PHYSICS Max Marks: 62

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

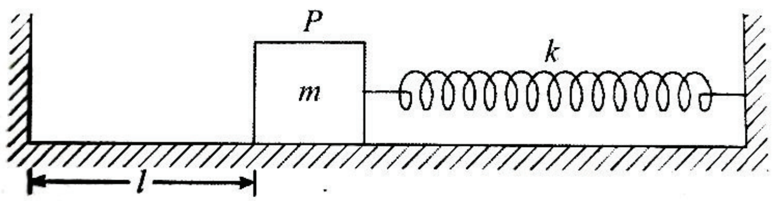
This section contains 4 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

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

Section 1 (Max Marks: 12)

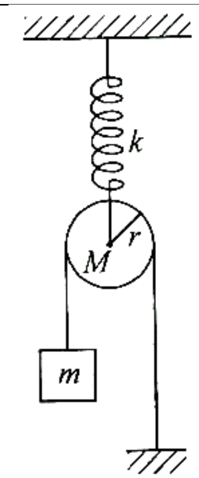
- Section 1 contains Four questions
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate Answer to each question will be :
  Full Marks: +**3** (If the answer is correct)
  Zero Marks: **0** (If the question is unanswered)
  Negative Marks: -1 (In all other cases)

1. Figure shows a block P of mass M resting on a horizontal smooth floor at a distance l from a rigid wall. Block is pushed toward right by a distance $3l/2$ and released, when block passes from its mean position another block of mass m_1 is placed on it which sticks to it due to friction. Find the value of m_1 so that the combined block just collides with the left wall.



A) $2m$ **B)** $\frac{5m}{4}$ **C)** $\frac{m}{2}$ **D)** $\frac{m}{4}$

2. The cord is light and inextensible in the spring-mass pulley system as in figure. Find the frequency of vibration if the mass m is displaced slightly and released. Assume that cord does not slip over pulley.



A) $\sqrt{\dfrac{k}{m+M}}$ B) $\sqrt{\dfrac{k}{2m+\dfrac{M}{2}}}$

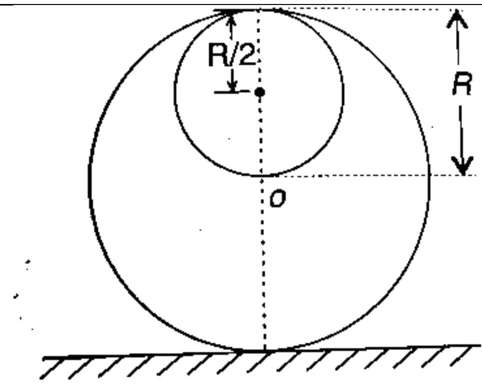
C) $\sqrt{\dfrac{k}{m+4M}}$ D) $\sqrt{\dfrac{k}{4m+\dfrac{3M}{2}}}$

3. A simple pendulum has a bob of mass m and it is oscillating with a small angular amplitude of θ_0. Calculate the average tension in the string averaged over one time period. [For small θ take $\cos\theta \simeq 1-\dfrac{\theta^2}{2}$]

A) $\dfrac{mg}{2}$ B) $mg+\dfrac{1}{2}mg\theta_0^2$

C) $mg+\dfrac{1}{4}mg\theta_0^2$ D) $\dfrac{mg\left(1+\theta_0^2\right)}{2}$

4. A spherical cavity of radius $\dfrac{R}{2}$ is removed from a solid sphere of radius R as shown in figure. The sphere is placed on a rough horizontal surface as shown. The sphere is given a gentle push. Friction is large enough to prevent slippage. Find the time period.



A) $2\pi\sqrt{\frac{177R}{10g}}$ **B)** $2\pi\sqrt{\frac{74}{5g}}$ **C)** $2\pi\sqrt{\frac{147}{4g}}$ **D)** $2\pi\sqrt{\frac{125}{4g}}$

SECTION – II
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains 8 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 -1 in all wrong cases

Section 2 (Max Marks: 32)

- Section two contains Eight (8) questions
- Each Question has Four Options and One Or More Than One of these four will be the correct answer.
- For each question, choose the option(s) corresponding to all the correct answer(s)

The Marking scheme to evaluate Answer to each question will be :

Full Marks: +**4** (If the answer is correct)
Partial Marks: +**3** (If all the four options are correct but **only 3** are chosen)
Partial Marks: +**2** (If THREE or More options are correct but **only 2** correct answers are chosen)
Partial Marks: +**1** (If TWO or More options are correct but **only 1** correct answer is chosen)
Zero Marks: **0** (If the question is unanswered)
Negative Marks: -1 (In all other cases)

5. A particle of mass m is attached to one end of a mass-less spring of force constant k, lying on a frictionless horizontal plane. The other end of the spring is fixed. The particle starts moving horizontally from its equilibrium position at time $t = 0$ with an initial velocity u_0. When the speed of the particle is $0.5u_0$, it collides elastically with a rigid wall. After this collision

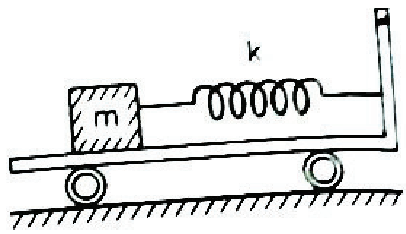
A) The speed of the particle when it returns to its equilibrium position is u_0

B) The time at which the particle passes through the equilibrium position for the first time is $t=\pi\sqrt{\frac{m}{k}}$

C) The time at which the maximum compression of the spring occurs is $t=\frac{4\pi}{3}\sqrt{\frac{m}{k}}$

D) The time at which the particle passes through the equilibrium position for the second time is $t=\frac{5\pi}{3}\sqrt{\frac{m}{k}}$

6. A block of mass m is attached to a massless spring of force constant k, the other end of which is fixed from the wall of a truck as shown in figure. The block is placed over a smooth surface and initially the spring is unstretched. Suddenly the truck starts moving towards right with a constant acceleration a_0. As seen from the truck



A) The particle will execute SHM

B) The time period of oscillations will be $2\pi\sqrt{\frac{m}{k}}$

C) The amplitude of oscillation will be $\frac{ma_0}{k}$

D) The energy of oscillation will be $\frac{m^2a_0^2}{k}$

7. Density of a liquid varies with depth as $\rho=\alpha h$. A small ball of density ρ_0 is released from the free surface of the liquid. Then

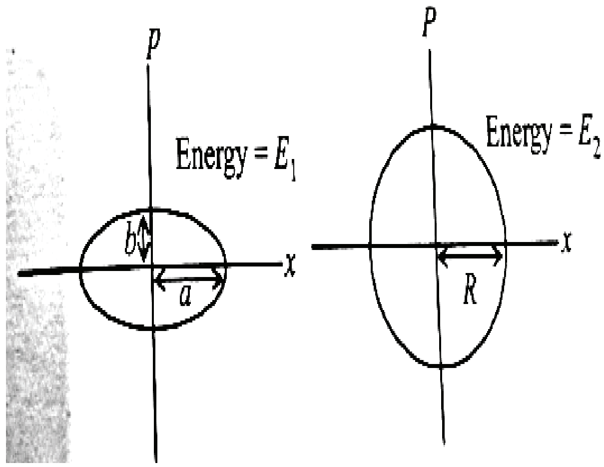
A) The ball will execute SHM of amplitude $\frac{\rho_0}{\alpha}$

B) The mean position of the ball will be at a depth $\frac{\rho_0}{2\alpha}$ from the free surface

C) The ball will sink to a maximum depth of $\frac{2\rho_0}{\alpha}$

D) The ball will sink to a maximum depth of $\frac{\rho_0}{\alpha}$

8. Two independent harmonic oscillators of equal mass are oscillating about the origin with angular frequencies ω_1 and ω_2 and have total energies E_1 and E_2, respectively. The variations of their momenta p with positions x are shown in the figures. If $\frac{a}{b} = n^2$ and $\frac{a}{R} = n$, then the correct equation(s) is(are)



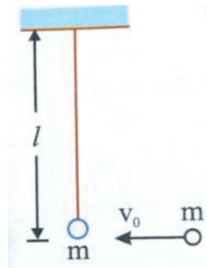
A) $E_1\omega_1 = E_2\omega_2$ **B)** $\frac{\omega_2}{\omega_1} = n^2$

C) $\omega_1\omega_2 = n^2$ **D)** $\frac{E_1}{\omega_1} = \frac{E_2}{\omega_2}$

9. A particle performing SHM undergoes initial displacement of A/2 where A is amplitude of SHM in one sec. At $t = 0$, the particle may be at extreme position or mean position. The time period of SHM can be

A) 6s **B)** 2.4s **C)** 12s **D)** 1.2s

10. A simple pendulum consists of a bob of mass m and a light string of length l as shown. Another identical ball moving with the small velocity v_0 collides with the pendulum's bob and sticks to it. For this new pendulum of mass 2m, mark out the correct statemet(s).



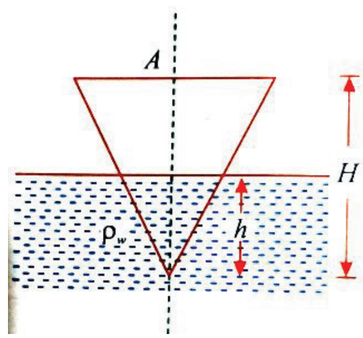
A) Time period of the pendulum is $2\pi\sqrt{\frac{l}{g}}$

B) The equation of motion for this pendulum is $\theta = \frac{v_0}{2\sqrt{gl}}\sin\left[\sqrt{\frac{g}{l}}t\right]$

C) The equation of motion for this pendulum is $\theta = \frac{v_0}{2\sqrt{gl}}\cos\left[\sqrt{\frac{g}{l}}t\right]$

D) Time period of the pendulum is $2\pi\sqrt{\frac{2l}{g}}$

11. A cone made of a material of relative density $\left[s = \frac{27}{64}\right]$ and height 4m floats with its apex downward in water. The submerged height of cone in water is h. If the cone is slightly displaced vertically from its equilibrium position, its time period of oscillations is T. Then (Given $g = 10ms^{-2}$?



A) $h = 3m$ **B)** $h = 2.5m$ **C)** $T = 2.98s$ **D)** $T = 1.98s$

12. 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,
[The body moves only along x]

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

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

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

D) For small displacements from stable equilibrium position the body executes SHM with angular frequency $\frac{3a}{2\sqrt{bm}}$

SECTION – III
(NUMERICAL VALUE TYPE)

This section contains 6 questions. Each question is numerical value type. For each question, enter the correct numerical value (e.g. 003.2343, 6.250023, 7.000000, -0.33, -.30, 30.27000, -127.0030).

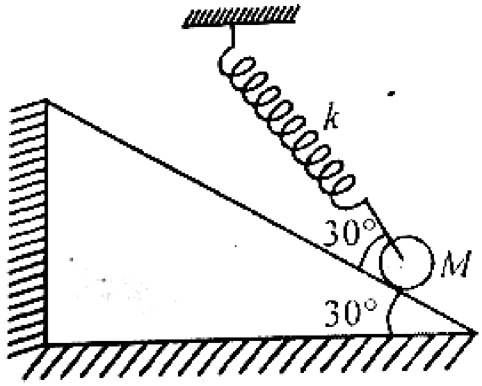
Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.

Section 3 (Max Marks: 18)

- This Section contains **Six (06)** Questions. The answer to each question is a Numerical Value
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numerical keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **round off the value to TWO decimal places**.
- The Marking scheme to evaluate Answer to each question will be :
  Full Marks: **+3** (If ONLY the correct numerical value is entered)
  Zero Marks: 0 (In all other cases)

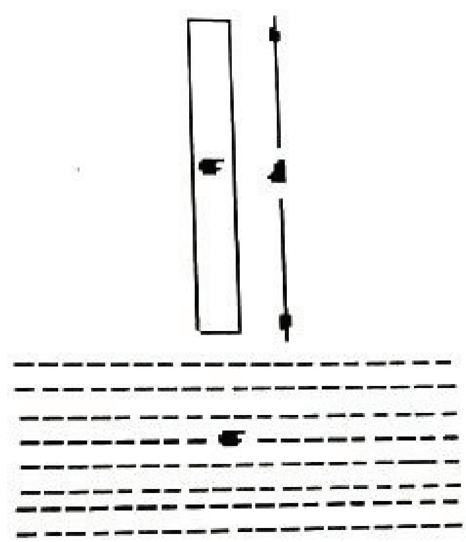
13. A particle is moving on x-axis has potential energy $U = 2 - 20x + 5x^2$ joules along x-axis. The particle is released at $x = -3$. If the mass of the particle is 0.1kg, then find the maximum velocity of the particle (in m/s)

14. A sphere of mass M and radius R is on a smooth fixed inclined plane in equilibrium as shown in the figure. If now the sphere is displaced through a small distance along the plane, what will be the angular frequency (in radian/sec) of the resulting SHM?(Given $k = 4M/3$)

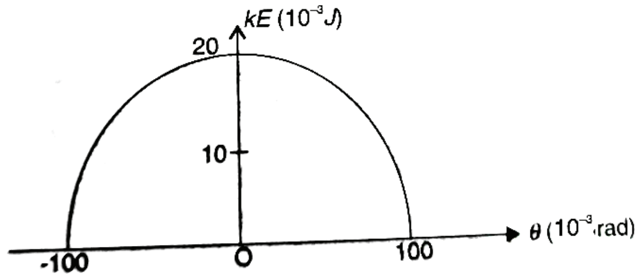


15. The displacement of a particle varies according to the relation $x = 3\sin 100t + 8\cos^2 50t$. Then maximum displacement of the particle from the origin is $'x'$ units, where $'x'$ is ____

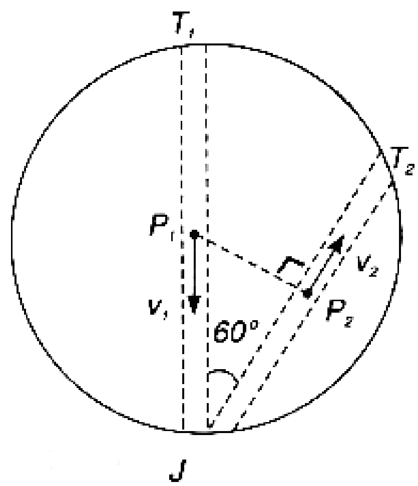
16. A uniform vertical cylinder is released from rest when its lower end just touches the liquid surface of a deep lake. Calculate maximum displacement of cylinder (in meter) .Take $\ell = 4m$ and $\dfrac{\sigma}{\rho} = \dfrac{1}{2}$



17. The given figure shows the variation of the kinetic energy of a simple pendulum with its angular displacement (θ) from the vertical. Mass of the pendulum bob is $m = 0.2kg$. Find the time period (in sec) of the pendulum. Take $g = 10ms^{-2}\,(\pi = 3.14)$



18. Two tunnels T_1 and T_2 are dug across the earth as shown in figure. One end of the two tunnels have a common meeting point on the surface of the earth. Two particles P_1 and P_2 are oscillating from one end to the other end of the tunnels. At some instant particles are at midpoint of their tunnels as shown in figure. Then



The maximum velocity of particle P_1 and P_2 is $\frac{x}{1}$, then x is

PHYSICS
Max Marks: 62

SECTION – I
(ONE OR MORE CORRECT ANSWER TYPE)

This section contains 8 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.

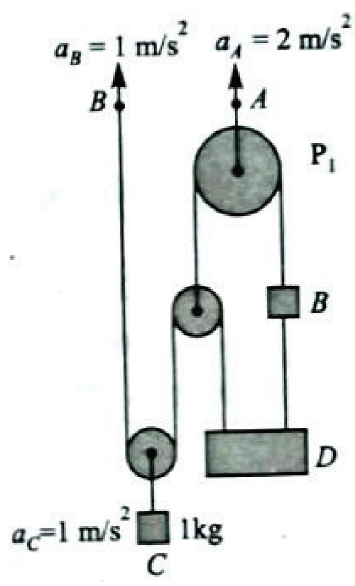
Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -1 in all wrong cases

Section 1 (Max Marks: 32)

- Section 1 contains eight questions.
- Each Question has Four Options and Only One of these four will be the correct answer.
- For each question, choose the option corresponding to the correct answer
- The Marking scheme to evaluate the Answer to each question:

Full Marks: +4 (If the answer is correct)
Partial Marks: +3 (If all the four options are correct but only 3 are chosen)
Partial Marks: +2 (If THREE or More options are correct but only 2 correct answers are chosen)
Partial Marks: +1 (If TWO or More options are correct but only 1 correct answer is chosen)
Zero Marks: 0 (If the question is unanswered)
Negative Marks: -1 (In all other cases)

1. In the arrangement shown in figure pulley and strings are ideal. End A of string connected to pulley P_1 is moved upwards with acceleration $a_A = 2m/s^2$ while end B of another string shown in figure is moved up with acceleration $a_B = 1m/s^2$. Block C of mass 1kg is moving up with acceleration $1m/s^2$. If block D to which string are connected symmetrically moves such that its orientations remains same then (assume $g = 10m/s^2$)



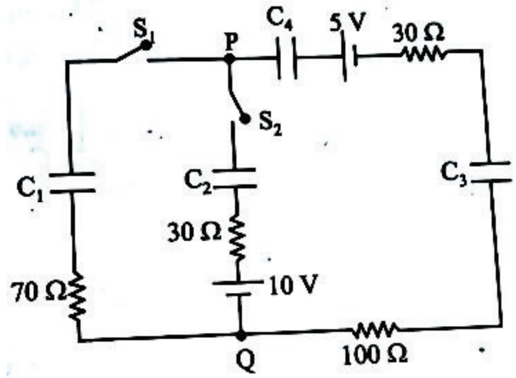
A) acceleration of block D is $1/2\,m/s^2$ upwards

B) end A is pulled with force of 22N

C) Mass of block B is $1/2\,kg$

D) Acceleration of block B is $7/3\,m/s^2$ upwards

2. In the circuit shown, initially there is no charge on capacitors and keys S_1 and S_2 are open. The values of the capacitors are $C_1 = 10\mu F, C_2 = 30\mu F$ and $C_3 = C_4 = 80\mu F$



Which of the following statement(s) is/are correct?

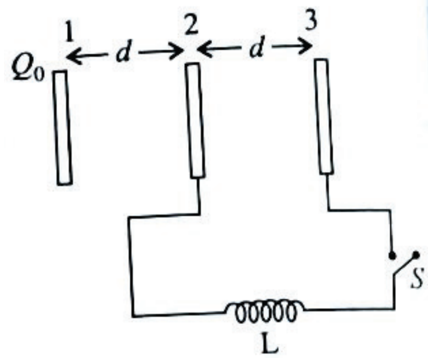
A) If key S_1 is kept closed for long time such that capacitors are fully charged, the voltage difference between points P and Q will be 10V.

B) The key S_1 is kept closed for long time such that capacitors are fully charged. Now key S_2 is closed, at this time, the instantaneous current across $30\,\Omega$ resistor (between points P and Q) will be 0.2A (round off to 1st decimal place)

C) At time $t = 0$, the key S_1 is closed, the instantaneous current in the closed circuit will be 25mA.

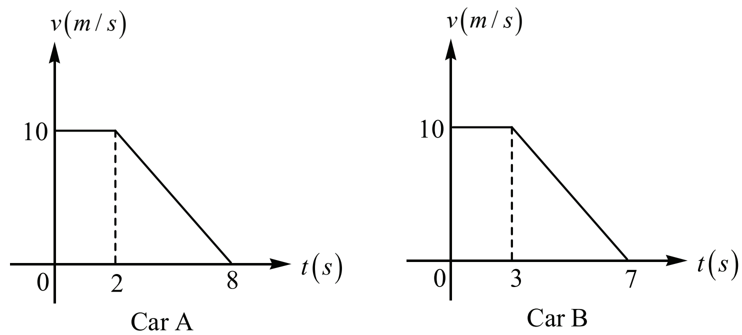
D) If key S_1 is kept closed for along time such that capacitors are fully charged, the voltage across the capacitors C_1 will be 4V.

3. Three identical large plates are fixed at separation of 'd' from each other as shown. The area of each plate is A. Plate 1 is given charge $+Q_0$ while paltes 2 and 3 are neutral and are connected to each other through coil of inductance L and switch S. If resistance of all connected wires is neglected the maximum current flow through coil after closing the switch is $\left(C = \frac{Q_0 A}{d}\right)$(neglect fringe effect)



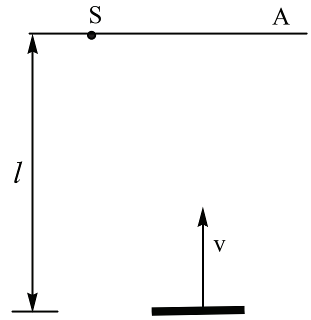
A) $\frac{Q_0}{2\sqrt{LC}}$ **B)** $\frac{Q_0}{\sqrt{LC}}$ **C)** $\frac{2Q_0}{\sqrt{LC}}$ **D)** Zero

4. Car A and B move on a straight road and their velocity versus time graphs are as shown in figure. Comparing the motion of car A in between $t=0$ and $t=8s$ and motion of car B in between $t=0$ to $t=7s$, pick the correct statement.



A) Distance travelled by car A is less than distance travelled by car B.
B) Distance travelled by car A is greater than distance travelled by car B.
C) Average speed of both cars are equal
D) Average speed of car A is less than average speed of car B.

5. A plane mirror M is arranged parallel to wall W at a distance l from it. The light produced by a point source S kept on the wall is reflected by the mirror and produces a light spot on the wall. The mirror moves with velocity v towards the wall. Then



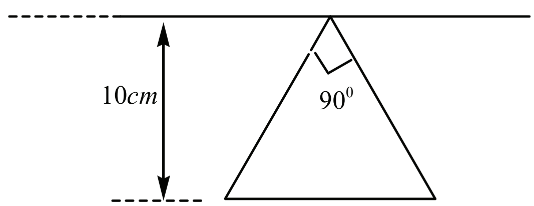
A) The spot of light will move with the speed v on the wall.

B) The spot of light will not move on the wall.

C) As the mirror comes closer, the spot of the light will becomes larger and shift away from the wall with speed larger then v.

D) The size of the light spot on the wall remains same.

6. A conducting loop in the shape of a right angled isosceles triangle of height 10cm is kept such that the 90^0 vertex is very close to an infinitely long conducting wire (see the figure). The wire is electrically insulated from the loop. The hypotenuse of the triangle is parallel to the wire. The current in the triangular loop is in counterclockwise direction and increases at a constant rate of $10As^{-1}$. Which of the following statement(s) is(are) true?



A) The magnitude of induced emf in the wire is $\left(\frac{\mu_0}{\pi}\right)$volts

B) If the loop is rotated at a constant angular speed about the wire, an additional emf of $\left(\frac{\mu_0}{\pi}\right)$volts is induced in the wire

C) The induced current in the wire is in opposite direction to the to the current along hypotenuse

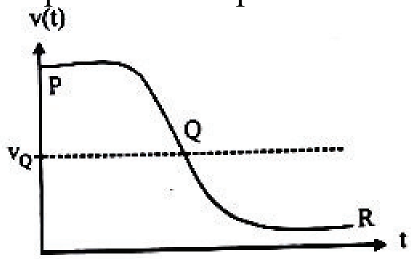
D) There is a repulsive force between the wire and the loop

7. Two loudspeakers M and N are located 20m apart and emit sound at frequencies 118Hz and 121Hz respectively. A car is initially at a point P, 1800m away from the midpoint Q of the line MN and moves towards Q constantly at 60km/hr along the perpendicular bisector of MN. It crosses Q and eventually reaches a point R, 1800m away from Q. Let v(t) represent the beat frequency measured by a person sitting in the car at time. Let v_p, v_Q and v_R be the beat frequencies measured at locations P,Q and R, respectively. The speed of sound in air is $330ms^{-1}$. Which of the following statement(s) is(are) true regarding the sound heard by the person?

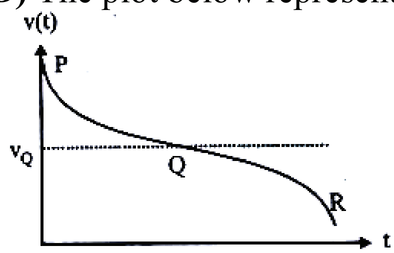
A) $v_p + v_R = 2v_Q$

B) The rate of change in beat frequency is maximum when the car passes through Q

C) The plot below represents schematically the variation of beat frequency with time



D) The plot below represents schematically the variation of beat frequency with time



8. A horizontal insulated cylinder of volume V is divided into four identical compartments by stationary semi-permeable thin partitions as shown. The four compartments from left are initially filled with 28g helium, 160g oxygen, 28g nitrogen and 20g hydrogen respectively. The left partition lets through hydrogen, nitrogen and helium while the right partition lets through hydrogen only. The middle partition lets through hydrogen and nitrogen both. The temperature T insides the entire cylinder is maintained constant. After the system is set in equilibrium.

He	O_2	N_2	H_2

A) Pressure of helium is $\frac{14RT}{V}$ **B)** Pressure of oxygen is $\frac{20RT}{V}$

C) Pressure of nitrogen is $\frac{4RT}{3V}$ **D)** Pressure of hydrogen is $\frac{10RT}{V}$

SECTION – II
(NUMERICAL VALUE TYPE)

This section contains 6 questions. Each question is numerical value type. For each question, enter the correct numerical value (e.g. 003.2343, 6.250023, 7.000000, -0.33, -.30, 30.27000, -127.0030).

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

Section 2 (Max Marks: 18)

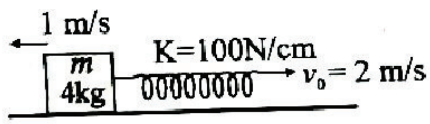
- Section two contains six (6) questions. The answer to each question is a NUMERICAL VALUE
- For each question enter the correct numerical value of the answer using the mouse and the on-screen virtual numerical keypad in the place designated to enter the answer. If the numerical values has more than two decimal places, truncate/round off the value to TWO decimal places.

Answer to each question will be evaluated according to the following marking scheme

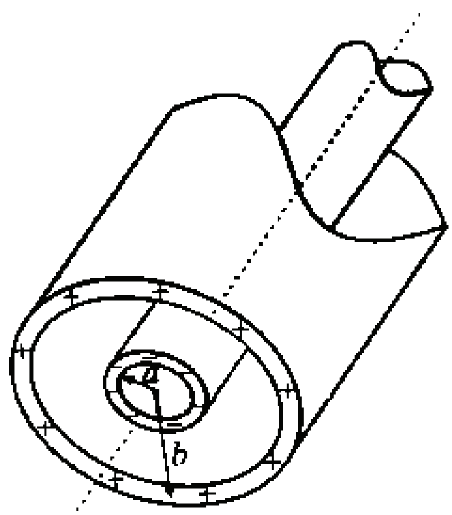
Full Marks: +3 (If only the correct numerical value is entered)

Zero Marks: 0 (In all other cases)

9. The spring block system lies on a smooth horizontal surface. The free end of the spring is being pulled towards right with constant speed $v_0 = 2m/s$. At $t = 0$sec, the spring of constant $k = 100\,N/cm$ is unscratched and the block has a speed $1m/s$ to left. The maximum extension (in cm) of the spring is

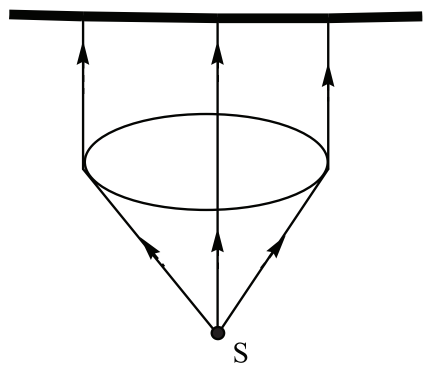


10. A positron, of charge $1.60\times10^{-19}C$, revolves in a circular path of radius r between and concentric with the cylinders as shown in figure. What must be its kinetic energy K in electron volt? Assume that $a = 2.0cm, b = 30cm$ and $\lambda = 30\,nC/m.\left(e = 1.6\times10^{-19}C, 1eV = 1.6\times10^{-19}J\right)$



11. A gas containing hydrogen like ions with atomic number Z, emits photons in transition $(n+2)\rightarrow n$ where $n=Z$. These photons fall on a metallic plate and eject electrons having minimum de-Broglie wavelength λ of $5A^{\circ}$. Find Z. (The work function of metal is $4.2eV$)

12. A totally reflecting a small plane mirror placed horizontally faces a parallel beam of light as shown in figure. The mass of the mirror is 20g. Assume that there is no absorption in the lens and that 30% of the light emitted by the source goes through the lens. Find the power(in MW) of the source needed to support the weight of the mirror. Take $g=10m/s^2$



13. A capacitor of capacitance C is given a charge Q. At $t=0$, it is connected to an uncharged capacitor of equal capacitance through a resistance R. If the charge on second capacitor as s function of time is $q=\frac{Q}{P}\left(1-e^{\frac{-2t}{RC}}\right)$. Find the value of P.

14. The capacitance of a capacitor becomes 4/3 times its original value if a dielectric slab of thickness t = d/2 is inserted between the plates (d is the separation between the plates). What is the dielectric constant of the slab?

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.

Section 3 (Max Marks: 12)

- This Section contains two (02) List-Match sets.
- Each List-Match set has TWO (02) Multiple-choice Questions
- Each List-Match set has two lists: List 1 and List 2
- List 1 has four entries (I), (II), (III), (IV) and List 2 has six entries (P), (Q), (R), (S), (T) and (U)

- Four options are given in each multiple choice question based on List 1 and List 2 and Only ONE of these four options satisfies the condition asked in the Multiple Choice Question.

Answer to each question will be evaluated according to the following marking scheme

Full Marks: +3 (If only the option corresponding to the correct combination is chosen))

Zero Marks: 0 (If none of the options is chosen (i.e. the question is unanswered)

Negative Marks: -1 (In all other cases)

Answer Q.15 and Q.16 by appropriately matching the list based on the information given in the paragraph

A charged particle (electron or proton) is introduced at the origin $(x=0, y=0, z=0)$ with a given initial velocity $\vec{v}$. A uniform electric field $\vec{E}$ and a uniform magnetic field $\vec{B}$ exist everywhere. The velocity $\vec{v}$, electric field $\vec{E}$ and magnetic field $\vec{B}$ are given in column 1,2 and 3, respectively. The quantities E_0, B_0 are positive in magnitude.

COLUMN-I	COLUMN-II	COLUMN-III
I)Electron with $\vec{v}=2\dfrac{E_0}{B_0}\hat{x}$	i) $\vec{E}=E_0\hat{z}$	P) $\vec{B}=-B_0\hat{x}$
II) Electron with $\vec{v}=\dfrac{E_0}{B_0}\hat{y}$	ii) $\vec{E}=-E_0\hat{y}$	Q) $\vec{B}=B_0\hat{x}$
III)Proton with $\vec{v}=0$	iii) $\vec{E}=-E_0\hat{x}$	R) $\vec{B}=B_0\hat{y}$
IV) Proton with $\vec{v}=2\dfrac{E_0}{B_0}\hat{x}$	iv) $\vec{E}=E_0\hat{x}$	S) $\vec{B}=B_0\hat{z}$

15. In which case will the particle move in a straight line with constant velocity?

A) $(III)(ii)(R)$ **B)** $(IV)(i)(S)$

C) $(III)(iii)(P)$ **D)** $(II)(iii)(S)$

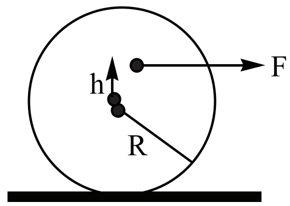
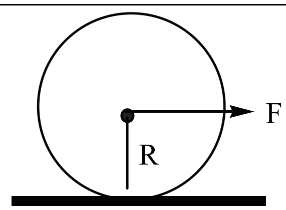
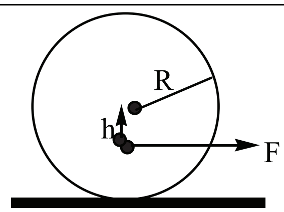
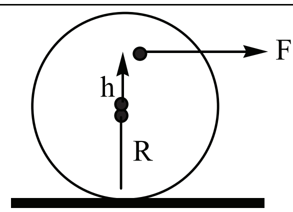
16. In which case will the particle describe a helical path with axis along the positive z direction?

A) $(IV)(i)(S)$ **B)** $(II)(ii)(R)$

C) $(III)(iii)(P)$ **D)** $(IV)(ii)(R)$

Answer Q.17 and Q.18 by appropriately matching the list based on the information given in the paragraph

In each, there is sufficient friction for regular rigid uniform body undergoes pure rolling on a rigid horizontal surface. Now match the column I and II.

	COLUMN-I		COLUMN-II
A)	 disc	P)	The direction of static friction may be backward or static friction may be forward or friction may be zero
B)	 disc	Q)	The direction of static friction is towards backward
C)	 disc	R)	The angular acceleration will be clockwise
D)	 disc	S)	Acceleration of the centre mass will be along the direction of F

17. Which of the following options is correct?

A) $A-P,S;B-Q,S;C-Q,S;D-P,S$

B) $A-P,R;B-Q,S;C-P,R;D-Q,S$

C) $A-P,Q;B-Q,R;C-P,R;D-Q,S$

D) $A-P,R;B-P,Q;C-P,S;D-Q,R$

18. Which of the following options is correct?

A) $A-R;B-R;C-R;D-R$

B) $A-P;B-P;C-P;D-P$

C) $A-Q;B-Q;C-Q;D-Q$

D) $A-S;B-S;C-S;D-S$

Sri Chaitanya IIT Academy., India.

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

A right Choice for the Real Aspirant

ICON Central Office , Madhapur – Hyderabad

Sec: Sr.Super60 **PTA-17** **Date: 09-01-2022**

Time: 09.00Am to 12.00 **2019_P1** **Max.Marks:180**

KEY SHEET

PHYSICS

1	B	2	D	3	C	4	A	5	A,D	6	A,B,C
7	A,C	8	B,D	9	A,C	10	A,B	11	A,D	12	A,B,D
13	50	14	1	15	9	16	4	17	2.7 to 2.9	18	2

CHEMISTRY

19	A	20	D	21	B	22	D	23	B,C,D	24	A,B
25	A,B,C	26	A,B,C	27	A,C	28	A,C,D	29	B,D	30	B,D
31	1	32	2	33	8	34	7	35	5	36	2

MATHEMATICS

37	D	38	D	39	D	40	B	41	ABCD	42	B,C,D
43	A,C,D	44	A,B,C	45	A,B,D	46	A,B,C	47	A,B,C	48	A,D
49	25	50	3	51	5	52	25	53	40	54	6

SOLUTIONS
PHYSICS

1. So velocity of block when passing from its mean position is given as

$$v = A\omega = \frac{3l}{2}\sqrt{\frac{k}{m}} \qquad \left[As\ \omega = \sqrt{\frac{k}{m}}\right]$$

If mass m_1 is added to it and just after if velocity of combined block becomes v_1, from momentum conservation we have

$$mv = (m+m_1)v_1$$

or $v_1 = \frac{m}{(m+m_1)}\left(\frac{3l}{2}\sqrt{\frac{k}{m}}\right)$

If this is the velocity of combined block at mean position, it must be given as

$$v_1 = A\omega_1\left[Now\ \omega_1 = \sqrt{\frac{k}{m_1+m_2}}\right]$$

Where A_1 and ω_1 are the new amplitude and angular frequency of SHM of the block. It is given that combined block just reaches the left wall thus the new amplitude of oscillation must be l so we have

$$\frac{m}{(m_1+m_2)}.\frac{3l}{2}\sqrt{\frac{k}{m}} = l_1\sqrt{\frac{k}{m+m_1}}$$

or $\frac{3\sqrt{m}}{2\sqrt{m+m_1}} = 1$

or $9m = 4m + 4m_1$

or $m_1 = \frac{5}{4}m$

2. In equilibrium if spring extension is h, we use

$Mg + 2mg = kh$ _____(1)

After displacing mass m down by x its equation of motion will be

$T_1 - mg = ma$ _____(1)

For pulley we write

$k(h + x/2) - T_1 - T_2 - Mg = Ma/2$ ____(2)

and $(T_1 - T_2)r' = \frac{1}{2}Mr^2\left(\frac{a}{2r}\right)$

From equation (1)

$$T_2 = \frac{Ma}{4} + ma + mg$$

From equation (2)

$$kh + k\frac{x}{2} - ma - mg - \frac{Ma}{4} - ma - mg - Mg = \frac{Ma}{2}$$

$$\Rightarrow a=\frac{\frac{kx}{2}}{2m+\frac{3}{4}M}$$

For restoring tandency we use

$$a=-\left(\frac{k}{4m+\frac{3}{2}M}\right)x$$

Comparing with $a=-\omega^2 x$

We get $\omega=\sqrt{\dfrac{k}{4m+\frac{3}{2}M}}$

3. Let the pendulum be at its positive extreme at $t=0$

$$\theta=\theta_0\cos(\omega t)\left[Where\,\omega=\sqrt{\frac{g}{\ell}}\right]$$

Angular velocity at time $'t'$ is $\dfrac{d\theta}{dt}=-\theta_0\omega\sin(\omega t)$

$\therefore$ velocity of the bob $V=\theta_0\omega\ell\sin(\omega t)$

Tension(T) is given by

$$T=mg\cos\theta+\frac{mV^2}{\ell}$$

$$T=mg\cos\theta+m\theta_0^2\omega^2\ell\sin^2\omega t=mg\left[1-\frac{\theta^2}{2}\right]+m\theta_0^2\omega^2\ell\sin^2\omega t$$

$$=mg-\frac{1}{2}mg\theta_0^2\cos\omega t+m\theta_0^2 g\sin^2\omega t$$

$$\left(\cos^2\omega t\right)=\left(\sin^2\omega t\right)=\frac{1}{2}$$

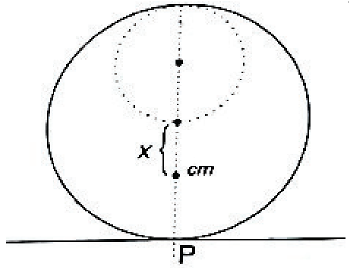
$$\therefore T_{av}=mg+\frac{1}{4}mg\theta_0^2$$

4. Location of centre of mass of the cavitied sphere is given by

$$\frac{4}{3}\pi\left(R^3-\frac{R^3}{8}\right)\rho\ x=\frac{4}{3}\pi\frac{R^3}{8}\rho\frac{R}{2}$$

$$\Rightarrow\frac{7}{8}x=\frac{R}{16}[\rho=density]$$

$$\Rightarrow x=\frac{R}{14}$$



Moment of inertia of the cavitied sphere about an axis ($\perp$r to plane of the figure) through point of contact (P) is calculated as follows

Let M = mass of cavitied sphere

$\therefore$ Mass of sphere of radius $\frac{R}{2}$ is $m = \rho \frac{4}{3}\pi \frac{R^3}{8} = \frac{M}{7}$

Mass of sphere without cavity $M_0 = m + M = \frac{8M}{7}$

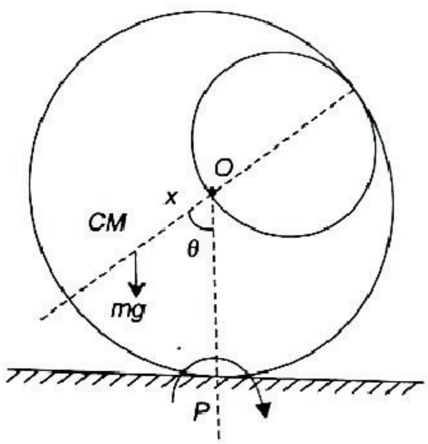
$\therefore$Required moment of inertia

I = (moment of inertia of complete sphere without cavity about an axis through P)

(moment of inertia of the cavity about the same axis)

$$= \frac{7}{5}\frac{8M}{7}R^2 - \left[\frac{47}{20}\frac{M}{7}R^2\right] = \frac{177}{140}MR^2$$

A purely rolling sphere can be considered to be is pure rotation about the point of contact. Consider the sphere at a slightly displaced position θ, as shown.



Restoring torque in this position is

$$\tau = Mgx\sin\theta \simeq \frac{R}{14}Mg\theta$$

$$\therefore I\alpha = -\frac{R}{14}Mg\theta$$

$$\Rightarrow \frac{177}{140}MR^2\alpha = -\frac{R}{14}Mg\theta$$

$$\Rightarrow \alpha = -\frac{140}{177\times 14}\frac{g}{R}\theta$$

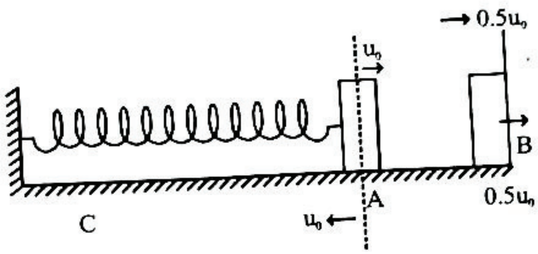
$$\therefore \omega^2 = \frac{10}{177}\frac{g}{R}$$

$$\Rightarrow T = 2\pi\sqrt{\frac{177R}{10g}}$$

5. The particle collides elastically with rigid wall.

$$\therefore e = \frac{V}{0.5u_0} = 1 \Rightarrow V = 0.5u_0$$

i.e., the particle rebounds with the same speed. Therefore the particle will return to its equilibrium position with speed u_0.



The velocity of the particle becomes $0.5u_0$ after time t. Using,

Equation $V = V_{\max}\cos\omega t$

$$0.5u_0 = u_0\cos\omega t$$

$$\therefore \frac{\pi}{3} = \frac{2\pi}{t}\times T \Rightarrow t = \frac{T}{6}$$

The time period $T = 2\pi\sqrt{\frac{m}{k}}\ \therefore t = \frac{\pi}{3}\sqrt{\frac{m}{k}}$

The time taken by the particle to pass through the equilibrium for the first time

$$= 2t = \frac{2\pi}{3}\sqrt{\frac{m}{k}}$$

The time taken for the maximum compression

$$= t_{AB} + t_{BA} + t_{AC}$$

$$= \frac{\pi}{3}\sqrt{\frac{m}{k}} + \frac{\pi}{3}\sqrt{\frac{m}{k}} + \frac{\pi}{3}\sqrt{\frac{m}{k}} = \pi\sqrt{\frac{m}{k}}\left[\frac{1}{3}+\frac{1}{3}+\frac{1}{2}\right]$$

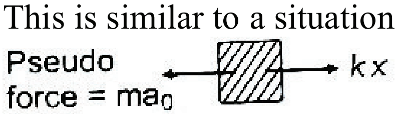
$$= \frac{7\pi}{6}\sqrt{\frac{m}{k}}$$

The time taken for particle to pass through the equilibrium position second time

$$= 2\left[\frac{\pi}{3}\sqrt{\frac{m}{k}}\right] + \pi\sqrt{\frac{m}{k}} = \pi\sqrt{\frac{m}{k}}\left(\frac{2}{3}+1\right) = \frac{5}{3}\pi\sqrt{\frac{m}{k}}$$

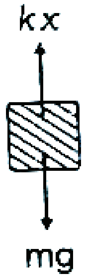
6. Fee body diagram of the block from non inertial frame of reference will be as shown

This is similar to a situation when a block is suspended from a vertical spring.



Therefore, the block will execute simple harmonically with time period

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



Amplitude will be given by $A = x = \frac{ma_0}{k}\left(ma_0 = kx\right)$

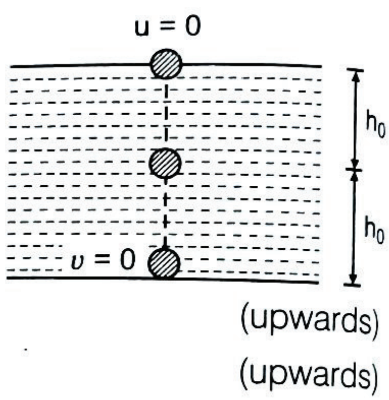
Energy of oscillation will be $E = \frac{1}{2}kA^2 = \frac{1}{2}k\left(\frac{ma_0}{k}\right)^2$

$= \frac{m^2 a_0^2}{2k}$

7. Net force on the ball will be zero at $\rho = \rho_0$

or $\alpha h_0 = \rho_0$

or $h_0 = \frac{\rho_0}{\alpha}$



i.e., the mean position is at a depth $h_0 = \frac{\rho_0}{\alpha}$

Net force at a depth $h_0 + x$ will be

$F = \left(\rho - \rho_0\right)Vg$

or $F = \alpha\, xVg$

F is proportional to $-x$

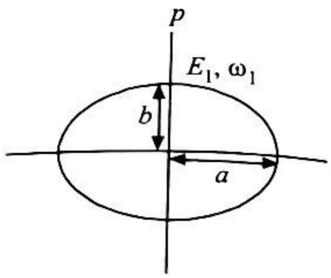
Thus, motion of the ball is simple harmonic

$h_{max} = 2h_0 = \frac{2\rho_0}{\alpha}$

8. For first harmonic oscillator,

Mass = m

Angular frequency $= \omega_1$
Amplitude $= a$
Total energy $= E_1$
Maximum momentum,
$p_{\max} = b$

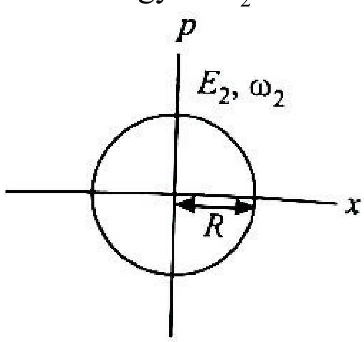


$$E_1 = \frac{1}{2} m\omega_1^2 a^2 \_\_\_\_\_ (i)$$

$$p_{\max} = mv_{\max} = ma\omega_1 \Rightarrow b = ma\omega_1$$

$$\frac{a}{b} = \frac{1}{m\omega_1} \_\_\_\_\_ (ii)$$

For second harmonic oscillator,
Mass $= m$
Angular frequency $= \omega_2$
Amplitude $= R$
Maximum momentum, $p_{\max} = R$
Total energy $= E_2$



$$E_2 = \frac{1}{2} m\omega_2^2 R^2 \_\_\_\_ (iii)$$

$$p_{\max} = mv_{\max} = m\omega_2 R$$

$$R = m\omega_2 R \Rightarrow m\omega_2 = 1 \_\_\_\_ (iv)$$

From eqns.(ii) and (iv).

$$\frac{a}{b} = \frac{\omega_2}{\omega_2} \_\_\_\_\_ (v)$$

From eqns. (i) and (iii),

$$\frac{E_1}{E_2} = \frac{\omega_1^2 a^2}{\omega_2^2 R^2}$$

If $\frac{a}{b}=n^2$ and $\frac{a}{R}=n$ then from eqn.(v)

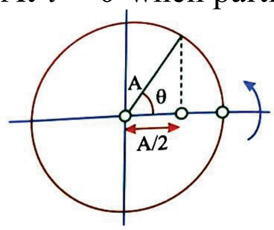
$$\frac{\omega_2}{\omega_1}=n^2$$

And from eqn.(vi)

$$\frac{E_1}{E_2}=\frac{\omega_1^2}{\omega_2^2}\times n^2=\frac{\omega_1}{\omega_2}$$

$$\therefore \frac{E_1}{\omega_1}=\frac{E_2}{\omega_2}$$

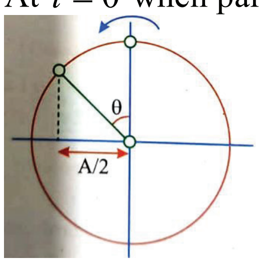
9. At $t=0$ when particle is at extreme position then situation is shown in figure



$$\theta=\omega t$$

From figure $\cos\theta=\frac{A/2}{A}=\frac{1}{2}\Rightarrow\theta=\frac{\pi}{3}$

At $t=0$ when particle is at mean position then situation is hown in figure



$$\theta=\omega t$$

From figure $\sin\theta=\frac{A/2}{A}\Rightarrow\theta=\frac{\pi}{6}$

$$\Rightarrow\frac{\pi}{6}=\frac{2\pi}{T}\times 1\Rightarrow T=12s$$

10. $T=2\pi\sqrt{\frac{l}{g}}$, independent of mass of bob:

Equation of motion is: $\theta=\theta_0\sin\omega t$

Calculation of θ_0 is from law of conservation of energy.

$$\frac{1}{2}(2m)\left(\frac{v_0}{2}\right)^2=2mg\left(1-\cos\theta_0\right)$$

11. In equilibrium of the cone Buoyant force = weight

$$\frac{1}{3}\left[A\left(\frac{h}{H}\right)^2\right]h\rho_w g=\frac{1}{3}(AH)\rho_w sg$$

or $h = H\left(s\right)^{1/3} = 4\left(\frac{27}{64}\right)^{1/3} = 3m$

When the cone is pushed slightly downwards, it performs oscillations. Consider the situation, when the cone is displaced downwards by x then, Buoyant force-weight-Mass × Acceleration

$$\frac{1}{3}A\left(\frac{h+x}{H}\right)^2\left(h+x\right)\rho_w g - \frac{1}{3}AH\rho_w sg = -\frac{1}{3}AH\rho_w sa$$

$$\frac{\left(h+x\right)^3}{H^2}g - Hsg = -Hsa$$

$$\frac{h^3}{H^2}\left(1+\frac{x}{h}\right)^3 g - Hsg = -Hsa$$

$$\frac{h^3}{H^2}\left(1+\frac{3x}{h}\right)g - Hsg = -Hsa$$

[$\because x << h$ and approximating using Binomial theorem]

$$\frac{3^3}{4^2}\left(1+\frac{3x}{3}\right)(10) - (4)\left(\frac{27}{64}\right)(10) = -4\left(\frac{27}{64}\right)a$$

$$\frac{270}{16}\times = -\frac{27}{16}a$$

$$\Rightarrow a = -10x \qquad \omega = \sqrt{10}$$

$$\Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{10}} = 1.98s$$

12. $U = ax^3 + bx^4$

$$F = \frac{-\partial U}{\partial x} = -3ax^2 - 4bx^3$$

$F = 0$ at $x = 0$ and $x = \frac{-3a}{4b}$

For small displacement restoring force is given by,

$$F_{res} = \frac{9a^2}{4b}\delta x$$

13. $F = 20 - 10x = -10\left(x-2\right)$

Hence, force constant is $k = 10; m = 0.1kg$

Angular frequency, $\omega = \sqrt{\frac{k}{m}} = 10\, rad/s$

$v_{\max} = \omega A = 50\, m/s$

14. Since, the sphere is moved down through a distance x, then elongation in the spring $= x\cos 30^0$

$\Rightarrow$ Restoring force $= kx\cos^2 30^0 = 3k\,x/4$

$$\Rightarrow M\frac{d^2x}{dt^2}=\frac{-3}{4}kx$$

$$\Rightarrow \frac{d^2x}{dt^2}=-\left(\frac{3k}{4M}\right)x$$

But $\frac{d^2x}{dt^2}=-\omega^2x$

$$\therefore \omega=\sqrt{\frac{3k}{4M}}=1rad/s$$

15. $x=3\sin 100t+4\times 2\cos^2 50t$

$=3\sin 100t+4\left(1+\cos 100t\right)$

$=4+3\sin 100t+4\cos 100t$

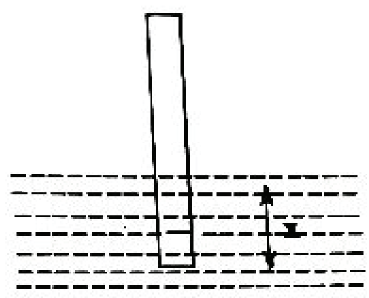
$=4+5\sin\left(100t+\frac{\pi}{4}\right)$

Clearly $A=5$, and mean position is at $x=4$

$\therefore$ maximum displacement of the particle from origin, $x=4+5=9$

16. $Al\sigma g-Ax\rho g=Al\sigma a$

$$a=b-\frac{\rho gx}{\sigma\ell}$$



$$\int_0^v vdv=\int_0^x g-\frac{\rho gx}{\sigma\ell}dx$$

$$\Rightarrow \frac{v^2}{2}=gx-\frac{\rho g}{\sigma\ell}\frac{x^2}{2}$$

At maximum displacement,

$$\Rightarrow x=\frac{2\sigma\ell}{\rho}=2\times\frac{1}{2}\times 4=4m$$

17. If V_0 is the speed at the mean position

$$\frac{1}{2}mV_0^2=20\times 10^{-3}$$

$$\frac{1}{2}\times 0.2\times V_0^2=20\times 10^{-3}\Rightarrow V_0=\sqrt{0.2}\,m/s$$

If linear amplitude is A then $V_0=A\omega=\sqrt{0.2}$

$$L\theta_0\sqrt{\frac{g}{L}} = \sqrt{0.2}\left[\because A = L\theta_0 \ \ where\,\theta_0 = angular\,amplitude\right]$$

$$\theta_0\sqrt{gL} = \sqrt{0.2}$$

$$L = \frac{0.2}{10\times\left(100\times10^{-3}\right)^2} = 2.0m$$

$$\therefore T = 2\pi\sqrt{\frac{L}{g}} = 2\times3.14\sqrt{\frac{2}{10}} = 2.80s$$

18. At the instant shown, both particle are at their mean and moving in opposite direction.

Phase difference $= 180^0$

As ω is same for both particle $\left\{\omega = \sqrt{\frac{GM}{R^3}}\right\}$ the phase difference will be maintained through and they will never meet.

$$v_{\max} = A\omega$$

$$\therefore \frac{v_1}{v_2} = \frac{R}{R/2} = \frac{2}{1}$$

CHEMISTRY

19. $\therefore \frac{C_{p,m}}{C_{V,m}} = \gamma$ and $C_{p,m} - C_{v,m} = R$

$$\therefore C_{v,m} = \frac{R}{\gamma - 1}$$

$C_{v,m} = \frac{C_v}{n}$ and $C_v = m.c_v$

$$\therefore \frac{R}{\gamma-1} = \frac{m.c_v}{m}\times M$$

$$\therefore C_v = \frac{R}{(\gamma-1)M}$$

20. $\Delta S = nC_{p,m}\ln\frac{T_2}{T_1} + nR\ln\frac{P_1}{P_2}$

$$= 3\times\frac{7}{2}R\ln\left(\frac{596}{298}\right) + 3R\ln\frac{1}{4}$$

$$= 6.3\,cal\,K^{-1}$$

21. For combustion of 1 mole of benzene

$$\Delta n_g = -1.5$$

$$\Delta H = \Delta U + \Delta n_g RT$$

Sec: *Sr.Super60* **CTA-16** **Date: 09-01-2022**

Time: 02.30Pm to 05.30Pm **2019_P2** **Max.Marks:180**

KEY SHEET

PHYSICS

1	BD	2	CD	3	A	4	D	5	BD	6	AD
7	ABC	8	ABCD	9	6	10	270	11	2	12	100
13	2	14	2	15	D	16	A	17	A	18	A

CHEMISTRY

19	AB	20	ABCD	21	ABCD	22	ABC	23	ACD	24	ABC
25	ABCD	26	ABCD	27	8	28	6	29	1	30	5
31	7	32	2	33	A	34	A	35	A	36	C

MATHEMATICS

37	AC	38	ACD	39	ABC	40	ABD	41	ABD	42	ABCD
43	AB	44	ABC	45	3	46	7	47	4	48	5
49	5	50	1	51	A	52	D	53	D	54	B

SOLUTIONS

PHYSICS

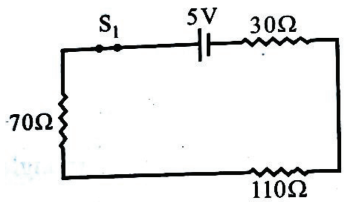
1. By constraint

$a_B + 4a_A = 2a_C + 3a_D$

$\Rightarrow a_D = \frac{7}{3} m/s^2$

$2T - 10 = 1 \Rightarrow T = 11/2N$

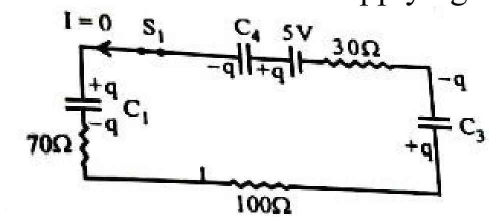
2. S_1 closed and S_2 open $(t=0)$



At $t=0$, capacitors do not have any charge.

Therefore $I = \frac{5}{70+100+30} = 0.25A = 25mA$

Option (c) is correct when S_1 is closed for a long time the all the capacitors are fully charged. As the capacitors are in series these carry equal charge q. Current in the circuit is now zero. Applying Krichhoff's law



$5 - \frac{q}{80} - \frac{q}{10} - \frac{q}{80} = 0 \qquad \therefore q = 40\mu c$

Potential difference across C_1 is

$\frac{q}{C_1} = \frac{40\times10^{-6}}{10\times10^{-6}} = 4V$

(d) is the correct option.

$V_p - 4 - 70\times25\times10^{-3} = V_Q$

$\therefore V_P - V_Q = 4 + 1.75 = 5.75V$

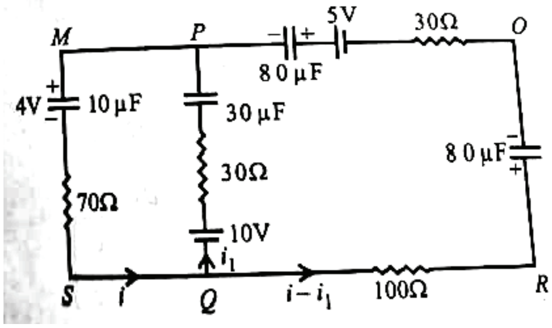
(a) is an incorrect option.

Now when key S_2 is closed

In loop MPQS

$+10 - 30i_1 - 4 - 70i = 0$

$70i + 30i_1 = 6$ ____(i)



In loop QROPQ,

$$+10 - 30i_1 \frac{40}{80} - 5 + (i - i_1) \times 130 + \frac{40}{80} = 0$$

$$130i - 160i_1 = 6 \_\_\_\_(ii)$$

On solving (i) & (ii), we get $i = 0.05A$

$\therefore i_1 = 0.077A$

(b) is an incorrect option.

3. $$\frac{1}{2}\left(\frac{Q_0^2}{2C}\right) = \frac{1}{2}Li_0^2 \text{ or } i_0 = \frac{Q_0}{2\sqrt{LC}}$$

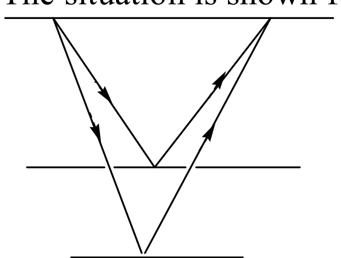
4. $$S_A = \frac{1}{2}(8+2) \times 10 = 50m$$

and $S_B = \frac{1}{2}(7+3) \times 10 = 50m$

$$v_A = \frac{S_A}{t} = \frac{50}{8} = 6.25\, m/s$$

and $v_B = \frac{S_B}{t} = \frac{50}{7} = 7.13\, m/s$

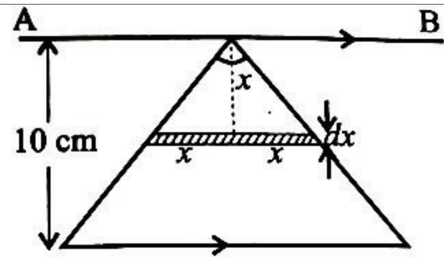
5. The situation is shown for two positions of the mirror.



6. The flux passing through the triangular wire if i current flows through the infinitely long conducting wire

$$= \int_0^{0.1} \frac{\mu_0 i}{2\pi x} \times 2\pi\, dx$$

$$\phi = \frac{\mu_0 i}{10\pi} = Mi$$



$$\frac{dI}{dt} = 10AS^{-1}$$

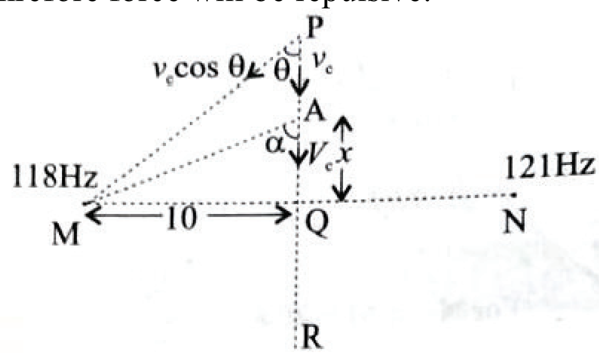
$$\therefore M = \frac{\mu_0}{10\pi}$$

Induced emf in the wire

$$= M\frac{di}{dt} = \frac{\mu_0}{10\pi} \times 10 = \frac{\mu_0}{\pi}$$

As the current in the triangular wire is increasing the induced current in AB is in the opposite direction as the current in the hypotenuse of the triangular wire. Threfore force will be repulsive.

7.



$$v_P = 121 - 118 = \left[\frac{v + v\cos\theta}{v}\right]$$

$$v_\theta = 121 - 118 = 3$$

$$v_R = (121 - 118) = \left[\frac{v - v_c\cos\theta}{v}\right]$$

$\therefore vP + vR = 2vQ \Rightarrow (a)$ is correct option

In general when the car is passing through A

$$v = 3\left[\frac{v + v_c\cos\alpha}{v}\right] \_\_\_\_\_(i)$$

$\therefore \frac{dv}{d\alpha} = -3\left[\frac{v_c \sin\alpha}{v}\right] \left|\frac{dv}{d\alpha}\right|$ is max when

$\sin\alpha = 1$

i.e., $\alpha = 90^0$ (at Q)

$\Rightarrow (b)$ is correct option.

From $(i)\dfrac{dv}{dt}=\dfrac{3v_c}{v}(-\sin\alpha)\dfrac{d\alpha}{dt}$ _____(ii)

Also $\tan\alpha=\dfrac{10}{x}\therefore\sec^2\alpha=\dfrac{d\alpha}{dt}=-\dfrac{10}{x^2}\dfrac{dx}{dt}$

$\therefore\dfrac{d\alpha}{dt}=-\dfrac{10v}{x^2\sec^2\alpha}$........$(iii)$

From (ii) and (iii)

$$\frac{dv}{dt}=-\frac{3v_c}{v}\sin\alpha\times\left(\frac{-10v}{x^2\sec^2\alpha}\right)=\frac{30V_c\sin\alpha}{x^2\sec^2\alpha}$$

$$\therefore\frac{dv}{dt}=\frac{30v_c\sin\alpha}{(10\cot\alpha)^2\sec^2\alpha}=0.3v_c\sin^3\alpha$$

At $\alpha=90^0$

$\dfrac{dv}{dt}=\max$

$\therefore(c)$ is the correct option

8. $20g$

He

$n_1=7\quad 160g$

O_2

$n_2=5\quad 28g$

N_2

$n_3=5\quad 20g$

H_2

$n_4=10$

After

He	He	$-$	$-$
H_2	H_2	H_2	H_2
N_2	N_2	N_2	

$$P_{He}=\frac{n_1RT}{V/2}=\frac{7RT}{V/2}=\frac{14RT}{V}$$

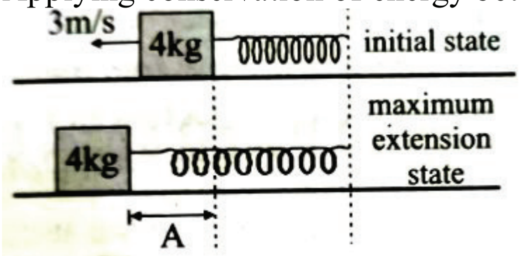
$$P_{O_2}=\frac{n_2RT}{V/4}=\frac{5RT}{V/4}=\frac{20RT}{V}$$

$$P_{N_2}=\frac{n_3RT}{\frac{3}{4}V}=\frac{4}{3}=\frac{RT}{V}$$

$$P_{H_2}=\frac{n_4RT}{V}=\frac{10RT}{V}$$

9. In the frame (inertial w.r.t.earth) of free end of spring, the initial velocity of block is 3m/s to left and the spring unnstretched.

Applying conservation of energy between initial and maximum extension state.



or $A=\sqrt{\frac{m}{k}}v$

$=\sqrt{\frac{4}{10000}}\times 3=6cm$

10. The electric field between the cylinders,

$E=\frac{\lambda}{2\pi\in_0 r}$

Which is only due to inner cylinder. For the motion of the positron, we have

$E_q=\frac{mv^2}{r}$

or $mv^2=Eqr$

$\therefore K=\frac{1}{2}mv^2=\frac{Eqr}{2}=\frac{\lambda qr}{4\pi\in_0 r}=\frac{\lambda q}{4\pi\in_0}$

After substituting the values, we can get

$K=270eV$.

11. $E=-(13.6eV)Z^2\left(\frac{1}{(Z+2)^2}-\frac{1}{Z^2}\right)$

$=13.6\times\left(\frac{Z^2-(Z+2)^3}{(Z+2)^2}\right)=\frac{4(Z+1)\times 13.6}{(Z+2)^2}eV$ ......(i)

[Now energy of electron is $k=\frac{h^2}{2\lambda^2 m}$; $\left(\text{we have}=\frac{h}{\sqrt{2mk}}\right)$ or, $k=6eV$

So, $\frac{4(Z+1)\times 13.6}{(Z+2)^2}=6+4.2=10.2eV$ or $\frac{Z+1}{(Z+2)^2}=\frac{3}{16}\Rightarrow(Z-2)(3Z+2)=0$

So, the value of $Z=2$ (neglecting the negative / fractional value)

12. For perfectly reflecting mirror, the force exerted by the light of power P is,

$F=\frac{2\,Power}{c}$

For the equilibrium of the mirror

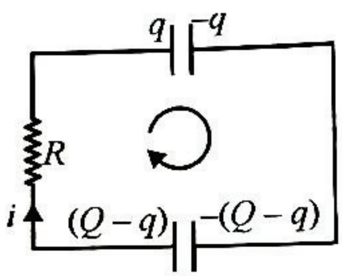
or $\dfrac{2\,Power}{c} = mg$

$\therefore Power = \dfrac{mg \times c}{2} = \dfrac{\left(20\times10^{-3}\times10\right)\times\left(3\times10^{8}\right)}{2} = 30\times10^{6}W$

As only 30% of the power of the source is given to the mirror, so power of source needed

$= \dfrac{30}{0.30} = 100MW$

13. Let at any instant the charge on the uncharged capacitor is q. The charge on charged capacitor remains $(Q-q)$.



Now by loop rule.

$-iR - \dfrac{q}{C} + \dfrac{(Q-q)}{C} = 0$

or $-\dfrac{dq}{dt}R + \left(\dfrac{Q-2q}{C}\right) = 0$

or $-\dfrac{dq}{(Q-2q)} = \dfrac{dt}{CR}$

Integrating on both sides of above expression, we get

$\int_0^q \dfrac{dq}{Q-2q} = \int_0^t \dfrac{dt}{RC}$

$\left|\dfrac{\ell n(Q-2q)}{-2}\right|_0^q = \dfrac{t}{RC}$

or $\ell n(Q-2q) - \ell nQ = -\dfrac{2t}{RC}$

or $\ell n\left(1-\dfrac{2q}{Q}\right) = -\dfrac{2t}{RC}$

$q = \dfrac{Q}{2}\left(1-e^{-\frac{2t}{RC}}\right)$

14. $\dfrac{\varepsilon_0 A}{d - \frac{d}{2} + \frac{d}{2k}} = \dfrac{4}{3}\left(\dfrac{\varepsilon_0 A}{d}\right)$ solve to get k = 2

15. Conceptual

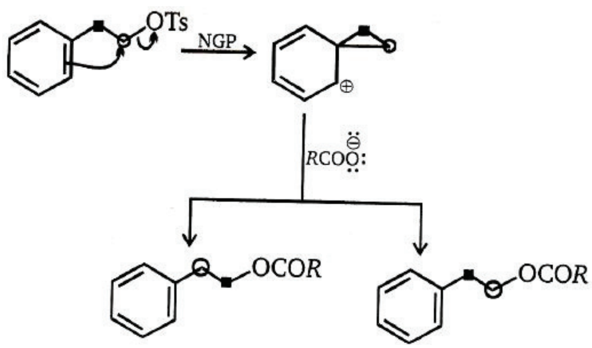
16. Conceptual

17. The sliding tendency of point of contact of the disc may be forward or backward depending on relative value of F and Fh. (B,C) sliding tendency of point of contact is forward so friction act in backward direction. The acceleration of C.M. will be in the direction of F

18. The sliding tendency of point of contact of the disc may be forward or backward depending on relative value of F and Fh. (B,C) sliding tendency of point of contact is forward so friction act in backward direction. The acceleration of C.M. will be in the direction of F

CHEMISTRY

19.



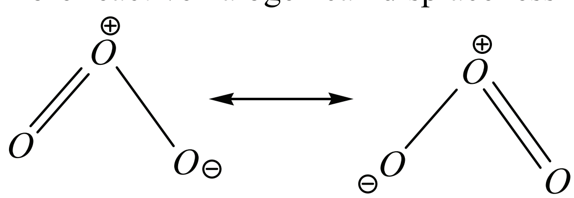
Both product (A) & (B) can be obtained by NGP (Neighbouring group participation).

20. Conceptual

21. All are facts

22. More reactive halogen can displace less reactive halogen from its salt solution

23.



Ozone is diamagnetic in nature (due to presence of paired electron) and both the $O-O$ bond length are equal. It has a bent structure.

24. In $S_2O_7^{2-}$ there is an $S-O-S$ bond unlike in other. So $S-S$ bond is absent as can be seen from the structure drawn.

$$\left[\begin{array}{c} \ \ O\ \ \ O \\ \ \ \|\ \ \ \| \\ -O-S-S-O- \end{array}\right]^{2-} ; \quad \left[\begin{array}{c} \ \ O\ \ \ \ \ \ \ O \\ \ \ \|\ \ \ \ \ \ \ \| \\ -O-S-O-S-O- \\ \ \ \|\ \ \ \ \ \ \ \| \\ \ \ O\ \ \ \ \ \ \ O \end{array}\right]^{2-} ;$$

$S_2O_4^{2-}$ $\qquad$ $S_2O_7^{2-}$

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09-01-2022_Sr.Super60_Jee-Adv(2019-P1)_PTA-17 Final Key

S.NO	SUB	Q.NO	GIVEN KEY	FINALIZED KEY	EXPLANATION
1	PHY	9	AC	ABCD	He said "displacement of $\frac{A}{2}$"soit can be after one round also.
2	PHY	17	2.7 to 2.9	2.60 to 3.00	Range should be given
3	CHE	33	8	8 or 8000	Units not mentioned KJ (or) J
4	MAT	48	AD	D	We can take A=(0.15,0.75)&C=(0.05,0.9)

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

Q.P Setters _ GNT_ICON/VIJ_RB-1

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S.NO	SUB	Q.NO	GIVEN KEY	FINALIZED KEY	EXPLANATION
1	PHY	18	A	A or D	D is also correct.

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