# Jupiter Academy

**Subjects : Physics** **PRACTICE PAPER 10**

**Total Marks : 180** **( Solutions )**

## Physics - Section A ( MCQ )

**1.** Two waves having the intensities in the ratio of $9 : 1$ produce interference. The ratio of maximum to the minimum intensity, is equal to

**A)** $2 : 1$ **B)** $4 : 1$ **C)** $9 : 1$ **D)** $10 : 8$

**Solution : (Correct Answer: B )**

(b) Let the intensity of the two waves be $I_1$ and $I_2$

Given: $I_2 : I_1 = 9 : 1 \Longrightarrow I_2 = 9I_1$

Now $\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_2}-\sqrt{I_1})^2} = \frac{(\sqrt{I_1}+\sqrt{9I_1})^2}{(\sqrt{9I_1}-\sqrt{I_1})^2} = \frac{16I_1}{4I_1}$

$\Longrightarrow I_{\max} : I_{\min} = 4 : 1$

**2.** The displacement of a particle is given by $y = 5 \times 10^{-4} \sin(100t - 50x)$, where $x$ is in meter and $t$ in sec, find out the velocity of the wave .... $m/sec$

**A)** $5000$ **B)** $2$ **C)** $0.5$ **D)** $300$

**Solution : (Correct Answer: B )**

(b)$v = \frac{\text{Co}-\text{efficient of } t}{\text{Co}-\text{efficient of } x} = \frac{100}{50} = 2\, m/\sec.$

**3.** The equation of a transverse wave is given by $y = 10 \sin \pi(0.01x - 2t)$ where $x$ and $y$ are in $cm$ and $t$ is in second. Its frequency is .... $\sec^{-1}$

**A)** $10$ **B)** $2$ **C)** $1$ **D)** $0.01$

**Solution : (Correct Answer: C )**

(c) Comparing with the standard equation,

$y = A \sin \frac{2\pi}{\lambda}(vt - x)$, we have

$v = 200cm/\sec,\ \lambda = 200cm\ ; \therefore n = \frac{v}{\lambda} = 1\sec^{-1}$

**4.** Two sound waves of intensity $2\ W/m^2$ and $3\ W/m^2$ meet at a point to produce a resultant intensity $5\ W/m^2$. The phase difference between two waves is .....

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

**Solution : (Correct Answer: C )**

(c)

$I = I_1 + I_2 + 2\sqrt{T_1}\sqrt{T_2}\cos\phi$

$5 = 3 + 2 + 2\sqrt{6}\cos\phi$

$\therefore \cos\phi = 0$

or $\phi = \frac{\pi}{2}$

**5.** The sound intensity level at a point $4\ m$ from the point source is $10\ dB$, then the sound level at a distance $2\ m$ from the same source will be ..... $dB$

**A)** $26$ **B)** $16$ **C)** $23$ **D)** $32$

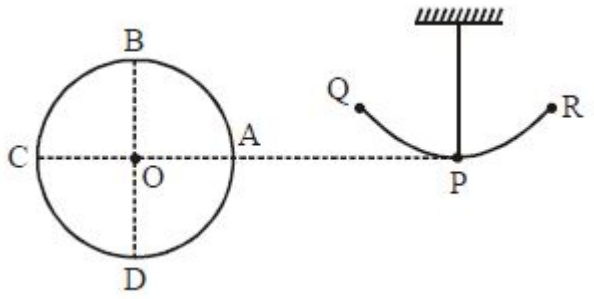
**Solution : (Correct Answer: B )**

(b)

$I \propto \frac{1}{r^2}$

$\therefore$ If at two $m$ intensity is $I_1$ at $4\,m$, intensity is $\frac{I_1}{4}$

**6.** A sound source is moving on a circular path of radius $R$ with constant angular speed $\omega$ in anticlockwise direction and emits a frequency $n$ . An observer performs simple harmonic along the path $QPR$ with time period $T = \frac{2\pi}{\omega}$ as shown in the figure. If at $t = 0$ source is at $A$ and observer is at $Q$ and assume $OP$ is very large as compare to radius $R$ and $QP$ , then




**A)** Observer will hear maximum frequency at $P$ if source is at $B$

**B)** Observer will hear maximum frequency at $P$ if source is at $D$

**C)** Observer will hear maximum frequencyat $Q$ if source is at $B$

**D)** Observer will hear maximum frequency at $Q$ if source is at $D$

**Solution : (Correct Answer: B )**

**7.** A wave travels uniformly in all directions from a point source in an isotropic medium. The displacement of the medium at any point at a distance $r$ from the source may be represented by ($A$ is a constant representing strength of source)

**A)** $[A/\sqrt{r}]sin(kr - \omega t)$

**B)** $[A/r]sin(kr - \omega t)$

**C)** $[Ar]sin(kr - \omega t)$

**D)** $[A/r^2]sin(kr - \omega t)$

**Solution : (Correct Answer: B )**

For a spherical wave (traveling uniformly in all direction from a point source), the amplitude decreases with distance from the center as $1/r$. As a result the intensity of wave varies as $1/r^2$.

Hence, the displacement of medium with $r$ goes as $y = \frac{A}{r}\sin(kr - \omega t)$

**8.** $41$ forks are so arranged that each produces $5$ beats per sec when sounded with its near fork. If the frequency of last fork is double the frequency of first fork, then the frequencies of the first and last fork are respectively

**A)** $200, 400$ **B)** $205, 410$
**C)** $195, 390$ **D)** $100, 200$

**Solution : (Correct Answer: A )**

(a) $n_{First} = n_{First} + (N-1)x$

$2n = n + (41-1) \times 5$

$\Rightarrow n_{First} = 200Hz$ and $n_{Last} = 400Hz$

**9.** Regarding speed of sound in gas match the following

| | |
|---|---|
| $(A)$ Temperature of gas is made $4$ times and pressure $2$ times | $(P)$ Speed becomes $2\sqrt{2}$ times |
| $(B)$ Only pressure is made $4$ times without change in temperature | $(Q)$ Speed become $2$ times |
| $(C)$ Only temperature is changed to $4$ times | $(R)$ Speed remains unchanged |
| $(D)$ Molecular mass of the gas is made $4$ times | $(S)$ Speed becomes half |

**A)** $A-Q,\ B-R,\ C-Q,\ D-S$
**B)** $A-Q,\ B-S,\ C-Q,\ D-S$
**C)** $A-S,\ B-R,\ C-Q,\ D-S$
**D)** $A-Q,\ B-R,\ C-Q,\ D-Q$

**Solution : (Correct Answer: A )**

$v = \sqrt{\frac{\gamma P}{\rho}}$ or $v = \sqrt{\frac{\gamma RT}{M_W}}$

**10.** A sound source is moving towards a stationary observer with $1/10$ of the speed of sound. The ratio of apparent to real frequency is

**A)** $10/9$ **B)** $11/10$
**C)** $(11/10)^2$ **D)** $(9/10)^2$

**Solution : (Correct Answer: A )**

(a) $n' = n\left(\frac{v}{v - v_S}\right) = n\left(\frac{v}{v - v/10}\right)$

==> $\frac{n'}{n} = \frac{10}{9}$

**11.** In a stationary wave, all particles are

**A)** At rest at the same time twice in every period of oscillation
**B)** At rest at the same time only once in every period of oscillation
**C)** Never at rest at the same time
**D)** Never at rest at all

**Solution : (Correct Answer: A )**

(a) In a stationary wave, all particles are at rest at the same twice in every period of oscillation.

Hence, Option $A$ is correct.

**12.** A transverse harmonic wave on a string is described by $y = 3\sin(36t + 0.018x + \frac{\pi}{4})$ where $x$ and $y$ are in $cm$ and $t$ in $s$. The least distance between two sucessive crests in the wave is .... $m$

**A)** $2.5$ **B)** $3.5$ **C)** $1.5$ **D)** $4.5$

**Solution : (Correct Answer: B )**

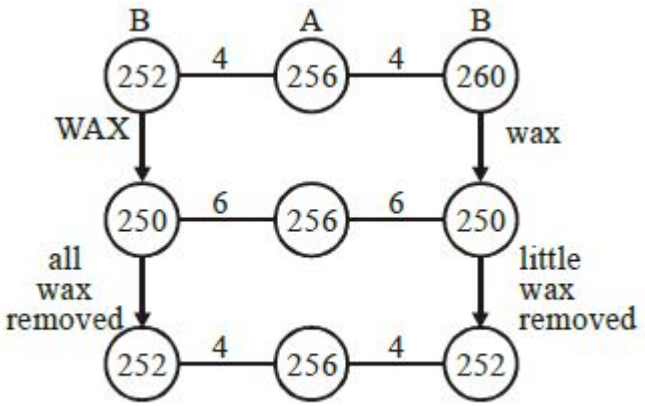
$\mathrm{k} = .018$

$\lambda = 2\pi/\mathrm{k} = \frac{2\pi}{.018} = 348.88 = 3.5\,\mathrm{m}$

**13.** Frequency of tuning fork $A$ is $256\,Hz$ . It produces four $beats/sec$ . with tuning fork $B$ . When wax is applied at tuning fork $B$ then $6$ $beats/sec$ . are heard. By reducing little amount of wax $4$ $beats/sec$ . are heard. Frequency of $B$ is .... $Hz$

**A)** $250$ **B)** $260$ **C)** $252$ **D)** $256$

**Solution : (Correct Answer: B )**




Ans. = 260

**14.** Three waves of equal frequency having amplitudes $10\mu m,\ 4\mu m,\ 7\mu m$ arrive at a given point with successive phase difference of $\frac{\pi}{2}$, the amplitude of the resulting wave in $\mu m$ is given by

**A)** $4$ **B)** $5$ **C)** $6$ **D)** $7$

**Solution : (Correct Answer: B )**

(b) The amplitudes of the waves are $a1 = 10\mu m, a2 = 4\mu m\ and\ a3 = 7\mu m$

and the phase difference between $1^{st}$ and $2^{nd}$ wave is $\frac{\pi}{2}$ and that between $2^{nd}$ and $3^{rd}$ wave is $\frac{\pi}{2}$. Therefore, phase difference between $1^{st}$ and $3^{rd}$ is $\pi$. Combining $1^{st}$ with $3^{rd}$, their resultant amplitude is given by

$A_1^2 = a_1^2 + a_3^2 + 2a_1a_3\cos\phi$

or $A_1 = \sqrt{10^2 + 7^2 + 2 \times 10 \times 7\cos\pi}$

$= \sqrt{100 + 49 - 140}$

$= \sqrt{9} = 3\mu m$ in the direction of first.

Now combining this with $2^{nd}$ wave we have, the resultant amplitude

$A^2 = A_1^2 + a_2^2 + 2A_1a_2\cos\frac{\pi}{2}$

or $A = \sqrt{3^2 + 4^2 + 2 \times 3 \times 4\cos 90^o} = \sqrt{9+16} = 5\mu m$

**15.** A student is performing the experiment of Resonance Column. The diameter of the column tube is $4\ cm$. The frequency of the tuning fork is $512\ Hz$. The air temperature is $38^oC$ in which the speed of sound is $336\ m/s$. The zero of the meter scale coincides with the top end of the Resonance column tube. When the first resonance occurs, the reading of the water level in the column is ..... $cm$

**A)** 14.0 **B)** 15.2 **C)** 16.4 **D)** 17.6

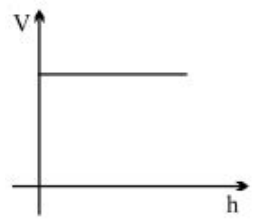
**Solution : (Correct Answer: B )**

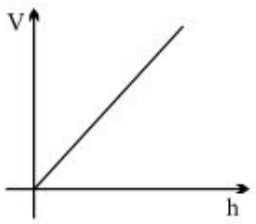
In resonance column experiment $\frac{\lambda}{4} = l_1 + e$ so,

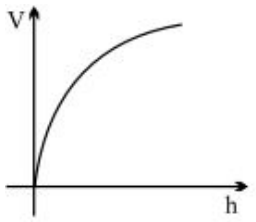
$l_1 = \frac{\lambda}{4} - e = \frac{v}{4f} - 0.3\,d$

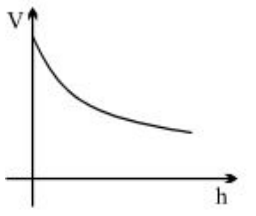
$= \frac{336 \times 100\,\text{cm}}{4 \times 512} - (0.3)(4\text{cm}) = 16.4 - 1.2 = 15.2\,\text{cm}$

**16.** A uniform rope having some mass hanges vertically from a rigid support. A transverse wave pulse is produced at the lower end. The speed $(v)$ of the wave pulse varies with height $(h)$ from the lower end as:

**A)** 


**B)** 


**C)** 


**D)** 


**Solution : (Correct Answer: C )**

$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{\mu x g}{\mu}} = \sqrt{gx} \Rightarrow v^2 = gx$

**17.** The Doppler's effect is applicable for

**A)** Light waves **B)** Sound waves

**C)** Space waves **D)** Both $(a)$ and $(b)$

**Solution : (Correct Answer: D )**

(d) Doppler's effect is applicable for both light and sound waves.

**18.** A stretched string of length $l$, fixed at both ends can sustain stationary waves of wavelength $\lambda$, given by

**A)** $\lambda = \frac{n^2}{2l}$ **B)** $\lambda = \frac{l^2}{2n}$

**C)** $\lambda = \frac{2l}{n}$ **D)** $\lambda = 2l\ n$

**Solution : (Correct Answer: C )**

(c) $\lambda = \frac{2l}{p}$ ($p$ = Number of loops)

**19.** A tuning fork of frequency $392Hz$, resonates with $50cm$ length of a string under tension $(T)$. If length of the string is decreased by $2\%$, keeping the tension constant, the number of beats heard when the string and the tuning fork made to vibrate simultaneously is

**A)** 4 **B)** 6 **C)** 8 **D)** 12

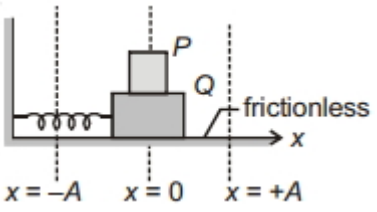
**Solution : (Correct Answer: C )**

(c) $n \propto \frac{1}{l}$ ==> $\frac{\Delta n}{n} = -\frac{\Delta l}{l}$

If length is decreased by $2\%$ then frequency increases by $2\%$ i.e., $\frac{n_2 - n_1}{n_1} = \frac{2}{100}$

==> $n_2 - n_1 = \frac{2}{100} \times n_1 = \frac{2}{100} \times 392 = 7.8 \approx 8.$

**20.** In the figure shown, there is friction between the blocks $P$ and $Q$ but the contact between the block $Q$ and lower surface is frictionless. Initially the block $Q$ with block $P$ over it lies at $x = 0$, with spring at its natural length. The block $Q$ is pulled to right and then released. As the spring - blocks system undergoes $S.H.M.$ with amplitude $A$, the block $P$ tends to slip over $Q.P$ is more likely to slip at




**A)** $x = 0$ **B)** $x = +A$

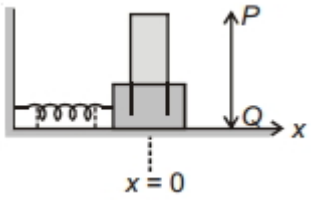
**C)** $x = +\frac{A}{2}$ **D)** $x = +\frac{A}{\sqrt{2}}$

**Solution : (Correct Answer: B )**

The block is most likely to slip when there is maximum acceleration.

This happens when the blocks are at the extremities where the displacement is either $+A$ or

$-A$.




**21.** The amplitude of a damped oscillator becomes one third in $2\,sec$. If its amplitude after $6\,sec$ is $1/n$ times the original amplitude then the value of $n$ is

**A)** $3^2$ **B)** $3\sqrt{2}$ **C)** $3\sqrt{3}$ **D)** $3^3$

**Solution : (Correct Answer: D )**

since $A_t = A_0 e^{\frac{-bt}{2m}}$

When $t = 2$ sec, $\frac{A}{3} = Ae^{\frac{-2b}{2m}}$

$\frac{1}{3} = e^{-b/m}$

When $t = 6$ sec

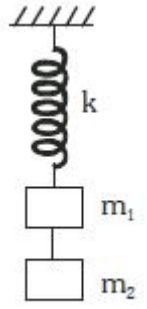
$\frac{A_0}{n} = A_0 e^{\frac{-6b}{2m}}$

$\frac{1}{n} = \left(e^{\frac{-b}{m}}\right)^3$

$\frac{1}{n} = \left(\frac{1}{3}\right)^3$

$n = 3^3$

**22.** Two masses $m_1$ and $m_2$ are supended together by a massless spring of constant $k$. When the masses are in equilibrium, $m_1$ is removed without disturbing the system; the amplitude of vibration is




**A)** $m_1 g/k$ **B)** $m_2 g/k$
**C)** $\frac{(m_1+m_2)\,g}{k}$ **D)** $\frac{(m_2-m_1)\,g}{k}$

**Solution : (Correct Answer: A )**

In equillibrium $F = (\mathrm{m_1 + m_2})\,\mathrm{g}$

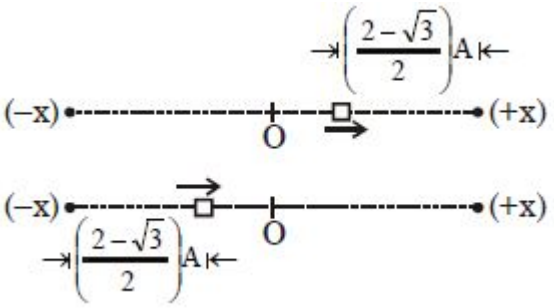
By removing mass $m_1$

$F' = \mathrm{m_2 g}$

$F_\mathrm{r} = F' - F = \mathrm{m_2 g} - (\mathrm{m_1 + m_2})$

$\mathrm{kx} = \mathrm{m_1 g} \Rightarrow \mathrm{x} = \frac{\mathrm{m_1 g}}{\mathrm{k}}$

**23.** Two bodies performing $SHM$ have same amplitude and frequency. Their phases at a certain instant are as shown in the figure. The phase difference between them is




**A)** $\frac{2\pi}{3}$ **B)** $\pi$
**C)** $\frac{\pi}{3}$ **D)** None of these

**Solution : (Correct Answer: A )**

Displacement form mean position

$= \mathrm{A} - \left(\frac{2-\sqrt{3}}{2}\right)\mathrm{A} = \frac{\sqrt{3}}{2}\mathrm{A}$

So phase of the particle which is going

towards $+x$ is $\phi_1 = \frac{\pi}{3}$

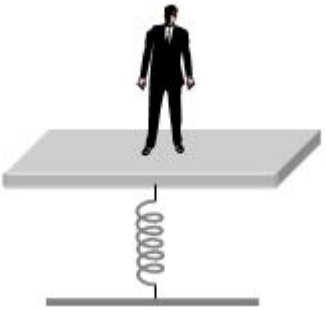
and for other particle $\phi_2 = 2\pi - \frac{\pi}{3} = \frac{5\pi}{3}$

phase difference $= \frac{5\pi}{3} - \frac{\pi}{3}$

$= \frac{4\pi}{3}$ or $\left(2\pi - \frac{4\pi}{3}\right)$

$= \frac{4\pi}{3}$ or $\frac{2\pi}{3}$

**24.** A man weighing $60\,kg$ stands on the horizontal platform of a spring balance. The platform starts executing simple harmonic motion of amplitude $0.1\,m$ and frequency $\frac{2}{\pi}Hz$. Which of the following statement is correct



**A)** The spring balance reads the weight of man as $60\,kg$
**B)** The spring balance reading fluctuates between $60\,kg$. and $70\,kg$
**C)** The spring balance reading fluctuates between $50\,kg$ and $60\,kg$
**D)** The spring balance reading fluctuates between $50\,kg$ and $70\,kg$

**Solution : (Correct Answer: D )**

The maximum force acting on the body executing simple harmonic motion is

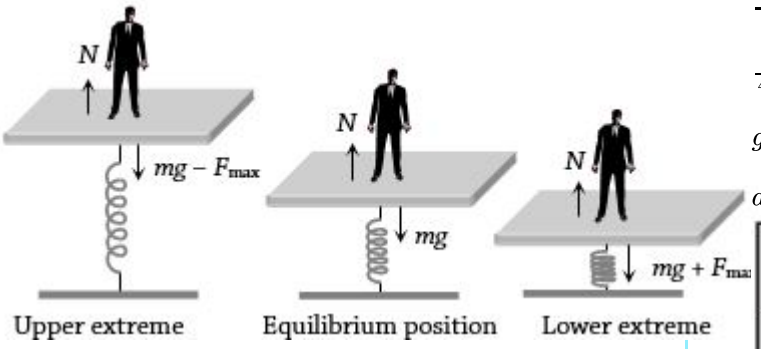
$m\omega^2 a = m \times (2\pi f)^2 a = 60 \times \left(2\pi \times \frac{2}{\pi}\right)^2 \times 0.1\, N$

$= 60 \times 16 \times 0.1 = 96N = \frac{96}{9.8} \approx 10\, kgf$ and this force is towards mean position.

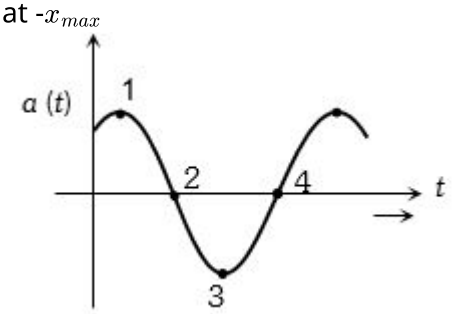
The reaction of the force on the platform away from the mean position. It reduces the weight of man on upper extreme i.e. net weight $= (60 - 10)\, kgf$.

This force adds to the weight at lower extreme position i.e. net weight becomes $= (60 + 10)\, kgf$.

Therefore, the reading the weight recorded by spring balance fluctuates between $50\, kgf$ and $70\, kgf$.




**25.** The acceleration $a$ of a particle undergoing $S.H.M.$ is shown in the figure. Which of the labelled points corresponds to the particle being at -$x_{max}$




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

**Solution : (Correct Answer: D )**

Using acceleration $A = -\omega^2 x$

$At - x_{\max}$ $A$ will be maximum and positive.

**26.** The displacement of a particle varies according to the relation $x = 3sin100t + 8cos^2 50t$. Which of the following is $INCORRECT$ about this motion

**A)** The motion of the particle is $S.H.M.$

**B)** The amplitude of the $S.H.M.$ of the particle is $5\ units$

**C)** The amplitude of the resultant $S.H.M.$ is $\sqrt{73}\ units$

**D)** The maximum displacement of the particle from the origin is $9\ units.$

**Solution : (Correct Answer: C )**

**27.** A pendulum is suspended in a lift and its period of oscillation when the lift is stationary is $T_0$. What must be the acceleration of the lift for the period of oscillation of the pendulum to be $T_0/2$ ?

**A)** $2g$ downward **B)** $2g$ upward

**C)** $3g$ downward **D)** $3g$ upward

**Solution : (Correct Answer: D )**

$T_0 = 2\pi\sqrt{\frac{\ell}{g}}$

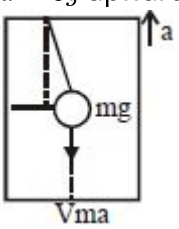
$\frac{T_0}{2} = 2\pi\sqrt{\frac{\ell}{g+a}}$

$\frac{2\pi\sqrt{\frac{\ell}{g}}}{2} = 2\pi\sqrt{\frac{\ell}{g+a}}$

$\frac{1}{4g} = \frac{1}{g+a}$

$g + a = 4g$

$a = 3g$ upward

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**28.** The displacement of a particle from its mean position (in metre) is given by

$y = 0.2 \sin(10\pi t + 1.5\pi) \cos(10\pi t + 1.5\pi)$

The motion of particle is

**A)** Periodic but not $S.H.M$

**B)** Non-periodic

**C)** Simple harmonic motion with period $0.1\ s$

**D)** Simple harmonic motion with period $0.2\ s$

**Solution : (Correct Answer: C )**

$y = 0.2 \sin(10\pi t + 1.5\pi) \cos(10\pi t + 1.5\pi)$

$= 0.1 \sin 2(10\pi t + 1.5\pi)$

$[\because \sin 2A = 2 \sin A \cos A]$

$= 0.1 \sin(20\pi t + 3.0\pi)$

Time period, $T = \frac{2\pi}{\omega} = \frac{2\pi}{20\pi} = \frac{1}{10} = 0.1\text{sec}$

**29.** A $U$ tube of uniform bore of cross-sectional area $A$ has been set up vertically with open ends facing up. Now $m$ gm of a liquid of density $d$ is poured into it. The column of liquid in this tube will oscillate with a period $T$ such that

**A)** $T = 2\pi\sqrt{\frac{M}{g}}$ **B)** $T = 2\pi\sqrt{\frac{MA}{gd}}$

**C)** $T = 2\pi\sqrt{\frac{M}{gdA}}$ **D)** $T = 2\pi\sqrt{\frac{M}{2Adg}}$

**Solution : (Correct Answer: D )**

If the level of liquid is depressed by $y\, cm$ on one side, then the level of liquid in column $P$ is $2y\, cm$

higher than $B$ as shown.

The weight of extra liquid on the side $P = 2Aydg$.

This becomes the restoring force on mass $M$.

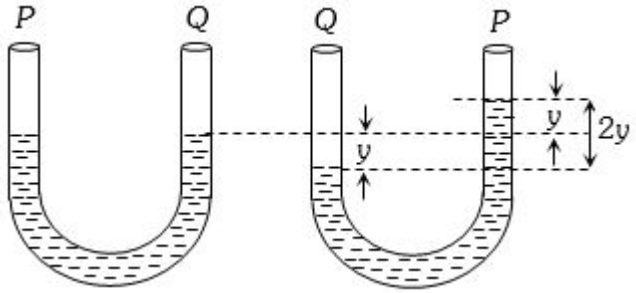
$\therefore$ Restoring acceleration $= \frac{-2Aydg}{M}$

This relation satisfies the condition of $SHM$ i.e. $a \propto -y$.

Hence time period $T = 2\pi\sqrt{\frac{\text{Displacement}}{|\text{Acceleration}|}}$

$= 2\pi\sqrt{\frac{y}{\frac{2Aydg}{M}}}$

$\Rightarrow T = 2\pi\sqrt{\frac{M}{2Adg}}$




**30.** A particle performs $SHM$ with a period $T$ and amplitude $a$. The mean velocity of the particle over the time interval during which it travels a distance $a/2$ from the extreme position is

**A)** $a/T$ **B)** $2a/T$ **C)** $3a/T$ **D)** $a/2T$

**Solution : (Correct Answer: C )**

$x = A\cos\omega t \Rightarrow \frac{A}{2} = A\cos\omega t$

$\Rightarrow \quad \cos\omega t = \frac{1}{2} = \cos\frac{\pi}{3}$

$\frac{2\pi}{T}t = \frac{\pi}{3}$

$\Rightarrow \quad t = \frac{T}{6}$

$v_{\text{av}} = \frac{a/2}{t} = \frac{a/2}{T/6} = \frac{3a}{T}$

**31.** Values of the acceleration $A$ of a particle moving in simple harmonic motion as a function of its displacement $x$ are given in the table below. The period of the motion is

| $A(mm\ s^{-2})$ | 16 | 8 | 0 | $-8$ | $-16$ |
|---|---|---|---|---|---|
| $x\ (mm)$ | $-4$ | $-2$ | 0 | 2 | 4 |

**A)** $\frac{1}{\pi}s$ **B)** $\frac{2}{\pi}s$ **C)** $\frac{\pi}{2}s$ **D)** $\pi\ s$

**Solution : (Correct Answer: D )**

(d) $|A| = \omega^2 x$ ==> $\frac{|A|}{x} = \omega^2$

From the given value $\frac{|A|}{x} = \omega^2 = 4$ ==> $\omega = 2$.

Also $\omega = \frac{2\pi}{T} \Rightarrow 2 = \frac{2\pi}{T} \Rightarrow T = \pi\ sec$

**32.** For a simple pendulum the graph between $L$ and $T$ will be.

**A)** Hyperbola **B)** Parabola
**C)** A curved line **D)** A straight line

**Solution : (Correct Answer: B )**

(b) $T = 2\pi\sqrt{\frac{l}{g}}$==> $l \propto T^2$ (Equation of parabola)

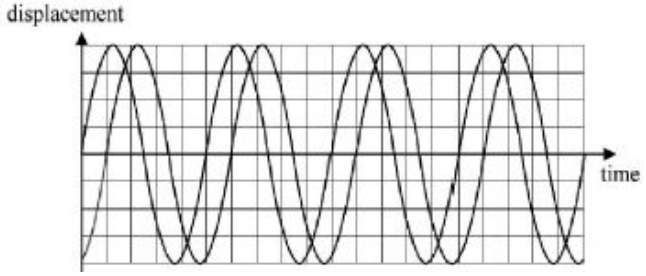
**33.** A spring having a spring constant '$K$' is loaded with a mass '$m$'. The spring is cut into two equal parts and one of these is loaded again with the same mass. The new spring constant is

**A)** $\frac{K}{2}$ **B)** $K$ **C)** $2K$ **D)** $K^2$

**Solution : (Correct Answer: C )**

(c) Spring constant $(k) \propto \frac{1}{\text{Length of the spirng } (l)}$ as length becomes half, $k$ becomes twice is $2k$.

**34.** The diagram shows two oscillations. What is the phase difference between the oscillations?




**A)** $\frac{\pi}{5}rad$ **B)** $\frac{2\pi}{5}rad$
**C)** $\frac{3\pi}{5}rad$ **D)** $\frac{4\pi}{5}rad$

**Solution : (Correct Answer: B )**

**35.** A particle of mass $10\ gm$ moves in a field where potential energy per unit mas is given by expression $v = 8 \times 10^4\ x^2\ erg/gm$. If the total energy of the particle is $8 \times 10^7\ erg$ then the relation between $x$ and time $t$ is

**A)** $x = 10\ \sin\ (400\,t + \phi)\ cm$
**B)** $x =\ \sin\ (400\,t + \phi)\ m$
**C)** $x = 10\ \sin\ (40\,t + \phi)\ cm$
**D)** $x = 100\ \sin\ (4\,t + \phi)\ m\ [\phi = \text{constant}]$

**Solution : (Correct Answer: A )**

Potential energy per unit mass $= \frac{1}{2}\omega^2 \text{x}^2$

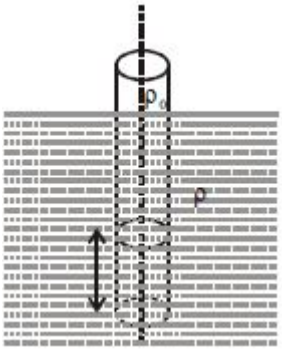
$8 \times 10^4 x^2$ erg. $= \frac{1}{2}\omega^2 x^2$

$\omega = 400$

total energy $= \frac{1}{2}\text{m}\omega^2\text{A}^2$

$\therefore A = 10\text{cm}$

**36.** A solid cylinder of density $\rho_0$, cross-section area $A$ and length $l$ floats in a liquid $\rho(>\rho_0)$ with its axis vertical, as shown. If it is slightly displaced downward and released, the time period will be




**A)** $2\pi\sqrt{\frac{l}{g}}$ **B)** $2\pi\sqrt{\frac{\rho_0 l}{\rho g}}$

**C)** $2\pi\sqrt{\frac{\rho l}{\rho_0 g}}$ **D)** $2\pi\sqrt{\frac{l}{2g}}$

**Solution : (Correct Answer: B )**

Let length of submerged part $= \mathrm{h}$

then $\mathrm{Ah}\rho = \mathrm{A}\ell\rho_0$

$\Rightarrow \mathrm{h} = \frac{\rho_0 \ell}{\rho}$

$\therefore \mathrm{T} = 2\pi\sqrt{\frac{\mathrm{h}}{\mathrm{g}}} \Rightarrow \mathrm{T} = 2\pi\sqrt{\frac{\rho_0 \ell}{\rho \mathrm{g}}}$

**37.** The potential energy of a simple harmonic oscillator at mean position is $2\,joules$. If its mean $K.E.$ is $4\,joules$, its total energy will be .... $J$

**A)** $7$ **B)** $8$ **C)** $10$ **D)** $11$

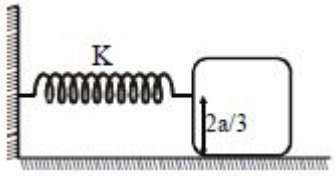
**Solution : (Correct Answer: C )**

Total energy $= \frac{1}{2}\mathrm{KA}^2 + \mathrm{U}_0$

$\mathrm{U}_0 = 2\mathrm{J}(\text{ given })$ and $\frac{1}{4}\mathrm{KA}^2 = 4\mathrm{J}$

So total energy $= 8 + 2 = 10\mathrm{J}$

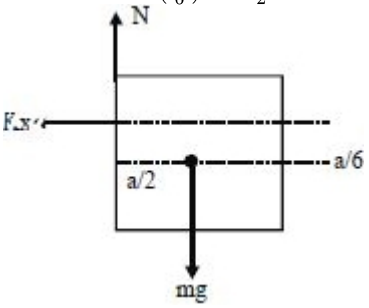
**38.** Find maximum amplitude for safe $SHM$ (block does not topple during $SHM$) of $a$ cubical block of side $'a'$ on a smooth horizontal floor as shown in figure (spring is massless)




**A)** $\frac{mg}{3K}$ **B)** $\frac{3mg}{K}$ **C)** $\frac{2mg}{3K}$ **D)** None

**Solution : (Correct Answer: B )**

$\tau = 0, \quad Kx\left(\frac{a}{6}\right) = \frac{Na}{2} \Rightarrow Kx\frac{a}{6} = mg\frac{a}{2} \Rightarrow x = \frac{3mg}{K}$




**39.** A particle of mass m is hanging vertically by an ideal spring of force constant K. If the mass is made to oscillate vertically, its total energy is

**A)** Maximum at extreme position
**B)** Maximum at mean position
**C)** Minimum at mean position
**D)** Same at all position

**Solution : (Correct Answer: D )**

(d)In simple harmonic motion, energy changes from kinetic to potential and potential to kinetic but the sum of two always remains constant.

**40.** Which of the following statements is not true ? In the case of a simple pendulum for small amplitudes the period of oscillation is

**A)** Directly proportional to square root of the length of the pendulum
**B)** Inversely proportional to the square root of the acceleration due to gravity
**C)** Dependent on the mass, size and material of the bob
**D)** Independent of the amplitude

**Solution : (Correct Answer: C )**

(c)

**41.** Which of the following is a necessary and sufficient condition for S.H.M.

**A)** Constant period
**B)** Constant acceleration
**C)** Proportionality between acceleration and displacement from equilibrium position
**D)** Proportionality between restoring force and displacement from equilibrium position

**Solution : (Correct Answer: D )**

(d)$F = -kx$

**42.** If speed of sound in air in $330\,m/s$ then, find the number of tones present in an open organ pipe of length $1\,m$ whose frequency if $\leq 1000$.

**A)** $2$ **B)** $4$ **C)** $8$ **D)** $6$

**Solution : (Correct Answer: D )**

The expression of fundamental frequency is given by.

$f = \frac{v}{2\ell}$

Substitute the values as,

$f = \frac{330}{2\times1}$

$= 165Hz$

Calculate the number of overtones allowed as,

$n = \frac{1000}{165}$

$= 6$

**43.** The number of possible natural oscillations of air column in a pipe closed at one end of length $85\ cm$ whose frequencies lie below $1250\ \ Hz$ are (Velocity of sound $= 340\ ms^{-1}$)

**A)** $4$ **B)** $5$ **C)** $6$ **D)** $7$

**Solution : (Correct Answer: C )**

Fundamental frequency of the closed organ pipe is

$v = \frac{v}{4L}$

Here, $v = 340\text{ms}^{-1}, L = 85\text{cm} = 0.85\text{m}$

$\therefore \quad v = \frac{340\text{ms}^{-1}}{4\times0.85\text{m}} = 100\text{Hz}$

The natural frequencies of the closed organ pipe will be

$v_n = (2n-1)v = v, 3v, 5v, 7v, 9v, 11v, 13v, ...$

$= 100\text{Hz}, 300\text{Hz}, 500\text{Hz}, 700\text{Hz}, 900\text{Hz}$

$1100\text{Hz}, 1300\text{Hz}, ...$ and so on

Thus, the natural frequencies lies below the $1250\text{Hz}$ is $6$.

**44.** $`SONAR'$ emits which of the following waves

**A)** Radio waves **B)** Ultrasonic waves
**C)** Light waves **D)** Magnetic waves

**Solution : (Correct Answer: B )**

$SONAR$ emits ultrasonic waves.

**45.** $Assertion$ : For a particle performing $SHM$, its speed decreases as it goes away from the mean position.
$Reason$ : In $SHM$, the acceleration is always opposite to the velocity of the particle.

**A)** If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
**B)** If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
**C)** If the Assertion is correct but Reason is incorrect.
**D)** If both the Assertion and Reason are incorrect.

**Solution : (Correct Answer: C )**

Speed $= \omega\sqrt{A^2 - x^2}$ as $|x|$ increases $\Rightarrow$ speed decreases Acceleration is in direction of speed as it comes towards mean position.