Q.1 When a source of frequency f_0 moves away a stationary observer with a certain velocity an apparent frequency f ' is observed. When it moves with same velocity towards the observer, the observed frequency is 1.2 f '. If velocity of sound in v, then the speed of source is -

(A) $\frac{v}{6}$ (B) $\frac{v}{11}$

(C) $\frac{3}{4}v$ (D) None of these **[B]**

Sol. $f' = f_0\left(\frac{v}{v+u}\right)$ and $1.2\, f' = f_0\left(\frac{v}{v-u}\right)$

$\therefore\ 1.2 = \frac{v+u}{v-u} \Rightarrow u = \frac{v}{11}$

Q.2 The period of rotation of the sun at its equator is T and its radius is R. Then the Doppler wavelength shift expected for light with wavelength λ emitted from the edge of the sun's disc is –

[c = speed of light]

(A) $\pm\frac{R\lambda}{cT}$ (B) $\pm\frac{T\lambda}{2\pi Rc}$

(C) $\pm\frac{2\pi Rc}{T\lambda}$ (D) $\pm\frac{2\pi R\lambda}{cT}$ **[D]**

Sol. $\Delta\lambda = \pm\frac{v}{c}\lambda$

$v = R\omega = \frac{R2\pi}{T}$

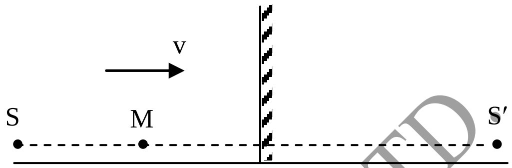
$\Delta\lambda = \pm\frac{2\pi R\lambda}{cT}$

Q.3 A man is standing between source and cliff. When he start moving along line joining him and source, he hears 10 beats per second. Velocity of man is : (Frequency of source = 60 Hz, Velocity of sound = 330 m/s)

(A) 5 m/s (B) 10 m/s

(C) 15 m/s (D) 2.5 m/s **[D]**

Sol.



Frequency of echo as heard by man

$\boldsymbol{\nu_1} = \frac{v+v_0}{v}\times\boldsymbol{\nu_0}$

[ν_0 = Frequency of sound
v_0 = Velocity of man
v = Velocity of sound]

Frequency of sound heard by man directly from source

$\boldsymbol{\nu_2} = \frac{v-v_0}{v}.\boldsymbol{\nu_0}$

$\therefore\ \nu_1 - \nu_2 = 10$

$\therefore\ v_0 = \frac{v\times 10}{2\times\nu_0} = 2.5$ m/s

Q.4 The apperent frequency of the whistle of an engine changes by the ratio 5/3 as the engine passes a stationary observer. If the velocity of sound is 340 m/s, then the velocity of the engine is -

(A) 340 m/s (B) 170 m/s

(C) 85 m/s (D) 42.5 m/s **[C]**

Sol. $\frac{n'}{n''} = \frac{V+V_s}{V-V_s} = \frac{5}{3}$

$3V + 3V_s = 5V - 5V_s$

$V_s = \frac{V}{4} = \frac{340}{4} = 85$ m/s

Q.5 When a source of frequency f_0 moves away a stationary observer with a certain velocity an apparent frequency f ' is observed. When it moves with the same velocity towards the observer, the observed frequency is 1.2 f'. If the velocity of sound is v, then the actual frequency f_0 is -

(A) $\frac{12}{11}f'$ (B) $\frac{11}{12}f'$

(C) $\frac{7}{6}f'$ (D) $\frac{6}{7}f'$ **[A]**

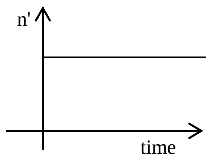
Sol. $f' = f_0\left(\frac{v}{v+u}\right)$ and $1.2\, f' = f_0\left(\frac{v}{v-u}\right)$

$\therefore \quad u = \dfrac{v}{11}$

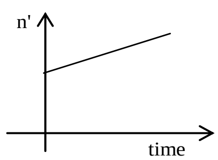
$\therefore \quad f_0 = f'\left(1+\dfrac{u}{v}\right) = \dfrac{12}{11}f'$

Q.6 An observer starts moving with uniform acceleration a toward a stationary sound source emitting a whistle of frequency n. As the observer approaches source, the apparent frequency n' heard by the observer varies with time as –

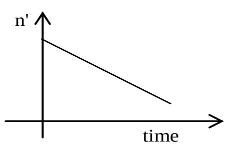
(A)



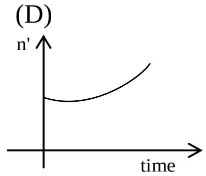
(B)



(C)



(D)



[B]

Sol. u = 0

a = constant

$v_0 = u + at = at$

$n' = \left(\dfrac{v+v_0}{v}\right)n = n + \dfrac{a\,n\,t}{v}$

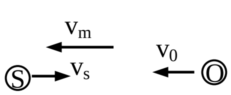
Q.7 Velocity of sound is v. Source and observer move towards each other with velocities v_s and v_0 respectively. Wind is blowing with a velocity v_m in the direction opposite to the propagation of sound; n is the pitch of the sound. The apparent pitch of the sound heard by the observer is -

(A) $\left(\dfrac{v+v_m+v_0}{v+v_m+v_s}\right)n$ (B) $\left(\dfrac{v-v_m+v_0}{v-v_m+v_s}\right)n$

(C) $\left(\dfrac{v+v_m-v_0}{v-v_m+v_s}\right)n$ (D) $\left(\dfrac{v-v_m+v_0}{v-v_m-v_s}\right)n$

[D]

Sol.



$\therefore n' = n\left(\dfrac{(v-v_m)+v_0}{(v-v_m)-v_s}\right)$

Q.8 Doppler's effect is valid for light waves also. If a star emitting yellow light accelerates away from the earth, the colour of star as observed by an observer on earth -

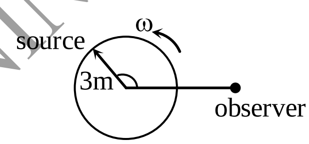
(A) remains yellow
(B) gradually turns red
(C) gradually turns blue
(D) first turns red then blue

Sol. **[B]**

Apply Doppler effect,

$\nu_{red} < \nu_{yellow} < \nu_{blue}$

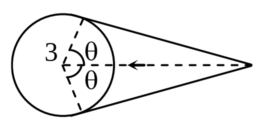
Q.9 A source is moving on a circle of radius 3 m with constant angular velocity ω = 5 rad/s. If the observer is at a distance 5 m from the centre of circle, the time interval between maximum and minimum frequency received by the observer is -



(A) $\dfrac{\pi}{5}$ (B) $\dfrac{2}{5}\cos^{-1}\left(\dfrac{3}{4}\right)$

(C) $\dfrac{2}{5}\cos^{-1}\left(\dfrac{3}{5}\right)$ (D) $\dfrac{2}{5}\sin^{-1}\left(\dfrac{3}{5}\right)$

Sol. [C]



$2\theta = \omega L$

$t = \dfrac{2}{5}\cos^{-1}\left(\dfrac{3}{5}\right)$

Q.10 A passenger is sitting in a fast moving train. The engine of the train blows a whistle of frequency n. If the apparent frequency of the sound heard by the passenger is n', then -

(A) n' < n (B) n' > n

(C) n' = n (D) n' = (1/n) **[C]**

Sol. $n' = n$ as No relative motion

Q.11 A source of sound of frequency 256 Hz is moving towards a wall with a velocity of 5m/s. Velocity of sound is 330 m/s. The number of beats heard by an observer standing behind the source is nearly -

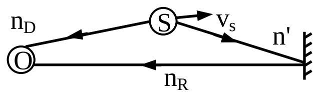
(A) $\dfrac{256\times330}{325}-256$

(B) $256-\dfrac{256\times330}{335}$

(C) $\dfrac{256\times330}{325}-\dfrac{256\times330}{335}$

(D) $\dfrac{256\times330}{325}-\dfrac{256\times330}{325}$ **[C]**

Sol.



$n_D = 256\left(\dfrac{330}{330+5}\right)$

$n_R = 256\left(\dfrac{330}{330-5}\right)$

$\Delta n = n_R - n_D = \dfrac{256\times330}{325}-\dfrac{256\times330}{335}$

Q.12 When a train approaches a stationary observer, the apparent frequency of the whistle is n' and when the same train recedes away from the observer, the apparent frequency is n''. Then the apparent frequency n when the observer moves with the train is -

(A) $n = \dfrac{n'+n''}{2}$ (B) $n = \sqrt{n'n''}$

(C) $n = \dfrac{2n'n''}{n'+n''}$ (D) $n = \dfrac{2n'n''}{n'-n''}$ **[C]**

Sol. $n' = n\left(\dfrac{V}{V-V_s}\right)$ ….(1)

$n'' = n\left(\dfrac{V}{V+V_s}\right)$ ….(2)

from (1) $\dfrac{n'}{n} = \dfrac{V}{V-V_s}$

$\dfrac{n'}{n}V - \dfrac{n'}{n}V_s = V$

$\therefore V\left(\dfrac{n'}{n}-1\right) = \dfrac{n'}{n}V_s$

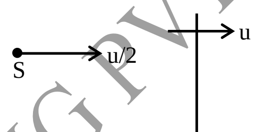
$\therefore V_s = \dfrac{V\left(\dfrac{n'}{n}-1\right)}{\dfrac{n'}{n}} = V\left(\dfrac{n'-n}{n}\right)\times\dfrac{n}{n'} = V\left(\dfrac{n'-n}{n}\right)$

Put in (2)

$n'' = n\left[\dfrac{V}{V+V\left(\dfrac{n'-n}{n}\right)}\right]$ $n'' = n\left[\dfrac{n}{n+n'-n}\right]$

$n^2 = n'\,n''$ $\boxed{n=\sqrt{n'n''}}$

Q.13 A wall is moving with velocity u and a source of sound moves with velocity $\dfrac{u}{2}$ in the same direction as shown in the figure. Assuming that the sound travels with velocity 10 u. The ratio of incident sound wavelength on the wall to the reflected sound wavelength by the wall is equal to -



(A) 9 : 11 (B) 11 : 9

(C) 4 : 5 (D) 5 : 4

Sol. **[A]**

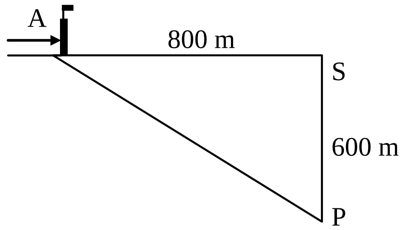
λ_1= wavelength of the incident sound = $\dfrac{10u-\dfrac{u}{2}}{f} = \dfrac{19u}{2f}$

f_1 = frequency of the incident sound = $\left(\dfrac{10u-u}{10u-\dfrac{u}{2}}\right)f = \dfrac{18}{19}f = f_r$ = frequency of the reflected sound.

λ_r = wavelength of the reflected sound = $\dfrac{10u+u}{f_r} = \dfrac{19}{18f}\times19 = \dfrac{11\times19}{18}\cdot\dfrac{u}{f}$

$\dfrac{\lambda_i}{\lambda_r} = \dfrac{19u}{2f}\times\dfrac{18f}{11\times19u} = \dfrac{9}{11}$.

Q.14 A person P is 600 m away from the station when train is approaching station with 72 km/h, it blows a whistle of frequency 800 Hz when 800 m away from the station. Find the frequency heard by the person. Speed of sound = 340 ms^{-1} -

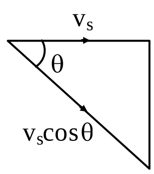


(A) 800 Hz (B) 839.5 Hz

(C) 829.5 Hz (D) 843.5 Hz

Sol. **[B]**

$\nu_{app} = \dfrac{v}{v - v_s\cos\theta}$ $\nu = \dfrac{340}{340-16} \times 800 = 839.5$



Q.15 A sound source is falling under gravity. At some time t = 0 the detector lies vertically below source at a height H as shown in Fig. If v is velocity of sound and f_0 is frequency of the source then the apparent frequency recorded after t = 2 second is -

(A) f_0 (B) $f_0\,\dfrac{(v+2g)}{v}$

(C) $f_0\,\dfrac{(v+2g)}{v}$ (D) $f_0\left(\dfrac{v}{v-2g}\right)$

Sol. **[D]**

$v_s = 0 + g.2 = 2g$

$\nu' = f_0\,\dfrac{v}{v - v_s} = f_0\left(\dfrac{v}{v-2g}\right)$

Q.16 When an engine passes near to a stationary observer then its apparent frequencies occurs in the ratio 5/3. If the velocity of engine is-

(A) 540 m/s (B) 270 m/s

(C) 85 m/s (D) 52.5 m/s **[C]**

Q.17 Two trains are moving towards each other at speeds of 20 m/s and 15 m/s relative to the ground. The first train sounds a whistle of frequency 600 Hz. The frequency of the whistle heard by a passenger in the second train before the train meets is (the speed of sound in air is 340 m/s)

(A) 600 Hz (B) 585 Hz

(C) 645 Hz (D) 666 Hz **[D]**

Q.18 A racing car moving towards a cliff sounds its horn. The driver observed that the sound reflected from the cliff has a pitch one octave higher than the actual sound of the horn. If V = the velocity of sound, the velocity of the car is –

(A) $V/\sqrt{2}$ (B) V/2

(C) V/3 (D) V/4 **[B]**

Q.19 An isotropic stationary source is emitting waves of frequency *n* and wind is blowing due north. An observer A is on north of the source while observer B is on south of the source. If both the observer are stationary, then–

(A) Frequency received by A is greater than *n*

(B) Frequency received by B is less than *n*

(C) Frequency received by A is equal to that received by B

(D) Frequencies received by A and B cannot be calculated unless velocity of waves in still air and velocity of wind are known. **[C]**

Q.20 A source at rest sends sound waves of constant wavelength. A wall moves towards the source with a velocity of 33 cm/s. The velocity of sound in the medium is 330 m/s. What is the percentage change in wavelength of sound after reflection from the wall–

(A) 0.1% (B) 2%

(C) 0.2% (D) 1% **[C]**

Q.21 ● ● ● ● ●

A S_1 B S_2 C

In the figure shown, S_1 and S_2 represents two stationary sources of sound having equal frequency, one observer is moving from A toward C with velocity V_0 then –

(A) Beats for three position A, B and C will be heard

(B) Beats will be heard from A and C but not in case of B

(C) Beats will be not heard for A and C but will be heard for B

(D) Beats will be not heard for three position of A, B and C **[C]**

Q.22 A bus is moving with a velocity of 5 m/s towards a huge wall. The driver sounds a horn of frequency 165Hz. If the speed of sound in air = 335 m/s, the number of beats heard per second by a passenger on the bus will be–

(A) 3 (B) 4

(C) 5 (D) 6 **[C]**

Q.23 A source and an observer are located at the same point. The source starts moving away from the observer at $t = 0$, with a constant acceleration a. If natural frequency of the source is n_0 and speed of sound in air is v, then frequency received by the observer at time t will be –

(A) equal to $\left(\frac{n_0 v}{v + at}\right)$

(B) equal to $\left(\frac{n_0 v}{v - at}\right)$

(C) greater than $\left(\frac{n_0 v}{v + at}\right)$

(D) None of these **[C]**

Q.24 A source of sound S is moving with a velocity 50 m/s towards a stationary observer. The observer measures the frequency of the source as 1000Hz. What will be the apparent frequency of the source when it is moving away from the observer after crossing him? The velocity of sound in the medium is 350 m/s –

(A) 750 Hz (B) 857 Hz

(C) 1143 Hz (D) 1333 Hz **[A]**

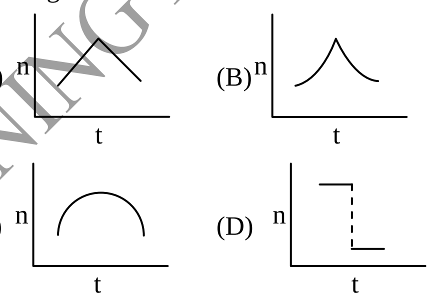
Q.25 If the velocity of sound is V, velocity of the observer is V_0 and the velocity of the source is V_s, then the necessary condition for the Doppler effect to hold good is -

(A) $V_s \geq V, V_0 > V$ (B) $V_s \geq V, V_0 < V$

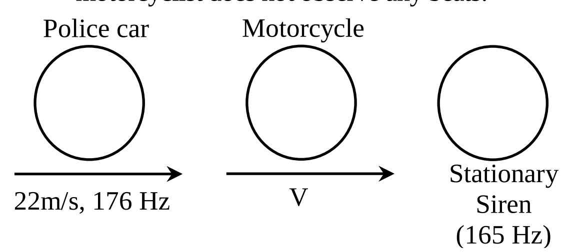
(C) $V_s < V, V_0 \geq V$ (D) $V_s < V, V_0 < V$ **[D]**

Q.26 A railway engine whistling at a constant frequency moves with a constant speed. It goes past a stationary observer standing beside the railway track. The frequency (n) of the sound heard by the observer is plotted against time (t). Which of the following best represents the resulting curve–

(A) (B) (C) (D) **[D]**



Q.27 A police car moving at 22m/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 the motorcyclist does not observe any beats:



(A) 33 m/s (B) 22 m/s

(C) zero (D) 11m/s

Sol.[A] As no beats $f_1 = f_2$

$$176\left(\frac{330 - v_0}{330 - 22}\right) = 165\left(\frac{330 + v_0}{330}\right)$$

$$\boxed{v_0 = 22 m/sec}$$

Q.28 A whistle is rotated with 2 rotations/sec in a circle of radius 1 meter. A listener is sitting in the plane of circle outside the centre, then ratio of maximum and minimum frequencies heard by him will be

(A) $\frac{(V+4\pi)}{(V-4\pi)}$ (B) $\frac{(V+4\pi)}{(V-2\pi)}$

(C) $\frac{(V+2)}{(V-2)}$ (D) $\frac{(V+4)}{(V-4)}$ **[A]**

Q.29 A man stands at rest in front of a large smooth wall. Directly infront of him, between him and the wall he holds a vibrating tuning fork of frequency 400Hz. He now moves the fork towards the wall with a speed of 1m/s. How many beats/s will he hear between the sound waves reaching him directly from the fork, and those reaching him after being reflected from the wall?

(A) 1.15 beats/s (B) 2.30 beats/s

(C) 4.60 beats/s (D) 9.20 beats/s **[B]**

Q.30 The apparent frequency of sound heard by a listener is 10% more than the actual frequency of the note emitted by the source when the source moves towards the stationary listener with velocity v. When the source moves with a velocity 2v, the apparent frequency will be more than the actual frequency by–

(A) 17.5% (B) 20%

(C) 22.22% (D) 21% **[C]**

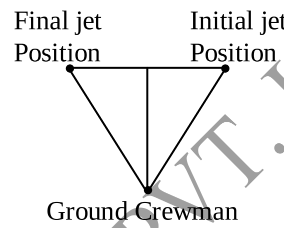
Q.31 A source of sound waves of frequency 1080 Hz moves to the right with a speed of 108 ft/s relative to the ground. To its right is a reflecting surface moving to the left with a speed of 216 ft/s relative to the ground. If the speed of sound is 1080 ft/s, the wavelength of sound emitted in air by the source is -

(A) 0.5 ft (B) 0.9 ft

(C) 1.0 ft (D) 1.8 ft **[C]**

Q.32 A jet fighter flies in a straight line over an airfield line over an airfield with a speed 264 m/s level with the ground, at a height of 600 m. If it emits a continuous note of frequency 1kHz, what is the change in apparent frequency as experienced by one of the ground crew over a 1.5 s interval as the jet flies overhead ?

(Assume speed of sound is 340 ms^{-1})



(A) 320 Hz (B) 420 Hz

(C) 520 Hz (D) 620 Hz **[C]**

Q.33 Two stars P and Q have slightly different surface temperatures T_P and T_Q respectively with $T_p > T_Q$ Both stars are receding from the earth with speed v_P and v_Q relative to the earth. The wavelength of light at which they radiate the maximum energy is found to be the same for both–

(A) $v_P > v_Q$

(B) $v_P < v_Q$

(C) $v_P = v_Q$, and the size of Q > the size of P

(D) Nothing can be said regarding v_P and v_Q from the given data **[A]**

Q.34 A whistle giving out 450 Hz approaches a stationary observer at a speed of 33 m/s. The frequency heard by the observer in Hz is –

[IIT–1997]

(A) 409 (B) 429

(C) 517 (D) 500 **[D]**

Q.35 A train moves towards a stationary observer with speed 34 m/s. The train sounds a whistle and its frequency registered by the observer is f_1. If the train's speed is reduced to 17 m/s, the frequency registered is f_2. If the speed of sound is 340 m/s then the ratio f_1/f_2 is –

[IIT–2000]

(A) 18/19 (B) 1/2

(C) 2 (D) 19/18 **[D]**

Q.36 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 – **[IIT–2001]**

(A) 242/252 (B) 2

(C) 5/6 (D) 11/6 **[B]**

Q.37 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 observes any beats. **[IIT - 2003]**

(A) 33 m/s (B) 22 m/s

(C) zero (D) 11 m/s **[B]**

Q.38 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]**

(A) 49 m (B) 98 m

(C) 147 m (D) 196 m **[B]**

Sol. When source in stationary and observer is moving away from the source.

$$n' = n\left(\frac{V - V_0}{V}\right)$$

$$\Rightarrow 0.94\, n = n\left(\frac{330 - V_0}{330}\right)$$

$$\Rightarrow V_0 = 19.8 \text{ m/s}$$

$$\because \quad V_0^2 = 0 + 2as$$

$$\therefore \quad S = \frac{V_0^2}{2a}$$

$$= \frac{19.8 \times 19.8}{2 \times 2}$$

= 98 m.

Q.39 Doppler's effect will be more effectively observed when the observer -

(A) is moving along line joining be the source

(B) is in motion in a direction perpendicular to the source

(C) is moving in any direction relative to the source

(D) None of the above **[A]**

Q.40 Doppler's effect is not applicable for -

(A) audio waves (B) ultrasonic waves

(C) shock waves (D) infrasonic wave

[C]

Q.41 Doppler's effect can be observed for -

(A) Supersonic speeds (B) Sound waves

(C) both the above (D) neither of them

[B]

Q.42 Doppler's effect will not be observed, if velocity of sound is -

(A) Less than the velocity of source

(B) Less than the velocity of medium

(C) Less than the velocity of observer

(D) All of the above **[D]**

Q.43 If the distance between the observer and source decreases with time then it shows that -

(A) apparent frequency will be less than actual frequency

(B) apparent frequency will be greater than actual frequency

(C) apparent frequency will be equal to the actual frequency

(D) nothing can be said about apparent frequency **[B]**

Q.44 Doppler's displacement doesn't depend upon -

(A) velocity of source

(B) velocity of observer

(C) frequency of wave

(D) Separation between source & observer **[D]**

Q.45 If the apparent frequency of sound heard by the observer is more than the actual frequency then-

(A) The listener will be moving away from source

(B) The source will be moving away from listener

(C) The separation between the source and listener will be increasing

(D) The separation between source and the listener is decreasing **[D]**

Q.46 Apparent frequency of train A is heard by observer in train B as 3/4 of the true frequency. Find the value of velocity of train B in m/sec. taking train A to be stationary. If the sound velocity is 332 m/sec. -

(A) 110 (B) 108

(C) 75 (D) 83 **[D]**

Q.47 A source and a listener are in unidirection at motion with velocities 30 and 45 km/hour respectively. If both have started to move simultaneously from same place, then apparent frequency heard by the listener will be -

(A) always less than true frequency

(B) always more than true frequency

(C) more than actual frequency

(D) less than the actual frequency first and then more **[A]**

Q.48 Which of the following property of waves is proved by Doppler's effect -

(A) Longitudinal nature

(B) Transverse nature

(C) both transverse and longitudinal nature

(D) neither longitudinal nor transverse nature

[D]

Q.49 A source of frequency n is moving with a uniform velocity v towards a stationary observer. If the velocity of sound is V, then the change in frequency would be -

(A) $\frac{vn}{V-v}$ (B) $\frac{vn}{V}$

(C) $\frac{Vn}{V-v}$ (D) $\frac{vn}{V+v}$ **[A]**

Q.50 If an observer is moving with uniform velocity v to wards a stationary source of frequency n, and if the velocity of sound in the medium is V, then the apparent change in the frequency of the sound, heard by the observer, is -

(A) $\frac{vn}{V-v}$ (B) $\frac{vn}{V}$

(C) $\frac{Vn}{V-v}$ (D) $\left(\frac{V+v}{v}\right)n$ **[B]**