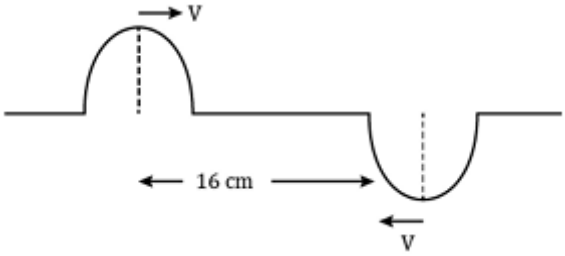
Chapter 9

Wave Optics

Exercise

Q.1 Two identical pulses whose centres are initially 16 cm apart are moving towards each other on a stretched string with same speed as shown in the figure. After 4 seconds, if the vertical displacement for resultant pulse is zero then the speed of pulses is



(A) 2 cm/s **(B)** 1 cm/s **(C)** 4 cm/s **(D)** 8 cm/s

Q.2 Light waves from two coherent sources superimposes at a point. The waves at this point can be expressed as $y_1 = a\,sin(10^{15}\pi t)$ and $y_2 = 2a\,sin(10^{15}\pi t + \phi)$. Here all quantities are in SI units. Find the resultant amplitude (in m), and frequency (in Hz), of the resultant wave, if phase difference ϕ is equal to $\pi/3$.

(A) $a\sqrt{5},\ 5 \times 10^{14}$ **(B)** $a\sqrt{7},\ 5 \times 10^{14}$ **(C)** $a\sqrt{5},\ 10^{15}$ **(D)** $a\sqrt{7},\ 10^{15}$

Q.3 A travelling wave is having wavelength of 3 cm. At any instant, the two particles at a distance of 16.5 cm apart, will have a phase difference of

(A) $12\,\pi$ **(B)** $11\,\pi$ **(C)** $10\,\pi$ **(D)** $13\,\pi$

Q.4 The amplitude of a wave represented by the displacement equation:

$y = \frac{1}{\sqrt{a}}\sin\omega t \pm \frac{1}{\sqrt{b}}\cos\omega t$ will be,

(A) $\frac{a+b}{ab}$ **(B)** $\frac{\sqrt{a}+\sqrt{b}}{ab}$ **(C)** $\frac{\sqrt{a}\pm\sqrt{b}}{ab}$ **(D)** $\sqrt{\frac{a+b}{ab}}$

Q.5 Two sinusoidal waves are defined by the functions:

$y_1 = (2.00\text{ cm})\,sin(20x - 32t)$ and

$y_2 = (2.00\text{ cm})\,sin(25x - 40t)$ where y_1, y_2 and x are in centimeters and t is in seconds. What is the phase difference between these two waves at the point $x = 5.00$ cm at $t = 2$ s?

(A) 516° **(B)** 258° **(C)** 333° **(D)** 412°

Q.6 Four independent waves are represented by the following equations:

$$X_1 = a_1 \sin\omega t \ldots (1)$$
$$X_2 = a_1 \sin 2\omega t \ldots (2)$$
$$X_3 = a_1 \sin\omega_1 t \ldots (3)$$
$$X_4 = a_1 \sin(\omega t + \delta) \ldots (4)$$

Interference is possible between waves represented by the equations,

(A) 3 and 4 **(B)** 1 and 2 **(C)** 2 and 4 **(D)** 1 and 4

Q.7 Two waves are passing through a region in the same direction and at the same time. If the equations of these waves are,

$$y_1 = a\sin\frac{2\pi}{\lambda}(vt - x),\ and$$
$$y_2 = b\sin\frac{2\pi}{\lambda}(vt - x + x_0)$$

The amplitude of the resulting wave for $x_0 = \left(\frac{\lambda}{2}\right)$ is

(A) $|a - b|$ **(B)** $\sqrt{a^2 + b^2}$ **(C)** $a + b$ **(D)** $\sqrt{a^2 - b^2}$

Q.8 A wave given by equation $y = 8\ sin 2\pi(0.1x - 2t)$ where x and y are in centimeters and t is in seconds. At any instant, the phase difference between two particles, separated by 2.0 cm along the x-direction, is,

(A) 18° **(B)** 36° **(C)** 54° **(D)** 72°

Q.9 There is a destructive interference between the two waves of wavelength λ coming from two different paths at a point. To get the constructive interference at that point, the path of one wave is to be increased by,

(A) $\frac{\lambda}{4}$ **(B)** $\frac{\lambda}{4}$ **(C)** $\frac{\lambda}{4}$ **(D)** λ

Q.10 The equation of displacement of two waves are given as:

$$y_1 = 10\ sin\left(3\pi t + \frac{\pi}{3}\right),\ \text{and}$$
$$y_2 = 5(sin\ 5\pi t + \sqrt{3}\ cos\ 5\pi t)$$

What is the ratio of their amplitudes?

(A) 1: 2 **(B)** 2: 1 **(C)** 1: 1 **(D)** None of the above

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(B)	(B)	(D)	(A)	(D)	(A)	(D)	(B)	(C)