

EXERCISE 7(A)

Solution:

The waves which require material medium to transfer energy are called mechanical waves.

Solution:

- (a) Distance between the resting position and the maximum displacement of the wave is known as amplitude.
- (b) Number of waves passing by a specific point per second is called frequency.
- (c) In one time period of vibration of the particle of the medium, the distance travelled by a wave is called wavelength
- (d) The distance travelled in one second by the wave is called its wave velocity.

Solution:

- (i) When a wave passing from one medium to another medium, the wavelength (or speed) of the wave changes.
- (ii) When a wave travelling in one medium passes to another medium, the frequency of the wave will not change.

Solution:

The speed of sound depends on the elasticity and density of the medium through which it is travelling. Sound travels faster in liquids when compared to gases and faster in solids when compared to liquids. Thus greater the elasticity and lower the density, sound travels faster in a medium.

Solution:

Light waves	Sound waves
Light waves are electromagnetic waves	Sound waves are the mechanical waves
They can travel in vacuum	They require a material medium for propagation. They cannot travel in vacuum.

Question: 6

What do you mean by reflection of sound? State one condition for the reflection of a sound wave. Name a device in which reflection of sound wave is used.

Solution:

The return of a sound wave on striking a surface such as wall, metal sheet, plywood etc. back in the same medium is called reflection of sound wave. The only condition for reflection of sound wave is that the size of the reflecting surface must be bigger than the wavelength of the sound wave. Megaphone (or speaking tube) is the device in which reflection of sound wave is used.

Question: 7

What is meant by an echo? State two conditions necessary for an echo to be heard distinctly.

Solution:

An echo is defined as 'the sound heard after reflection from a distant obstacle (such as a cliff, a hillside, wall of a building etc.) after the original sound is ceased, is called an echo.

The two conditions for an echo to be heard distinctly are

- (i) The minimum distance between the source of sound and the reflector in air must be 17 m.
- (ii) The size of the reflector must be large enough as compared to the wavelength of the sound wave

Question: 8

A man is standing at a distance of 12m from a cliff. Will he be able to hear a clear echo of his sound? Give a reason for your answer.

Solution:

The time taken to hear the echo is

$$t = 2d / v$$

$$t = (2 \times 12) / 340$$

$$t = 24 / 340 < 0.1 \text{ seconds}$$

The man will not hear the echo as the sensation of a sound persists in our ears for about 0.1 second after the exciting stimulus ceases to act.

Question: 9

State two applications of echo.

Solution:

The applications of echo are

- (i) Dolphins use the technique of echolocation to locate their ways as they cannot see from their eyes. From the reflected sound they can understand if there is any object before it. Thus by using this technique it hunt its prey.
- (ii) In medical field, doctors use this technique in cardiography, sonogram and many other medical diagnosis.

Question: 10

Explain how the speed of sound can be determined by the method of echo?

Solution:

The sound has to travel from the source of sound to the reflector and back from the reflector to the source of the sound to hear an echo. If d is the distance between the source and the reflector, then the total distance travelled is $2d$ and the time taken can be taken as t .

The speed of sound can be calculated by using the relation

Speed = Total distance travelled / Time taken

$$V = 2d / t$$

Question: 11

State the use of echo by a bat, dolphin and fisherman.

Solution:

Bats produce sound which get reflected back from an obstacle. By hearing the echo, they come to know the location of the obstacle and fly safely without colliding with it.

By hearing their echo and emitting the ultrasonic waves dolphins detect their enemy and obstacle. They hunt their prey by using ultrasonic waves.

A fisherman sends an ultrasonic pulse from a source and receive the pulse from the fish. Hence fisherman use echoes to catch fishes.

Question: 12

How do bats avoid obstacles in their way, when in flight?

Solution:

Bats are able to produce and detect the sound of very high frequency up to about 100 kHz. While flying the sound produced by bats gets reflected back from an obstacle in front of it. They come to know even in the dark where the obstacles are by hearing the echoes. Hence without colliding with the obstacles, bats can fly safely.

Question: 13

What is meant by sound ranging? Give one use of sound ranging.

Solution:

Sound ranging is the process of detecting obstacles with the help of echo. Animals like bats, dolphin use sound ranging to detect their enemies.

Question: 14

Name the waves used for sound ranging. State one reason for their use. Why are the waves mentioned by you not audible to us?

Solution:

For the sound ranging, ultrasonic waves are used. These ultrasonic waves have a frequency more than 20,000 Hz while the range of audibility of human ear is 20 Hz to 20,000 Hz

Question: 15

What is 'SONAR'? State the principle on which it is based.

Solution:

Sound navigation and ranging is known as 'SONAR'. From the ship, ultrasonic waves are sent in sea water in all directions. After reflection these waves are received back from the obstacle such as iceberg, sunken ship, etc. This process is called echo depth sounding.

Question: 16

State the use of echo in medical field.

Solution:

In medical science, for the imaging of human organs such as liver, gall bladder, uterus, womb, echo method of ultrasonic waves are used. This is known as ultrasonography. Similarly to obtain the image of human heart echo cardiography is used.

MULTIPLE CHOICE TYPE

Question: 1

The minimum distance between the source and the reflector in air, so that an echo is heard is approximately:

(a) 10 m

(b) 17 m

(c) 34 m

(d) 50 m

Solution:

The minimum distance between the source and the reflector in air, so that an echo is heard is approximately 17 m

Question: 2

To detect the obstacles in their path, bats produce:

(a) Infrasonic waves

(b) Ultrasonic waves

(c) Electromagnetic waves

(d) Radio waves

Solution:

To detect the obstacles in their path, bats produce ultrasonic waves.

NUMERICALS

Question: 1

The wavelength of waves produced on the surface of water is 20cm. If the wave velocity is 24m s^{-1} , calculate (i) the number of waves produced in one second and (ii) the time in which one wave is produced.

Solution:

(i) The number of waves produced in one second or frequency

$$= \text{velocity} / \text{wavelength}$$

$$= 24 / 20 \times 10^{-2}$$

$$= 120$$

(ii) Time in which one wave is produced = $1 / \text{frequency}$

$$= 1 / 120$$

$$= 8.3 \times 10^{-3} \text{ seconds}$$

Question: 2

Calculate the minimum distance in air required between the source of sound and the obstacle to hear an echo. Take the speed of sound in air = 350m s^{-1}

Solution:

We know that

$$\text{Velocity} = 2D / 0.1$$

$$D = (350 \times 0.1) / 2$$

$$D = 17.5 \text{ m}$$

Question: 3

What should be the minimum distance between the source and reflector in water so that echo is heard distinctly? (The speed of sound in water = 1400m/s)

Solution:

$$\text{Velocity} = 2D / \text{Time}$$

$$1400 = 2 \times D / 0.1$$

$$D = 1400 \times 0.1 / 2$$

$$D = 70 \text{ m}$$

Question: 4

A man standing 25 m away from a wall produces a sound and receives the reflected sound. (a) Calculate the time after which he receives the reflected sound if the speed of sound in air is 350 m/s⁻¹. (b) Will the man be able to hear a distinct echo? Explain the answer.

Solution:

(a) $\text{Velocity} = 2D / \text{Time}$

$$\text{Time} = 2 \times 25 / 350$$

$$\text{Time} = 0.143 \text{ seconds}$$

(b) The reflected sound reaches the man 0.1 second after the original sound is heard and this original sound persists only for 0.1 second. Therefore the man able to hear a distinct echo.

Question: 5

A RADAR sends a signal to an aeroplane at a distance 300 km away, with a speed of $3 \times 10^8 \text{ m s}^{-1}$. After how much time is the signal received back after reflecting from the aeroplane?

Solution:

Given

Speed of sound transmitted from RADAR = $3 \times 10^8 \text{ m s}^{-1}$

Distance at which the signal is transmitted = 300 km = 300000 m

The signal travels twice, i.e when transmitted and when it is being received by the RADAR, the distance is calculated twice.

Total distance the signal travels = $2 \times 300000 \text{ m}$

Time taken to receive the signal back after reflecting from the aeroplane is

$$t = d / s$$

$$t = (2 \times 3 \times 10^5) / 3 \times 10^8$$

$$t = 0.002 \text{ seconds}$$

Therefore after 0.002 seconds, the signal is received back after reflecting from the aeroplane.

Question: 6

A man standing 48 m away from a wall fires a gun. Calculate the time after which an echo is heard. (The speed of sound in air is 320m/s^{-1}).

Solution:

$$\text{Velocity} = 2 \times D / \text{Time}$$

$$\text{Time after which an echo is heard} = 2D / \text{velocity}$$

$$= 2 \times 48 / 320$$

$$= 0.3 \text{ seconds}$$

Question: 7

A ship on the surface of water sends a signal and receives it back from the submarine inside water after 4s. Calculate the distance of submarine from the ship. (The speed of sound in water is 1450 m s^{-1}).

Solution:

$$2D = \text{velocity} \times \text{time}$$

$$D = (\text{velocity} \times \text{time}) / 2$$

$$D = (1450 \times 4) / 2$$

$$D = 2900 \text{ m}$$

$$D = 2.9 \text{ km}$$

Question: 8

A pendulum has a frequency of 5 vibrations per second. An observer starts the pendulum and fires a gun simultaneously. He hears an echo from the cliff after 8 vibrations of the pendulum. If the velocity of sound in air is 340m s^{-1} , find the distance between the cliff and the observer.

Solution:

Given

5 vibrations by pendulum per second

So, for 8 vibrations = $8 / 5$ seconds

= 1.6 seconds

$$\text{Velocity} = 2 \times D / \text{time}$$

$$340 = 2 \times D / 1.6$$

$$D = (340 \times 1.6) / 2$$

$$D = 272 \text{ m}$$

Question: 9

A person standing between two vertical cliffs produces the sound. Two successive echoes are heard at 4s and 6s. Calculate the distance between the cliffs. (Speed of sound in air = 320m/s)

Solution:

The distance of first cliff from the person, $2 \times D1 = \text{velocity} \times \text{time}$

$$D1 = (320 \times 4) / 2$$

$$D1 = 640 \text{ m}$$

Distance of the second cliff from the person, $D2 = (320 \times 6) / 2$

$$D2 = 960 \text{ m}$$

Distance between cliffs = $D1 + D2$

$$= 640 + 960$$

$$= 1600 \text{ m}$$

Question: 10

A person standing at a distance x in front of a cliff fires a gun. Another person B standing behind the person A at a distance y from the cliff hears two sounds of the fired shots after 2s and 3s respectively. Calculate x and y (take speed of sound 320 ms^{-1})

Solution:

The person B hears two of the fired shots, the first one is direct from the gun while other sound comes after reflection from the cliff

Given speed of sound 320 m / s

Time taken by the sound to reach from A to B directly

Speed = distance / time

$$320 = (y - x) / 2$$

$$(y - x) = 320 \times 2$$

$$(y - x) = 640 \quad (1)$$

After reflection from the cliff

$$320 = (y + x) / 3$$

$$(y + x) = 320 \times 3$$

$$(y + x) = 960 \quad (2)$$

By adding equation (1) and (2)

$$2y = 1600$$

$$y = 1600 / 2$$

$$y = 800 \text{ m}$$

$$x = 160 \text{ m}$$

Question: 11

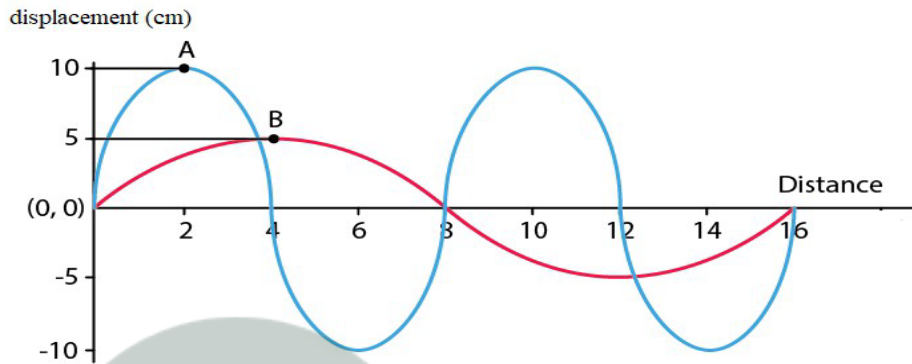
On sending an ultrasonic wave from a ship towards the bottom of a sea, the time interval between sending the wave and receiving it back is found to be 1.5 s. If the velocity of wave in sea water is 1400 m/s , find the depth of sea.

Solution:

$$\begin{aligned} \text{Depth of the sea} &= (\text{velocity} \times \text{time}) / 2 \\ &= (1400 \times 1.5) / 2 \\ &= 1050 \text{ m} \end{aligned}$$

Question: 12

Figure below shows the distance-displacement graph of two waves A and B. Compare (i) the amplitude, (ii) the wavelength of the two waves.



Solution:

Amplitude is the maximum displacement from the mean position.

For A the maximum displacement = 10 cm and

For B the maximum displacement = 5 cm

The ratio of maximum amplitude is $A_1 / A_2 = 10 / 5 = 2 / 1 = 2:1$

Wavelength of A = 8 cm

Wavelength of B = 16 cm

The ratio of wavelength is $\lambda_1 / \lambda_2 = 8 / 16 = 1 / 2 = 1:2$