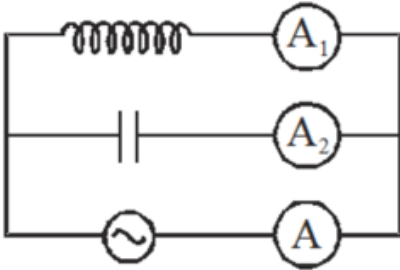## Physics Numerical (Maximum Marks: 28)

Question No. 1
Numerical Type
The answer has to be filled into the input box provided below.

Consider a circuit with an alternating source and contains inductor and capacitor. Given reading of A_1 and A_2 as 3 ampere and 5 ampere respectively. Find the reading of A in ampere.
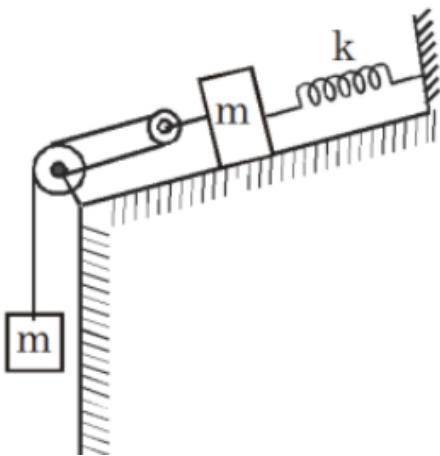

Question No. 2
Numerical Type
The answer has to be filled into the input box provided below.

In the given figure time period (in second) of small oscillations is (m = 1 kg, k = 5 N/m)
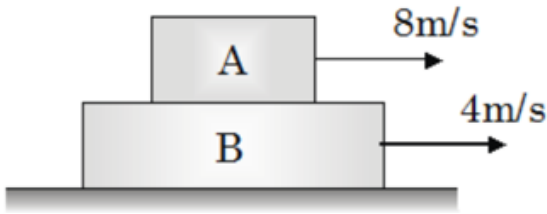

Question No. 3
Numerical Type
The answer has to be filled into the input box provided below.

At an instant t = 0 , Block A of mass 1 kg is moving with speed 8 m/s towards right on rough surface of block B of mass 3 kg. Block B, which is placed on smooth horizontal surface is moving with speed 4 m/s towards right at same instant ($t = 0$) . The net work done against the frictional force in long time is (block A will not fall from block B)

Question No. 4
Numerical Type
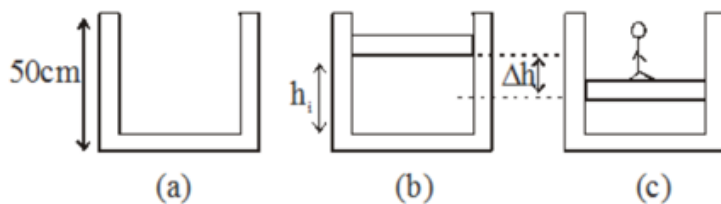The answer has to be filled into the input box provided below.

In YDSE experiment two thin transparent sheets are used in front of the slits S_1 and S_2, one of the thin sheet has refractive index $\mu_1 = 1.6$ and other has $\mu_2 = 1.4$. If both sheets have average thickness ($\frac{t_1+t_2}{2}$) the central maxima is at 5 mm from center O. Now the sheets are replaced by two sheets of same material of refractive index ($\frac{\mu_1+\mu_2}{2}$) but having thickness t_1 and t_2 now central maxima is observed at a distance of 8 mm from center O. For $t_1 > t_2$ find the ratio $\frac{t_1}{t_2}$.
Given d = 1 mm, D = 1 m

Question No. 5
Numerical Type
The answer has to be filled into the input box provided below.

A highly conducting cylinder that has cross-sectional area of 100 cm^2 and 50 cm deep is filled with air at 21°C and 1.00 atm figure (a). A 20 kg piston is now lowered into the cylinder, compressing the air trapped inside figure (b). Finally a 80 kg man stands on the piston, further compressing the air, which remains at 21°C figure (c). What temperature T (in °C) should the gas be maintained to raise the piston and the man back to h_i. Take g = 10 m/s^2
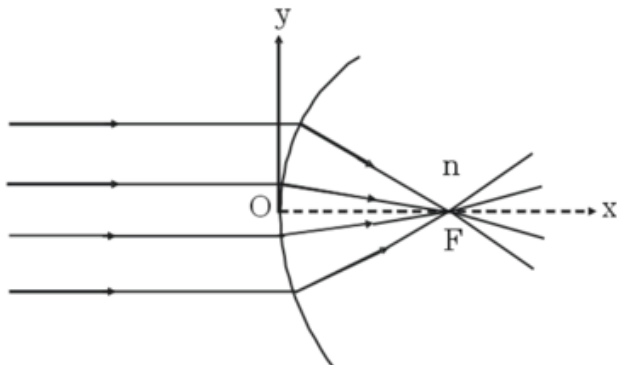

Question No. 6
Numerical Type
The answer has to be filled into the input box provided below.

Section of a refracting surface is shown in figure. The section is symmetrical about x axis. Refractive index of medium on right of the surface is n with respect to the medium on left of the surface. Parallel monochromatic light rays are incident on the surface as shown in figure and the refracted rays are focused at F at a distance f from origin O of the co-ordinate system shown in figure. The equation $y(x)$ of shape of the section shown is found to be

$(n^2 - 1)x^2 + n^2 y^2 - Bn(n-1)$ $fx = 0$. Find B.

Question No. 7
Numerical Type
The answer has to be filled into the input box provided below.

Consider an infinite mesh as shown in figure Each side of the mesh has resistance R. Consider hexagonal part ABCDEF of infinite mesh and equivalent resistance between any two points of hexagon is measured. Equivalent resistance between A and B is $\frac{\alpha R}{\beta}$. find the least value of $\alpha + \beta$.
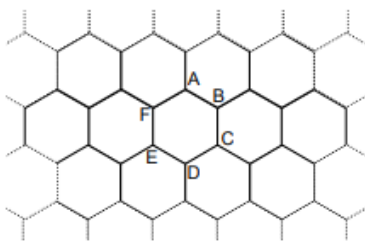
Physics Multiple Correct (Maximum Marks: 28)

Question No. 1
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

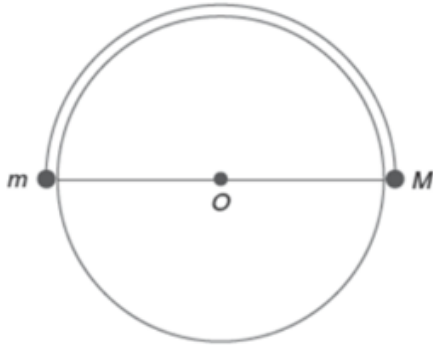Two particles of masses M and $m(M > m)$ are connected by a light string of length πR and lying in vertical plane. The string is hung over a fixed circular frame of radius R. Initially the particles lie at the ends of the horizontal diameter of the circle (see figure). Neglect friction.

If the system is released, and if m remains in contact with the circle, the speed of the masses

A. when M has descended through a distance $R\theta(\theta < \pi)$ is $\sqrt{2gR \frac{(M\theta - m\sin\theta)}{M+m}}$

If the system is released, and if m remains in contact with the circle, the reaction force between the frame and m when M has descended through a distance $R\theta(\theta < \pi)$ is

B. $\frac{mg}{M+m} [(M + 3\,m)\sin\theta - 2M\theta]$

C. m will certainly remain in contact with the frame, just after the release, if $4m > M$.

D. m will certainly remain in contact with the frame, just after the release, if $3\,m > M$.

Question No. 2
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

A uniform disc of mass m and radius R is kept on frictionless horizontal surface. The Figure shows top view of the smooth surface. Two particles each of mass m are connected to the disc by two identical light inextensible strings as shown in the figure. The particles are given velocity V_0 perpendicular to the length of strings. Select the correct the alternatives for the moment just after the projection.
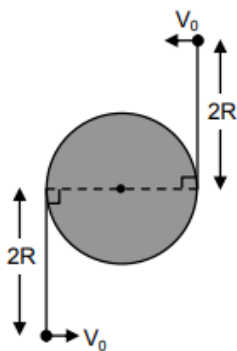
A. Acceleration of the particle will be $\frac{V_0^2}{2R}$

B. Angular acceleration of disc will be $\frac{2V_0^2}{5R^2}$

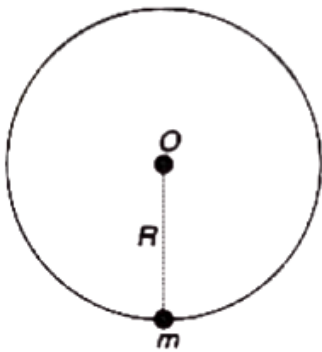C. Tension in the strings is $\frac{m_0^2}{20R}$

D. Tension in the strings is $\frac{mV_0^2}{10R}$

Question No. 3
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

A disc of mass $M = 2m$ and radius R is pivoted at its centre. The disc is free to rotate in the vertical plane about its horizontal axis through its centre O. A particle of mass m is stuck on the periphery of the disc. The frequency of small oscillations of the system about its equilibrium position.

A. $\frac{1}{2\pi} \sqrt{\dfrac{g}{R}}$

B. $\frac{1}{2\pi} \sqrt{\dfrac{g}{2R}}$

C. $\frac{1}{\pi} \sqrt{\dfrac{g}{2R}}$

D. $\frac{1}{\pi} \sqrt{\dfrac{g}{R}}$

Question No. 4
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

In a standard YDSE setup, the fringe width on the screen is 1.5 mm. When a thin glass film is pasted in front of the upper slit, the fringe pattern shifts up. But it is seen that at a point P above central maxima where intensity was one fourth the intensity at central maxima, intensity remains the same. There were no maxima between central maxima and point P before film was introduced. What can be the thickness of the film ? Take $\mu = 1.5, \lambda = 450$ nm   :-

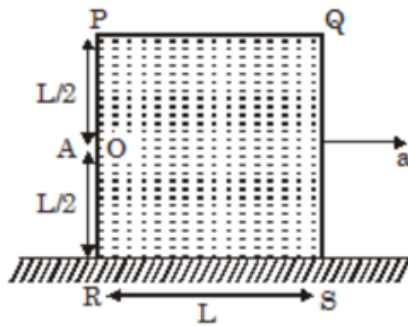A. 3×10^{-7} m

B. 5×10^{-7} m

C. 9×10^{-7} m

D. 1.4×10^{-6} m

Question No. 5
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

A small solid ball of density ρ is held inside at point A of cubical container of side L, filled with an ideal liquid of density 4ρ as shown in the figure. Now, if the container starts moving with constant acceleration a horizontally and the ball is released from point A simultaneously, then

A. For ball to hit the top of container at end Q, a = 3 g
B. For ball to hit the top of container at end $Q, a = 2g$
C. Ball hits the top of container at end Q after a time $t = \sqrt{\dfrac{L}{3g}}$
D. Ball hits the top of container at end Q after a time $t = \sqrt{\dfrac{2L}{3g}}$

Question No. 6
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

A potentiometer as shown in figure in which three batteries between A \& B are connected when the point P is the null point, measured by the potentiometer arrangement. Then choose correct statement(s)
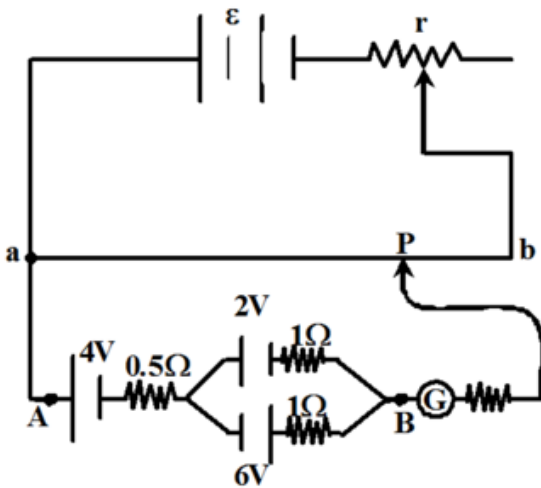
A. Current passing through 6 V battery is 4 A
B. Current passing through 2 V battery is 4 A
C. $V_A - V_B = 2$ V
D. $V_A - V_B = 6$ V

Question No. 7
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

A spherical surface separates air \& medium for which $\mu = 1.615$ for violet and $\mu = 1.600$ for red color. A paraxial beam parallel to optic axis is incident on the surface as shown. The distance between point of convergence for violet and red color is Δf.

A. $\Delta f = 0.41$ cm
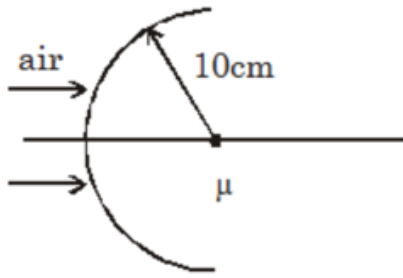B. Point of convergence for red is closer to optical centre than that for violet.
C. Point of convergence for violet is closer to optical centre than that for red.
D. $\Delta f = 0.84$ cm .

Physics Single Correct (Maximum Marks: 6)

Question No. 1
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

An observer ' O ' at an accelerated trolley observes a projectile Q of mass 5 kg moving under uniform gravitational field of earth acting towards negative z-axis. He observes the momentum $\vec{P}$ of the projectile Q as $\vec{P} = 15t\hat{i} - 10t^2\hat{j} - 50t\hat{k}$(kg m/s)   , where t denotes time in second. Find the acceleration of the trolley at $t = 2$sec . (Take g $= 10$ m/s^2)

A. $6\hat{i} - 8\hat{j} - 20\hat{k}$m/s^2
B. $3\hat{i} - 8\hat{j}$m/s^2
C. $-3\hat{i} - 8\hat{j}$m/s^2
D. $-3\hat{i} + 8\hat{j}$ m/s^2

Question No. 2
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

A plane thick wall having uniform surface temperature along planes are $0°$K and $T_0°$K$(T_0 = 300$ K) at x $= 0$ and x $= x_0$ respectively. Thermal conductivity varies linearly with temperature

K $= K_0(1 + T)$ The temperature of wall at the plane x $= 2x_0$ is approximately: (where T is in kelvin)

A. 300 K
B. 400 K
C. 425 K
D. 450 K

Physics Matrix Match Type (Maximum Marks: 6)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Two light rods of length 1 m each are hinged together as shown in figure. Rod AB makes an angle θ with vertical while rod BC makes an angle ϕ with horizontal. End C of rod BC remains in contact with horizontal. Rod AB is rotated with constant angular velocity $\omega = 1$rad/s in clockwise direction. At the instant when $\theta = 30°$ and $\phi = 30°$ match the variables in list-I with values in list-II.
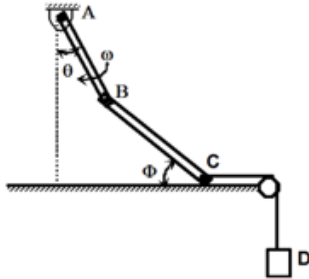
	List-I		List-II
(P)	Angular velocity of rod BC in rad/s	(1)	$\frac{(3\sqrt{3}+1)}{3\sqrt{3}}$
(Q)	Velocity of block D in m/s	(2)	$\frac{(\sqrt{3}-1)}{\sqrt{6}}$
(R)	Magnitude of angular acceleration of rod BC in rad/s^2	(3)	$\frac{1}{\sqrt{3}}$
(S)	Acceleration of point B in m/s^2	(4)	1

A. $P \to 4; Q \to 1; R \to 2; S \to 3$
B. $P \to 1; Q \to 4; R \to 3; S \to 2$
C. $P \to 3; Q \to 3; R \to 1; S \to 4$
D. $P \to 3; Q \to 2; R \to 4; S \to 1$

Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Consider a system of five large conducting plates of area A. The charge on plate $1, 2, 3, 4, 5$ are given as $Q, 2Q, 3Q, 4Q$ and $5Q$ respectively. Initially the two switches are opened. Area of each plate is A. The distance between every successive plate is very very small equal to d.

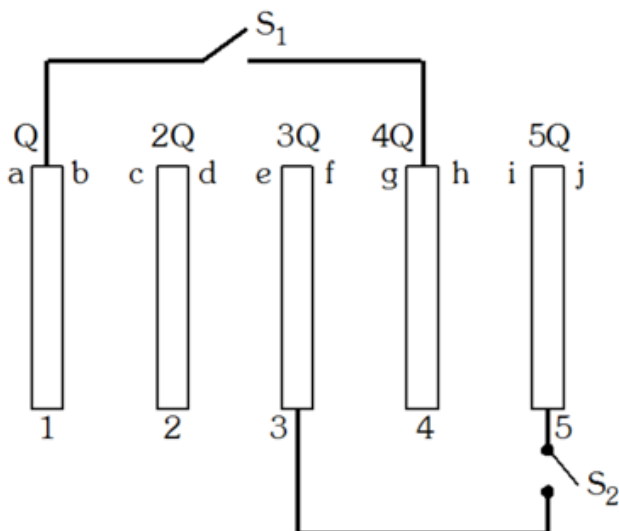|	List-I		List-II
(P)	The charge on surface b is	(1)	$-\frac{9}{2}\left(\frac{Qd}{A\varepsilon_0}\right)$
(Q)	The potential difference between plate 2 and 3 $(V_2 - V_3)$ is	(2)	$-0.6Q$
	Now both the switches S_1 and S_2 are closed simultaneously. Now Consider a new steady state.		
(R)	The charge on surface b is	(3)	$-1.3Q$
(S)	The charge on surface f is	(4)	None of these

A. $P \rightarrow 4; Q \rightarrow 3; R \rightarrow 1; S \rightarrow 4$
B. $P \rightarrow 2; Q \rightarrow 4; R \rightarrow 3; S \rightarrow 2$
C. $P \rightarrow 3; Q \rightarrow 3; R \rightarrow 1; S \rightarrow 4$
D. $P \rightarrow 4; Q \rightarrow 1; R \rightarrow 3; S \rightarrow 4$

Chemistry Numerical (Maximum Marks: 28)

Question No. 1
Numerical Type
The answer has to be filled into the input box provided below.

40ml of 0.05M solution of sodium sesquicarbonate $(Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O)$ is titrated against 0.05M HCl. " X " ml of HCl is used when phenolphthalein is the indicator and " Y " ml of HCl is used when methyl orange is the indicator in two separate titrations. Hence, value of $\frac{(Y-X)}{10}$ is

Question No. 2
Numerical Type
The answer has to be filled into the input box provided below.

Following reaction takes place at $(\frac{600}{2.303\times0.8314})K$ temperature.

$$H_2(g) + 2Ag^+(aq) \rightleftharpoons 2Ag(s) + 2H^+(aq)$$
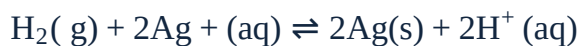
$P_{H_2} = 1.0\text{bar}, [Ag^+] = 10^{-6}\,M, [H^+] = 10^{-3}\,M, \quad \Delta_f G°(Ag^+, aq) = 75\text{ kJ mol}^{-1}$

Calculate z.

where $z = \dfrac{|\Delta_r G(\text{ in kJ})|}{19}$

Question No. 3
Numerical Type
The answer has to be filled into the input box provided below.

1 mol of $IO_3^\ominus$ ions is heated with excess of $I^\ominus$ ions in the presence of acidic conditions as per the following equation $IO_3^\ominus + I^\ominus \longrightarrow I_2$. How many moles of acidified hypo solution will be required to react completely with I_2 thus produced ?

Question No. 4
Numerical Type
The answer has to be filled into the input box provided below.

How many isomers (X) of C_8H_{10} when reacts with hot alkaline $KMnO_4$ gives only aromatic dicarboxylic acid? How many isomers (Y) of C_4H_8 when reacts with hot alkaline $KMnO_4$ to give carbondioxide? What is the sum of 'X' and 'Y' ?

Question No. 5
Numerical Type
The answer has to be filled into the input box provided below.

How many of the following compound(s) give precipitate with solution of chrome alum.

(i) $BaCl_2$

(ii) Na_2CO_3

(iii) $(NH_4)_2 S$

(iv) Excess $NaOH$

Question No. 6
Numerical Type
The answer has to be filled into the input box provided below.

1 mole of an ideal gas initially present in a 2 L insulated cylinder at 300 K is allowed to expand against vaccum to 8 L. then $|\Delta G_{sys}|$ in calories will be [$\ln 2 = 0.7$]

Question No. 7

Numerical Type

The answer has to be filled into the input box provided below.

One mole of a real gas obeys $P(V_m - b) = RT$; where ' b ' and ' R ' are constants with usual meanings. If occupied volume of the gas is ' $10b$ ' then the compressibility factor of gas will be :

Chemistry Multiple Correct (Maximum Marks: 28)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which process of metal purification is also associated with distillation of metal

A. Parke's process
B. Amalgamation
C. Polling
D. Puddling process

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A and B are two volatile liquids with their vapour pressure : $P_A^0 = 340 \text{ mm}$ of Hg and $P_B^0 = 420 \text{ mm}$ of Hg at 25˚C. To a flask containing 8 mole of 'A' , 5 mole of ' B ' was added. As soon as ' B ' was added , 'A' starts associating to form a non-volatile solid A_x (solid) which is soluble in both liquids A and B. The association of 'A' follows 1st order kinetics. The vapour pressure of solution measured after 1 hour is 360 mm of Hg and after very long time it is 300 mm of Hg. Identify correct statements(s)

A. The value of $x = 4$
B. At t = 1hr, 0.5 mole of A_x (solid) is formed
C. At t = 1hr, 4 mole of 'A' (liquid) remains in solution.
D. The value of $x = 2$

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following element(s) undergoes disproportination in basic medium?

A. P_4
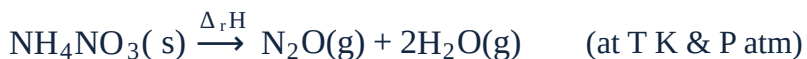B. Cl_2
C. S_8
D. Si

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

For thermal decomposition of $NH_4NO_3(s)$:

The correct information(s) is/are -

$$NH_4NO_3(s) \xrightarrow{\Delta_r H} N_2O(g) + 2H_2O(g) \qquad \text{(at T K \& P atm)}$$

    A. Heat of reaction is positive
    B. Entropy change of the reaction must be $\frac{\Delta_r H}{T}$
    C. Heat of reaction at constant volume is equal to $(\Delta_r H = 3RT)$
    D. $\Delta_r G$ of this reaction may be negative at high temperature.

Question No. 5
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

Select the correct statement(s) regarding following galvanic cell taken at temperature TK .
$$Pt \mid H_2(g, 1 \text{ bar}) \big| HCl(10^{-3} M) \big| AgCl(s) \mid Ag(s)$$
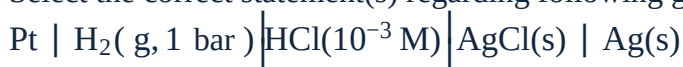
Given that : $\frac{2.303RT}{F} = 0.06$ volt

$\& E^o_{Ag|AgCl|Cl^-} = -0.18\text{volt}$

    A. Cell potential of this cell is 0.54 volt.
    B. During discharging, $H_2(g)$ converts into H^+ (aq.)
    C. $H_2(g)$ is obtained at cathode during working of this galvanic cell.
    D. $E^\circ Ag^+ \mid Ag$ is equal to 0.78 volt if K_{sp} of AgCl is 1×10^{-10} .

Question No. 6
One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

The wave function of two different orbitals X and Y in Be^{+3} ion are given by -

$$\psi_X = \frac{1}{9\sqrt{3}} \left(\frac{1}{4\pi}\right)^{1/2} \left(\frac{z}{a_0}\right)^{3/2} (6 - 6\sigma + \sigma^2)e^{-\sigma/2}$$

$$\psi_Y = \frac{1}{9\sqrt{6}} \left(\frac{3}{4\pi}\right)^{1/2} \left(\frac{z}{a_0}\right)^{3/2} (4 - \sigma)\sigma e^{-\sigma/2} \cos\theta$$

$$\sigma = \frac{2zr}{na_0}$$

where $a_0 = 1^{st}$ Bohr radius of H-atom, $z =$ Charge number of nucleus, $r =$ distance from nucleus From this we can conclude :

    A. Total number of nodal surface is same for both orbitals
    B. The angular nodal surface of Y orbital will occur at $\theta = \frac{\pi}{2}$
    C. Energy of electron in Y-orbital is greater than in X-orbital
    D. Average distance of X orbital from nucleus is greater than Y orbital

Question No. 7

One or More Options Correct Type
The question has multiple options out of which ONE or MORE is/are correct.

Select process which is/are exothermic $(\Delta H = -ve)$:

A. $Li^{+2}_{(g)} + He_{(g)} \rightarrow Li^{+}_{(g)} + He^{+}_{(g)}$
B. $O^{-}_{(g)} + S_{(g)} \rightarrow O_{(g)} + S^{-}_{(g)}$
C. Conversion of tetrachloridocobaltate(II) ion to hexaaquacobalt(II) ion in aqueous solution.
D. dioxygenium ion $+e^{-} \rightarrow$ molecular oxygen

Chemistry Single Correct (Maximum Marks: 6)

Question No. 1
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

In a hypothetical solid, "C" atoms forming cubical closed packed lattice. "A" atoms occupy all tetrahedral void and "B" atoms occupy all octahedral voids. There is no distortion in ccp lattice. Fraction of body diagonal not covered up by atoms is : :

A. 0.76
B. 0.24
C. 0.68
D. 0.12

Question No. 2
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

product.

$(X + Y)$ is :

A. 3
B. 2
C. 4
D. 8

Chemistry Matrix Match Type (Maximum Marks: 6)

Question No. 1
Only One Option Correct Type
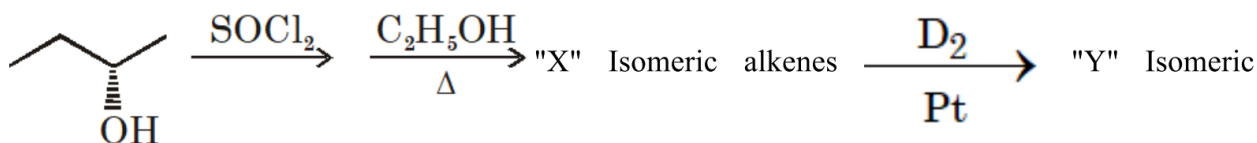Each question has multiple options out of which ONLY ONE is correct.

Complete the following reactions identify the major products and apply a chemical test to distinguish between following pairs :

	List-I (Pairs)		List-II (Chemical Test)
(P)	J and M	(1)	Na-metal
(Q)	J and K	(2)	NaOI
(R)	K and M	(3)	2,4-DNP
(S)	L and M	(4)	NaHSO$_3$

Reactions are as follows

$$CH_3MgBr \begin{cases} \xrightarrow[\text{(ii) } NH_4Cl]{\text{(i) } CO_2} J \\[4pt] \xrightarrow[\text{(ii) } H_3O^{\oplus}]{\text{(i) } CH_3CN} K \\[4pt] \xrightarrow{CH_3OH/H^{\oplus}} L \\[4pt] \xrightarrow[\text{(ii) } H_3O^{\oplus}]{\text{(i) } CH_2O} M \end{cases}$$
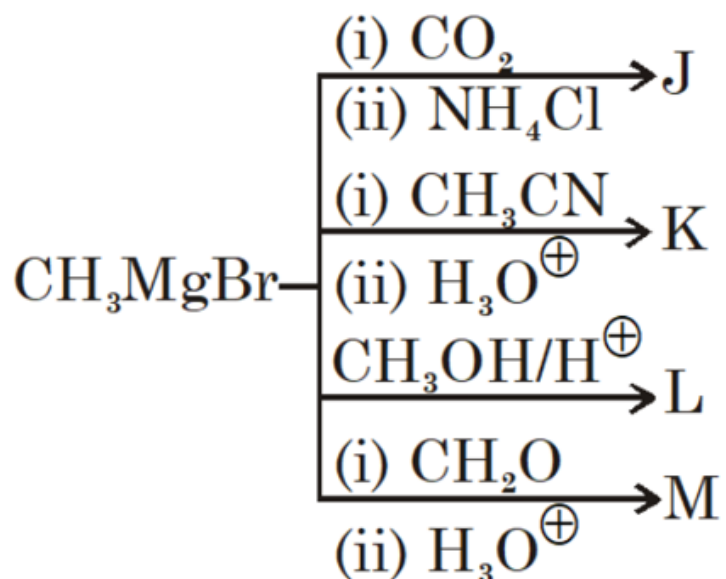
A. P → 3; Q → 2; R → 1; S → 4
B. P → 2; Q → 3; R → 4; S → 1
C. P → 2; Q → 1; R → 3; S → 4
D. P → 1; Q → 2; R → 4; S → 3

Question No. 2
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

	List-I		List-II
(P)	Aniline with $CHCl_3$, KOH/Δ	(1)	Carbanion is intermediate
(Q)	Phenyl CH(D) group attached to $C(=O)-NH_2$ with $KOBr$	(2)	Carbene is intermediate
(R)	Phenol with (i)$CHCl_3/NaOH$ (ii)$H^{\oplus}$	(3)	Product containing N-atom
(S)	H_3C, H $C=N$ OH with H_2SO_4, Δ	(4)	Cyanide or isocyanide is product

A. P → 1, 3, 4; Q → 3, 4; R → 2, 3; S → 2, 3, 4
B. P → 1, 2, 3, 4; Q → 3; R → 1, 2; S → 3, 4
C. P → 2; Q → 1, 3, 4; R → 2, 3; S → 1, 2
D. P → 3, 4; Q → 3, 4; R → 2, 3; S → 2, 3

Mathematics Numerical (Maximum Marks: 28)

Question No. 1
Numerical Type
The answer has to be filled into the input box provided below.

Given two circle $x^2 + y^2 + 3\sqrt{2}(x+y) = 0$ and $x^2 + y^2 + 5\sqrt{2}(x+y) = 0$, the radius of third circle which is tangent to the two given circles and to their common diametre is

Question No. 2
Numerical Type
The answer has to be filled into the input box provided below.

Let $f(x)$ is a quadratic expression with positive integral coefficients such that for every. $\alpha\beta \in R$, $\beta > \alpha$.

$\int_\alpha^\beta f(x)dx > 0$ Let $g(t) = f''(t) \cdot f(t)$ and $g(0) = 12$. If no of quadratics are ab where a and b are natural number than $\frac{a+b}{2}$ is equal to. (ab is 2 digit number)

Question No. 3
Numerical Type

The answer has to be filled into the input box provided below.

Let $f(x) = \begin{vmatrix} \sec x & \cos x & \sec^2 x + \cot x \csc x + \cos x \\ \cos^2 x & \cos^2 x & \csc^2 x + \cos^4 x \\ 1 & \cos^2 x & \cos^2 x \end{vmatrix}$ then the value $\left| \int_0^{\pi/2} f(x)\,dx \right|$ is

(use $\pi = \frac{22}{7}$)

Question No. 4
Numerical Type

The answer has to be filled into the input box provided below.

OA, OB, OC are the sides of a rectangular parallelopiped whose diagonals are OO', AA', BB' and CC'. D is the centre of rectangle $AC'O'B'$ and D' is centre of rectangle $O'A'CB'$. If sides OA, OB, OC are in ratio $1 : 2 : 3$ and $\angle DOD' = \alpha$ then $\frac{697\cos^2\alpha}{128}$ is (Centre of rectangle is mid point of diagonal)

Question No. 5
Numerical Type

The answer has to be filled into the input box provided below.

All the face cards from a pack of 52 playing cards are removed. From the remaining pack half of the cards are randomly removed whithout looking at them and then randomly drawn two cards simultaneously from the remaining. If the probability that, two cards drawn are both aces, is $\frac{p\left(^{38}C_{20}\right)}{^{40}C_{20} \cdot ^{20}C_2}$, then the value of p is ?

Question No. 6
Numerical Type

The answer has to be filled into the input box provided below.

Normal to the curve $y = f(x)$ at $(1, 1)$ is $3x + 4y = 7$. Also $f(x) \geqslant \frac{4x-1}{3}$ for $x \geq 1$ and $f(x) \leqslant \frac{4x-1}{3}$ for $x \leq 1$. where $f(x)$ is twice differentiable everywhere in its domain. Evaluate $\lim_{x \to 1} \frac{3f'(x) - 2f(x) - 2x}{f(x) - x^2}$

Question No. 7
Numerical Type

The answer has to be filled into the input box provided below.

A sequence is obtained by deleting all perfect squares from set of natural number. The remainder when the 2003$^{\text{rd}}$ term of new sequence is divided by 2048, is ?

Mathematics Multiple Correct (Maximum Marks: 28)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let $(x - k)^2 + y^2 = r^2, (k, r > 0)$ is the largest circle, no part of which is lying outside the ellipse $3x^2 + 4y^2 = 12$. Now

   A. if $k < \frac{1}{2}$ then $r + k = 2$
   B. if $k > \frac{1}{2}$ then $r + k = 2$
   C. if $k < \frac{1}{2}$ then $r + k < 2$
   D. if $k > \frac{1}{2}$ then $r + k < 2$

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let $C_k = {}^nC_k$ for $0 \le k \le n$ and $A_k = \begin{bmatrix} C_{k-1} & 0 \\ 0 & C_k \end{bmatrix}$ for $k \ge 1$ and

$A_1 A_2 + A_2 A_3 + A_3 A_4 + \ldots + A_{n-1} A_n = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$ then

   A. $a = b$
   B. $a + b = 2({}^{2n}C_{n-1} - n)$
   C. $a = 2b$
   D. $a + b = 0$

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Probability that the length of a randomly chosen chord of a circle lies between $\frac{1}{2}$ and $\frac{3}{4}$ of its diameter is $\frac{p}{q}$ where p and q are coprime number, then

   A. $p + q = 21$
   B. $q - p = 11$
   C. $p + q = 20$
   D. $q - p = 10$

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

For two complex numbers z_1 and z_2; $(az_1 + b\bar{Z}_1)(czz_2 + d\bar{z}_2) = (cz_1 + d\bar{z}_1)(azz_2 + b\bar{Z}_2)$

if

   A. $\frac{a}{b} = \frac{c}{d}$
   B. $\frac{a}{d} = \frac{b}{c}$
   C. $|z_1| = |z_2|$
   D. $\arg(z_1) = \arg(z_2)$

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let $f(x)$ be a differentiable function for $x > -1$ and $f(0) = 1$, $f'(0) > 0$ also $f'(x)(1 + f(x)) = 1 + x$ then

    A. $f'(x) > 0 \forall x > 0$
    B. $f'(x) < 0 \forall x > 0$
    C. $f(x) > -1 \forall x > 0$
    D. $f(x) < -1 \forall x > 0$

Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

For distinct complex numbers $z_1, z_2, \ldots, z_n$, $(n > 2)$ the value of

$$\frac{|z_2 - z_1|^2 + |z_3 - z_2|^2 + \ldots + |z_n - z_{n-1}|^2}{|z_n - z_1|^2}$$ can not be less than

    A. $\frac{1}{n-1}$
    B. $\frac{1}{n}$
    C. $\frac{1}{n+1}$
    D. $\frac{1}{n+2}$

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

In $\triangle ABC$ (with usual notation), if $\cos A + \cos B = 4\sin^2 \frac{C}{2}$, then which of the following hold(s) good?

    A. $\cot \frac{A}{2} \cot \frac{B}{2} = 2$
    B. $\cot \frac{A}{2} \cot \frac{B}{2} = 3$
    C. a, c, b are in A.P.
    D. a, b, c are in G.P.

Mathematics Single Correct (Maximum Marks: 6)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

The tangent at any point $P(a\sec\theta, b\tan\theta)$ of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ makes an intercept of length p between the point of contact and the transverse axis of the hyperbola. If p_1, p_2 are the lengths of the perpendiculars drawn from the foci on the normal at P, then

    A. p is an arithmetic mean between p_1 and p_2
    B. p is a geometric mean between p_1 and p_2
    C. p is a harmonic mean between p_1 and p_2
    D. none of these

Question No. 2
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

The minimum number of real roots of $(x^2 + 3x + a)(x^2 + ax + 1) = 0$, is (where $a \in R$)

   A. 4
   B. 2
   C. 0
   D. 1

Mathematics Matrix Match Type (Maximum Marks: 6)

Question No. 1
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

Let $\phi(x) = 3f(\frac{x^2}{3}) + f(3 - x^2) \forall x \in (-3, 4)$ where $f''(x) > 0 \forall x \in (-3, 4)$,

$g(x) = (a^2 - 3a + 2)(\cos^2 \frac{x}{4} - \sin^2 \frac{x}{4}) + (a - 1)x + \sin 1$

Match List-I with List-II and select the correct answer using the code given below the list.

	List-I		List-II
(P)	$\phi(x)$ is increasing in	(1)	$(0, 1) \cup (1, 4)$
(Q)	$\phi(x)$ is decreasing in	(2)	$\left[-\frac{3}{2}, 0\right] ; \left[\frac{3}{2}, 4\right)$
(R)	The set of values of a for which g(x) does not possess critical point is	(3)	$\left(-3, -\frac{3}{2}\right] ; \left[0, \frac{3}{2}\right]$
(S)	The set of values of a for which g(x) possess critical point is	(4)	$(-\infty, 0] \cup \{1\} \cup [4, \infty)$

   A. $P \rightarrow 2; Q \rightarrow 3; R \rightarrow 1; S \rightarrow 4$
   B. $P \rightarrow 2; Q \rightarrow 3; R \rightarrow 4; S \rightarrow 1$
   C. $P \rightarrow 3; Q \rightarrow 2; R \rightarrow 1; S \rightarrow 4$
   D. $P \rightarrow 3; Q \rightarrow 2; R \rightarrow 4; S \rightarrow 1$

Question No. 2
Only One Option Correct Type
Each question has multiple options out of which ONLY ONE is correct.

(i) Let harmonic mean, arithmetic mean and geometric mean of two positive numbers a and b respectively be 4, A and G. If $2A + G^2 = 27$ then $a^2 + b^2 = \alpha_1$

(ii) If the value of $x + y + z = 15$ where a, x, y, z, b are in arithmetic progression while the value of $\frac{1}{x} + \frac{1}{y} + \frac{1}{z}$ is $\frac{5}{8}$ where a, x, y, z, b are in harmonic progression, then the value of $a^2 + b^2$ is α_2

(iii) The value of $\sum_{r=1}^{16} \left(\frac{1^3 + 2^3 + \ldots\ldots + r^3}{1 + 3 + \ldots + (2r-1)} \right)$ is α_3

(iv) If the geometric mean and harmonic mean of two positive numbers x_1 and x_2 are 18 and $\frac{216}{13}$ respectively then the value of $|x_1 - x_2|$ is α_4.

Match List-I with List-II and select the correct answer using the code given below the list.

	List-I		List-II
(P)	The value of α_1 is	(1)	52
(Q)	The value of α_2 is	(2)	45
(R)	The value of α_3 is	(3)	446
(S)	The value of α_4 is	(4)	15

A. P → 2; Q → 1; R → 2; S → 3
B. P → 2; Q → 2; R → 1; S → 4
C. P → 2; Q → 1; R → 3; S → 4
D. P → 1; Q → 1; R → 4; S → 2