STATIONARY WAVES (Waves and Vibration)

e-content for B.Sc Physics (Honours) B.Sc Part-I Paper-I

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STATIONARY WAVES

| 1. | A so stret fund 100 F mate | nome ched amen Iz. De rial o | eter wire by a we tal freque etermine t f wire. | of ler eight o ency o he line | ngth 0.5 m is of 5 kg. The f vibration is ear density of | For Sol | mula : n ution : | = | $\frac{1}{2l}\sqrt{\frac{T}{m}}$ | |
|-----------|---|--|--|--|--|----------------|---|---|--|---|
| Giv | ren : l T | = = = | 0.5 m Mg = 100 Hz | 5 × 9. | 8 N | | n | = | $\frac{1}{2l}\sqrt{\frac{\mathrm{T}}{\mathrm{m}}}$ | 1 |
| To | Find : | = | ? | | | | Since, n | ₁ ∝ | $\frac{1}{l_1}$ and $n_2 \propto$ | $\frac{1}{l_2}$ |
| For | mula : | | • | | | | n1 | | la | |
| | n | = | $\frac{1}{2l}\sqrt{\frac{T}{m}}$ | | | | $\frac{n_1}{n_2}$ $n_1 l_1$ 100 p | = | $\frac{l_2}{l_1}$ $n_2 l_2$ | |
| Sol | ution : | | | | | ••• | 100 111 | | 90 II ₂ | |
| | n | = | $\frac{1}{2l}\sqrt{\frac{\mathrm{T}}{\mathrm{m}}}$ | | | | n ₂ | = | $\frac{100}{90}$ n ₁ | |
| ÷ | 100 | = | $\frac{1}{2 \times 0.5}$ | $\frac{5 \times 9.8}{m}$ | $=\sqrt{\frac{49}{m}}$ | ÷ | $l_1 > l_2$ the | = hen | $\frac{10}{9}n_1$ $n_2 > n_1$ | |
| | Squaring both sides, we get | | | | $n_{2}^{1} - n_{1}^{2}$ | = | 8 | | | |
| | (100)² | = | <u>49</u> m | | | .÷. | $\frac{10}{9}n_1 - n_1$ | = | 8 | |
| | m | = | $\frac{49}{(100)^2}$ | = | 0.0049 kg/m | n ₁ | $\left(\frac{10}{9}-1\right)$ | = | 8 | |
| | m | = | 0.0049 k | g/m | | | n ₁ n | = | 9 x 8 = n = | 72 Hz 72 Hz |
| 2. Giv | A son a res its le per s of tu ren : l_1 l_2 N Find : n_1 | nome onanc ngth econd ning = = = = | ter wire 10 ce with a is decreas are heard fork. 100 cm 100 - 10 $n_1 \sim n_2$? | 00 cm 1 tuning ed by 3 I. Find = = = | ong produces g fork. When 10 cm, 8 beats the frequency 90 cm 8s ⁻¹ | 3. Giv | Two with having fundam 1 : 2, a compared of the second se | ires the nent nd e rat = | of the same e same rad: al frequence tension in io of their lo $\frac{1}{2}$ $\frac{1}{8}$ | e material and ius have thei ies in the ratio the ratio 1 : 8 engths. |

To Find : 4. A wire, 1 m long and weighing 2 g, will be in resonance with a frequency of 300 $\frac{l_1}{l_2}$ Hz. Find tension on stretching the wire. ? Given : Formula : 1 1 m = Μ 2 gm $= 2 \times 10^{-3} \text{ kg}$ = $= \frac{1}{2l}\sqrt{\frac{T}{m}}$ 300 Hz n n = To Find : Solution : Т ? Formula : $= \frac{1}{2l}\sqrt{\frac{T}{m}}$ n $= \frac{1}{2l}\sqrt{\frac{T}{m}}$ n $n_1 = \frac{1}{2l_1}\sqrt{\frac{T_1}{m}}$ Solution : ... $= \frac{2 \times 10^{-3}}{1}$ = 2 × 10⁻³ kg/m $\frac{M}{l}$ $\frac{1}{2n_1}\sqrt{\frac{T_1}{m}}$ *l*₁ = ... (i) *:*.. For second case, $= \frac{1}{2l}\sqrt{\frac{T}{m}}$ Now, n $n_2 = \frac{1}{2l_2} \sqrt{\frac{T_2}{m}}$ $300 = \frac{1}{2 \times l} \sqrt{\frac{T}{2 \times 10^{-3}}}$... $l_2 = \frac{1}{2n_2}\sqrt{\frac{T_2}{m}}$... (ii) :. $\sqrt{\frac{T}{2 \times 10^{-3}}}$ 600 [m is constant because both wires are made of same material] Divide (i) by (ii) $\frac{T}{2 \times 10^{-3}}$ $(600)^2 =$ *.*.. $\frac{l_1}{l_2} = \frac{2n_2}{2n_1} \sqrt{\frac{T_1}{m} \times \frac{m}{T_2}}$ Т $36 \times 10^4 \times 2 \times 10^{-3}$... Т ... = 720 N $= \frac{n_2}{n_1} \sqrt{\frac{T_1}{T_2}}$ 5. A stretched sonometer wire is in unison with a tuning fork, when the length is increased by 4 %, the number of beats $\left(\frac{2}{1}\right)\sqrt{\frac{1}{8}}$ heard per second is 6. find the frequency of the fork. Given : $\frac{l_1}{l_2}$ 0.707:1 l, $1.04 l_1$ = *:*. $\frac{l_2}{l_1}$:. 1.04, Ν 6s⁻¹ = To Find : ? n,

| Form | ula : | | | 5 | Solu | tion : | mae | s of the wire |
|---------------|---------------------|-------------------|----------------------------------|-------------------------|--------------|-------------|------------------|---|
| | n | _ | $1 \overline{T}$ | | | M | - mas | $V_{0} = \Lambda_{0}^{1}$ |
| | 11 | _ | 2 <i>l</i> V m | | | Also | _ | $\mathbf{v}\mathbf{p}$ – $At\mathbf{p}$ |
| Solu | tion : | | | | | 1 1100 | , | M Alo |
| | | | $1 \overline{T}$ | | | m | = | $\frac{1}{1} = \frac{1}{1}$ |
| | n | = | $\overline{2l}\sqrt{\mathrm{m}}$ | | . . | m | = | Αρ |
| Since | l, | > | l, | | | | | · T |
| then | n, | > | n, | I | Now | , V | = | $\sqrt{\frac{1}{m}}$ |
| : п | $n_1 - n_2$ | = | 6 Hz | | | | | |
| <i>:</i> . | n ₂ | = | n ₁ – 6 | | | v | = | $\sqrt{\frac{1}{1}}$ |
| | For t | wo w | ires of same mater | ial | | | | γΑρ |
| | $n_1 l_1$ | = | $n_2 l_2$ | | | 2 | _ | T |
| But, | n ₂ | = | n ₁ – 6 | • | •• | V- | = | Αρ |
| and | l_2 | = | $1.04 l_1$ | | | | | Т |
| ·• | $n_1 l_1$ | = | $(n_1 - 6) (1.04 l_1)$ | | ·• | А | = | $\overline{v^2 \rho}$ |
| | n ₁ | = | $(n_1 - 6) (1.04)$ | | | | | Г 0.0 |
| : 1 | l.04 n ₁ | - n ₁ | = 6.24 | | | А | = | $\frac{9.8}{()^2}$ |
| ·• | 0. | 04 n ₁ | = 6.24 | | | | | (68) ×7900 |
| | | n | = <u>6.24</u> | | . . . | А | = | $2.683 \times 10^{-7} \text{ m}^2$ |
| •• | | 11 | 0.04 | , | 7 | A tr | ansve | erse wave is produced |
| | | n | = 156 Hz | | | strec | hed s | string 0.7 m long and fix |
| 6 | The | an a a d | of a transmore and | | | its er | nds. F | ind speed of transverse v |
| 0. | unif | orm n | etal wire, when it | is under a | | when | n it v tone c | of frequency 300 Hz |
| | tensi | ion of | 1000 g wt. is 68 | m/s. If the | Give | n : | ione e | or frequency 500 fiz. |
| | dens | ity of | metal is 7900 kg/m | ³ . Find the | | 1 | = | 0.7 m |
| Civo | area | of cro | ss section of the w | ire. | | n | = | 300 Hz |
| Give | т | = | 1000 g wt. | - - | To Fi | ind : | | |
| | | = | 1000 × 10 ⁻³ kg wt | | | v | = | ? |
| | | = | $1 \times 9.8 \text{ N} = 9.8$ | 3 N | Form | ula: | = | n) |
| | v | = | 68 m/s | | Solu | v tion · | _ | 1170 |
| | ρ | = | 7900 kg/m³ | | 501u | v v | = | n λ |
| | ind • | | _ | | | In 2r | nd ove | ertone, 3 loops are forme |
| To Fi | ina . | = | ? | | | 1 | | 3 |
| To Fi | A | | | | | l | = | $\frac{1}{2}\lambda$ |
| To Fi Form | A ula: | | | | | | | <u> </u> |
| To Fi Form | A ula: | _ | $\sqrt{\frac{T}{T}}$ | | | _ | | 21 |
| To Fi | A aula : v | = | $\sqrt{\frac{T}{m}}$ | | ÷ | λ | = | $\frac{2l}{3}$ |

Now, v =

$$v = n\left(\frac{2l}{3}\right)$$
$$v = 300\left(\frac{2}{3}\times0.7\right)$$
$$v = 140 \text{ m/s}$$

nλ

8. A uniform wire under tension, is fixed at its ends. If the ratio of tension in the wire to the square of its length is 360 dyne/cm² and fundamental frequency of vibration of wire is 300 Hz. Find its linear density.

Given :

:..

| $\frac{\mathrm{T}}{l^2}$ | = | 360 dyne/cm ² |
|--------------------------|---|--------------------------|
| n | = | 300 Hz |
| To Find : | | |
| m | = | ? |
| Formula : | | |

Fo

| | | 1 T |
|---|---|-------------------------|
| n | = | $\overline{2l}\sqrt{m}$ |

Solution :

m

m

m

m

...

=

=

=

| n | = | $\frac{1}{2l}\sqrt{\frac{\mathrm{T}}{\mathrm{m}}}$ |
|-------|---|--|
| n² | = | $\frac{1}{4l^2} \cdot \frac{T}{m}$ |
| m | = | $\frac{1}{4n^2} \cdot \left(\frac{T}{l^2}\right)$ |

m =
$$\frac{1}{4 \times (300)^2} \times \frac{360}{1}$$

90

90000 10^{-3}

10⁻³ g/cm 10⁻⁴ kg/m

9. A wire is in unison with a fork of frequency 250 Hz, when streched by a weight hanging vertically. On immersing the weight in water, the wire produces ten beats per second with the same fork. Calculate density of material of weight, Given :

When wire is stretched by a weight hanging vertically, $n_1 = 250$ Hz,

Frequency of wire when the weight is immersed in water producing 10 beats per second = n_2

$$n_2 = n_1 - 10 = 250 - 10 = 240 \text{ Hz}$$

 $\mathbf{\rho}_w = 1 \text{ g/cc}$

To Find :

...

$$\frac{n_1}{n_2} = \sqrt{\frac{\rho}{\rho - 1}}$$

Solution :

:.

...

$$\frac{\mathbf{n_1}}{\mathbf{n_2}} = \sqrt{\frac{\mathbf{p}}{\mathbf{p}-1}}$$
$$\frac{250}{240} = \sqrt{\frac{\mathbf{p}}{\mathbf{p}-1}}$$

$$\frac{25}{24} = \sqrt{\frac{\rho}{\rho - 1}}$$

Squaring both sides,

$$\frac{625}{576} = \frac{\rho}{\rho - 1}$$

$$\therefore \quad 625 \ (\rho - 1) = \quad 576 \ \rho$$

$$\therefore \quad 625 \ \rho - 576 \ \rho = \quad 625$$

$$\therefore \quad 49 \ \rho = \quad 625$$

$$\therefore \quad \rho = \quad \frac{625}{49}$$

$$\therefore \quad \rho = \quad 12.76 \ \text{g/cm}^3$$

ρ

=

| 10. | Two are re | simple harmonic progressive waves presented by | | у | = | $4\cos\left(\frac{2\pi x}{60}\right)\sin 2\pi (100 t)$ | | |
|------|--------------------|--|------|---------------------|----------------------------------|--|--|--|
| | y ₁ = 2 | $2 \sin 2\pi \left(100t - \frac{x}{60} \right) $ cm and | | Com y We o | paring = vet | (i) g above equation with, R sin (2 π t) | | |
| | $y_2 = 2$ | $2\sin 2\pi \left(100t + \frac{x}{60}\right) cm.$ | | VIC 8 | (2πv |) | | |
| | The wave | vaves combine to from a stationary | | 4 cos | $\left(\frac{2\pi x}{60}\right)$ | $\int = R$ | | |
| | i) | amplitude at antinode | But, | R | = | $2\pi \cos\left(\frac{2\pi R}{\lambda}\right)$ | | |
| | ii) | distance between adjacent node | | λ | = | 60 cm | | |
| | iii) iv) | loop length wave velocity | | Amp of R. | litude | at antinode is maximum value | | |
| Give | n : | - (v) | i.e, | R is r | naxim | um when $\cos\left(\frac{2\pi x}{\lambda}\right) = 1$ | | |
| | У ₁ | $= 2\sin 2\pi \left(100t - \frac{x}{60}\right) cm$ | | R | = | $4 \times 1 = 4 \text{ cm}$ | | |
| | У ₂ | = $2\sin 2\pi \left(100t + \frac{x}{60}\right)$ cm | ii) | λ | = | 60 cm | | |
| To F | ind : | | | $\frac{\lambda}{4}$ | = | $\frac{60}{4} = 15 \mathrm{cm}$ | | |
| | i) ii) | R = ? $\frac{\lambda}{2} = 2$ | .:. | Dista antir | ance b 10de = | etween successive node and 15 cm | | |
| | iii) | $\begin{array}{c} 4 \\ 1 \\ \end{array} = \begin{array}{c} ? \end{array}$ | iii) | 1 | = | length of loop | | |
| Form | iv) | v = ? | | | = | $\frac{\lambda}{2} = \frac{60}{2}$ | | |
| | y | = $R \sin 2\pi nt$ | | 1 | = | 30 cm | | |
| wher | re, R | $= 2A\cos\left(\frac{2\pi x}{\lambda}\right)$ | iv) | v | = | wave velocity = $n\lambda$ | | |
| Solu | tion : | | ·. | V | = | n λ | | |
| i) | Resu | ltantant equation of wave is given | | From | n equa | tion (i), we get, | | |
| | by | | | n | = | 100 Hz | | |
| | у | $=$ $y_1 + y_2$ | | λ | = | 60 cm | | |
| | | $-2 \sin 2\pi \left(100t \times 1\right)$ | | v | = | n λ | | |
| | | $-2\sin 2\pi \left(100t-\frac{1}{60}\right)$ | | v | = | 100 × 60 | | |
| | | | | v | = | 6000 cm/s | | |
| | | $+2\sin 2\pi\left(100t+\frac{x}{60}\right)$ | ·· | V | = | 60 m/s | | |
| ÷ | у | $= 2 \times 2 \sin 2\pi (100 \text{ t}) \cos 2\pi \left(\frac{x}{60}\right)$ | | | | | | |

| 11. | The o given Find interf frequ interf | equat by y = the a fering tency fering | ion of a standing wave is = 0.02 cos (π x) sin (100 π t) m. Implitude of either wave , wavelength, time period, and wave velocity of waves. | 12. Giver | In Melde's experiment, find weight added in the pan when number of loops on the string changes from 4 to 2. If initial tension on the string is 1960 dyne and mass of the pan in one gram. | | | | |
|------------|---|---|---|--------------|--|--------------------|--------------------------|---------------------|----------------------|
| Give | 1 : | | | 0110 | n | = | 4 | | |
| 01101 | v | = | $0.02 \cos{(\pi x)} \sin{(100 \pi t)}$ | | P ₁ | _ | - n | | |
| To Fi | nd : | | | | P_2 | - | 2 | | |
| | Α | = | ? | | M_0 | = | 1 g | | |
| | λ | = | ? | | T ₁ | = | (M ₀ + | · M ₁)g | |
| | Т | = | ? | | | = | 1960 | dyne | |
| | n | = | ? | | Τ. | = | (M. + | · M_)g | |
| | v | = | ? | To Fi | nd · | | × 0 | 2/0 | |
| Form | ula : | | | 1011 | м | _ | 2 | | |
| | у | = | $R \sin 2\pi nt$ | T | 1v1 ₂ | - | ÷ | | |
| wher | e, | | | Form | ula : | | | | |
| | D | | $2\pi x$ | | $T_{1}p_{1}^{2}$ | = | $T_{2}p_{2}^{2}$ | | |
| | R | = | $2 \operatorname{A} \cos \frac{\lambda}{\lambda}$ | Solut | ion : | | | | |
| Calcu | lation | ı: | | | $T_{1}p_{1}^{2}$ | = | T,p ² | | |
| | y | = | $0.02 \cos{(\pi x)} \sin{(100 \pi t)}$ | | | | | | |
| . . | y | = | $0.02\cos\left(\frac{2\pi x}{2}\right)\sin[2\pi (50)t]$ | | T ₂ | = | $\frac{T_1p_1^2}{p_2^2}$ | - | |
| | C | | | | | | , | , | · . ? |
| | Comp | baring | R sin 2=nt | | | _ | (M ₀ | $+M_{1})$ | $\underline{g(4)^2}$ |
| whor | у | - | K SIII 2 n III | | | - | | $(2)^{2}$ | |
| where | ς, | | | | | | | () | |
| | R | = | $2 \operatorname{A} \cos \frac{2\pi x}{\lambda}$ | ·· | T ₂ | = | 16(N | $\frac{A_0 + M}{4}$ | (1)g |
| We g | et, | | | | | | 1060 | v 16 | |
| А | = | ampli | tudeof interfering waves | | | = | 1900 | X 10 | |
| | = | 0.01 n | n | | T | | 4 | | |
| λ | = | Wave | length of interfering waves | | 1 ₂ | = | 4 X I | 1960 | _ |
| | = | 2m | 0 | | But (I | M ₀ + N | Л <u>2</u>)g | = | T_2 |
| n | _ | Eroau | oncy of interfering waves | . . | (. | M ₀ + N | М ₂)g | = | 4 × 1960 |
| 11 | _ | FO II- | ency of interfering waves | | (1 | + M ₂) | 980 | = | 4 × 1960 |
| - | - | 50 П2 | | | | (M, | + 1) | = | 4×2 |
| Т | = | Time | period interfering waves | | | M | +1 | = | 8 |
| | | 1 | 1 | • | | | 2 – M | = | 8_1 |
| | = | — = n | $=$ $\frac{1}{50}$ $=$ 0.025 | | | | 1112 М | _ | \sim 1 |
| V | = | Veloc | ity of interfering ways | | | | 1VI ₂ | - | 7 g wi |
| v | _ | v e100 | - E0 x 2 | | | | | | |
| | = | n k | - 50 x 2 | | | | | | |
| ·• | V | = | 100 m/s | | | | | | |
| | | | | | | | | | |

| 13. | In N arran were when | lelde' ged in form streto | 's experiemnt, fo parallel position and ed along a length of ched by a weight of | rk was 16100ps of 7.2 m 10 g. If | ÷ | N N | = | <u>6×7×10</u> 7.2 58.33 Hz | = | $\frac{70}{1.2}$ |
|----------------|--|---|--|---|-------------|--|--|--|--|---|
| Giver To Fi | mass the fr n : p L M M' nd : | of the reqeur = = = = = = = | e string is 14.4 × 10 ⁻¹ focy of tuning fork. 6 7.2 m 10 g 10 × 10 ⁻³ 10 ⁻² kg 14.4 × 10 ⁻² g 14.4 × 10 ⁻⁵ kg | ² g, find | 14. Give | Find an ai at on and temp [Inne n : l | the from r colur e end, speed eratur er dian = = = | equency of fif nn vibrating i , length of pi l of sound in e is 350 m/s. neter of pipe i 42.10cm 42.10 × 10 ⁻² m 0.4210 m | fth over n a pipo pe is 4 n air a s 3.5 cn | rtone of e closed 2.10 cm t room 1] |
| Form | N ula · | = | ? | | | v d | = | 3.5 cm = 3 | .5 × 10-2 | ² m |
| FOIII | n | = | $\frac{P}{2I}\sqrt{\frac{T}{m}}$ | | To Fi | nd : Freat | = 1ecv of | 0.035 m fifth overtone | e n_ = ? | |
| Solut | ion : n For p | = arallel | $\frac{P}{2L}\sqrt{\frac{T}{m}}$ | , of fork | Form | ula : Func close n | lament d at or = | tal frequency ne end is giver | in air 1 by | column |
| | is giv | en by | position, nequency | OI IOIK | Solut | tion · | | 4L | | |
| <i>:</i> . | N N | = | $\frac{2.P}{2L}\sqrt{\frac{T}{m}}$ | | | L L | = = = | <i>l</i> + 0.3 d 0.4210 + 0.3 x 0.42 10 + 0.01 0.4315 m | : 0.035 05 | |
| | N | = | $\frac{P}{L}\sqrt{\frac{T}{m}}$ | (i) | Now | ,n | = | $\frac{V}{4L}$ | | |
| Now, | m | = | $\frac{M'}{l}$ | | | n | = | $\frac{350}{4(0.4315)}$ | | |
| | m | = | $\frac{14.4 \times 10^{-5}}{7.2}$ | | | n | = | $\frac{350}{4 \times 0.4315}$ | | |
| ∴ Subst | m ituting | = 2 the v | 2×10^{-3} kg/m values in (i), we get, | | | n | = | 202.78 Hz | 1- | |
| | N | = | $\frac{6}{7.2}\sqrt{\frac{10^{-2} \times 9.8}{2 \times 10^{-5}}}$ | | ∴ ∴ | P th ov Frequ n ₅ n. | vertone iencey = = | e is given by n of fifth overt (2 × 5 + 1)n 11 n | _p = (2p one is, | + 1)n |
| | N | = | $\frac{6}{7.2}\sqrt{49\times10^2}$ | | | o n | = | 11 × 202.78 2230.59 Hz 2230 59 Hz | | |
| | | | | | •• | ¹¹ ₅ | _ | 2230.39 IIZ | | |

| 15. | Two organ pipes, open at both ends, are sounded together and 5 beats are heard | | | | | Using (i), we get, | | | | | | |
|------------------|--|---|---|---|---------------------------------|--|--|---|---|---|--|--|
| | soun | aea to | gether and 5 b | eats are nearu | 625 | – n ₂ | = | 5 | | | | |
| | is 0. | .25 m | find the le | ength of the | ·• | n ₂ | = | 620 Hz | | | | |
| | other | pipe. | (Given : veloci | ty of sound in | | | | v | | | | |
| | air = | 350 m | /s, end orrectio | on at one end = | Also, | n ₂ | = | $2L_2$ | | | | |
| <u> </u> | 0.015 | m sar | ne for both pip | oes) | | | | 250 | | | | |
| Give | n : | _ | 0.25 m | | | 620 | = | 350 | | | | |
| | ¹ 1 | _ | $350 \mathrm{m/s}$ | | | | | ∠L ₂ | | | | |
| | v | _ | 550 m/ s | | | 21 | _ | 350 | | | | |
| n ₁ - | · 11 ₂ | - | 5 | (| •• | $2L_2$ | _ | 620 | | | | |
| | e | = | 0.015 m same | for both pipes. | | | | 350 | | | | |
| 10 F1 | na: | _ | 2 | | | L_2 | = | 2×620 | | | | |
| Болга | ι ₂ | _ | <u>:</u> | | | | | 25 | | | | |
| Form | ula : | | | | | L_2 | = | $\frac{33}{124}$ | = | 0.2823 m | | |
| | n | = | V | | •• | T | _ | 124 | | | | |
| | | | 2L | | • | L ₂ | _ | $l_2 + 2e$ | | | | |
| Solu | ion : | 1 | tal fue au en en | of ourses wind | •• | 1 1 | _ | $L_2 - 2e$ | 0.02 | | | |
| | runc | amen at bot | th ends | of organ pipe | | l ₂ | - | 0.2625 - | 0.05 | | | |
| | open | ut bot | | | | l ₂ | = | 0.2523 n | n | | | |
| | n | = | $\frac{V}{2I}$ | | 16. | The | funda | mental f | reaue | ncv of a pipe | | |
| | 2L | | | | | closed at one end is unison with t | | | | | | |
| | whom | 0 | | | | close | ed at o | one end | is uni | ison with the | | |
| | when | e | 1+ 0 | | | close thire | edato dove | one end rtone o | is uni of an | ison with the open pipe. | | |
| | when L | e = | <i>l</i> + e | | | close thire Calc | ed at o d ove ulate f | one end rtone o the ratio | is uni of an of the | ison with the open pipe. eir lengths of | | |
| | wher L | re = _{_1} < I | l + e L_2 then $n_1 > n_2$ | | | close thire Calc air co | ed at o d ove ulate f olumn | one end rtone o the ratio | is uni of an of the | ison with the open pipe. eir lengths of | | |
| n ₁ | when L - n ₂ | re = ₁ < I = | l + e L_2 then $n_1 > n_2$ 5 | (i) | Give | close thire Calc air co n : | ed at o d ove ulate f olumn | one end rtone o the ratio | is uni of an of the | ison with the open pipe. eir lengths of | | |
| n ₁ | when L - n ₂ Since | re = < < I = e pipe i | l + e L_2 then $n_1 > n_2$ 5 s open at both e | (i) ends hence end | Give | close third Calc air co n : n ₀ when | ed at o d ove ulate t olumn = re | one end rtone c the ratio n _c | is uni of an of the | ison with the open pipe. eir lengths of | | |
| n ₁ | when L - n ₂ Since corre | $= \frac{1}{1} < I$ $= 0$ $= 0$ $= 0$ $= 0$ $= 0$ | l + e L_2 then $n_1 > n_2$ 5 s open at both e is (2e) | (i) ends hence end | Give | close third Calc air co n: n ₀ when n ₂ | ed at o d ove ulate f olumn = ce = | one end rtone c the ratio n _c frequen | is uni of an of the | ison with the open pipe. eir lengths of | | |
| n₁ ∴ | when L - n ₂ Since corre | re = < I = e pipe i ction i ct leng | l + e L_2 then $n_1 > n_2$ 5 s open at both e is (2e) gth of 1 st pipe | (i) ends hence end | Give | close third Calc air co n: n _o when n _o | ed at o d ove ulate f olumn = re = | ne end rtone o the ratio n _c frequen of open | is uni of an of the cy of t pipe | ison with the open pipe. eir lengths of | | |
| n₁ | when L - n ₂ Since corre L ₁ | re = < I = pipe i ction i ct leng = | l + e L_2 then $n_1 > n_2$ 5 s open at both e is (2e) gth of 1 st pipe $l_1 + 2e$ | (i) ends hence end | Give | close third Calc air co n: n _o when n _o n _c | ed at o d ove ulate t olumn = re = = | ne end rtone c the ratio n _c frequen of open fundan | is unit of an of the cy of t pipe netal | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre Corre | re = t ₁ < I = pipe i ction i ct lens = = | l + e L_2 then $n_1 > n_2$ 5 s open at both e is (2e) gth of 1 st pipe $l_1 + 2e$ $0.25 + 2 \times 0.01$ | (i) ends hence end 15 | Give | close third Calc air co n : n ₀ when n ₀ n ₀ | ed at o d ove ulate f olumn = re = = | ne end rtone c the ratio n _c frequen of open fundan closed p | is unit of an of the cy of the pipe netal to pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ | when L - n ₂ Since corre Corre L ₁ | re = < I = pipe i ction i ct lens = = = | l + e L_2 then $n_1 > n_2$ 5 s open at both e is (2e) gth of 1 st pipe $l_1 + 2e$ $0.25 + 2 \times 0.01$ 0.25 + 0.03 | (i) ends hence end 15 = 0.28 m | Give To Fi | close third Calc air co n : n _o when n _o n _o | ed at o d ove ulate f olumn = re = = | ne end rtone o the ratio n _c frequen of open fundan closed p | is unit of an of the cy of the pipe netal b pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ | when L - n ₂ Since corre L ₁ L ₁ | re = < I = pipe i ction i ct leng = = = | $l + e$ $L_2 \text{ then } n_1 > n_2$ 5 s open at both e is (2e) gth of 1 st pipe $l_1 + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ v | (i) ends hence end 15 = 0.28 m | Give To Fi | close third Calc air co n_{o} when n_{o} n_{c} nd : $\underline{L_{c}}$ | ed at o d ove ulate f olumn = re = = | ne end rtone o the ratio n _c frequen of open fundan closed p | is uni of an of the cy of the pipe netal to pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre Corre L ₁ L ₁ | re = < < I = pipe i ction i ct leng = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{V}{2L_{1}}$ | (i) ends hence end 5 = 0.28 m | Give To Fi | close third Calc air co n: n_o when n_o n_c nd: $\frac{L_c}{L_o}$ | ed at o d ove ulate f olumn = ce = = | ne end rtone o the ratio n _c frequen of open fundan closed p ? | is uni of an of the cy of t pipe netal b bipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre Corre L ₁ L ₁ | re = = pipe i ction i ct lens = = = | l + e L_2 then $n_1 > n_2$ 5 s open at both e is (2e) gth of 1 st pipe $l_1 + 2e$ $0.25 + 2 \times 0.01$ 0.25 + 0.03 $\frac{v}{2L_1}$ | (i) ends hence end 15 = 0.28 m | Give: To Fi Form | close third Calc air co n_{o} when n_{o} n n n the constraints n_{c} n ula : | ed at o d ove ulate f olumn = re = = | ne end rtone of the ratio n _c frequen of open fundan closed p | is uni of an of the cy of t pipe netal t pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre Corre L ₁ L ₁ | re = < I = pipe i ction i ct leng = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{V}{2L_{1}}$ $\frac{350}{2L_{1}}$ | (i) ends hence end 15 = 0.28 m | Give To Fi Form | close third Calc air co n n_{c} n_{c} nd : $\frac{L_{c}}{L_{0}}$ ula : | ed at o d ove ulate f olumn = ce = = | ne end rtone of the ratio n _c frequen of open fundan closed p ? | is uni of an of the cy of t pipe netal p pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre L ₁ L ₁ | re = = = pipe i ction i ct lens = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{v}{2L_{1}}$ $\frac{350}{2 \times 0.28}$ | (i) ends hence end 15 = 0.28 m | Give To Fi Form | close third Calc air co n : n_o when n_c nd : $\frac{L_c}{L_o}$ ula : n | ed at o d ove ulate f olumn = re = = = | ne end rtone of the ratio n _c frequen of open fundan closed p ? <u>V</u> 2L | is uni of an of the cy of t pipe netal b pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre L ₁ L ₁ n ₁ | re = 1 1 < I = 2 pipe i ction i ct leng = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{V}{2L_{1}}$ $\frac{350}{2 \times 0.28}$ $\frac{350}{2 \times 0.28} = 0$ | (i) ends hence end 15 = 0.28 m | Give To Fi Form Solut | close third Calc air co n "when n n n ton : $\frac{L_c}{L_0}$ ula : n | ed at o d ove ulate f olumn = ce = = | one end rtone of the ratio n_c frequen of open fundan closed p ? $\frac{V}{2L}$ | is uni of an of the cy of t pipe netal h pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre L ₁ L ₁ n ₁ | re = < I = pipe i ction i ct lens = = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{v}{2L_{1}}$ $\frac{350}{2 \times 0.28}$ $\frac{350}{0.56} =$ | (i) ends hence end 5 = 0.28 m | Give To Fi Form Solut | close third Calc air co n: n_o when n_o nd: $\frac{L_c}{L_o}$ ula: n 3rd c | ed at o d ove ulate f olumn = = = = = = | one end rtone of open n_c frequen of open fundan closed p ? $\frac{V}{2L}$ | is unit of an of the cy of t pipe netal to pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre L ₁ L ₁ n ₁ | re = = = pipe i ction i ct lens = = = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{V}{2L_{1}}$ $\frac{350}{2 \times 0.28}$ $\frac{350}{0.56} = 625 \text{ Hz}$ | (i) ends hence end 15 = 0.28 m 625 Hz | Give To Fi Form Solut | close third Calc air co n n_{o} m n_{c} nd : $\frac{L_{c}}{L_{o}}$ ula : n tion : 3rd c | ed at o d ove ulate t olumn = = = = = = | one end rtone of the ratio n_c frequen of open fundan closed p ? $\frac{V}{2L}$ | is unit of an of the cy of the pipe netal to pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |
| n₁ ∴ | when L - n ₂ Since corre Corre L ₁ L ₁ n ₁ | re = < I = pipe i ction i ct lens = = = = = = | $l + e$ $L_{2} \text{ then } n_{1} > n_{2}$ 5 s open at both e is (2e) gth of 1 st pipe $l_{1} + 2e$ $0.25 + 2 \times 0.01$ $0.25 + 0.03$ $\frac{v}{2L_{1}}$ $\frac{350}{2 \times 0.28}$ $\frac{350}{0.56} = 625 \text{ Hz}$ | (i) ends hence end 5 = 0.28 m 625 Hz | Giver To Fi Form Solut | close third Calc air co n: n_{o} when n_{c} nd: $\frac{L_{c}}{L_{o}}$ ula: n 3rd co n_{o} | ed at o d ove ulate t olumn = = = = = = = = | one end rtone of the ratio n_c frequen of open fundan closed p ? $\frac{V}{2L}$ the of open $4\left(\frac{v}{2L}\right)$ | is uni of an of the cy of the pipe netal b pipe | ison with the open pipe. eir lengths of third overtone freqeuncy of | | |

| | Funda one er | d pipe at | <i>.</i> | 2e(| n ₁ – n ₂ | <u>)</u> = | 2 ^l ; | $l_2 - n_1 l_1$ | | | | |
|--------------|----------------------|--------------------------|----------------------------------|---------------------|---------------------------------|------------|----------------------|----------------------------|-----------------------------|-------------------------------|-------------------------------|--------------------------------------|
| | n _c | = | $\frac{v}{4L_c}$ | | | ÷ | | | e = | $\frac{n_2}{2(}$ | $n_1 - n_2$ |) |
| \therefore | n _c : | = | n _o | | | 18. | Inaı | resona | nce tu | be exp | eriment | atuning |
| ••• | v 4L _c | = | $4\left(\frac{v}{2L_{o}}\right)$ | | | | fork long cm l | resona and ag ong. (| ates w gain re Calcul | th an a esonate ate the | ir colur s when e wavel | nn 10 cm , it is 32.2 ength of |
| | L _o | | 0 | | | Civo | wave | e and t | the en | d corre | ection. | |
| <i>:</i> . | L _c | = | 8 | | | Give | п. 1. | = | 10 cn | ı | | |
| | т | | 1 | | | | l, | = | 32.2 1 | n | | |
| . . | $\frac{L_c}{I}$: | = | $\frac{1}{8}$ | | | To Fi | ind : | | _ | | | |
| | L ₀ | | 0 | | | | λ | = | ? | | | |
| | <u>L</u> | = | $1 \cdot 8$ | | | Form | e ula: | — | : | | | |
| •• | L _o | | 1.0 | | | | i) | L | = | <i>l</i> + e | | |
| 17 | Show | that f | for a nin | e open at h | oth ands | | | | | $l_{2} - 3l_{2}$ | 1 | |
| 17. | the en | d cor | rection i | s | oth enus | | ii) | e | = | 2 | 1 | |
| | | n.1. | - n .1. | | | Solu | tion : | | | | | |
| | e = | $\frac{n_2 v_2}{2(n_1)}$ | $\frac{-n_{1}n_{1}}{-n_{2}}$ | | | | L | = | <i>l</i> + e | | | |
| Calu | Lion . | -("1 | ¹¹ 2) | | | | т | _ | 1 + 0 | _ λ | | (;) |
| 501u | | | | | | ••• | L ₁ | — | $l_1 + e$ | - 4 | | (1) |
| | Let, | 1 | = Vibra | ting longth | s of nine | | т | | 1 | 3λ | , | () |
| | r_1 and n_2 and | ¹ 2 | = Reso | nating freqe | uncy | | L ₂ | = | l_2 +e | = 4 | - | (11) |
| | N and | = 11 ² | Velocity | of sound in | a air | | Subt | ract eq | uatior | n (i) fro | m equa | tion (ii) |
| | v e | = | Find cor | rection | i all | | (1) | \sim (1 | | _ | <u>3</u> λ | λ |
| i) | E For th | e first | t resonar | nce | | ••• | (l ₂ + | $e) - (l_1)$ | т e) | - | 4 | - 4 |
| 1) | 101 th | C 1115 | t resonar | | | | | (1 | | | λ | |
| | n, · | = | $\frac{V}{2(1+2)}$ | <u>,</u> | | • | | $(l_2$ | $-l_{1}$ | = | 2 | |
| | 1 | | $2(l_1 + 2)$ | e) | | | λ | = | $2(l_2 -$ | l ₁) | | |
| <i>:</i> . | v | = | $2n_1(l_1 +$ | 2e) | (i) | | | = | 2(32.2 | 2 – 10.0 |)) | |
| ii) | For the | e seco | ond reso | nance | | | λ | = | 2(22 44.4 c | 2) rm | | |
| | | | v | | | •• | 70 | | 1 2 |)1)1 | | |
| | n ₂ | = | $\frac{1}{2(l_2+2)}$ | e) | | Now | ,e | = | $\frac{l_2 - c_1}{2}$ | <u>ⁿ1</u> | | |
| • | v | = | 2n (1 + | 2e) | (ii) | | | | (00.0 |) 0(1) | 2) | |
| ••• | From | (i) an | d (ii) we | _c) | (11) | | e | = | (32.2 | $\frac{2}{2} - 3(10)$ | <u>)</u> | |
| ш) | . /1 | | - (II) WE | g(l + 2) | | | | | | 2 | | |
| | $n_1(l_1)$ | + 2e) | = | $n_2(l_2 + 2e)$ | | ·. | e | = | $\frac{2.2}{2}$ | | | |
| | $n_1 l_1 + 2a_1 r_2$ | 2e n ₁ | . = | $n_2 l_2 + 2e n_2$ | | | | _ | 2 | | | |
| <u></u> | 2e n ₁ - | - 2e n ₂ | 2 = | $n_2 l_2 - n_1 l_1$ | | ·• | e | = | 1.1 CI | n | _ | |