DPP – 1 (Waves)

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Q 1. A wave is represented by the equation $y = 7\sin\{\pi(2t - 2x)\}$ here x is in metres and t in seconds. The velocity of the wave is
(a) 1 m/s (b) 2 m/s
(c) 5 m/s (d) 10 m/s

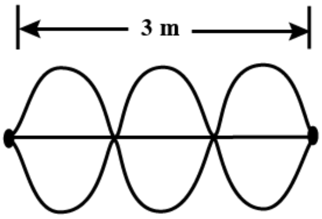
Q 2. The equation of a wave motion (with t in seconds and x in meters) is given by$y = 7\sin\left\{7\pi t - 0.4\pi x + \frac{\pi}{3}\right\}$. The velocity of the wave will be
(a) 17.5 m/s (b) 49π m/s
(c) $\frac{49}{2\pi}$ m/s (d) $\frac{2\pi}{49}$ m/s

Q 3. The equation of a wave is $y = 4\sin\left[\frac{\pi}{2}\left(2t + \frac{1}{8}x\right)\right]$, where y and x are in centimeters and t is in seconds. Which of the following is incorrect statement?
(a) The amplitude, wavelength, velocity, and frequency of wave are 4cm,16cm,32cm/s and 1 Hz, respectively, with wave propagating along-x direction.
(b) The amplitude, wavelength, velocity, and frequency of wave are 4cm,32cm,16cm/s and 0.5 Hz, respectively, with wave propagating along-x direction.
(c) two positions occupied by the particle at time interval of 0.4 s have a phase difference of 0.4π radian.
(d) two positions occupied by the particle at separation of 12cms have a phase difference of 135°.

Q 4. The equation of a wave is $y = 2\sin[\pi(0.5x - 200t)]$, where x and y are expressed in cm and t in sec. The wave velocity is
(a) 100 cm/sec (b) 200 cm/sec
(c) 300 cm/sec (d) 400 cm/sec

Q 5. The wave described by $y = 0.25\sin[(10\pi x - 2\pi t)]$, where x and y are in meters and t in seconds, is a wave travelling along the
(a) $+ve$ x direction with frequency 1 Hz and wavelength λ=0.2m
(b) $-ve$ x direction with amplitude 0.25 m and wavelength λ=0.2m
(c) $-ve$ x direction with frequency 1 Hz
(d) $+ve$ x direction with frequency π Hz and wavelength λ=0.2m

Q 6. Calculate the wavelength of the wave as shown above:



(a) 1 m (b) 2 m
(c) 3 m (d) 6 m

Q 7. The equation of a progressive wave is $y = 8\sin\left[\pi + \left(\frac{t}{10} - \frac{x}{4}\right)\frac{\pi}{3}\right]$. The wavelength of the wave is (where x and y are in meter)
(a) 24 m (b) 4 m
(c) 2 m (d) 10 m

Q 8. A plane wave is represented by $x = 1.2\sin(314t + 12.56y)$ Where x and y are distances measured along in x and y direction in meters and t is time in seconds. This wave has
(a) A wavelength of 0.25 m and travels in $+ve$ x direction
(b) A wavelength of 0.25 m and travels in $+ve$ y direction
(c) A wavelength of 0.5 m and travels in - ve y direction
(d) A wavelength of 0.5 m and travels in - ve x direction

Q 9. A travelling wave passes a point of observation. At this point, the time interval between successive crests is 0.2 seconds
(a) The wavelength is 5 m
(b) The frequency is 5 Hz
(c) The velocity of propagation is 5 m/s
(d) The wavelength is 0.2 m

Q 10. At a moment in a progressive wave, the phase of a particle executing S.H.M. is $\frac{\pi}{3}$. Then the phase of the particle 15 cm ahead and at the time $\frac{T}{2}$ will be, if the wavelength is 60 cm
(a) $\frac{\pi}{2}$ (b) $\frac{2\pi}{3}$
(c) zero (d) $\frac{5\pi}{6}$

Q 11. Which one of the following does not represent a travelling wave?
(a) $y = \sin(x - vt)$ (b) $y = y_m \sin k(x + vt)$
(c) $y = y_m \log(x - vt)$ (d) $y = f(x^2 - vt^2)$

Q 12. If the equation for the transverse wave in a string is given by $y = 5\sin\left[2\pi\left(\frac{t}{0.02} - \frac{x}{50}\right)\right]$ with lengths expressed in cm and time period in seconds, calculate the wave velocity and maximum particle velocity

(a) 25 m/s, 5π m/s (b) 5π m/s, 25 m/s

(c) 25 m/s, $\frac{5}{\pi}$ m/s (d) $\frac{5}{\pi}$ cm/s, 25 m/s

Q 13. The equation of a simple harmonic wave is given by $y = 3\sin\left[\frac{\pi}{2}(50t - x)\right]$ where x and y are in meters and x is in second. The ratio of maximum particle velocity to the wave velocity is

(a) 2π (b) $\frac{3}{2}\pi$

(c) 3π (d) $\frac{2}{3}\pi$

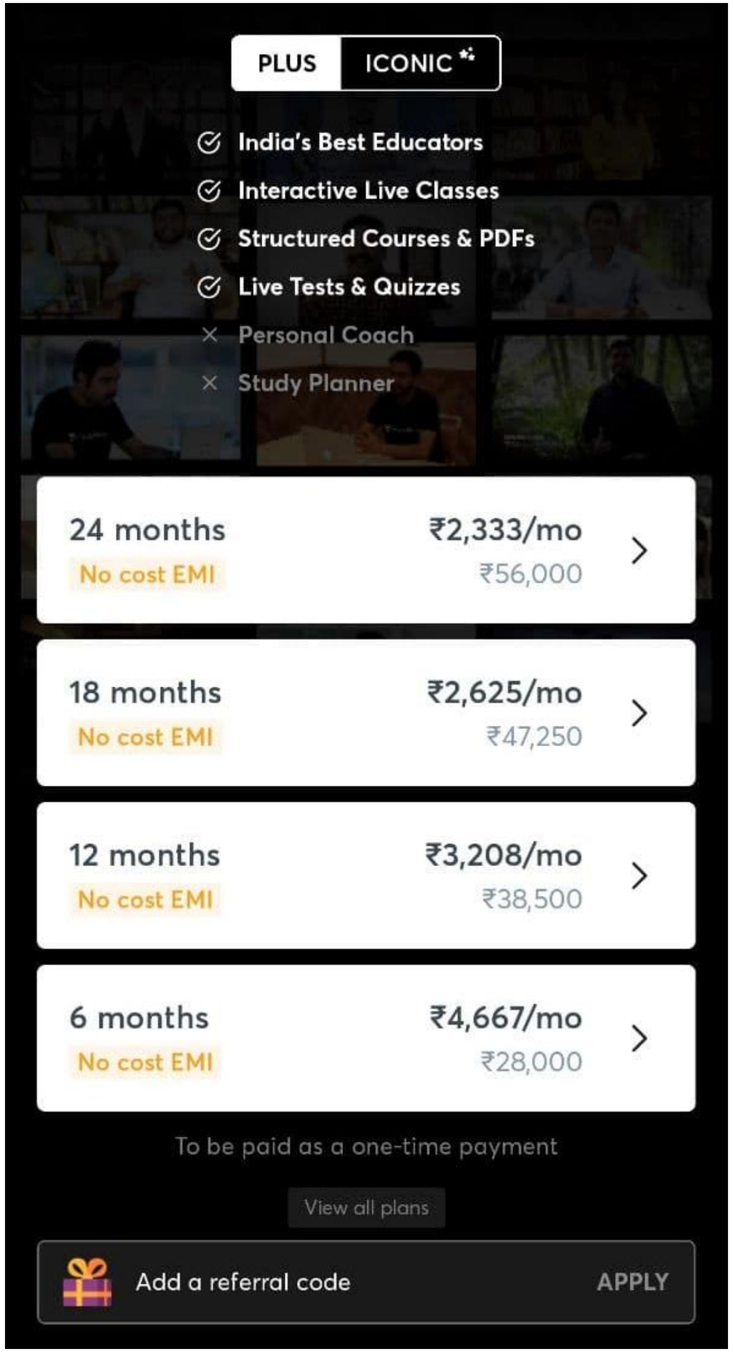
Q 14. A transverse wave is given by $y = A\sin\left[2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)\right]$. The maximum particle velocity is equal to 4 times the wave velocity when

(a) $\lambda = 2\pi A$ (b) $\lambda = \frac{1}{2}\pi A$

(c) $\lambda = \pi A$ (d) $\lambda = \frac{1}{4}\pi A$

Answer Key

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



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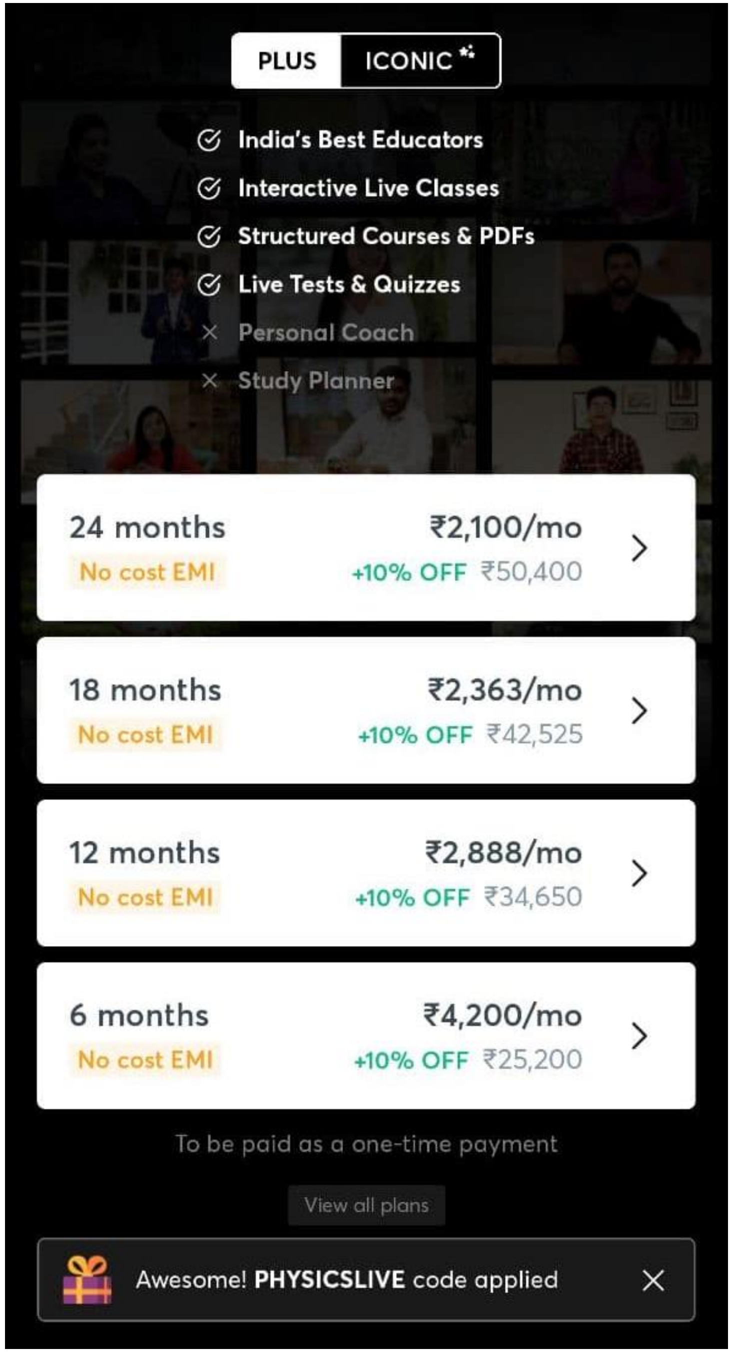

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Written Solution

DPP-1 Waves: Equation of travelling Wave and Wave & Particle Velocity

By Physicsaholics Team

Solution: 1

$$y = 7\sin[\pi(2t - 2x)]$$

$$y = 7\sin[2\pi(t - x)]$$

Compare with

$$y = A\sin\left[\omega\left(t - \frac{x}{v}\right)\right]$$

So, $\omega = 2\pi$ rad/s

& $\boxed{v = 1\ \text{m/s}}$ Ans

Ans. a

Solution: 2

$$y = 7\sin\left\{7\pi t - 0.4\pi x + \frac{\pi}{3}\right\}$$

$\omega = 7\pi$ rad/s

$k = 0.4\pi$

$$\frac{\omega}{v} = 0.4\pi$$

$$\frac{7\pi}{v} = 0.4\pi$$

$$v = \frac{7\pi}{0.4\pi} = \frac{70}{4}$$

$$v = \frac{35}{2}$$

$$\boxed{v = 17.5 \text{ m/s}}$$ Ans

Ans. a

Solution: 3

$y = 4\sin\left[\frac{\pi}{2}\left(2t + \frac{x}{8}\right)\right]$

$= 4\sin\left[\frac{\pi}{2}\times 2\left(t + \frac{x}{16}\right)\right]$

$y = 4\sin\left[\pi\left(t + \frac{x}{16}\right)\right]$

Compare with

$y = A\sin\left[\omega\left(t - \frac{x}{v}\right)\right]$

$\boxed{A = 4\,cm}$; $\omega = \pi$ rad/s

$2\pi f = \pi \Rightarrow f = \frac{1}{2}\,Hz \Rightarrow \boxed{f = 0.5\,Hz}$

$v = -16$ m/s

$\Rightarrow$ moving in $-ve$ x dirn

So; speed; $\boxed{v = 16\,cm/s}$

wavelength $\Rightarrow \lambda = \frac{v}{f}$

$\lambda = \frac{16}{0.5}$

$\boxed{\lambda = 32\,cm}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{\pi} = 2\,sec$

$\boxed{T = 2\,sec}$

(c) $\Delta\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{\lambda}(v\Delta t)$

$\Delta\phi = \frac{2\pi}{32}(16 \times 0.4) = 0.4\pi$

$\boxed{\Delta\phi = 0.4\pi}$

(d) $\Delta\phi = \frac{2\pi}{\lambda}\Delta x = \frac{2\pi}{32} \times 12 = \frac{3\pi}{4}$

$\Delta\phi = \frac{3}{4} \times 180$

$\boxed{\Delta\phi = 135^\circ}$

Ans. a

Solution: 4

$$y = 2\sin[\pi(0.5x - 200t)]$$

$$= 2\sin[\pi \times 0.5(x - 400t)]$$

$$= 2\sin\left[\frac{\pi}{2}(x - 400t)\right]$$

$$= 2\sin\left[-\frac{\pi}{2}(400t - x)\right]$$

$$= -2\sin\left[\frac{\pi}{2}(400t - x)\right]$$

$$= -2\sin\left[\frac{\pi}{2}\times 400\left(t - \frac{x}{400}\right)\right]$$

$$y = -2\sin\left[200\pi\left(t - \frac{x}{400}\right)\right]$$

so; $\boxed{v = 400 \text{ cm/s}}$

OR

$$\because y = 2\sin[\pi(0.5x - 200t)]$$

$$= 2\sin[(0.5\pi x - 200\pi t)]$$

$$\omega = 200\pi$$

$$\& \ k = 0.5\pi$$

$$v = \frac{\omega}{k} = \frac{200\pi}{0.5\pi}$$

$\boxed{v = 400 \text{ cm/s}}$ Ans

Ans. d

Solution: 5

$y = 0.25 \sin(10\pi x - 2\pi t)$

↳ -ve sign

so; -ve sign means; wave is travelling in +ve x dirn.

now; $k = 10\pi = \frac{2\pi}{\lambda}$

$\lambda = \frac{2\pi}{10\pi} = 0.2$

$\boxed{\lambda = 0.2\,m}$

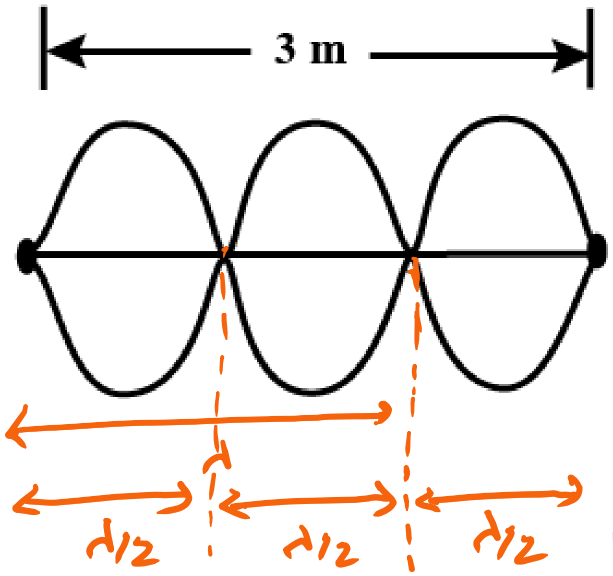
$\omega = 2\pi$ rad/s

$2\pi f = 2\pi$

$\boxed{f = 1\,Hz}$

Ans. a

Solution: 6



so; from diagram

$$3\left(\frac{\lambda}{2}\right) = 3m.$$

$$\Rightarrow \boxed{\lambda = 2m} \text{ Ans}$$

Ans. b

Solution: 7

$$y = 8\sin\left[\pi + \left(\frac{t}{10} - \frac{x}{4}\right)\frac{\pi}{3}\right]$$

$$y = 8\sin\left[\pi + \left(\frac{\pi}{30}t - \frac{\pi}{12}x\right)\right]$$

so; $\omega = \frac{\pi}{30}$ rad/s

& $k = \frac{\pi}{12}$

as; $k = \frac{2\pi}{\lambda} = \frac{\pi}{12}$

$\boxed{\lambda = 24\ m}$ Ans

Ans. a

Solution: 8

$x = 1.2 \sin(314t + 12.56 y)$

+ve sign means wave is moving in -ve y dirn.

and

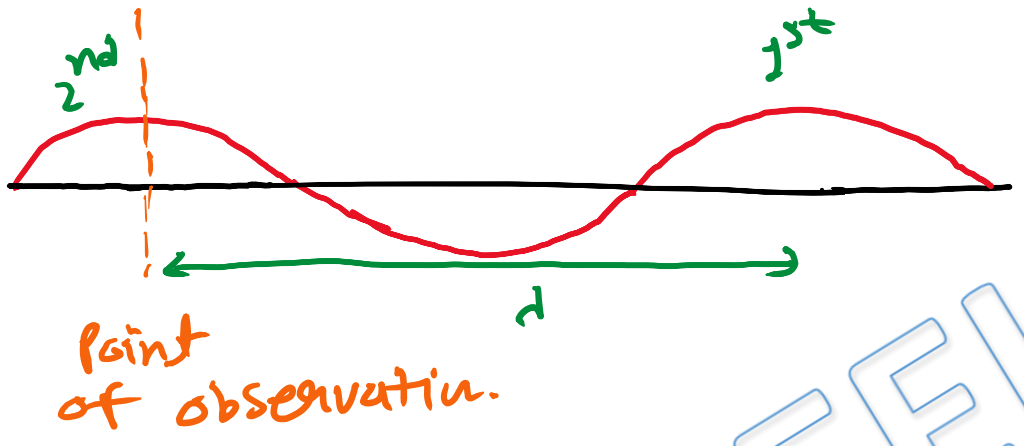
$k = 12.56 = \frac{2\pi}{\lambda}$

$\lambda = \frac{2\pi}{12.56}$

$\boxed{\lambda = 0.5 m}$ Ans

Ans. c

Solution: 9



& we can't calculate wavelength & velocity of wave from given information.

Length betwn two successive crests = d

time taken = Time period = 0.2 sec

so; $T = 0.2$ sec

$\frac{2\pi}{\omega} = 0.2$ sec

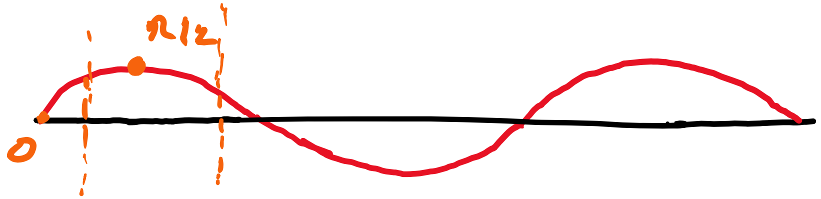
$\omega = 10\pi$ rad/s

$2\pi f = 10\pi$

$f = 5$ Hz

Ans. b

Solution: 10



$\phi = \frac{\pi}{3}$ ↳ $\phi' = \frac{\pi}{3} + \Delta\phi$

$\because \lambda = 60\,cm$

& $\Delta x = 15\,cm$

then; $\Delta\phi = \frac{2\pi}{\lambda}\Delta x$

$= \frac{2\pi}{60} \times 15$

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

$\phi' = \phi_i + \Delta\phi$

$\phi' = \frac{\pi}{3} + \frac{\pi}{2}$

$\phi' = \frac{2\pi}{6} + \frac{3\pi}{6}$

$$\boxed{\phi' = \frac{5\pi}{6}}$$ Ans

Ans. d

Solution: 11

if a function is wave then it must satisfy

$$\frac{d^2y}{dt^2} = v^2 \frac{d^2y}{dx^2}$$

(d) function of $f(x \pm vt)$

(a) $y = \sin(x - vt) = f(x - vt)$

Similar to standard wave form ✓

(b) $y = y_m \sin[k(x + vt)] = f(x + vt)$

this also similar to standard wave form. ✓

$y = y_m \log(x - vt)$

(c) $\frac{dy}{dx} = y_m\left[\frac{1 \times (1)}{(x - vt)}\right] = \frac{y_m}{(x - vt)} = y_m (x - vt)^{-1}$

$\frac{d^2y}{dx^2} = -y_m (x - vt)^{-2}$ —— (1)

$\frac{dy}{dt} = y_m \frac{1(-v)}{x - vt} = -\frac{v\, y_m}{x - vt} = -v y_m (x - vt)^{-1}$

$\frac{d^2y}{dt^2} = -v y_m \left[(-1)(x - vt)^{-2} \cdot (-v)\right] = -v^2 y_m (x - vt)^{-2}$

$\frac{d^2y}{dt^2} = -v^2 y_m (x - vt)^{-2}$ — (2)

from eq^n (1) & (2)

$\frac{d^2y}{dt^2} = v^2 \frac{d^2y}{dx^2}$ ✓ [∴ give function is wave]

(d) $y = f(x^2 - vt^2)$

$\frac{d^2y}{dt^2} = -2v$ & $\frac{d^2y}{dx^2} = 2$

$\frac{d^2y}{dt^2} \neq v^2 \frac{d^2y}{dx^2}$

So, this function dose not represents wave.

Ans. d

Solution: 12

$$y = 5\sin\left[2\pi\left(\frac{t}{0.02} - \frac{x}{50}\right)\right]$$

$$y = 5\sin\left[\frac{2\pi}{0.02}\left(t - \frac{0.02x}{50}\right)\right]$$

$$y = 5\sin\left[100\pi\left(t - \frac{x}{2500}\right)\right]$$

so, $\boxed{\omega = 100\pi \text{ rad/s}}$

$$v = 2500 \text{ cm/s}$$

$$\boxed{v = 25 \text{ m/s}}$$

$$(V_p)_{max} = A\omega = (5\times10^{-2}\text{ m})\times(100\pi)$$

$$\boxed{(V_p)_{max} = 5\pi \text{ m/s}}$$

Ans. a

Solution: 13

$$y = 3\sin\left[\frac{\pi}{2}(50t - x)\right]$$

$$= 3\sin\left[\frac{50\pi}{2}\left(t - \frac{x}{50}\right)\right]$$

$$y = 3\sin\left[25\pi\left(t - \frac{x}{50}\right)\right]$$

wave velocity $= v = 50$ m/s

max particle velocity; $v_p = A\omega$

$= 3 \times 25\pi = 75\pi$ m/s

so; $\frac{v_p}{v} = \frac{75\pi}{50} = \frac{3\pi}{2}$

$$\boxed{\frac{v_p}{v} = \frac{3\pi}{2}}$$ Ans

Ans. b

Solution: 14

$$y = A\sin\left[2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)\right]$$

$$\because \omega = \frac{2\pi}{T} \quad \& \quad k = \frac{2\pi}{\lambda}$$

given; $(v_p)_{max} = 4V$

$$(A\omega) = 4\left(\frac{\omega}{k}\right)$$

$$k = \frac{4}{A}$$

$$\frac{2\pi}{\lambda} = \frac{4}{A}$$

$$\lambda = \frac{2\pi A}{4}$$

$$\boxed{\lambda = \frac{\pi A}{2}} \text{ Ans}$$

Ans. b

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Chalo Niklo