1.

A system is shown in the figure. The time period for small oscillations of the two blocks will be -

(A) $2\pi\sqrt{\frac{3m}{k}}$ (B*) $2\pi\sqrt{\frac{3m}{4k}}$ (C) $2\pi\sqrt{\frac{3m}{8k}}$ (D) $2\pi\sqrt{\frac{3m}{2k}}$

Sol^n $T = 2\pi\sqrt{\frac{m_{red}}{k_{eq}}} = 2\pi\sqrt{\frac{3m}{4k}}$

$m_{red} = \frac{m_1 m_2}{m_1+m_2} = \frac{m}{2}$

$k_{eq} = \frac{2k}{3}$

2.

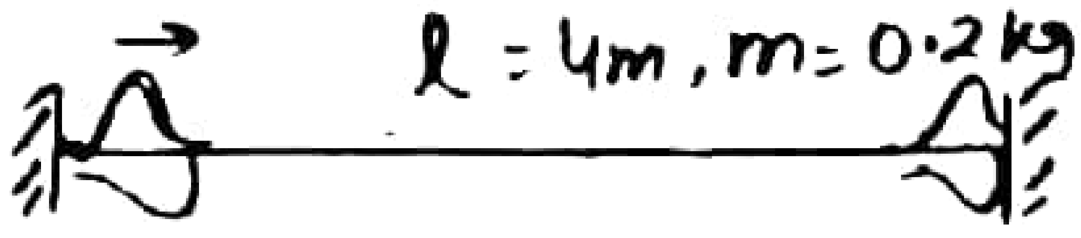
A wire is 4 m long and has a mass 0.2 kg. The wire is kept horizontally. A transverse pulse is generated by plucking one end of the taut (tight) wire. The pulse makes four trips back and forth along the cord in 0.8 sec. The tension is the cord will be -

(A*) 80 N (B) 160 N (C) 240 N (D) 320 N

$\frac{\overset{400}{1600} \times 0.2}{4} = T$

$80N = T$

Sol



$l = 4m, m = 0.2kg$

after 1 trip it comes in phase Time = 1 Time pd.

time (1 trip) = $T = \frac{0.8}{4} = 0.2sec$

Wave speed $V = \frac{8m}{0.2sec} = 40m/s = \sqrt{\frac{T}{\mu}}$

3.

The frequency of transverse vibrations in a stretched string is 200 Hz. If the tension is increased four times and the length is reduced to one-fourth the original value, the frequency of vibration will be :

(A) 25 Hz (B) 200 Hz (C) 400 Hz (D*) 1600

$$f = \frac{v}{2l} = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

$$f' = \frac{1}{2\times\frac{l}{4}}\sqrt{\frac{4T}{\mu}} = 8\times\frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

$$f' = 8f = 8\times 200 = 1600\ Hz$$

4.

A particle moves such that its acceleration is given by

$$a = -\beta(x-2)$$

Here : β is a positive constant and x is the position from origin. Time period of oscillations is -

(A) $2\pi\sqrt{\beta}$ (B*) $2\pi\sqrt{\frac{1}{\beta}}$ (C) $2\pi\sqrt{\beta+2}$ (D) $2\pi\sqrt{\frac{1}{\beta+2}}$

Sol

$$a = -\beta x + 2\beta$$

$$a - 2\beta = -\beta x$$

$$a' = -\beta x = -\omega^2 x$$

$$\omega = \sqrt{\beta} \quad T = 2\pi\sqrt{\frac{1}{\beta}}$$

5.

Two particles A and B execute simple harmonic motion with periods of T and $\frac{5T}{4}$ respectively. They start simultaneously from mean position. The phase difference between them when A completes one oscillation will be -

(A) 0 (B) $\frac{\pi}{2}$ (C) $\frac{\pi}{4}$ (D*) $\frac{2\pi}{5}$

$$\phi_1 = \omega_1 t \qquad \phi_2 = \omega_2 t$$

$$\Delta\phi = (\omega_1 - \omega_2) t$$

$$= \left[\frac{2\pi}{T} - \frac{2\pi \times 4}{5T}\right] \times T$$

$$= 2\pi \times \frac{1}{5} = \frac{2\pi}{5}$$

6.

Two strings of copper are stretched to the same tension. If their cross-section area are in the ratio 1 : 4, then the respective wave velocities will be -

(A) 4 : 1 (B*) 2 : 1 (C) 1 : 2 (D) 1 : 4

Sol

$$\frac{A_1}{A_2} = \frac{1}{4} \qquad T = \text{Same}, \quad \rho = \text{Same}$$

$$V = \sqrt{\frac{T}{\rho A}} \propto \frac{1}{\sqrt{A}}$$

$$\frac{V_1}{V_2} = \sqrt{\frac{A_2}{A_1}} = \frac{2}{1}$$

7.

The displacement of two identical particles executing SHM are represented by equations

$x_1 = 4\sin\left(10t + \frac{\pi}{6}\right)$ and $x_2 = 5\cos(\omega t)$

For what value of ω energy of both the particles is same?

(A) 16 unit (B) 6 unit (C) 4 unit (D*) 8 unit

$\frac{1}{2} m\omega^2 A^2 =$ Same

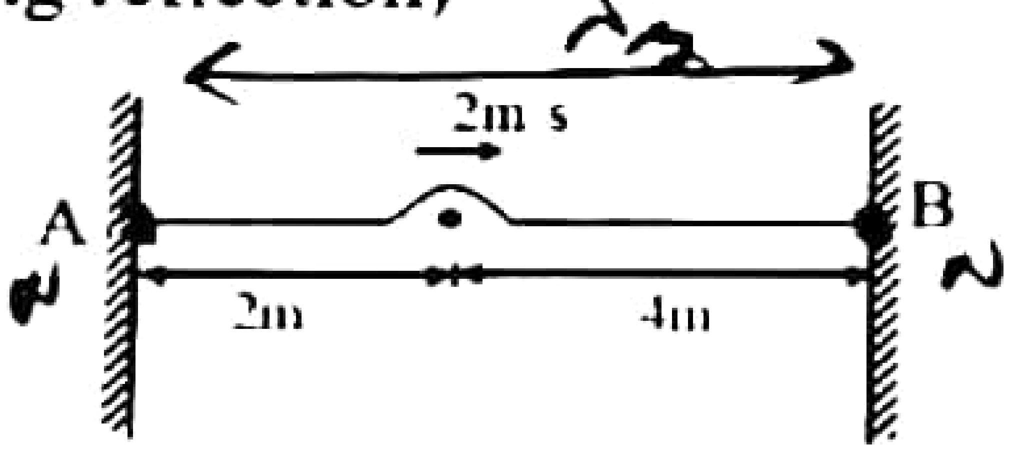
$A_1\omega_1 = A_2\omega_2$

$4 \times 10 = 5 \times \omega$

$\omega = 8$

8.

A string is tied at two rigid support. A pulse is generated on the string as shown in figure. Minimum time after which string will regain its shape : (Neglect the time during reflection)



(A) 2 sec (B) 4 sec

(C*) 6 sec (D) None of these

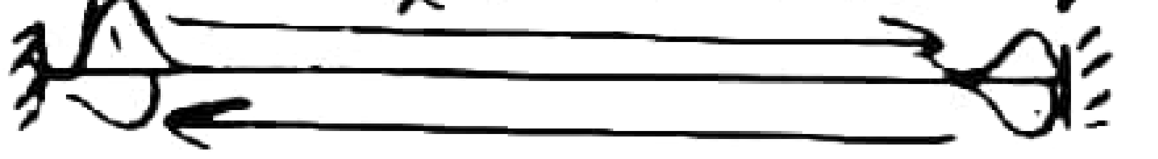
$\frac{\lambda}{2} = 6$ $\lambda = 12$ $t = \frac{\lambda}{v} = \frac{12}{2} = 6$ sec

9.

A string of length 0.4 m and mass 10^{-2} kg is tightly clamped at its ends. The tension in the string is 1.6 N. Identical wave pulses are produced at one end at equal intervals of time, ΔT. The minimum value of ΔT which allows constructive interference between successive pulses is –

(A) 0.05 s (B*) 0.10 s (C) 0.20 s (D) 0.40 s

$l = 0.4\,m$ $m = 10^{-2}\,kg$, $T = 1.6\,N$



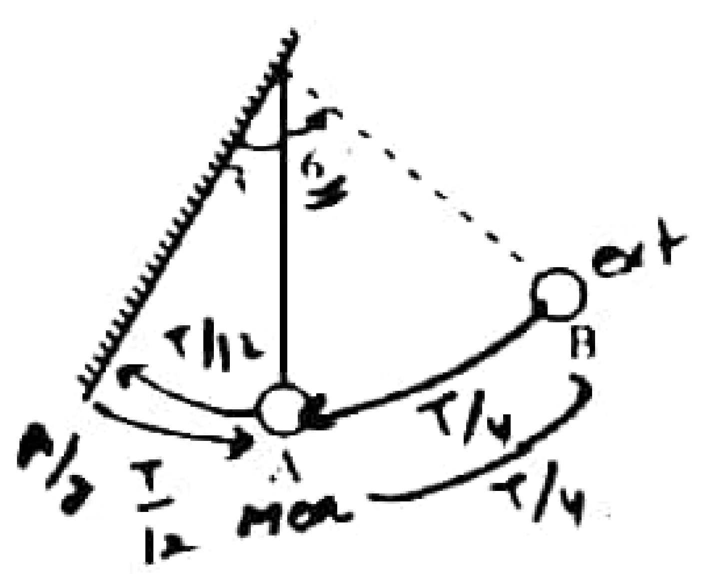
$$V = \sqrt{\frac{T}{m/l}} = \sqrt{\frac{1.6 \times 0.4}{10^{-2}}}$$

$$= 8\,m/s$$

$$\Delta T = \frac{0.8}{8} = 0.1\,sec$$

10.

A pendulum of length 10 cm is hanged by wall making an angle 3° with vertical. It is swinged to position B. Time period of pendulum will be



(A) π/5 sec (B*) $\frac{2\pi}{15}$ sec (C) π/6 sec

(D) Subsequent motion will not be periodic

$$t = \frac{T}{6} + \frac{T}{2} = \frac{2T}{3} = \frac{2}{3} \times 2\pi\sqrt{\frac{0.1}{10}} = \frac{4\pi}{30} = \frac{2\pi}{15}\,s$$

11.

Two vibrating string of the same material but lengths L and 2L have radii 2r and r respectively. They are stretched under the same tension. Both the strings vibrate in their fundamental modes, the one of length L with frequency v_1 and the other frequency v_2. The ratio v_1/v_2 is given by

(A) 2 (B) 4 (C) 8 (D*) 1

ρ = same, T = same

$L_1 = L$, $r_1 = 2r$

$L_2 = 2L$, $r_2 = r$

$\nu = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{T}{\rho \pi r^2}}$

$\frac{\nu_1}{\nu_2} = \frac{r_2 L_2}{r_1 L_1} = \frac{r \times 2L}{2r \times L} = \frac{1}{1}$

12.

The frequency of sonometer wire is f, but when the weights producing the tensions are completely immersed in water the frequency becomes f/2 and on immersing the weights in a certain liquid the frequency becomes f/3. The specific gravity of the liquid is -

(A) $\frac{4}{3}$ (B) $\frac{16}{9}$ (C) $\frac{15}{12}$ (D*) $\frac{32}{27}$

Sol.

$f \propto \sqrt{T} \propto \sqrt{Mg}$ —(1)

$\frac{f}{2} \propto \sqrt{Mg\left(1-\frac{\rho}{\sigma}\right)}$ —(2)

$\frac{f}{3} \propto \sqrt{Mg\left(1-\frac{\rho_1}{\sigma}\right)}$ —(3)

$2 = \sqrt{\frac{\sigma}{\sigma-\rho}}$

$4\sigma - 4\rho = \sigma$

$3\sigma = 4\rho$

$\boxed{\sigma = \frac{4\rho}{3}}$

$9 = \frac{\sigma}{\sigma-\rho_1}$

$9\sigma - 9\rho_1 = \sigma$

$8\sigma = 9\rho_1$

$\boxed{\sigma = \frac{9\rho_1}{8}}$

$\frac{4\rho}{3} = \frac{9}{8}\rho_1 \Rightarrow \frac{\rho_1}{\rho} = \frac{32}{27}$

13.

Statement 1 : In simple harmonic motion A is the amplitude of oscillation. If t_1 be the time to reach the particle from mean position to $\frac{A}{\sqrt{2}}$ and t_2 the time to reach from $\frac{A}{\sqrt{2}}$ to A. Then $t_1 = \frac{t_2}{\sqrt{2}}$. Incorrect

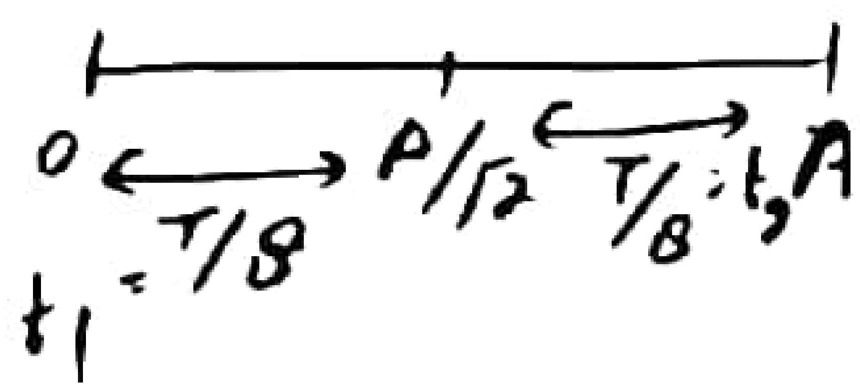
Statement-2 : Equation of motion for the particle starting from mean position is given by $x = \pm A \sin \omega t$ and of the particle starting from extreme position is given by $x = \pm A \cos \omega t$. Correct

(A) If both Statement-1 and Statement-2 are true and the Statement-2 is the correct explanation of the Statement-1.

(B) If both Statement-1 and Statement-2 are true and the Statement-2 is not the correct explanation of the Statement-1.

(C) If Statement-1 is true but Statement-2 is false.

(D*) If Statement-1 is false but Statement-2 is true.



14.

Statement 1 . If two waves of same amplitude produce a resultant wave of same amplitude, then the phase difference between them will be 120°. Correct

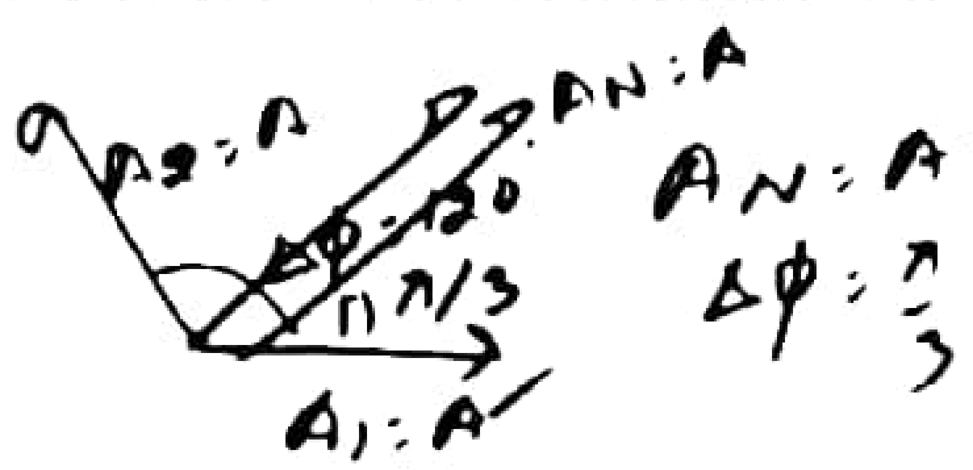
Statement-2 : The resultant amplitude of two waves is equal to sum of amplitudes of two waves. Incorrect

(A) If both Statement-1 and Statement-2 are true and the Statement-2 is the correct explanation of the Statement-1.

(B) If both Statement-1 and Statement-2 are true and the Statement-2 is not the correct explanation of the Statement-1.

(C*) If Statement-1 is true but Statement-2 is false.

(D) If Statement-1 is false but Statement-2 is true.



15.

If the same weight is suspended from three springs having lengths 1 : 3 : 5, the period of oscillations shall be in the ratio of -

(A) 1 : 3 : 5

(B✓) $1 : \sqrt{3} : \sqrt{5}$

(C) 15 : 5 : 3

(D) $1 : \frac{1}{\sqrt{3}} : \frac{1}{\sqrt{15}}$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$T \propto \sqrt{l}$$

$$T_1 : T_2 : T_3 = \sqrt{l_1} : \sqrt{l_2} : \sqrt{l_3}$$

$$= 1 : \sqrt{3} : \sqrt{5}$$

16.

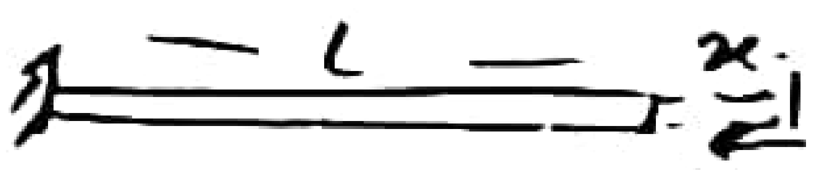
A string of length L is stretched by L/20 and speed of transverse wave along it is v. The speed of wave when it is stretched by L/10 will be: (assume that Hooke's law is applicable) -

(A) 2v

(B) $\frac{v}{\sqrt{2}}$

(C✓) $\sqrt{2}v$

(D) 4v



$$F = kx$$

$$T = F = \frac{YA}{L} \times x$$

$$v \propto \sqrt{T} \propto \sqrt{x}$$

$$v \propto \sqrt{\frac{L}{20}} \qquad \frac{v}{v'} = \frac{1}{\sqrt{2}} \qquad v' = \sqrt{2}v$$

$$v' \propto \sqrt{\frac{L}{10}}$$

17.

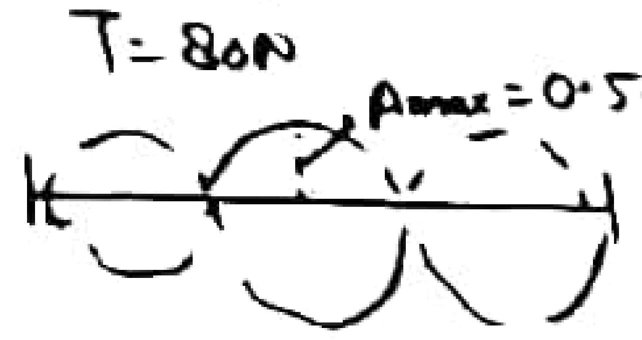
A string of mass 0.2 kg/m and length $l = 0.6$ m is fixed at both ends and stretched such that it has a tension of 80 N. The string vibrates in 3 segments with maximum amplitude of 0.5cm. The maximum transverse velocity amplitude is -

(A*) 1.57m/s (B) 6.28m/s (C) 3.14m/s (D) 9.42m/s

Sol $\mu = 0.2$ kg/m $l = 0.6$ m

$T = 80$ N

$A_{max} = 0.5$ cm



$L = \frac{3\lambda}{2}$

$\lambda = \frac{2L}{3}$

$(V_p)_{max} = A\omega$

Wave speed $= V = \frac{\omega}{k}$

$\omega = kV = \frac{2\pi}{\lambda} \times V$

$(V_p)_{max} = A \times \frac{2\pi}{\lambda} \times \sqrt{\frac{T}{\mu}}$

$(V_p)_{max} = A \times \frac{2\pi \times 3}{2L} \sqrt{\frac{T}{\mu}}$

$(V_p)_{max} = \frac{0.5 \times 10^{-2} \times \pi \times 3}{0.6} \sqrt{\frac{80}{0.2}}$

$(V_p)_{max} = \frac{5 \times 10^{-2} \times \pi \times 20}{2}$

$= 50 \times 10^{-2}\pi$

$= 0.5 \times 3.142$

$= 1.57$ m/s

18.

Fundamental frequency of closed pipe is 100 Hz and that of an open pipe is 200 Hz. Match the following ($v_s = 330$ m/s) :

	Column-I		Column-II
(A)	Length of closed pipe → P	(P)	0.825 m
(B)	Length of open pipe → P	(Q)	1.65 m
(C)	Lowest harmonic of closed pipe which is equal to any of the harmonic of open → S	(R)	5
		(S)	None

(A*) A → P ; B → P ; C → S (B) A → R ; B → S ; C → P
(C) A → Q ; B → R ; C → P (D) A → S ; B → R ; C → Q

$f_{cop} = \frac{V}{4L_c} = 100$ Hz $\quad f_{oop} = \frac{V}{2L_o} = 200$ Hz

$\frac{330}{4} = 100 \times L_c$

$L_c = 0.825$ m $\quad L_o = 0.825$ m

$\frac{m \times V}{4L} = \frac{n \times V}{2L}$

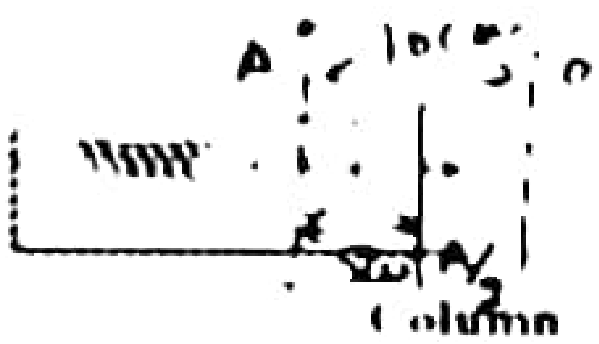
$m = 2n$

$n = 1$, $m = 2$ ✗

$n = 2$, $m = 4$ ✗

$n = 3$, $m = 6$ ✗

19.



$m = 2\,kg$

$k = 3200\,N/m$

Column I	Column II
(A) ... distance ... (P)	(P) $\frac{\pi}{160}$ sec
(B) ... (Q)	(Q) $\frac{\pi}{240}$ sec
(C) ... energy ... (R)	(R) $\frac{\pi}{120}$ sec
(D) ... energy becomes ... (S)	(S) $\frac{\pi}{40}$ sec

$\frac{T}{6} = \frac{\pi}{120} \to P$

$\frac{T}{12} = \frac{\pi}{240} \to Q$

$T/8 = \pi/160 \to P$

$K = \frac{1}{4} \times K_{max}$, $t = \frac{T}{12} \to Q$

(A) A→R B→Q C→P D→Q

(B) A→R C→S D→P

(C) A→P C→Q D→R

(D) A→S C→R D→Q

$\frac{1}{2}mv^2 = \frac{1}{4} \times \frac{1}{2} m v_{max}^2$

$v = \frac{v_{max}}{2} \Rightarrow \omega\sqrt{A^2 - x^2} = \frac{A\omega}{2}$

$4A^2 - 4x^2 = A^2$

$x = \frac{\sqrt{3}A}{2}$

20.

A clock with an Iron Pendulum keeps correct time at 20°C. How much will it lose or gain if temperature changes to 40°C? [Given cubical expansion of iron = $36 \times 10^{-6}\ °C^{-1}$]

(A) 10.368 sec gain

(B*) 10.368 sec loss

(C) 5.184 sec gain

(D) 5.184 sec loss

$$\frac{\Delta T}{T} = \frac{1}{2}\alpha\Delta\theta$$

$$\Delta T = \frac{1}{2}\alpha\Delta\theta \times T$$

$$= \frac{1}{2} \times \frac{\gamma}{3} \times \Delta\theta \times 86400$$

$$= \frac{1}{2 \times 3} \times 36 \times 10^{-6} \times 20 \times 86400 = 10.368 \text{ loose}$$

21.

A tuning fork and a sonometer wire were sounded togather and produce 4 beats per second. When the length of sonometer wire is 95 cm or 100 cm, the frequency of the tuning fork is(given speed of wave on wire is 304 m/s)

(A*) 156 Hz (B) 152 Hz (C) 148 Hz (D) 160 Hz

$f_T - f_W = 4 \uparrow$ or $(\downarrow)$ $f_W - f_T = 4 \downarrow$

$f_T = f_W - 4$

$= \frac{v}{2l} - 4 = \frac{304}{2 \times 0.95} - 4$

$= \frac{304}{1.9} - 4 = 160 - 4 = 156 \text{ Hz}$

22.

The speed of sound in air at N.T.P is 300 m/s. If pressure of air is increased to four times keeping the temperature constant, the speed of sound will becomes –

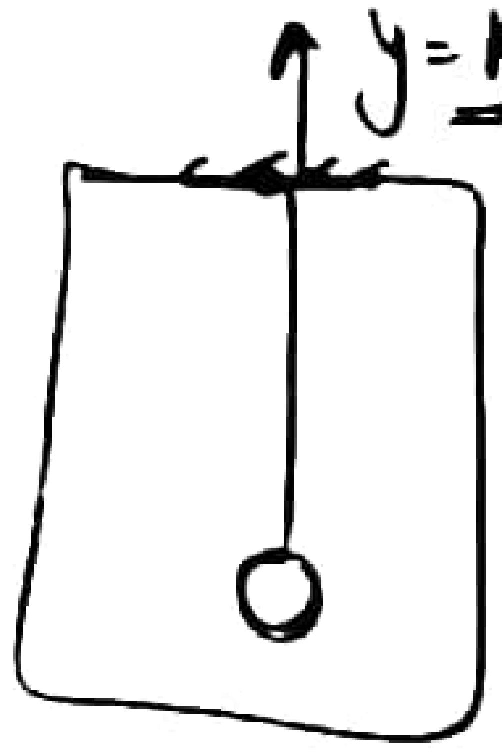
(A) 150 m/s (B*) 300 m/s (C) 600 m/s (D) 1200 m/s

23.

Time period of a simple pendulum is T_1. When point of suspension of the pendulum is moving upward following the equation $y = kt^2$ (where $k = 1 m/s^2$, y is the displacement of point of suspension) its time period becomes T_2, then -

(A) $\frac{T_1^2}{T_2^2} = \frac{5}{6}$ (B*) $\frac{T_1^2}{T_2^2} = \frac{6}{5}$ (C) $\frac{T_1^2}{T_2^2} = 1$ (D) $\frac{T_1^2}{T_2^2} = \frac{4}{5}$

$y = kt^2$ $a = 2k$



$a = 2k$

$g_{eff} = g + a = g + 2k = g + 2$

$\frac{T_1}{T_2} = \sqrt{\frac{g+2}{g}}$

$\frac{T_1^2}{T_2^2} = \frac{12}{10} = \frac{6}{5}$

24.

An unknown fork produces 4 beats per second with a tuning fork of frequency 288 Hz. When unknown fork is loaded with wax it again produces 4 beats per second. The unknown frequency of tuning fork is -

(A) 284 Hz (B*) 292 Hz (C) 290 Hz (D) 288 Hz

$288 - f = 4$ or $f - 288 = 4$

$f = 4 + 288 = 292 Hz$

25.

A wave of frequency $\nu = 1000$ Hz, propagates at a velocity $v = 700$ m/sec along x-axis. Phase difference at a given point x during a time interval $\Delta t = 0.5 \times 10^{-3}$ sec is -

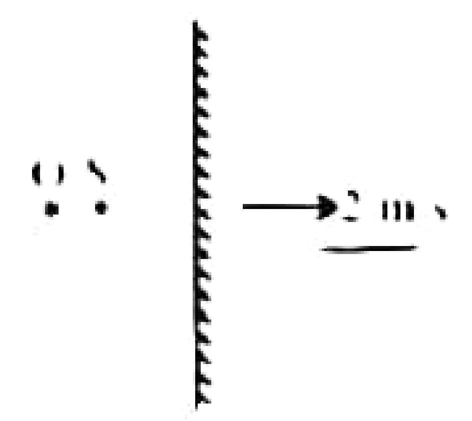
(A*) π (B) $\pi/2$ (C) $3\pi/2$ (D) 2π

Sol

$$\Delta\phi = \omega \Delta t$$
$$= \frac{2\pi}{T} \times \Delta t$$
$$= 2\pi f \Delta t$$
$$= 2\pi \times 1000 \times 0.5 \times 10^{-3}$$
$$= \pi$$

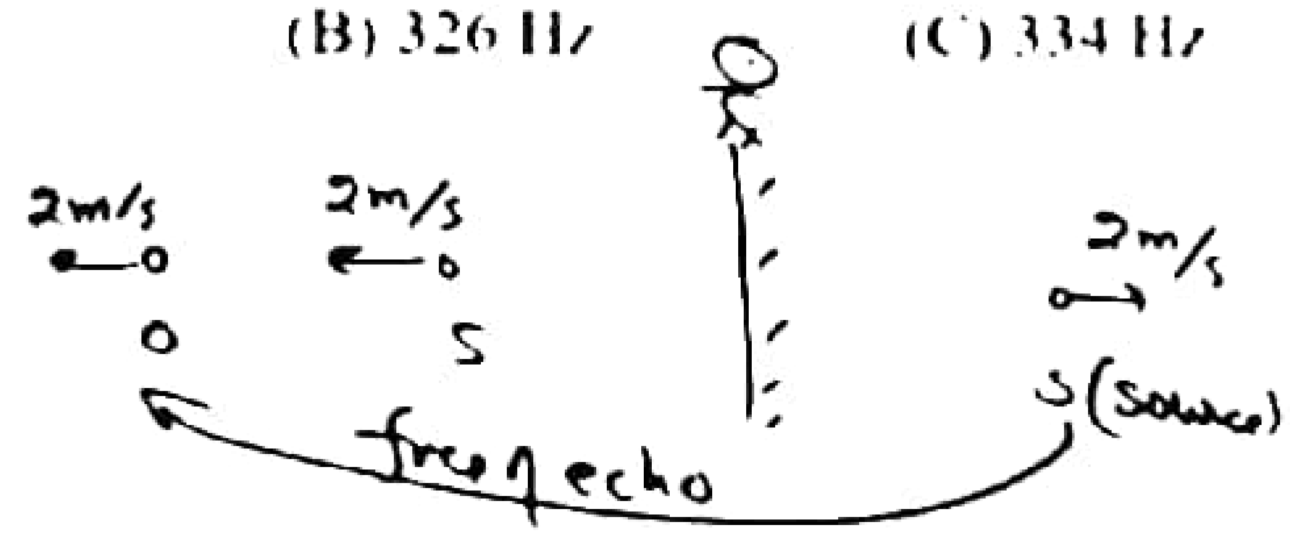
26.

A stationary sound source S of frequency 334 Hz and a stationary observer O are placed near reflecting surface moving away from the source with velocity 2m/s as shown in figure. Velocity of sound waves in air v = 330 m/s. The apparent frequency of echo is



$332 \overline{)334} (1.006$
332
2000

(A) 332 Hz (B) 326 Hz (C) 334 Hz (D*) 330 Hz

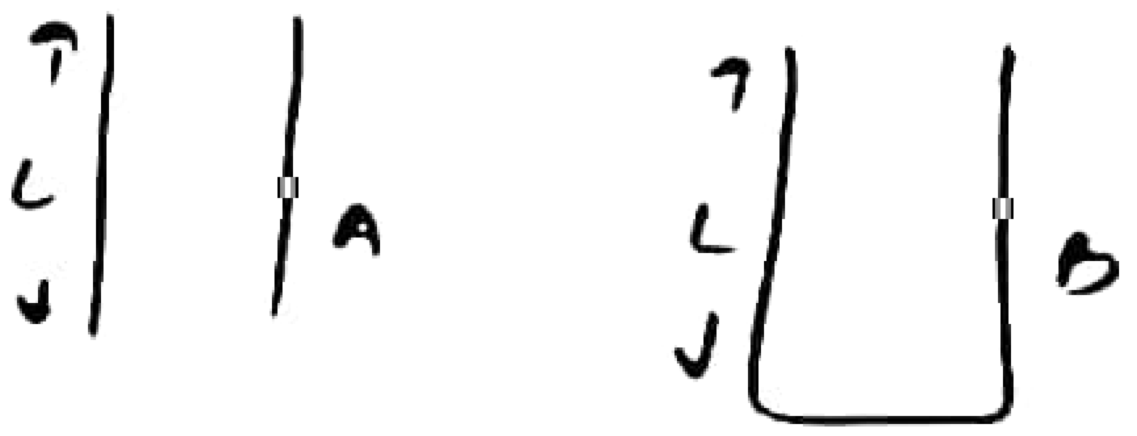


$$f' = f\left[\frac{v-u}{v+u}\right]$$
$$f' = 334\left[\frac{328}{332}\right]$$
$$f' = 1.006 \times 328 = 330 \text{ Hz}$$

27.

Tube A has both ends open while tube B has one end closed, otherwise they are identical. The ratio of fundamental frequency of tube A and B is :

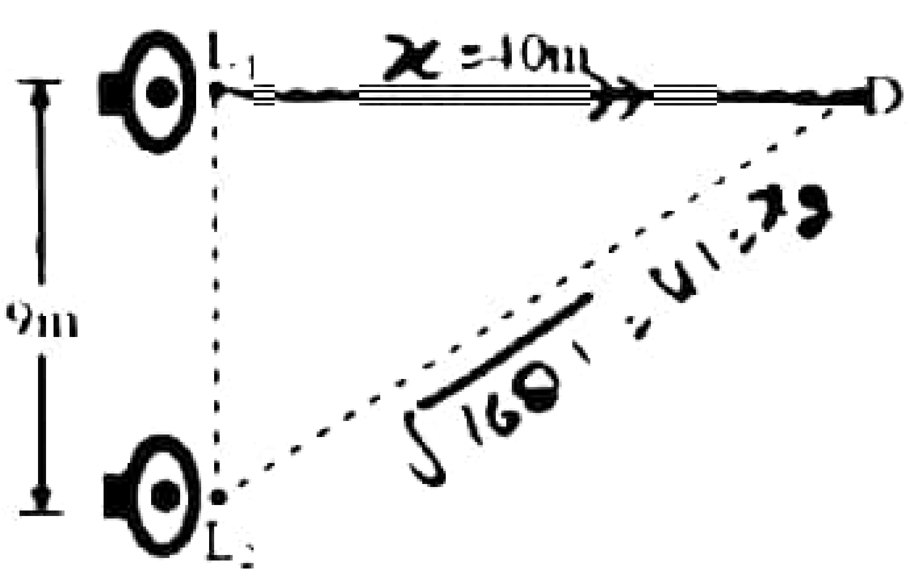
(A) 1 : 2 (B) 1 : 4 (C*) 2 : 1 (D) 4 : 1



$$\frac{f_A}{f_B} = \frac{\frac{v}{2L}}{\frac{v}{4L}} = \frac{2}{1}$$

28.

Two loudspeakers L_1 and L_2 driven by a common oscillator and amplifier, are arranged as shown. The frequency of the oscillator is gradually increased from zero and the detector at D records a series of maxima and minima. If the speed of sound is 330 ms^{-1} then the frequency at which the first maximum is observed is :



$\Delta x = 1m = n\lambda$

$1 = n \times \frac{v}{f}$

$f = nv$

$f_{min} = 1 \times v = 330$ Hz

(A) 165 Hz (B*) 330 Hz (C) 496 Hz (D) 660 Hz

29.

At a pressure of 10^5 N/m^2 the volume strain of water is 5×10^{-5}. Calculate the speed of sound in water density of water is 1×10^3 kg/m^3

(A) 2.828×10^3 m/s (B*) 1.414×10^3 m/s

(C) 0.707×10^3 m/s (D) 4.2×10^3 m/s

Sol $V = \sqrt{\dfrac{B}{\rho}}$

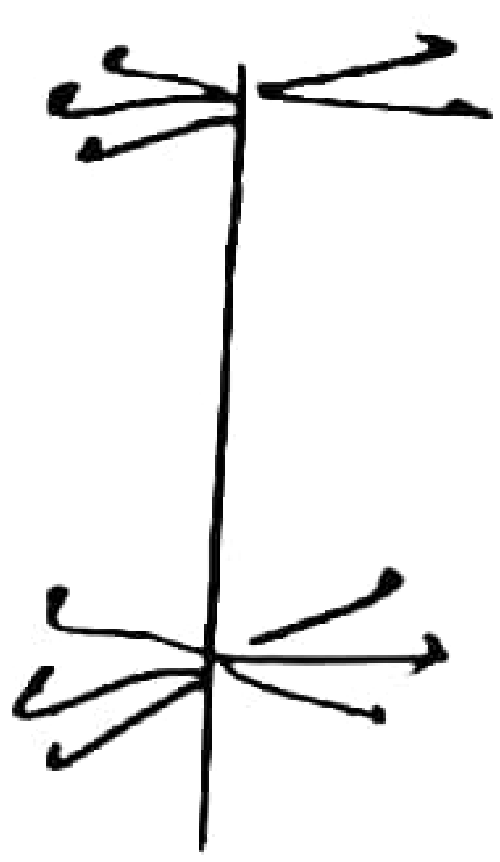
$$B = \frac{\Delta P}{\Delta V/V} = \frac{10^5}{5\times10^{-5}} = 2\times10^{9}\ N/m^2$$

$$v = \sqrt{\frac{2\times10^{9}}{10^3}} = \sqrt{2\times10^6} = 1.414\times10^3\ m/s.$$

30.

A source of sound is in the shape of a long narrow cylinder radiating sound waves normal to the axis of the cylinder. Two points P and Q are at perpendicular distances of 9 m and 25 m from the axis. The ratio of the amplitudes of the waves at P and Q is -

(A*) 5 : 3 (B) $\sqrt{5} : \sqrt{3}$ (C) 3 : 5 (D) 25 : 9



$$Int = \frac{Power}{2\pi r h}$$

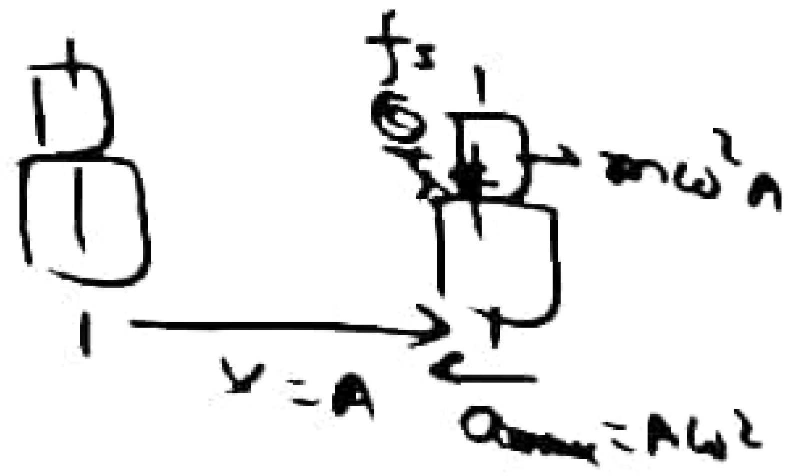
$$Int \propto \frac{1}{r} \propto A^2$$

$$\frac{A_1}{A_2} = \sqrt{\frac{r_2}{r_1}} = \sqrt{\frac{25}{9}} = \frac{5}{3}$$

31.

A block of mass m =1 kg placed on top of another block of mass M = 5 kg is attached to a horizontal spring of force constant K = 20 N/m as shown in figure. The coefficient of friction between the blocks is μ where as the lower block slides on a frictionless surface. The amplitude of oscillation is 0.4 m. What is the minimum value of μ such that the upper block does not slip over the lower block ?

(A) 0.133 ✓ (B) 0.5 (C) 0.362 (D) 0.21



$m\omega^2 A \le \mu_s m g$

$\mu_s \ge \frac{\omega^2 A}{g}$

$\mu_{min} = \frac{\omega^2 A}{g} = \frac{K}{(M+m)} \times \frac{A}{g} = \frac{20 \times 0.4}{6 \times 10} = \frac{0.8}{6} = 0.133$

32.

A sources of sound gives 5 beats per second when sounded with another sources of frequency 100 second^{-1}. The second harmonic of the source, together with a source of frequency 205 second^{-1} gives 5 beats per second. What is the frequency of the source ?

(A) 95 second^{-1} (B) 100 second^{-1}

(C) 105 second^{-1} ✓ (D) 205 second^{-1}

$f - 100 = 5$ or $100 - f = 5$ ✗

$f = 105$ Hz ✓ $f = 95$

$2f - 205 = 5$ or $205 - 2f = 5$

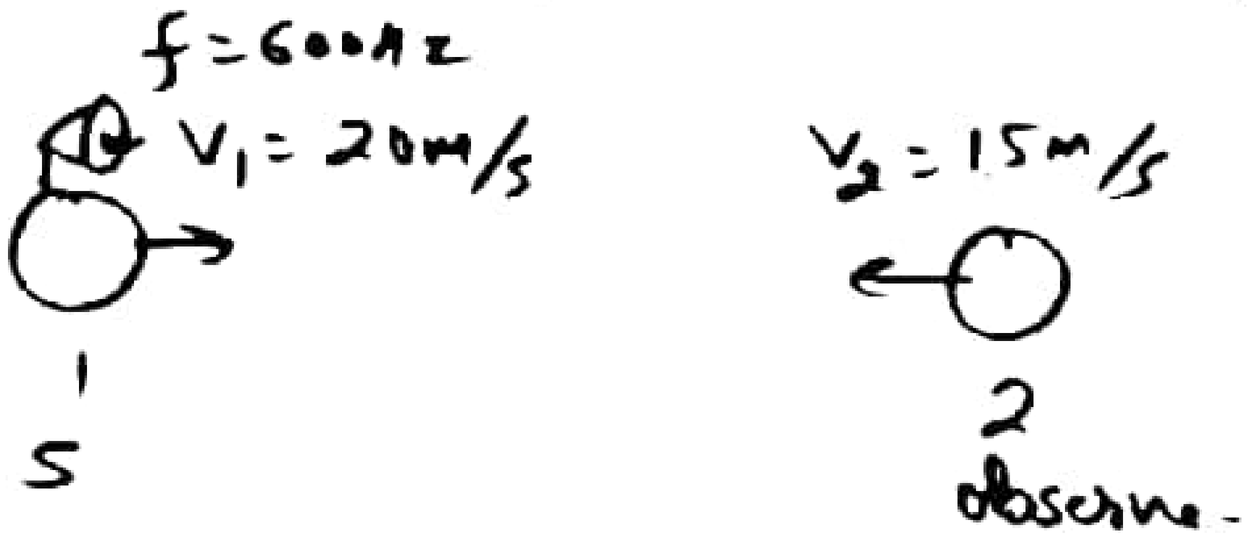
$210 - 205 = 5 = 5$ $205 - 2 \times 95 = 205 - 190$

$= 15$ Hz

33.

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



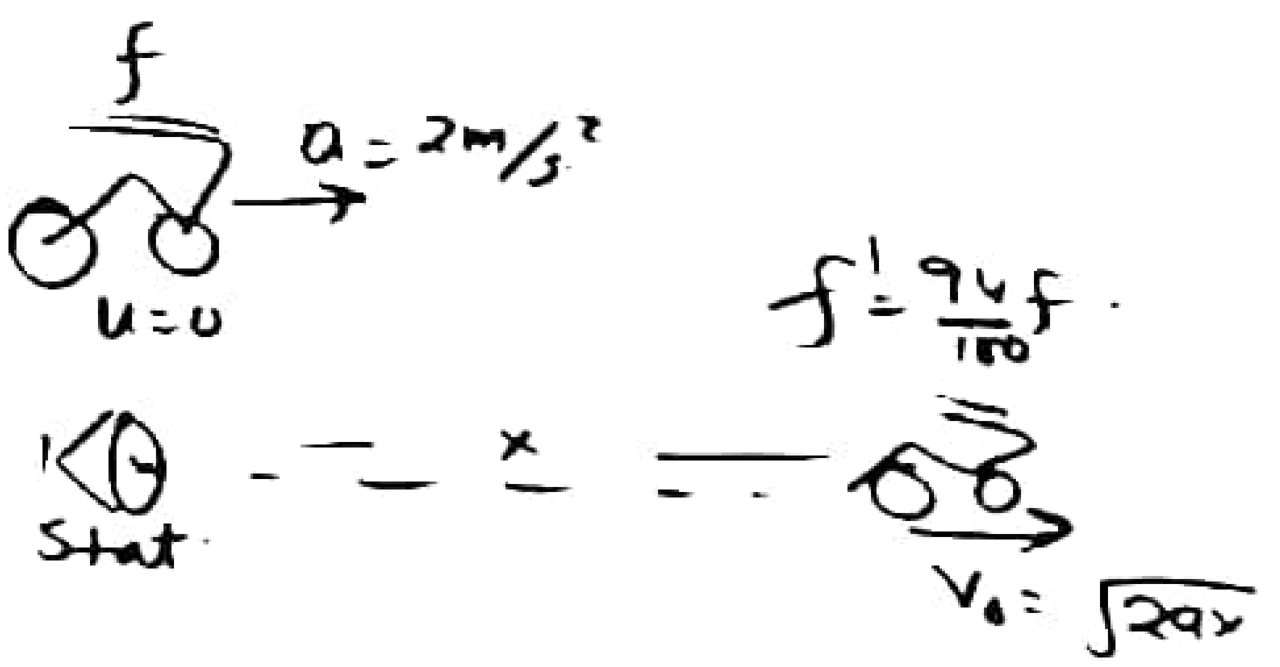
$$f' = f\left(\frac{V+V_0}{V-V_s}\right) = 600\left(\frac{355}{320}\right) = 666\text{ Hz}$$

34.

A motor cycle starts from rest and accelerates along a straight path at 2 m/s². 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)

(A) 49 m (B*) 98 m (C) 147 m (D) 196 m

Sol



$f' = \frac{94}{100} f$

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

$$\frac{94}{100} = \frac{V-V_0}{V}$$

$94V = 100V - 100V_0$

$6V = 100V_0$

$V_0 = \frac{6}{100} \times 330$

$\sqrt{2ax} = 19.8$

$\sqrt{4x} = 19.8$

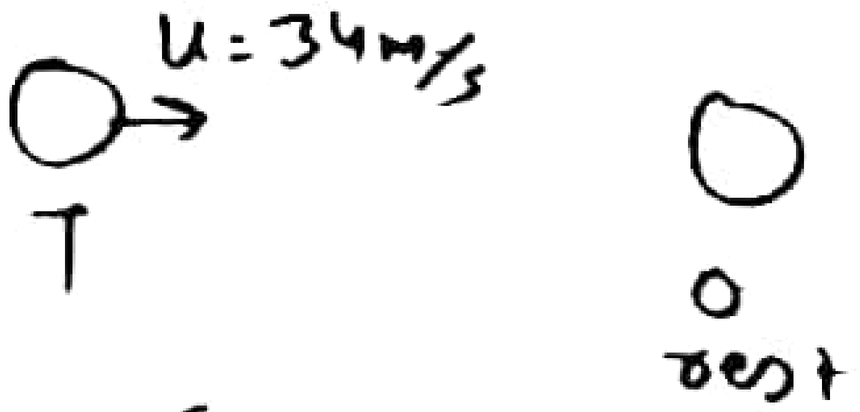
$\sqrt{x} = 9.9$

$x = 98$ m

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 –

(A) 18/19 (B) 1/2 (C) 2 (D*) 19/18



$$f_1 = f\left(\frac{v}{v-u_1}\right)$$
$$f_2 = f\left(\frac{v}{v-u_2}\right)$$

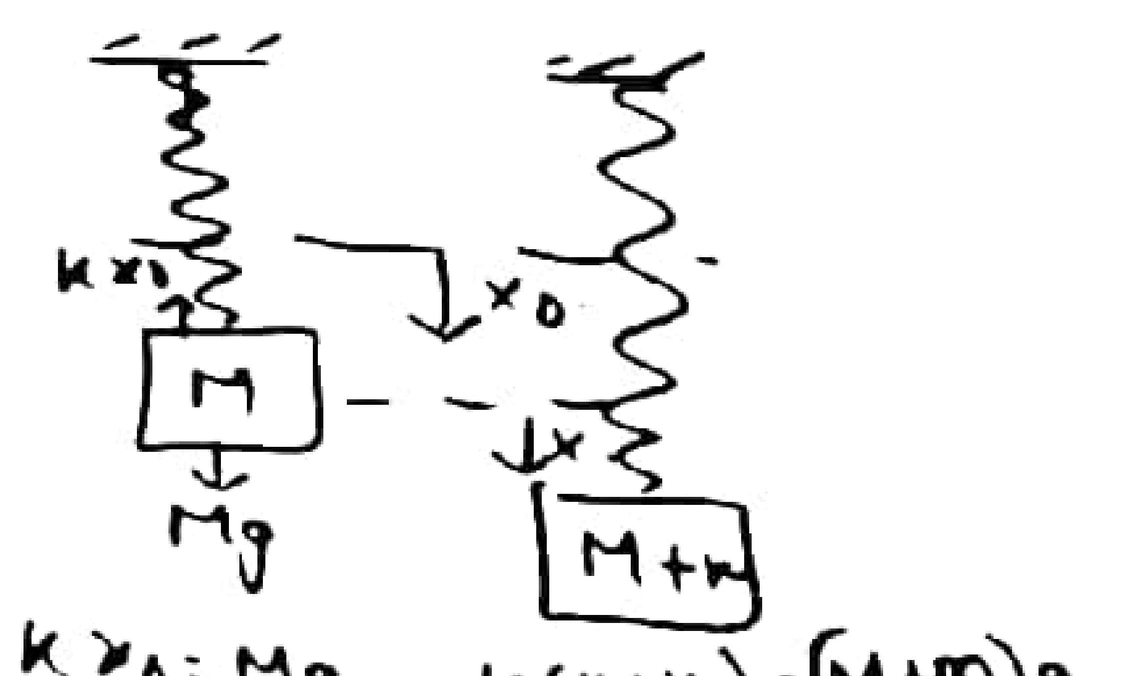
$$\frac{f_1}{f_2} = \frac{v-u_2}{v-u_1} = \frac{340-17}{340-34} = \frac{323}{306} = \frac{19}{18}$$

36.

A mass M is suspended from a light spring. An additional mass m added displaces the spring further by a distance X. Now the combined mass will oscillate on the spring with period

(A) $T = 2\pi\sqrt{\frac{mg}{(M+m)X}}$ (B*) $T = 2\pi\sqrt{\frac{(M+m)X}{mg}}$

(C) $T = \frac{\pi}{2}\sqrt{\frac{mg}{(M+m)X}}$ (D) $T = 2\pi\sqrt{\frac{(M+m)}{mgX}}$

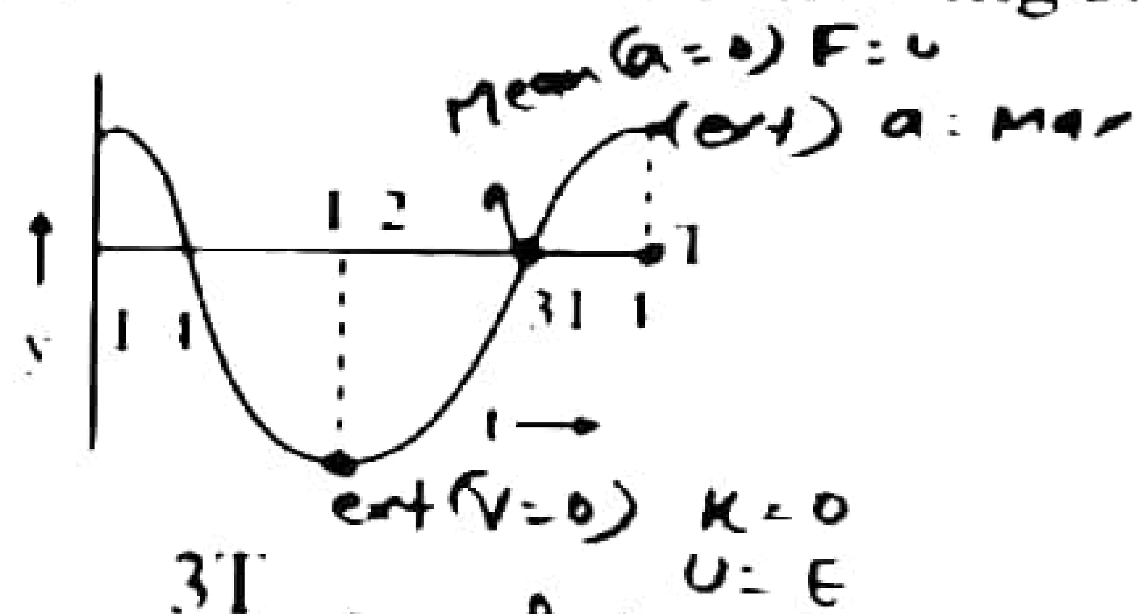


$$kx_0 = Mg \qquad k(x+x_0) = (M+m)g$$

$$kx + Mg = Mg + mg$$
$$kx = mg$$
$$k = \frac{mg}{x}$$
$$T = 2\pi\sqrt{\frac{(M+m)x}{mg}}$$

37.

The graph in the figure shows how the displacement of a particle describing S.H.M. varies with time. Which one of the following statements is not true?



(A) the force is zero at time $\frac{3T}{4}$ - Correct

(B*) the velocity is maximum at time T/2 incorrect

(C) the acceleration is maximum at time T Correct

(D) the P.E. = total energy at time T/2 Correct

38.

Two pendulum of length 1.69 m & 1.44 m start swinging together. After how many vibration will they swing together -

(A) 8 (B) 10 (C*) 12 (D) 14

$n_1 T_1 = n_2 T_2$

$n_1 \sqrt{l_1} = n_2 \sqrt{l_2}$

$\frac{n_1}{n_2} = \sqrt{\frac{l_2}{l_1}} = \sqrt{\frac{1.44}{1.69}} = \frac{12}{13}$

39.

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 standard fork will be-

(A*) 100 Hz (B) 106 Hz (C) 103 Hz (D) 112 Hz

$f_A = \frac{103f}{100}$ f $f_B = \frac{97}{100}f$

$\left(\frac{103}{100} - \frac{97}{100}\right)f = 6$

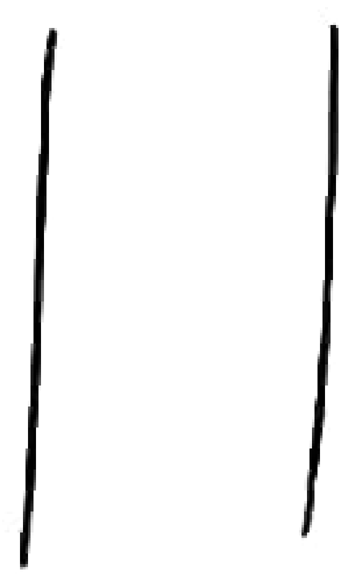
$\frac{6}{100} \times f = 6$ $f = 100\text{Hz}$

40.

An organ pipe open at one end is vibrating in first overtone and is in resonance with another pipe open at both ends and vibrating in third harmonic. The ratio of length of two pipes is -

(A*) 1 : 2 (B) 4 : 1 (C) 8 : 3 (D) 3 : 8

$n - 1 = 1$
$n = 2.$
$2n - 1 = 3$
$f_1 = \frac{3v}{4L_1}$



3^{rd} Harm
$n = 3$
$f_2 = \frac{3v}{2L_2}$

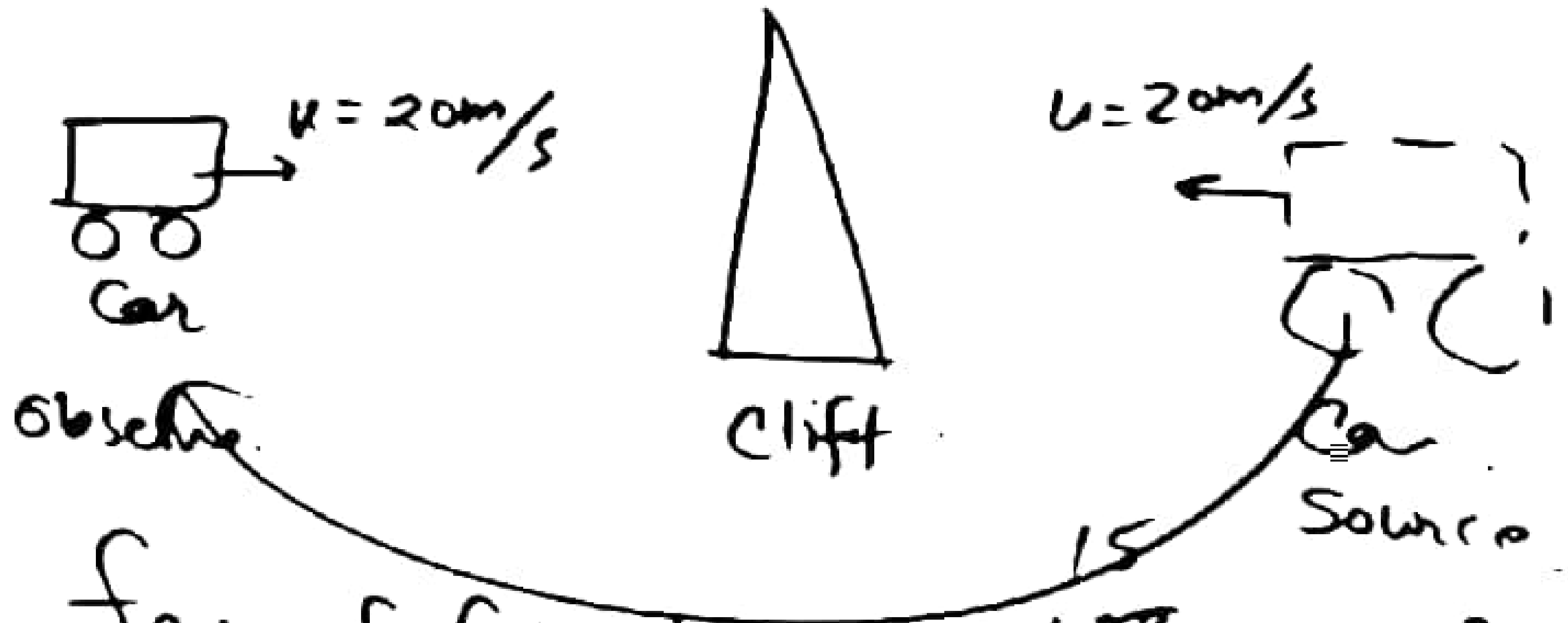
$\frac{3v}{4L_1} = \frac{3v}{2L_2} \Rightarrow \frac{L_1}{L_2} = \frac{1}{2}$

41.

A car sounding its horn at 480 Hz moves towards a high wall at a speed of 20 m/s the frequency of the reflected sound heard by the man sitting in the car will be nearest to -

(A) 480 Hz (B) 510 Hz (C*) 540 Hz (D) 570 Hz

Sol)

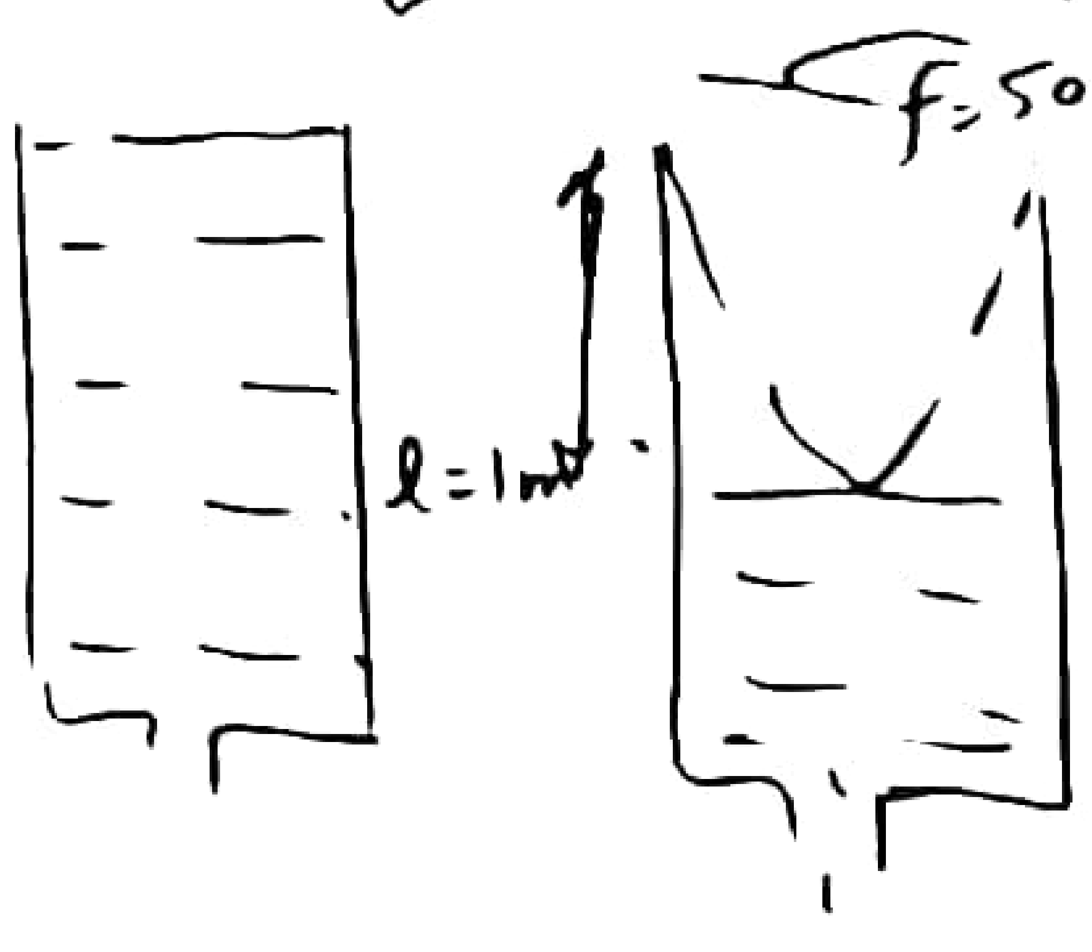


$$f_{ref} = f\left(\frac{v+u}{v-u}\right) = (480)\left(\frac{360}{320}\right) = 15 \times 36 = 540\ Hz$$

42.

A glass tube of 1.0 m length is filled with water, the water can be drained out slowly at the bottom of the tube. If a vibrating tuning fork of frequency 500 Hz is brought at the upper and of the tube and the velocity of sound is 330 m/s then the total no. of resonances obtained will be -

(A) 4 (B*) 3 (C) 2 (D) 1



$f = \frac{(2n-1)v}{4L}$

$f = \frac{mv}{4L}$

$\frac{500 \times 4 \times L}{330} = m$

$m = 1.5 \times 4 \times L$

$m = 6L$

$L = 0 \quad m = 0$

$L = 1m \quad m = 6$

$m = 1, 3, 5$

43.

Four simple harmonic vibrations $x_1 = 8\sin\omega t$,

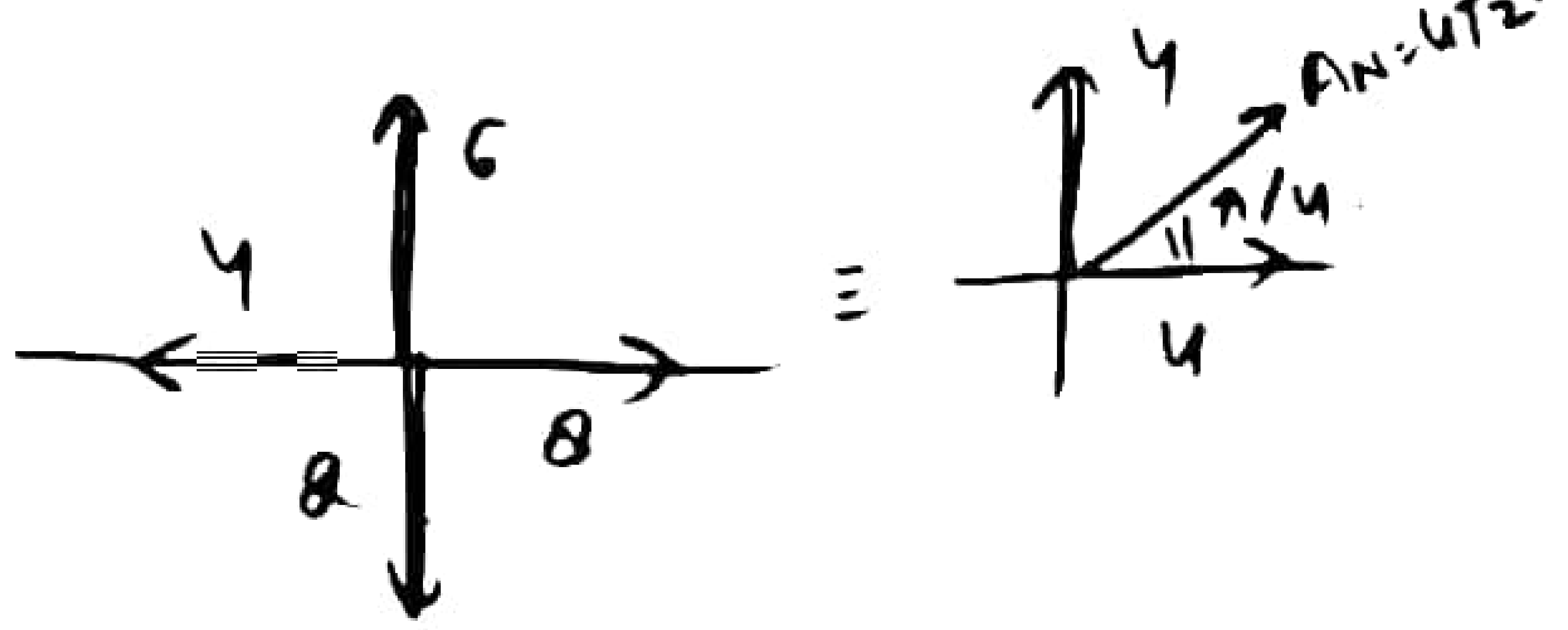
$x_2 = 6\sin(\omega t + \pi/2)$, $x_3 = 4\sin(\omega t + \pi)$ and

$x_4 = 2\sin(\omega t + 3\pi/2)$ are superimposed on each other. The resulting amplitude and its phase difference with x_1 are respectively -

(A) $20, \tan^{-1}\left(\frac{1}{2}\right)$ (B) $4\sqrt{2}, \frac{\pi}{2}$

(C) $20, \tan^{-1}(2)$ (D*) $4\sqrt{2}, \frac{\pi}{4}$

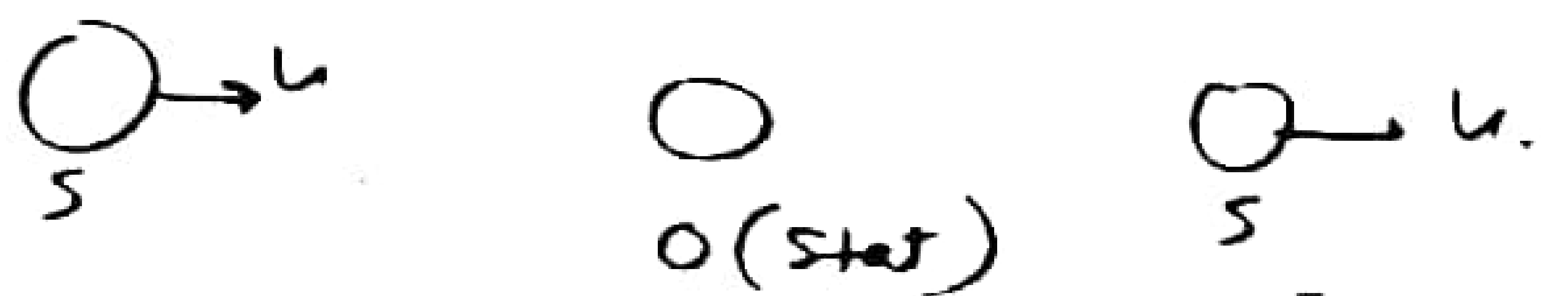
Ans: $4\sqrt{2}$



44.

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



$$f_1 = f\left(\frac{v-0}{v-u}\right)$$

$$f_2 = f\left(\frac{v}{v+u}\right)$$

$$\frac{f_1}{f_2} = \frac{v+u}{v-u} = \frac{5}{3}$$

$$3v + 3u = 5v - 5u$$

$$8u = 2v$$

$$u = \frac{v}{4} = \frac{340}{4} = 85\ m/s$$

45.

Statement-1 : Two SHM's along x and y axes with angular frequency ratio $\omega_1 : \omega_2 = 1 : 2$, with same amplitude results in a parabolic path on super-position. correct

Statement-2: The x and y displacements are related as $y \propto x^2$.

(A*) If both Statement-1 and Statement-2 are true and the Statement-2 is the correct explanation of the Statement-1.
(B) If both Statement-1 and Statement-2 are true and the Statement-2 is not the correct explanation of the Statement-1.
(C) If Statement-1 is true but Statement-2 is false.
(D) If Statement-1 is false but Statement-2 is true.

$X = A\sin(\omega t)$ $\quad y = A\cos(2\omega t)$

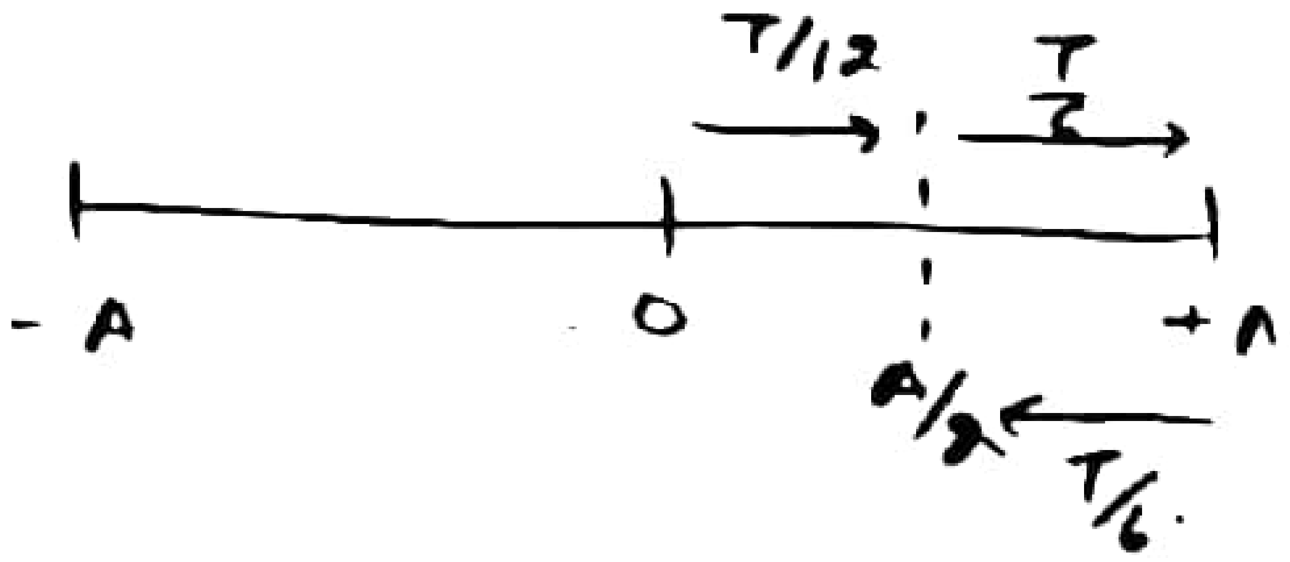
$y = A\left[1 - 2\sin^2(\omega t)\right]$

$y = A\left(1 - \frac{2x^2}{A^2}\right)$ $\quad y \propto x^2$

46.

A particle undergoes simple harmonic motion having time-period T. The time taken 3/8th oscillation is-

(A) (3/8)T (B) (5/8) T (C*) (5/12)T (D) (7/12)T



$\text{time} = \frac{T}{12} + \frac{T}{3} = T\left[\frac{1+4}{12}\right] = \frac{5T}{12}$

47.

In $y = A \sin \omega t + A \sin\left(\omega t + \frac{2\pi}{3}\right)$ match the following table:

	Column-I		Column-II
(A)	Motion → Q	(P)	is periodic but not SHM
(B)	Amplitude → R	(Q)	is SHM
(C)	Initial phase → S	(R)	A
(D)	Maximum velocity → U	(S)	$\pi/3$
		(T)	$\omega A/2$
		(U)	None

(A*) A → Q, B → R; C → S; D → U

$V_{max} = A\omega = A \times \omega$

(B) A → R, B → S; C → T, D → Q

(C) A → T; B → Q, C → R; D → S

(D) A → P; B → Q; C → S; D → R

48.

Statement-1- Doppler effect for sound wave is symmetric w.r.t. speed of source and speed of observer. *incorrect*

Statement-2- Change in frequency due to motion of source w.r.t. stationary observer is not same with that due to motion of observer w.r.t. stationary source. *correct*

(A) If both Statement-1 and Statement-2 are true and the Statement-2 is the correct explanation of the Statement-1.

(B) If both Statement-1 and Statement-2 are true and the Statement-2 is not the correct explanation of the Statement-1.

(C) If Statement-1 is true but Statement-2 is false.

(D*) If Statement-1 is false but Statement-2 is true.

49.

Source has frequency f. Source and observer both have same speed. For the apparent frequency observed by observer match the following :

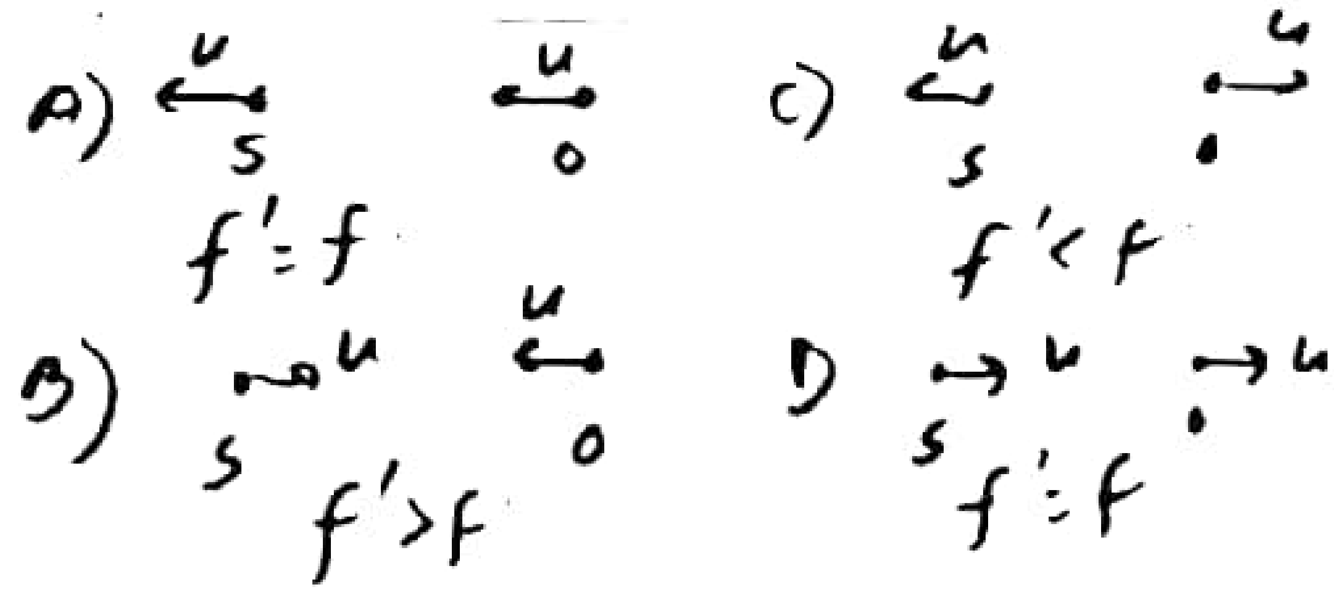
	Column – I		Column – II
(A)	Observer is approaching the source but source is receding from the observer → R	(P)	more than f
(B)	Observer and source both approaching towards each other → P	(Q)	less than f
(C)	Observer and source both receding from each other → Q	(R)	equal to f
(D)	Source is approaching but observer is receding → R		

(A) ✓ A → R ; B → P ; C → Q ; D → R

(B) A → P ; B → R ; C → S ; D → R

(C) A → P ; B → R ; C → P ; D → Q

(D) A → Q ; B → P ; C → R ; D → R



50.

Two equal masses M and N are suspended in two springs of constant K_1 and K_2. If their oscillations satisfy the condition that their maximum velocities are equal, the ratio of the amplitude of the oscillations of M and N is

(A) $\frac{K_1}{K_2}$ (B) $\frac{K_2}{K_1}$ (C) $\sqrt{\frac{K_1}{K_2}}$ (D) ✓ $\sqrt{\frac{K_2}{K_1}}$

Sol

$V_1 = V_2$

$A_1 \omega_1 = A_2 \omega_2$

$A_1 \sqrt{\frac{k_1}{M}} = A_2 \sqrt{\frac{k_2}{M}}$

$\frac{A_1}{A_2} = \sqrt{\frac{k_2}{k_1}}$