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

Solution:

Parameter	Description	Value
k	angular wave number	$2\pi(0.008)$
$\lambda = \frac{2\pi}{k}$	wavelength	$125\,cm$
f	frequency	10
A	amplitude	2.0
ϕ	phase constant	$2\pi(0.35)$
θ	phase of harmonic wave	
x	position of harmonic wave	
t	time	
$x_2 - x_1$	path difference	$400\,cm$
		$50\,cm$
		$\frac{\lambda}{2}$
		$\frac{3\lambda}{4}$

TABLE 1
Given parameters

Parameter	Description	subquestion	Value
$\Delta\theta$	phase difference	(a)	6.4π radians
		(b)	0.8π radians
		(c)	π radians
		(d)	$\frac{3\pi}{2}$ radians

TABLE 2
Phase differences

General form of harmonic wave :

$$y(x,t) = A\cos(2\pi ft - kx + \phi) \tag{1}$$
$$y(x,t) = 2.0\cos 2\pi(10t - 0.0080x + 0.35) \tag{2}$$

Phase of harmonic wave (at x):

$$= (2\pi ft - kx + \phi) \tag{3}$$

$$\text{Phase difference}\,(\Delta\theta) = \theta_1 - \theta_2 \tag{4}$$
$$= (2\pi ft - kx_1 + \phi)$$
$$- (2\pi ft - kx_2 + \phi) \tag{5}$$
$$= k(x_2 - x_1) \tag{6}$$