doubtnut
India's Number 1 Education App

PHYSICS

NCERT - NCERT PHYSICS(ENGLISH)

WAVES

Solved Example

1. Given below are some examples of wave motion. State in each case, if the wave motion is transverse, longitudinal or a combination of

both?

(i) Motion of a kink in a long coil spring produced by displacing one end of spring side ways.

(ii) Waves produed in a cylinder containing a liquid by moving its piston back and forth.

(iii) Waves produed by a motor boat sailing in water.

(iv) Light waves travelling from sun to earth.

(v) ultrasonic waves in air produced by a vibrating quartz crystal.

Watch Video Solution

2. A wave travelling along a strong is described by

$y(x, t) = 0.005 \sin(80.0x - 3.0t)$

in which the numerical constants are in SI units $(0.005m, 80.0radm^{-1}$ and $3.0rads^{-1})$. Calculate (a) the amplitude. (b) the wavelength (c) the period and frequency of the wave. Also , calculate the displacement y of the wave at a distance $x = 30.0$ cm and time t=20 s?

Watch Video Solution

3. A steel wire 0.72 m long has a mass of 5.0×10^{-3} kg . If the wire is under a tension of 60 N, what is the speed of transverse waves on the wire ?

Watch Video Solution

4. Estimate the speed of sound in air at standard temperature and pressure. The mass of 1 mole of air is $29.0 \times 10^{-3} kg$, λ for air $= 7/5.$

Watch Video Solution

5. A pipe 30.0 cm long is open at both ends. Which harmonic mode of the pipe resonates with a 1.1kHz source? Will resonance with the same source be observed if one end of the pipe is closed ? Take the speed of sound in air as $330ms^{-1}$.

Watch Video Solution

6. Two sitar strings A and B playing the note 'Dha' are slightly out of tune and produce

beats of frequency 5 Hz. The tension of string B is slightly increased and the beat frequency is found to decrease to 3 Hz. What is the original frequency of B, if the frequency of A is 427 Hz?

Watch Video Solution

7. A rocket is moving at a speed of $200ms^{-1}$ towards a stationary target. While moving, it emits a wave of frequency 1000 Hz. Some of the sound reaching the target gets reflected

back to the racket as an echo. Calculate the frequency of sound as detected by the person at the position of target and frequency of echo as detected by the rocket . Given velocity of sound $= 330ms^{-1}$.

Watch Video Solution

Exercise

1. A string of mass 2.50kg is under a tension os 200N. The length of the stretched string is

20.0m. If the transverse jerk is struck at one end of the string, how long does the disturbance take to reach the other end?

Watch Video Solution

2. A stone dropped from the top of a tower of height 300 m high splashes into the water of a pond near the base of the tower. When is the splash heard at the top ? Given that the speed of sound in air is $340ms^{-1}$? $(g = 9.8ms^{-2})$.

Watch Video Solution

3. A steel wire has a length of 12.0m and a mass of 2.10kg. What should be the tension in the wire so that speed of a transverse wave on the wire equals the speed of sound in dry air at $20^{\circ}C = 343ms^{-1}$.

Watch Video Solution

4. Use the formula $v = \sqrt{\frac{\gamma P}{\rho}}$ to explain why the speed of sound in air

(a) is independent of pressure, (b) increases with temperature, (c) increases with humidity.

Watch Video Solution

5. you have learnt that a travelling wave in one dimension is represented by a function $y = f(x, t)$ where x and t must appear in the combination $ax \pm bt$ or $x - vt$ or $x + vt$,i.e. $y = f(x \pm vt)$. Is the converse true? Examine if the folliwing function for y can possibly represent a travelling wave

(a) $(x - vt)^2$

(b) $\log[(x + vt)/x_0]$

(c) $1/(x + vt)$

Watch Video Solution

6. A bat emits ultrasonic sound of frequency 1000 kHz in air. If the sound meets a water surface, what is the wavelength of (i) the reflected sound, (ii) the transmitted sound ? Speed of sound in air is 340 ms^{-1} and in water $1486ms^{-1}$.

Watch Video Solution

7. A hospital uses an ultrasonic scanner to locate tumour in a tissue. What is the wavelength of sound in a tissue in which the speed of sound is $1.7km/s$? The operating frequency of the scanner is $4.2MHz$.

Watch Video Solution

8. A transverse harmonic wave on a strin is decribed by

$y(x, t) = 3.0 \sin(36t + 0.018x + \pi/4)$

Where x and y are in cm and t in s. The positive direction of x is from left to right.

(a) Is this a travelling wave or a stationary wave ?

If it is travelling, what are the speed and direction of its propagation ?

(b) What are its amplitude and frequency ?

(c) What is the initial phase at the starting point ?

What is the least distance between two successive crests in the wave ?

View Text Solution

9. For the wave described in Exercise 15.8, plot the displacement (y) versus (t) graphs for x = 0, 2 and 4 cm. What are the shapes of these graphs? In which aspects does the oscillatory motion in travelling wave differ from one point to another: amplitude, frequency or phase?

View Text Solution

10. For a travelling harmonic wave $y = 2.0\cos(10t - 0.0080x + 0.35)$, where x and y are in centimetres and t in seconds. What is the phase difference between oscillatory motion of two points separated by a distance of (a) 4m (b) 0.5 m (c) $\lambda/2$ (d) $3\lambda/4$

Watch Video Solution

11. The transvers displacement of a string (clamped at its both ends) is given by

$$y(x,t) = 0.06 \sin\left(\frac{2\pi}{3}s\right)\cos(120\pi t)$$

Where x and y are in m and t in s. The length of the string $1.5m$ and its mass is $3.0 \times 10^{-2} kg$.

Answer the following :

(a) Does the funcation represent a travelling wave or a stational wave ?

(b) Interpret the wave as a superposition of two waves travelling in opposite directions. What is the wavelength. Frequency and speed

of each wave ?

Datermine the tension in the string.

Watch Video Solution

12. (i) The transverse displacement of a string (clamped at its two ends) is given by $y(x, t) = 0.06 \sin\left[\frac{2\pi}{3}x\right] \cos 120\pi t,$

where x, y are in m and t is in s.

Do all the points on the string oscillate with the same (a) frequency, (b) phase, (c) amplitude ? Explain your answers.

Watch Video Solution

13. Given below are some functions of x and t to represent the displacement (transverse or longitudinal) of an elastic wave. State which of these represent (i) a travelling wave, (ii) a stationary wave or (iii) none at all?

(a) $y = 2\cos(3x)\sin(10t)$

(b) $y = 3\sin(5x - 0.5t) + 4\cos(5x - 0.5t)$

(c) $y = \cos x \sin t + \cos 2x \sin 2t$

Watch Video Solution

14. A wire stretched between two rigid supports vibrates in its fundamental mode with a frequency of 45Hz. The mass of the wire is 3.5×10^{-2}kg and its linear mass density is $4.0 \times 10^{-2} kgm^{-1}$. What is (a) the speed of a transverse wave on the string , and (b) the tension in the string?

Watch Video Solution

15. A metre-long tube open at one end, with a movable piston at the other end, shows resonance with a fixed frequency source (a tuning fork of frequency 340Hz) when the tube length is 25.5cm or 79.3cm. Estimate the speed of sound in air at the temperature of the experiment. The edge effects amy be neglected.

Watch Video Solution

16. A steel rod 100 cm long is clamped at its middle. The fundamental frequency of loungitudinal vibrations of the fundamental frequency of longitudinal vibrations of the rod are given to be 2.53 KHz. What is the speed of soind in steel?

Watch Video Solution

17. A pipe 20cm long is closed at one end. Which harmonic mode of the pipe is

resonantly excited by a 430Hz source? Will the same source be in resonance with the pipe if both ends are open? Take speed of sound in air $340 m / s$.

Watch Video Solution

18. Two sitar strings A and B playing the note 'Ga' are slightly out of tune and produce beats of frequency 6 Hz. The tension in the string A is slightly reduced and the beat frequency is found to reduce to 3 Hz. If the original

frequency of A is 324 Hz, what is the frequency of B?

Watch Video Solution

19. Explain why (or how) : (a) In a sound wave, a displacement node is a pressure antinode and vice-versa,

(b) Bats can ascertain distances, directions, nature and size of obstacles without any eyes,

(c) a violin note and sitar note may have the same frequency, yet we can distinguish

between the two notes, (d) Solids can support both longitudinal and transverse waves, but only longitudinal waves can propagate in gases,

(e) The shape of pulse gets distorted during propagation in a dispersive medium.

View Text Solution

20. A train, standing at the outer signal of a railway station blows a whistle of frequency 400Hz in still air. (i) What is the frequency of

the whistle for a platform observer when the train (a) approaches the platform with a speed of $10ms^{-1}$, (b) receeds from the platform with a speed of $10ms^{-1}$? (ii) What is the speed of sound in each case ? The speed of sound in still air can be taken as $340ms^{-1}$

Watch Video Solution

21. A train, standing in a stationyard, blows a whistle of frequency 400Hz in still air. The wind starts blowing in the direction from the

yard to the station at a speed of $10ms^{-1}$. What are the frequency, wavelength, and speed of sound for an observer standing on the station's platform ? Is the situation exactly identical to the case when the air is still and the observer runs towards the yard at a speed of $10ms^{-1}$? Th speed of sound in still air can be taken as $340ms^{-1}$.

View Text Solution

22. A travelling harmonic wave on a string is described by $y(x, t) = 7.5 \sin(0.0050x + 12t + \pi/4)$ (a) what are the displacement and velocity of oscillation of a point at $x = 1cm,$ and $t = 1s$? Is this velocity equal to the velocity of wave propagation ?

(b) Locate the point of the string which have the same transverse displacement and velocity as $x = 1cm$ point at $t = 2s, 5s$ and 11s.

View Text Solution

23. A narrow sound pulse (for example, a short pip by a whistle) is sent across a medium. (a) Does the pulse have a definite (i) wavelength, (ii) frequency, (iii) speed of propagation ? (b) If the pulse rate is 1 after every $20s$, (i.e. the whistle is blown for a split second after every $20s$) is the frequency of the note produced by the whistle equal to $\frac{1}{20} = 0.05Hz$?

Watch Video Solution

24. One end of a long string of linear mass dnesity $8.0 \times 10^{-3} kgm^{-1}$ is connected to an electrically driven tuning fork of frequency 256 Hz. The other end passes over a pulley and is tied to a pan containing a mass of 90 kg. The pulley end absorbs all the incoming energy so that reflected waves at this end have negligible amplitude. At $t = 0$ the left end (fork end) of the string $x = 0$ has zero transverse displacement $(y = 0)$ and is moving along positive y-direction. The amplitude of the wave is 5.0 cm. Write down

the transverse displacement y as function of x and t that describest the wave on the string.

View Text Solution

25. A SONAR system fixed in a submarine operates at a frequency 40.0kHz. An enemy submarine moves towards the SONAR with a speed of 360 kmh^{-1}. What is the frequency of sound reflected by the submarine ? Take the speed of sound in water to be 1450 ms^{-1}.

Watch Video Solution

26. Earthquakes generate sound waves inside the earth. Unlike a gas, the earth can experience both transverse (S) and longitudinal (P) sound waves. Typically, the speed of S wave is about 4.0 km s^{-1}, and that of P wave is 8.0 kms^{-1}. A seismograph records P and S waved from an earthquake. The first P wave arrives 4 min before the first S wave. Assuming the waves travel in straight line, how far away does the earthquake occur?

Watch Video Solution

27. A bat is flitting about in a cave, navigating via ultrasonic beeps. Assume that the sound emission frequency of the bat is 40kHz. During one fast swoop directly toward a flat wall surface. The bat is moving at 0.03 times the speed of sound in air. What frequency does the bat hear reflected off the wall ?

Watch Video Solution