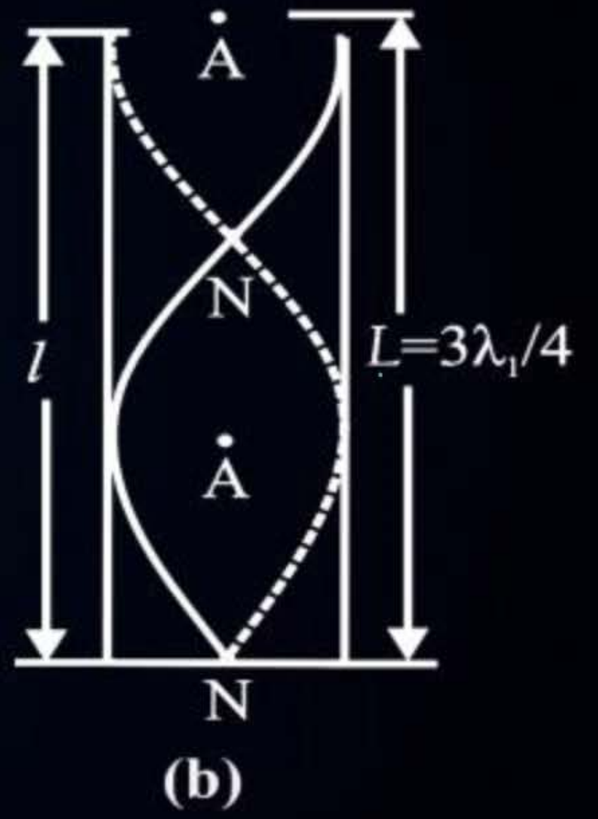
$$n_1 = \frac{v}{\lambda_1}$$

$$n_1 = \frac{v}{4L/3}$$

$$\boxed{n_1 = \frac{3v}{4L}}$$

$$n_1 = 3 \times \frac{v}{4L}$$

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



(b)

Here $L = l + e$

$$l = \frac{5\lambda_2}{4}$$

$$\lambda_2 = \frac{4L}{5}$$

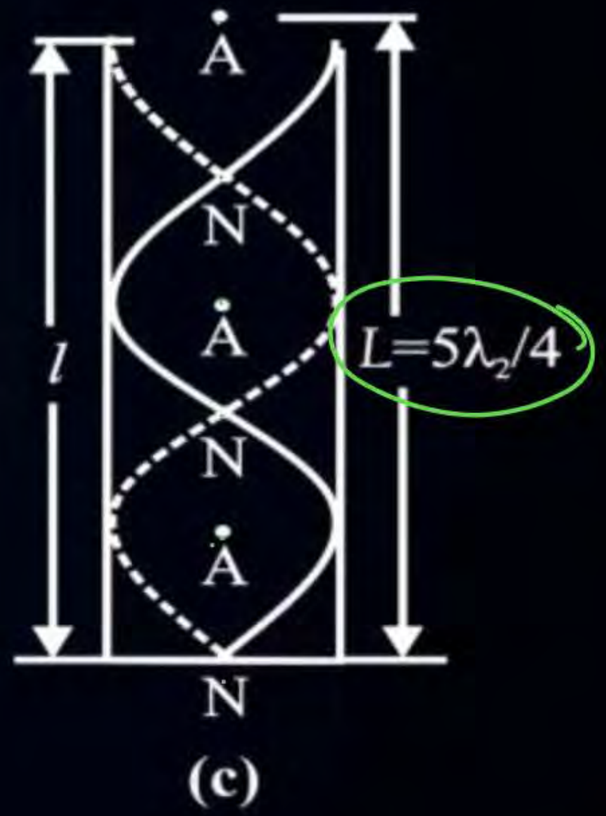
$$v = n\lambda$$

$$n_2 = \frac{v}{\lambda_2}$$

$$\therefore n_2 = \frac{v}{4L/5}$$

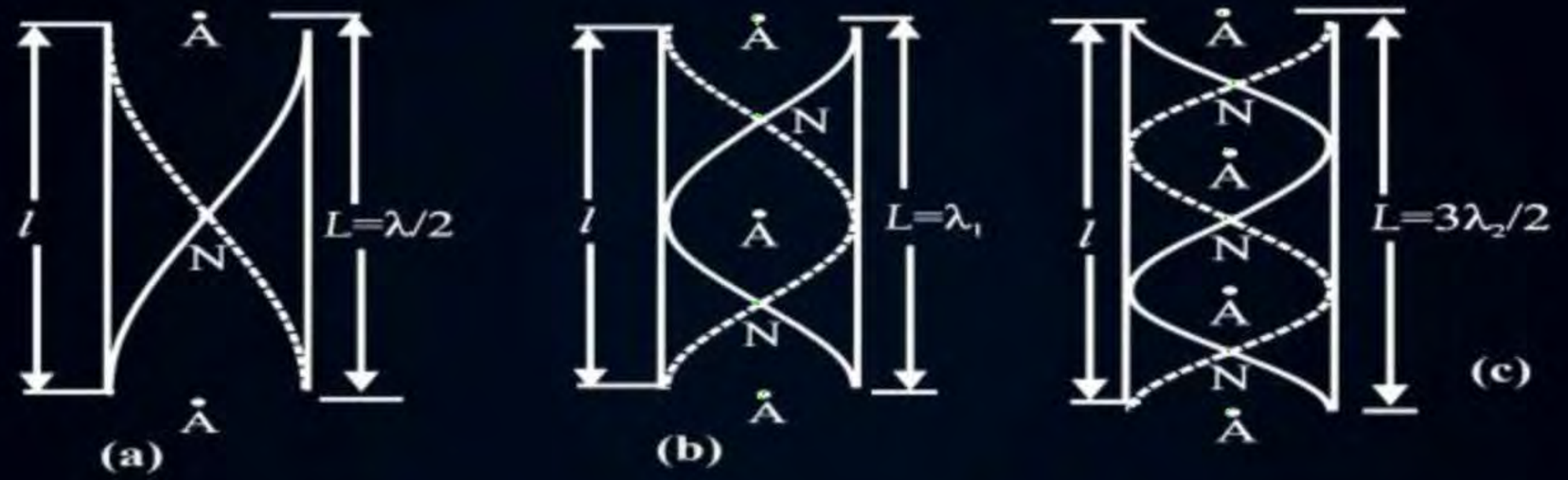
$$\boxed{n_2 = \frac{5v}{4L}}$$

$$\boxed{n_2 = 5n}$$



(c)

Vibrations of air column in a pipe open at both ends



$n = V/\lambda$

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

$n_1 = \frac{V}{\lambda_1}$

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

$n_2 = V/\lambda_2$

$n_2 = \frac{3V}{2L} = 3n$

Vibrations Produced in a String

$V = \sqrt{\frac{T}{m}}$.

(I)

$l = \lambda/2$

$\lambda = 2l$

$V = \sqrt{T/m}$

$n = V/\lambda$

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

(II)

$l = \lambda_1$

$n_1 = V/\lambda_1$

$$n_1 = \frac{1}{l}\sqrt{\frac{T}{m}}$$

$$n_1 = 2n$$

(III)

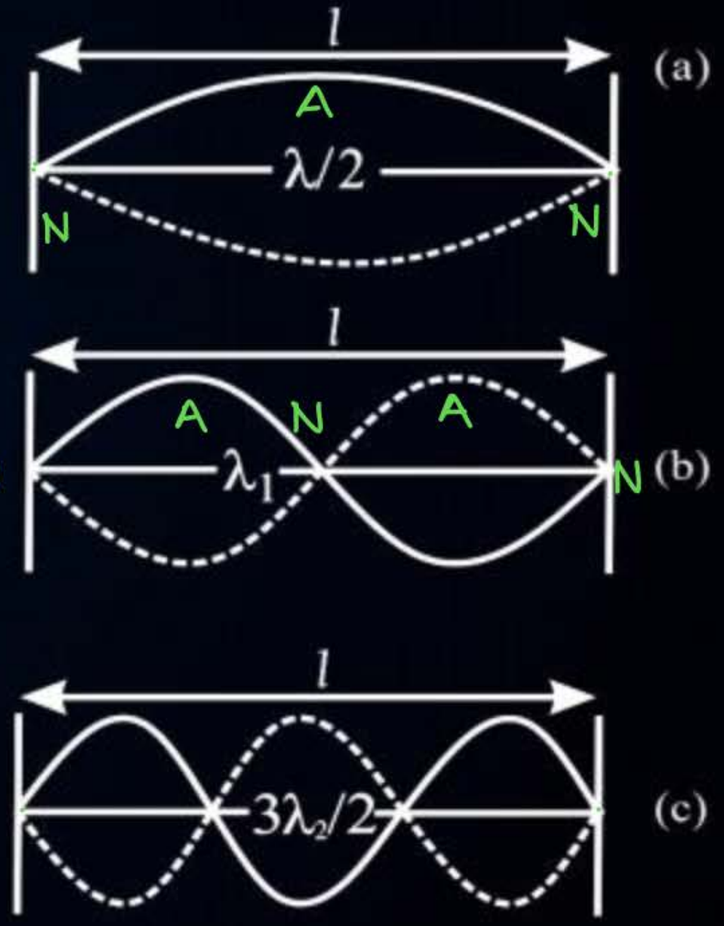
$l = \frac{3\lambda_2}{2}$

$\lambda_2 = \frac{2l}{3}$

$n_2 = V/\lambda_2$

$$n_2 = \frac{3}{2l}\sqrt{\frac{T}{m}}$$

$$n_2 = 3n$$



Closed Pipe

n, $3n$, $5n$, $7n$ $\quad$ $2n, 4n, 6n$ missing

Open Pipe

n, $2n$, $3n$, $4n$ ...

String

n, $2n$, $3n$, $4n$ ...

Harmonics and Overtones

- The first frequency of vibration and all its integral multiple.
- It may or may not present in vibration.

- The frequency higher than fundamental frequency is c/a overtone
- It always present in vibration.


धन्यवाद