PHYSICS **Max. Marks: 61**

SECTION – I

(MULTIPLE CORRECT ANSWER TYPE)

This section contains 6 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE than ONE** option can be correct.

Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases.

1. A body of mass m is attached to a spring of spring constant k which hangs from the ceiling of an elevator at rest in equilibrium. Now the elevator starts accelerating upwards with its acceleration a varying with time as $a = pt + q$, where p and q are finite positive constants. In the frame of elevator

A. The block will perform S H M for all value of p and q

B. The block will not perform S H M in general for all value of p and q expect p = 0

C. The block will perform S H M in general for all value of p and q expect p = 0

D. The velocity of the block will vary simple harmonically for all value of p and q

2. The potential energy of a particle of mass 2kg moving along the x-axis is given by $U(x) = 16(x^2 - 2x)$ joule. Its velocity at x = 1 m is 2m/s. Then :

A. The particle is moving in uniformly accelerated motion

B. The particle describes oscillatory motion between $x_1 = 0.5m$ to $x_2 = 1.5m$

C. The particle executes simple harmonic motion

D. The period of oscillation of the particle is $\pi / 2$ second

3. Two simple harmonic motions are represented by the equations $y_1 = 3(\sqrt{3}\cos 3\pi t + \sin 3\pi t)$ and $y_2 = 6\sin(6\pi t + \pi / 6)$,having amplitude A_1 and A_2 ,maximum velocities V_1 and V_2 respectively then;

A. The ratio A_1 / A_2 of their amplitude is ½

B. The ratio A_1 / A_2 of their amplitude is 1

C. The ratio V_1 / V_2 of their maximum velocities is ½

D. The ratio V_1 / V_2 of their maximum velocities is 2

4. A block is placed on a horizontal plank. The plank is performing SHM along a vertical line with amplitude of 40cm. The block just loses contact with the plank when the plank is momentarily at rest. Then (acceleration due to gravity = $10\,m/s^2$)
(consider vertical line is parallel to the gravity)

A. The period of its oscillation is $2\pi/5\,\text{sec}$.

B. The normal reaction due to the block on the plank is double the block's weight, when the plank is at one of the positions of momentary rest

C. The normal reaction due to the block on the plank is 1.5 times the block's weight, when the plank is halfway down from the mean position

D. The normal reaction due to the block on the plank is equal the block's weight, when velocity of the plank is maximum

5. A body of mass m is in a field where its potential energy is given by $U = ax^3 + bx^4$, where a and b are positive constants. Then, [consider the body moves only along x direction]

A. $x = 0$ is a point of equilibrium

B. $x = \dfrac{-3a}{4b}$ is a point of stable equilibrium

C. $x = \dfrac{-3a}{4b}$ is a point of unstable equilibrium

D. for small displacement from stable equilibrium position the body executes shm with angular frequency $\dfrac{3a}{2\sqrt{bm}}$

6. A particle of mass m moves in a straight line. If v is the velocity at a distance x from a fixed point on the line and $v^2 = a - bx^2$, where a and b are positive constants, then : (Assume potential energy at mean position is zero)

A. The particle moves only along the positive x-direction during its entire motion

B. The motion of the particle is simple harmonic

C. The particle oscillates with a frequency equal to $\dfrac{\sqrt{b}}{2\pi}$

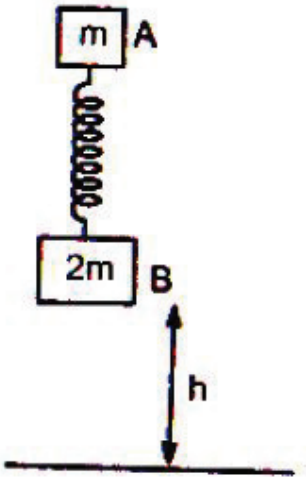
D. The total energy of the particle is ma

SECTION-II

(NUMERICAL VALUE TYPE)

This section contains 8 questions. Each question is numerical value. 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).
Marking scheme +3 for correct answer , 0 if not attempted and 0 in all other cases.

7. From what minimum height h (in m) must the system be released when spring is unstretched so that after perfectly inelastic collision (e = 0) with ground, B may be lifted off the ground: (spring constant = k)



Given $m = 1kg$, $g = 10m/s^2$ and $k = 100N/m$

8. Two particles execute SHM of the same amplitude and same frequency along the same straight line. If they cross each other while going in opposite directions, each time their displacement is half their amplitude, then the phase difference between them in radian is: (take $\pi = 3.14$)

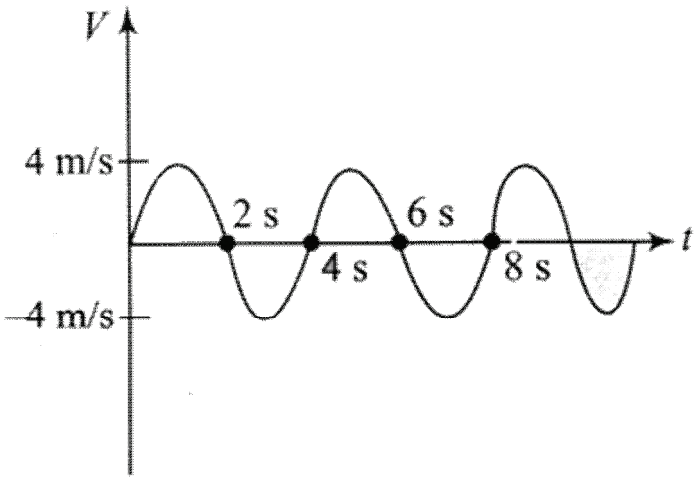
9. The time-period of particle in simple harmonic motion is 8 seconds. At t=0, it is at the mean position. The ratio of the distances travelled by it in the first and second second respectively is : (take = $\sqrt{2} = 1.41$)

10. 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 of the particle is …..

11. Two particles P and Q are oscillating along lines parallel to x-axis, both with their respective mean positions at x = 0 and extreme positions at $\pm A$. Both have same time – period T. At t=0, particle P is $x=-\frac{A}{2}$ moving along negative x direction and Q is $+\frac{A}{\sqrt{2}}$ and moving along positive x direction. Minimum time after t =0, when the two particles have same x position is $\frac{T}{n}$. Find 'n'

12. A particle oscillation is SHM along x- axis has its mean position at x = 2cm and has an amplitude a = 4cm. At t = 0, the particle is at origin and moving along positive x direction with a velocity 1 cm/s. The equation describing the SHM is $x=2+4\sin(\omega t-\phi)$ where x is in cm, ω is in rad /s and ϕ is in rad. Find the ratio $\frac{\phi}{\omega}$ is 's'. (Take $\pi=3.14$ and $\sqrt{3}=1.73$)

13. If velocity of a particle moving along a straight-line changes sinusoidally with time as shown in the graph. The average speed over time interval t=0 to t=2(2n-1) seconds; (n being any positive integer) is $\frac{k}{\pi}$ m/s . Find the value of k



14. A particle executes SHM along a straight line parallel to x-axis with mean position at x=0, having time period 20s and amplitude 5cm. find the shortest time taken (in seconds) by the particle to go from $x=4cm$ to $x=-3cm$:

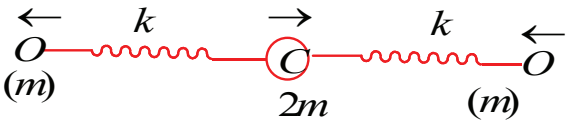
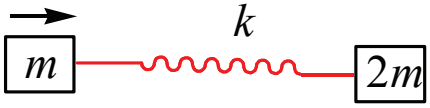
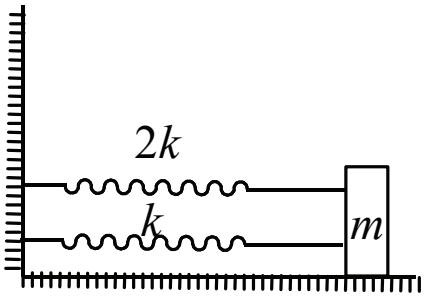
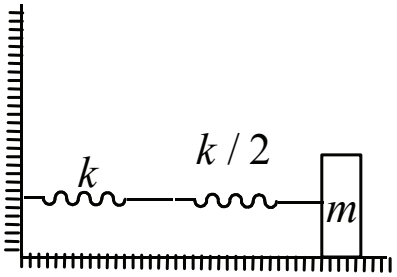
SECTION-III

(MATCHING LIST TYPE)

This section contains 4 questions, each having two matching lists (List-1 & List-II). The options for the correct match are provided as (A), (B),(C) and (D) out of which **ONLY ONE** is correct.

Marking scheme: +3 for correct answer, 0 if not attempted and -1 in all other cases.

15. Column – I list the various modes of oscillations of masses connected to springs.
Column – II lists the corresponding frequencies
Match them properly

Column-I		**Column-II**	
i)		**P.**	$\frac{1}{2\pi}\sqrt{\frac{3k}{2m}}$
ii)		**Q.**	$\frac{1}{2\pi}\sqrt{\frac{2k}{m}}$
iii)		**R.**	$\frac{1}{2\pi}\sqrt{\frac{k}{3m}}$
IV)		**S.**	$\frac{1}{2\pi}\sqrt{\frac{3k}{m}}$

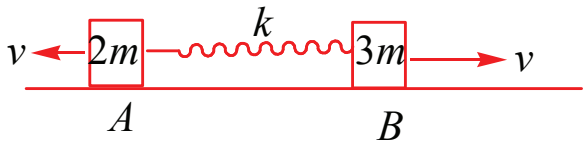
A. i-q; ii-r; iii-s; iv-p

B. i-p; ii-r; iii-s; iv-q

C. i-q; ii-p; iii-s; iv-r

D. i-r; ii-s; iii-p; iv-q

16. Two blocks A and B of masses 2m and 3m placed on smooth horizontal surface are connected with a light spring. The two blocks are given velocities as shown when spring is at natural length



Column-I	Column-II
i) minimum magnitude of velocity of $A(v_{A_{mn}})$ during the motion	**P.** v
ii) maximum magnitude of velocity of $A(v_{A_{mn}})$ during the motion	**Q.** $\frac{v}{5}$
iii) maximum magnitude of velocity of $B(v_{B_{mn}})$ during the motion	**R.** 0
IV) velocity of center of mass (v_{CM}) of the system comprised of blocks A, B and spring	**S.** $\frac{7v}{5}$

A. i-r; ii-s; iii-p; iv-q **B.** i-r; ii-p; iii-r; iv-s

C. i-s; ii-r; iii-q; iv-q **D.** i-p; ii-q; iii-p; iv-s

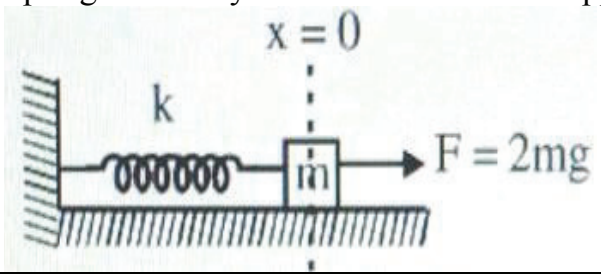
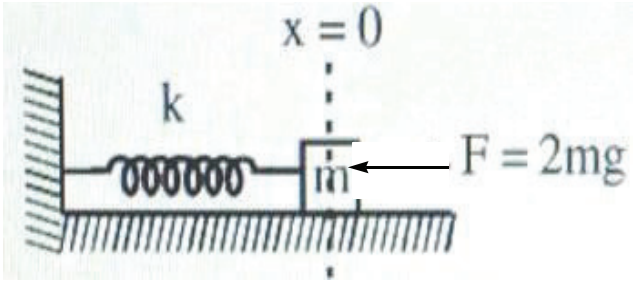
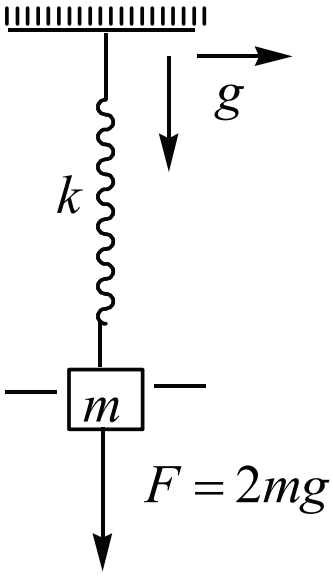
17. Two points P and Q oscillating in SHM along X-axis have time periods T and 4T respectively. Both have x=0 as mean position and x=∓A as extreme position. At t=0 both of them are at positive extreme position.

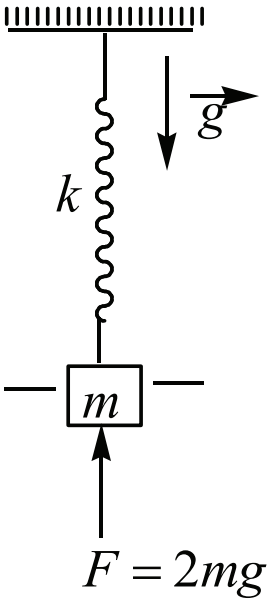
Column I	Column II
i) minimum time after t=0 when they are again in phase	p) 4T
ii) minimum time after t=0 when they are again at same position	q) 2T/3
iii) minimum time after t=0 when they are out of phase	r) 4T/5
iv) minimum time after t=0 when they again meet at positive extreme position	s) 4T/3

A. i- s, ii-r, iii-q, iv-p **B.** i- r, ii-s, iii-q, iv-p

C. i- s, ii-p, iii-q, iv-p **D.** i- s, ii-r, iii-p, iv-q

18. Column-I shows spring block system with a constant force permanently acting on block match entries of column I with column II (assume initial kinetic energy of the block is zero)

	Column-I		Column-II
I	Spring is initially relaxed when force is applied 	p	Time period of oscillation $T = 2\pi\sqrt{\frac{m}{k}}$
Ii	Spring is initially relaxed when force is applied 	q	Amplitude of oscillation is $A = \frac{2mg}{k}$
Iii	Before force is applied block is in equilibrium position 	r	maximum velocity attained by block is $2g\left[\sqrt{\frac{m}{k}}\right]$

iv	when force is applied block is in equilibrium position 	**s**	maximum magnitude of acceleration of block is 2g
		t	Velocity of block when spring is in a natural length is zero.

A. i-pqrst; ii-pqrst; iii-pqrs; iv-pqrs
B. i-pq; ii-rs; iii-pqrs; iv-t
C. i-rs; ii-pq; iii-pqt; iv-pt
D. i-pqst; ii-pqrst; iii-pqr; iv-qt

Sri Chaitanya IIT Academy., India.

AP, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

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ICON Central Office , Madhapur – Hyderabad

Sec: Jr.Super60	WTA-22	Date: 03-01-21
Time: 10:20Am to 01:20Pm	2018_P2	Max.Marks: 180

KEY SHEET

PHYSICS

1	**BD**	2	**BCD**	3	**BC**	4	**ABCD**	5	**ABD**
6	**BC**	7	**0.40**	8	**2.09**	9	**2.41**	10	**1.66 to 1.67**
11	**2.52**	12	**1.80 to 1.82**	13	**8.00**	14	**5.00**	15	**C**
16	**A**	17	**A**	18	**A**				

CHEMISTRY

19	**ABCD**	20	**BC**	21	**ABD**	22	**ABCD**	23	**BC**
24	**CD**	25	**4**	26	**4**	27	**4**	28	**8**
29	**6**	30	**3**	31	**4**	32	**5**	33	**C**
34	**D**	35	**B**	36	**C**				

MATHS

37	**ABC**	38	**AB**	39	**BD**	40	**BC**	41	**BCD**
42	**CD**	43	**3**	44	**8**	45	**7**	46	**2**
47	**8**	48	**3**	49	**0**	50	**1**	51	**B**
52	**D**	53	**C**	54	**D**				

SOLUTIONS

PHYSICS

01. Let x be elongation in the spring then $mg + mpt + mq - kx = mq$ where a' is acceleration of block in elevator frame

So $a' = g + q - (k/m)x + Pt$

$\because$ oscillation will be SHM only if P = 0 However $\frac{da'}{dt} = -\frac{k}{m}v + P$. So v is in SHM, for all values of P and q

02. $F = \frac{-\partial u}{\partial x} = -32x + 32$

So $a = -16x + 16 = -16(x-1)$

So $w^2 = 16 \Rightarrow T = \frac{\pi}{2}s$

Also $u(x=1) = -16J$

And $k(x=1) = 4J$

$E = -12J$

Mean position is $x_0 = 1$

$E = -12J$

$A \times w = 2 \Rightarrow A = 0.5m$

So particle oscillating between 0.5m to 1.5m

03. $y_1 = 3\sqrt{3}\cos(3\pi t) + 3\sin(3\pi t) = 6\sin(3\pi t + \pi/3)$

$y_1 = 3\sqrt{3}\cos(3\pi t) + 3\sin(3\pi t) = 6\sin(3\pi t + \pi/3)$

So $\frac{A_1}{A_2} = 1, \frac{v_1}{v_2} = \frac{1}{2}$

04. $w^2 A = g \Rightarrow w = \sqrt{g/A} = 5rad/s$

So $T = \frac{2\pi}{5}s$

The block loses contact at the upper extreme position. So at the upper extreme position N = 0.At the lower extreme.

$N = m(g+a) = 2mg$

Similarly C and D are also correct

05. $F = -\frac{du}{dx} = -(3ax^2 + 4bx^3)$

$3ax^2 + 4bx^3 = 0$

$\Rightarrow x = 0$ or $x = -\frac{3a}{4b}$

$\frac{d^2u}{dx^2} = 6ax + 12bx^2$

So $x = \frac{-3a}{4b}$ is stable equilibrium

$\frac{df}{dx} = -6ax - 12bx^2$

$-6ax - \frac{3a}{4b} - 12b \times \frac{9a^2}{16b^2}$

$= \frac{9}{2}\frac{a^2}{b} - \frac{27}{4}\frac{a^2}{b} = -\frac{9}{4}\frac{a^2}{b}$

So $\frac{dF}{m} = -\frac{9}{4}\frac{a^2}{bm}dx$ so $w = \frac{3a}{2\sqrt{bm}}$

06. $2v\frac{dv}{dx} = -2bx \Rightarrow a = -bx$

So $w = \sqrt{b}$ and $f = \frac{\sqrt{b}}{2\pi}$

Total energy $= \frac{ma}{2}$

07. At the time of collision with group $v = \sqrt{2gh}$

Assuming block A oscillates, after that

$2gh = \frac{k}{m}(A^2 - \frac{m^2g^2}{n^2})$

For block to be lifted

$A \geq \frac{3m^2g}{k}$

So, $\frac{2mgh}{k} = \frac{8m^2g^2}{k^2} \Rightarrow h = \frac{4mg}{k} = \frac{40}{100} = 0.4m$

08. **2.09**

$\phi = \frac{2\pi}{3}$

09. **2.41**

$x = A\sin\omega t$

10. $\frac{d^2x}{dt^2} = \frac{80}{9} - \frac{25}{9}x$

$\omega = \frac{5}{3}$

11. use phasor diagram

12. at $t = 0$, $x = 0$

So $\phi = \frac{\pi}{6}$

$v = 4\omega \cos\left(\omega t - \pi/6\right)$

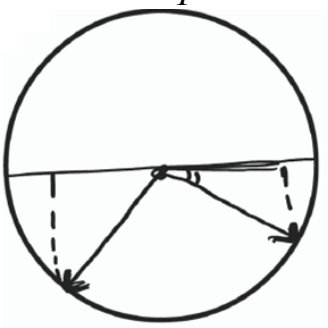
at $t = 0$, $4\omega \times \frac{\sqrt{3}}{2} = 1$ cm/s

$\Rightarrow \omega = \frac{1}{2\sqrt{3}}$

So $\frac{\phi}{\omega} = \frac{\pi}{6} \times 2\sqrt{3} = \frac{\pi}{\sqrt{3}}$

13. $v_{avg} = \frac{2v_0}{\pi}$

14. $\frac{\pi}{2 \times w} = \frac{\pi}{2 \times \frac{2\pi}{T}} = \frac{T}{4} = 5s$



15. **C**

16. **A**

In Center of mass for frame it is an oscillating system

17. **A**

Use phasor diagram

18. **A**

CHEMISTRY

19. Metal cation decreases electron density in alkynes

20.

$$2HC \equiv CH \xrightarrow[NH_4Cl]{CH_2Cl_2} H_2C = CH - C \equiv CH \xrightarrow{HCl} H_2C = CH - \underset{\displaystyle Cl}{\underset{|}{C}} = CH_2$$

2-chloro.1,3-butadiene

21. $HC \equiv CH + NaOH \rightarrow$ **no reaction**

$$H_3C - C \equiv C - CH_3 + NaNH_2 \rightarrow H_3C - CH_2 - C \equiv CH \xrightarrow{NaNH_2} H_3C - CH_2 - C \equiv CNa^+ + NH_3$$

22.

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03-01-2021_Jr.Super60_Jee-Adv(2018-P2)_WTA-22_Final Key

S.NO	SUB	Q.NO	GIVEN KEY	FINALIZED KEY	EXPLANATION
1	PHY	9	2.41	2.41 to 2.44	Range should be given
2	PHY	11	2.52	2.52 to 2.53	Range required
3	CHE	19	ABCD	Delete	Wrong concept
4	CHE	22	ABCD	AC	B, D are not possible
5	CHE	29	6	7	Diels-Alder Reaction Concept
6	CHE	31	4	3	Y is $CH_3-C\equiv C-\overset{\overset{CH_3}{\mid}}{C}=CH_2$, having DOU is 3
7	MAT	40	BC	B	C is not possible
8	MAT	50	1	1 or 2 or 3	it should be '2b' instead of b
9	MAT	52	D	Delete**(Online)**	Online options are mismatch

Question Paper Setter is **Total responsible** for the Key finalization**:**

Question Paper Setters &finalized		
MATHS	**PHYSICS**	**CHEMISTRY**
VSP_ICON Mr. KIRAN KUMAR-9740940008	VSP_ICON Mr. PANDA-7306537807	VSP_ICON Mr. MURTHY-9948970932
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