LAKSHYA

MHTCET 2025

Physics | Lecture-07

Superposition of Waves

By - Sushant Sir

Topics *to be covered*

1. Numerical Questions

QUESTION

If we want to increase the frequency of transverse oscillations of a stretched string by 40%, the tension must be increased by [2020]

A. 140%

B. 96%

C. 40%

D. 100%

$n_1 = n$

$n_2 = \frac{140}{100} n$

$n_2 = \frac{7}{5} n$

$T_1 = T$

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

$\frac{n_1}{n_2} = \sqrt{\frac{T_1}{T_2}}$

$\frac{n}{7/5 n} = \sqrt{\frac{T}{T_2}}$

$\frac{5}{7} = \sqrt{\frac{T}{T_2}}$

$\frac{25}{49} = \frac{T}{T_2}$

$T_2 = \frac{49}{25} T$

$T_2 = \frac{49 \times 4}{100} T$

$T_2 = \frac{196}{100} T$

T must increase by 96%

QUESTION

A sonometer wire of length l_1, is in resonance with a frequency 250 Hz. If the length of wire is increased to l_2, then 2 beats s^{-1} are heard. The ratio of lengths l_1/l_2 of wire will be [2020]

A 1:250

B 1:2

C 2:1

D 124: 125

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

$n \propto \frac{1}{l}$

Hence if length increases then frequency decreases.

$N = n_1 - n_2$

$2 = 250 - n_2$

$n_2 = 248$

$n_1 l_1 = n_2 l_2$

$\frac{l_1}{l_2} = \frac{n_2}{n_1} = \frac{248}{250} = \frac{124}{125}$

QUESTION

A tuning fork of frequency 340 Hz is held vibrating at the open end of an empty measuring cylinder of length 100 cm. Water is then, poured in it slowly. What is the minimum height of water in cylinder, for which resonance will be obtained? (Velocity of sound in air = 340 m/s, neglect end correction). [2020]

A 25 cm

B 75 cm

C 80 cm

D 50 cm

$n = 340$ Hz.

$v = 340$ m/s

$n = \frac{v}{4L_1}$

$L_1 = \frac{v}{4n}$

$L_1 = \frac{340}{4 \times 340}$

$= \frac{1}{4} = 0.25$ m

$L_1 = 25$ cm.

$\lambda/4 = 25$ cm

for next mode

$$l_2 = \frac{3\lambda}{4}$$

$$= 3 \times 25$$

$$l_2 = 75\ cm$$

$\therefore$ minimum level of water

is $100 - 75 = 25\ cm$.

QUESTION

If the ratio of amplitudes of two sound waves is 4: 3, then the ratio of maximum and minimum intensities is: [2021]

A 7:1

B 49:1

C 1:49

D 1:7

$\frac{A_1}{A_2} = \frac{4}{3}$

Intensity $\propto A^2$

$I_{max} \propto A_{max}^2$

$\therefore I_{max} \propto (A_1 + A_2)^2$

$I_{min} \propto A_{min}$

$I_{min} \propto (A_1 - A_2)^2$

$\frac{I_{max}}{I_{min}} = \frac{(4+3)^2}{(4-3)^2}$

$= \frac{49}{1}$

$I_1 \propto A_1$

$I_2 \propto A_2$

$A_{max} = A_1 + A_2$

$A_{min} = A_1 - A_2$

QUESTION

The length and diameter of a metal wire used in sonometer is doubled. The fundamental frequency will change from n to [2021]

A $n/8$

B $n/2$

C $n/4$

D $n/16$

$l_1 = l$

$l_2 = 2l$

$r_1 = r$

$r_2 = 2r$

$n_1 = n$

$n_2 = ?$

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

$n = \frac{1}{2l}\sqrt{\frac{T}{\pi \rho r^2}}$

$n = \frac{1}{2lr}\sqrt{\frac{T}{\pi \rho}}$

$n \propto \frac{1}{lr}$

$\frac{n_2}{n_1} = \frac{l_1 r_1}{l_2 r_2}$

$n_2 = \frac{lr}{2l \cdot 2r} \cdot n$

$\boxed{n_2 = \frac{n}{4}}$

$m = \frac{M}{L}$

$= \frac{V\rho}{L}$

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

$= \pi r^2 \rho$

QUESTION

A pipe closed at one end has length 1 m and at its open end, 0.25 m long uniform string is vibrating in its third harmonic and resonates with fundamental frequency of pipe. If the tension in the string is m 100 N and speed of sound is 340 m/s then mass of the string is nearly [2021]

(A) 125 g

(B) 150 g

(C) 200 g

(D) 175 g

$L_p = 1\,m$

$L_s = 0.25\,m$

$T = 100\,N$

$V = 340\,m/s$

$M = ?$

According to condn

$3n_s = n_p$

$$3 \times \frac{1}{2L_s}\sqrt{\frac{T}{m}} = \frac{V}{4L_p}$$

$$\frac{3}{2\times 0.25}\sqrt{\frac{100}{m}} = \frac{\overset{8}{\cancel{340}}}{\cancel{4}\times 1}$$

$$6\sqrt{\frac{100}{m}} = 85$$

$$\frac{60}{\sqrt{m}} = 85$$

$$\sqrt{m} = \frac{\overset{12}{\cancel{60}}}{\cancel{85}_{17}}$$

$$\sqrt{m} = \frac{12}{17}$$

$$M_s = m \times l_s$$

$$= \left(\frac{12}{17}\right)^2 \times \frac{1}{4}.$$

$$= \frac{12 \times 12^3}{17 \times 17 \times \cancel{4}}$$

$$M. = \frac{36}{289.} = 0.12\ kg.$$

$$M = 125\ gm$$

$$290\overline{)360}\ (0.12$$

$$290$$

$$700$$

QUESTION

A transverse wave of ampliltude 0.05 m and frequency 250 Hz is travelling along a stretched string with a speed of 100 m/s. What would be the displacement of a particle at a distance 1.1 m origin after 0.02s?

$\left[\sin\frac{\pi}{2}=1;\cos\frac{\pi}{2}=0\right]$

[2022]

A. 0.1 m

B. 0.15 m

C. 0.05 m

D. 0.02 m

$A = 0.05\ m$

$n = 250\ Hz$

$v = 100\ m/s$

$x = 1.1\ m$

$t = 0.02\ s$

$y = A\sin(\omega t - kx)$

$= A\sin\left(2\pi nt - \frac{2\pi}{\lambda}x\right)$

$= A\sin 2\pi\left(nt - \frac{xn}{v}\right)$

$= A\sin 2\pi n\left(t - \frac{x}{v}\right)$

$v = n\lambda$

$\lambda = \frac{v}{n}$

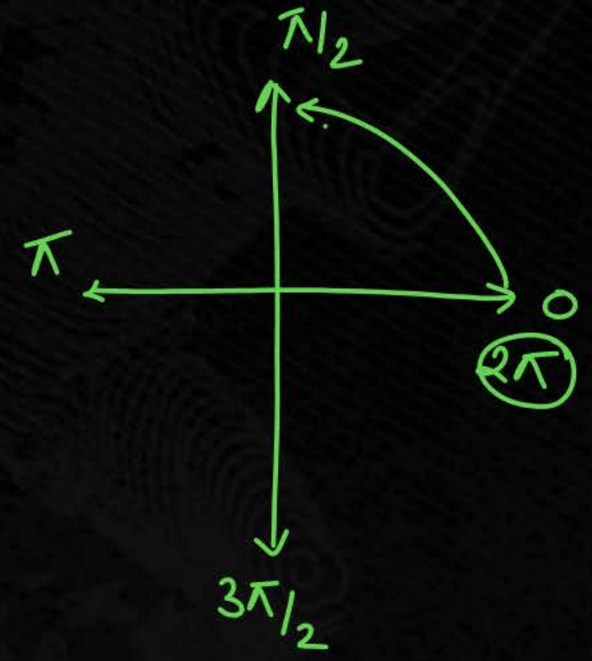
$$y = 0.05 \sin 2\pi 250\left[0.02 - \frac{1.1}{100}\right]$$

$$= 0.05 \sin 500\pi\left[\frac{2 - 1.1}{100}\right]$$

$$= 0.05 \sin 5\pi [0.9]$$

$$= 0.05 \sin 4.5\pi$$

$$y = 0.05 \text{ m}$$



QUESTION

A body sends waves 100 mm long through medium P and 0.25 m long in medium Q. If the velocity of wave in medium P is 80 cm s^{-1}. The velocity of wave in medium) is [2022]

A $1\ ms^{-1}$

B $2\ ms^{-1}$

C $5\ ms^{-1}$

D $7\ ms^{-1}$

Home work.

Homework

1) Revise all lectures

2) Revise all DPP's & Numericals.


धन्यवाद