Chapter 8: Sound

EXERCISES [PAGES 157 - 158]

Exercises | Q 1. (i) | Page 157

Choose the correct alternatives.
A sound carried by air from a sitar to a listener is a wave of the following type.

1. Longitudinal stationary
2. Transverse progressive
3. Transverse stationary
4. **Longitudinal progressive**

SOLUTION

Longitudinal progressive

Exercises | Q 1. (ii) | Page 157
Choose the correct alternatives.
When sound waves travel from air to water, which of these remains constant?

1. Velocity
2. **Frequency**
3. Wavelength
4. All of above

SOLUTION

Frequency

Exercises | Q 1. (iii) | Page 157
Choose the correct alternatives.
The Laplace's correction in the expression for velocity of sound given by Newton is needed because sound waves

1. are longitudinal
2. propagate isothermally
3. **propagate adiabatically**
4. are of long wavelength

SOLUTION

propagate adiabatically

Exercises | Q 1. (iv) | Page 157
Choose the correct alternatives.
Speed of sound is maximum in

1. air
2. water
3. vacuum

4. **solid**

SOLUTION

Speed of sound is maximum in **solid**.

Exercises | Q 1. (v) | Page 157
Choose the correct alternatives.
The walls of the hall built for music concerns should
1. amplify sound
2. reflect sound
3. transmit sound
4. **absorb sound**

SOLUTION

The walls of the hall built for music concerns should **absorb sound.**

Exercises | Q 2. (i) | Page 157
Answer briefly.
Wave motion is doubly periodic. Explain.

SOLUTION

1. A wave particle repeats its motion after a definite interval of time at every location, making it periodic in time.

2. Similarly, at any given instant, the form of a wave repeats itself at equal distances making it periodic in space.

3. Thus, wave motion is a doubly periodic phenomenon, i.e., periodic in time as well as periodic in space.

Exercises | Q 2. (ii) | Page 157

Answer briefly.
What is Doppler effect?

SOLUTION

The apparent change in the frequency of sound heard by a listener, due to relative motion between the source of sound and the listener is called Doppler effect in sound.

Exercises | Q 2. (iii) | Page 157
Answer briefly.
Describe a transverse wave.

SOLUTION

Transverse wave: A wave in which particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave is called a transverse wave. Example: Ripples on the surface of water, light waves

Characteristics of transverse waves:

1. All the particles of medium in the path of wave vibrate in a direction perpendicular to the direction of propagation of wave with the same period and amplitude.

2. When a transverse wave passes through the medium, the medium is divided into alternate crests i.e., regions of positive displacements and troughs i.e., regions of negative displacement, that are periodic in time.

3. A crest and an adjacent trough form one cycle of a transverse wave. The distance between any two successive crests or troughs is called wavelength ‘λ’ of the wave.

4. Crests and troughs advance in the medium and are responsible for the transfer of energy.

5. Transverse waves can travel only through solids and not through liquids and gases. Electromagnetic waves are transverse waves, but they do not require material medium for propagation.

6. When transverse waves advance through a medium, there is no change of pressure and density at any point of the medium, but the shape changes periodically.

7. A transverse wave can be polarised.

8. Medium conveying a transverse wave must possess elasticity of shape, i.e., modulus of rigidity.

Exercises | Q 2. (iv) | Page 157

Answer briefly.
Define a longitudinal wave.

SOLUTION

A wave in which particles of the medium vibrate in a direction parallel to the direction of propagation of the wave is called a longitudinal wave. Example: Sound waves.

Exercises | Q 2. (v) | Page 157

Answer briefly.
State Newton’s formula for the velocity of sound.

SOLUTION

1. Let v be the velocity of sound in the air when the pressure is P and density is ρ.
2. Using Laplace's formula, we can write,
   v = $\sqrt{\frac{\gamma P}{\rho}}$ ....(1)
3. If V be the volume of gas having mass M then, $\rho = \frac{M}{V}$
4. Substituting ρ in equation (1), we get,
   v = $\sqrt{\frac{\gamma PV}{M}}$ ....(2)
5. But according to Boyle's law,
   PV = constant (at constant temperature)
   Also, Also, M and γ are constant.
   ∴ v = constant
6. Hence, the velocity of sound does not depend upon the change in pressure, as long as the temperature remains constant.
7. For a gaseous medium, PV= nRT. Substituting in equation (2), we get,
   v = $\sqrt{\frac{\gamma nRT}{M}}$
8. Thus, even for a gaseous medium obeying the ideal gas equation, the velocity of sound does not depend upon the change in pressure, as long as the temperature remains constant.

Exercises | Q 2. (vi) | Page 157

Answer briefly.
What is the effect of pressure on the velocity of sound?

SOLUTION

1. Let v be the velocity of sound in the air when the pressure is P and density is ρ.
2. Using Laplace's formula, we can write,
   v = $\sqrt{\frac{\gamma P}{\rho}}$ ....(1)
3. If V be the volume of gas having mass M then, $\rho = \frac{M}{V}$
4. Substituting ρ in equation (1), we get,
   v = $\sqrt{\frac{\gamma PV}{M}}$ ....(2)

5. But according to Boyle's law,
   PV = constant (at constant temperature)
   Also, Also, M and γ are constant.
   $\therefore$ v = constant
6. Hence, the velocity of sound does not depend upon the change in pressure, as long as the temperature remains constant.
7. For a gaseous medium, PV= nRT. Substituting in equation (2), we get,
   $v = \sqrt{\frac{\gamma nRT}{M}}$
8. Thus, even for a gaseous medium obeying the ideal gas equation, the velocity of sound does not depend upon the change in pressure, as long as the temperature remains constant.

Exercises | Q 2. (vii) | Page 157

Answer briefly.
What is the effect of humidity of air on velocity of sound?

SOLUTION

1. Let v_m and v_d be the velocities of sound in moist air and dry air respectively.
   $\therefore v_m = \sqrt{\frac{\gamma P}{\rho_m}}$ and $v_d = \sqrt{\frac{\gamma P}{\rho_d}}$
   $\therefore \frac{v_m}{v_d} = \sqrt{\frac{\gamma P}{\rho_m}} \times \sqrt{\frac{\rho_d}{\gamma P}}$
   $= \sqrt{\frac{\gamma}{\gamma} \times \frac{\rho_d}{\rho_m}} = \sqrt{\frac{\rho_d}{\rho_m}}$
2. Humid air contains a large proportion of water vapour. Density of water vapour at 0 °C is 0.81 kg/m^3 while that of dry air at 0 °C is 1.29 kg/m^3. So, the density ρ_m of moist air is less than the density ρ_d of dry air i.e.,$\rho_m < \rho_d$.
3. Thus, $\frac{v_m}{v_d} > 1$
   $\therefore v_m > v_d$
4. Hence, sound travels faster in moist air than in dry air. It means that the velocity of sound increases with an increase in moistness (humidity) of air.

Exercises | Q 2. (viii) | Page 157

Answer briefly.
What do you mean by an echo?

SOLUTION

An echo is the repetition of the original sound because of reflection from some rigid surface at a distance from the source of sound.

Exercises | Q 2. (ix) | Page 157

Answer briefly.

State any two applications of acoustics.

SOLUTION

Application of acoustics in nature:

1. Bats apply the principle of acoustics to locate objects. They emit short ultrasonic pulses of frequency 30 kHz to 150 kHz. The resulting echoes give them information about the location of the obstacle. This helps the bats to fly in even in the total darkness of caves.

2. Dolphins navigate underwater with the help of an analogous system. They emit subsonic frequencies which can be about 100 Hz. They can sense an object about 1.4 m or larger.

Medical applications of acoustics:

1. High pressure and high amplitude shock waves are used to split kidney stones into smaller pieces without invasive surgery. A reflector or acoustic lens is used to focus a produced shock wave so that as much of its energy as possible converges on the stone. The resulting stresses in the stone cause the stone to break into small pieces which can then be removed easily.

2. Ultrasonic imaging uses the reflection of ultrasonic waves from regions in the interior of the body. It is used for prenatal (before the birth) examination, detection of anomalous conditions like a tumour, etc. and the study of heart valve action.

3. Ultrasound at a very high-power level destroys selective pathological tissues which are helpful in the treatment of arthritis and a certain type of cancer.

Underwater applications of acoustics:

1. SONAR (Sound Navigational Ranging) is a technique for locating objects underwater by transmitting a pulse of ultrasonic sound and detecting the reflected pulse.

2. The time delay between transmission of a pulse and the reception of reflected pulse indicates the depth of the object.

3. Motion and position of submerged objects like submarine can be measured with the help of this system.

Applications of acoustics in environmental and geological studies:

1. The acoustic principle has important application to environmental problems like noise control. The quiet mass transit vehicle is designed by studying the generation and propagation of sound in the motor's wheels and supporting structures.

2. Reflected and refracted elastic waves passing through the Earth's interior can be measured by applying the principles of acoustics. This is useful in studying the properties of the Earth.

3. Principles of acoustics are applied to detect local anomalies like oil deposits etc. making it useful for geological studies.

Exercises | Q 2. (x) | Page 157

Answer briefly.
Define amplitude.

SOLUTION

Amplitude (A): The largest displacement of a particle of a medium through which the wave is propagating, from its rest position, is called the amplitude of that wave. SI unit is (m).

Exercises | Q 2. (xi) | Page 157

Answer briefly.
Define wavelength of a wave.

SOLUTION

Wavelength (λ): The distance between two successive particles which are in the same state of vibration is called the wavelength of the wave. SI unit is (m).

Exercises | Q 2. (xi) | Page 157

Answer briefly.

Draw a wave and indicate points which are

i. in phase

ii. out of phase

iii. have a phase difference of $\frac{\pi}{2}$

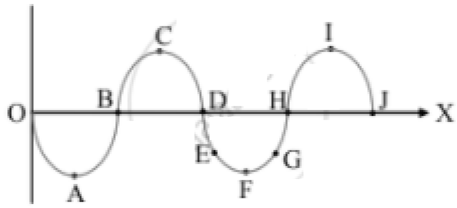
SOLUTION

i. **In phase point:** A and F; B and H; C and I; D and J

ii. **Out of phase points:** A and B, B and D, H and J, E and F, etc.

iii. **Point having phase difference of $\frac{\pi}{2}$:**

A and B; B and C; C and D; D and F; F and H; H and I; J and I



Exercises | Q 2. (xii) | Page 158

Answer briefly.

Define the relation between velocity, wavelength and frequency of the wave.

SOLUTION

1. A wave covers a distance equal to the wavelength (λ) during one period (T).
   Therefore, the magnitude of the velocity (v) is given by,
   Magnitude of velocity = $\frac{\text{Distance covered}}{\text{Corresponding time}}$
2. $v = \frac{\lambda}{T}$ i.e., $v = \lambda \times \left(\frac{1}{T}\right)$ ....(1)
3. But reciprocal of the period is equal to the frequency (n) of the waves.
   $\therefore \frac{1}{T} = n$ ....(2)
4. From equations (1) and (2), we get
   $v = n\lambda$
   i.e., wave velocity = frequency × wavelength.

Exercises | Q 2. (xiii) | Page 158

Answer briefly.

State and explain the principle of superposition of waves.

SOLUTION

Principle:

As waves don't repulse each other, they overlap in the same region of the space without affecting each other. When two waves overlap, their displacements add vectorially.

Explanation:

1. Consider two waves travelling through a medium arriving at a point simultaneously.

2. Let each wave produce its own displacement at that point independent of the others. This displacement can be given as,
   y_1 = displacement due to first wave.
   y_2 = displacement due to second wave.

3. Then according to the superposition of waves, the resultant displacement at that point is equal to the vector sum of the displacements due to all the waves.

$$\therefore \vec{y} = \vec{y}_1 + \vec{y}_2$$

Exercises | Q 2. (xiv) | Page 158

Answer briefly.

State the expression for apparent frequency when source of sound and listener are

i. moving towards each other
ii. moving away from each other

SOLUTION

1. Let, n_0 = actual frequency of the source.
   n = apparent frequency of the source.
   v = velocity of sound in air.
   v_s = velocity of the source.
   v_L = velocity of the listener.
2. Apparent frequency heard by the listener is given by, $n = n_0\left(\frac{v \pm v_L}{v \mp v_s}\right)$
   Where upper signs (+ ve in numerator and -ve in denominator) indicate that the source and observer move towards each other. Lower signs (-ve in numerator and +ve in denominator) indicate that the source and listener move away from each other.
3. If source and listener are moving towards each other, then apparent frequency is given by,
   $n = n_0\left(\frac{v + v_L}{v - v_s}\right)$ i.e., apparent frequency increases.
4. If source and listener are moving away from each other, then apparent frequency is given by,
   $n = n_0\left(\frac{v - v_L}{v + v_s}\right)$ i.e., apparent frequency decreases.

Exercises | Q 2. (xv) | Page 158

Answer briefly.

State the expression for apparent frequency when source is stationary and listener is

i. moving towards the source
ii. moving away from the source

SOLUTION

1. Let, n = actual frequency of the source.

   n_0 = apparent frequency of the source.

   v = velocity of sound in air.

   v_s = velocity of the source.

   v_1 = velocity of the listener.

2. If listener is moving towards source then apparent frequency is given by,

   $n = n_0\left(\frac{v + v_L}{v}\right)$, i.e., apparent frequency increases.

3. If listener is receding away from source then apparent frequency is given by,

   $n = n_0\left(\frac{v - v_L}{v}\right)$, i.e., apparent frequency decreases.

Exercises | Q 2. (xvi) | Page 158

Answer briefly.

State the expression for apparent frequency when listener is stationary and source is

i. Moving towards the listener
ii. Moving away from the listener

SOLUTION

1. Let, n = actual frequency of the source.

   n_0 = apparent frequency of the source.

   v = velocity of sound in air.

   v_s = velocity of the source.

   v_1 = velocity of the listener.

2. If source is moving towards observer then apparent frequency is given by,

$n = n_0\left(\frac{v}{v - v_s}\right)$, i.e., apparent frequency increases.

3. If source is receding away from observer then apparent frequency is given by,

$n = n_0\left(\frac{v}{v + v_s}\right)$, i.e., apparent frequency decreases.

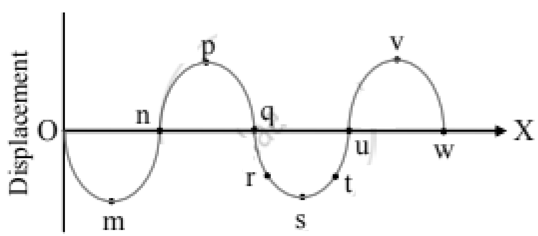
Exercises | Q 2. (xvii) | Page 158

Answer briefly.

Explain what is meant by phase of a wave.

SOLUTION

1. The state of the oscillation of a particle is called the phase of the particle.
2. The displacement, direction of velocity, and oscillation number of the particle describe the phase of the particle at a place.



Displacement as a function of distance along the wave

3. Particles r and t (q and u or v and s) have the same displacements but the directions of their velocities are opposite.
4. Particles having same magnitude of displacements and the same direction of velocity are said to be in phase during their respective oscillations. Example: particles v and p.
5. Separation between two particles which are in phase is wavelength (λ).
6. The two successive particles differ by '1' in their oscillation number i.e., if particle v is at its n^{th} oscillation, particle p will be at its $(n+1)^{th}$ oscillation as the wave is travelling along + X direction.

7. In the given graph, if the disturbance (energy) has just reached the particle w, the phase angle corresponding to particle is 0°. At this instant, particle v has completed quarter oscillation and reached its positive maximum (sin θ = +1). The phase angle θ of this particle v is $\frac{\pi^c}{2}$ = 90° at this instant.
8. Phase angles of particles u and q are π c (180°) and $2\pi^c$ (360°) respectively.
9. Particle p has completed one oscillation and is at its positive maximum during its second oscillation.
   ∴ phase angle = $2\pi^c + \frac{\pi^c}{2} = \frac{5\pi^c}{2}$.
10. v and p are the successive particles in the same state (same displacement and the same direction of velocity) during their respective oscillations. Phase angle between these two differs by $2\pi^c$.

Exercises | Q 2. (xviii) | Page 158

Answer briefly.
Define progressive wave.

SOLUTION

Waves in which a disturbance created at one place travels to distant points and keeps travelling unless stopped by an external force are known as travelling or progressive waves.

Exercises | Q 2. (xix) | Page 158

Answer briefly.
State any four properties of progressive wave.

SOLUTION

Properties of progressive waves are:
Amplitude, wavelength, period, double periodicity, frequency and velocity.

Progressive waves are classified into two types:

a. Transverse progressive waves
b. Longitudinal progressive waves

Characteristics of progressive waves:

1. All the vibrating particles of medium have same amplitude, period, and frequency.
2. 2. State of oscillation i.e., phase changes from particle to particle.

Exercises | Q 2. (xx) | Page 158

Answer briefly.
What is its limitation of velocity of sound?

SOLUTION

Limitations of velocity of sound:

1. Experimentally, it is found that the velocity of sound in air at N. T. P is 332 m/s. Thus, there is a considerable difference between the value predicted by Newton's formula and the experimental value.
2. The experimental value is 16% greater than the value given by the formula. Newton failed to provide a satisfactory explanation for the difference.

Exercises | Q 3. (i) | Page 158

Solve the following problem.

A certain sound wave in air has a speed 340 m/s and wavelength 1.7 m for this wave, calculate

a. the frequency
b. the period

SOLUTION

Given: v = 340 m/s, λ = 1.7 m

To find: frequency (n), period (T)

Formulae:

1. $n = \frac{v}{\lambda}$
2. $T = \frac{1}{n}$

Calculation: From formula (i),

$$n = \frac{340}{1.7}$$

∴ n = **200 Hz**

From formula (ii),

$$T = \frac{1}{200} = \frac{1}{2 \times 10^2}$$

$= 5 \times 10^{-3}$ ....(using reciprocal table)

∴ T = **0.005 s**

The frequency of the sound wave is **200 Hz** and its period is **0.005 s.**

Exercises | Q 3. (ii) | Page 158

Solve the following problem.

A tuning fork of frequency 170 Hz produces sound waves of wavelength 2 m. Calculate the speed of sound.

SOLUTION

Given: n = 170 Hz, λ = 2 m

To find: velocity of sound (v)

Formula: v = nλ

Calculation: From formula,

v = 170 × 2

∴ v = 340 m/s

The velocity of sound **340 m/s**.

Exercises | Q 3. (iii) | Page 158

Solve the following problem.

An echo-sounder in a fishing boat receives an echo from a shoal of fish 0.45 s after it was sent. If the speed of sound in water is 1500 m/s, how deep is the shoal?

SOLUTION

Given: t = 0.45 s, v = 1500 m/s,

To find: depth (d)

Formula: Speed (v) = $\frac{\text{distance}}{\text{time}}$

Calculation: For an echo distance travelled by the sound wave = 2 × (distance between echo sounder and shoal) (d)

$$v = \frac{2 \times d}{t}$$

$$\therefore d = \frac{1500 \times 0.45}{2} = 337.5 \text{ m}$$

The shoal is **337.5** deep.

Exercises | Q 3. (iv) | Page 158

Solve the following problem.

A girl stands 170 m away from a high wall and claps her hands at a steady rate so that each clap coincides with the echo of the one before.

a. If she makes 60 claps in 1 minute, what value should be the speed of sound in air?

b. Now, she moves to another location and finds that she should now make 45 claps in 1 minute to coincide with successive echoes. Calculate her distance for the new position from the wall.

SOLUTION

Given: distance (s) = 170 m

To find:

i. velocity of sound (v)

ii. distance (s)

Formula: Speed = $\frac{\text{distance}}{\text{time}}$

Calculation:

i. Girl produces 60 claps in 1 minute i.e., 1 clap in second From formula,

$v = \frac{2(s)}{t}$ .....(for an echo)

$\therefore v = \frac{2 \times 170}{1}$ = **340 m/s**

ii. Girl produces 45 claps per minute i.e., 1 clap in $\frac{4}{3}$ s

From formula,

$v = \frac{2(s)}{t}$ ....(for an echo)

$\therefore 2s = v \times t$

$\therefore s = \frac{340 \times 4}{2 \times 3} = \frac{340 \times 2}{3}$ = **226.67 m**

Exercises | Q 3. (v) | Page 158

Solve the following problem.

Sound wave A has period 0.015 s, sound wave B has a period of 0.025 s. Which sound has greater frequency?

SOLUTION

Given: T_A = 0.015 s, T_B = 0.025 s

To find: greater frequency (n)

Formula: n = $\frac{1}{T}$

Calculation: From formula,

$$n_A = \frac{1}{T_A} = \frac{1}{0.015} = \frac{1}{1.5 \times 10^{-2}}$$

∴ n_A = 66.67 Hz ....(using reciprocal table)

$$n_B = \frac{1}{T_B} = \frac{1}{0.025} = \frac{1}{2.5 \times 10^{-2}}$$

∴ n_B = 40 Hz ....(using reciprocal table)

∴ n_B > n_B

Sound wave A has a greater frequency than sound B.

Exercises | Q 3. (vi) | Page 158

Solve the following problem.
At what temperature will the speed of sound in the air be 1.75 times its speed at S.T.P?

SOLUTION

Given:

v_{air} = 1.75 $V_{S.T.P.} = \frac{7}{4} V_{STP}, T_{S.T.P.} = 273$K

To find: temperature T_{air}

Formula: $v \propto \sqrt{T}$

Calculation: From formula,

$$\frac{v_{STP}}{v_{air}} = \sqrt{\frac{T_{STP}}{T_{air}}}$$

$$\therefore \frac{v_{STP}}{1.75 v_{air}} = \sqrt{\frac{273}{T_{air}}}$$

$$\therefore \frac{v_{STP}}{7/4 v_{STP}} = \sqrt{\frac{273}{T_{air}}}$$

$$\therefore T_{air} = \frac{273 \times 49}{16}$$

$\therefore T_{air}$ = 836 K = 563 °C

At **836 K (563 °C),** the speed of sound in air will be 1.75 times its speed at S.T.P.

Exercises | Q 3. (vii) | Page 158

Solve the following problem.

A man standing between 2 parallel cliffs fires a gun. He hears two echoes one after 3 seconds and other after 5 seconds. The separation between the two cliffs is 1360 m, what is the speed of sound?

SOLUTION

Given: distance (s) = 1360 m, t

ime for first echo = 3 s,

time for second echo = 5 s

To find: speed of sound (v)

Formula: speed = $\frac{\text{distance}}{\text{time}}$

Calculation: Time for first echo = 3 s

$\therefore$ time taken by sound to travel given distance t_1

$$= \frac{3}{2} = 1.5 \text{ s}$$

Time for second echo = 5 s

$\therefore$ time taken by sound to travel given distance t_2

$$= \frac{5}{2} = 2.5 \text{ s}$$

$\therefore$ Total time taken by sound to travel given distance, T = 1.5 + 2.5 = 4 s

From formula, $v = \frac{1360}{4}$

$\therefore$ v = 340 m/s

The speed of sound is **340 m/s**.

Exercises | Q 3. (viii) | Page 158

Solve the following problem.

If the velocity of sound in air at a given place on two different days of a given week are in the ratio of 1:1.1. Assuming the temperatures on the two days to be same what quantitative conclusion can your draw about the condition on the two days?

SOLUTION

Let v_1 and v_2 be the velocity of sound on day 1 and day 2 respectively.

$$\frac{v_1}{v_2} = \frac{1}{1.1}$$

We know, $\mathbf{v} \propto \frac{1}{\sqrt{\rho}}$

Let ρ_1 and ρ_2 be the density of air on day 1 and day 2 respectively.

$$\therefore \sqrt{\frac{\rho_2}{\rho_1}} = \frac{1}{1.1}$$

$$\therefore \frac{\rho_2}{\rho_1} = \left(\frac{1}{1.1}\right)^2$$

$$\therefore \rho_1 = 1.1^2 \rho_2 = 1.21\ \rho_2$$

From above equation, we can conclude,

$\rho_1 > \rho_2$

$\therefore v_2 > v_1$ i.e., the velocity of sound is greater on the second day than on the first day.

We know, speed of sound in moist air (v_m) is greater than speed of sound in dry air (v_d).

$\therefore$ We can conclude, air is moist on the second day and dry on the first day.

Exercises | Q 3. (ix) | Page 158

Solve the following problem.
A police car travels towards a stationary observer at a speed of 15 m/s. The siren on the car emits a sound of frequency 250 Hz. Calculate the recorded frequency. The speed of sound is 340 m/s.

SOLUTION

Given: v_s = 15 m/s, n_0 = 250 Hz, v = 340 m/s

To find: Frequency (n)

Formula: $n = n_0\left(\frac{v}{v - v_s}\right)$

Calculation: As the source approaches listener, apparent frequency is given by,

$$n = 250\left(\frac{340}{340 - 15}\right) = \frac{3400}{13}$$

$\therefore$ n = 261.54 Hz

The frequency heard by the audience as the car approaches stand is **261.54 Hz**.

Exercises | Q 3. (x) | Page 158

Solve the following problem.
The sound emitted from the siren of an ambulance has a frequency of 1500 Hz. The speed of sound is 340 m/s. Calculate the difference in frequencies heard by a stationary observer it the ambulance initially. travels towards and then away from the observer at a speed of 30 m/s.

SOLUTION

Given: v_s = 30 m/s, n_0 = 1500 Hz, v = 340 m/s

To find: Difference in apparent frequencies (n_A - n'_A)

Formulae:

i. When the ambulance moves towards he stationary observer then $\mathbf{n_A = n_0\left(\frac{v}{v - v_s}\right)}$

ii. When the ambulance moves away from the stationary observer then, $\mathbf{n\prime_A = n_0\left(\frac{v}{v + v_s}\right)}$

Calculation: From formula (i),

$$\mathbf{n_A = 1500\left(\frac{3400}{340 - 30}\right)}$$

∴ n_A = 1645 Hz

From formula (ii),

n'A = 1500$\mathbf{\left(\frac{340}{340 + 30}\right)}$

∴ n'_A = 1378 Hz

Difference between n_A and n'_A

= n_A - n'_A = 1645 - 1378 = 267 Hz

The difference in frequencies heard by the stationary observer is **267 Hz.**