

NCERT 11.15. Q10

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Question: For the travelling harmonic wave $y(x, t) = 2.0 \cos 2\pi (10t - 0.0080x + 0.35)$ where x and y are in cm and t in s. Calculate the phase difference between oscillatory motion of two points separated by a distance of

- (a) 4 m
- (b) 0.5 m
- (c) $\lambda/2$
- (d) $3\lambda/4$

Solution:

Harmonic wave :

$$y(x, t) = 2.0 \cos 2\pi (10t - 0.0080x + 0.35) \quad (1)$$

Phase of harmonic wave (at x):

$$= 2\pi (10t - 0.0080x + 0.35) \quad (2)$$

$$k = 2\pi(0.008) \quad (3)$$

$$\therefore k = \frac{2\pi}{\lambda} \quad (4)$$

$$\lambda = \frac{2\pi}{k} \quad (5)$$

$$\lambda = \frac{2\pi}{2\pi \times 0.008} \quad (6)$$

$$\lambda = 125\text{cm} \quad (7)$$

(a) phase of harmonic wave at $(x+400\text{cm})$:

$$= 2\pi (10t - 0.0080(x + 400) + 0.35) \quad (8)$$

(from equation (2))

\Rightarrow phase difference :

$$= 2\pi (10t - 0.0080(x + 400) + 0.35) - 2\pi (10t - 0.0080x + 0.35) \quad (9)$$

$$= 2\pi \times 0.0080 \times 400 \quad (10)$$

$$= 6.4\pi \text{ radians} \quad (11)$$

(b) phase of harmonic wave at $(x + 50\text{cm})$:

$$= 2\pi (10t - 0.0080(x + 50) + 0.35) \quad (12)$$

(from equation (2))

\Rightarrow phase difference :

$$= 2\pi (10t - 0.0080(x + 50) + 0.35) - 2\pi (10t - 0.0080x + 0.35) \quad (13)$$

$$= 2\pi \times 0.0080 \times 50 \quad (14)$$

$$= 0.8\pi \text{ radians} \quad (15)$$

(c) phase of harmonic wave at $\left(x + \frac{\lambda}{2}\right)$:

$$= 2\pi (10t - 0.0080\left(x + \frac{\lambda}{2}\right) + 0.35) \quad (16)$$

(from equation (2))

\Rightarrow phase difference :

$$= 2\pi \left(10t - 0.0080\left(x + \frac{\lambda}{2}\right) + 0.35\right) - 2\pi (10t - 0.0080x + 0.35) \quad (17)$$

$$= 2\pi \times 0.0080 \times \frac{\lambda}{2} \quad (18)$$

$$= 2\pi \times 0.0080 \times \frac{125}{2} (\because \lambda = 125) \quad (19)$$

$$= \pi \text{ radians} \quad (20)$$

(d) phase of harmonic wave at $\left(x + \frac{3\lambda}{4}\right)$:

$$= 2\pi \left(10t - 0.0080\left(x + 3 \times \frac{\lambda}{4}\right) + 0.35\right) \quad (21)$$

(from equation (2))

\Rightarrow phase difference :

$$= 2\pi \left(10t - 0.0080\left(x + 3 \times \frac{\lambda}{4}\right) + 0.35\right) - 2\pi (10t - 0.0080x + 0.35) \quad (22)$$

$$= 2\pi \times 0.0080 \times 3 \times \frac{\lambda}{4} \quad (23)$$

$$= 2\pi \times 0.0080 \times 3 \times \frac{125}{4} (\because \lambda = 125) \quad (24)$$

$$= \frac{3\pi}{2} \text{ radians} \quad (25)$$