VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced Revision Test - 2 | Paper – 1 | JEE 2024

Date: 18/02/2024 **Maximum Marks: 180**

Timing: 10:00 AM to 1:00 PM **Duration: 3.0 Hours**

General Instructions

1. The question paper consists of 3 Subjects (Subject I: **Physics**, Subject II: **Chemistry**, Subject III: **Mathematics**). Each subject has **four** sections (Section 1, Section 2, Section 3 and Section 4).

2. **Section 1** contains **3 Multiple Correct Answers Type Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

Section 2 contains **4 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

Section 3 contains **TWO (02) paragraphs**. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

Section 4 contains **6 Non-Negative Integer Type Questions**. The answer to each question is a **NON-NEGATIVE INTEGER.**

3. For answering a question, an ANSWER SHEET (OMR SHEET) is provided separately. Please fill your **Test Code, Roll No.** and **Group** properly in the space given in the ANSWER SHEET.

Syllabus: Complete Class XII Syllabus

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ Invigilator's Signature _____

MARKING SCHEME

SECTION – 1 | (Maximum Marks: 12)

- This section consists of **Three (03)** Questions. Each question has **FOUR** options. **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- 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 and both of which are correct

Partial Marks: +1 If two or more options are correct but ONLY one option is chosen, and it is a correct option

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

Negative Marks: –2 In all other cases.

SECTION – 2 | (Maximum Marks: 12)

- This section contains **Four (04)** Multiple Choice Questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme.

Full Marks : +3 If ONLY the correct option 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.

SECTION – 3 | (Maximum Marks: 12)

- This section contains **TWO (2) paragraphs**. Based on each paragraph, there are **TWO (02)** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme;

Full Marks : +3 If ONLY the correct option 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.

SECTION – 4 | (Maximum Marks: 24)

- This section contains **SIX (06)** Questions.
- The answer to each question is a **NON-NEGATIVE INTEGER**
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme.

Full Marks : +4 If ONLY the correct integer is entered;

Zero Marks : 0 In all other cases.

SUBJECT I : PHYSICS 60 MARKS

SECTION-1

This section consists of 3 Multiple Correct Answers Type Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

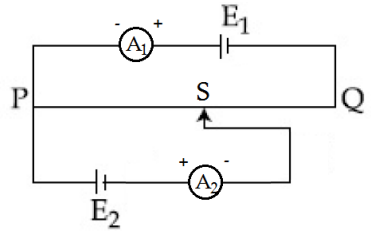
1. A circular loop of radius a is made out of a uniform wire of diameter d (such that $d \ll a$) and resistivity ρ. The loop is fixed in the X-Y plane, in the presence of a magnetic field $\vec{B} = B_0 \sin(\omega t)\,\hat{k}$, where B_0 and ω are constants. Let the maximum magnitude of the induced current in the loop be I_M and let the average rate of heat dissipation in the loop be H_{AV} Which of these options is/are correct?

(A) $I_M = \dfrac{\pi B_0 \omega a d^2}{8\rho}$ **(B)** $I_M = \dfrac{\pi B_0 \omega a^2 d}{8\rho}$

(C) $H_{AV} = \dfrac{\pi^2 B_0^2 \omega^2 a d^3}{16\rho}$ **(D)** $H_{AV} = \dfrac{\pi^2 B_0^2 \omega^2 a^3 d^2}{16\rho}$

SPACE FOR ROUGH WORK

2. In the given circuit, PQ is a uniform potentiometer wire of length 120 cm and resistance $40\,\Omega$. The length PS is 90 cm. The EMF of the battery E_2 is 20 V. The battery E_1 is ideal, but the battery E_2 is non-ideal. The ideal ammeters A_1 and A_2 read +1.8 A and +1.0 A respectively. Which of these options is/are correct?



(A) The potential difference between P and S is 24 V

(B) The EMF of the battery E_1 is 36 V

(C) The internal resistance of the battery E_2 is $4\,\Omega$

(D) The current through ammeter A_2 can be made zero by changing the length PS

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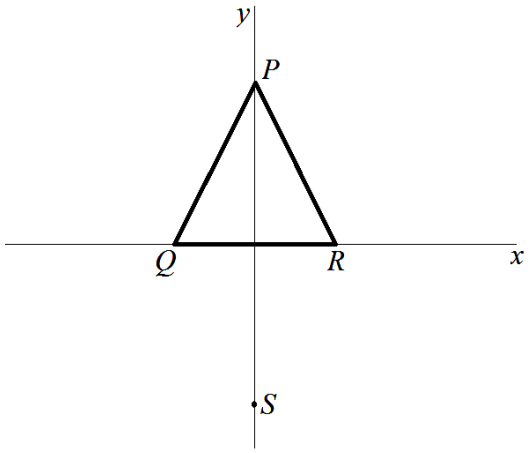
3. A triangular, equilateral loop is placed in the X-Y plane with its vertices at $P\left(0,\frac{a\sqrt{3}}{2}\right)$, $Q\left(-\frac{a}{2},0\right)$ and $R\left(\frac{a}{2},0\right)$. The loop carries a steady current I in the direction $P\to Q\to R\to P$. Let the point S have the coordinates $\left(0,-\frac{a\sqrt{3}}{2}\right)$. Which of the following statements is/are correct?



(A) The magnetic field at S due to the side PQ is in the –Z direction

(B) The magnetic field at S due to the side PQ and the magnetic field at S due to the side RP have the same magnitude

(C) The net magnetic field at S is in the –Z direction

(D) The net magnetic field at S has magnitude $\frac{\mu_0 I}{2\pi a}\left(\frac{2}{\sqrt{3}}-1\right)$

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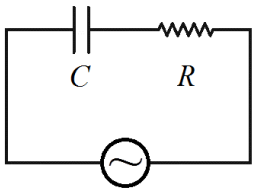
SECTION-2

This section consists of 4 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

4. A cylindrical shell of inner and outer radius R and $3R$ and length L is made out of a material of resistivity ρ. A potential difference V is applied between the inner and outer curved surfaces of the shell. The electric field at a point at a distance $2R$ from the axis of the shell is:

(A) $\dfrac{V}{R\log_e(3)}$ **(B)** $\dfrac{V}{2R\log_e(3)}$ **(C)** $\dfrac{V}{R\log_e(2)}$ **(D)** $\dfrac{V}{2R\log_e(2)}$

5. A capacitor of capacitance C is connected in series with a resistance R and a source of alternating voltage of angular frequency $\omega = \dfrac{1}{RC}$. The current in the circuit varies with time as: $I(t) = I_0\cos(\omega t)$, with the clockwise direction of current taken as positive. At $t = 0$, the capacitor is completely uncharged. The charge on the left plate of the capacitor varies with time as:



(A) $Q(t) = \dfrac{I_0}{\omega}\sin(\omega t)$ **(B)** $Q(t) = \dfrac{I_0}{\omega}\cos\left(\omega t - \dfrac{\pi}{4}\right)$

(C) $Q(t) = \dfrac{\sqrt{2}I_0}{\omega}\sin(\omega t)$ **(D)** $Q(t) = \dfrac{\sqrt{2}I_0}{\omega}\cos\left(\omega t - \dfrac{\pi}{4}\right)$

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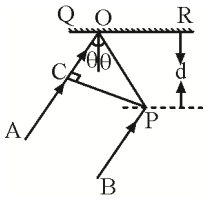
6. The region $r < \frac{R}{2}$ of a non-conducting sphere (r denotes the distance from the centre of the sphere) is uncharged, and the region $\frac{R}{2} \le r \le R$ is charged with charge density $\rho(r) = \rho_0\left(\frac{r}{R}\right)$, where ρ_0 is a constant. In the region $\frac{R}{2} \le r \le R$, the electric field $E(r)$ varies as:

(A) $E(r) = \frac{\rho_0}{4\varepsilon_0 R}\left(r^2 - \frac{R^4}{4r^2}\right)$ **(B)** $E(r) = \frac{\rho_0}{4\varepsilon_0 R}\left(r^2 - \frac{R^4}{16r^2}\right)$

(C) $E(r) = \frac{\rho_0}{16\varepsilon_0 R^2}\left(r^3 - \frac{R^4}{4r}\right)$ **(D)** $E(r) = \frac{\rho_0}{16\varepsilon_0 R^2}\left(r^3 - \frac{R^4}{16r}\right)$

7. In the below figure, *CP* represents a wavefront and *AO* and *BP*, the corresponding two rays. Find the condition on θ for constructive interference at *P* between the ray *BP* and reflected ray *OP*.



(A) $\cos\theta = 3\lambda/2d$ **(B)** $\cos\theta = \lambda/4d$

(C) $\sec\theta - \cos\theta = \lambda/d$ **(D)** $\sec\theta - \cos\theta = 4\lambda/2d$

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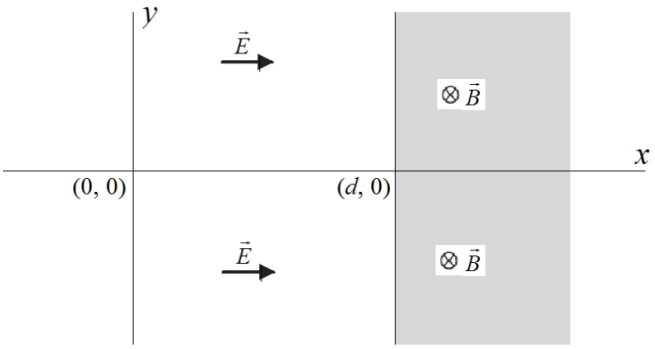
SECTION-3

This section consists of TWO (02) paragraphs. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

Paragraph for Questions 8 – 9

A uniform electric field of magnitude E pointing in the +X direction exists in the region $0 \le x < d$, and a uniform magnetic field of magnitude B pointing in the –Z direction exists in the region $x \ge d$. A particle of mass m and carrying positive charge q is released from rest at the origin.



8. If the Y-coordinate of the point where the particle leaves the magnetic field for the first time is y_0, then y_0 is proportional to:

(A) $\left(\frac{Ed^2}{mqB^2}\right)^{1/2}$ **(B)** $\left(\frac{mEd}{qB^2}\right)^{1/2}$ **(C)** $\left(\frac{mqEd}{B^2}\right)^{1/2}$ **(D)** $\left(\frac{mE}{qB^2d}\right)^{1/2}$

9. Suppose that just after entering the magnetic field for the second time, the particle splits into two parts 1 and 2 such that:

(i) the two parts carry charge $+\frac{3q}{2}$ and $-\frac{q}{2}$ respectively,

(ii) the linear momentum of both parts is in the same direction as the particle's linear momentum just before the split, and

(iii) the magnitude of linear momentum of the two parts after the split is in the ratio 1:3

If after the split, the parts 1 and 2 leave the magnetic field for the first time at points whose Y-coordinates are y_1 and y_2 respectively, then, $|y_1 - y_2|$ is equal to:

(A) $\frac{14}{9}y_0$ **(B)** $\frac{4}{3}y_0$ **(C)** $\frac{10}{9}y_0$ **(D)** $\frac{5}{3}y_0$

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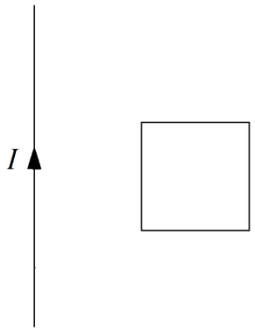
Paragraph for Questions 10 – 11

A long straight wire and a wire loop are placed in the same plane as shown. The wire is fixed, and the loop is free to move. The long wire carries a current I in the direction shown.



10. The loop is initially at rest. Keeping its direction the same, the current I is varied slowly. Neglect the self-inductance of the loop. Which of these options is correct?

(A) If I is increased, the magnetic force on the loop is towards the wire, and if I is decreased, the magnetic force on the loop is away from the wire

(B) If I is increased, the magnetic force on the loop is away from the wire, and if I is decreased, the magnetic force on the loop is towards the wire

(C) The magnetic force on the loop is towards the wire whether I is increased or decreased

(D) The magnetic force on the loop is away from the wire whether I is increased or decreased

11. Now, the current I is held constant, and the loop is moved either directly towards (case 1) or directly away (case 2) from the wire ("directly" means the velocity of the loop is perpendicular to the wire), always keeping it in the same plane as the wire. Neglect the self-inductance of the loop. Which of these options is correct?

(A) The magnetic force on the loop is towards the wire in both cases

(B) The magnetic force on the loop is away from the wire in both cases

(C) The magnetic force on the loop is in the same direction as its velocity in both cases

(D) The magnetic force on the loop is opposite to its velocity in both cases

SECTION-4

This section consists of 6 NON-NEGATIVE INTEGER Type Questions. The answer to each question is a NON-NEGATIVE INTEGER.

1. A square wire loop of side length L is made out of a uniform thin conducting wire. The resistance of the loop is R. The loop is placed in the X-Y plane with its sides parallel to the coordinate axes and its centre at the origin. The loop is pivoted to rotate without friction about the Y-axis. A uniform magnetic field of magnitude B exists in the +Z direction.
At $t = 0$, the loop is given an angular impulse J about the Y-axis. If the loop rotates by an angle 180º before it comes to rest, and $J = \left(\frac{\pi B^2 L^4}{XR}\right)$, then X is _____.

2. Electric field at a point (x, y, z) in space is given by $\vec{E}(x, y, z) = x^2\hat{i} - y^2\hat{j} + 2z\hat{k}$ in SI units.. Charge density at a point $(2, 1, 1)$ is $P \in_0$, where $\in_0$ is permittivity of free space. Value of P is _____.

3. Suppose a $^{226}_{88}Ra$ nucleus at rest and in ground state undergoes $\alpha - decay$ to a $^{222}_{86}Rn$ nucleus in its excited state. The kinetic energy of the emitted α particle is found to be 4.44 MeV. $^{222}_{86}Rn$ nucleus then goes to its ground state by $\gamma - decay$. The energy of the emitted γ photon is____ keV.

[Given: atomic mass of $^{226}_{88}Ra = 226.005u$, atomic mass of $^{222}_{86}Rn = 222.000u$, atomic mass of α particle = 4.000u, 1u = 931 MeV/c^2, c is speed of the light] .

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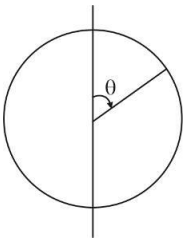
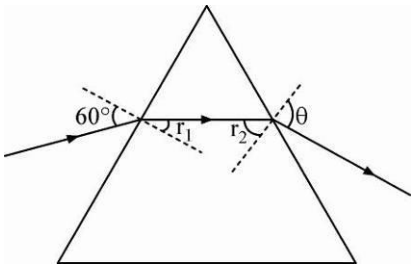
4. An uncharged metallic sphere of radius R is placed into an external uniform field, as a result of which an induced change appears on the sphere with surface density $\sigma = \sigma_0 \cos\theta, \sigma_0$ is a positive constant and θ is the polar angle. Magnitude of resultant electric force acting on the positive charges on the sphere is $\frac{\sigma_0^2 R^2 \pi}{\alpha \in_0}$, value of α is _____.



5. Two identical capacitors of plate area *A* and plate separation *d* initially have vacuum between the plates. Now, two dielectric slabs of dielectric constant *K* and 4*K* and widths $\frac{d}{3}$ and $\frac{2d}{3}$ are inserted in the first capacitor, and a single dielectric slab of dielectric constant K_0 and width *d* is inserted into the second capacitor. After the insertion, the capacitance of the two capacitors is equal. Then, $\frac{K_0}{K}$ = ____.

6. A monochromatic beam of light is incident at 60° on one face of an equilateral prism of refractive index *n* and emerges from the opposite face making an angle $\theta(n)$ with the normal (see figure). For $n = \sqrt{3}$ the value of θ is $60°$ and $\frac{d\theta}{dn} = m$. The value of *m* is _____.



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SUBJECT II : CHEMISTRY 60 MARKS

SECTION-1

This section consists of 3 Multiple Correct Answers Type Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

1. With respect to white, red and black phosphorous, which of the statement(s) given below is (are) correct ?

(A) White phosphorous is most reactive form

(B) Black phosphorous is thermodynamically most stable form

(C) $\Delta_f H^\circ$ of white phosphorous is zero

(D) Red phosphorous is linear polymeric form

2. Ammonium dichromate on heating liberates a gas. Same gas will be obtained by:

(A) Heating $NaNO_2$ and NH_4Cl

(B) Treating HNO_2 with $NaNO_2$

(C) Passing NH_3 gas over red hot CuO

(D) Treating NH_3 gas with $KMnO_4$ in neutral medium

3. $CH_3-\underset{\underset{O}{\|}}{C}-OH \xrightarrow{NaOH} \xrightarrow{\text{electrolysis}} \xrightarrow[h\nu]{1\text{eq. } Br_2} \xrightarrow[\Delta]{\text{alc. KOH}} \xrightarrow[\substack{Co_2(CO)_8\\ \text{High temp.}\\ \text{High pressure}}]{CO+H_2} A \xrightarrow{Ni/H_2} B$

Which of the following statement(s) is/are incorrect:

(A) A gives positive iodoform test

(B) B gives immediate turbidity on reaction with Lucas reagent

(C) B gives violet colour in neutral $FeCl_3$ test

(D) B produce red colouration with ceric ammonium nitrate

SPACE FOR ROUGH WORK

SECTION-2

This section consists of 4 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

4. Liquids A and B form an ideal solution. The plot of $\frac{1}{X_A}$ (Y-axis) versus $\frac{1}{Y_A}$ (X-axis) (where X_A and Y_A are the mole fractions of A in liquid and vapour phases at equilibrium respectively) is linear whose Y-intercept and slope, respectively, are given as:

(A) $\frac{P_A^\circ - P_B^\circ}{P_B^\circ}, \frac{P_A^\circ}{P_B^\circ}$ **(B)** $\frac{P_A^\circ}{P_B^\circ}, \frac{P_B^\circ - P_A^\circ}{P_B^\circ}$ **(C)** $\frac{P_B^\circ - P_A^\circ}{P_B^\circ}, \frac{P_A^\circ}{P_B^\circ}$ **(D)** $\frac{P_B^\circ}{P_A^\circ}, \frac{P_B^\circ - P_A^\circ}{P_B^\circ}$

5. When 2g non volatile hydrocarbon containing 94.4% carbon by mass, is dissolved in 100g benzene, the vapour pressure of benzene at 30°C is lowered from 89.78 mm of Hg to 89 mm of Hg. The molecular formula of hydrocarbon is:

(A) $C_{12}H_{34}$ **(B)** $C_{13}H_{22}$ **(C)** $C_{14}H_{12}$ **(D)** $C_{14}H_{10}$

6. $SO_2Cl_2 \longrightarrow SO_2 + Cl_2$ is a first order gaseous reaction, with rate constant $k = 2.5\times10^{-5}\,sec^{-1}$ at 320°C. The percentage of SO_2Cl_2 decomposed on heating for 100 minutes is? [$\ell n(1.16) = 0.15$]

(A) 86.2% **(B)** 15% **(C)** 85% **(D)** 13.8%

7. At 70K, the adsorption of $N_2(g)$ at iron surface obeys Freundlich adsorption isotherm. The following data is collected experimentally:

P(bar)	4	25	64
$\frac{x}{m}$	0.2	0.5	0.8

Where $\frac{x}{m}$ is the mass (in g) of $N_2(g)$ adsorbed per g of iron at 'P' bar pressure. The number of moles of $N_2(g)$ adsorbed per g iron at 36 bar and 70K is:

(A) $\frac{6}{10}$ **(B)** $\frac{3}{70}$ **(C)** $\frac{3}{140}$ **(D)** $\frac{3}{280}$

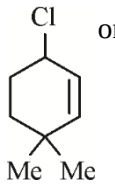
SPACE FOR ROUGH WORK

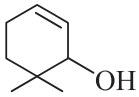
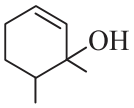
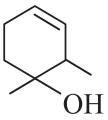
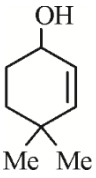
SECTION-3

This section consists of TWO (02) paragraphs. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

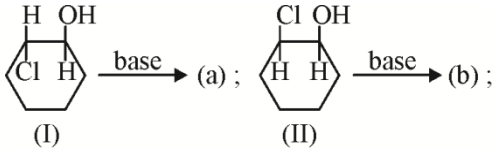
Paragraph for Questions 8 - 9

Nucleophilic substitution reactions occur either by S_N1 or S_N2 mechanism. The rate of S_N1 reaction depends upon the concentration of alkyl halide and is independent of the concentration of the nucleophile whereas rate of S_N2 reactions depends upon the concentration of both the alkyl halide as well as the nucleophile.

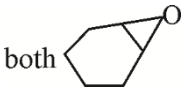
8.  on treatment with aqueous KOH by S_N1 mechanism gives:

(A)  **(B)**  **(C)**  **(D)** 

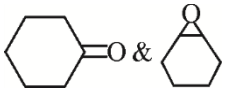
9. In the following reactions,

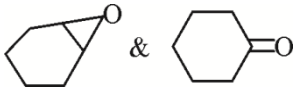


The compounds (a) and (b) are respectively:

(A) 

(B) 

(C) 

(D) 

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Paragraph for Questions 10 - 11

Bleaching substances are produced on a large scale and used in several bleaching processes. The bleaching action of a substance can be permanent as well as temporary.

10. Hydrolysis of NCl_3 produced an oxoacid as one of its hydrolysis product. The anhydride of that oxoacid is:

(A) N_2O_3 **(B)** Cl_2O_7 **(C)** N_2O_5 **(D)** Cl_2O

11. In which of the following the bleaching action is temporary:

(A) Moist Na_2O_2 **(B)** Moist O_3 **(C)** Moist SO_2 **(D)** Moist ClO_2

SPACE FOR ROUGH WORK

SECTION-4

This section consists of 6 NON-NEGATIVE INTEGER Type Questions. The answer to each question is a NON-NEGATIVE INTEGER.

1. Safrole is contained in oil of sassafras and was once used to flavour root of beer. A 2.4 mg sample of safrole was dissolved in 100mg of diphenyl ether. The solution had a freezing point of 25.64°C. The freezing point of pure diphenyl ether is 26.84°C and the freezing point depression constant of diphenyl ether is 8°C/m. The molar mass of safrole in gm/mol is_____ .

2. An alloy weighing 2.7 mg of Pb–Ag was dissolved in desired amount of HNO_3 and volume was made 250ml. A silver electrode was dipped in the solution and E_{cell} of the cell $Pt\,|\,H_2(1bar)\,|\,H^+(1M)\,||\,Ag^+\,|\,Ag$ was 0.5V at 298K. The percentage of lead in the alloy is _____ .

(Given: $E^o_{Ag^+|Ag} = 0.8V, \frac{2.303RT}{F} = 0.06$, molar mass of Ag = 108 g mol^{-1})

3. X-ray diffraction analysis of crystalline C_{60} (buckminster fullerene) shows that the crystal structure at 300K can be regarded as FCC with a one-molecule basis and unit cell edge length of $4\sqrt{2}$ nm. The molecules are orientationally disordered due to rotation. The centre to centre distance (in A°) between nearest neighbour C_{60} molecules in the solid at 300K is_____ .

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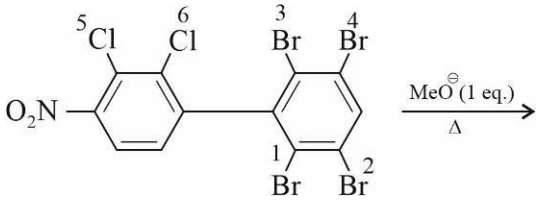
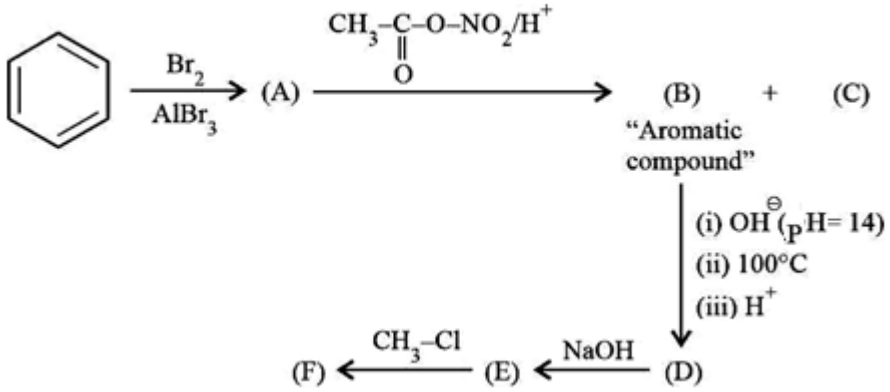
4. For the reaction: $R-X+OH^- \longrightarrow R-OH+X^-$

Rate law is given as: rate $=(6\times10^{-5})[R-X][OH^-]+[2\times10^{-7}][R-X]$. The percentage of R – X react by S_N2 mechanism when $[OH^-]=0.01M$ is_____ .

5. In the following reaction the nucleophile (MeO^-) will displace which of the halogen atom most readily.



6. Consider the following reaction:



The molar mass of product 'F' in g mol^{-1} is _____.

(Molar mass of C = 12, H = 1, O = 16, N = 14 g mol^{-1})

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SUBJECT III : MATHEMATICS 60 MARKS

SECTION-1

This section consists of 3 Multiple Correct Answers Type Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONE OR MORE THAN ONE CHOICE** is correct.

1. The point of intersection of the lines $l_1 : \vec{r}(t) = \left(\hat{i} - 6\hat{j} + 2\hat{k}\right) + t\left(\hat{i} + 2\hat{j} + \hat{k}\right)$

$l_2 : \vec{R}(u) = \left(4\hat{j} + \hat{k}\right) + u\left(2\hat{i} + \hat{j} + 2\hat{k}\right)$

(A) at $\vec{r}(7)$ **(B)** at $\vec{R}(4)$ **(C)** (8, 8, 9) **(D)** at $\vec{R}(2)$

2. If A and B are two invertible matrices of the same order, then AB is equal to :

(A) $\dfrac{1}{|(AB)^{-1}|} adj((AB)^{-1})$ **(B)** $|AB| adj(B^{-1}) adj(A^{-1})$

(C) $|AB| adj(A^{-1}) adj(B^{-1})$ **(D)** $\dfrac{1}{|AB|} adj(A^{-1}) adj(B^{-1})$

3. Consider $f(\theta) = \begin{vmatrix} \sin\theta & \cos\theta & \sin\theta \\ \cos\theta & \sin\theta & \cos\theta \\ \cos\theta & \sin\theta & \sin\theta \end{vmatrix}$ then:

(A) $f(\theta) = 0$ has exactly 2 real solutions in $[0, \pi]$

(B) $f(\theta) = 0$ has exactly 3 real solutions in $[0, \pi]$

(C) Range of function $\dfrac{f(\theta)}{1 - \sin 2\theta}$ is $\left(-\sqrt{2}, \sqrt{2}\right)$

(D) Range of function $\dfrac{f(\theta)}{\sin 2\theta - 1}$ is $\left[-\sqrt{2}, \sqrt{2}\right]$

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SECTION-2

This section consists of 4 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.

4. Differential equation of the family of circles touching the line $y=2$ at (0, 2) is:

(A) $x^2+(y-2)^2+\frac{dy}{dx}(y-2)=0$ **(B)** $x^2+(y-2)\left(2-2x\frac{dx}{dy}-y\right)=0$

(C) $x^2+(y-2)^2+\left(\frac{dx}{dy}+y-2\right)(y-2)=0$ **(D)** $\frac{d^2y}{dx^2}=0$

5. The equation of the curves through the point (1, 0) and whose slope is $\frac{y-1}{x^2+x}$ is:

(A) $(y-1)(x+1)+2x=0$ **(B)** $2x(y-1)+x+1=0$

(C) $x(y-1)(x+1)+2=0$ **(D)** $x^2+y^2=1$

6. If $\vec{r}=3\vec{i}+2\vec{j}-5\vec{k}, \vec{a}=2\vec{i}-\vec{j}+\vec{k}; \vec{b}=\vec{i}+3\vec{j}-2\vec{k}$ and $\vec{c}=-2\vec{i}+\vec{j}-3\vec{k}$ such that $\vec{r}=\lambda\vec{a}+\mu\vec{b}+\nu\vec{c}$, then:

(A) $\mu, \frac{\lambda}{2}, \nu$ are in A.P. **(B)** λ, μ, ν are in A.P.

(C) λ, μ, ν are in H.P. **(D)** μ, λ, ν are in G.P.

7. If $\vec{a}$ and $\vec{b}$ are two unit vectors, then the vector $(\vec{a}+\vec{b})\times(\vec{a}\times\vec{b})$ is parallel to the vector:

(A) $\vec{a}-\vec{b}$ **(B)** $\vec{a}+\vec{b}$ **(C)** $2\vec{a}-\vec{b}$ **(D)** $2\vec{a}+\vec{b}$

SPACE FOR ROUGH WORK

SECTION-3

This section consists of TWO (02) paragraphs. Based on each paragraph, there are **TWO (02)** questions. Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.

Paragraph for Questions 8-9

Rolle's theorem states that if $f(x)$ is continuous and differentiable in $[a, b]$ and $f(a) = f(b)$, then $f'(x) = 0$ for at least one value between *a* & *b*. Also $\frac{d}{dx}\left\{e^{-\alpha x} f(x)\right\} = e^{-\alpha x}\left[f'(x) - \alpha f(x)\right]$

8. $f(x)$ and $g(x)$ are twice differentiable functions

$f(0) = 6,\ g(0) = 3\ ;\quad f(1) = 15,\ g(1) = 6$

Then between 0 & 1 which of the following is definitely true at least once?

(A) $2f'(x) = g'(x)$ **(B)** $f'(x) = 2g'(x)$

(C) $3f'(x) = g'(x)$ **(D)** $f'(x) = 3g'(x)$

9. Let $y = f(x)$ be a twice differentiable function such that $f(2014) = f(2016) = f(2018) = 0$, then:

(A) $2f(x) = f'(x)$ has atleast two real roots

(B) $2f(x) = f'(x)$ has atleast three real roots

(C) $2f(x) = f'(x)$ has atleast four real roots

(D) Nothing can be concluded

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Paragraph for Questions 10-11

If $\cos^{-1}\frac{x}{2}+\cos^{-1}\frac{y}{3}=\theta$ then the value of $9x^2-12xy\cos\theta+4y^2$ is equal to $N\sin^2\theta$ (where N is a positive integer) and complete set of values of x for which $(\cos^{-1}x)^2-(\sin^{-1}x)^2>0$, is $[p, q)$.

10. Which of the following values lie in $[p, q)$?

(A) $\sqrt{N}-3$ **(B)** $\sqrt{N}-4$ **(C)** $\sqrt{N}-5$ **(D)** $\sqrt{N}-6$

11. Which of the following functions cannot be defined at $x=\sqrt{N}-6$?

(A) $\sin^{-1}x$ **(B)** $\cos^{-1}x$ **(C)** $\tan^{-1}x$ **(D)** $\sec^{-1}x$

SPACE FOR ROUGH WORK

SECTION-4

This section consists of 6 NON-NEGATIVE INTEGER Type Questions. The answer to each question is a NON-NEGATIVE INTEGER.

1. In a book fair, the entry ticket is `1. There are six people in a queue to enter the fair, three among them have a `1 coin and three among them have a `2 coin. The ticket vendor has no money to begin with. If p be the probability that the queue can proceed without getting choked, then $36p$ is equal to ____.

2. If $\int_0^{2\pi} \frac{x\sin^8 x}{\sin^8 x+\cos^8 x}dx = k\left(\frac{\pi}{2}\right)^2$, then the value of k is _____.

3. Let $\overrightarrow{OA}=\vec{a}, \overrightarrow{OB}=2\vec{a}+10\vec{b}, \overrightarrow{OC}=\vec{b}$ where O, A, C are non collinear points. Let λ denote the area of the quadrilateral $OABC$. Let m denotes the area of parallelogram with $\overrightarrow{OA}$ and $\overrightarrow{OC}$ as adjacent sides. If $\lambda=2\lambda m$ then find the value of λ. $(\lambda\neq 0)$

SPACE FOR ROUGH WORK

4. If $\hat{i}\times\left[(\vec{a}-\hat{j})\times\hat{i}\right]+\hat{j}\times\left[(\vec{a}-\hat{k})\times\hat{j}\right]+\hat{k}\times\left[(\vec{a}-\hat{i})\times\hat{k}\right]=0$ and $\vec{a}=x\hat{i}+y\hat{j}+z\hat{k}$ then $8(x^3-xy+zx)$ is equal to :

5. The area bounded by the curves $y=x(x-3)^2$ and $y=x$ is _____. (in sq. units)

6. Let $a, b>0$ and $\vec{\alpha}=\frac{\hat{i}}{a}+\frac{4\hat{j}}{b}+b\hat{k}$ and $\vec{\beta}=b\hat{i}+a\hat{j}+\frac{1}{b}\hat{k}$ then the reciprocal of the maximum value of $\frac{1}{5+\vec{\alpha}\cdot\vec{\beta}}$ is____.

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