# DPP – 3 (Waves)

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Q 1. Two coherent waves of amplitude 5mm and 7mm reach a point in opposite phase. What is the resultant amplitude?

(a) 2 mm (b) 12 mm

(c) $\sqrt{74}$ mm (d) $\sqrt{24}$ mm

Q 2. Two waves of same frequency but of amplitudes a and 2a respectively superimpose over each other. The resultant amplitude if the phase difference is $\frac{3\pi}{2}$, will be

(a) a (b) $\sqrt{3}a$

(c) $\sqrt{5}a$ (d) $3a$

Q 3. If the ratio in the amplitudes for two waves of equal frequencies is 1 : 3 then the ratio of the energies carried out by the waves will be

(a) 1 : 3 (b) 1 : 9

(c) 9 : 1 (d) None of these

Q 4. Two sound waves (expressed in CGS units) given by $y_1 = 0.3 \sin \frac{2\pi}{\lambda}(vt - x)$ and $y_2 = 0.4 \sin \frac{2\pi}{\lambda}(vt - x + \theta)$ interfere. The resultant amplitude at a place where phase difference is $\frac{\pi}{2}$ will be

(a) 0.7 cm (b) 0.7 cm

(c) 0.5 cm (d) $\frac{\sqrt{7}}{10}$ cm

Q 5. Phase difference between two waves having same frequency (v) and same amplitude (A) is 2π/3. If these waves superimpose each other, then resultant amplitude will be–

(a) 2A (b) zero

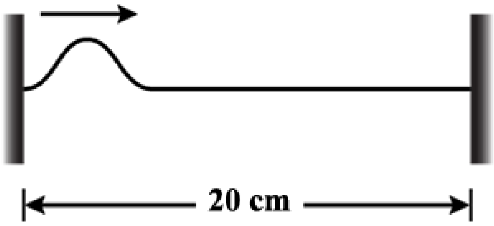
(c) A (d) $A^2$

Q 6. The equation of a plane progressive wave is $y = 0.9 \sin 4\pi \left[t - \frac{x}{2}\right]$. When it is reflected at a rigid support at x = 0, its amplitude becomes $\frac{2}{3}$ of its previous value. The equation of the reflected wave is

(a) $y = 0.6 \sin 4\pi \left[t + \frac{x}{2}\right]$ (b) $y = -0.6 \sin 4\pi \left[t + \frac{x}{2}\right]$

(c) $y = -0.9 \sin 4\pi \left[t - \frac{x}{2}\right]$ (d) $y = -0.9 \sin 4\pi \left[t + \frac{x}{2}\right]$

Q 7. A string of length 20 cm and linear mass density 0.4 g/cm is fixed at both ends and is kept under a tension of 16 N. A wave pulse is produced at t = 0 near an end as shown in figure which travels towards the other end. The string have the shape shown in the figure again in $2 \times 10^{-x}$ sec. Find x (a) A wavelength of 0.25 m and travels in $+ve$ x direction



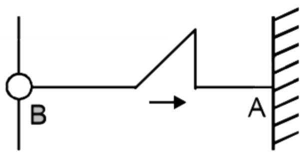

(a) 1 (b) 2
(c) 8 (d) 3

Q 8. A progressive wave gets reflected at a boundary such that the ratio of amplitudes of the reflected and incident wave is 1:2. Find the percentage of energy transmitted.
(a) 25 % (b) 44 %
(c) 67 % (d) 75 %

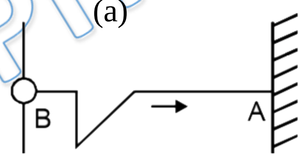
Q 9. A pulse shown here is reflected from the rigid wall A and then from free end B. The shape of the string after these 2 Reflection will be.



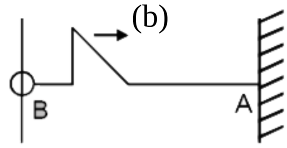
(a)




(b)




(c)




(d)

Q 10. Two waves represented by $y_1 = 10\sin(2000\pi t + 2x)$ and $y_2 = 10\sin\left(2000\pi t + 2x + \frac{\pi}{2}\right)$ are superposed at any point at a particular instant. The resultant amplitude is:
(a) 10 unit (b) 20 unit
(c) 14.1 unit (d) zero

Q 11. The refracted and the incident pulses for a wave travelling in a string have an amplitude ratio of 1:2. The ratio of their phases will be

(a) 1 : 2 (b) 2 : 1

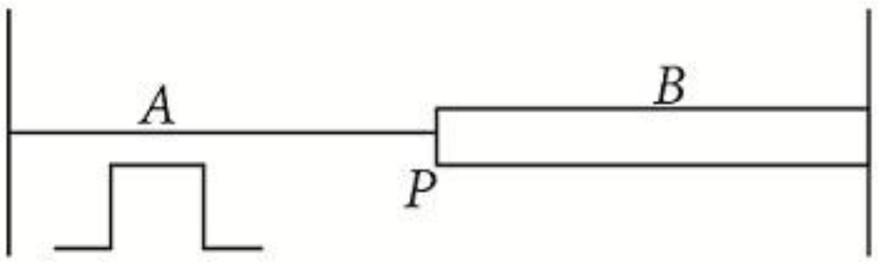
(c) 1 : 1 (d) 1 : 4

Q 12. Two wires made of the same material, one thick and the other thin, are connected to form a composite wire. The composite wire is subjected to some tension. A wave travelling along the wire crosses the junction point. The characteristic that doesn't undergoes a change at the junction point is

(a) Frequency only (b) Speed of propagation only

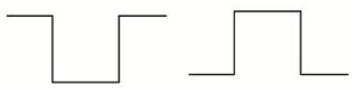
(c) Wavelength only (d) The speed as well as wavelength

Q 13. P is the junction of two wires A and B. B is made of steel and is thicker while A is made of aluminium and is thinner as shown. If a wave pulse as shown in the figure approaches P, the reflected and transmitted waves from P are respectively:




(a)

(b)



(b)

(d)

Q 14. Two strings of linear mass densities u and 9u are stretched under same tension. A wave travelling on the lighter string towards the heavier string gets partially reflected and transmitted at the junction. Then fraction of incident wave energy getting transmitted to the heavier string is

(a) $\frac{1}{4}$ (b) $\frac{1}{2}$

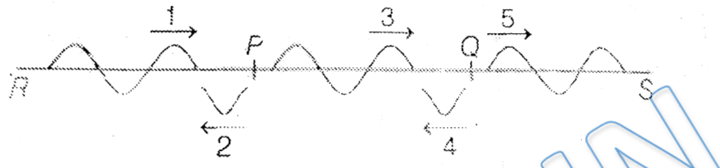
(c) $\frac{3}{4}$ (d) $\frac{9}{16}$

Q 15. A wave pulse, travelling on a two piece string, gets partially reflected and partially transmitted at the junction, The reflected wave is inverted in shape as compared to the incident one. If the incident wave has speed v and the transmitted wave v'

(a) v' > v (b) v' = v

(c) v' < v (d) nothing can be said about the relation of v and v'

Q 16. There are three strings RP, PQ and QS as shown. Their mass and length are RP = (0.1 kg , 2 m), PQ = ( 0.2 kg , 3 m) ,QS = ( 0.15 kg , 4 m) respectively. All the strings are under the same tension. Wave -1 is incident at P, it is partly reflected (wave -2 ) and partly transmitted (wave -3). Now wave - 3 is incident at Q, it is again partly transmitted (wave -5) and partly reflected (wave -4). phase difference between wave -1 and wave




(a) 2 is π

(b) 4 is zero

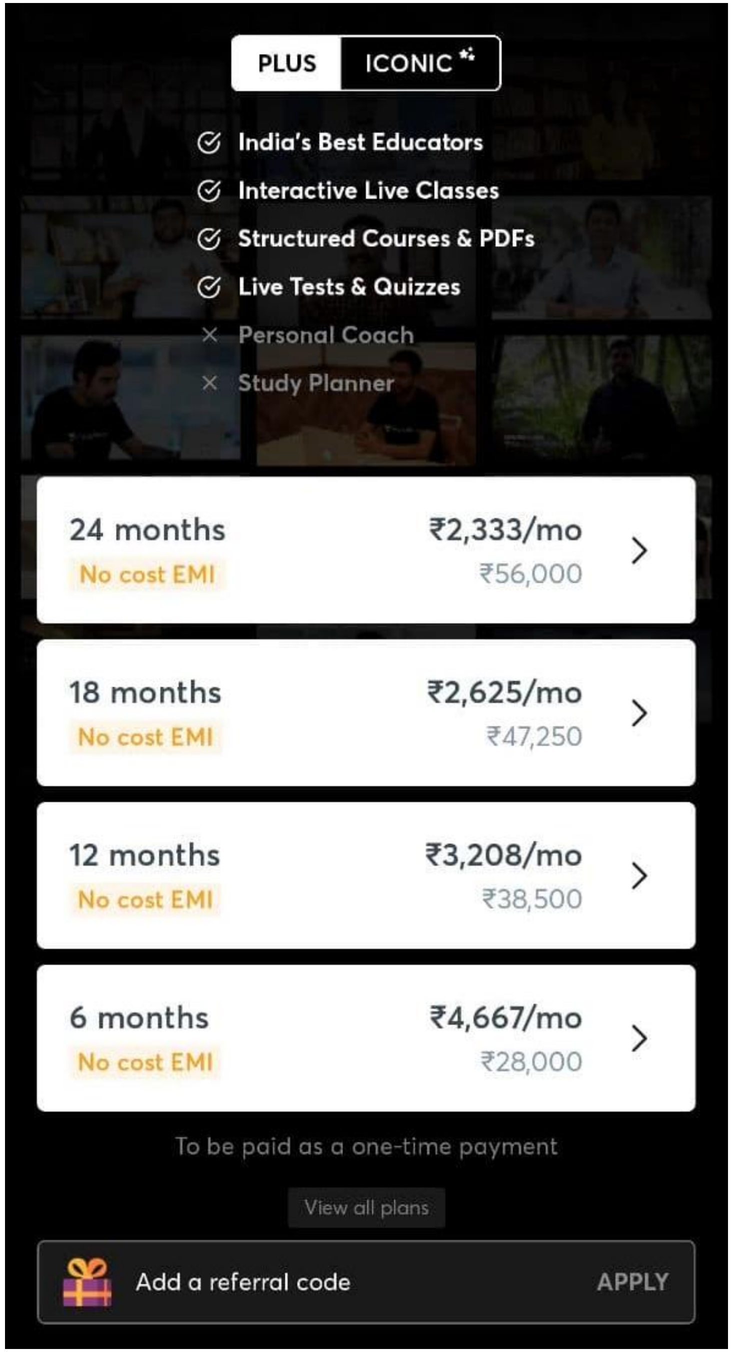
(c) Both (a) and (b) are correct

(d) Both (a) and (b) are incorrect



# Answer Key

| | | | | |
|---|---|---|---|---|
| **Q.1 a** | **Q.2 c** | **Q.3 b** | **Q.4 c** | **Q.5 c** |
| **Q.6 b** | **Q.7 b** | **Q.8 d** | **Q.9 a** | **Q.10 c** |
| **Q.11 c** | **Q.12 a** | **Q.13 c** | **Q.14 c** | **Q.15 c** |
| **Q.16 c** | | | | |

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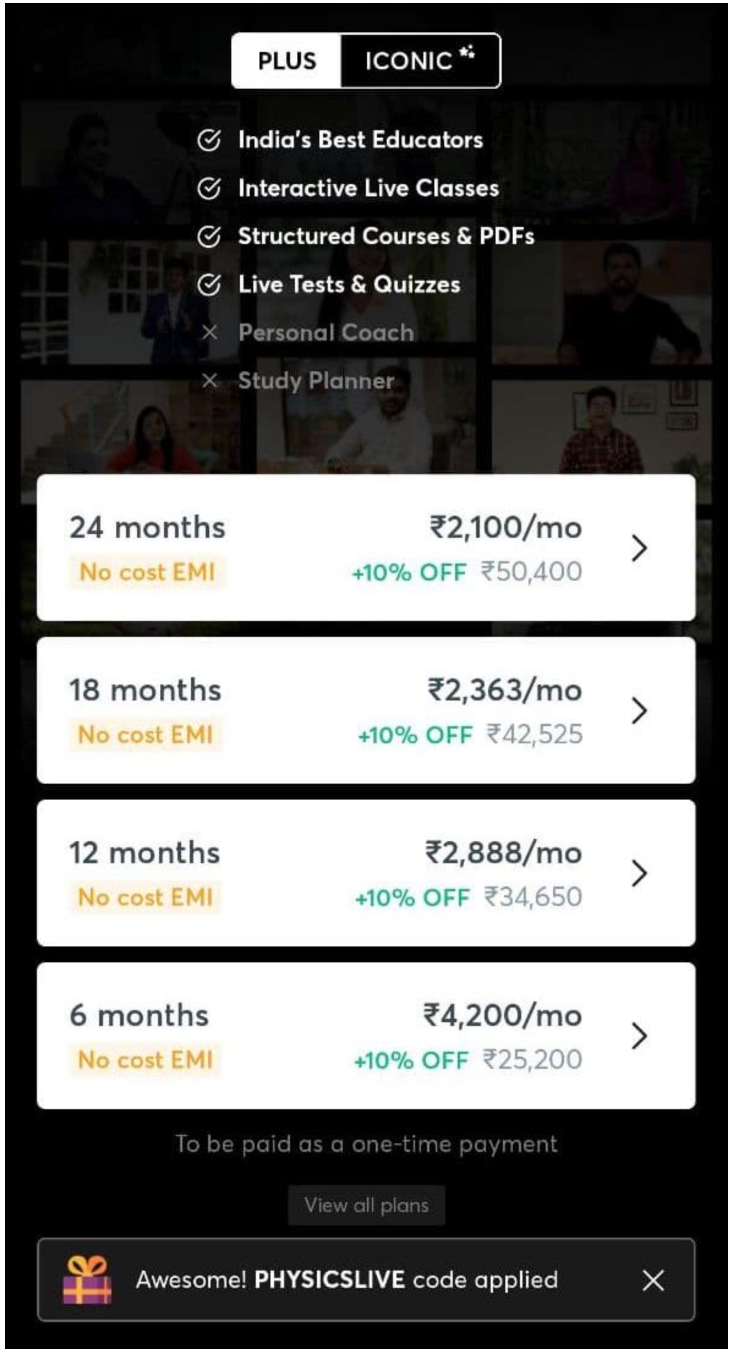


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# Written Solution

DPP-3 Waves: Superposition of wave, Reflection & Transmission

**By Physicsaholics Team**

Solution: 1

If two waves are in opposite phase

means; $\Delta\phi = 180^\circ$

& $A = |A_1 - A_2|$

Because; $A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\phi}$

$= \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos 180^\circ}$

$= \sqrt{A_1^2 + A_2^2 - 2A_1A_2}$

$= \sqrt{(A_1 - A_2)^2}$

$$\boxed{A = |A_1 - A_2|}$$

So; $A = |5 - 7|$

$A = |-2|$

$$\boxed{A = 2\ mm}$$ Ans



Ans. a

Solution: 2

$$A_r = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\phi}$$

$$= \sqrt{a^2 + (2a)^2 + 2(a)(2a)\cos\left(\frac{3\pi}{2}\right)}$$

$$= \sqrt{a^2 + 4a^2 + 0}$$

$$A_r = \sqrt{5}\,a$$



Ans. c

Solution: 3

$E \propto A^2$

so; $\frac{E_1}{E_2} = \left(\frac{A_1}{A_2}\right)^2$

$= \left(\frac{1}{3}\right)^2$

$\boxed{\frac{E_1}{E_2} = \frac{1}{9}}$ Ans.



Ans. b

Solution: 4

$$y_1 = 0.3 \sin \frac{2\pi}{\lambda}(vt - x)$$

$$y_2 = 0.4 \sin \frac{2\pi}{\lambda}(vt - x + \theta)$$

when, $\theta = \frac{\pi}{2} = \Delta\phi$

then, $A = \sqrt{A_1^2 + A_2^2}$

$$A = \sqrt{(0.3)^2 + (0.4)^2}$$

$$\boxed{A = 0.5\ cm}$$ Ans.



Ans. c

Solution: 5

$$A_1 = A_2 = A$$

$$A_r = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\phi}$$

$$= \sqrt{A^2 + A^2 + 2(A)(A)\cos\left(\frac{2\pi}{3}\right)}$$

$$= \sqrt{A^2 + A^2 + 2A^2\left(-\frac{1}{2}\right)}$$

$$= \sqrt{A^2 + A^2 - A^2}$$

$$A_r = \sqrt{A^2}$$

$$\boxed{A_r = A} \quad \text{Ans.}$$



Ans. c

## Solution: 6

$y = 0.9 \sin 4\pi\left[t - \frac{x}{2}\right]$

$A = 0.9$ unit

Amplitude of reflected wave; $A_r = \frac{2}{3}A$

$A_r = \frac{2}{3}(0.9)$

$A_r = 0.6$ unit

And reflected from rigid support; $\Delta\phi = \pi$

& direction of motion will be opposite to the incident wave

so; $y_R = 0.6 \sin\left[4\pi\left[t + \frac{x}{2}\right] + \pi\right]$

$y_R = 0.6 \sin\left[4\pi\left[t + \frac{x}{2}\right] + \pi\right]$

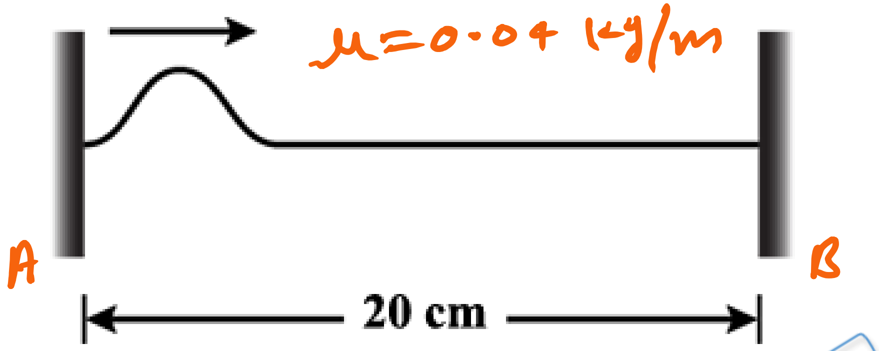
$y_R = -0.6 \sin 4\pi\left[t + \frac{x}{2}\right]$ Ans

Ans. b

# Solution: 7

$\mu = 0.4\ g/cm$

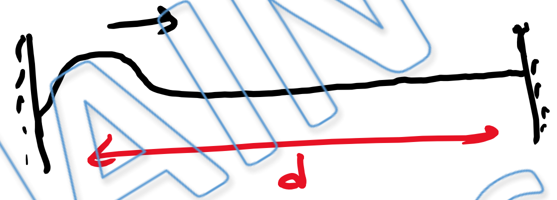
$\mu = 0.04\ kg/m$




first it will reflect from rigid support of wall 'B'


$t = \frac{d}{v}$

Now it will again reflect from rigid support of wall A




$t_2 = \frac{d}{v}$

& this came into initial shape.

so; $t = t_1 + t_2 = \frac{2d}{v}$

$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{16}{0.04}} = \frac{4}{0.2}$

$\boxed{v = 20\ m/s}$

so; $t = \frac{2 \times (20 \times 10^{-2})}{20} = 2 \times 10^{-2}$ sec

$\boxed{t = 2 \times 10^{-2}\ sec}$ so; $\boxed{x = 2}$ Ans

Ans. b

## Solution: 8

$\frac{A_R}{A} = \frac{1}{2}$

$\because E \propto A^2$

so; $\frac{E_R}{E} = \left(\frac{A_r}{A}\right)^2 = \left(\frac{1}{2}\right)^2$

$\frac{E_R}{E} = \frac{1}{4}$

$E_R = \frac{E}{4}$

where; $E_R$ = reflected energy

& $E$ = incident energy.

so; Transmitted energy.

$E_T = E - E_R$

$= E - \frac{E}{4}$

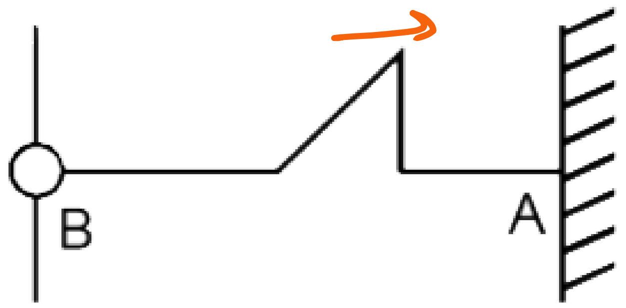
$E_T = \frac{3E}{4}$

so; $E_T = (75\%)$ of $E$ Ans



Ans. d

# Solution: 9




After 1st reflection at 'A'

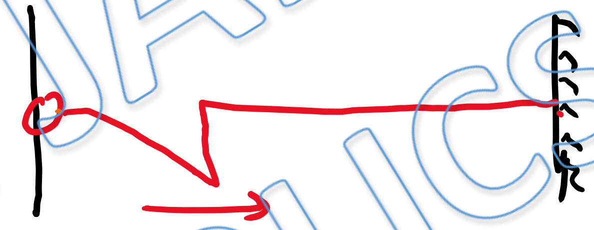
A is rigid support

so;

Now it will reflect from 'B'

∵ B is free support.

so;



Ans



Ans. a

## Solution: 10

$y_1 = 10 \sin(2000\pi t + 2\pi)$

$y_2 = 10 \sin(2000\pi t + 2\pi + \frac{\pi}{2})$

so; $A_1 = A_2 = 10$ unit

& $\Delta\phi = \frac{\pi}{2}$

So; $A_r = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\Delta\phi}$

$= \sqrt{(10)^2 + (10)^2 + 2(10)(10)\cos 90^\circ}$

$= \sqrt{2(10)^2}$

$A_r = 10 \times \sqrt{2}$

$A_r = 10\sqrt{2}$ unit

$A_r = 10 \times 1.41$

$A_r = 14.1$ unit Ans

Ans. c

Solution: 11

The incident and refracted pulses have same phase. Hence the ratio of phases is 1:1



Ans. c

## Solution: 12

$\because$ $v = \sqrt{\frac{T}{\mu}}$

T = constant

but $\mu \neq$ same

so; $v_1 \neq v_2$

But f = always same

Because f depends on source of disturbance.

& $v = f\lambda$

when; f = constant

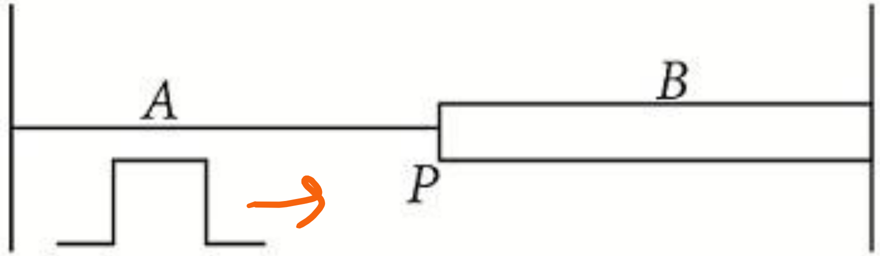
&. $v_1 \neq v_2$

so; $\lambda_1 \neq \lambda_2$



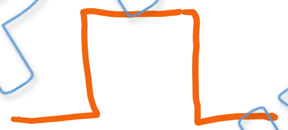
Ans. a

# Solution: 13




Transmitted wave will be same as incident wave only amplitude will change

so; wave in wire 'B'!

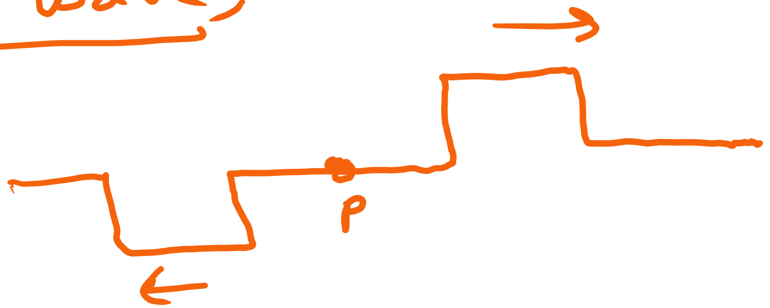


But reflected wave will be at phase difference of π; Because wire is thick / denser

so; it will behave like rigid support

so; reflected wave in wire 'A':-

so; final wave;




Ans.

Ans. c

# Solution: 14

$\because E \propto \sqrt{\mu} A^2$

$$A_T = \left[\frac{2\sqrt{\mu_1}}{\sqrt{\mu_1} + \sqrt{\mu_2}}\right] A$$

$$= \frac{2\sqrt{u}}{\sqrt{u} + \sqrt{9u}} A$$

$$= \frac{2\sqrt{u}}{\sqrt{u} + 3\sqrt{u}} A$$

$$A_T = \frac{2}{4} A$$

$$\boxed{\frac{A_T}{A} = \frac{1}{2}}$$

and $E \propto \sqrt{\mu} A^2$

$$\frac{E_T}{E} = \sqrt{\frac{\mu_2}{\mu_1}} \left(\frac{A_T}{A}\right)^2$$

$$= \sqrt{\frac{9u}{u}} \left(\frac{1}{2}\right)^2$$

$$\boxed{\frac{E_T}{E} = \frac{3}{4}}$$ Ans



Ans. c

## Solution: 15

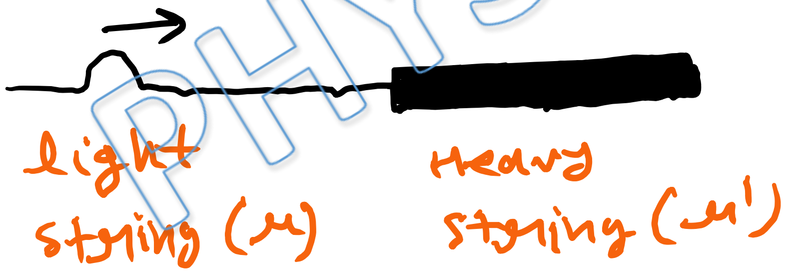
$\because \quad v = \sqrt{\frac{T}{\mu}}$

$T$ = same in both parts.

But; as reflected wave is inverted in shape as compare to incident wave.

So; Reflection is taken place at Rigid boundary.

So;




$\mu$ = linear mass density.

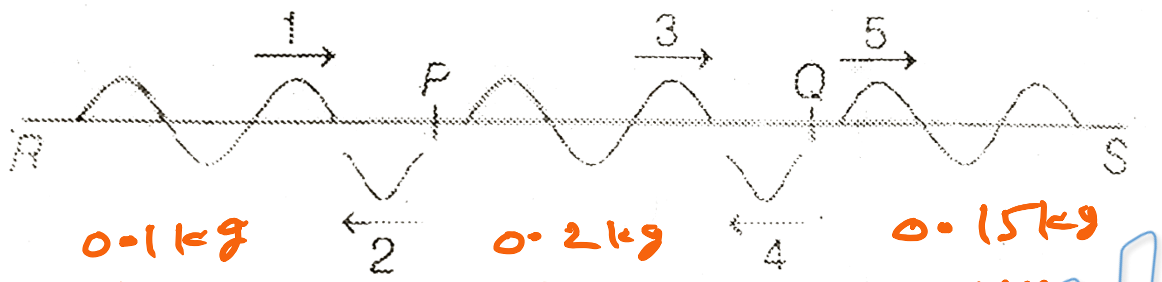
as; $\mu' > \mu$

and $v \propto \frac{1}{\sqrt{\mu}}$

so; $\boxed{v' < v}$ Ans

Ans. c

# Solution: 16




0.1 kg, 2 m, $\mu_1$ — 0.2 kg, 3 m, $\mu_2$ — 0.15 kg, 4 m, $\mu_3$

$\mu_1 = \frac{0.1}{2} = 0.05$ kg/m

$\mu_2 = \frac{0.2}{3} = 0.067$ kg/m

$\mu_3 = \frac{0.15}{4} = 0.037$ kg/m

as; $\mu_2 > \mu_1 > \mu_3$

so; RP → PQ [rare to denser]

PQ → QS [denser to rare]

as; RP → PQ [rare to denser]

so; reflected wave will be at phase difference of 'π'

so; wave-1 & wave-2 has $\boxed{\Delta\phi = \pi}$

Now; as we know that transmitted & incident waves are in phase

so; wave-1 & wave-3 — (1)

$\Delta\phi = 0$

∵ at PQ → QS [denser to rare]

so; reflected wave will be in same phase with incident wave

so; wave-3 & wave-4 — (2)

$\Delta\phi = 0$

From eqn (1) & (2) wave-1, 3 & 4 are in same phase; so; $\boxed{\Delta\phi = 0}$ Ans.

Ans. c

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