#419534

A SONAR (sound navigation and ranging) uses ultrasonic waves to detect and locate objects under water. In a submarine equipped with a SONAR the time delay between generation of a probe wave and the reception of its echo after reflection from an enemy submarine is found to be $77.0\ s$. What is the distance of the enemy submarine? (Spee of sound in water = $1450\ ms^{-1}$).

Solution

Let the distance between the ship and the enemy submarine be$S$.

Speed of sound in water = $1450m/s$

Time lag between transmission and reception of Sonar waves = $77s$

In this time lag, sound waves travel a distance which is twice the distance between the ship and the submarine $(2S)$.

Time taken for the sound to reach the submarine = $\frac{1}{2}\times 77 = 38.5s$

Distance between the ship and the submarine, $S = 1450\times 38.5 = 55825m = 55.8km$

#420447

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 sizes of the 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, and

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

Solution

(a) A node (N) is a point where the amplitude of vibration is the minimum and pressure is the maximum.

An antinode (A) is a point where the amplitude of vibration is the maximum and pressure is the minimum.

Therefore, a displacement node is nothing but a pressure antinode, and vice versa.

(b) Bats emit ultrasonic waves of large frequencies. When these waves are reflected from the obstacles in their path, they give them the idea about the distance, direction, size and nature of the obstacle.

(c) The overtones produced by a sitar and a violin, and the strengths of these overtones, are different. Hence, one can distinguish between the notes produced by a sitar and a violin even if they have the same frequency of vibration.

(d) This is because solids have both, the elasticity of volume and elasticity of shape, whereas gases have only the volume elasticity.

(e) A sound pulse is a combination of waves of different wavelength. As waves of different λ travel in a dispersive medium with different velocities, therefore, the shape of the pulse gets distorted.

#463001

Choose the correct answer:

Sound can travel through

A Gases only

B Solids only

C Liquids only

D Solids, liquids and gases

Solution

Sound requires a material medium for travelling.

It can travel in solid, liquid and gases. But it can't travel in vacuum.

#463013

Lightning and thunder take place in the sky at the same time and at the same distance from us. Lightning is seen earlier and thunder is heard later. Can you explain?

Solution

Lightning is seen earlier than the thunder because speed of light is more than the speed of sound. Therefore, even though both occurs as same time and place in the sky, lightning is seen earlier.

#464573

What is sound and how is it produced?

Solution

Sound is defined as vibrations that travel through the air or another medium as an audible mechanical wave. It is produced from a vibrating body. The vibrating body causes th medium (water, air, etc.) around it to vibrate thus producing sound.

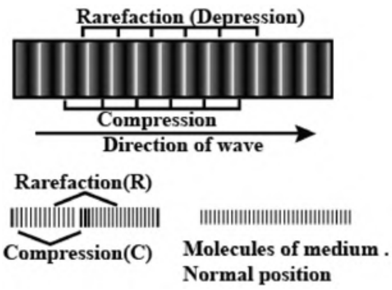
#464574

Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound :

Solution

When a vibrating body swings forward, it pushes and compresses the air in front of it creating a region of high pressure. This region is called a compression. This compression starts to move away from the vibrating object.

When the vibrating body swings backwards, it creates a region of low pressure called rarefaction. As the object swings / oscillates back and forth rapidly, a series of compressions and rarefactions is created in the air. These make the sound wave that propagates through air.



#464575

Cite an experiment to show that sound needs a material medium for its propagation :

Solution

Apparatus required:

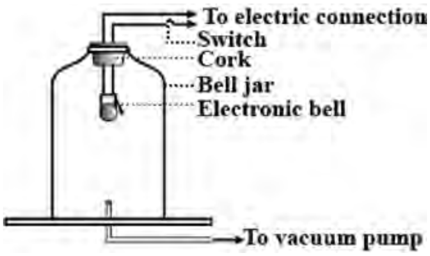
A strong jar, Electronic Bell, Cork, Vacuum pump.

Procedure:

Take an electronic bell and connect it to electrical supply. You should hear the bell ringing. This confirms that the bell is working. Now, take a jar and make a small hole in the bottom and insert a small pipe through it. Connect the other end of the pipe to a vacuum cleaner. Make a very small hole in the cork (just enough to insert wires) and insert wir connected to the electronic bell. Fit the cork as shown in the figure. Turn on the bell and the vacuum cleaner. You will observe no sound is heard.

Conclusion:

Since the bell was working but its sound could not be heard outside the jar when air was pumped out, it can be concluded that sound needs a medium for propagation.



#464576

Why is sound wave called a longitudinal wave?

Solution

When a sound wave propagate, the particles of the medium vibrate in the direction parallel to the direction of propagation of disturbance (sound waves) which is the characteristic property of longitudinal waves. Hence the sound waves are called longitudinal waves.

The vibration of medium that travel along or parallel to the direction of wave is called a longitudinal wave. In a sound wave, the particles of the medium vibrate in the direction parallel to the direction of propagation of disturbances.
Hence, a sound wave is called a longitudinal wave.

#464577

Which characteristics of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Solution

The two sounds can have same pitch, same amplitude i.e intensity and hence same loudness, but two sounds cannot have same quality. The quality of sound acts as fingerprints to distinguish between the two persons.
Thus the friend can be identified by the quality of his sound.

Timbre and pitch are the characteristics of sound which help to identify the sound of different voices. Thus, because of difference in timbre and pitch of the sound wave, a person can identify the voice of his friend sitting with others in a dark room.

#464578

Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen. Why?

Solution

At first we have to observe this question and reach at the conclusion that it is comprised of two word Flash which state shine/light and Thunder which state a loud noise,hence we can reach to the result of speed of both light and sound.

$V_{light} = 3 \times 10^8 m/sec$

$V_{sound} = 340 m/sec$

hence $V_{light} > V_{sound}$

so,thunder is heard a few second after the flash is seen.

Speed of sound in air $(330\ ms^{-1})$ is very less than speed of light in air $(3 \times 10^8 m/s)$.
Hence although flash and thunder are produced simultaneously, light (flash) reaches the earth surface a little earlier than sound (i.e thunder) .
So thunder is heard a few seconds after the flash is seen.

#464579

A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sounc in air as $344\ ms^{-1}$:

Solution

Given data

$f_1 = 20 Hz$

$f_2 = 20000 Hz$

$V_{sound} = 344 m/sec$ (which is always constant be constant)

So,from the relation between frequency,wavelength,speed are as follow

$$speed(V) = frequency(f) \times wavelength(\lambda)$$
$$\lambda_1 = \frac{V}{f_1} = \frac{344}{20} = 172\ m$$
$$\lambda_2 = \frac{V}{f_2} = \frac{344}{20000} = 0.0172\ m$$

Given : Velocity of sound in air $v = 344\ ms^{-1}$

Wavelength of the sound waves $\lambda = \frac{v}{\nu}$

For $\nu_1 = 20$ Hz, $\lambda_1 = \frac{344}{20} = 17.2$ m

For $\nu_2 = 20$ kHz, $\lambda_2 = \frac{344}{20 \times 1000} = 1.72 \times 10^{-2}$m

#464580

Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.

Solution

Let the distance between the two children be d

Also let the time taken by sound to reach other child via air be t_1 and via aluminium rod be t_2.

Velocity of sound in air $v_a = 340\ m/s$

$\therefore \quad t_1 = \frac{d}{v_a} = \frac{d}{340}$ ....(1)

Velocity of sound in aluminium rod $v_R = 6420\ m/s$

$\therefore \quad t_2 = \frac{d}{v_R} = \frac{d}{6420}$ ....(2)

Dividing equation (1) and (2), we get $\frac{t_1}{t_2} = \frac{6420}{340} = 18.88$

#464581

The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Solution

Frequency is the no of vibration produced in one second.

No. of Vibration i $1sec = 100$

$1min = 60sec$

So, No of vibration in one minute $= 60 \times 100 = 6000$vibrations.

We know that $velocity = frequency \times wavelength$

where

speed of sound,m/sec

wavelength,meter

frequency,Hertz.

so,if the frequency of sound is 100 Hz,in 1 second.

so in 1 minute=100$\times$60=60000 times.

Frequency of source of sound $\nu = 100$ Hz

This means the source vibrates 100 times in 1 sec.

$\therefore$ Number of times the source vibrates in 60 s is $N = 60 \times 100$

$\implies N = 6000$

#464582

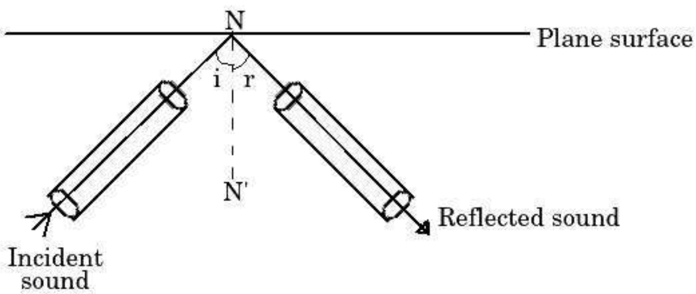
Does sound follow the same laws of reflection as light does? Explain.

Solution

Yes, sound also follows the law of reflection in the same manner as the light does.

Law of reflection for sound- The incident sound, the point of normal to the incident sound and the reflected sound all lie in same plane and also the angle of incidence with th normal & the reflected angle with the normal are equal.

$\angle i = \angle r$



Yes, sound follows the same laws of reflection as light does. Sound follows the following properties during reflection:

1) Angle of incidence is equal to angle of reflection.

2) The incident wave, the reflected wave and the normal at the point of incidence lie in the same plane.

#464583

When a sound is reflected from a distinct object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. D you hear echo sound on a hotter day?

Solution

Velocity of sound increases with temperature. Thus velocity of sound in air increases in the hotter day. Hence the time difference between the incident wave and the reflected wave decreases.

Now a human ear requires a minimum time interval of $\frac{1}{10}th$ of a second to hear an echo. Thus, if the time interval is greater than 0.1 second on the hotter day, then an echo can be heard.

But, on a hotter day, the time gap between the incidence of original and reflected sound is less than $0.1s$ due to higher velocity of sound. So, chances of hearing echo is less.

#464584

Give two practical applications of reflection of sound waves.

Solution

Following are the practical application of reflection of the sound wave.

1)In stethoscope, which is kind of device used by a doctor for hearing the heartbeat of a patient's.Here the multiple reflection of sound wave will took place before it reaches th ear of a doctor.

2)In megaphones, we can also call it as blow horn in which the multiple reflections of the sound wave will take place and finally we can get an amplified sound.

Two practical applications of sound waves -

$1)$ Echo, which is used to find the distance between the two distant objects

$2)$ Sound navigation and ranging $(SONAR)$, which is used to find the depth of ocean.

#464585

A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, $g = 10\ ms^{-2}$ and speed of sound $= 340\ ms^{-1}$.

Solution

Time taken by stone to reach the pond is given by second equation of motion

i.e. $S = ut + \frac{1}{2}at^2$

where $S = 500m$ = diatance

$u = 0$=initial velocity

$t = ?$

$a =$ acceleration = 10 =g

$500 = 0 + \frac{1}{2} \times 10 \times t^2$

$t^2 = \frac{500 \times 2}{10} = 100$

$Rightarrowt = 10s$ -------------(1)

Also, times taken by sound to reach top ,

$= \frac{Distance}{Speed} = \frac{500}{340} = 1.5s$---------(2)

So, total time taken for the splash to reach the tower $= 10 + 1.5 = 11.5s$

Let the time to hear the splash be t seconds

Given : Height of the tower $H = 500$ m

Thus time taken by the stone to reach the bottom $t_1 = \sqrt{\frac{2H}{g}}$

$t_1 = \sqrt{\frac{2 \times 500}{10}} = 10$ s

Speed of sound $v = 340\ ms^{-1}$

Thus time taken by sound to reach the top $t_2 = \frac{H}{v} = \frac{500}{340} = 1.47$s

$\therefore$ Total time taken to hear the sound of splash $t = t_1 + t_2 = 10 + 1.47 = 11.47$s

#464586

A sound wave travels at a speed of $339\ ms^{-1}$. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Solution

we know that speed=frequency$\times$wavelength

speed=339m/sec

wavelength=0.015 meter

$frequency = \frac{speed}{wavelength} = \frac{339}{0.015} = 22600Hz$

hence a normal audible range of a human ear is 20Hz to 20kHz,but here the value of frequency is exceeding than the audible value so it can not be audible.

The audible Frequency range is between $20Hz$ to $20KHz$

Here, Speed $= 339m/s$

Wavelength ,$\lambda = 1.5cm = 0.015m$

We know, Frequency, $f = \frac{speed}{wavelength} = \frac{339}{0.015} = 22600Hz$

$\Rightarrow 22.6KHz$

So, since the frequency is not in the range of audible frequency, it will not be audible.

Velocity of sound wave $v = 339\ ms^{-1}$

Wavelength of the waves $\lambda = 1.5\,cm = 0.015\,m$

$\therefore$ Frequency of the waves $\nu = \dfrac{v}{\lambda} = \dfrac{339}{0.015} = 22.6$kHz

Audible frequency range for human ear lies between 20 Hz to 20 kHz

Thus this waves is not audible.

#464587

What is reverberation? How can it be reduced?

Solution

Persistence of sound (after the source stops producing sound) due to the repeated reflection is called reverberation. Reverberation can be reduced by absorbing the sound using some materials as it reaches the wall and ceiling of the room and thus prevent the sound from getting reflected. Some materials which are used to reduce reverberation are fibreboard, heavy curtains, plastics etc.

#464588

What is loudness of sound? What factors does it depend on?

Solution

Loudness is a characteristic of a sound. It refers to how much energy a sound wave posses.

It depends on amplitude of the sound wave. More the amplitude, more is the loudness of the sound.

#464589

Explain how bats use ultrasound to catch a prey.

Solution

The bats use ultrasound to catch a prey by using the phenomenon of reflection of sound waves.

The bats produce the ultrasonic wave which gets reflected from the prey and returns to the bats' ears. This makes the bat to find out the distance and position of the prey.

#464590

How is ultrasound used for cleaning?

Solution

The objects to be cleansed are put in cleaning solution and ultrasonic sound waves are passed through that solution. The high frequency of these ultrasound waves detaches the dirt from the objects and hence the objects are cleaned.

#464591

Explain the working and application of a sonar.

Solution

Sonar is the short form for 'Sound Navigation and Ranging'. It is a technique that uses sound propagation and its reflection to detect objects underwater.

A sound wave is transmitted from the vehicle (or submarine) underwater and its reflection is received from an object. Using the speed of wave underwater and time-interval between the two instances, the location and distance of the said object can be found.

#464592

A sonar device on a submarine sends out a signal and receives an echo 5 s later. Calculate the speed of sound in water if the distance of the object from the submarine is 362 m :

Solution

We know that, $Speed = \frac{Distance}{time}$

Time $= 5s$

Distance $= 3625$ m

Total distance 2×3625, As it is the distance taken by sonar wave to transmit and receive $= 7250$ m

So, Speed $= \frac{7250}{5} = 1450 m/s$

Time of receiving of an echo $t = 5$ s

Distance between the object and the submarine $d = 3625$ m

Thus the sound wave travels a distance of $2d$ in 5 seconds.

Let the speed of sound in water be v

$\therefore \quad 2d = v \times t$

$2 \times 3625 = v \times 5 \qquad \implies v = 1450 \ ms^{-1}$

#464593

Explain how defects in a metal block can be detected using ultrasound.

Solution

Ultrasonic waves are sent through one end of the metal block and a detector is placed on the opposite end of the block. The defects in the block donot allow these ultrasonic waves to pass through them and thus the detector do not detect any wave. So if after passing these waves through the block, if detector detects the waves, then there is no defect in the metal block whereas if no waves are detected on the detector, then the metal block has defect.

Ultrasound is passed through one end of the the metal and a detector is installed at the other end. When the metal is perfect, the ultrasonic waves travel as expected and hen are detected on the other end. For a metal with defect, the waves are reflected back and hence don't reach the other end. When no detections are received, it can be concluded that the metal has a defect.

#464594

Explain how the human ear works.

Solution

The human ear converts sound into understandable form by brain. The outer ear collects the sound from the surroundings. It is passed through the auditory canal. At the end c the auditory canal there is a thin membrane called the eardrum or tympanic membrane. The vibrations of the sound waves are transferred to the eardrum. These vibrations are amplified several times by three bones (the hammer, anvil and stirrup) in the middle ear. The middle ear transmits the amplified pressure variations received from the sound wave to the inner ear. In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve and the brain interprets them as sound.