PHYSICS **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. A flat horizontal board moves up and down in SHM of amplitude A. Then the shortest permissible time period of the vibration, such that an object placed on the board may not lose contact with the board is

1) $2\pi\sqrt{\frac{g}{A}}$ **2)** $2\pi\sqrt{\frac{A}{g}}$ **3)** $2\pi\sqrt{g\times A}$ **4)** $\frac{1}{2\pi}\sqrt{\frac{g}{A}}$

2. The amplitude of a damped oscillator decreases to 0.9 times its original magnitude in 5 sec. In another 10 a it will decrease to α times its original magnitude, where α equals:

1) 0.7 **2)** 0.81 **3)** 0.729 **4)** 0.6

3. Two simple harmonic motions are represented by:

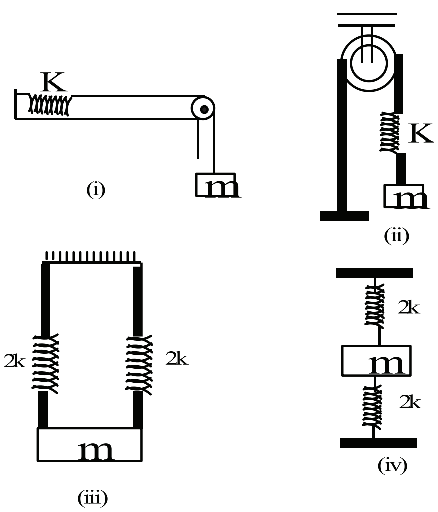
$y_1 = 10\sin\left(4\pi t+\frac{\pi}{4}\right)$ *and* $y_2 = 5\left(\sin 4\pi t+\sqrt{3}\cos 4\pi t\right)$. The ratio of the amplitudes of two SHM is

1) 1:1 **2)** 1:2 **3)** 2:1 **4)** $1:\sqrt{3}$

4. A 1Kg block is executing simple harmonic motion of amplitude 0.1 m on a smooth horizontal surface under the restoring force of a spring of spring constant 100N/m. A block of mass 3Kg is gently placed on it at the instant it passes through the mean position. Assuming that the two blocks move together, the amplitude of the motion is

1) 1cm **2)** 2cm **3)** 3cm **4)** 5cm

5. A block of mass m is suspended by different springs of force constant shown in figure. Let time period of oscillation in these four positions be T_1, T_2, T_3 *and* T_4. Then



1) $T_1 = T_2 = T_4$ **2)** $T_1 = T_2 \; and \; T_3 = T_4$

3) $T_1 = T_2 = T_3$ **4)** $T_1 = T_3 \; and \; T_2 = T_4$

6. Let T_1 & T_2 be the time periods of two springs A and B, when a mass m is suspended from them separately. Now both the springs are connected in parallel and same mass m is suspended with them. Now, let T be the time period in this position. Then

1) $T = T_1 + T_2$ **2)** $T = \dfrac{T_1 T_2}{T_1 + T_2}$

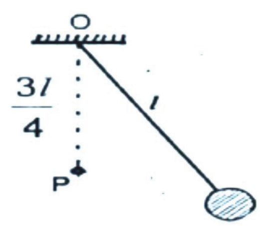
3) $T^2 = T_1^2 + T_2^2$ **4)** $\dfrac{1}{T^2} = \dfrac{1}{T_1^2} + \dfrac{1}{T_2^2}$

7. An accurate pendulum clock is mounted on the ground floor of high building. How much time will it lose or gain in one day, if it is transferred to top storey of a building which is h=200m higher than the ground floor. Radius of earth is $6.4 \times 10^6 m$

1) It will lose 6.2s **2)** It will lose 2.7s

3) It will gain 5.2s **4)** It will gain 1.6s

8. A pendulum has time period T for small oscillations. An obstacle P is situated below the point of suspension O at a distance $\dfrac{3l}{4}$. The pendulum is released from rest. Throughout the motion, the moving string makes small angle with vertical. Time after which the pendulum returns back to its initial position is



1) T **2)** $\dfrac{3T}{4}$ **3)** $\dfrac{3T}{5}$ **4)** $\dfrac{4T}{5}$

9. A particle executing SHM while moving from one extremity is found at distance $x_1, x_2 \; and \; x_3$ from the centre at the end of three successive seconds. The time period of oscillation is

1) $\dfrac{2\pi}{\cos^{-1}\left(\dfrac{x_1 + x_3}{2x_2}\right)}$ **2)** $\dfrac{\pi}{\cos^{-1}\left(\dfrac{x_1 + x_3}{2x_2}\right)}$

3) $\cos^{-1}\left(\dfrac{x_1 + x_3}{2x_2}\right)$ **4)** $\dfrac{\pi}{2\cos^{-1}\left(\dfrac{x_1 + x_3}{2x_2}\right)}$

10. A simple pendulum with length L and mass m of the bob is vibrating with an amplitude a. Then, the maximum tension in the string is :

1) mg **2)** $mg\left[1+\left(\frac{a}{L}\right)^2\right]$

3) $mg\left[1+\left(\frac{a}{2L}\right)^2\right]$ **4)** $mg\left[1-\left(\frac{3a}{L}\right)^2\right]$

11. A heavy brass sphere is hung from a spring and it executes vertical vibrations with period T. The sphere is now immersed in a non-viscous liquid with a density (1/10)th that of brass. When set into vertical vibrations with the sphere remaining inside liquid all the time, then the time period will be:

1) $\sqrt{9/10}T$ **2)** $\sqrt{10/9}T$ **3)** $(9/10)T$ **4)** Unchanged

12. The displacement x of a particle in motion is given in terms of time by $x(x-4)=1-5\cos\omega t$

1) The particle executes SHM
2) The particle executes oscillatory motion which is not SHM
3) The motion of the particle is nether oscillatory nor simple harmonic
4) The particle is not acted upon by a force when it is x=4

13. Two particles execute SHM of the same amplitude and frequency along the same straight line. If they pass one another when going in opposite directions, each time their displacement is half their amplitude; the phase difference between them is :

1) $\frac{\pi}{3}$ **2)** $\frac{\pi}{4}$ **3)** $\frac{\pi}{6}$ **4)** $\frac{2\pi}{3}$

14. One end of a long metallic wire of length L is tied to the ceiling. The other end is tied to a massless spring of spring constant K. A mass m hangs freely from the free end of the spring. The area of cross-section and young's modulus of the wire are A and Y respectively. The time period with which mass m will oscillate, if it is slightly pulled down and released is :

1) $T=2\pi\sqrt{\frac{mL}{YA}}$ **2)** $T=2\pi\sqrt{\frac{m}{k}}$

3) $T=2\pi\sqrt{\frac{k}{m}}$ **4)** $T=2\pi\sqrt{\frac{m(AY+KL)}{YAK}}$

15. The time period of a particle in simple harmonic motion is 8 seconds. At t=0, It is at the mean position. The ratio of the distances travelled by it in the first and second seconds is :

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

16. The period of oscillation of a simple pendulum of length l suspended from the roof of the vehicle which moves down without friction on an inclined plane of inclination α, is given by:

1) $2\pi\sqrt{\frac{l}{g\cos\alpha}}$ **2)** $2\pi\sqrt{\frac{l}{g}}$ **3)** $2\pi\sqrt{\frac{l}{g\sin\alpha}}$ **4)** $2\pi\sqrt{\frac{l}{g\tan\alpha}}$

17. A particle of mass m is located at a place where it is acted upon by a one dimensional conservative force and its potential energy is given by:
$U(x)=A(1-\cos px)$, where A and p are constants. The period of small oscillations of the particle is :

1) $2\pi\sqrt{\frac{m}{(Ap)}}$ **2)** $2\pi\sqrt{\frac{m}{(Ap^2)}}$ **3)** $2\pi\sqrt{\frac{m}{A}}$ **4)** $\frac{1}{2\pi}\sqrt{\frac{Ap}{m}}$

18. A pendulum with time period of 1s is losing energy. At certain time its energy is 45J. If after completing 15 osillations, its energy has become 15J, its damping constant is:

1) $\frac{1}{2}$ **2)** $\frac{1}{30}In3$ **3)** 2 **4)** $\frac{1}{15}In3$

19. Spherical solid ball of volume V is made of a material of density ρ_1, partially immersed in a liquid of density $\rho_2(\rho_2<\rho_1)$. Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed υ. The ball is slightly pushed down from equilibrium position and released.
I) Ball describes oscillatory motion with varying amplitude
II) Ball describes oscillatory motion with constant amplitude
III) Ball may not oscillate
IV) Time taken to complete successive oscillations remains constant
V) Time taken to complete successive oscillations varies
VI) Oscillatory energy varies with time
The number of statements that are correct?

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

20. A horizontal spring-block system of mass 2Kg executes. S.H.M. When the block is passing through its equilibrium position, an object of mass 1kg is put on it and the two move together. The new amplitude of vibration is (A being its initial amplitude):

1) $\sqrt{\frac{2}{3}}A$ **2)** $\sqrt{\frac{3}{2}}A$ **3)** $\sqrt{2}A$ **4)** $\frac{A}{\sqrt{2}}$

(NUMERICAL VALUE TYPE)

This section contains 10 questions. Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, 0.33, 30, 30.27, 127.30).
Attempt any five questions out of 10.
Marking scheme: +4 for correct answer, 0 if not attempted and 0 in all other cases.

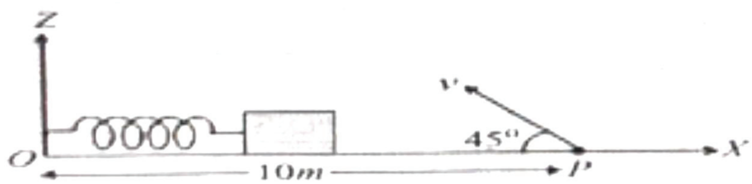
21. The motion of a particle is described by $9\frac{d^2x}{dt^2}+25x=80$. Where x is displacement and t is time. Angular frequency of small oscillations is $\left(rads^{-1}\right)$

22. The amplitude of an oscillating particle subjected to two SHMs $\sin\omega t \;\; and \;\; \sin(\omega t+\pi/3)$ along the same direction is

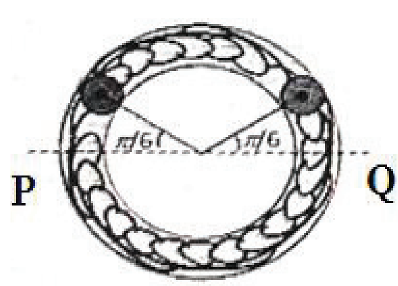
23. A body executing simple harmonic motion has a maximum acceleration equal to 24m s^{-2} and maximum velocity of 16 ms^{-1}, the amplitude of the simple harmonic motion is - - - - m.

24. A small block is connected to one end of a massless spring of un-stretched length 4.9m. The other end of the spring (see the figure) is fixed. The system lies on a horizontal frictionless surface. The block is stretched by 0.2m and released from rest at t= 0. It then executes harmonic motion with angular frequency $\omega=\frac{\pi}{3}rad/s$.

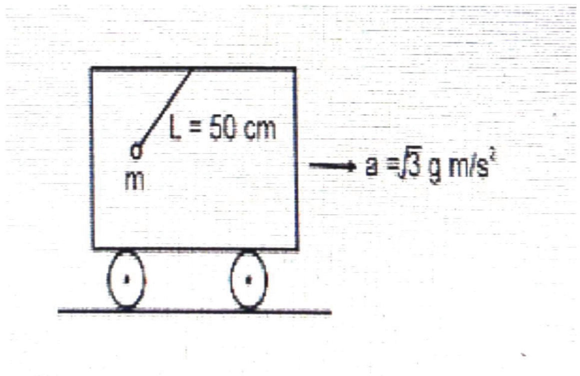
Simultaneously at t=0, a small pebble is projected with speed 'v'(m/s) from point p is at angle of $45°$ as shown in the figure. Point p is at a horizontal distance of 10 m from 0. If the pebble hits the block at t = 1s, the value of v is (take g = $10m/s^2$)



25. Two identical balls A and B each of mass 0.1 kg are attached to two identical massless springs. The spring mass system is constrained to move inside a rigid smooth pipe bent in the form of circle as shown in the figure. The pipe is fixed in a horizontal plane. The centres of the balls can move in a circle of radius 0.06 m. Each spring has a natural length of 0.06π m and force constant 0.1N/m. Initially both the balls are displaced by a angle $\theta=\pi/6$ radian with respect to the diameter PQ of the circle and released from rest. The time period of oscillation of the ball B is……. Hz. $(\pi=3.14)$



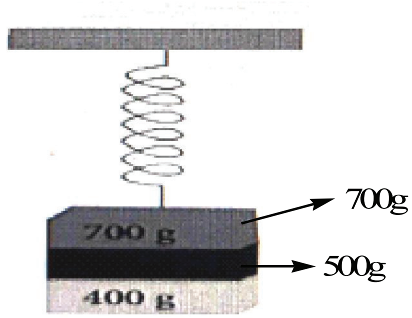
26. A simple pendulum 50cm long is suspended from the roof of a cart accelerating in the horizontal direction with constant acceleration $\sqrt{3}gm/s^2$. The period of small oscillations of the pendulum about its equilibrium position is…….. second. $(g = \pi^2 m/s^2)$:



27. A ring of diameter 2m oscillates as a physical pendulum about a horizontal axis passing though a point at its rim. It oscillates such that its centre move in a plane which is perpendicular to the plane of the ring. The equivalent length of the simple pendulum is……m

28. A 25kg uniform solid sphere with a 20cm radius is suspended by a vertical wire such that the point of suspension is vertically above the centre of the sphere. A torque of 0. 10N-m is required to rotate the sphere though an angle of 1.0 radian and then maintains the orientation (so that the wire gets twisted). If the sphere is then released from this orientation , its time period of the oscillation will be…… second

29. Three masses 700g, 500g and 400g are suspended at the end of a spring and are in equilibrium as shown in figure. When the 700g mass is removed, the system oscillates with a period of 3 seconds; When the 500g mass is also removed, it will oscillate with a period of …… second



30. A forced oscillator is acted upon by a force $F = F_0 \sin \omega t$. The amplitude of oscillation is given by $\frac{55}{\sqrt{2\omega^2 - 36\omega + 9}}$. The resonant angular frequency is:

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ICON Central Office – Madhapur – Hyderabad

Sec: **Sr.Super60**	**Jee-Main**	Date:08-01-2022
Time: 09.00Am to 12.00	**PTM-17**	Max.Marks:300

Key Sheet

PHYSICS

1	B	2	C	3	A	4	D	5	B
6	D	7	B	8	B	9	A	10	B
11	D	12	A	13	D	14	D	15	C
16	A	17	B	18	D	19	C	20	A
21	1.66 to 1.67	22	1.73	23	10.66 to 1067	24	7.07	25	3.14
26	1.00	27	1.50	28	12.56	29	2.00	30	9.00

CHEMISTRY

31	C	32	C	33	B	34	D	35	C
36	C	37	B	38	D	39	A	40	B
41	D	42	A	43	A	44	C	45	D
46	D	47	D	48	A	49	B	50	A
51	450	52	213.00	53	-4988.4	54	42	55	1.50
56	38.29	57	8.00	58	10.00	59	-9.11	60	-2035.00

MATHEMATICS

61	C	62	D	63	A	64	D	65	B
66	A	67	A	68	B	69	A	70	C
71	B	72	A	73	B	74	D	75	A
76	A	77	C	78	B	79	D	80	A
81	2.00	82	45	83	11.0	84	0.00	85	3.00
86	5.00	87	40.00	88	3.00	89	6.00	90	20.00

SOLUTIONS

PHYSICS

1. $a=-\omega^2 A,\ g=-\omega^2 A,\ \omega=\sqrt{g/A}$

2. $A=A_0 e^{-\frac{bt}{2m}}$

3. $A_1=10,\ A_2=\sqrt{5^2+\left(5\sqrt{3}\right)^2}=10$

4. $V_0=A_0\omega=0.1\sqrt{\frac{100}{1}}=1ms^{-1}$

$V_0=(1+3)V$

$\frac{4V^2}{2}=\frac{kA^2}{2}$

5. Effective spring constant in i), ii), iii), iv) are k, k, 4k, 4k

6. $T_1=2\pi\sqrt{\frac{m}{k_1}},\ T_2=2\pi\sqrt{\frac{m}{k_2}},\quad T=2\pi\sqrt{\frac{m}{k_1+k_2}}$

7. $g'=g\left(1-\frac{2h}{R}\right)$

$\Delta T=\frac{T}{2}\left(\frac{\Delta g}{g}\right)$

8. $T_1=2\pi\sqrt{\frac{l}{g}},\ T_2=2\pi\sqrt{\frac{\frac{l}{4}}{g}}$

$t=\frac{T_1}{2}+\frac{T_2}{2}$

9. $x_1=A\cos\omega,\ x_2=A\cos 2\omega,\ \ x_3=A\cos 3\omega$

10. $\frac{mv^2}{2}=mgl(1-\cos\theta)$

$T-mg=\frac{mv^2}{l}$

$\cos\theta=1-\frac{\theta^2}{2}$

$\theta=\frac{a}{L}$

11. Restoring force remains constant

12. $x^2-4x=1-5\cos\omega t$

$x=2\pm 2\sqrt{10}\sin\left(\frac{\omega t}{2}\right)$

13. Conceptual

14. Conceptual

15. Conceptual

16. $T = 2\pi\sqrt{\dfrac{l}{g_{eff}}}$

17. $F = -\dfrac{du}{dx}$

$a = \dfrac{f}{M}$

18. $A = A_0 e^{-\frac{bt}{2m}}$

19. Conceptual

20. $(m_1 + m_2)V = m_1 v_0$

$\dfrac{1}{2}(m_1 + m_2)v^2 = \dfrac{KA^2}{2}$

21. $a = -\omega^2 x$

22. $A_R = 1^2 + 1^2 + 2(1)(1)\cos 60^0$

23. Maximum acceleration is given by

$= a\omega^2 = 24 ms^{-2}$ ....(i)

Maximum velocity = $a\omega = 16 ms^{-2}$ ....(ii)

Dividing Eq. (i) by Eq. (ii)

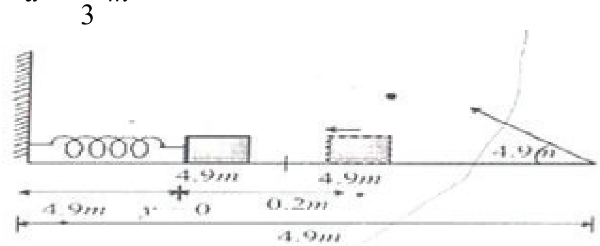
$\dfrac{a\omega^2}{a\omega} = \omega = \dfrac{24}{16} = \dfrac{6}{4} = \dfrac{3}{2}$

Now putting the value of ω in Eq. (ii) We get

$a \times \dfrac{3}{2} = 16$

$a = \dfrac{32}{3} m$

24.



The block is released from A x = 4.9m + (0.2m) sin $\left(\omega t + \dfrac{\pi}{2}\right)$

At t = 1s;x = 5m

So range of projectile will be 5m

Now $5 = \dfrac{v^2 \sin 90°}{g} \Rightarrow v^2 = 50 \Rightarrow v = \sqrt{50}$

25. As here two masses are connected by two springs, this problem is equivalent to the oscillation of a reduced mass m_r of a spring of effective spring constant

$T = 2\pi\sqrt{\dfrac{m_r}{K_{eff.}}}$

Here $m_r = \dfrac{m_1 m_2}{m_1 + m_2} = \dfrac{m}{2} \Rightarrow K_{eff.} = k_1 + k_2 = 2k$

$\therefore n=\frac{1}{2\pi}\sqrt{\frac{K_{eff}}{m_r}}=\frac{1}{2\pi}\sqrt{\frac{2k}{m}\times 2}=\frac{1}{\pi}\sqrt{\frac{0.1}{0.1}}=\frac{1}{\pi}HZ$

26. Conceptual

27. Conceptual

28. $\tau=k\theta,\quad T=2\pi\sqrt{I/K}$

29. When mass 700g is removed , the left out mass 500+400) g oscillates with a period of 3 sec.

Therefore, 3= t

$=2\pi\sqrt{\frac{(500+400)}{k}}$ ...(i)

When 500g mass is also removed, the left out mass is 400g.

Therefore,

$t=2\pi\sqrt{\frac{400}{k}}$ ...(ii)

Dividing equation (i) by (ii), we get

$\frac{3}{t'}=\sqrt{\frac{900}{400}},\qquad t'=2s$

30. At resonance, amplitude of oscillation is maximum,

$\Rightarrow 2\omega^2-36\omega+9$ is minimum

$\Rightarrow 4\omega-36=0$ (derivative is zero)

$\Rightarrow \omega=9$

CHEMISTRY

31. The reaction is:

$\frac{1}{2}I_2(s)+\frac{1}{2}cl_2(g)\rightarrow ICI(g)$

$\Delta_f H_{1-cl}=[\frac{1}{2}\Delta H_{I_2(s)\rightarrow I_{2(g)}}+\frac{1}{2}\Delta H_{I-I}+\frac{1}{2}\Delta H_{Cl-Cl}]-[\Delta H_{I-cl}]$

$=[\frac{1}{2}\times 62.76+\frac{1}{2}\times 151+\frac{1}{2}\times 242.3]-[211.3]$

$=16.73\ KJ\ mol^{-1}]$

32. $C_6H_{12}O_6(s)+6O_2(g)\rightarrow 6CO_2(g)+6H_2O(l)$

$\Delta H=[6\Delta_f H_{CO_2}+6\Delta_f H_{H_2O}]-[\Delta_f H_{c_6H_{12}o_6}+6\Delta_f H_{o_2}]$

$=[6(-400)+6(-300)]-[-1300+0]$

$=-4200+1300=-2900KJ/mol$

Enthalpy of combustion per gram = $\frac{-2900}{180}=-16.11KJ/g]$

33. At equilibrium , $H_2O(l)\rightleftharpoons H_2O(g)\quad (1atm, 100°C)$

$\Delta S_{total}=0$

i.e., $\Delta S_{system}+\Delta S_{surrounding}=0$

$\therefore\quad \Delta s_{system}>0\ and\ \Delta S_{suroundings}<0]$

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08-01-2022_Sr.Super60_Jee-Main_PTM-17 Final Key

S.NO	SUB	Q.NO	GIVEN KEY	FINALIZED KEY	EXPLANATION
1	PHY	2	3	1 or 3	Amplitude is found out experimentally, so as 0.9 has significant figure, 0.729 should be reported as 0.7
2	PHY	18	4	Delete	No clarity in question whether asking b (or) b/2m units not given
3	PHY	19	3	Delete	Body oscillates only if $\rho_2 > \rho_1$, but given is $\rho_1 > \rho_2$. Only III is correct
4	PHY	28	12.56	12.56 or 1.26	Both are possible
5	CHE	51	450	150	Given expanded so temperature decreases
6	CHE	54	42	–42	Exothermic reach $\Delta H = -ve$
7	CHE	55	1.50	Delete	In an adiabatic process, pressure can't be constant with $T \propto \frac{1}{\sqrt{V}}$
8	CHE	56	38.29	38.19 to 38.39	Range should be given
9	CHE	58	10.00	530 to 535	Exact answer is (531.45)
10	MAT	81	2.00	1.00	Calculation error

Question Paper Setters is **Total responsible** for the Key finalization

Q.P Setters / Verifiers HYD_NKT IPL/HYD_HYD_NKT IPL

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