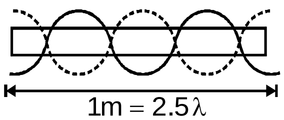
EXERCISE – V JEE QUESTIONS

1. 

Amplitude = $2 \times 10^{-6} \sin kx$

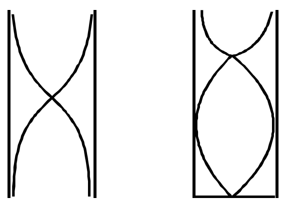
$= 2 \times 10^{-6} \sin \frac{2\pi}{2} \times 5 \times 0.02$

$\because$ 1 m = 2.5 λ $\Rightarrow \lambda = 2/5$ m

$v = \sqrt{\frac{\gamma}{\rho}} = \sqrt{\frac{2\times10^{11}}{8\times10^{3}}} = 5000\,m/s$

$f = \frac{5000}{2/5} = \frac{25000}{2}$

$\therefore$ y = $2 \times 10^{-6} \sin (0.1\,\pi) \cos (25000\,\pi t + \theta)$

2. 

$\lambda/2 = L$ $\qquad$ $\Rightarrow 3\lambda/4 = L$

$\Rightarrow \lambda = 2L$ $\qquad$ $\Rightarrow \lambda = 4L/3$

(i) T= k.x

$v = k\sqrt{T}$

$v' = k\sqrt{1.5T}$

$\frac{v'}{v} = \frac{\sqrt{1.5}}{1} = 1.22$

(ii) $\frac{3v}{4L} - 100 = \frac{v}{2L}$

$\Rightarrow \frac{3}{2}x - 100 = x$

$\Rightarrow$ x = 200 Hz

3. $\lambda = \frac{300}{25} = 12\,m$

Phase diff^n = $\frac{2\pi}{\lambda}.\Delta x = \frac{2\pi}{12} \times 6 = \pi$

Phase diff^n = π

Amplitude diff^n = 0

4. A

v = A ω

5. (i) B,C

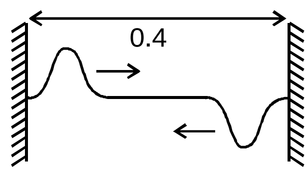
node at x = 0 $\qquad$ y = 0

x = L $\quad$ y = L

$\therefore$ B & C

(ii) B

$v = \sqrt{\frac{1.6}{10^{-2}} \times 0.4} = 8\,m/s$



$t = \frac{0.8}{8}$

t = 0.1 sec.

(iii) A,C

$a\omega = \frac{v}{10}$

$10^{-3} \times 2\pi f = \frac{10}{10}$

$f = \frac{10^3}{2\pi}$

6. 

$v_1 = \sqrt{\frac{T}{\mu_1}}$ $\quad$ $v_2 = \sqrt{\frac{T}{\mu_2}}$

$v_1 = \sqrt{\frac{80\times4.8}{0.06}} = 80\,m/s$

$v_2 = \sqrt{\frac{80\times2.56}{0.2}} = 32\,m/s$

(a) Total time taken

$= \frac{4.8}{80} + \frac{2.56}{32}$ = 0.06 + 0.08

= 0.14 s

(b) $A_r = \frac{v_2 - v_1}{v_1 + v_2}.A_i = -\frac{48}{112} \times 3.5 = -1.5\,cm$

$A_t = \frac{2v_2}{v_1+v_2}A_i = \frac{64}{112} \times 3.5 = 2cm$

7. A,C,D

For spherical wave

$$I \propto \frac{1}{r^2}$$

Total power remains const.

8. B,C,D

$$y = \frac{0.8}{\left[4(x+\frac{5}{4}t)^2\right]+5}$$

comparing with gen. equation f(x – vt)

$$v = -\frac{5}{4} \text{ m/s}$$

⇒ wave moving in – ve x direction

$$\Rightarrow v = \frac{5}{4} = 125 \text{ m/s}$$

⇒ it will travel 2.5 m is 2 s.

9. A,B,C

A - Electric field

B - magnetic field

C -displacement

10. A,B,C

Waves must be travelling in opposite direction.

11. D

$$f_1 = \frac{1}{2\ell}\sqrt{\frac{T}{\rho\pi(2r)^2}} = \frac{1}{2\ell}.\frac{1}{2}\sqrt{\frac{T}{\rho\pi r^2}}$$

$$f_2 = \frac{1}{2(2\ell)}\sqrt{\frac{T}{\rho\pi r^2}}$$

$$\frac{f_1}{f_2} = 1$$

12. C

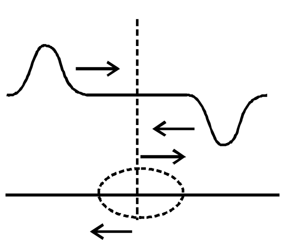
$E_1 \propto \mu A^2 \omega^2$

$$\frac{E_1}{E_2} = \frac{\omega_1^2}{\omega_2^2} = \frac{\omega^2}{(2\omega)^2} = \frac{1}{4}$$

$4E_1 = E_2$

13. B

It will behave as standing wave.



14. A

$$\frac{5\lambda}{2} = \ell$$

$$f = \frac{5}{2\ell}\sqrt{\frac{T}{\mu}} \quad ...(1)$$

$$f = \frac{3}{2\ell}\sqrt{\frac{Mg}{\mu}} \quad ...(2)$$

$$\frac{5}{2\ell}\sqrt{\frac{T}{\mu}} = \frac{3}{2\ell}\sqrt{\frac{Mg}{\mu}} \quad (T = 9g)$$

$\Rightarrow 5 \times 3 = 3\sqrt{M}$

$\Rightarrow M = 25$ Kg

15. $$dE = \frac{1}{2} dm\, v_p^2$$

$$= \frac{1}{2}\mu dx[(A \sin kx)\omega]^2$$

$$E = \int_0^{\lambda/2} \frac{1}{2}\mu dx A^2\omega^2 \sin^2 kx$$

$$= \frac{1}{2}\mu A^2\omega^2 \int_0^{\lambda/2} \frac{1}{2}(1-\cos 2kx)\,dx$$

$$= \frac{1}{4}\mu A^2\omega^2.\frac{\lambda}{2}$$

$$\omega^2 = 4\pi^2\frac{v^2}{\lambda^2} \quad (\lambda = 2\text{ L})$$

$$\Rightarrow \omega^2 = \frac{4\pi^2 \times T}{4L^2 \times \mu}$$

$$\Rightarrow E = \frac{1}{4}\mu A^2 \times \frac{4\pi^2}{4L^2} \times \frac{T}{\mu} \times L$$

$$\Rightarrow E = \frac{\pi^2 A^2 T}{4L}$$

16. C

$f_1 = \frac{v}{\ell}$

$f_2 = \frac{nv}{4\ell} = \frac{n}{4} f_1$

$\because f_2 > f_1$ given

$\Rightarrow n > 4$

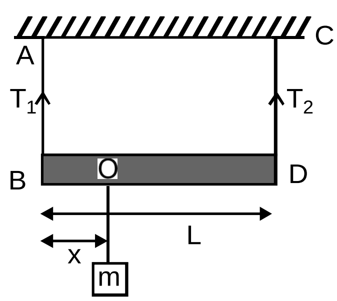
17. $Aw = 3$

$A\omega^2 = 90 \quad (A = 0.1\text{ m})$

$\omega = 30$ rad/s

$y = (10\text{ cm}) \sin\left[30t \pm \frac{3}{2}x + \phi\right]$

18. A



$T_1 + T_2 = mg$

$f_{AB} = \frac{v_1}{2\ell} = \frac{1}{2\ell}\sqrt{\frac{T_1}{\mu}}$

$f_{CD} = \frac{2}{2\ell}\sqrt{\frac{T_2}{\mu}}$

$\Rightarrow \sqrt{T_1} = 2\sqrt{T_2}$

$\Rightarrow T_1 = 4T_2$

$T_1 = \frac{4}{5}mg, \qquad T_2 = \frac{mg}{5}$

Torque balance at $T_1 x = T_2(\ell - x)$

$\Rightarrow \frac{4}{5}mgx = \frac{mg}{5}(\ell - x)$

$\Rightarrow x = \frac{\ell}{5}$

19. A

$\lambda = 0.5$ m $\quad A = 10$ cm

$v_p = \omega\sqrt{10^2 - 5^2} \quad \Rightarrow v_p = 5\sqrt{3}\,\omega$

$\omega = 2\pi\frac{v}{\lambda} = 2\pi \; \frac{10}{50} \; = \frac{2\pi}{5}$

$v_p = 2\sqrt{3}\,\pi\text{ cm/s}$

$v_o = \frac{\sqrt{3}\,\pi}{50}\hat{j}$

20. $\ell = 20$ cm, $\mu = \frac{1\times10^2}{10^3\times20} = \frac{0.5}{100}$ kg/m

$T = 0.5$ N

$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{0.5\times100}{0.5}} = 10$ m/s

Now $\quad f = \frac{nv}{2\ell} \Rightarrow 100 = \frac{n\times10}{2\times0.20}$

$n = 4$

$\Rightarrow \frac{n\lambda}{2} = \ell$

$\Rightarrow \frac{4\times\lambda}{2} = \frac{20}{100} = \frac{1}{10}\text{ m} = 10\text{ cm}$

separation between successive node = $\frac{\lambda}{2}$ = 5 cm.