WAVE MOTION
PREVIOUS EAMCET BITS
Engineering paper

1. Two sources A and B are sending notes of frequency 680 Hz. A listener moves A to B a constant velocity 'u'. If the speed of sound in air is 340 ms^{-1} what must be the value of 'u. So that he hears 10 beats per second? **[EAMCET 2009 E]**

1) 2.0 ms^{-1} 2) 2.5 ms^{-1} 3) 3.0 ms^{-1} 4) 3.5 ms^{-1}

Ans : 2

Sol: When the listener is moving away from A then the apparent frequency of sound is less than actual frequency of sound

$$n' = n\left[\frac{v - v_0}{v}\right] = n\left[\frac{v-u}{v}\right] \text{............(1)}$$

when the listener is approaching B then the apparent frequency of sound

$$n'' = n\left[\frac{v + v_0}{v}\right] = n\left[\frac{v+u}{v}\right] \text{............(2)}$$

from (1) & (2)

$$n'' - n' = \frac{n}{v}\left[v + u - v + u\right]$$

$$\therefore\ 10 = \frac{2un}{v} \Rightarrow u = 2.5ms^{-1}$$

2. Two identical piano wires have a fundamental frequency of 600 c/s when kept under the same tension. What fractional increase in the tension of one wire will lead to the occurrence of 6 beats per second when both wires vibrate simultaneously ? **[EAMCET 2009 E]**

1) 0.01 2) 0.02 3) 0.03 4) 0.04

Ans : 2

Sol: We know that $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$

$$\therefore\ \frac{\Delta n}{n} = \frac{1}{2}\frac{\Delta T}{T}$$ [from small approximation method]

$$\therefore\ \frac{6}{600} = \frac{1}{2}\frac{\Delta T}{T} \Rightarrow \frac{\Delta T}{T} = 0.02$$

3. When the sound wave of wavelength 'λ' is propagating in a medium, the maximum velocity of the particle is equal to the wave velocity. The amplitude of wave is **[EAMCET 2008E]**

1) λ 2) $\frac{\lambda}{2}$ 3) $\frac{\lambda}{2\pi}$ 4) $\frac{\lambda}{4\pi}$

Ans: 3

Sol: $V_{(\text{max. particle})} = \text{Velocity}_{(\text{wave})}$

$$A\omega = \frac{\omega}{k} \Rightarrow A = \frac{1}{k} = \frac{\lambda}{2\pi}\ \left[\text{since } k = \frac{2\pi}{\lambda}\right]$$

4. A car is moving with a speed of 72 kmph towards a hill car blows horn at a distance of 1800m from the hill. If echo is heard after 10 seconds, the speed of sound in (ms^{-1}) is **[EAMCET 2008]**

1) 400 ms^{-1} 2) 340 ms^{-1} 3) 300 ms^{-1} 4) 420 ms^{-1}

Ans: 2

Sol: $s=\left(\frac{u+v}{2}\right)t$

$1800=\left(\frac{20+v}{2}\right)10$

$\therefore$ v = 340 ms^{-1}

5. A whistle of frequency 540 Hz rotates ina horizontal circle of radius 2 m at an angular speed of 25 rad/s. The highest frequency heard by a listener at rest with respect to the centre of circle is **[EAMCET 2007E]**

1) 590 Hz 2) 594 Hz 3) 598 Hz 4) 602 Hz

Ans: 2

Sol: Velocity of source = $v_s = r\omega = 2\times15 = 30ms^{-1}$

As the listener is at rest frequency heard is maximum when the source is moving towards stationary observer

$\therefore\ n' = n\left[\frac{v}{v-v_s}\right] = 540\left[\frac{330}{330-30}\right] = 594Hz$

6. A segment of wire vibrates with a fundamental frequency of 450Hz under a tension of 9 kg wt. Then tension at which the fundamental frequency of the same wire becomes 900 Hz is **[EAMCET 2007E]**

1) 36 kg.wt 2) 27 kg.wt 3) 18 kg.wt 4) 72 kg.wt

Ans: 3

Sol: From the relation = $n=\frac{1}{2\ell}\sqrt{\frac{T}{m}}$ (or) $\frac{n_2}{n_1}=\sqrt{\frac{T_2}{T_1}}$

$\Rightarrow \frac{900}{450}=\sqrt{\frac{T_2}{9}} \Rightarrow T_2 = 18\,kg.wt$

7. Two strings A and B of lengths, L_A = 80 cm and L_B = x cm respectively are used separately in a sonometer. The ratio of their densities (d_A/ d_B) is 0.81. The diameter of B is one-half that of A. If the strings have the same tension and fundamental frequency the value of x is**[EAMCET 2006E]**

1) 33 2) 102 3) 144 4) 130

Ans: 144

Sol: From the relation $n=\frac{1}{2\ell}\sqrt{\frac{T}{m}}=\frac{1}{2\ell}\sqrt{\frac{T}{\pi r^2\rho}}$

Given L_A = 80 cm, L_B = x cm

$\frac{\rho_A}{\rho_B}=0.81,\ r_A = 2r_B$

$n_A = n_B,\ T_A = T_B$ [given]

$\Rightarrow \frac{1}{\ell_B}\sqrt{\frac{T}{\pi r_A^2\rho_A}}=\frac{1}{\ell_B}\sqrt{\frac{T}{\pi r_B^2\rho_B}} \Rightarrow \frac{\ell_B}{\ell_A}=\sqrt{\frac{r_A^2\rho_A}{r_B^2\rho_B}}$

on simplifying x = 144 cm

8. An observer is standing 500 m away from a vertical hall. Starting between the observer and the hill, a police van sounding a siren of frequency 1000Hz moves towards the hill with a uniform speed. If the frequency of the sound heard directly from the siren is 970 Hz, the frequency of the sound heard after reflection from the hill (in Hz) is about, (velocity of sound= 330 ms^{-1}). **[EAMCET 2006 E]**

1) 1042 2) 1032 3) 1022 4) 1012

Ans : 2

Sol: As the source of sound is moving away from the stationary observer, the frequency of the sound heard directly from the source is less than the original frequency

$\therefore\ n' = n\left[\dfrac{v}{v+v_s}\right]$

$\therefore\ 970 = 1000\left[\dfrac{330}{330+v_s}\right] \Rightarrow v_s = 10.2 ms^{-1}$

The frequency of the reflected sound is given by $n'' = n\left[\dfrac{v}{v-v_s}\right]$

$\therefore\ n'' = 1000\left[\dfrac{330}{330-10.2}\right]$

$\therefore\ n'' = 1032\ Hz$

9. A vehicle sounding a whistle of frequency 256 Hz is moving on a straight road, towards a hill with a velocity of 10 ms^{-1}. The number of beats per second observed by a person travelling in the vehicle is **[EAMCET 2005E]**

1) zero 2) 10 3) 14 4) 16

Ans: 16

Sol: number of beats $= n_1 \sim n_2$

= frequency of direct sound ~ frequency of reflected sound

$$= n \sim \frac{n(v+v_0)}{(v-v_s)} \Rightarrow 256 \sim \frac{256(330+10)}{(330-10)} = 16$$

10. A transverse wave propagating on a stretched string of linear density 3×10^{-4} kg.m^{-1} is represented by the equation y = 0.2 sin(15x + 60t) where x is in metres and t is in seconds. The tension in the string (in newton) is **[EAMCET 2005E]**

1) 0.24 2) 0.48 3) 1.20 4) 1.80

Ans: 2

Sol: From the equation $y = 0.2\sin(1.5x + 60t)$

i) $\omega t = 60t$ or $\omega = 60$ ii) $kx = 1.5x \Rightarrow k = 1.5$

$\therefore\ v = \sqrt{\dfrac{T}{m}}$ but v = velocity of wave = $\dfrac{\omega}{k}$

$\therefore\ \dfrac{\omega}{k} = \sqrt{\dfrac{T}{m}} \Rightarrow T = 0.48\,N$

11. The wavelength of two notes in air are $\dfrac{36}{195}$m and $\dfrac{36}{193}$m. Each note produces 10 beats per second separately with a third note of fixed frequency. The velocity of sound in air in m/s is. **[EAMCET 2004E]**

1) 330 2) 340 3) 350 4) 360

Ans: 4

Sol: Beat frequency = $n_1 - n_2$

Let n is the frequency of third note

$\therefore\ n_1 - n = 10$ and $n - n_2 = 10$

$\Rightarrow \frac{195v}{36} - n = 10$ ……..(1) and $n - \frac{193v}{36} = 10$ …………(2)

Adding (1) and (2)

$v = 360ms^{-1}$

12. An iron load of 2 kg is suspended in air from the free end of a sonometer wire of length 1 m. A tuning fork of frequency 256 Hz, is in resonance with $1/\sqrt{7}$ times the length of the sonometer wire. If the load is immersed in water, the length of the wire in metre that will be in resonance with the same tuning fork is : (Specific gravity of iron = 8) **[EAMCET 2004E]**

1) $\sqrt{8}$ 2) $\sqrt{6}$ 3) $\frac{1}{\sqrt{6}}$ 4) $\frac{1}{\sqrt{8}}$

Ans : 4

Sol: In air $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} = \frac{1}{2\ell}\sqrt{\frac{Mg}{m}}$

In water $n_1 = \frac{1}{2\ell_1}\sqrt{\frac{Mg\left(1 - \frac{d_\ell}{d_s}\right)}{m}}$

Given that n= n_1

$\therefore \frac{\ell_1}{\ell} = \sqrt{1 - \frac{d_\ell}{d_s}}$

$\therefore \frac{\ell_1}{\ell} = \sqrt{1 - \frac{1}{8}} = \sqrt{\frac{7}{8}}$

$\therefore \ell_1 = \frac{1}{\sqrt{7}} \times \sqrt{\frac{7}{8}} = \frac{1}{\sqrt{8}}$

13. Two uniform strings A and B made of steel are made to vibrate under the same tension. If the first overtone of A is equal to the second overtone of B and if the radius of A is twice that of B, the ratio of the lengths of the strings is **[EAMCET 2003E]**

1) 1 : 2 2) 1 : 3 3) 1 : 4 4) 1 : 5

Ans: 2

Sol: Number of overtone = number of harmonic + 1

$\therefore 2n_A = 3n_B, r_A = 2r_B$

From the relation $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} = \frac{1}{2\ell}\sqrt{\frac{T}{\pi r^2 \rho}} \Rightarrow \frac{n_A}{n_B} = \frac{3}{2}$[given]

$\frac{n_A}{n_B} = \frac{\ell_B}{\ell_A}\sqrt{\frac{r_B^2}{r_A^2}} \Rightarrow \frac{3}{2} = \frac{\ell_B}{\ell_A} \times \frac{r_B}{2r_B}$

On substituting and simplifying $\frac{\ell_A}{\ell_B} = \frac{1}{3}$

14. If the length of a stretched string is shortened by 40% and the tension is increased by 44% then the ratio of the final and initial fundamental frequency is **[EAMCET 2003E]**

1) 2 : 1 2) 3 : 2 3) 3 : 4 4) 1 : 3

Ans: 1

Sol: $\ell_2 = \frac{60\ell_1}{100}, T_2 = \frac{144T_1}{100}$

$\therefore \frac{n_2}{n_1} = \frac{\ell_1}{\ell_2}\sqrt{\frac{T_2}{T_1}}$

$\therefore \frac{n_2}{n_1} = \frac{100}{60}\sqrt{\frac{144}{100}} = 2:1$

15. A metallic wire with tension T and at temperature 30°C vibrates with its fundamental frequency of 1 kHz. The same wire with the same tension but at 10°C temperature vibrates with a fundamental frequency of 1.001 kHz. The coefficient of linear expansion of the wire is

[EAMCET 2002E]

1) $2\times10^{-4}/°C$ 2) $1.5\times10^{-4}/°C$ 3) $1\times10^{-4}/°C$ 4) $0.5\times10^{-4}/°C$

Ans: 3

Sol: From $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} = \frac{1}{2\ell}\sqrt{\frac{y \propto \Delta t}{\rho}}$

From small approximation method

$\frac{\Delta n}{n} = \frac{1}{2}\propto \Delta t \Rightarrow \frac{0.001}{1} = \frac{1}{2}\times \propto \times 20$

$\Rightarrow \propto = 1\times10^{-4}/°C$

16 An auditorium has volume of $10^5 m^3$ and surface area of absorption $2\times10^4 m^2$. Its average absorption coefficient is 0.2. The reverberation time of the auditorium in second is

[EAMCET 2002E]

1) 6.5 2) 5.5 3) 4.25 4) 3.25

Ans : 3

Sol: Reverberation time = $\frac{0.17V}{A} = \frac{0.17V}{QS}$

$= \frac{0.17\times10^5}{2\times10^4\times0.2} = 4.25$

17. The sound waves of wavelengths 5 m and 6 m formed 30 beats in 3 seconds. The velocity of sound is **[EAMCET 2001E]**

1) $300\ ms^{-1}$ 2) $310\ ms^{-1}$ 3) $320\ ms^{-1}$ 4) $330\ ms^{-1}$

Ans: 1

Sol: $\lambda_1 = 5m, \lambda_2 = 6m$

Frequency of first $n_1 = \frac{\nu}{\lambda_1}$, Similarly, $n_2 = \frac{\nu}{\lambda_2}$

No.of beats per sec $(n_1 - n_2) = \frac{30}{3}$

$\frac{\nu}{\lambda_1} - \frac{\nu}{\lambda_2} = 10 \Rightarrow \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right) = 10$

$\nu\left(\frac{1}{5} - \frac{1}{6}\right) = 10 \Rightarrow \nu\left(\frac{1}{30}\right) = 10 \Rightarrow \nu = 300\,m/s$

18. In order to double the frequency of the fundamental note emitted by a stretched string, the length is reduced to 3/4th of the original length and the tension is to be changed is **[EAMCET 2001E]**

1) $\frac{3}{8}$ 2) $\frac{2}{3}$ 3) $\frac{8}{9}$ 4) $\frac{9}{4}$

Ans: 4

Sol: Frequency of stretched string $n = \frac{1}{21}\sqrt{\frac{T}{m}}$

where m = mass per unit length of the string which is same in both the cases,

so $n \propto \frac{\sqrt{T}}{\ell} \Rightarrow \frac{n_1}{n_2} = \frac{\ell_2}{\ell_1}\sqrt{\frac{T_1}{T_2}}$

$$\frac{n}{2n} = \frac{\frac{3}{4}\ell}{\ell}\sqrt{\frac{T_1}{T_2}} \Rightarrow \frac{1}{2} = \frac{3}{4}\sqrt{\frac{T_1}{T_2}}$$

$$\therefore \sqrt{\frac{T_1}{T_2}} = \frac{2}{3} \Rightarrow \frac{T_1}{T_2} = \frac{4}{9} \Rightarrow T_2 = \frac{9}{4}T_1$$

$\therefore$ Tension should be changed by the factor $\frac{9}{4}$

19. The frequency of a stretched uniform wire under tension is in resonance with the fundamental frequency of a closed tube. If the tension in the wire is increased by 8N, it is in resonance with the first over-tone of the closed tube. The initial tension in the wire is **[EAMCET 2000 E]**

1) 1 N 2) 4 N 3) 8 N 4) 16 N

Ans : 1

Sol: Frequency of stretched wire $n_1 = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$

Fundamental frequency of closed tube $n_2 = \frac{\nu}{4\ell}$

Frequency of first overtone of closed tube $n_3 = \frac{3\nu}{4\ell}$

Ist condition $n_1 = n_2$, $\frac{1}{2\ell}\frac{\sqrt{T}}{m} = \frac{\nu}{4\ell}$ ……………..(1)

IInd condition $\frac{1}{2\ell}\frac{\sqrt{T+8}}{m} = \frac{3\nu}{4\ell}$ ………………….(2)

Equation (1) $\div$ (2) $\frac{\sqrt{T/m}}{\sqrt{(T+8)/m}} = \frac{1}{3}$

$$\frac{T/m}{(T+8)/m} = \frac{1}{9} \Rightarrow \frac{T}{m} \times \frac{m}{T+8} = \frac{1}{9}$$

$$9T = T + 8 \Rightarrow T = 1N$$

20. If vibrating tuning fork of frequency 255 Hz is moving with a velocity 4 ms^{-1} towards the wall the number of beats heard per second is (speed of sound in air = 340 ms^{-1}) **[EAMCET 2000E]**

1) 3 2) 4 3) 5 4) 6

Ans: 3

Sol: $n = 255Hz,\ v_s = 4m/s$

Apparent frequency when tuning fork move towards the wall

$$n' = \frac{\nu}{\nu - \nu_s} \times n = \frac{340}{340-4} \times 255 = 258\text{Hz}$$

Number of beats heard = 258-253 = 5

21. A source producing sound of frequency 170 Hz is approaching a stationary observer with a velocity of 17 ms^{-1}. The apparent change in the wavelength of sound heard by the observer is : (speed of sound in air = 340 ms^{-1}) **[EAMCET 2000E]**

1) 0.1 m 2) 0.2 m 3) 0.4 m 4) 0.5 m

Ans: 0.1 m

Sol: n = 170 Hz

Velocity of source $\nu_s = 17\,\text{m/s}$

Apparent frequency $n' = \frac{\nu}{\nu - \nu_s} \times n$

$$= \frac{340}{340-17} \times 170 = \frac{340}{323} \times 170 = 179\text{Hz}$$

Initial wavelength $\lambda_1 = \frac{\nu}{n} = \frac{340}{170} = 2\text{m}$

Final wavelength $\lambda_2 = \frac{\nu}{n} = \frac{340}{179} = 1.9\text{Hz}$

$\therefore$ Change in wavelength = 2 – 1.9 = 0.1 m

MEDICAL PAPER

22. A theatre of volume $100 \times 40 \times 10\text{m}^3$ can accommodate 1000 visitors. The reverberation time of the theatre when empty is 8.5 sec. If the theatre is now filled with 500 visitors, occupying the front-hall seats, the reverberation time changes to 6.2 seconds. The average absorption coefficient of each visitor is nearly **[EAMCET 2009 M]**

1) 0.6 2) 0.5 3) 0.45 4) 0.7

Ans: 1

Sol: According to Sabine's formula

$$8.5 = \frac{(0.17)V}{A}$$

$$\Rightarrow A = \frac{(0.17)(4 \times 10^4)}{8.5} = 800$$

Now, $8.5 = \frac{0.17V}{800}$ …………..(1)

$$6.2 = \frac{0.17V}{800 + (500)a} \quad \text{……….(2)}$$

from (1) and (2)

$$\frac{8.5}{6.2} = \frac{800 + 500a}{800} \Rightarrow a = 0.59 = 0.6$$

23. An observer is standing 500 mts away from a vertical hill. Starting from a point between the observer and the hill, a police van moves towards the hill with uniform speed sounding a siren of frequency of 1000 Hz. If the frequency of the sound heard by the observer directly from the siren

is 970 Hz, the frequency of the sound heard by the observer after reflection from the hill (Hz) is nearly : (Velocity of sound in air = 330 m/s) **[EAMCET 2009 M]**

1) 1042 2) 1031 3) 1022 4) 1012

Ans: 2

Sol: According to Doppler's effect the apparent frequency

$$n^1 = n\left[\frac{v}{v+v_s}\right]$$

$n^1 \rightarrow$ apparent frequency

$n \rightarrow$ natural frequency

$v \rightarrow$ velocity of sound

$v_s \rightarrow$ velocity of source

$$\Rightarrow 970 = \left(\frac{330}{330+v_s}\right)(1000) \Rightarrow v_s = 10.21\,ms^{-1}$$

$$\therefore\ n'' = n\left[\frac{v}{v-v_s}\right] = \left(\frac{330}{330-10.21}\right)1000 = 1031.93\,Hz$$

24. The frequency of three tuning forks A, B and C have a relation $n_A > n_B > n_C$. When the forks A and B are sounded together the number of beats produce is n_1. When A and C are sounded together the number of beats produced is n_2 then the number of beats produced when B and C are sounded together is **[EAMCET 2008 M]**

1) $n_1 + n_2$ 2) $(n_1 + n_2/2)$ 3) $n_2 - n_1$ 4) $n_1 - n_2$

Ans: 3

Sol: given that $n_A - n_B = n_1$ ....(1) and $n_A - n_C = n_2$ ....(2)

Simplifying (1) and (2)

$n_B - n_C = n_2 - n_1$

25. Two strings of the same material and the same area of cross- section are used in sonometer experiments. One is loaded with 12 kg and the other with 3 kg. The fundamental frequency of the first string is equal to the first overtone of the second string. If the length of the second string is 100 cm, then the length of the first string is **[EAMCET 2008 M]**

1) 300 cm 2) 200 cm 3) 100 cm 4) 50 cm

Ans: 3

Sol. let n_1 and n_2 are the fundamental frequencies of the two wires

$\therefore\ n_1 = 2n_2$

$$\therefore\ n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} \Rightarrow \frac{n_1}{n_2} = \frac{\ell_2}{\ell_1}\sqrt{\frac{T_1}{T_2}}$$

$$\therefore\ 2 = \frac{100}{\ell_1}\sqrt{\frac{12}{3}} \Rightarrow \ell_1 = 100\,cm$$

26. A uniform wire of linear density 0.0004 kg-m when stretched between two rigid supports with a tension 3.6×10^2 N, resonates with frequency of 420 Hz. The next harmonic with which the wire resonates is 490Hz. The length of the wire in metre is **[EAMCET 2007 M]**

1) 1.41 2) 2.14 3) 2.41 4) 3.14

Ans: 3

Sol: As $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}}$

But n = fundamental frequency

$\therefore\ 490 - 420 = \frac{1}{2\times\ell}\sqrt{\frac{3\times10^2}{0.004}}$

$\therefore\ \ell_1 = 2.14\text{m}$

27. To increase the frequency by 20%, the tension in the string vibrating on a sonometre has to be increases by **[EAMCET 2007 M]**

1) 44% 2) 33% 3) 22% 4) 11%

Ans: 1

Sol: from $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} \Rightarrow n \propto \sqrt{T}$

$\therefore\ \frac{n_2}{n_1} = \sqrt{\frac{T_2}{T_1}} \Rightarrow \frac{120}{100} = \sqrt{\frac{T_2}{T_1}} \Rightarrow \frac{T_2}{T_1} = \frac{36}{25}$

Percentage increase in tension = $\left(\frac{T_2 - T_1}{T_1}\right)\times 100$

$= \left(\frac{36-25}{25}\right)\times 100 = 44\%$

28. The frequency of a tuning fork is 256 Hz. The velocity of sound in air is 344 ms^{-1}. The distance travelled (in metres) by the sound during the time in which the tuning fork completes 32 vibrations is **[EAMCET 2006 M]**

1) 21 2) 43 3) 86 4) 129

Ans: 2

Sol: Wavelength = $\lambda = \frac{v}{n} = \frac{344}{256} = \frac{43}{32}\text{m}$

$\therefore$ distance travelled by the sound during the time in which the tuning fork completes 32 vibrations = $32\times\frac{43}{32} = 43\text{m}$

29. A uniform string of length 1.5 m has two successive harmonics of frequencies of 70 Hz and 84 Hz. The speed of the wave in the string (in ms^{-1}) is **[EAMCET 2006 M]**

1) 84 2) 42 3) 21 4) 10.5

Ans: 2

Sol: As two successive harmonic has frequency of 70 Hz and 84 Hz.

$\therefore$ Fundamental frequency = 84 – 70 = 14 Hz

$\therefore$ frequency $= \frac{v}{2\ell} = 14 \Rightarrow v = 14\times2\times1.5 = 42\text{ms}^{-1}$

30. A lightwave and a sound wave have same frequency f and their wave lengths are respectively λ_L and λ_S then : **[EAMCET 2005 M]**

1) $\lambda_L = \lambda_S$ 2) $\lambda_L > \lambda_S$ 3) $\lambda_L < \lambda_S$ 4) $\lambda_L = 2\lambda_S$

Ans: 2

Sol: From the relation $v = n\lambda$ we can conclude that $\lambda \propto v$. Therefore as velocity of light >> velocity of sound.

$\therefore\ \lambda_L > \lambda_S$

31. A source of sound and an observer are approaching each other with the same speed which is equal to (1/10) times the speed of sound. The apparent relative change in the frequency of the source is **[EAMCET 2005 M]**

1) 22.2% increase 2) 22.2 decrease 3) 18.2 % decrease 4) 18.2% increase

Ans: 1

Sol: As source of sound and an observer are approaching each with the same speed = $\frac{v}{10}$

$$\therefore\ n^1 = n\left[\frac{v+v_0}{v-v_s}\right] \Rightarrow n\left[\frac{v+\frac{v}{10}}{v-\frac{v}{10}}\right]$$

$$\Rightarrow n' = \frac{11}{9}n \Rightarrow \frac{n'}{n} = \frac{11}{9}\ \text{(or)}\ \frac{n'-n}{n} = \frac{2}{9}$$

$$\Rightarrow \frac{n'-n}{n}\times 100 = \frac{2}{9}\times 100 = 22.22\%$$

$\therefore$ Percentage increases in apparent change in frequency of sound = 22.2%

32. Consider the following statements A and B gives below and identify the correct answer.

A) The reverberation time is dependent on the shape of the enclosure, position of the source and observer

B) The unit of absorption coefficient in MKS system is metric sabine. **[EAMCET 2004 M]**

1) Both A and B are true 2) Both A and B are false

3) A is true but B is false 4) A is false but B is true

Ans: 4

Sol: Reverberation time depends on the dimension of enclosure, average absorption current and is independent of shape of enclosure and position of the sources and observer.

The unit of absorption coefficient in m-k-s system is metric sobine .

33. Two identical strings of the same material same diameter and the same length are in unison when stretched by the same tension. If the tension on one string is increased by 21%, the number of beats heard per second is ten. The frequency of the note in Hertz when the strings are in unison is **[EAMCET 2004 M]**

1) 210 2) 200 3) 110 4) 100

Ans: 4

Sol: $T_1 = T \qquad T_2 = T + \frac{2\pi}{100} = \frac{121T}{100} = 1.21T$

$$\therefore\ \frac{n_2}{n_1} = \sqrt{\frac{T_2}{T_1}} \Rightarrow \frac{n_2}{n_1} = \sqrt{\frac{1.21T}{T}} \Rightarrow \frac{n_2}{n_1} = 1.1$$

$$\therefore\ \left(\frac{n_2-n_1}{n_1}\right)\times 100 = (1.1-1)\times 100 = 10\%$$

$$\therefore\ \frac{10}{n_1}\times 100 = 10 \Rightarrow n_1 = 100\text{Hz}$$

34. Two uniform wires are vibrating simultaneously in their fundamental modes. The tensions, lengths, diameters and the densities of the two wires are in the ratios 8: 1, 36 : 35, 4: 1 and 1 :2 respectively. If the note of the higher pitch has a frequency 360 Hertz, the number of beats produced per second is **[EAMCET 2003 M]**

1) 5 2) 10 3) 15 4) 20

Ans: 2

Sol: $n = \frac{1}{2\ell}\sqrt{\frac{T}{m}} = \frac{1}{2\ell}\sqrt{\frac{T}{\pi r^2 \rho}}$

[since linear density = $m = \frac{\text{mass}}{\text{length}} = \frac{\text{volume} \times \text{density}}{\text{length}} = \frac{\text{Area} \times \text{length} \times \text{density}}{\text{length}} = A\rho = \pi r^2 \rho$]

$\therefore \frac{n_2}{n_1} = \frac{\ell_1}{\ell_2}\sqrt{\frac{T_2}{T_1} \times \left(\frac{r_1}{r_2}\right)^2 \times \frac{\rho_1}{\rho_2}}$

$\frac{360}{n_1} = \frac{36}{35}\sqrt{\frac{1}{8} \times \frac{16}{1} \times \frac{1}{2}}$

$\frac{360}{n_1} = \frac{36}{35} \Rightarrow n_1 = 350\text{Hz}$

$\therefore$ Number of beats = 360 – 350 =10

35. A radar sends a radio signal of frequency $9\times10^9\,\text{Hz}$ towards an aircraft approaching the radar. If the reflected wave shows as frequency shift of $3\times10^8\,\text{Hz}$, the speed with which the aircraft is approaching the radar in m/s (Velocity of the radio signal is 3×10^8 m/s) **[EAMCET 2003 M]**

1) 150 2) 100 3) 50 4) 25

Ans: 3

Sol: Frequency of radio signal = n = $9\times10^9\,\text{Hz}$

Shift in frequency signal = $3\times10^3\,\text{Hz}$

Velocity of radio signal = c = $3\times10^8\,\text{ms}^{-1}$

$\therefore$ frequency shift = $n_1 - n = \left(\frac{v+u}{v-u}\right)n - n$

$\therefore$ shift = $\left(\frac{2u}{v-u}\right)n$

sub the values $u = 50\text{ms}^{-1}$

36. A stretched wire of some length under a tension is vibrating with its fundamental frequency. Its length is decreased by 45% and tension is increased by 21%. Now its fundamental frequency **[EAMCET 2002 M]**

1) increases by 50% 2) increases by 100 %

3) decreases by 50% 4) decreases by 25%

Ans: 2

Sol: $\ell_1 = \ell,\ \ell_2 = \ell - \frac{45\ell}{100} = \frac{55\ell}{100}$

$T_1 = T,\quad T_2 = T + \frac{21T}{100} = \frac{121T}{100}$

$\therefore \frac{n_2}{n_1} = \frac{\ell_1}{\ell_2}\sqrt{\frac{T_2}{T_1}}$

$\frac{n_2}{n_1} = \frac{\ell \times 100}{55\ell}\sqrt{\frac{121T}{100 \times T}} \Rightarrow \frac{n_2}{n_1} = \frac{10}{5} = 2$

$\therefore \ \dfrac{n_2 - n_1}{n_1} \times 100 = (2-1) \times 100 = 100\%$

37. One train is approaching an observer at rest and another train is receding him with same velocity 4 m/s. Both the trains blow whistles of same frequency of 243Hz. The beat frequency in Hz as heard by the observer is : (Speed of sound in air = 320 m/s) **[EAMCET 2002 M]**
1) 10 2) 6 3) 4 4) 1
Ans: 2

Sol: The apparent frequency heard by observer when source is approaching observer is

$$n' = n\left[\frac{v}{v - v_s}\right]$$

The apparent frequency heard by observer when source is moving away from observer is

$$n'' = n\left[\frac{v}{v + v_s}\right]$$

$$\therefore \ \Delta n = n' - n'' = \frac{2nv_s}{v} = \frac{2 \times 243 \times 4}{320}$$

$\therefore \ \Delta n = 6$

38. Two stretched strings of same radius and made of same material having lengths 75 cm and 150 cm are in resonance when they are stretched by masses of 1 kg and 2 kg respectively. The velocities of transverse waves in these strings are in the ratio : **[EAMCET 2001 M]**
1) 1 : 4 2) $\sqrt{3}:1$ 3) $1:\sqrt{2}$ 4) 1 : 2
Ans: 3

Sol: $V = \sqrt{\dfrac{T}{M}} \Rightarrow \dfrac{V_1}{V_2} = \sqrt{\dfrac{T_1}{T_2}} = \sqrt{\dfrac{75}{150}} = \dfrac{1}{\sqrt{2}}$

39. When the temperature of an ideal gas is increased by 600K, the velocity of the sound in the gas becomes $\sqrt{3}$ times the initial velocity in it. The initial temperature of the gas is **[EAMCET 2000] M]**
1) $-73°C$ 2) $27°C$ 3) $127°C$ 4) $327°C$
Ans: 2

Sol: We know $\dfrac{V_1}{V_2} = \sqrt{\dfrac{T_1}{T_2}}$

$V_1 = V, V_2 = \sqrt{3}V$ and $T_1 = T$ the $T_2 = T + 600$

$$\Rightarrow \frac{V}{\sqrt{3}V} = \sqrt{\frac{T}{T+600}} \Rightarrow \frac{1}{3} = \frac{T}{T+600}$$

$\Rightarrow T = 300k = 27°C$

40. A man is standing between two parallel cliffs and fires a gun. If he hears first and second echoes after 1.5s and 3.5 s respectively, the distance between the cliffs is [Velocity of sound in air = 340 ms^{-1}] **[EAMCET 2000 M]**
1) 1190 m 2) 850 m 3) 595 m 4) 510 m
Ans: 2

Sol: Velocity of sound = 340 ms^{-1}
Time = $1.5 + 3.5 = 5\sec$

$$V = \frac{2d}{t} \Rightarrow d = \frac{vt}{2} = \frac{(340)5}{2} = 850m$$

41. The fundamental frequency of a closed pipe is 220 Hz. If the $1/4^{th}$ of the pipe is filled with water the frequency of the 1^{st} overtone of the pipe now is **[EAMCET 2000 M]**
1) 220 Hz 2) 440 Hz 3) 880 Hz 4) 1760 Hz
Ans:3

Sol: Fundamental frequency of closed pipe $n = \frac{V}{2\ell} = 220\text{Hz}$

If $1/4^{th}$ pipe is filled with water

$\frac{3\lambda}{4} = \frac{3\ell}{4} \Rightarrow n_1 = \frac{v}{\ell} = 4(n) = 880\text{Hz}$