VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced - 1 | Paper – 1 | JEE 2024

Date: 29th October 2023 **Maximum Marks: 180**

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

General Instructions

1. The question paper consists of 3 Subject (Subject I: **Physics**, Subject II: **Chemistry**, Subject III: **Mathematics**). Each Part 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 **4** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5). **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

   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.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ **Invigilator's Signature** _____

Syllabus:

Physics: Electrostatics, DC Circuits, Capacitors, Magnetic effects of a Current, EMI, AC Circuits, EM Waves.

Chemistry: Solid State, Theory of Solutions, Chemical Kinetics, Electrochemistry, Surface Chemistry, Organic Halides, Organic Concepts, OCOC – I, II and III.

Mathematics: Functions, Inverse Trigonometry, DC – I and II, IC – I and II, Statistics

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 **Four (04)** Matching List sets. Each set has **TWO** lists: **List I** and **List II**. **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme.

Full Marks : +3 If ONLY the 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 particle with specific charge α is projected with a velocity $\vec{v} = v_0(\hat{i} + \hat{j})$ in a magnetic field $\vec{B} = B_0(\hat{j} + \hat{k})$. Which of the following statements is/are correct?

(A) The particle will rotate in a circular path in a fixed plane with radius $\frac{v_0}{\alpha B_0}$

(B) The particle will move in a helical path with radius $\frac{\sqrt{3}v_0}{2\alpha B_0}$

(C) Frequency of rotations will be $\frac{\alpha B_0}{\sqrt{2}\pi}$ **(D)** The pitch of helical path will be $\frac{\pi v_0}{\alpha B_0}$

2. A conducting ring having mass $m = 1\text{kg}$, radius $r = 1m$ and resistance $R = 5\Omega$ is placed on a frictionless horizontal surface. A time varying magnetic field $\vec{B} = (2\hat{i} + t^2\hat{j})T$ is present in the region, where *t* is time in seconds and $\hat{j}$ is vertical. (Take $\pi^2 = 10$). Then choose the correct option(s).

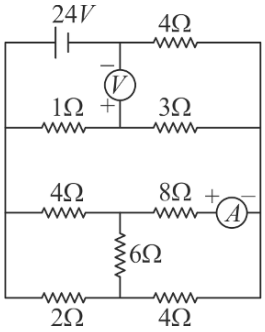
(A) The ring will topple after 1.25 s

(B) The ring will topple after 2.5 s

(C) Heart generated through the ring before the toppling starts is $\frac{125}{24}J$

(D) Heart generated through the ring before the toppling starts is $\frac{125}{12}J$

3. In the circuit shown, the battery, the ammeter and the voltmeter are ideal. Pick the correct choice(s):



(A) Power supplied by battery is 72 *W*

(B) Rate of heat dissipation in 3Ω resistance is 12 *W*

(C) The ammeter reads $\frac{4}{3}A$

(D) The voltmeter reads 22 *V*

Space for Rough Work

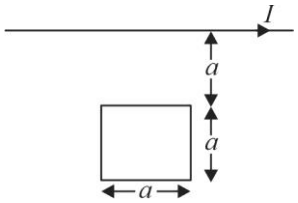
SECTION-2

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. The electromagnetic wave that delivers a cellular phone call to a car has a magnetic field with an rms value of $1.5\times10^{-10}T$. The wave passes perpendicularly through an open window, the area of which is $0.20m^2$. How much energy does this wave carry through the window during a phone call that lasts $45s$?

(A) $4.8\times10^{-5}J$ **(B)** $3.2\times10^{-5}J$ **(C)** $6.4\times10^{-5}J$ **(D)** $1.6\times10^{-5}J$

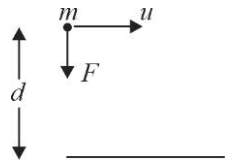
5. A square loop of side *a*, mass *m* and resistance *R* is placed coplanar with a long fixed wire carrying current I as shown. The current in the conductor is suddenly switched off. Neglecting gravity, the velocity acquired by the loop will be:



(A) $\dfrac{\mu_0 I^2 a\ell n2}{8\pi^2 mR}$ **(B)** $\dfrac{(\mu_0 I)^2 a\ell n2}{16\pi^2 mR}$ **(C)** $\dfrac{(\mu_0 I)^2 a\ell n2}{24\pi^2 mR}$ **(D)** $\dfrac{(\mu_0 I)^2 a\ell n2}{\pi^2 mR}$

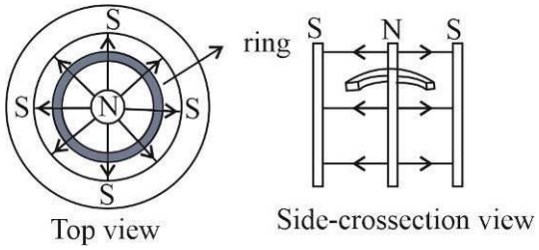
Space for Rough Work

6. An electron is projected from a distance d and with initial velocity v_0 parallel to a uniformly charged flat conducting plate carrying surface charge density σ as shown. Neglecting gravity, the distance where it falls off on ground is:



(A) $u\sqrt{\frac{2m\varepsilon_0 d}{\sigma e}}$ **(B)** $u\sqrt{\frac{4m\varepsilon_0 d}{\sigma e}}$ **(C)** $u\sqrt{\frac{3m\varepsilon_0 d}{\sigma e}}$ **(D)** $u\sqrt{\frac{m\varepsilon_0 d}{\sigma e}}$

7. A thin circular horizontal laminated copper ring of radius r with square cross-section of area A is released from rest and it falls freely under gravity through a horizontal, radial magnetic field B created by North and South poles. Resistance of the copper ring is R. What is current in the copper ring when it is moving with speed v?



(A) Zero **(B)** $\frac{2\pi Bvr}{R}$ **(C)** $\frac{Bvr}{R}$ **(D)** $\frac{\pi Bvr}{R}$

Space for Rough Work

SECTION-3

This section consists of 4 Matching List Sets. Each set has **ONE** Multiple Choice Question. Each set has **TWO** lists: **List-I** and **List-II**. **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5). **FOUR** options are given in each Multiple-Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

8. List I lists some charged distributions. Let us define $V_0 = \frac{\rho R^2}{\varepsilon_0}$

List – I		List - II	
(P)	An insulating sphere of radius R with uniform charge density ρ.	**(i)**	$\frac{1}{2}$
(Q)	A conducting, spherical shell of radius R with uniform surface charge density $\frac{\rho R}{3}$	**(ii)**	$\frac{1}{3}$
(R)	An insulating spherical shell of inner and outer radii $\frac{R}{2}$ and R respectively and uniform charge density ρ	**(iii)**	$\frac{1}{4}$
(S)	An insulating sphere of radius R with non-uniform charge density $\rho(x) = \frac{\rho x}{R}$, where x is the distance from the centre of the shell.	**(iv)**	$\frac{3}{8}$
		(v)	$\frac{1}{8}$
		(vi)	$\frac{7}{24}$

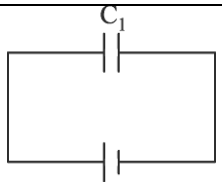
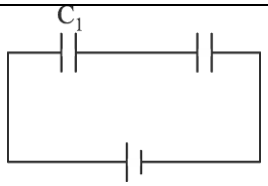
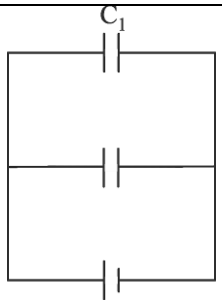
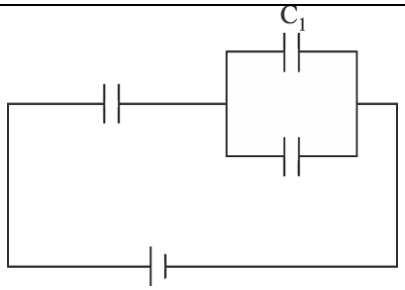
Match each item is column I with the potential at the centre of the sphere (or spherical shell) in each case as a multiple of V_0.

(A) P – i, Q – ii, R – vi, S – iii **(B)** P – i, Q – ii, R – iv, S – iv

(C) P – i, Q – iii, R – iv, S – iii **(D)** P – i, Q – iii, R – vi, S – i

Space for Rough Work

9. List – I lists some capacitor circuits. All capacitors have capacitance C. All batteries have EMF *V*. Once the capacitors(s) are charged, a di-electric slab of di-electric constant *K* = 2 is inserted into capacitor C_1. The thickness and area of the di-electric is the same as capacitor C_1. The slab is inserted very slowly.

List – I		List - II	
(P)		**(i)**	2
(Q)		**(ii)**	$\frac{4}{3}$
(R)		**(iii)**	$\frac{1}{2}$
(S)		**(iv)**	3
		(v)	3/2
		(vi)	5/3

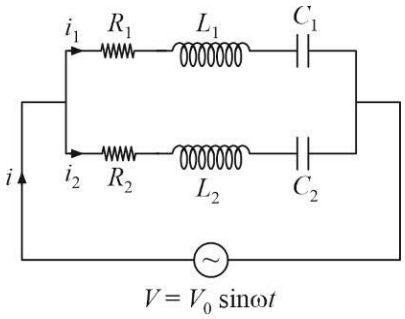
If in any case, charge on C_1 before insertion of slab was Q_i and after insertion of slab was Q_f, match each choice in column with the correct value for $\frac{Q_f}{Q_i}$.

(A) P – i, Q – ii, R – i, S – v **(B)** P – i, Q – iii, R – iv, S – v

(C) P – ii, Q – iii, R – i, S – iv **(D)** P – i, Q – ii, R – ii, S – vi

Space for Rough Work

10. Figure shows an AC circuit having resistors, capacitors and inductors. Relation among $R_1, R_2, L_1, L_2, C_1, C_2$ are given in List-I and phase difference between i_1 and i_2 are given in List-II.



List - I		List - II	
(I)	$\omega L_1 - \frac{1}{\omega C_1} = \frac{3R_1}{4}, \ \frac{1}{\omega C_2} - \omega L_2 = \frac{3R_2}{4}$	**(P)**	i_1 leads i_2 by 90°
(II)	$\frac{1}{\omega C_1} - \omega L_1 = \frac{4R_1}{3}, \omega L_2 - \frac{1}{\omega C_2} = \frac{4R_2}{3}$	**(Q)**	i_2 leads i_1 by 90°
(III)	L_1 is removed and C_2 is removed $\frac{1}{\omega C_1} = R_1, \ \omega L_2 = R_2$	**(R)**	i_1 leads i_2 by 106°
(IV)	L_2 is removed and C_1 is removed $\omega L_1 = R_1, \ \frac{1}{\omega C_2} = R_2$	**(S)**	i_2 leads i_1 by 106°
		(T)	i_1 leads i_2 by 74°
		(U)	i_2 leads i_1 by 74°

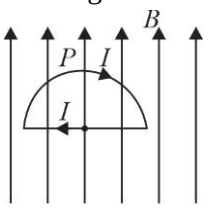
Which of the following options shows the correct match?

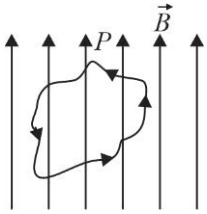
(A) (I) - (T), (II) - (S), (III) - (Q), (IV) - (S) **(B)** (I) - (U), (II) - (S), (III) - (P), (IV) - (Q)

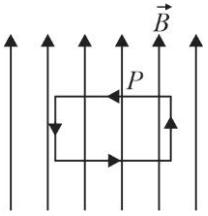
(C) (I) - (S), (II) - (T), (III) - (Q), (IV) - (S) **(D)** (I) - (U), (II) - (R), (III) - (Q), (IV) - (S)

Space for Rough Work

11. Referring to the system shown in the figure (i), (ii) and (iii), match the following :

(i) Current carrying semi-circular loop in a uniform magnetic field 

(ii) Current carrying loop of irregular shape in a uniform magnetic field 

(iii) Current carrying rectangular loop in a uniform magnetic field 

List -I		List -II	
(P)	Semi-circular loop in figure (i)	**(1)**	Net force is zero
(Q)	Loop of irregular shape in figure (ii)	**(2)**	Torque acting is, in general, non-zero
(R)	Rectangular loop in figure (iii)	**(3)**	Torque acting is zero
(S)	If we consider only the straight part of conductor in figure (i)	**(4)**	Force acting is non-zero
		(5)	Point *P* on the loop moves outward just after releasing the loop

(A) (P-1, 2, 5); (Q-1, 2); (R-1, 2); (S-4) **(B)** (P-1, 2, 5); (Q-1, 4); (R-1, 3); (S-5)

(C) (P-1, 5); (Q-1, 2, 4); (R-1, 2); (S-4) **(D)** (P-1, 4, 5); (Q-1, 2); (R-1, 4); (S-3)

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. A charged particle of mass 'm' and charge q is projected with a speed v_0 from a large distance towards a stationary particle of mass '$2m$' and charge 'q'. The minimum separation between the particles will be $\frac{Nq^2}{4\pi \in_0 mv_0^2}$. N is _____.

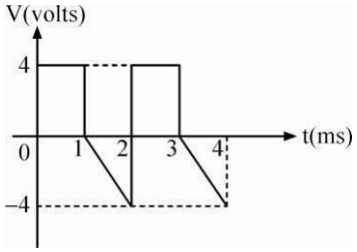
2. A long wire is placed along X-axis having current i along positive X-axis. The magnetic field at a point $(a, 3a, -4a)$ is given as $\vec{B} = \frac{\mu_0 i}{50\pi a}(p\,\hat{j} + q\hat{k})$. The value of $p+q$ is _____.

3. Two identical conducting plates of area A are separated by a distance d and charged to a potential difference V. The separation between the plates is increased further by $2d$ keeping the charge constant. The work done by external means is $\frac{N\varepsilon_0 AV^2}{2d}$. Then N is _____.

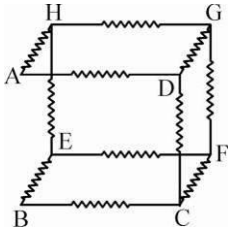
Space for Rough Work

4. If a dipole of dipole moment $p\hat{i}$ is placed at a point (0, *y*) and a point charge at origin, net electric field at point $(x, x+y)$ vanishes. If *x* and *y* both are positive then $y = nx$, where *n* is _____ .

5. In an *AC* circuit, variation of voltage with time is as shown. rms voltage for this circuit is found to be $N\sqrt{\frac{2}{3}}$ volt. Find *N*.



6. Eleven equal wires, each of resistance 5Ω, form the edges of an incomplete skeleton cube. Find the total resistance between points A and B of the vacant edge (in Ω).



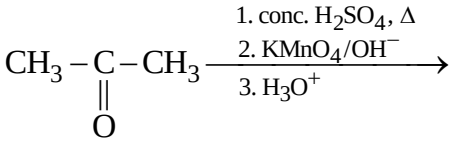
Space for Rough Work

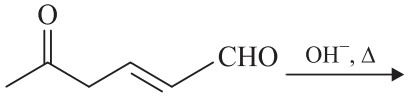
SUBJECT II : CHEMISTRY 60 MARKS

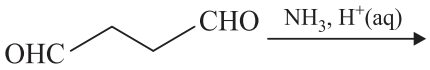
SECTION-1

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. Which of the following reaction(s) will give an aromatic compound as the major product?

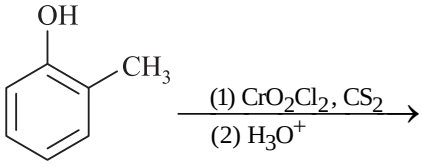
(A) 

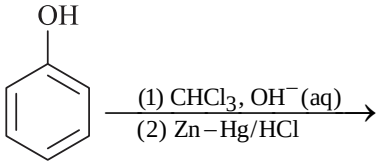
(B) 

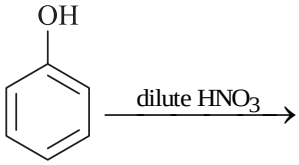
(C) 

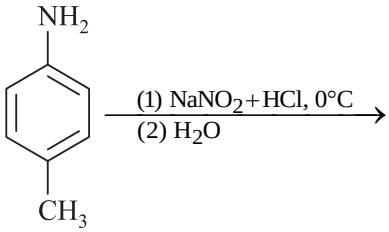
(D) 

2. Major organic products of which of the following reaction can show positive phthalein dye test, positive neutral $FeCl_3$ test but negative Tollen's reagent test?

(A) 

(B) 

(C) 

(D) 

3. Select correct statement/s regarding colloids:

(A) Colloidal particles of Au and Ag are negatively charged

(B) Colloidal particles of methylene blue dye are positively charged

(C) Gelatin can be protective colloid to prevent flocculation of hydrated metal oxides sols

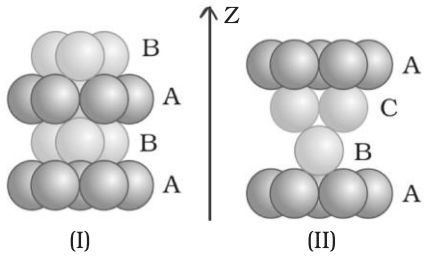
(D) Congo red dye can be protective colloid to prevent flocculation of CdS sols

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. Spherical particles of identical radii were been used to create hexagonally packed layers A, B and C. Two different stacking of those layers are shown as (I) and (II) in the given figure. Identify the incorrect statement in reference to these arrangements:



(A) Arrangement (I) is 3D hcp while (II) is ccp

(B) Coordination number of a particle is 12 in both arrangements

(C) In both arrangements number of spheres contributing their 100% volume to each unit cell is 3

(D) The ratio of gap between two layers of identical notation, along z-axis in arrangement I and II is 2:3

5. Insulin is dissolved in a suitable solvent and the osmotic pressure (π) (in atm) of solutions of various concentrations (g/cc) C is measured at 20°C. The slope of the plot of π against 'C' is found to be 4.65×10^{-3}. The molecular weight of insulin is: [Take R = 0.0821 atm-L/mole-K]

(A) 4.8×10^{5} **(B)** 9×10^{5} **(C)** 3×10^{5} **(D)** 5.17×10^{6}

Space for Rough Work

6. Consider the following sequential first order conversion.

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

k_1 and k_2 are first order rate constant having relation $k_1 = 2k_2$. If at certain time t, molarity of A is $[A]_t$ and net rate of formation of B is nine times to that of C then molarity of B at that time "t" can be given as:

(A) $5[A]_t$ **(B)** $\frac{[A]_t}{10}$ **(C)** $\frac{[A]_t}{5}$ **(D)** $\frac{2}{9}[A]_t$

7. During discharging of a lead storage battery following reactions occurs at anode and cathode. If $E^\circ_{PbSO_4/Pb} = -0.02\,V$ and $E^\circ_{PbSO_4/PbO_2} = -1.50\,V$ then the magnitude of maximum non mechanical work that can be done by the battery under standard conditions is: [F is the Faraday's constant]

$$\left[\begin{array}{ll} \text{Anode :} & Pb + H_2SO_4 \rightleftharpoons PbSO_4 + 2H^+ + 2e^- \\ \text{Cathode :} & PbO_2 + H_2SO_4 + 2H^+ + 2e^- \rightleftharpoons PbSO_4 + 2H_2O \end{array}\right]$$

(A) 1.97 F **(B)** 3.04 F **(C)** 0.72 F **(D)** 2.48 F

Space for Rough Work

SECTION-3

This section consists of 4 Matching List Sets. Each set has **ONE** Multiple Choice Question. Each set has **TWO** lists: **List-I** and **List-II**. **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5). **FOUR** options are given in each Multiple-Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

8. The major products obtained from the reactions in List-II are the reactants for the named reactions mentioned in List-I. Match List-I with List-II and choose the correct option.

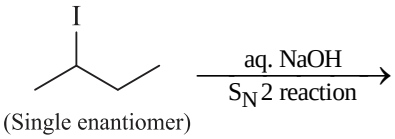
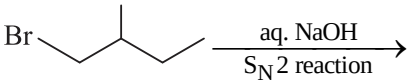
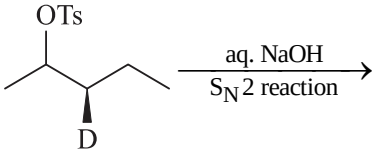
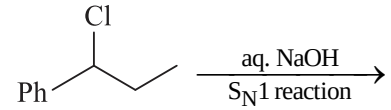
List-I		**List-II**	
(P)	Etard reaction	**(1)**	Chlorobenzene $\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) NaOH, } \Delta}$
(Q)	Gattermann reaction	**(2)**	Toluene $\xrightarrow[\text{(ii) } SOCl_2]{\text{(i) } KMnO_4, KOH, \Delta}$
(R)	Gattermann-Koch reaction	**(3)**	Benzaldehyde $\xrightarrow[\text{Glycol}]{NH_2-NH_2, OH^-}$
(S)	Rosenmund reaction	**(4)**	Aniline $\xrightarrow[273\text{-}278\,K]{NaNO_2/HCl}$
		(5)	Benzene diazonium chloride $\xrightarrow{H_3PO_2}$

(A) P $\rightarrow$ 2; Q $\rightarrow$ 4; R $\rightarrow$ 1; S $\rightarrow$ 3 **(B)** P $\rightarrow$ 1; Q $\rightarrow$ 3; R $\rightarrow$ 5; S $\rightarrow$ 2

(C) P $\rightarrow$ 3; Q $\rightarrow$ 2; R $\rightarrow$ 1; S $\rightarrow$ 4 **(D)** P $\rightarrow$ 3; Q $\rightarrow$ 4; R $\rightarrow$ 5; S $\rightarrow$ 2

Space for Rough Work

9. Match the reactions in List-I with the features of their products in List-II and choose the correct option.

List-I		List-II	
(P)	 (Single enantiomer)	**(1)**	Inversion of configuration
(Q)	 (Single enantiomer)	**(2)**	Retention of configuration
(R)		**(3)**	Mixture of enantiomers
(S)	 (Single enantiomer)	**(4)**	Mixture of structural isomers
		(5)	Mixture of diastereomers

(A) P $\rightarrow$1; Q $\rightarrow$2; R $\rightarrow$5; S $\rightarrow$3 **(B)** P $\rightarrow$2; Q $\rightarrow$1; R $\rightarrow$3; S $\rightarrow$5

(C) P $\rightarrow$1; Q $\rightarrow$2; R $\rightarrow$5; S $\rightarrow$4 **(D)** P $\rightarrow$2; Q $\rightarrow$4; R $\rightarrow$3; S $\rightarrow$5

Space for Rough Work

10. Match product of electrolysis from List-I with appropriate electrolysis process in List-II.

List-I		List-II	
(P)	$H_2(g)$ as cathode product	**(1)**	$CuSO_4(aq)$ electrolysis using Pt electrodes
(Q)	$O_2(g)$ as anode product	**(2)**	Dilute H_2SO_4 electrolysis using Pt electrodes
(R)	Coinage metal as cathode product	**(3)**	Electrolysis of conc. NaCl using Pt electrodes
(S)	Active metal as cathode product	**(4)**	Electrolysis of NaCl(aq) using Hg cathode and graphite anodes
		(5)	Electrolysis of $CH_3COONa(aq)$ using Pt electrodes

(A) P $\rightarrow$2, 3, 4, 5; Q $\rightarrow$1, 2, 5; R $\rightarrow$1, 5; S $\rightarrow$4, 5

(B) P $\rightarrow$2, 3, 5; Q $\rightarrow$1, 2; R $\rightarrow$1; S $\rightarrow$4

(C) P $\rightarrow$2, 3; Q $\rightarrow$3, 4; R $\rightarrow$1, 2; S $\rightarrow$4, 5

(D) P $\rightarrow$3, 4; Q $\rightarrow$1, 2, 5; R $\rightarrow$1, 2; S $\rightarrow$1, 4

11. Certain nuclei X undergoes different nuclear processes to produce Y as given in List-II, Y has some relationship with the parent nuclei X as given in List-I. Find the appropriate match of entries given in List-I and List-II and select the correct alternative.

List-I		List-II	
(P)	Y is an isodiaphere of X	**(1)**	$X \longrightarrow 2\,{}^{4}_{2}\alpha + 4\,{}^{0}_{-1}\beta + Y$
(Q)	Y is an isotope of X	**(2)**	$X \longrightarrow {}^{4}_{2}\alpha + Y$
(R)	Y is isotone to X	**(3)**	$X \longrightarrow {}^{0}_{-1}\beta + Y$
(S)	Y is isobar of X	**(4)**	$X \longrightarrow {}^{0}_{+1}\beta + Y$
		(5)	$X \longrightarrow {}^{1}_{+1}P + Y$

(A) P $\rightarrow$1; Q $\rightarrow$2, 3; R $\rightarrow$3; S $\rightarrow$5 **(B)** P $\rightarrow$2; Q $\rightarrow$1, 2; R $\rightarrow$5; S $\rightarrow$3, 4

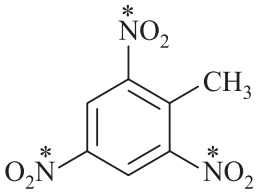
(C) P $\rightarrow$3, 4; Q $\rightarrow$1; R $\rightarrow$2; S $\rightarrow$5 **(D)** P $\rightarrow$1; Q $\rightarrow$4; R $\rightarrow$4; S $\rightarrow$3, 5

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 solid boron nitride BN(s) the overall alternate arrangement of boron and nitrogen atoms is identical to arrangement of carbon atoms in graphite. The number of BN formula units per unit cell in the BN(s) is_____.

2. 

$\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } KMnO_4,\ OH^-,\ \Delta}$ A $\xrightarrow{{}^{*}NH_3,\ \Delta}$ B $\xrightarrow[\text{(ii) Sn, HCl}]{\text{(i) } Br_2,\ OH^-(aq),\ \Delta}$ C

Mass percentage of nitrogen in major product C is _____. (Closest integer)

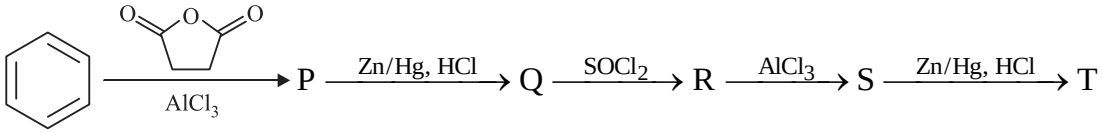
[Here $^{*}N$ is ^{15}N isotope; Atomic masses are 12, 1, 16, 80 respectively for C, H, O and Br]

3. For the first order thermal decomposition of $N_2O_5(g)$ into $NO_2(g)$ and $O_2(g)$, occurring by following reaction.

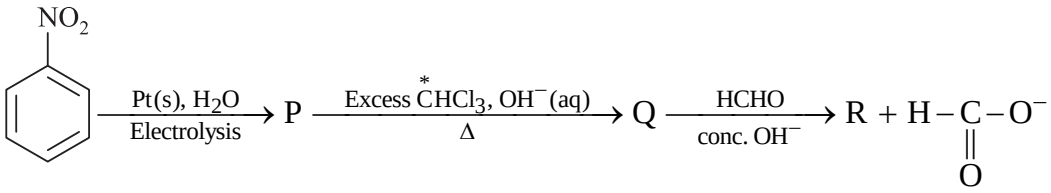
$$2N_2O_5(g) \xrightarrow{k} 2NO_2(g) + O_2(g)$$ (k is rate constant)

If pressure of $N_2O_5(g)$ decreases from 100 torr to 80 torr in 50 min then rate constant of the reaction is $2.303\times10^{-x}\ min^{-1}$. Value of x is _____. [Take : $\log_{10} 2 = 30,\ \log_{10} 3 = 0.48,\ \log_{10} 5 = 0.70$]

Space for Rough Work

4. 

Degree of unsaturation of the organic compound T is _____.

5. 

[Here $^{*}C$ is ^{14}C isotope]

Compound Q is a foul smelling and can give 2, 4-DNP test. Compound P forms Para-N-acetyl phenol (i.e., paracetamol) on reaction with 1 equivalent of CH_3COCl. Number of $^{*}C$ carbon atoms in one molecule of the product R is _____.

6. Standard reduction potential of $Cl_2(g)$ into $Cl^-(aq)$ is 1.35 volt.

Standard reduction potential for conversion of acetone into propan-2-ol is –0.25 volt in alkaline medium. If E° for disproportionation of Cl_2 into Cl^- and ClO^- in alkaline medium is 1.20 volt then E° for oxidation of propan-2-ol into acetone by ClO^- in alkaline medium during the haloform reaction is x volt. Value of x is _____.

Reactions involved:

$$Cl_2 + 2OH^- \rightarrow Cl^- + ClO^- + H_2O \quad \ldots\ldots (1)$$

$$CH_3 - \underset{\underset{OH}{|}}{CH} - CH_3 + ClO^- \rightarrow CH_3 - \underset{\underset{O}{||}}{C} - CH_3 + Cl^- + H_2O \quad \ldots\ldots (2)$$

Space for Rough Work

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. Let $f(x)=max\{1+sin\,x, 1, 1-cos\,x\}$, $x\in[0, 2\pi]$ and $g(x)=max\{1, |x-1|\}$, $x\in R$, then :

(A) $g(f(0))=1$ **(B)** $g(f(1))=1$ **(C)** $f(f(1))=1$ **(D)** $f(g(0))=1+sin1$

2. Let $f(x)=[x]$ and $g(x)=\begin{cases}0, & x\in Z\\ x^2, & x\in R-Z\end{cases}$ ([.] represents greatest integer function). Then :

(A) $\lim\limits_{x\to1} g(x)$ exists but $g(x)$ is not continuous at $x = 1$

(B) $f(x)$ is not continuous at $x = 1$

(C) *gof* is continuous for all x

(D) *fog* is continuous for all x

3. A function $f(x)$ which satisfies the relation $f(x)=e^x+\int_0^1 e^x f(t)\,dt$, then :

(A) $f(0) < 0$ **(B)** $f(x)$ is a decreasing function

(C) $f(x)$ is a increasing function **(D)** $\int_0^1 f(x)\,dx > 0$

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. The value of $\sum_{m=1}^{n} \tan^{-1}\left(\frac{2m}{m^4+m^2+2}\right)$ is:

(A) $\tan^{-1}\left(n^2+n\right)$ **(B)** $\tan^{-1}\left(\frac{n^2+n+1}{n^2+n+2}\right)$

(C) $\tan^{-1}\left(\frac{n}{n+1}\right)$ **(D)** $\tan^{-1}\left(\frac{n^2+n}{n^2+n+2}\right)$

5. The least and greatest values of $\left(\sin^{-1}x\right)^3+\left(\cos^{-1}x\right)^3$ are respectively:

(A) $-\frac{\pi}{2},\frac{\pi}{2}$ **(B)** $-\frac{\pi^3}{8},\frac{\pi^3}{8}$ **(C)** $\frac{\pi^3}{32},\frac{7\pi^3}{8}$ **(D)** $\frac{\pi^3}{32},\frac{\pi^3}{8}$

6. The mean and variance of 8 observations are 10 and 13.5 respectively. If six of these observations are 5, 7, 10, 12, 14, 15 then the absolute difference of the remaining two observations is :

(A) 9 **(B)** 5 **(C)** 3 **(D)** 7

7. The area defined by $|y| \le e^{-|x|} - \frac{1}{2}$ in cartesian co-ordinate system, is:

(A) $(4-2ln2)$ **(B)** $(4-ln2)$ **(C)** $(2-ln2)$ **(D)** $(2-2ln2)$

Space for Rough Work

SECTION-3

This section consists of 4 Matching List Sets. Each set has **ONE** Multiple Choice Question. Each set has **TWO** lists: **List-I** and **List-II**. **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5). **FOUR** options are given in each Multiple-Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.

8. If $x, y, z \in R$ satisfies the system of equations $x+[y]+\{z\}=12.7$. $[x]+\{y\}+z=4.1$ and $\{x\}+y+[z]=2$ (where {.} and [.] denotes the fractional and integral parts respectively), then match the following :

	List - I		**List - II**
(A)	$\{x\}+\{y\}=$	**(P)**	7.7
(B)	$[z]+[x]=$	**(Q)**	1.1
(C)	$x+\{z\}=$	**(R)**	1
(D)	$z+[y]-\{x\}=$	**(S)**	3
		(T)	4

(A) [A-R] [B-S] [C-P] [D-Q] **(B)** [A-S] [B-R] [C-Q] [D-T]

(C) [A-R] [B-S] [C-Q] [D-P] **(D)** [A-S] [B-T] [C-P] [D-Q]

Space for Rough Work

9. Match the following $\int f(x)dx$ is equal to, if :

	List - I		**List – II**
(A)	$f(x)=\dfrac{1}{\left(x^2+1\right)\sqrt{x^2+2}}$	**(P)**	$\dfrac{x^5}{5\left(1-x^4\right)^{5/2}}+C$
(B)	$f(x)=\dfrac{1}{\left(x+2\right)\sqrt{x^2+6x+7}}$	**(Q)**	$sin^{-1}\left(\dfrac{x+1}{\left(x+2\right)\sqrt{2}}\right)+C$
(C)	$f(x)=\dfrac{x^4+x^8}{\left(1-x^4\right)^{7/2}}$	**(R)**	$\left(\sqrt{x}-2\right)\sqrt{1-x}+cos^{-1}\sqrt{x}+C$
(D)	$f(x)=\sqrt{\dfrac{1-\sqrt{x}}{1+\sqrt{x}}}$	**(S)**	$-tan^{-1}\sqrt{1+\dfrac{2}{x^2}}+C$
		(T)	$\dfrac{x^6}{6\left(1-x^4\right)^{5/2}}+C$

(A) [A-S] [B-Q] [C-R] [D-P] **(B)** [A-S] [B-Q] [C-T] [D-R]

(C) [A-Q] [B-R] [C-P] [D-S] **(D)** [A-S] [B-Q] [C-P] [D-R]

Space for Rough Work

10. Match the column :

	List – I		**List – II**
(A)	$\int_0^{\pi/2} \frac{\cos x}{(1+\sin x)(2+\sin x)}dx =$	**(P)**	$\frac{\pi}{6}$
(B)	$\int_0^{41\pi/4} \lvert \cos x \rvert dx =$	**(Q)**	$20+\frac{1}{\sqrt{2}}$
(C)	$\int_{-1/2}^{1/2} \left([x]+ln\left(\frac{1+x}{1-x}\right)\right)dx =$	**(R)**	$\ell n4-\ell n3$
	where, [.] is greatest integer solution		
(D)	$\int_0^{\pi/2} \frac{2\sqrt{\cos\theta}}{3\left(\sqrt{\sin\theta}+\sqrt{\cos\theta}\right)}d\theta =$	**(S)**	$-\frac{1}{2}$
		(T)	$\frac{1}{3}$

(A) [A-Q] [B-R] [C-S] [D-P] **(B)** [A-R] [B-Q] [C-S] [D-P]

(C) [A-Q] [B-R] [C-T] [D-S] **(D)** [A-R] [B-T] [C-P] [D-S]

Space for Rough Work

11. Match the column :

	List – I		List – II
(A)	Given $f(x)=\frac{1}{u^2+u-2}$, where $u=\frac{1}{x-1}$, then $f(x)$ is	**(P)**	continuous at $x = 0$
(B)	If $f(x)=\operatorname{sgn}\left(x\left(1-x^2\right)\right)$, then $f(x)$ is	**(Q)**	discontinuous at $x=1, \frac{1}{2}, 2$
(C)	If $\lim_{x\to 0}\frac{f(x)}{x}$ exists and $f(0) = 0$ then $f(x)$ is	**(R)**	discontinuous function
(D)	The function $f(x)=\lim_{n\to\infty}\frac{nx+\operatorname{sgn} x}{1+n}$ is	**(S)**	discontinuous at $x = 2$

(A) [A-Q,R,S] [B-P] [C-R] [D-P] **(B)** [A-P,Q,R,S] [B-P,R] [C-P] [D-R]

(C) [A-P,Q,R, S] [B-R] [C-P] [D-P] **(D)** [A-Q,R,S] [B-P,R] [C-P,Q] [D-P]

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. A continuous function $f(x)$ on $R \to R$ satisfies the relation

$$f(x)+f(2x+y)+5xy=f(3x-y)+2x^2+1$$

For $\forall\, x, y \in R$, then the value of $|f(4)|$ is _____.

2. If $\lim\limits_{x\to 1}\dfrac{a\sin(x-1)+b\cos(x-1)+4}{x^2-1}=-2$, then $|a+b|$ is _____.

3. A differentiable function f satisfying a relation $f(x+y)=f(x)+f(y)+2xy(x+y)-\dfrac{1}{3}\forall\, x, y \in R$ and $\lim\limits_{h\to 0}\dfrac{3f(h)-1}{6h}=\dfrac{2}{3}$. Then the value of $[f(2)]$ is _____. (where $[x]$ represents greatest integer function)

Space for Rough Work

4. If the function $f(x) = -4e^{\frac{1-x}{2}} + 1 + x + \frac{x^2}{2} + \frac{x^3}{3}$ and $g(x) = f^{-1}(x)$, then the reciprocal of $g'\left(\frac{-7}{6}\right)$ is _____.

5. A curve is given by the equation $x = \sec^2\theta,\ y = \cot\theta$. If the tangent at *P* where $\theta = \frac{\pi}{4}$ meets the curve again at *Q*, then [*PQ*] is _____. (where [.] represents the greatest integer function)

6. For a cubic function $y = f(x)$, $f''(x) = 4x$ at each point (x, y) on it and it crosses the *x*-axis at $(-2, 0)$ at an angle of $45°$ with positive direction of the *x*-axis. Then the value of $\left|\frac{f(1)}{5}\right|$ is _____.

Space for Rough Work

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