NCERT 11.15. Q10

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Question: For the travelling harmonic wave $y(x,t) = 2.0cos2\pi(10t - 0.0080x + 0.35)$ 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 :

Parameter	Description	Value
k	angular wave number	$2\pi(0.008)$
$\lambda = \frac{2\pi}{k}$	wavelength	$125\,cm$
f	natural frequency	10
A	amplitude	2.0
ϕ	phase	$2\pi(0.35)$

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

Phase of harmonic wave (at x):

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

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

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

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

$$\lambda = \frac{2\pi}{2\pi \times 0.008}$$

$$\lambda = 125\text{cm} \quad (6)$$

$$\text{Phase difference} = \theta_1 - \theta_2 \quad (7)$$

$$= (kx_1 + \omega t + \phi) - (kx_2 + \omega t + \phi) \quad (8)$$

$$= k(x_1 - x_2) \quad (9)$$

(a) $\because (x_1 - x_2) = 400\,cm$

$$\text{phase difference} = k(x_1 - x_2) \quad (9)$$

$$= 2\pi \times 0.0080 \times 400$$

$$= 6.4\pi \text{ radians} \quad (10)$$

(b) $\because (x_1 - x_2) = 50\,cm$

$$\text{phase difference} = k(x_1 - x_2) \quad (9)$$

$$= 2\pi \times 0.0080 \times 50$$

$$= 0.8\pi \text{ radians} \quad (11)$$

(c) $\because (x_1 - x_2) = \frac{\lambda}{2}\,cm$

$$\text{phase difference} = k(x_1 - x_2) \quad (9)$$

$$= 2\pi \times 0.0080 \times \frac{\lambda}{2} \quad (12)$$

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

$$= \pi\text{radians} \quad (13)$$

(d) $\because (x_1 - x_2) = \frac{3\lambda}{4}\,cm$

$$\text{phase difference} = k(x_1 - x_2) \quad (9)$$

$$= 2\pi \times 0.0080 \times 3 \times \frac{\lambda}{4} \quad (14)$$

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

$$= \frac{3\pi}{2}\text{radians} \quad (15)$$