

NCERT 11.15. Q10

EE23BTECH11010 - Venkatesh Bandawar*

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):

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

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

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

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

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

$$\lambda = 125 \quad (7)$$

(a) phase of harmonic wave (at $x=4$) :

$$= 2\pi (10t - 0.0080(x+4) + 0.35) \quad (8)$$

(from equation (2))

\Rightarrow phase difference :

$$= 2\pi (10t - 0.0080(x+4) + 0.35) - 2\pi (10t - 0.0080x + 0.35) \quad (9)$$

$$= 2\pi \times 0.0080 \times 4 \quad (10)$$

$$= \frac{8\pi}{125} \text{ radians} \quad (11)$$

(b) phase of harmonic wave (at $x=0.5$) :

$$= 2\pi (10t - 0.0080(x+0.5) + 0.35) \quad (12)$$

(from equation (2))

\Rightarrow phase difference :

$$= 2\pi (10t - 0.0080(x+0.5) + 0.35) - 2\pi (10t - 0.0080x + 0.35) \quad (13)$$

$$= 2\pi \times 0.0080 \times 0.5 \quad (14)$$

$$= \frac{\pi}{125} \text{ radians} \quad (15)$$

(c) phase of harmonic wave (at $x=\lambda/2$) :

$$= 2\pi (10t - 0.0080(x+\lambda/2) + 0.35) \quad (16)$$

\Rightarrow phase difference :

$$= 2\pi (10t - 0.0080(x+\lambda/2) + 0.35) - 2\pi (10t - 0.0080x + 0.35) \quad (17)$$

$$= 2\pi \times 0.0080 \times \lambda/2 \quad (18)$$

$$(\because \lambda = 125, \text{ from equation (7)})$$

$$= 2\pi \times 0.0080 \times 125/2 \quad (19)$$

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

(d) phase of harmonic wave (at $x=3\lambda/4$) :

$$= 2\pi (10t - 0.0080(x+3\lambda/4) + 0.35) \quad (21)$$

\Rightarrow phase difference :

$$= 2\pi (10t - 0.0080(x+3\lambda/4) + 0.35) - 2\pi (10t - 0.0080x + 0.35) \quad (22)$$

$$= 2\pi \times 0.0080 \times 3\lambda/4 \quad (23)$$

$$(\because \lambda = 125, \text{ from equation (7)})$$

$$= 2\pi \times 0.0080 \times 3 \times 125/4 \quad (24)$$

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