Exercise-1

✍ **Marked Questions can be used as Revision Questions.**

OBJECTIVE QUESTIONS

Section(A) :

Equation of sound wave, wavelength, frequency, pressure and displacement amplitude

A 1. When sound wave is refracted from air to water, which of the following will remain unchanged?
(1) wave number (2) wavelength (3) wave velocity (4) frequency

A 2.✍ The frequency of a man's voice is 300 Hz and its wavelength is 1 meter. If the wavelength of a child's voice is 1.5 m, then the frequency of the child's voice is:
(1) 200 Hz (2) 150 Hz (3) 400 Hz (4) 350 Hz.

Section (B):Speed of sound

B 1.✍ The ratio of speed of sound in neon to that in water vapours at any temperature (when molecular weight of neon is 2.02×10^{-2} kg mol^{-1} and for water vapours is 1.8×10^{-2} kg mol^{-1})
(1) 1.06 (2) 1.60 (3) 6.10 (4) 15.2

B 2. Under similar conditions of temperature and pressure, In which of the following gases the velocity of sound will be largest.
(1) H_2 (2) N_2 (3) He (4) CO_2

B 3. If v_m is the velocity of sound in moist air and v_d is the velocity of sound in dry air, then -
(1) $v_d > v_m$ (2) $v_d = v_m$ (3) $v_d \neq v_m$ (4) $v_m > v_d$

Section (C) : Intensity of sound, decibel scale and interference

C 1.✍ A person is talking in a small room and the sound intensity level is 60 dB everywhere within the room. If there are eight people talking simultaneously in the room, what is the sound intensity level ?
(1) 60 dB (2) 69 dB (3) 74 dB (4) 81 dB

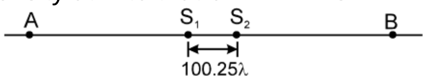
C 2. When two waves with same frequency and constant phase difference interfere,
(1) there is a gain of energy
(2) there is a loss of energy
(3) the energy is redistributed and the distribution changes with time
(4) the energy is redistributed and the distribution remains constant in time

C 3. The terms pitch, quality and loudness of sound are associated with the following, respectively-
(1) intensity, frequency and waveform (2) Frequency, intensity and waveform
(3) Frequency, waveform and intensity (4) Waveform, frequency and intensity

C 4.✍ For a wave displacement amplitude is 10^{-8} m, density of air 1.3 kg m^{-3}, velocity in air 340 ms^{-1} and frequency is 2000 Hz. The intensity of wave is
(1) 5.3×10^{-4} Wm^{-2} (2) 5.3×10^{-6} Wm^{-2} (3) 3.5×10^{-8} Wm^{-2} (4) 3.5×10^{-6} Wm^{-2}

C 5. The sound intensity is 0.008 W/m^2 at a distance of 10 m from an isotropic point source of sound. The power of the source is :
(1) 2.5 watt (2) 0.8 watt (3) 8 watt (4) 10 watt

C 6. S_1 and S_2 are two coherent sources of radiations separated by distance 100.25 λ, where λ is the wave length of radiation. S_1 leads S_2 in phase by $\pi/2$. A and B are two points on the line joining S_1 and S_2 as shown in figure. The ratio of amplitudes of component waves from source S_1 and S_2 at A and B are in ratio 1:2. The ratio of intensity at A to that of B $\left(\frac{I_A}{I_B}\right)$ is



(1) ∞ (2) $\frac{1}{9}$ (3) 0 (4) 9

C-7. Two waves of intensity I and 4I superpose on each other. Then in interference, maximum and minimum intensity are respectively -
(1) 3I and 2I (2) 25 I and 9 I (3) 9 I and I (4) 5 I and 3 I

C-8. If the ratio of two sound intensities is 1 : 16, the ratio of their amplitudes of sound waves will be-
(1) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) $\frac{1}{8}$ (4) $\frac{1}{16}$

C-9. Two waves of same frequency and of intensity I_0 and $9I_0$ produces interference. If at a certain point the resultant intensity is $7I_0$ then the minimum phase difference between the two sound waves will be -
(1) 90º (2) 100º (3) 120º (4) 110º

C-10. If the ratio of amplitudes of two waves at any point in the medium is 1 : 3, then the ratio of maximum and minimum intensities due to their superposition will be
(1) 2 : 3 (2) 3 : 1 (3) 2 : 1 (4) 4 :1

Section (D) : Reflection of sound equation of stationary waves

D 1. When a sound wave is reflected from a wall, the phase difference between the reflected and incident pressure wave is:
(1) 0 (2) π (3) $\pi/2$ (4) $\pi/4$

D 2. In stationary waves displacement, antinodes are the points where there is -
(1) Minimum displacement and minimum pressure change
(2) Minimum displacement and maximum pressure change
(3) Maximum displacement and maximum pressure change
(4) Maximum displacement and minimum pressure change

Section (E) : Organ Pipes and Resonance

E 1. If λ_1, λ_2, λ_3 are the wavelengths of the waves giving resonance in the fundamental, first and second overtone modes respectively in a open organ pipe, then the ratio of the wavelengths $\lambda_1 : \lambda_2 : \lambda_3$, is :
(1) 1 : 2 : 3 (2) 1 : 3 : 5 (3) 1 : 1/2 : 1/3 (4) 1 : 1/3 : 1/5

E 2. An open organ pipe of length L vibrates in its fundamental mode. The pressure variation is maximum
(1) at the two ends (2) at the middle of the pipe
(3) at distance L/4 inside the ends (4) at distance L/8 inside the ends

E 3. The fundamental frequency of a closed organ pipe is same as the first overtone frequency of an open pipe. If the length of open pipe is 50 cm, the length of closed pipe is
(1) 25 cm (2) 12.5 cm (3) 100 cm (4) 200 cm

E 4. A cylindrical tube, open at both ends, has a fundamental frequency υ. The tube is dipped vertically in water so that half of its length is inside the water. The new fundamental frequency is
(1) $\upsilon/4$ (2) $\upsilon/2$ (3) υ (4) 2υ

E 5. An open pipe of length 33 cm resonates to a frequency of 1000 Hz. The mode of vibration is: (velocity of sound = 330 m/s)
(1) Fundamental (2) The 2nd harmonic (3) The 3rd harmonic (4) The 4th harmonic

E 6*. In Resonance tube experiment, if 400 Hz tuning fork is used, the first resonance occurs when length of air column in the tube is 19 cm. If the 400 Hz. tuning fork is replaced by 1600 Hz tuning fork then to get resonance, the water level in the tube should be further lowered by (take end correction = 1 cm)
(1) 5 cm (2) 10 cm (3) 15 cm (4) 20 cm

Section (F) : Beats

F 1. If two tuning forks A & B give 4 beats/sec. with each other, on loading A with wax, 2 beats/sec. are given. If frequency of A is 256 Hz, then frequency of B is -
(1) 250 Hz (2) 252 Hz (3) 260 Hz (4) 262 Hz

F 2. The frequency of a fork A is 3% more than the frequency of a standard fork whereas the frequency of fork B is 3% less. The forks A and B produce 6 beats per second. The frequency of stadard fork will be
(1) 100 Hz (2) 106 Hz (3) 103 Hz (4) 112 Hz

F 3. A closed organ pipe and an open pipe of same length produce 4 beats when they are set into vibrations simultaneously. If the length of each of them were twice their initial lengths, the number of beats produced will be [Assume same mode of vibration in both cases]
(1) 2 (2) 4 (3) 1 (4) 8

F 4. Two identical wires are stretched by the same tension of 101 N & each emits a note of frequency 202 Hz. If the tension in one wire is increased by 1 N, then the beat frequency is:
(1) 2 Hz (2) $\frac{1}{2}$ Hz (3) 1 Hz (4) none of these

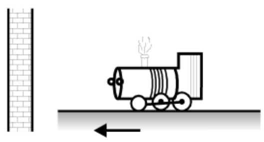
F-5. Each of the two string of length 51.6 cm and 49.1 cm are tensioned separately by 20 N force. Mass per unit length of both the strings is same and equal to 1 gm^{-1}. When both the strings vibrate simultaneously the number of beats is
(1) 5 (2) 7 (3) 8 (4) 3

F-6. Two identical straight wires are stretched so as to produce 6 beats per second when vibrating simultaneously. On changing the tension slighthly in one of them, the beat frequency still remains unchanged. Denoting by T_1 and T_2, the higher and the lower initial tensions in the strings, it could be said that while making the above changes in tension :
(1) T_1 was decreased (2) T_1 was increased (3) T_2 was decreased (4) None of these

Section (G) : Doppler Effect

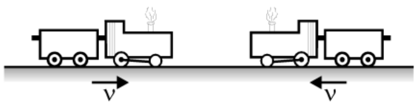
G 1. The change in frequency due to Doppler effect does not depend on
(1) the speed of the source (2) the speed of the observer
(3) the frequency of the source (4) separation between the source and the observer

G 2. An engine driver moving towards a wall with velocity of 50 ms^{-1} emits a note of frequency 1.2 kHz. The frequency of note after reflection from the wall as heard by the engine driver when speed of sound in air is 350 ms^{-1} is :



(1) 1 kHz (2) 1.8 kHz
(3) 1.6 kHz (4) 1.2 kHz

G 3. Two trains move towards each other with the same speed. Speed of sound is 340 ms^{-1}. If the pitch of the tone of the whistle of one when heard on the other changes by 9/8 times, then the speed of each train is :



(1) 2 ms^{-1} (2) 40 ms^{-1}
(3) 20 ms^{-1} (4) 100 ms^{-1}

G 4. A receiver & a source of sonic oscillations of frequency 200 Hz are located on the x - axis. The receiver is fixed and the source swings harmonically along that axis with a circular frequency ω and an amplitude 50 cm. At what value of ω (in rad/sec) will the frequency band width (f_{max} - f_{min}) registered by the stationary receiver be equal to 20 Hz. [The velocity of sound is equal to 340 m/s]
(1) 17 (2) 34 (3) 68 (4) 8.5

Exercise-2

Marked Questions can be used as Revision Questions.

PART - I : OBJECTIVE QUESTIONS

1. If v_{rms} = root mean square speed of molecules,
v_{av} = average speed of molecules.
v_{mp} = most probable speed of molecules,
v_s = speed of sound in a gas
Then, identify the correct relation between these speeds.
(1) $v_{rms} > v_{av} > v_{mp} > v_s$ (2) $v_{av} > v_{mp} > v_{rms} > v_s$
(3) $v_{mp} > v_{av} > v_{rms} > v_s$ (4) $v_{rms} > v_{av} > v_s > v_{mp}$

2. The sound intensity is 0.008 W/m^2 at a distance of 10 m from an isotropic point source of sound. The power of the source is :
(1) 2.5 watt (2) 0.8 watt (3) 8 watt (4) 10 watt

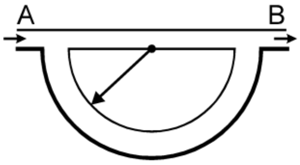
3. Sound waves from a tuning fork F reach a point P by two separate routes FAP and FBP (when FBP is greater than FAP by 12 cm there is silence at P). If the difference is 24 cm the sound becomes maximum at P but at 36 cm there is silence again and so on. If velocity of sound in air is 330 ms^{-1}, the least frequency of tuning fork is :
(1) 1537 Hz (2) 1735 Hz (3) 1400 Hz (4) 1375 Hz

4. The second overtone of an open pipe A and a closed pipe B have the same frequencies at a given temperature. Both pipes contain air. The ratio of fundamental frequency of A to the fundamental frequency of B is:
(1) 3: 5 (2) 5: 3 (3) 5: 6 (4) 6: 5

5. In the case of sound waves, wind is blowing from source to receiver with speed U_W. Both source and receiver are stationary. If λ_0 is the original wavelength with no wind and V is speed of sound in air then wavelength as received by the receiver is given by :
(1) λ_0 (2) $\left(\frac{V+U_w}{V}\right)\lambda_0$ (3) $\left(\frac{V-U_w}{V}\right)\lambda_0$ (4) $\left(\frac{V}{V+V_w}\right)\lambda_0$

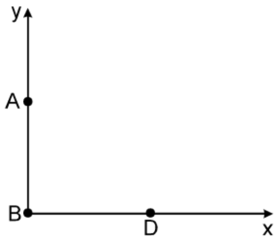
6. Two sound sources each emitting sound of wavelength λ are fixed some distance apart. A listener moves with a velocity u along the line joining the two sources. The number of beats heard by him per second is
(1) $\frac{2u}{\lambda}$ (2) $\frac{u}{\lambda}$ (3) $\frac{u}{3\lambda}$ (4) $\frac{2\lambda}{u}$

7. Sound signal is sent through a composite tube as shown in the figure. The radius of the semicircular portion of the tube is r. Speed of sound in air is v. The source of sound is capable of giving varied frequencies in the range of ν_1 and ν_2 (where $\nu_2 > \nu_1$). If n is an integer then frequency for maximum intensity is given by :



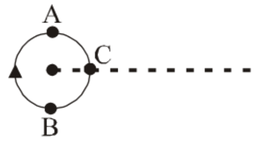
(1) $\frac{nv}{r}$ (2) $\frac{nv}{r(\pi-2)}$
(3) $\frac{nv}{\pi r}$ (4) $\frac{nv}{(r-2)\pi}$

8. An interference is observed due to two coherent sources 'A' & 'B' separated by a distance 4λ along the y-axis where λ is the wavelength of the source. A detector D is moved on the positive x-axis. The number of points on the x-axis excluding the points, $x = 0$ & $x = \infty$ at which maximum will be observed is -



(1) three (2) four (3) two (4) infinite

9. A small source of sound moves on a circle as shown in fig. and an observer is sitting at O. Let at $\upsilon_1, \upsilon_2, \upsilon_3$ be the frequencies heard when the source is at A, B, and C respectively.

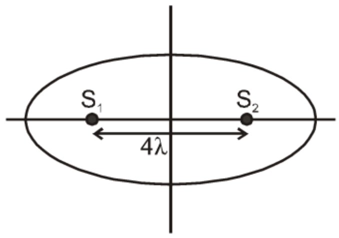


(1) $\upsilon_1 > \upsilon_2 > \upsilon_3$ (2) $\upsilon_1 = \upsilon_2 > \upsilon_3$
(3) $\upsilon_2 > \upsilon_3 > \upsilon_1$ (4) $\upsilon_1 > \upsilon_3 > \upsilon_2$

10. Two sound sources produce progressive waves given by $y_1 = 12 \cos 100\pi t$ and $y_2 = 4 \cos 102\pi t$ near the ear of an observer. When sounded together, the observer will hear
(1) 2 beats per two sound source with an intensity ratio of maximum to minimum nearly 4 : 1
(2) 1 beat per second with an intensity ratio of maximum to minimum nearly $\sqrt{2}$: 1
(3) 2 beats per second with an intensity ratio of maximum to minimum nearly 9 : 1
(4) 1 beat per second with an intensity ratio of maximum to minimum nearly 4 : 1

11. A tuning fork of frequency 512 Hz is vibrated with a sonometer wire and 6 beats per second are heard. The beat frequency reduces if the tension in the string is slightly increased. The original frequency of vibration of the string is
(1) 506 Hz (2) 512 Hz (3) 518 Hz (4) 524 Hz

12. S_1, S_2 are two coherent sources (having initial face difference zero) of sound located alongx-axis separated by 4λ where λ is wavelength of sound emitted by them. Number of maxima located on the elliptical boundary around it will be :



(1) 16 (2) 12
(3) 8 (4) 4

13. Two sound waves with wavelengths 5.0 m and 5.5 m respectively, each propagate in a gas with velocity 330 m/s. We expect the following number of beats per second :-
(1) 12 (2) 0 (3) 1 (4) 6

PART- II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion/Reasoning

A-1. **STATEMENT 1 :** Doppler formula for sound wave is symmetric with respect to the speed of source and speed of observer
STATEMENT 2 : Motion of source with respect to stationary observer is not equivalent to the motion of an observer with respect to a stationary source.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

A-2. **STATEMENT 1 :** The base of Laplace correction was that exchange of heat between the region of compression and rarefaction in air is negligible.
STATEMENT 2 : Air is bad conductor of heat and velocity of sound in air is quite large.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

A-3. **STATEMENT 1 :** In sound waves variation of pressure and density of gas above and below average have maximum value at displacement node.
STATEMENT 2 : When particle on opposite side of displacement node approach each other gas between them is compressed and pressure rises so that at displacement node gas undergoes maximum amount of compression.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

Section (B) : Match the column

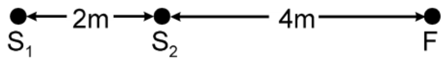
B-1. Regarding speed of sound in gas, match the statements in column-I with the results in column-II

Column I	Column II
(1) Temperature of gas is made 4 times and pressure 2 times	(p) speed becomes $2\sqrt{2}$ times the initial value
(2) Only pressure is made 4 times without change in temperature	(q) speed becomes 2 times the initial value
(3) Only temperature is changed to 4 times	(r) speed remains unchanged
(4) Only Molecular mass of the gas is made 4 times	(s) speed becomes half the initial value

Section (C) : One or More Than One Options Correct

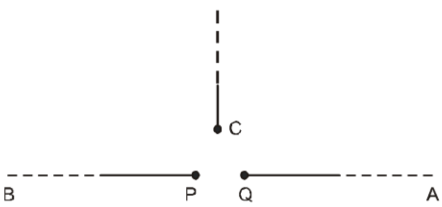
C-1. Which one of the following statements is incorrect for stable interference to occur between two waves?
(1) The waves must have the same wave length
(2) The waves must have a constant phase difference
(3) The waves must be transverse only
(4) The waves must have equal amplitudes.

C-2. S_1 and S_2 are two sources of sound emitting sine waves. The two sources are in phase. The sound emitted by the two sources interfere at point F. The waves of wavelength :



(1) 1 m will result in constructive interference
(2) $\frac{2}{3}$ m will result in constructive interference
(3) 2m will result in destructive interference
(4) 4m will result in destructive interference

C-3. Two monochromatic sources of electromagnetic wave, P and Q emit waves of wavelength λ = 20 m and separated by 5m as shown. A,B and C are three points where interference of these waves is observed. If phase of a wave generated by P is ahead of wave generated by Q by $\pi/2$ then (given intensity of both waves is I) :



C is symmetrical with respect to P and Q

(1) phase difference of these waves at B is 180^0
(2) intensities at A,B and C are in the ratio 2 : 0 : 1 respectively.
(3) intensities at A,B and C are in the ratio 1 : 2 : 0 respectively.
(4) phase difference at A is 0^0.

C-4. The energy per unit area associated with a progressive sound wave will be doubled if :
(1) the amplitude of the wave is doubled
(2) the amplitude of the wave is increased by 50%
(3) the amplitude of the wave is increased by 41%
(4) the frequency of the wave is increased by 41%

C-5. As a wave propagates :
(1) the wave intensity remains constant for a plane wave

(2) the wave intensity decreases as the inverse of the distance from the source for a spherical wave
(3) the wave intensity decreases as the inverse square of the distance from the source for a spherical wave
(4) total power of the spherical wave over the spherical surface centered at the source remains constant at all times .

C-6. At the closed end of an organ pipe :
(1) the displacement is zero
(2) the displacement amplitude is maximum
(3) the pressure amplitude is zero
(4) the pressure amplitude is maximum

C-7.✍ A cylindrical tube, open at one end and closed at the other, is in acoustic unison (resonance) with an external source of sound of single frequency held at the open end of the tube, in its fundamental note. Then :
(1) the displacement wave from the source gets reflected with a phase change of π at the closed end
(2) the pressure wave from the source get reflected without a phase change at the closed end
(3) the wave reflected from the closed end again gets reflected at the open end
(4) the wave reflected from the closed end does not suffer reflection at the open end

C-8.✍ The effect of making a hole exactly at ($1/3^{rd}$) of the length of the pipe from its closed end is such that
(1) its fundamental frequency is an octave higher than the open pipe of same length
(2) its fundamental frequency is thrice of that before making a hole
(3) the fundamental frequency is 3/2 time of that before making a hole
(4) the fundamental alone is changed while the harmonics expressed as ratio of fundamentals remain the same

C-9. It is desired to increase the fundamental resonance frequency in a tube which is closed at one end. This can be achieved by
(1) replacing the air in the tube by hydrogen gas
(2) increasing the length of the tube
(3) decreasing the length of the tube
(4) opening the closed end of the tube

Exercise-3

✍ **Marked Questions can be used as Revision Questions.**
*** Marked Questions may have more than one correct option.**

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. If two soap bubbles of different radii are connected by a tube : **[AIEEE 2004; 3/225, –1]**
(1) air flows from the bigger bubble to the smaller bubble till the sizes become equal
(2) air flows from bigger bubble to the smaller bubble till the sizes are interchanged
(3) air flows from the smaller bubble to the bigger
(4) there is no flow of air

2. A 20 cm long capillary tube is dipped in water. The water rises upto 8 cm. If the entire arrangement is put in a freely falling elevator, the length of water column in the capillary tube will be : **[AIEEE 2005; 3/225, –1]**
(1) 8 cm
(2) 10 cm
(3) 4 cm
(4) 20 cm

3. A whistle producing sound waves of frequencies 9500 Hz and above is approaching a stationary person with speed v ms_{-1}. The velocity of sound in air is 300 ms_{-1}. If the person can hear frequencies upto a maximum of 10,000 Hz, the maximum value of v upto which he can hear the whistle is: **[AIEEE 2006; 3/165, –1]**

(1) 30 ms_{-1} (2) $15\sqrt{2}$ ms_{-1} (3) $15\sqrt{2}$ ms_{-1} (4) 15 ms_{-1}

4. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of :
[AIEEE 2007; 3/120, –1]

(1) 1000 (2) 10000 (3) 10 (4) 100

5. The speed of sound in oxygen (O_2) at a certain temperature is 460 ms^{-1}. The speed of sound in helium (He) at the same temperature will be (assume both gases to be ideal) : **[AIEEE 2008, 3/105, –1]**

(1) 500 ms^{-1} (2) 650 ms^{-1} (3) 330 ms^{-1} (4) 1419 ms^{-1}

6. While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18 cm during winter. Repeating the same experiment during summer, she measures the column length to be x cm for the second resonance. Then
[AIEEE 2008, 3/105, –1]

(1) x > 54 (2) 54 > x > 36 (3) 36 > x > 18 (4) 18 > x

7. A motor cycle starts from rest and accelerates along a straight path at 2 m/s^2. At the starting point of the motor cycle there is a stationary electric siren. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycle was at rest? (Speed of sound = 330 ms^{-1}) **[AIEEE 2009, 4/144, –1]**

(1) 98 m (2) 147 m (3) 196 m (4) 49 m

8. Three sound waves of equal amplitudes have frequencies (ν - 1), ν (ν + 1). They superpose to give beats. The number of beats produced per second will be: **[AIEEE 2009, 4/144, –1]**

(1) 3 (2) 2 (3) 1 (4) 4

9. A cylindrical tube, open at both ends, has a fundamental frequncy, f, in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air-column is now:
[AIEEE 2012 ; 4/120, –1]

(1) f (2) f/2 (3) 3f/4 (4) 2f

10. A pipe of length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250 Hz. The velocity of sound in air is 340 m/s.
[JEE-(Main) 2014; 4/120. –1]

(1) 12 (2) 8 (3) 6 (4) 4

11. A train is moving on a straight track with speed 20 ms^{-1}. It is blowing its whistle at the frequency of 1000 Hz. The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound = 320 ms^{-1}) close to : **[JEE(Main)-2015; 4/120, –1]**

(1) 6% (2) 12% (3) 18% (4) 24%

12. A pipe open at both ends has fundamental frequency *f* in air. The pipe is dipped vertically in water so that half of it is in water. The fundamental frequency of the air column is now :
[JEE(Main)-2016; 4/120, –1]

(1) $\frac{3f}{4}$ (2) 2*f* (3) *f* (4) $\frac{f}{2}$

13. An observer is moving with half the speed of light towards stationary microwave source emitting waves at frequency 10GHz. What is the frequency of the microwave measured by the observer ?(speed of light = $3 \times 10^8 ms^{-1}$) **[JEE(Main)-2017; 4/120, –1]**

(1) 15.3 GHz (2) 10.1 GHz (3) 12.1 GHz (4) 17.3 GHz

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. A siren placed at a railway platform is emitting sound of frequency 5 kHz. A passenger sitting in a moving train A records a frequency of 5.5 kHz, while the train approaches the siren. During his return journey in a different train B he records a frequency of 6.0 kHz while approaching the same siren. The ratio of the velocity of train B to that of train A is **[JEE - 2002 (Screening), 3/90]**

(A) $\frac{242}{252}$ (B) 2 (C) $\frac{5}{6}$ (D) $\frac{11}{6}$

2. A police car moving at 22 m/s, chases a motorcyclist. The police man sounds his horn at 176 Hz, while both of them move towards a stationary siren of frequency 165 Hz. Calculate the speed of the motorcycle, if it is given that he does not observe any beats. (velocity of sound = 330 m/s) **[JEE-2003 (screening)3/84]**

(A) 33 m/s (B) 22 m/s (C) zero (D) 11 m/s

3. In the experiment for the determination of the speed of sound in air using the resonance column method, the length of the air column that resonates in the fundamental mode, with a tuning fork is 0.1 m. When this length is changed to 0.35 m, the same tuning fork resonates with first overtone. Calculate the end correction. **[JEE- 2003 (Screening), 3/84]**

(A) 0.012 m (B) 0.025 m (C) 0.05 m (D) 0.024 m

4. A source of sound of frequency 600 Hz is placed inside water. The speed of sound in water is 1500 m/s and in air it is 300 m/s. The frequency of sound recorded by an observer who is standing in air is : **[JEE- 2004 (screening)3/84]**

(A) 200 Hz (B) 3000 Hz (C) 120 Hz (D) 600 Hz

5. A closed organ pipe of length L and an open organ pipe contain gases of densities ρ_1 and ρ_2 respectively. The compressibility of gases are equal in both the pipe. Both the pipes are vibrating in their first overtone with same frequency. The length of the open organ pipe is : **[JEE- 2004 (screening)3/84]**

(A) $\frac{L}{3}$ (B) $\frac{4L}{3}$ (C) $\frac{4L}{3}\sqrt{\frac{\rho_1}{\rho_2}}$ (D) $\frac{4L}{3}\sqrt{\frac{\rho_2}{\rho_1}}$

6. An open organ pipe is in resonance in its 2nd harmonic with a tuning fork of frequency f_1. Now it is closed at one end. If the frequency of the tuning fork is increased slowly from f_1 then again a resonance is obtained when the frequency is f_2. If in this case the pipe vibrates in nth harmonic then **[JEE- 2005 (Screening), 3/84]**

(A) $n = 3, f_2 = \frac{3}{4} f_1$ (B) $n = 3, f_2 = \frac{5}{4} f_1$ (C) $n = 5, f_2 = \frac{5}{4} f_1$ (D) $n = 5, f_2 = \frac{3}{4} f_1$

Paragraph for question Nos. 7 to 9

Two plane harmonic sound waves are expressed by the equations. **[JEE' 2006, 5 × 3 = 15 /184]**

$y_1(x, t) = A \cos (0.5 \pi x - 100 \pi t)$

$y_2(x, t) = A \cos (0.46 \pi x - 92 \pi t)$

(All parameters are in MKS) :

7. How many times does an observer hear maximum intensity in one second ?

(A) 4 (B) 10 (C) 6 (D) 8

8. What is the speed of the sound ?

(A) 200 m/s (B) 180 m/s (C) 192 m/s (D) 96 m/s

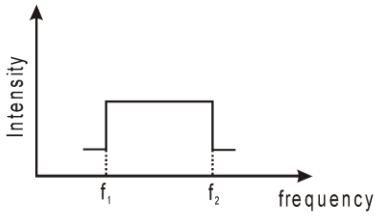
9. At x = 0 how many times $y_1 + y_2$ is zero in one second ?

(A) 192 (B) 48 (C) 100 (D) 96

Paragraph for Question Nos. 10 to 12

Two trains A and B are moving with speeds 20 m/s and 30 m/s respectively in the same direction on the same straight track, with B ahead of A. The engines are at the front ends. The engines of train A blows a long whistle.

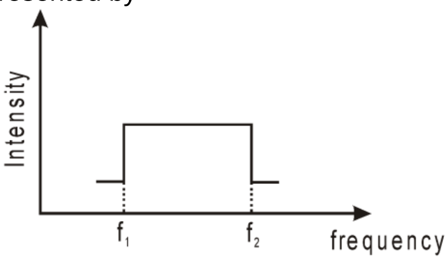
Assume that the sound of the whistle is composed of components varying in frequency from f_1 = 800 Hz to f_2 = 1120 Hz, as shown in the figure. The spread in the frequency (highest frequency – lowest frequency) is thus 320 Hz. The speed of sound in still air is 340 m/s.



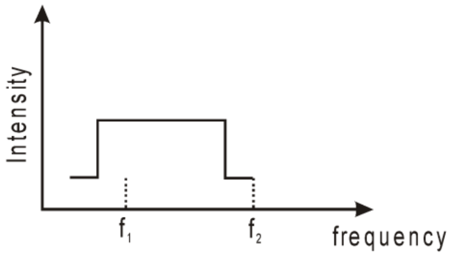
[JEE' 2007, 4 × 3 = 12 /81]

10. The speed of sound of the whistle is
(A) 340 m/s for passengers in A and 310 m/s for passengers in B
(B) 360 m/s for passengers in A and 310 m/s for passengers in B
(C) 310 m/s for passengers in A and 360 m/s for passengers in B
(D) 340 m/s for passengers in both the trains

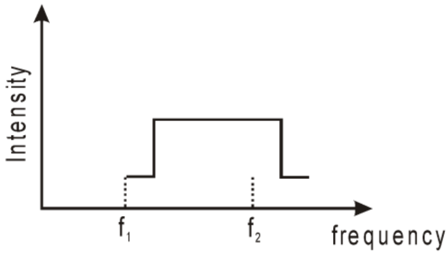
11. The distribution of the sound intensity of the whistle as observed by the passengers in train A is best represented by



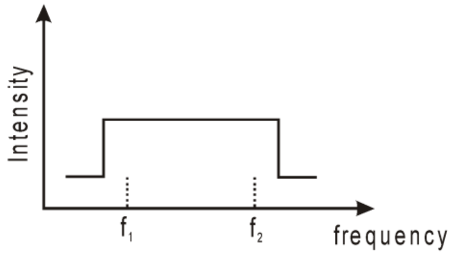
(A)



(B)



(C)



(D)

12. The spread of frequency as observed by the passengers in train B is
(A) 310 Hz (B) 330 Hz (C) 350 Hz (D) 290 Hz

13. A vibrating string of certain length ℓ under a tension T resonates with a mode corresponding to the first overtone (third harmonic) of an air column of length 75 cm inside a tube closed at one end. The string also generates 4 beats per second when excited along with a tuning fork of frequency n. Now when the tension of the string is slightly increased the number of beats reduces to 2 per second. Assuming the velocity of sound in air to be 340 m/s, the frequency n of the tuning fork in Hz is **[JEE' 2008, 3/163]**
(A) 344 (B) 336 (C) 117.3 (D) 109.3

14.* A student performed the experiment to measure the speed of sound in air using resonance air-column method. Two resonances in the air-column were obtained by lowering the water level. The resonance with the shorter air-column is the first resonance and that with the longer air-column is the second resonance. Then, **[JEE' 2009, 4/160, –1]**
(A) the intensity of the sound heard at the first resonance was more than that at the second resonance
(B) the prongs of the tuning fork were kept in a horizontal plane above the resonance tube
(C) the amplitude of vibration of the ends of the prongs is typically around 1 cm
(D) the length of the air-column at the first resonance was somewhat shorter than 1/4th of the wavelength of the sound in air.

15. A hollow pipe of length 0.8 m is closed at one end. At its open end a 0.5 m long uniform string is vibrating in its second harmonic and it resonates with the fundamental frequency of the pipe. If the tension in the wire is 50 N and the speed of sound is 320 ms^{-1}, the mass of the string is :

[JEE' 2010, 5/163, –2]
(A) 5 grams (B) 10 grams (C) 20 grams (D) 40 grams

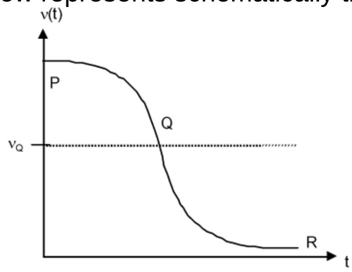
16. A police car with a siren of frequency 8 kHz is moving with uniform velocity 36 km/hr towards a tall building which reflects the sound waves. The speed of sound in air is 320 m/s. The frequency of the siren heard by the car driver is **[JEE' 2011, 3/160, –1]**
(A) 8.50 kHz (B) 8.25 kHz (C) 7.75 kHz (D) 7.50 kHz

17. A person blows into open-end of a long pipe. As a result, a high-pressure pulse of air travels down the pipe. When this pulse reaches the other end of the pipe. **[IIT-JEE-2012, Paper-1; 4/70]**
(A) a high-pressure pulse starts traveling up the pipe, if the other end of the pipe is open.
(B) a low-pressure pulse starts traveling up the pipe, if the other end of the pipe is open.
(C) a low-pressure pulse starts traveling up the pipe, if the other end of the pipe is closed.
(D) a high-pressure pulse starts traveling up the pipe, if the other end of the pipe is closed.

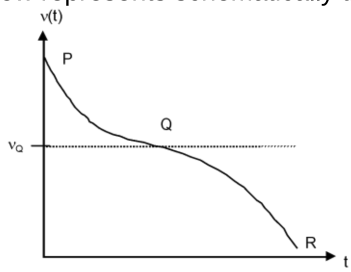
18. A student is performing the experiment of Resonance Column. The diameter of the column tube is 4cm . The distance frequency of the tuning for k is 512 Hz. The air temperature is 38°C in which the speed of sound is 336 m/s. The zero of the meter scale coincides with the top and of the Resonance column. When first resonance occurs, the reading of the water level in the column is
[IIT-JEE-2012, Paper-2; 3/66, –1]
(A) 14.0 (B) 15.2 (C) 16.4 (D) 17.6

19.* Two vehicles, each moving with speed u on the same horizontal straight road, are approaching each other. Wind blows along the road with velocity w. One of these vehicles blows a whistle of frequency f_1. An observer in the other vehicle hears the frequency of the whistle to be f_2. The speed of sound in still air is V. The correct statement(s) is (are) : **[JEE(Advanced)-2013; 3/60]**
(A) If the wind blows from the observer to the source, $f_2 > f_1$.
(B) If the wind blows from the source to the observer, $f_2 > f_1$.
(C) If the wind blows from the observer to the source, $f_2 < f_1$.
(D) If the wind blows from the source to the observer, $f_2 < f_1$.

20. Two loudspeakers M and N are located 20m apart and emit sound at frequencies 118 Hz and 121 Hz, respectively. A car in initially at a point P, 1800 m away from the midpoint Q of the line MN and moves towards Q constantly at 60 km/hr along the perpendicular bisector of MN. It crosses Q and eventually reaches a point R, 1800 m away from Q. Let ν(t) represent the beat frequency measured by a person sitting in the car at time t. Let ν_P, ν_Q and ν_R be the beat frequencies measured at locations P, Q and R, respectively. The speed of sound in air is 330 ms^{-1}. Which of the following statement(s) is(are) true regarding the sound heard by the person? **[JEE (Advanced) 2016; P-1, 3/62, –1]**
(A) $\nu_P + \nu_R = 2\nu_Q$
(B) The rate of change in beat frequency is maximum when the car passes through Q
(C) The plot below represents schematically the variation of beat frequency with time



(D) The plot below represents schematically the variation of beat frequency with time



Answers

EXERCISE # 1

Section(A)

A 1.	(4)	**A 2.**	(1)		

Section (B)

B 1.	(1)	**B 2.**	(1)		
B 3.	(4)				

Section (C)

C 1.	(2)	**C 2.**	(4)	**C 3.**	(3)
C 4.	(4)	**C 5.**	(4)	**C 6.**	(2)
C-7.	(3)	**C-8.**	(2)	**C-9.**	(3)
C-10.	(4)				

Section (D)

D 1.	(1)	**D 2.**	(4)		

Section (E)

E 1.	(3)	**E 2.**	(2)	**E 3.**	(2)
E 4.	(3)	**E 5.**	(2)	**E 6.**	(1,3)

Section (F)

F 1.	(2)	**F 2.**	(1)	**F 3.**	(1)
F 4.	(3)	**F-5.**	(2)	**F-6.**	(1)

Section (G)

G 1.	(4)	**G 2.**	(3)	**G 3.**	(3)
G 4.	(2)				

EXERCISE # 2

PART - I

1.	(1)	**2.**	(4)	**3.**	(4)
4.	(2)	**5.**	(2)	**6.**	(1)
7.	(2)	**8.**	(1)	**9.**	(4)
10.	(4)	**11.**	(1)	**12.**	(1)
13.	(4)				

PART- II

Section (A)

A-1.	(4)	**A-2.**	(1)	**A-3.**	(1)

Section (B)

B-1. (1 → q) ; (2 → r) ; (3 → q) ; (4 → s)

Section (C)

C-1.	(3,4)	**C-2.**	(1,2,4)	**C-3.**	(1,2,4)
C-4.	(3,4)	**C-5.**	(1,3,4)	**C-6.**	(1,4)
C-7.	(1,2,4)	**C-8.**	(2,4)	**C-9.**	(1,3,4)

EXERCISE # 3

PART - I

1.	(3)	**2.**	(4)	**3.**	(4)
4.	(4)	**5.**	(4)	**6.**	(1)
7.	(1)	**8.**	(3)	**9.**	(1)
10.	(3)	**11.**	(2)	**12.**	(3)
13.	(4)				

PART - II

1.	(B)	**2.**	(B)	**3.**	(B)
4.	(D)	**5.**	(C)	**6.**	(C)
7.	(A)	**8.**	(A)	**9.**	(C)
10.	(B)	**11.**	(A)	**12.**	(A)
13.	(A)	**14.**	(A,D)	**15.**	(B)
16.	(A)	**17.**	(B,D)	**18.**	(B)
19.	(A,B)	**20.**	(A,B,C)		