



PHYSICS

BOOKS - PEARSON IIT JEE

FOUNDATION

WAVES MOTION AND SOUND

Example

1. A source of longitudinal waves vibrates 320 times in two seconds. If the velocity of this

wave in the air is 240ms^{-1} , find the wavelength of the wave .

A. 1 m

B. 1.5 m

C. 2 m

D. 2.5 m

Answer: B



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2. The distance between any two successive antinodes or nodes of a stationary wave is 0.75 m . If the velocity of the wave is 300ms^{-1} , find the frequency of the wave .



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3. An engine of a train is moving towards a platform with a velocity of 100ms^{-1} . If the frequency of sound produced is 200 Hz , find the apparent frequency of the sound as

observed by an observer standing on the platform (Taking velocity of sound = 320m s^{-1})

.



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4. A source of sound and a listener are moving towards each other . The velocity of the source is 20m s^{-1} and that of the observer is 15m s^{-1} . If the velocity of sound is 340 m s^{-1} and its frequency is 640 Hz , find the apparent frequency of the sound .



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5. The fundamental frequency of a stretched string fixed at both the ends is 50 Hz. If the velocity of transverse wave created in string is 10ms^{-1} , find its length .

A. 0.1 m

B. 0.0001 m

C. 100 m

D. 1000 m

Answer: A



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6. A string of 2 m length is fixed at both the ends . The transverse wave created in it propogates with a speed of $50ms^{-1}$. If the string is made to vibrate with three loops , find the frequency of the wave produced .



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7. The mass suspended from the stretched string of a sonometer is 2 kg and the frequency of the tuning fork used is 100 Hz. If the length of the string between the wedges is 50 cm,

find the linear mass density of the string (Taking $g = 10\text{ms}^{-2}$).



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8. An air column enclosed in an open pipe is vibrating in its fundamental mode . The fundamental frequency is 30 Hz. If the velocity of sound air is 300ms^{-1} , find the length of the pipe and frequency of 3rd overtone .



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9. In an experiment conducted to determine the velocity of sound by the resonating air column method , the first resonating length is

noted as 30 cm for a tuning fork of 250 Hz frequency . What is approximate value of second resonating length and what is the approximate value of velocity of sound .



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Test Your Concepts Very Short Answer Questions

1. What is a compression ?



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2. What is wavelength ?



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3. What is a rarefaction ?



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4. Mention the audible range in terms of the time period of waves .



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5. What is node?



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6. Arrange the three states of matter in the decreasing order of velocity of sound in them.



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7. What is a wave ?





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8. Why sound cannot travel through vacuum ?



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9. What is a transverse wave ?



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10. SONAR



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11. What is a longitudinal wave ?



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12. Why transverse waves cannot propagate through vacuum ?



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13. What is a mechanical wave ?



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14. What is frequency ?



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15. What is an electromagnetic wave ?



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16. The points of maximum displacement in a stationary wave are known as _____.



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17. What is a progressive wave ?



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18. What is audible range ?



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19. What is a stationary wave ?



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20. What is time period ?



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21. What is a crest ?



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22. What are infrasonics ?



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23. What is a trough ?



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24. What is an antinode ?



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25. What are ultrasonic's ?



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26. What is phase ?



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27. S.I. unit of frequency is _____.



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28. What do we mean by the term 'in phase'?



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29. On what factors does the speed of sound in a material depend ?



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30. What do we mean by the term 'out of phase'?



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Short Answer Type Questions

1. Distinguish between progressive and stationary waves .



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2. The frequency of fundamental mode of vibration of a stretched string fixed at both the ends is 25 Hz. If the string is made to vibrate with 7 nodes , what is the frequency of vibration ? If the length of string is 3 m , what is the frequency of the 4th harmonic ?



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3. Explain simple harmonic motion in the case of a simple pendulum .



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4. The first resonating length of an air column , for a given tuning fork , is 16.5 cm and the second resonating length is 49.5 cm . If the velocity of sound in air is 300 ms^{-1} , find the frequency of tuning fork used .



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5. Derive the equations $v = n\lambda$, where n and λ are frequency and wavelength .



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6. The frequency of fundamental mode of vibration of an air column enclosed in a closed end pipe is 250 Hz. If its length is 33 cm , find the velocity of sound in air.



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7. What is SONAR ? Mention its uses .



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8. Explain different types of waves .



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9. From the string of a sonometer a constant weight is suspended . The resonating length of the string is noted as 50 cm for a tuning fork of 200 Hz. If a tuning fork of 250 Hz is used , what should be the distance between the two knife edges to get resonance ?



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10. Explain the factors on which the velocity of sound in a gas depends .



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11. Distinguish between mechanical and electromagnetic waves .



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12. Explain the factors on which the velocity of sound in air does not depend.



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13. A source of sound is moving away from an observer at rest with a velocity of 50ms^{-1} . If the frequency of sound is 200 Hz, find the apparent frequency observed by the observer. (Take velocity of sound = 300ms^{-1})



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14. Distinguish between transverse and longitudinal wave motion.



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15. What are ultrasonics and mention their uses ?



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16. Describe an experiment to show that sound waves can be reflected. What are the laws of reflection of sound waves.



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17. Cite an experiment to show that sound needs a material for its propagation.



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18. State and explain 'sonic boom' and reverberation .



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Level 1

1. There is no phase difference between the particles within a loop of a stationary wave .



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2. During resonance , the body undergoing forced vibrations vibrates with a large amplitude .



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3. The velocity of sound in a gas is directly proportional to the square root of the temperature of the gas taken in degree celsius .



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4. The frequencies of stationary waves formed in closed end organ pipes are in the ratio $1:3:5:7\dots$



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5. Light waves are transverse in nature .



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6. In simple harmonic motion , the acceleration of the body is inversely proportional to its displacement from the mean position .



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7. Velocity of sound in solids is affected by their density .



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8. The fundamental frequency of a stretched string is directly proportional to $\frac{1}{\sqrt{m}}$, where 'm' is the _____ of the string .



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9. Jet planes which move with speeds greater than the speed of sound are called _____



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10. If the motion of an object repeats itself at regular intervals of time , it is called _____ motion .



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11. The velocity of sound is _____ when the density of a gas is quadrupled , with the pressure remaining constant .



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12. In stationary wave, phase difference between two particles can't be $\frac{\pi}{3}$. Is this statement true or false?



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13. What is the audible range of the average human ear ?



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14. Calculate the frequency of fifth harmonic of a closed organ pipe of length 50cm, if the velocity of sound in air is 330 m/s.



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Column A		Column B	
A.	Simple harmonic motion	()	a. Ultra sonic sounds
B.	Pulse	()	b. Independent of amplitude of vibration
C.	Other name for mechanical waves	()	c. Phase change of π radians
D.	Dolphins	()	d. Total mechanical energy is conserved
E.	Velocity of sound in air	()	e. $n \propto \sqrt{\frac{T}{m}}$
F.	Supersonic speeds	()	f. Pressure waves
G.	Intensification of sound	()	g. Disturbance for a short duration
H.	Reflection of sound wave in an open tube	()	h. SONAR
I.	Law of vibration of a stretched string	()	i. Resonance
J.	Tracking of fish in an ocean	()	j. Mach number > 1 .

15.



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16. The fundamental frequency of a stretched string is given by _____.

(l , T , m have their usual meaning)

A. $n = l \sqrt{\frac{T}{m}}$

B. $n = l^2 \sqrt{\frac{T}{m}}$

C. $n = \frac{1}{2l} \sqrt{\frac{T}{m}}$

D. $n = \frac{1}{2l^2} \sqrt{\frac{T}{m}}$

Answer: C



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17. The special technique used in ships to calculate the depth of ocean beds is

A. LASER

B. SONAR

C. sonic boom

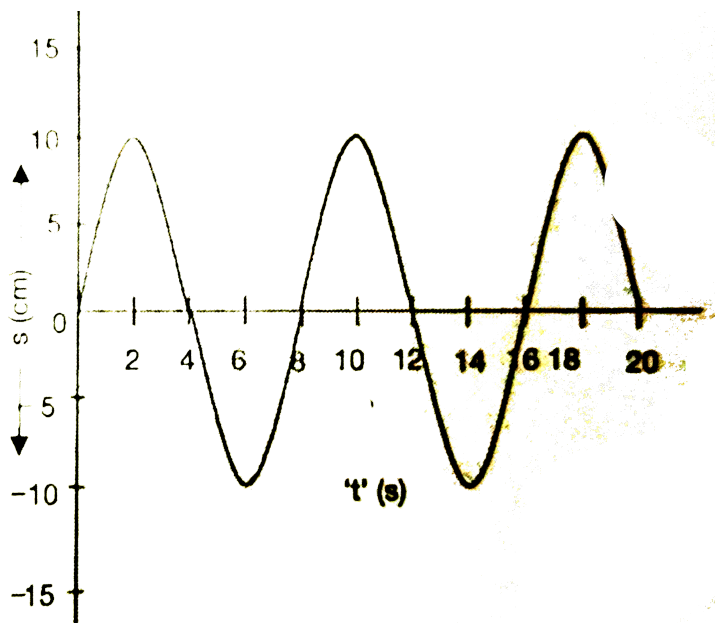
D. reverberation

Answer: B



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18. The following graph shows the displacement of the bob from its mean position versus time . The time period and the amplitude of the bob are :



A. 4s , 5 cm

B. 8s , 10 cm

C. 4s , 10 cm

D. 8s , 5 cm

Answer: B



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19. The minimum distance between the particles in a medium vibrating in same phase is known as

A. amplitude

B. wavelength

C. frequency

D. phase

Answer: B



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20. The velocity of ultrasonic sound in water is 1400 m s^{-1} . The depth of the ocean as

detected by SONAR if the time taken to receive the reflected wave is 15 s , is _____.

A. 21 km

B. 10.5 km

C. 105 m

D. 1500m

Answer: B



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21. The tuning of a radio transistor is based on the principle of _____.

A. beats

B. resonance

C. echo

D. reverberation

Answer: B



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22. If the fundamental frequency of a wave in an open pipe is 540 Hz , the frequency of the $(p - 1)^{th}$ harmonic is _____ Hz.

A. $(p - 1) 540$

B. $p(540)$

C. $(p + 1) (540)$

D. 0

Answer: A



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23. The minimum distance to hear an echo is
(Taking the velocity of sound in air to be 330 m s^{-1})

A. $1/20\text{ m}$

B. 16.5 m

C. 20 m

D. Cannot be determined

Answer: B



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24. A medium should possess the property of _____ for the propagation of mechanical waves .

A. permeability

B. inertia

C. elasticity

D. both (b) and (c)

Answer: D



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25. The velocity of sound in a gas is 30ms^{-1} at 27°C . What is the velocity of the sound in the same gas at 127°C ?

A. 20ms^{-1}

B. 30ms^{-1}

C. $20\sqrt{3}\text{ms}^{-1}$

D. 60ms^{-1}

Answer: C



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26. If the direction of the vibration of particles is parallel to the direction of the propagation of a wave , then the wave is

- A. transverse wave
- B. longitudinal waves
- C. electromagnetic wave
- D. All the above

Answer: B



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27. Which of the following is false regarding progressive waves ?

A. They carry energy and momentum from one place to another

B. The energy possessed by these waves is kinetic in nature .

C. There is no phase difference between the particles in a wave .

D. When they propagate in a medium ,
crests and troughs or compressions and
rarefractions are formed .

Answer: C



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28. When the pressure of a gas is changed ,
then

A. the density of the gas also changes

B. the ratio of the pressure to the density

remains unaffected

C. the velocity of the sound remains

unaffected

D. All the above

Answer: D



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29. A body travelling with a speed of more than the velocity of sound in air is said to travel with

A. supersonic speed

B. hypersonic speed

C. ultrasonic speed

D. infrasonic speed

Answer: A



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30. The correct statement among the following is

A. sounds with frequency greater than 20

kHz are known as ultra-sonics .

B. Dogs can hear ultrasonic sounds .

C. In SONAR , ultra-sonics are used .

D. All the above

Answer: D



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31. A particle executing SHM completes 120π vibrations in one minute . What is the frequency of this motion ?

A. 5 Hz

B. 2π Hz

C. 1 Hz

D. None of the above.

Answer: B



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32. If wind blows in a direction opposite to the sound propagation , then the velocity of the sound

A. increases

B. decreases

C. remains constant

D. Cannot be determined

Answer: B



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33. The phenomenon of apparent change in the frequency of sound whenever there is relative motion between the source of sound and the observer is called _____.

A. Photo electric effect

B. Doppler effect

C. Reflection

D. Refraction

Answer: B



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34. A sound wave propagates in a medium which has the property/properties of

- A. inertia
- B. elasticity
- C. Both (a) and (b)
- D. Neither (a) and (b)

Answer: C



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35. At S.T.P. the ratio of volumes occupied by 1 mole of each O_2 and CO_2 gases , respectively , is _____

A. 4 : 1

B. 1 : 4

C. 1 : 2

D. 1 : 1

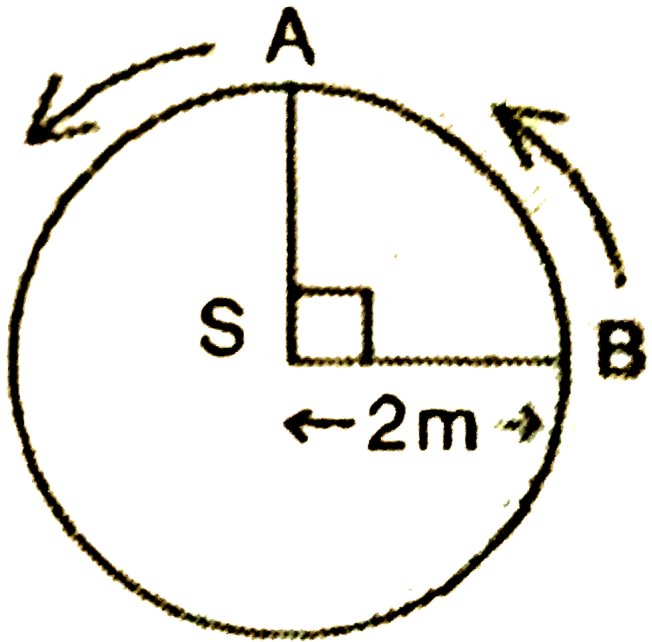
Answer: D



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36. A source which is situated at the centre of a circle is producing sound . Then the change in frequency (f) of sound heard by two persons at 'A' and 'B' if they move with velocities $20ms^{-1}$ and $10ms^{-1}$, respectively , along the circular path as shown in figure is

_____. (Velocity of sound is 330ms^{-1})



A. $2f$

B. f

C. zero

D. None of these

Answer: C



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37. If ' v ' is the velocity of sound in a gas , then ' v ' is directly proportional to (here M , d and T represents molecular weight of gas , density of gas and its temperature , respectively.)

A. \sqrt{M}

B. $\frac{1}{\sqrt{d}}$

C. \sqrt{T}

D. both (b) and (c)

Answer: D



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38. When a sound wave passes from a highly polluted region to a pollution-free area , which of the following physical quantities remain unaltered ?

A. amplitude

B. Velocity

C. frequency

D. Wavelength

Answer: C



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39. Velocity (v) of sound in air , by vibrating resonating columns is found by _____ (l_1, l_2 and n are first second resonating lengths

and frequency of tuning fork used ,
respectively) .

A. $v = 2(l_2 - l_1)$

B. $\frac{v}{n} = (l_2 - l_1)$

C. $v = \left(\frac{l_2 - l_1}{2n} \right)$

D. $v = 2n(l_2 - l_1)$

Answer: D



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40. Which of the following is not the law of a stretched string ? (n , l , T and m are frequency of vibration , length of vibrating string , tension in string and linear mass density , respectively .)

A. $n \propto \frac{1}{\sqrt{T}}$

B. $n \propto \frac{1}{l}$

C. $n \propto \frac{1}{\sqrt{m}}$

D. All the above

Answer: A



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41. Arrange the following steps in a sequential order to verify the laws of reflection.

(A) A hard , smooth surface (AB) is mounted vertically over a horizontal board on which two tubes P and Q , point towards the surface AB.

(B) The tube Q is adjusted such that the listener would be able to hear the ticking sound clearly at the end away from AB.

(C) The sound waves from a source , like

ticking clock are directed to the surface AB through the pipe P inclined at an angle to AB .

(D) By measuring the angles the tubes make with the surface AB , the laws of reflection are verified .

A. ABCD

B. ACBD

C. DCBA

D. CDAB

Answer: B



42. The mass suspended from the stretched string of a sonometer is 4 kg and the linear mass density of string $4 \times 10^{-3} \text{kgm}^{-1}$. If the length of the vibrating string is 100 cm, arrange the following steps in a sequential order to find the frequency of the tuning fork used for the experiment.

(A) The fundamental frequency of the

vibrating string is, $n = \frac{1}{2l} \sqrt{\frac{T}{m}}$.

(B) Get the value of length of the string (l),

and linear mass density (m) of the string from the data in the problem .

(C) Calculate the tension in the string using , $T = mg$.

(D) Substitute the appropriate values in

$$n = \frac{1}{2l} \sqrt{\frac{T}{m}} \text{ and find the value of 'n' .}$$

A. BCAD

B. ABCD

C. DCBA

D. BADC

Answer: A



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43. Write the following statements in a sequential order to find the depth of the ocean bed by the using sonar .

(A) The depth of the ocean bed can be found

by $d = \frac{vt}{2}$.

(B) At the bottom of a ship two devices , one is transmitter which products ultrasonics and a receiver for the detection of the reflected

ultrasonics from the ocean bed are fixed .

(C) The velocity of ultrasonics in ocean water is 'v' and the time taken to receive the reflected ultrasonics from the ocean bed be 't'.

(D) If the depth of ocean bed is 'd' , then

$$v = \frac{d + d}{t} = \frac{2d}{t}.$$

A. ABCD

B. BDCA

C. BCDA

D. BCAD

Answer: C



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44. An experiment is conducted to determine the velocity of sound by resonating air column method where the first and second resonating lengths are 20 cm and 60 cm , respectively , for a tuning fork of frequency 100 Hz. Arrange the following steps in a sequential order to determine the velocity of sound .

(A) Note the frequency of the tuning fork (n) that is used to produce resonance in the closed organ tube .

(B) This will be the fundamental frequency of air column .

(C) The velocity of sound in air ,
 $v = 2n(l_2 - l_1)$.

(D) Identify the first and second resonating lengths when the tuning fork of frequency (n) is used from the given information . Let it be l_1 and l_2 . respectively.

A. ABDC

B. ABCD

C. DCBA

D. ADBC

Answer: A



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45. A swimming pool is constructed in the shape of a square to side 10 m . If a stone is dropped at the centre of the pool so that it produces waves of frequency 100 Hz and wavelength 5 cm , then the time taken by first water wave to reach one of its walls is _____s.

A. 0.5

B. 1

C. 2

D. 4

Answer: B



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Level 2

1. The frequency of a tuning fork is 350 Hz .
Find how many vibrations it executes while the sound produced by it travels a distance of 70 m . (velocity of sound in air 330 m s^{-1}) .



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2. A SONAR system fixed in a submarine operates at a frequency 50 kHz . It is moving towards a rocky hill present inside water with a speed of 432 km h^{-1} . What is the apparent

frequency of sound observed at the submarine
after reflection by the rocky hill ?

(Take velocity of sound in water to be 1450
 $m s^{-1}$)



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3. The fundamental frequency of an open is
 450 Hz and that of a closed pipe is 350 Hz .
The two pipes are joined together to form a
longer pipe . Find the fundamental frequency

of this new pipe . Take velocity of sound are 330 m s^{-1} .



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4. How does a stethoscope help a doctor to hear the sound of a patient's heart-beat ?



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5. A man standing at a point on the line joining the feet of two cliffs fires a bullet . If he

hears the 1st echo after 4 seconds and the next after 6 seconds , then what is the distance between the two cliffs ? (Take the velocity of sound in air as 330ms^{-1})



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6. Do the velocity , frequency and wavelength of a sound wave increase , decrease or remain constant , when it is reflected from an obstacle ? Explain .



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7. A string vibrating with a fundamental frequency of 8 Hz has tension T_1 . This string vibrates with a fundamental frequency of 15 Hz when the tension is T_2 .

Find the fundamental frequency of the string when its tension is $T_1 + T_2$.



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8. S.P. Balasubrahmanyam is conducting a musical night in an open auditorium in New

York . Taking into account , two persons, one who is sitting in the auditorium at a distance of 1 km from the stage and the other who is watching the live program on a television set sitting in front on it Hyderabad , who will hear him first ? Explain .



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9. What should the length of an open pipe be if it is to resonate with a closed pipe 1 m long at their fundamental frequencies ?



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10. Two trains A and B are approaching each other with 108kmh^{-1} and 126 km h^{-1} , respectively. If the train A sounds a whistle of frequency 500 Hz , find the frequency of the whistle as heard by a passenger in the train B.

(a) before the trains cross each other and

(b) after the trains cross each other. (Take velocity of sound as 330ms^{-1})



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11. Under similar conditions of temperature and pressure , two gases (x and y) of equal masses and taken such that x and y occupy volumes of 2 l and 50 l , respectively . When sound waves are passed through both the gases , in which gas does sound travel with a greater velocity ?



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12. Why cannot transverse waves be produced in air ?



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13. The driver of a car approaching a cliff with a uniform velocity of 15 m s^{-1} sounds the horn and the echo is heard by the driver after 3 seconds . If the velocity of sound is 330 m s^{-1} , calculate the distance between the cliff and the point where the horn was sounded ?

Also calculate the distance between the cliff and the point where the echo is heard ?



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14. A rope of length of 2m is tied between two ends . If the speed of transverse waves propagating in the rope is $4ms^{-1}$ and the tension in the rope is 2 N , find the mass of the rope in C.G.S units .



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15. Two diatomic gases A and B of masses 12 g and 32g occupy volumes of 1200 ml and 1920 ml , respectively . When sound waves are

passed through these gases , in which gas does sound travel with least velocity and also by how many times ? Assume that the pressure and temperature are same in both the gases .



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16. In a loud - speaker , sound is produced by a diaphragm on supplying electrical energy . Explain what type of motion the diaphragm

exhibits while producing the sound ? How is sound produced in a loud speaker ?



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17. In a certain experiment , a sound wave was observed to have undergone a change in its velocity and wavelength but the frequency remained the same .

In another experiment , no change was observed in the velocity , wavelength or frequency but there was a change in the phase

. if the direction of the wave propagation is changed in both the cases , identify the phenomena that took place in the two experiments . Give reasons for the changes in the physical quantities .



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18. A source of wave vibrates with a frequency 500 Hz. The wave travels 33m in 0.1s . How far does the waves travels when the source executes 150 vibrations ?



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19. The distance between two adjacent particles which are in the same phase in a progressive wave is 20 cm.

Determine the velocity of the wave if its frequency is 10 Hz.



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20. The average speed of the bob of a seconds pendulum is $2ms^{-1}$. Determine the (a) linear

amplitude (b) angular amplitude and the (c) frequency of oscillation .



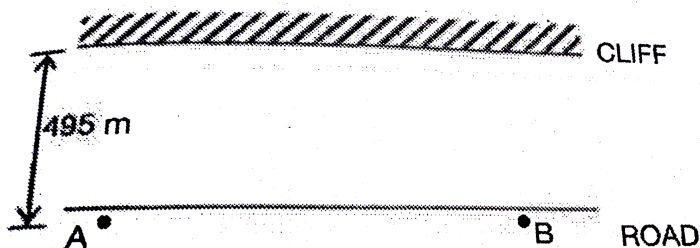
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Level 3

1. A road runs parallel to a vertical cliff at a distance of 495 m as shown in the figure . A car standing at A blows the horn and the driver of the car hears the echo after 3 s. But a person standing at B hears the sounds of horn

twice within an interval of $2s$.

Explain why the person at 'B' heard the sound twice . Also find the distance between the car and the person .



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2. Why are sirens of mills heard upto longer distance in the rainy season as compared to the summer season ?



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3. The shock waves and sonic booms produced by super sonic jets can cause hearing loss in people living near the air bases and not in those living in areas away from these bases .Explain .



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4. By placing tuning forks of different frequencies at the open end of a pipe, it is found that the pipe has a resonating frequency at 450 Hz and the next harmonic at 750 Hz. Find whether the pipe is closed at one end or open at both ends. Also find the fundamental frequency of the pipe.



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5. Why are the ultrasonic sounds preferred to audible and infrasonic sounds in detecting the tumors in a physical body .



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6. Ravi filled two cylinders with two gases (X and Y) of equal masses such that under similar conditions of temperature and pressure they occupy volumes of 2 l and 50 l , respectively . If he produces sound through both the gases

inside the cylinders , then in which gas does sound travel with greater velocity ?

Explain (Given that the value of γ is same for both the gases



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7. A scooterist moves towards a vertical wall with a speed of 54 km h^{-1} . A person is standing on the ground and is behind the scooter , hears the sound . If the scooterist sounds the horn of frequency 400 Hz ,

calculate the apparent frequency sound heard by the person when

(a) It is coming directly from the horn.

(b) coming after reflection from the vertical wall. (Take speed of sound to be 330ms^{-1})



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8. Two monoatomic gases of equal masses are in two different containers at S.T.P. if the ratio of velocities of sound in them is $1:2$, then find the ratio of their volumes .



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9. Anil and Sunil brought two rods A and B of length 5 m each, respectively. The Young's modulus of elasticity of rod A is twice that of rod B, and the density of rod A is 8 times that of rod B. When a sound wave is allowed to traverse through each rod, Anil and Sunil claimed that the sound waves travel faster in their respective rods. Find in which rod will the sound wave take lesser time?



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10. The frequency of fundamental mode of vibration of an air column enclosed in a closed end pipe is 250 Hz. If its length is 33 cm , find the velocity of sound in air.



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