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BEWARE OF NEGATIVE MARKING

PART-1 : PHYSICS

SECTION-1 : (Maximum Marks : 21)

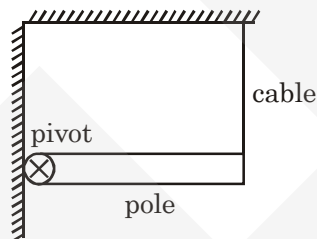
- This section contains **SEVEN** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

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Zero Marks : 0 If none of the bubbles is darkened.

Negative Marks : -1 In all other cases

1. A uniform pole is attached to a vertical wall by a frictionless pivot. The pole is held horizontal by a vertical massless cable attached to the ceiling as shown in the diagram. Considering torques on the pole about the axis of the pivot, which of the statement is **CORRECT** ?



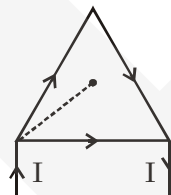
- (A) The magnitude of the torque due to tension in the cable is greater than the magnitude of torque due to weight of pole.
- (B) The magnitude of the torque due to pivot on the pole is equal to the magnitude of torque due to weight of pole.
- (C) The magnitude of torque due to tension in cable is equal to magnitude of torque due weight of pole.
- (D) Tension in cable is more than the weight of the pole

Space for Rough Work

2. For progressive wave : $y = (2\text{cm}) \sin(3t - 4x)$
 Statement-1 : The particle at $x = 0$ is moving towards positive y -axis at $t = 0$.
 Statement-2 : The particle at $x = 8\text{m}$ is in phase with particle at $x = 1\text{m}$.
 Statement-3 : The acceleration of particle at $x = \frac{\pi}{8}\text{m}$ at $t = \frac{\pi}{6}\text{sec}$ is increasing in magnitude.
 Statement-4 : The velocity of particle at $x = \frac{\pi}{6}\text{m}$ is in direction of propagation of wave at all times.

The **CORRECT** statement are :

- (A) 1 (B) 1 and 3 (C) 1, 2 and 3 (D) 1, 2, 3 and 4
3. An organ pipe open at both ends is oscillating in fifth overtone. The separation between two points where pressure amplitude is $\frac{1}{\sqrt{2}}$ times the pressure amplitude at the anti-nodes is 10cm. The length of the organ tube is : (Take speed of sound in air to be 330 m/s)
- (A) 40 cm (B) 80 cm (C) 100 cm (D) 120 cm
4. A wire of uniform resistance per unit length is bent to form an equilateral triangle of side L . A current I flows into one corner and flows out of an adjacent corner, as shown. The magnetic field at the centroid of triangle due to the current in the triangular frame is



- (A) $3\mu_0 I/2\pi L$ (B) $3\mu_0 I/\pi L$ (C) $3\sqrt{3}\mu_0 I/2\pi L$ (D) zero

Space for Rough Work

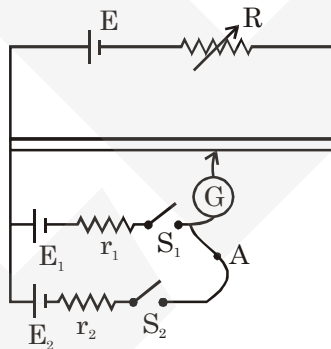
5. Rank the vernier callipers/screw gauge in the order of their increasing precision :
- (1) Screw gauge having main scale division 1mm and no. of circular division = 200.
(2) Screw gauge having main scale division 0.5 mm and no. of circular division = 400.
(3) Vernier callipers having main scale division = 1mm such that 9 MSD = 10 VSD.
(4) Vernier callipers having main scale division = 1mm such that 4 MSD = 5 VSD.
- (A) $4 < 2 < 3 < 1$ (B) $2 < 4 < 1 < 3$ (C) $4 < 3 < 2 < 1$ (D) $4 < 3 < 1 < 2$
6. For a liquid moving in a cylindrical tube of radius R and length ℓ , the pressure difference at the ends of the tube is related by poiseuille's law given by $\Delta P = \left(\frac{8\eta\ell}{\pi r^4}\right)Q$. For a tube having radius $r = 2.00 \text{ cm} \pm 0.01 \text{ cm}$, $\ell = 10.0 \text{ cm} \pm 0.1 \text{ cm}$ the error in measurement of pressure difference is : (Take : $\eta = \pi \text{ N-s/m}^2$, $Q = 1 \text{ m}^3/\text{sec}$)
- (A) 2% (B) 3% (C) 4% (D) 6%
7. A thin mica sheet ($\mu = 1.6$) is used to cover one slit of Young's double slit arrangement. The central fringe is now formed at the previous seventh bright fringe. If $\lambda = 5500 \text{ \AA}$, the thickness of the mica sheet is :
- (A) $1.2 \mu\text{m}$ (B) $6.41 \mu\text{m}$ (C) 6.4 mm (D) $2.4 \mu\text{m}$

Space for Rough Work

SECTION-2 : (Maximum Marks: 28)

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- Answer to each question will be evaluated according to the following marking scheme:
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Partial Marks : +3 If all the four options are correct but **ONLY** three options are chosen.
Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option.
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- **For Example** : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -2 marks.

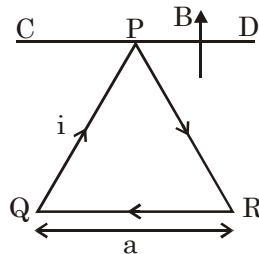
1. Two batteries of EMF E_1 and E_2 and internal resistance r_1 and r_2 respectively are connected across an potentiometer as shown. When only switch S_1 is closed, reading of potentiometer is l_1 . When only switch S_2 is closed, reading of potentiometer is l_2 . When both switches are closed, reading is l_3 . Mark the **CORRECT** statement(s) :



- (A) $l_3 = \frac{l_1 + l_2}{2}$
- (B) $l_1 < l_3 < l_2$ or $l_2 < l_3 < l_1$
- (C) If another galvanometer is attached at point A in series and both switches are closed, it will show zero deflection.
- (D) A change in primary circuit rheostat R changes all the reading of potentiometer.

Space for Rough Work

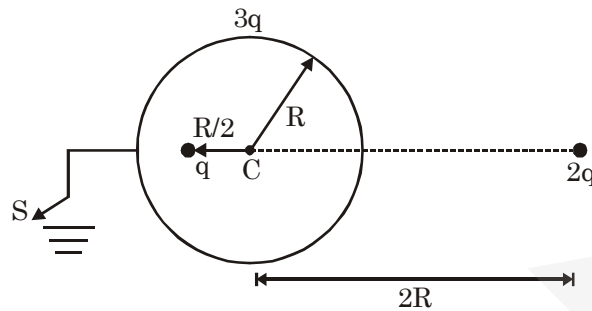
2. A loop PQR formed by three identical uniform conducting rods each of length 'a' is suspended from one of its vertices (P) so that it can rotate about horizontal fixed smooth axis CD. Initially plane of loop is in vertical plane. A constant current 'i' is flowing in the loop. Total mass of the loop is 'm'. At $t = 0$, a uniform magnetic field of strength B directed vertically upwards is switched on. Acceleration due to gravity is 'g'.



- (A) Minimum value of B so that the plane of the loop becomes horizontal (even for an instant) during its subsequent motion is $\frac{2mg}{3ia}$.
- (B) Minimum value of B so that the plane of the loop becomes horizontal (even for an instant) during its subsequent motion is $\frac{4mg}{3ia}$.
- (C) The equilibrium position (angle of the plane of the loop with vertical) is given by $\tan^{-1}\left(\frac{3Bai}{2mg}\right)$.
- (D) The equilibrium position (angle of the plane of the loop with vertical) is given by $\tan^{-1}\left(\frac{3Bai}{4mg}\right)$.

Space for Rough Work

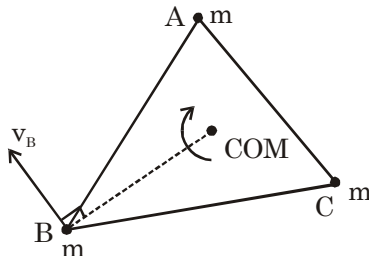
3. A spherical shell of radius R is given charge $3q$ on its surface and a point charge q is placed at distance $R/2$ from its centre C . Also there is a charge $2q$ placed outside the shell at a distance of $2R$ as shown. Then :



- (A) The magnitude of electric field at the centre C due to charges on the outer surface of shell is $\frac{Kq}{2R^2}$ before closing the switch S .
- (B) The electric potential at the centre C due to charges on the outer surface of shell is $\left(\frac{-Kq}{R}\right)$ before closing the switch S .
- (C) The electric potential at the centre C due to charges on the outer surface of shell is $\left(\frac{-Kq}{R}\right)$ after closing the switch S .
- (D) Charge flown through the switch into earth after closing the switch S is $5q$.

Space for Rough Work

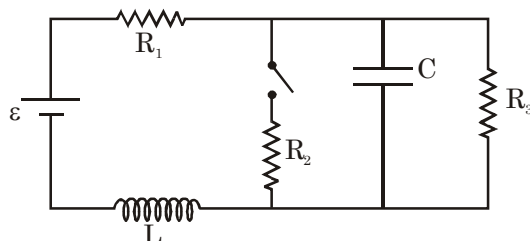
4. Three small balls A, B and C of same mass m are fixed by massless rods at the vertices of equilateral triangle with side L . The system is placed on a smooth horizontal surface and set in rotation about the stationary COM with angular speed ω . At a certain instant ball B breaks off the system with a velocity \vec{v}_B as shown in diagram where $|\vec{v}_B| = \frac{2\omega L}{\sqrt{3}}$.



- (A) The COM of A and C moves with a velocity $\frac{-\vec{v}_B}{2}$.
- (B) The tension in rod connecting A and C after B breaks off is $m\omega^2 \frac{\ell}{2}$
- (C) The speed of A just after B breaks off is $\frac{v_B}{2}$.
- (D) The speed of A, after a time $\frac{\pi}{\omega}$ after B breaks off is $\frac{\sqrt{19}}{6} \omega \ell$
5. A syringe is filled with water. Its volume is 20 cm^3 and cross-section of its interior part is 4 cm^2 . The syringe is held vertically such that its nozzle is at its top and its 100 g piston is pressed by external agent and moves it with a constant speed. The ejected water has a initial upward velocity of 2 m/s and cross-section of the beam of water at the nozzle is 1 mm^2 .
- (A) The speed with which the piston is moving is 5 mm/sec .
- (B) The external force acting on the piston is 42 N .
- (C) The total work done by external agent in emptying the syringe is 0.095 J
- (D) The external force remains constant during the process.

Space for Rough Work

6. The circuit shown in the diagram is in steady state with the switch open. When the switch is closed, which of the following will not change immediately?



- (A) Potential difference across capacitor C.
 (B) Current through the inductor L.
 (C) Potential difference across resistance R_1 .
 (D) Current through the resistance R_2 .
7. The velocity of electron in two Bohr's orbit (n_1 and n_2) of the hydrogen atom as :

$$\frac{1}{v_{n_1}} + \frac{1}{v_{n_2}} = \frac{5}{v_1}$$

Where v_{n_1} , v_{n_2} and v_1 are velocity of electron in lower, higher and first energy levels. The energy difference between n_1 and n_2 can be (approximately) :

- (A) 12.75 eV (B) 1.89 eV (C) 0.472 eV (D) 12.09 eV

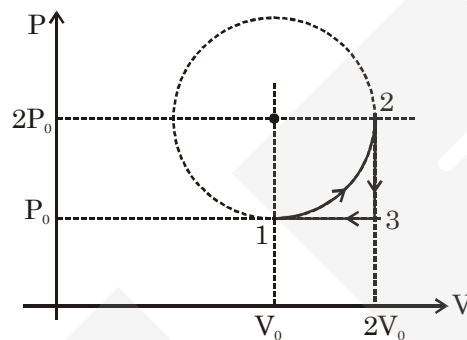
Space for Rough Work

SECTION-3 : (Maximum Marks : 12)

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Paragraph for Questions 1 and 2

One mole of an ideal monoatomic gas is taken along a cyclic process : (take : $\pi = 3.14$)



Process (1 - 2) : One fourth of the circle

Process (2 - 3) : Isochoric

Process (3 - 1) : Isobaric

1. Net work done around the cyclic process is :

(A) P_0V_0 (B) $\frac{P_0V_0}{3}$ (C) $0.22 P_0V_0$ (D) $\frac{4}{5} P_0V_0$

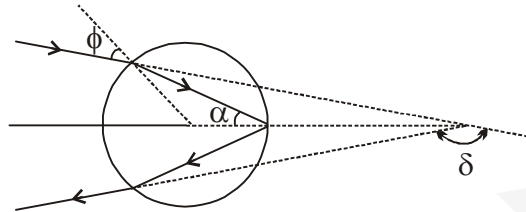
2. The efficiency of cyclic process is :

(A) 0.4 (B) 0.08 (C) 0.04 (D) 0.57

Space for Rough Work

Paragraph for Questions 3 and 4

A ray of light enters a spherical drop of water of index n as shown in figure. Light is partially reflected from the rear surface, the reflected light re-enters air after refraction as shown. The angle between incoming ray and outgoing ray is known as angle of deflection. ($n < 1$)



3. Expression for the angle of deflection δ (in clockwise) is

- (A) $\pi - 4\alpha - 2\phi$ (B) $\pi - 4\alpha + 2\phi$ (C) 2ϕ (D) 4α

4. The angle ϕ which produces minimum deflection is

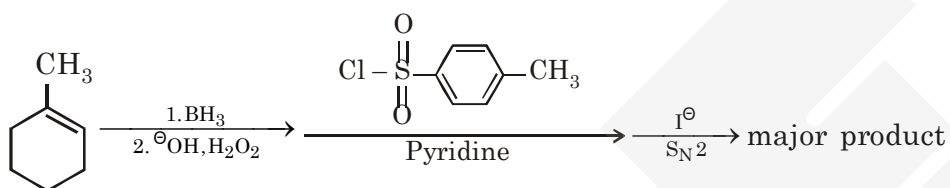
- (A) $\cos^{-1} \sqrt{\frac{n^2}{3}}$ (B) $\cos^{-1} \sqrt{\frac{n}{3}}$ (C) $\cos^{-1} \sqrt{\frac{n^2 - 1}{3}}$ (D) $\cos^{-1} \sqrt{\frac{n^2 - 2}{3}}$

Space for Rough Work

PART-2 : CHEMISTRY
SECTION-1 : (Maximum Marks : 21)

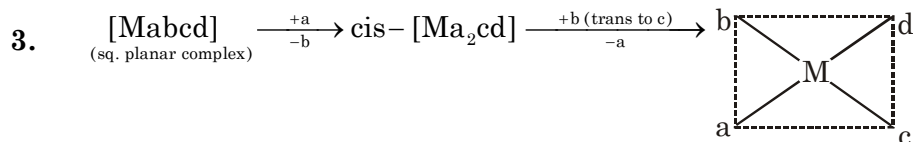
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1. Choose the major product of the following reaction sequence

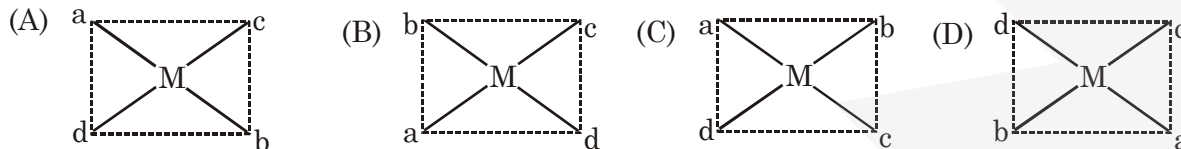


2. A hexapeptide has the composition Ala, Gly, Phe, Val₃. Both the N-terminal and C-terminal units are Val. Cleavage of the hexapeptide by chymotrypsin gives two different tripeptides, both having Val as the N-terminal group (Chymotrypsin hydrolyzes on the C-side of amino acids that contain aromatic six membered ring). Among the products of random hydrolysis is a Ala-Val dipeptide fragment. What is the primary structure of the hexapeptide?
- (A) Val-Gly-Phe-Val-Ala-Val (B) Val-Ala-Phe-Val-Gly-Val
 (C) Val-Gly-Ala-Val-Phe-Val (D) Val-Phe-Val-Ala-Gly-Val

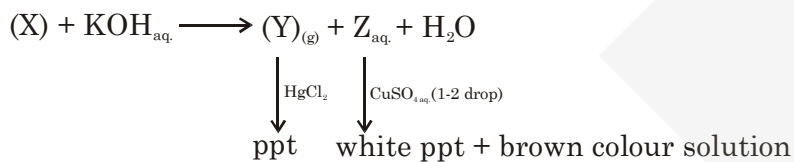
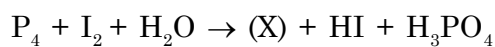
Space for Rough Work



INCORRECT geometrical arrangement of reactant complex is.



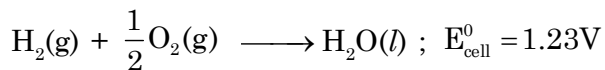
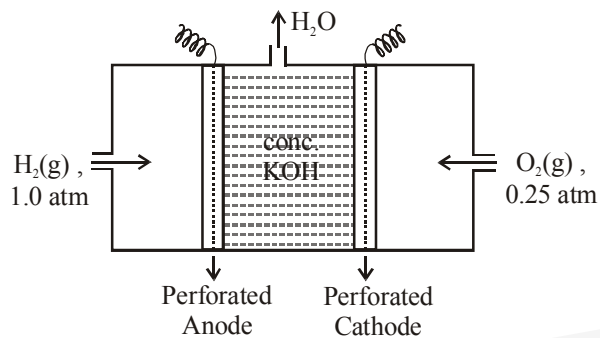
4. Select **INCORRECT** for given reaction sequence.



- (A) $Y_{(g)}$ produce ppt with CuSO_4
- (B) Reaction of $Z_{aq.} + \text{CuSO}_4$ is redox change
- (C) Bond angle in $P_4 < (Y)_{(g)}$
- (D) On heating H_3PO_4 it produce $Y_{(g)}$

Space for Rough Work

5. Given hydrogen-oxygen fuel cell -



$$(\Delta_f H)_{\text{H}_2\text{O}(\text{g})} = -245 \text{ kJmol}^{-1}, \Delta_{\text{vap}} H(\text{H}_2\text{O}, \text{l}) = 40 \text{ kJmol}^{-1}$$

$$\log 2 = 0.3, \frac{2.303RT}{F} = 0.06$$

The efficiency of fuel cell is -

- (A) 96.08 % (B) 41.3 % (C) 61.95% (D) 82.68%

6. Which is **INCORRECT** statement ?

- (A) Brownian movement is responsible for the stability of colloidal solution
 (B) No Tyndall effect observed in True solution
 (C) Haemoglobin (blood) and gold sol are negative charge colloids
 (D) Casein act as emulsifier for milk

7. Given :



which is correct statement ?

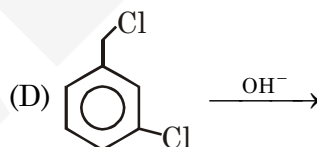
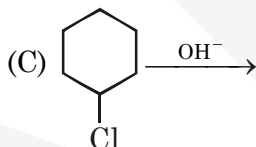
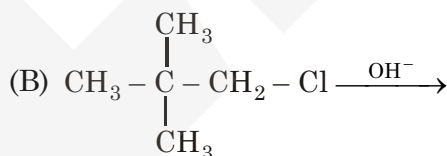
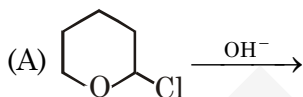
- (A) Number of gm equivalent of H_2O_2 and KMnO_4 reacts in the ratio of 5 : 2
 (B) Number of moles of MnSO_4 and O_2 produced in the ratio of 5 : 2
 (C) Equivalent mass of H_2SO_4 is 29.4
 (D) 100 ml 2.27 V H_2O_2 reacts completely with 160 ml 0.5M KMnO_4 in given reaction

Space for Rough Work

SECTION-2 : (Maximum Marks: 28)

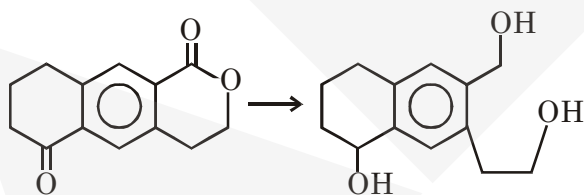
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1. Which of following gives same product by S_N1 and S_N2 (excluding stereo)



Space for Rough Work

2. Select the correct statement -
- (A) Area enclosed by a cycle on P-V diagram is same as on T-S diagram
- (B) $\Delta S = nC_{pm} \ln \frac{T_2}{T_1}$ can be used in isobaric process for both ideal and real gas
- (C) $\Delta S = nC_{pm} \ln \frac{T_2}{T_1} + nR \ln \frac{P_1}{P_2}$ is applicable for both reversible and irreversible process for an ideal gas not undergoing any chemical and phase change.
- (D) Work done on a diatomic gas will be more than monoatomic gas compressed reversibly adiabatically from same initial state to same final volume.
3. As per Fajan's rule polarization (covalent character) will be increased by?
- (A) High charge and small size cation
- (B) High charge and large size anion
- (C) Low charge and small size anion
- (D) Low charge and large size cation
4. The following first order reaction -
 $2A(aq.) \rightarrow 3B(aq.) + 4C(aq.)$
 is monitored by measuring optical rotation of reaction mixture containing optical active dextrorotatory inert impurity at different time interval. The species A, B and C are optically active with specific rotation 20° , 40° and -80° per mol respectively.
- | Time (min) | 0 | 22 | ∞ |
|--------------------------------------|-------------|-------------|--------------|
| Optical rotation of reaction mixture | 120° | -40° | -120° |
- (Given - $\ln 3 = 1.1$, $\ln 2 = 0.7$)
 which is/are correct statements -
- (A) Rate constant of reaction is 0.05 min^{-1}
- (B) Rate constant of appearance of C is 0.1 min^{-1}
- (C) The time in which 75% of A reacted is 28 min
- (D) The time in which 50% of A reacted is 420 sec.
5. Reagent which can't be used to carryout this conversion are :



- (A) LiAlH_4 (B) $\text{N}_2\text{H}_4 / \text{OH}^- / \Delta$ (C) $\text{N}_2\text{H}_4 / \text{H}_2\text{O}_2$ (D) Zn(Hg)HCl

Space for Rough Work

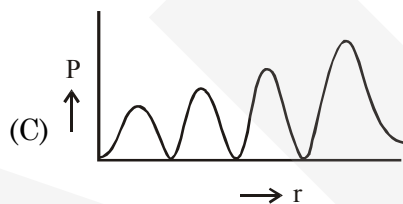
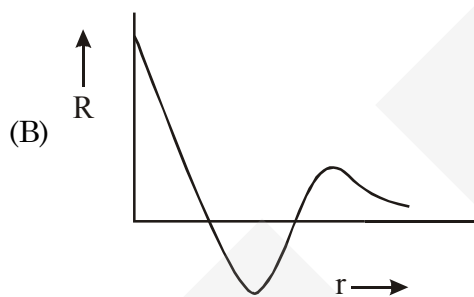
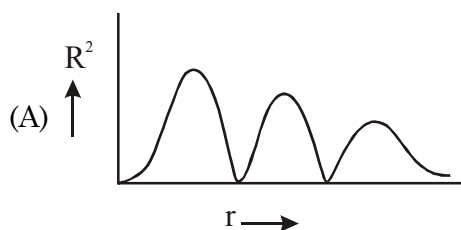
6. Select **CORRECT** statement(s).
- (A) Blue solution of Na in liq. NH_3 is unstable with respect to amide formation
 (B) Na_2O_2 react with CO and evolve O_2
 (C) Li^+ does not form alum due to its high hydration energy
 (D) NaNO_3 when heated at 800°C produce two gases both are paramagnetic

7. Given :

$$\Psi_{\text{radial}} : \frac{1}{9\sqrt{2}} \cdot \left(\frac{1}{a_0}\right)^{3/2} (\sigma^2 - 4\sigma + 3) e^{-\sigma}$$

where $\sigma = \frac{2r}{a_0}, a_0 = 0.529\text{\AA}$

which is/are correct statement -



- (D) Distance between 2nd radial nodes and 1st radial nodes is equal to 0.529\AA

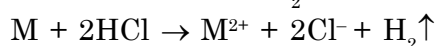
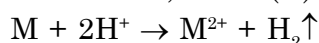
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SECTION-3 : (Maximum Marks : 12)

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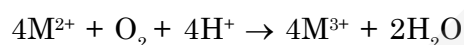
Paragraph for Questions 1 and 2

Metal (**M**) is a white, crystalline metal and is not appreciably ductile or malleable. It has very high melting point. The metal is soluble in dilute or concentrated hydrochloric acid. If air is excluded, Metal(II) ions are formed :

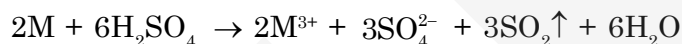


Metal(II) ions are rather unstable as they are strong reducing agent, they decompose even in acidic solution with the formation of hydrogen and M^{+3} .

In the presence of atmospheric oxygen, metal (**M**) gets partly or wholly oxidized to the tervalent state :



Dilute sulphuric acid attacks metal (**M**) slowly, with the formation of hydrogen. In hot, concentrated sulphuric acid metal (**M**) dissolves readily, to form metal(III) ions and sulphur dioxide:



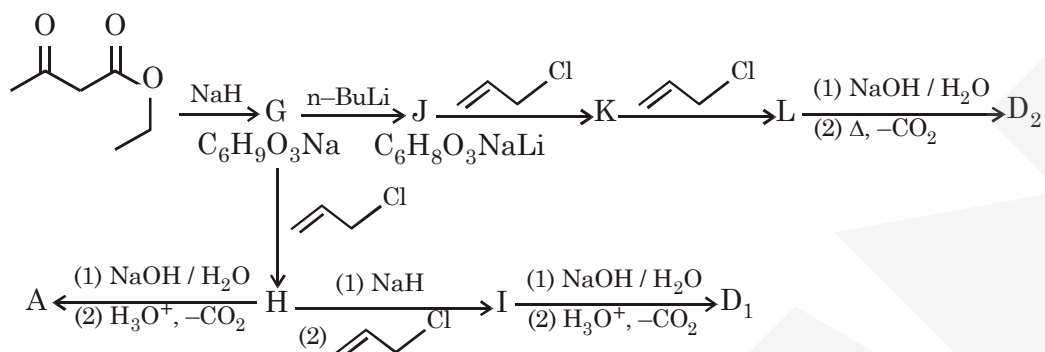
Both dilute and concentrated nitric acid render metal (**M**) passive.

1. Colour of M^{+2} ion & M^{+3} ion respectively when obtain by dissolving MO & M_2O_3 in dil. HCl.
 (A) Blue, Green (B) Green, Blue (C) Blue, Yellow (D) Violet, Blue
2. Aqueous solution of $MCl_3 \cdot 6H_2O$ when reacts with Na_2O_2 it produce coloured solution(s). Coloured solution(s) does not produce any ppt with $(BaCl_2 + \text{dil. HCl})$, but yellow ppt is produced with $(BaCl_2 + CH_3COOH_{aq.})$.
 Select **INCORRECT** about $MCl_3 \cdot 6H_2O$.
 (A) Produce violet pink appearance with excess NH_4OH in aq.
 (B) Produce light green solution with excess $NaOH_{aq.}$
 (C) Produce M_2S_3 when react with aq. solution of $(NH_4)_2S$
 (D) It is paramagnetic

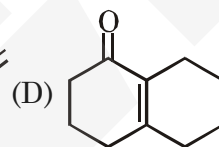
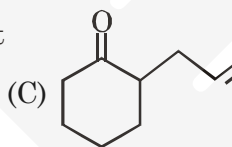
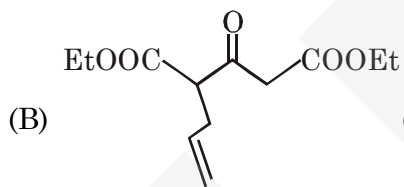
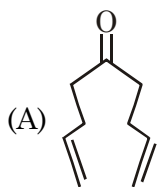
Space for Rough Work

Paragraph for Questions 3 and 4

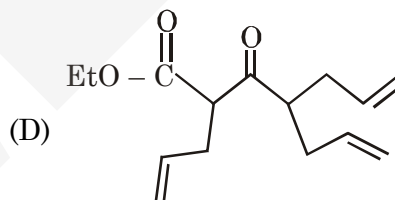
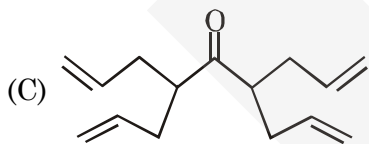
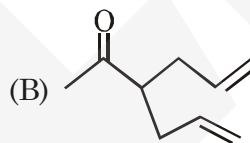
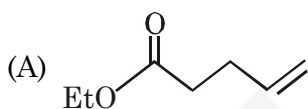
One of the best methods for the regioselective alkylation of ketones consists in an activation of the required α -carbon atom. For example :



3. Identify structure of 'D₂'?



4. Identify structure of D₁?



Space for Rough Work

PART-3 : MATHEMATICS
SECTION-1 : (Maximum Marks : 21)

- This section contains **SEVEN** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :
Full Marks : +3 If only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 If none of the bubbles is darkened.
Negative Marks : -1 In all other cases

1. If E_1 and E_2 are two events such that $P(E_1) = \frac{1}{4}$, $P\left(\frac{E_2}{E_1}\right) = \frac{1}{2}$ and $P\left(\frac{E_1}{E_2}\right) = \frac{1}{4}$, then which one is **INCORRECT**
 - (A) E_1 and E_2 are mutually independent events.
 - (B) E_1 and E_2 are exhaustive events
 - (C) E_2 is twice as likely to occur as E_1
 - (D) $P(E_1 \cap E_2), P(E_1), P(E_2)$ are in G.P.
2. Let N be the number of 5-digit natural numbers beginning with 9 that has exactly three identical digits (other digits are distinct). Then the sum of the digits of N is equal to -
 - (A) 9
 - (B) 8
 - (C) 7
 - (D) 6
3. Let $f(x)$ be a polynomial function of degree five satisfying

$$f(|x|) = |f(x)|, \forall x \in \mathbb{R}$$

$$f(1) = 0, f(2) = 18$$
 then which of the following is **NOT** correct
 - (A) $x = 1$ is a twice repeated root of $f(x) = 0$
 - (B) $x = -1$ is a twice repeated root of $f(x) = 0$
 - (C) Minimum number of distinct real roots of $(f'(x))^2 + f(x).f''(x) = 0$ is 4
 - (D) Minimum number of distinct real roots of $(f'(x))^2 + f(x).f''(x) = 0$ is 6

Space for Rough Work

4. If number of 5-digit numbers of the form abcde where $a, b, c, d, e \in \{0, 1, 2, \dots, 9\}$ and $b = a + c$, $d = c + e$ is λ , then $\left[\frac{\lambda}{100} \right]$ is (where $[.]$ represents greatest integral function)
- (A) 4 (B) 5 (C) 3 (D) 6
5. Let A and B be two non-singular square matrices of order 4×4 . If $AA^T = I = A^T A$ and $B = B^4$ such that $\det(A) \neq \det(B)$, then the value of $\sum_{r=1}^{20} \det(\text{adj}(A^r B^{2r+1}))$ is equal to -
- (where I is an identity matrix of order 4 and A^T represent transpose of A)
- (A) 1 (B) -1 (C) 0 (D) 4
6. Let \vec{a}, \vec{b} and \vec{c} be 3 mutually perpendicular unit vectors. If \vec{d} is a unit vector which is equally inclined to \vec{a}, \vec{b} and \vec{c} , then the value of $|\vec{a} + \vec{b} + \vec{c} + \vec{d}|^2$ is -
- (A) $4 + 2\sqrt{3}$ (B) $4 + 3\sqrt{2}$ (C) $2 + \sqrt{5}$ (D) $\sqrt{5} - 2$
7. Equation of lines
 $L_1 : 2x - 2y + 3z - 2 = 0, x - y + z + 1 = 0$
 $L_2 : x + 2y - z - 3 = 0, 3x - y + 2z - 1 = 0$
 Distance of point P(0,0,0) from the plane containing L_1 and L_2 and measured along the line $x = y = z$ is -
- (A) $\frac{1}{3\sqrt{2}}$ (B) $\frac{3\sqrt{3}}{8}$ (C) $\frac{\sqrt{3}}{8}$ (D) $\frac{\sqrt{3}}{4}$

Space for Rough Work

SECTION-2 : (Maximum Marks: 28)

- This section contains **SEVEN** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:
Full Marks : +4 If only (all) the correct option(s) is (are) chosen.
Partial Marks : +3 If all the four options are correct but **ONLY** three options are chosen.
Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct options.
Partial Marks : +1 If two or more options are correct but **ONLY** one option is chosen and it is a correct option.
Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered).
Negative Marks : -2 In all other cases.
- **For Example** : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -2 marks.

1. If $\alpha, \beta \in \mathbb{R}$, $\beta \neq 0$, $n \in \mathbb{N}$ and $\lim_{n \rightarrow \infty} \frac{n^2(1!)(2!)(3!) \dots (n!)}{n^\alpha} = \beta$, then

(A) $\alpha = \frac{1}{2}$ (B) $\beta = e^{-\frac{3}{4}}$ (C) $\alpha = 1$ (D) $\beta = \frac{1}{\sqrt{e}}$

2. If $y = f(x)$ is a solution of $\frac{dy}{d(x^2)} + \frac{y}{x^2} = \frac{\sin^{-1} x}{2x^2}$ and $f(0) = 0$, then

(A) $f(1) = \frac{\pi}{8}$ (B) $f(-1) = -\frac{\pi}{8}$
 (C) $f\left(\frac{1}{2}\right) = \frac{\sqrt{3}}{4} - \frac{\pi}{6}$ (D) $x^2 f(x) = \frac{1}{2}(2x^2 - 1)\sin^{-1} x + \frac{1}{4}x\sqrt{1-x^2} + \frac{1}{4}$

Space for Rough Work

3. If $f(x) = \begin{vmatrix} 5 + \sin^2 x & \cos^2 x & 4 \sin 2x \\ \sin^2 x & 5 + \cos^2 x & 4 \sin 2x \\ \sin^2 x & \cos^2 x & 5 + 4 \sin 2x \end{vmatrix}$, then which of the following is/are correct -
- (A) $f(x)$ is a non-monotonic function
 (B) $f(x) = 0$ has no real roots
 (C) $f'(x)$ has infinitely many maxima and minima
 (D) Number of integers in the range of $f(x)$ is 201
4. If $\cos \frac{2\pi}{2019} \cdot \cos \frac{4\pi}{2019} \cdot \cos \frac{6\pi}{2019} \dots \cos \frac{2018\pi}{2019}$ is 2^{-k} where $k = \frac{p}{q}$, $p, q \in \mathbb{N}$ and p and q are relatively prime, then
- (A) $(p + q)$ is a 4-digit number
 (B) sum of the digits in $(p + q)$ is 2
 (C) $(p + q)$ is a 3-digit number
 (D) number of divisors of p is 8
5. For the curve $\sin x + \sin y = 1$, $\lim_{x \rightarrow 0} (x^\alpha) \frac{d^2 y}{dx^2}$ exists then α can be
- (A) $\frac{3}{2}$
 (B) 2
 (C) $\frac{5}{2}$
 (D) 1
6. A point P moves inside a square with vertices $A(1,1)$, $B(-1,1)$, $C(-1,-1)$ and $D(1,-1)$ such that $\min\{PA, PB, PC, PD\} \leq 1$. If the area bounded by the curve traced out by moving point P is λ , then which of the following is/are correct -
- (A) λ is a rational number
 (B) $[\lambda] = 3$ (where $[.]$ represents greatest integral function)
 (C) λ is an irrational number
 (D) $[\lambda] = 0$ (where $[.]$ represents greatest integral function)
7. $\lim_{x \rightarrow 0} \frac{x^2 \sin \beta x}{\tan \alpha x - \sin x} = 4$ where $\alpha, \beta \in \mathbb{R}$, then which of the following is/are correct -
- (A) $\alpha = 1$
 (B) $\beta = 2$
 (C) $\alpha = 2$
 (D) $\beta = 1$

Space for Rough Work

SECTION-3 : (Maximum Marks : 12)

- This section contains **TWO** paragraphs.
- Based on each paragraph, there are **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :
Full Marks : +3 If only the bubble corresponding to the correct answer is darkened.
Zero Marks : 0 In all other cases.

Paragraph for Questions 1 and 2

Let \vec{a}, \vec{b} and \vec{c} be three mutually perpendicular unit vectors

1. Let \vec{r} be a unit vector satisfying $(\vec{b} - \vec{c}) \times (\vec{r} \times \vec{a}) + (\vec{c} - \vec{a}) \times (\vec{r} \times \vec{b}) + (\vec{a} - \vec{b}) \times (\vec{r} \times \vec{c}) = \vec{0}$. Then \vec{r} is equal to
(A) $\frac{1}{\sqrt{3}}(\vec{a} + \vec{b} + \vec{c})$ only
(B) $-\frac{1}{\sqrt{3}}(\vec{a} + \vec{b} + \vec{c})$ only
(C) Both option (A) and option (B) are correct
(D) None of these
2. Let \vec{r} be a vector having components 12, 5 and 13 along \vec{a}, \vec{b} and \vec{c} respectively. If λ is component of \vec{r} along $(\vec{a} + \vec{b} + \vec{c})$, then $[\lambda] =$
(where $[\cdot]$ represents greatest integer function)
(A) 17 (B) 30 (C) 10 (D) 18

Space for Rough Work

Paragraph for Questions 3 and 4

Let $f(x)$ and $g(x)$ be two quadratic polynomials $f(x) = ax^2 + bx + c$, $g(x) = dx^2 + ex + f$ where $a, b, c, d, e, f \in \mathbb{R}$

3. If a, b, c are the positive real numbers and $f(x) \geq 0 \forall x \in \mathbb{R}$, then the minimum value of $\left(\frac{a+b+c}{b}\right)$ is
- (A) 1 (B) 2 (C) 3 (D) 0

4. If $H(x) = f(x) \cdot g(x)$ where $ad = 1$

and $H(1) = 1$, $H(2) = 2$, $H(3) = 3$, then $\left\{\frac{H(-1) + H(5)}{H(0) + H(4)}\right\} =$

(where $\{ \}$ represents fractional function) is

- (A) $\frac{5}{7}$ (B) $\frac{2}{7}$ (C) $\frac{3}{7}$ (D) $\frac{4}{7}$

Space for Rough Work