VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Advanced Home Practice Test -7 | Paper -2 | JEE 2024

Date: 10/05/2024 **Maximum Marks: 180**

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 **three** sections (Section 1, Section 2 & Section 3).

Section 1 contains **SIX (06) 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 **8 Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, ⊖ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08).

Section 3 contains **4 matching lists LIST-I** and **LIST-II.**

FOUR options are given representing matching of elements from LIST-I and LIST-II. ONLY ONE of these four options corresponds to a correct matching.

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** _____

MARKING SCHEME

SECTION-I (Maximum Marks: 24)

- This section contains **SIX (06)** 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.

SECTION-II (Maximum Marks: 24)

- This section contains **EIGHT (08)** questions. The answer to each question is a **NUMERICAL VALUE.**
- The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	**+3**	If ONLY the correct numerical value is entered as answer.
Zero Marks	:	**0**	In all other cases.

SECTION-III (Maximum Marks: 12)

- This section contains **FOUR (04)** questions.
- Each question has **TWO (02)** matching lists: **LIST-I** and **LIST-II**.
- **FOUR** options are given representing matching of elements from **LIST-I** and **LIST-II**. **ONLY ONE** of these four options corresponds to a correct matching.
- For each question, choose the option corresponding to the correct matching.
- For each question, marks will be awarded according to the following marking scheme:

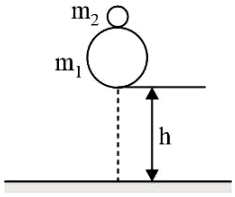
Full Marks	:	**+3**	If ONLY the option corresponding to the correct matching is chosen.
Zero Marks	:	**0**	If none of the options is chosen (i.e. the question is unanswered).
Negative Marks	:	**–1**	In all other cases.

SUBJECT I : PHYSICS 60 MARKS

SECTION 1

This section consists of 6 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. An object of mass m_1 and another of mass m_2 are dropped from a height h, the second one immediately following the first one. All collisions are perfectly elastic and occur along a vertical line. Which of the following is (are) correct?



(A) It $m_1 : m_2 = 4,$ then m_1 will remain at rest after collision

(B) It $m_1 : m_2 = 3,$ then m_1 will remain at rest after collision

(C) If m_1 is at rest after collision, m_2 rises to a maximum height of $4h$

(D) If m_1 is at rest after collision, m_2 rises to a maximum height of $5h$

2. A uniform rod of mass per unit length $\lambda\, kg/m,$ length L, is hanging from ceiling. The Young's modulus of rod is $\gamma\ \ N/m^2$. The specific heat of the rod equals $S_0\ J/kg.°c$. (neglect thermal expansion of rod). Then for elongation under gravity, which of the following is/are correct?

(A) The ratio of work done by gravity on upper half to work done by gravity on lower half equals 5 : 11.

(B) The ratio of elastic potential energy stored in upper half to elastic potential energy stored in lower half equals 1.

(C) The ratio of work done by gravity on whole rod to elastic potential energy stored in whole rod equals 2 :1.

(D) The increase of temperature if length of rod taken be $l_1 = l_0$ is $\Delta T_1,$ and the increase in temperature if length of rod taken be $l_2 = 2l_0$ is ΔT_2, then $\dfrac{\Delta T_1}{\Delta T_2} = 1$.

3. A small bead of mass m and charge q is threaded on a thin horizontal ring of radius R made of insulating material. The bead can move on the circular track without friction and is initially at rest. A magnetic field that is cylindrically symmetric (about axis of ring) is created, in which the component of magnetic induction that is perpendicular to the plane of the track depends only on the distance r measured from the centre and time t:

$$B(r,t) = \frac{E_0}{r}.t,$$

Where E_0 is a given constant. (In a negligibly small neighbourhood of $r = 0$ the induction has some finite value)

Which of the following is (are) correct?

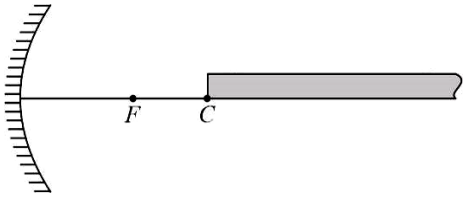
(A) The velocity-time function of the bead is $\dfrac{E_0 q}{2m}t$

(B) The velocity-time function of the bead is $\dfrac{E_0 q}{m}t$

(C) The radial component of the normal force between the bead and the track is zero

(D) The radial component of the normal force between the track bead and the has non-zero value

4. A long rectangular plate is placed on the principal axis of a concave mirror as shown in figure. F is the focus and C is the centre of curvature of mirror. The radius of curvature of the concave mirror is very large compared to the height of the plate. Which of the following is (are) correct?



(A) The image is similar in shape to a rectangle

(B) Area of image is smaller than that of object

(C) The image is similar in shape to a triangle

(D) The image is similar in shape to a trapezium

5. In a radioactive decay chain, $^{238}_{92}\mathrm{U}$ nucleus decays to $^{206}_{82}\mathrm{Pb}$ nucleus. Let a and b be the number of α and β^- particles, respectively, emitted in this decay process. Which of the following statements is (are) true?

(A) $a = 8$ **(B)** $a = 6$ **(C)** $b = 2$ **(D)** $b = 6$

6. A driver in a stationary car blows a horn which produces sound waves of frequency 1000 Hz normally towards a reflecting wall. The wall approaches the car with a speed of $3.3\,ms^{-1}$, which of the following options is (are) correct? (Speed of sound = 330 m/s^{-1})

(A) The frequency of sound reflected from wall and heard by the driver is 1020 *Hz*

(B) The frequency of sound reflected from wall and heard by the driver is 980 *Hz*

(C) The frequency of sound reflected from wall is 1010 *Hz*

(D) The frequency of sound reflected from wall 1000 *Hz*

SPACE FOR ROUGH WORK

SECTION 2

NUMERICAL VALUE TYPE QUESTIONS

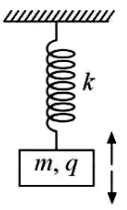
This section contains of 8 **Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25, 0.08).

7. When hard brakes are applied (so as to lock the wheels) in a car travelling on a wet rod it can "hydro-plane". A film of water is created between the tires and the road and, theoretically, the car can slide a very long distance. [In practice film is destroyed much before such distance can be achieved]. Consider a car of mass M moving on a wet road with speed v_0. Hard brakes are applied. Let the total area of film under all four tires be A and thickness of the film be h. Coefficient of viscosity of water is η.

Calculate the distance (in km) to which the car will slide before coming to rest. [Take $M = 10^3\, kg$, $A = 0.2\, m^2$, $h = 0.1\, mm$, $v_0 = 20\, ms^{-1}$, and $\eta = 10^{-3}\, kg\, m^{-1}$]

8. A ball is thrown from the foot of a plane whose inclination to horizontal is 30°. It strikes the inclined plane at a distance 0.7 m from the point of projection. After collision with the inclined plane it rebounds, without any loss of energy, and follows its former path exactly in reverse. The speed with which it was projected is _____. ($g = 10\ m/s^2$)

9. The following figure shows a block of mass m with charge q. The block is oscillating simple harmonically in the vertical plane in the presence of a uniform electric field.



We wish to measure the maximum elongation in the following cases.
In case-1, the electric field $E = mg/q$ is upward
In case-2, the electric field $E = mg/q$ is downward
In case-3, the electric field is zero
In case-4, the electric field $E = 2mg/q$ is downward
The speed at mean position of block is same in all cases. The elongation is maximum in case _____ (answer is 1 if case 1, answer is 2 if case 2 and so on).

10. A moving coil galvanometer has a sensitivity of 10 rad/A. When a current flows through the galvanometer, a full scale deflection occurs if the coil rotates by 0.1 rad. The resistance of the coil of the galvanometer is $20\,\Omega$. This galvanometer is to be converted into a voltmeter capable of measuring voltage in the range 0 – 1.0 V. For this, a resistance is to be added in series to the galvanometer. The value of this resistance, in ohms, is _____.

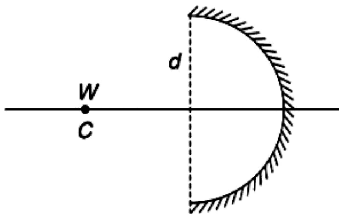
11. A very long uniformly charged thread oriented along the axis of a circle of radius R rests on its centre with one of the ends. The charge of the thread per unit length is equal to λ.

The magnitude of electric flux through the circle area is $x\dfrac{\lambda R}{\epsilon_0}$, where x is _____.

12. 1 mole of a perfect gas is compressed adiabatically from 6 m^3 to 2 m^3. The initial pressure of the gas is $10^5\, N/m^2$. Molar specific heat of the gas at constant volume is $3R/2$. The work done in MJ is _____. (Take $(3)^{1.67} = 6.26$)

13. A metal plate is exposed to light with wavelength 5000 *nm*. It is observed that electrons are ejected from the surface of the plate. When a retarding uniform electric field 0.01 *N*/*C* is imposed, no electron can move away from the plate farther than a certain distance *d*. If the threshold wavelength for the material of the plate is twice the incident light wavelength then the distance d is _____ *m*. (Take $hc = 1243\ eV - nm$)

14. A spherical concave mirror has aperture diameter *d* and radius of curvature *R*. A point source of light is placed at its centre of curvature. Source emits power *W* and the mirror surface is completely reflecting. The force on the mirror due to light incident on it is $x\frac{Wd^2}{2R^2C}$, where *x* is _____.



SPACE FOR ROUGH WORK

SECTION - 3
MATRIX MATCH TYPE

This section contains **4 Single Choice Questions**. Each question has TWO (02) matching lists: List-I and List-II. The codes for the lists have 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** Choice is Correct.

15. The magnetic field B is measured at a point $P(0, 0, d)$ generated due to various current distributions and the dependence of B on d is found to be different for different current distributions. List-I contains different relations between B and d. List-II describes different current distributions, along with their locations. Match the functions in List-I with the related current distributions in List-II.

List-I		List-II	
(P)	B is independent of d	**(1)**	A hollow cylindrical current carrying wire, of radius l, with its axis coincident with the y-axis. Take $2l << d$
(Q)	$B \propto \frac{1}{d}$	**(2)**	A small current carrying ring in the xy plane with centre at origin and radius l. Take $2l << d$
(R)	$B \propto \frac{1}{d^2}$	**(3)**	An infinite current carrying wire coincident with x-axis
(S)	$B \propto \frac{1}{d^3}$	**(4)**	Two infinite current carrying wires parallel to the x-axis. The one along ($y = 0$, $z = l$) has a current I and the one along ($y = 0$, $z = -l$) has a current $-I$. Take $2l << d$
		(5)	Infinite plane coincident with the xy plane with uniform current per unit length k.

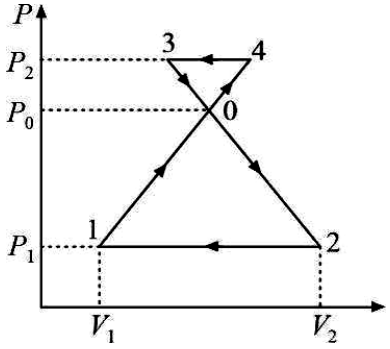
(A) (P) – (5), (Q) – (3, 4), (R) – (1), (S) – (2)
(B) (P) – (5), (Q) – (1, 3), (R) – (4), (S) – (2)
(C) (P) – (5), (Q) – (3), (R) – (1, 2), (S) – (4)
(D) (P) – (4), (Q) – (2, 3), (R) – (1), (S) – (5)

16. A planet of mass M, has two natural satellites with masses m_1 and m_2. The eccentricity of their elliptical orbits are 0.6 and 0.8 respectively. They are moving such that their semi-major axis are of same length. Ignore the gravitational force between the satellites. Define v_1, L_1, K_1 and T_1 to be, respectively, the speed, angular momentum, kinetic energy at perihelion and time period of revolution of satellite 1; and v_2, L_2, K_2 and T_2 to be the corresponding quantities of satellite 2. Given $m_1/m_2 = 4$ match the ratios in List-I to the numbers in List-II.

List-I		List-II	
(P)	v_1/v_2	**(1)**	1
(Q)	L_1/L_2	**(2)**	$\frac{4}{3}$
(R)	K_1/K_2	**(3)**	$\frac{32}{9}$
(S)	T_1/T_2	**(4)**	$\frac{32}{3}$

(A) (P) – (4), (Q) – (2), (R) – (1), (S) – (3)
(B) (P) – (3), (Q) – (2), (R) – (4), (S) – (1)
(C) (P) – (2), (Q) – (3), (R) – (1), (S) – (4)
(D) (P) – (2), (Q) – (4), (R) – (3), (S) – (1)

17. One mole of a monoatomic ideal gas undergoes thermodynamic processes as shown schematically in the *PV*-diagram below. Process 1-4 is a straight line passing through origin. Match the statements in List-I with the corresponding statements in List-II.



List-I		List-II	
(P)	Work done by the gas is zero	**(1)**	In process 2-1
(Q)	Temperature of the gas remains unchanged	**(2)**	In process 4-3
(R)	Work done is positive	**(3)**	In process 0-4
(S)	Work done is negative	**(4)**	In process 0-4-3-0
		(5)	In process 0-2-1-0
		(6)	In process 1-0
		(7)	None of these

(A) (P) – (7), (Q) – (4, 5), (R) – (3, 5, 6), (S) – (1, 2, 4)
(B) (P) – (7), (Q) – (3, 5, 6), (R) – (2, 5), (S) – (4)
(C) (P) – (3, 5), (Q) – (4, 6), (R) – (1), (S) – (2)
(D) (P) – (7), (Q) – (4, 6), (R) – (2), (S) – (1)

18. In the List-I below, four different paths of a particle are given as functions of time. In these functions, α and β are positive constants of appropriate dimensions and $\alpha \neq \beta$. In each case, the force acting on the particle is either zero or conservative. In List-II, certain statements are given about speed and angular velocity of the particle about origin. Match each path in List-I with those quantities in List-II.

List-I		List-II	
(P)	$\vec{r}(t) = \alpha t\,\hat{i} + \beta t\,\hat{j}$	**(1)**	Speed is constant
(Q)	$\vec{r}(t) = \alpha(\cos\omega t\,\hat{i} + \sin\omega t\,\hat{j})$	**(2)**	Speed is decreasing with time
(R)	$\vec{r}(t) = \alpha\,\hat{i} + \beta t\,\hat{j}$	**(3)**	Speed is increasing with time
(S)	$\vec{r}(t) = \alpha t\,\hat{i} + \frac{\beta}{2}t^2\,\hat{j}$	**(4)**	Angular velocity is constant
		(5)	Angular velocity is decreasing with time
		(6)	Angular velocity is increasing with time

(A) (P) – (1, 5), (Q) – (2, 5), (R) – (3, 4), (S) – (5)
(B) (P) – (1,4), (Q) – (1,4), (R) – (1, 5), (S) – (3,5)
(C) (P) – (2, 4), (Q) – (3, 5), (R) – (1, 4), (S) – (2, 5)
(D) (P) – (3, 5), (Q) – (2, 5), (R) – (2, 4), (S) – (2, 5)

SPACE FOR ROUGH WORK

SUBJECT II : CHEMISTRY 60 MARKS

SECTION 1

This section consists of **6 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 statement(s) is/are true about the complex ion $[Pt(en)_2Cl_2]^{2+}$? $[en = H_2N\,CH_2\,CH_2\,NH_2]$

(A) It has two geometrical isomers-cis and trans.

(B) Both the cis and trans isomers display optical activity.

(C) Only the cis isomer has non-superimposable mirror images.

(D) The oxidation state of Pt in the complex is +4.

2. Which of the following statement(s) is/are true?

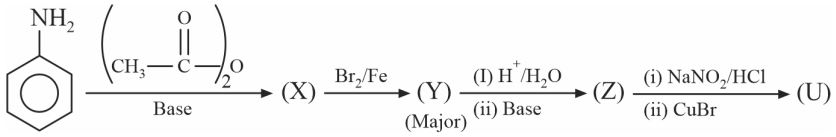
(A) Ag^+ ions give white precipitate with excess of concentrated HCl.

(B) Cu^{2+} ions produce a white precipitate when KCN solution is added in a small quantity and allowed to stand.

(C) Hg^{2+} ions give deep blue precipitate with cobalt acetate and ammonium thiocyanate.

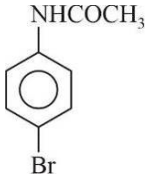
(D) Black precipitate of BiI_3 turns white when heated with water.

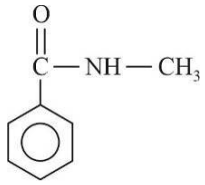
3. The correct statement(s) for the following reaction sequence is/are:



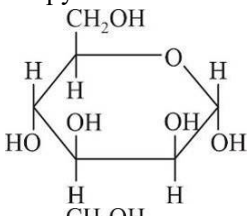
(A) The compound (U) is 

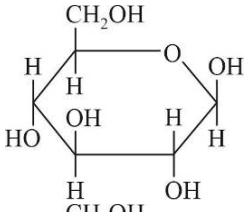
(B) The compound (Z) is 

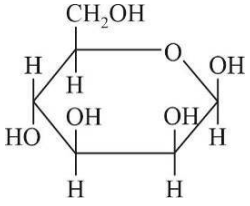
(C) The compound (Y) is 

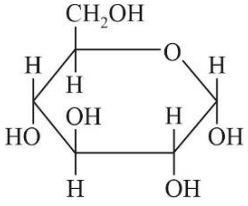
(D) The compound (X) is 

4. D-Mannose differs from D-glucose in its stereochemistry at C – 2. Which is/are not the correct structure of pyranose form of D-Mannose.

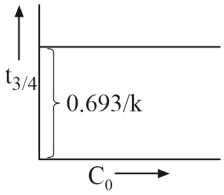
(A) 

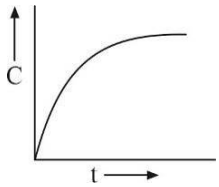
(B) 

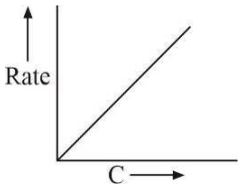
(C) 

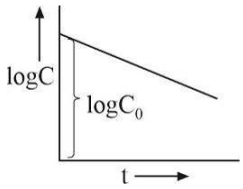
(D) 

5. For the first order reaction $A_{(g)} \longrightarrow B_{(g)} + C_{(g)}$ at constant volume and 300 K, the concentration of A at time t = 0 is C_0 and the concentration of A after time t = t is C. $t_{3/4}$ represents the time required to reach the concentration of A to $C_0/4$. The correct option(s) is/are: (Given k is rate constant)

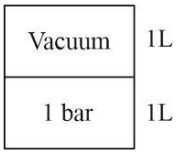
(A) 

(B) 

(C) 

(D) 

6. A container of volume 2L is separated into equal compartments. In one compartment one mole of an ideal monoatomic gas is filled at 1 bar pressure and the other compartment is completely evacuated. A pinhole is made in the separator so that gas expands to occupy full 2L and heat is supplied to gas so that finally pressure of gas equals to 1 bar. The correct statement(s) is/are: (Given : 1 litre bar = 100J).



(A) $\Delta U = 150$ J

(B) $\Delta H = 250$ J

(C) Entropy change of system is greater than zero

(D) Work done by gas is zero

SPACE FOR ROUGH WORK

SECTION 2
NUMERICAL VALUE TYPE QUESTIONS

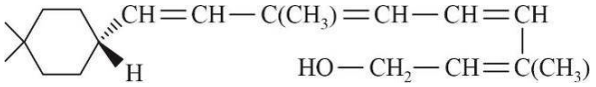
This Section contains of 8 **Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled.* (Example: 6, 81, 1.50, 3.25, 0.08).

7. The total number of compounds having $p\pi - d\pi$ bonding among the molecules given below are:
SO_2, SO_3, CO_2, H_3PO_4, H_3BO_3, $HClO_4$, HNO_3, HOCl

8. The mass of Zn (atomic mass = 65) required to recover Ag from a 500 ml solution of 0.5 M sodium argento cyanide is x gram. The value of 16x is _____.

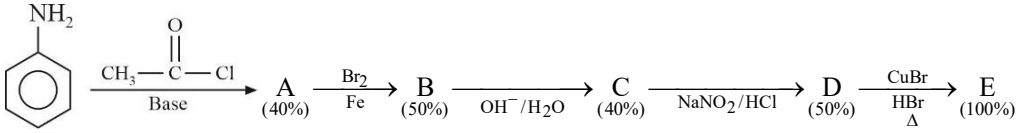
9. The percentage of available chlorine in 3.55-gram sample of bleaching powder which was dissolved in 100 ml of water is x%. 25 ml of this solution, on treatment with KI and dilute acid, required 20 ml of 0.125 N sodium thiosulphate solution. The value of 11x is _____.

10. The number of stereoisomers possible for the following compound are x.



The value of 16x is:

11. In the following reaction sequence the amount of E (in gram) formed from 25 moles of aniline is ___. (Atomic weight in g/mol; H = 1, C = 12, Br = 80, N = 14, O = 16. The yield (%) corresponding to the product in each step is given in the parenthesis)



12. NO and O_2 react to form NO_2 at 298 K according to the reaction.

$$NO_{(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons NO_{2(g)}$$

Initially pressure of NO and O_2 are 1 atm and 11/4 atm respectively and the final pressure of NO is $x \times 10^{-8}$ atm. The value of x is _____.

Given: $\Delta G_f^\circ(NO_2)_{(g)} = 52$ kJ/mol, $(10^{6.13} = 1.34 \times 10^6)$, $\Delta G_f^\circ(NO)_{(g)} = 87$ kJ/mol, $R = 8.314 \frac{J}{mol-k}$

13. For a first order reversible reaction $A \underset{K_b}{\overset{K_f}{\rightleftharpoons}} B$, the initial concentration of A and B are $[A]_0$ and zero respectively. If concentrations at equilibrium are $[A]_{eq}$ and $[B]_{eq}$. The time taken to attain concentration of B to $\frac{[B]_{eq}}{2}$ is $\frac{1}{6}\ln 2$. K_f and K_b are rate constant of forward and backward reaction. $K_b - K_f = 2\ min^{-1}$ at 300 K. The value of ΔG° in J/mol is _____. (Given: RT = 2500 J/mol at 300 K, $\log_{10} 2 = 0.3$)

14. Consider an hypothetical electrochemical, Cell: $A_{(s)} \mid A^{2+}_{(aq)} \mid\mid B^{2+}_{(aq)} \mid B_{(s)}$

The standard emf of the given cell at 25°C and 20°C are 0.3525 V and 0.3533 V respectively. The value of magnitude of ΔS° for the cell in (J/K) is _____.

SPACE FOR ROUGH WORK

SECTION - 3
MATRIX MATCH TYPE

This section contains **4 Single Choice Questions**. Each question has TWO (02) matching lists: List-I and List-II. The codes for the lists have 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** Choice is Correct.

15. Match each set of hybrid orbitals from List-I with complex(es) given in List-II.

List-I		List-II	
(P)	d^2sp^3	**(1)**	$Ni(CO)_4$
(Q)	sp^3	**(2)**	$[Fe(en)_3]^{3+}$
(R)	sp^3d^2	**(3)**	$Na_2[Zn(CN)_4]$
(S)	dsp^2	**(4)**	$[NiCl_6]^{2-}$
		(5)	$[Co(C_2O_4)_3]^{3-}$
		(6)	$K_2[PtCl_4]$

The correct option is:

(A) (P) – (2), (Q) – (3), (R) – (4, 5), (S) – (1, 6)

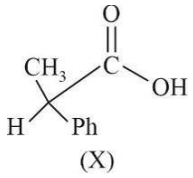
(B) (P) – (2, 5), (Q) – (1, 3), (R) – (4), (S) – (6)

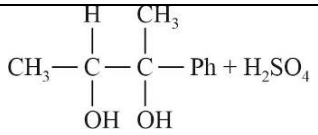
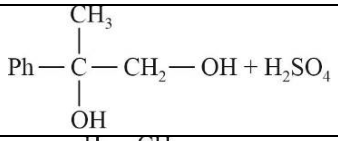
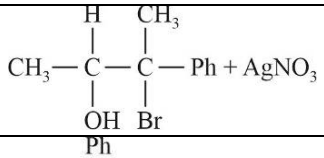
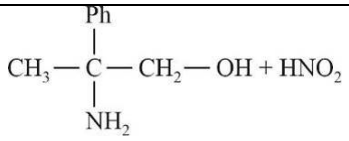
(C) (P) – (2, 5), (Q) – (3, 6), (R) – (4), (S) – (1)

(D) (P) – (2), (Q) – (3, 6), (R) – (4, 5), (S) – (1)

16. The desired product X can be prepared by reacting the major product of the reactions in List-I with one or more appropriate reagents in List-II followed by acidification.

Given: order of migratory aptitude : (hydrogen > aryl > alkyl)


(X)

List-I		List-II	
(P)		**(1)**	Br_2, NaOH
(Q)		**(2)**	$[Ag(NH_3)_2]OH$
(R)		**(3)**	HCHO, NaOH
(S)		**(4)**	Fehling solution
		(5)	NaOCl

The correct option is:

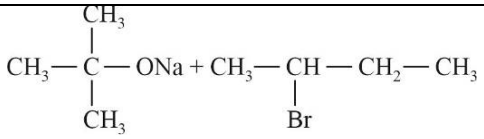
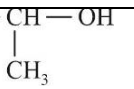
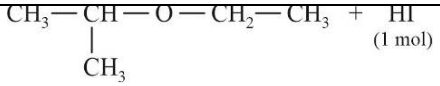
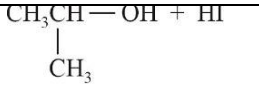
(A) (P) – (1, 5), (Q) – (2, 3, 4), (R) – (1, 5), (S) – (2, 3, 4)

(B) (P) – (1), (Q) – (2, 4), (R) – (1), (S) – (2, 4)

(C) (P) – (1, 5), (Q) – (2, 4), (R) – (1, 5), (S) – (2, 4)

(D) (P) – (1), (Q) – (2, 3, 4), (R) – (1), (S) – (2, 3, 4)

17. List-I contains reactions and List-II contains major products.

List-I		List-II	
(P)		**(1)**	
(Q)	$CH_3-CH_2-CH_2-CH_2-OH + H_2SO_4/\Delta$	**(2)**	
(R)		**(3)**	$CH_3-CH_2-CH=CH_2$
(S)		**(4)**	$CH_3-CH=CH-CH_3$
		(5)	CH_3CH_2OH

Match each reaction in List-I with one or more products in List-II and choose the correct option:

(A) (P) – (3), (Q) – (4), (R) – (2), (S) – (1) **(B)** (P) – (4), (Q) – (3), (R) – (2), (S) – (1)

(C) (P) – (3), (Q) – (4), (R) – (1), (S) – (1) **(D)** (P) – (4), (Q) – (3), (R) – (5), (S) – (1)

18. Dilution process of different aqueous solution, with water are given in List-I. The effects of dilution of the solution on $[H^+]$ are given in List-II (Note : Degree of dissociation (α) of weak acid and weak base is << 1, degree of hydrolysis of salt << 1, $[H^+]$ represents the concentration of H^+ ions).

List-I		List-II	
(P)	(100 ml of 0.2 M NH_4OH + 100 ml of 0.1 M HCl) diluted to 400 ml	**(1)**	The value of $[H^+]$ change to $\frac{1}{2}$ times of initial value on dilution
(Q)	(100 ml of 0.2 M CH_3COOH + 100 ml of 0.2 M NaOH) diluted to 800 ml	**(2)**	The value of $[H^+]$ changes to $\frac{1}{3}$ times of initial value on dilution
(R)	(100 ml of 0.2 M CH_3COOH + 100 ml of 0.4 M NaOH) diluted to 600 ml	**(3)**	The value of $[H^+]$ does not change on dilution
(S)	(100 ml of 0.1 M NH_4OH + 100 ml of 0.4 M HCl) diluted to 600 ml	**(4)**	The value of $[H^+]$ changes to 3 times of initial value on dilution
		(5)	The value of $[H^+]$ changes to 2 times of initial value on dilution

Match each process given in List-I with one or more effect(s) in List-II. The correct option is:

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

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

SPACE FOR ROUGH WORK

SUBJECT III : MATHEMATICS 60 MARKS

SECTION 1

This section consists of 6 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 $f(n)=\sum_{r=1}^{n}\cot^{-1}\left(\frac{r^3}{2}+\frac{r}{2}+\frac{1}{r}\right)$; the inverse trigonometric functions assume values from their principal branch. Which of the following statement(s) is (are) incorrect?

(A) $\lim_{n\to\infty} f(n)=\frac{\pi}{2}$

(B) $\lim_{n\to\infty} f\left(\frac{1}{n}\right)-\lim_{n\to\infty} f(2n)=0$

(C) $\frac{\tan\left(f(n)+\frac{\pi}{4}\right)}{\cot\left(f(n)-\frac{\pi}{4}\right)}=1$

(D) $\lim_{n\to\infty}[f(n)]=0$; where $[x]$ represents greatest integer value of x

2. Each of circles $x^2+y^2+4y-1=0$; $x^2+y^2+6x+y+8=0$ and $x^2+y^2-4x-4y-37=0$ touch the other two then which of the following statement(s) is/are correct?

(A) Point of concurrence of the tangents at point of contacts of circle is (–3, –3)

(B) Point of concurrence of the tangents at point of contacts of circle is (–2, –1)

(C) Point of contacts of circles form the vertices of scalene triangle

(D) Centroid of triangle formed by centres of circles is $\left(-\frac{1}{3},-\frac{1}{6}\right)$

3. Let system of equations

$-x+2y+5z=a$; $2x-4y+3z=b$; $x-2y+2z=c$

has atleast one solution for some non-zero real values of (a, b, c) then which of the following system of equation(s) is/are inconsistent?

(A) $x+2y+z=a$, $2x+4y+2z=b$, $3x+6y+3z=c$

(B) $x+y+3z=a$, $5x+2y+6z=b$, $2x+y+3z+c=0$

(C) $x+y=a$, $y+z=b$, $z+x=c$

(D) $x+y+z=a$, $2x+2y+2z=-b$, $x+y+z=2c$

4. The normal at points A and B on a parabola $y^2=4ax$ intersect at a point C on the curve. If M is mid-point of AB, N is the mid-point of MC then which of the following statement(s) is/are correct?

(A) Locus of mid-point of MC is a parabola with latus rectum $a/3$

(B) Length of longest common chord of locus of mid-point of MC and given curve which is perpendicular to axis of both curves is $\frac{4a}{\sqrt{11}}$ units

(C) Directrix of locus of mid-point of MC is $x=-\frac{13a}{12}$

(D) Eccentricity of locus of mid-point of MC is $x=-\frac{11a}{12}$

5. Let $A(z_1)$, $B(z_2)$, $C(z_3)$ and $D(z_4)$ be the vertices of a trapezium in this order in anti-clokwise sense in argand plane let $|z_1 - z_2| = 4$, $|z_3 - z_4| = 10$ and diagonals AC and BD intersect at P.

It is also given that $\arg\left(\frac{z_4 - z_2}{z_3 - z_1}\right) = \frac{\pi}{2}$ and $\arg\left(\frac{z_3 - z_2}{z_4 - z_1}\right) = -\frac{\pi}{4}$ then which of the following statement(s) is/are correct?

(A) Area of triangle PCB is equal to $\frac{200}{21}$ square unit

(B) Area of trapezium $ABCD$ is equal to $\frac{140}{3}$ square unit

(C) $|CP - PD|$ is $\frac{10}{\sqrt{21}}$ unit

(D) Product of diagonals of trapezium is $\frac{100}{7}$

6. Let f be a twice differentiable function except at one point such that $\lim\limits_{t \to x} \frac{e^t f(x) - e^x f(t)}{(t - x)(f(x))^2} = 3$ and $f(0) = 1$ then which of the following statement(s) is/are correct?

(A) $f(0) + f'(0) = -1$

(B) $f(1) = \frac{e}{4}$

(C) $f(x) > \frac{e}{4}$ in $x \in (1, 2)$

(D) $f(x)$ is decreasing function for $\forall\, x > 1$

SPACE FOR ROUGH WORK

SECTION 2

NUMERICAL VALUE TYPE QUESTIONS

Section 2 contains 8 **Numerical Value Type Questions**. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places. If the answer is an Integer value, then do not add zero in the decimal places. *In the OMR, do not bubble the ⊕ sign for positive values. However, for negative values, Θ sign should be bubbled*. (Example: 6, 81, 1.50, 3.25, 0.08).

7. The value of $\int_0^{\pi/4} \sqrt[4]{\operatorname{cosec}^3 x \cdot \sec^5 x}\, dx$ is:

8. Let $F(x)=\begin{vmatrix} 1+x\sin\alpha & \cos(x+\alpha) & \sin(x+\alpha) \\ 2+x\sin\beta & \cos(x+\beta) & \sin(x+\beta) \\ 3+x\sin\gamma & \cos(x+\gamma) & \sin(x+\gamma) \end{vmatrix}$, the total number of integers in the range of $F'(x)$.

9. Let set A has 5 elements and set B has 3 elements. If 'a' be number of one-one functions from set B to set A and 'b' be number of onto functions from set A to set B. Find value of $\left(\frac{a \cdot b}{1000}\right)$.

10. Let $f: R-\{n\pi\} \to R,\ n \in \mathbb{Z}$ be a differentiable function with $f\left(\frac{\pi}{2}\right)=e-1$. If $y=f(x)$ satisfies the differential equation $\frac{dy}{dx}=(e^{\sin x}-y)\cdot\cot x,$ then the value of $\lim_{x\to 0} f(x)$ is:

11. A function $f(x)$ satisfies the relation; $f(x+y)=f(x)+f(y)+xy(x+y)\ \forall\ x, y \in R$. If $f'(0)=-1,$ then $\log_2(f'(3))$ is _____.

12. Let P be a point whose image Q in the plane $x - y + 3z + 3 = 0$ lies in the plane $x + y + z = 0$. If the line segment PQ is bisected by y-axis. Then the value of $(PQ)^2$ is _____.

13. Consider the cube in the first octant with side OP, OQ and OR of length 1, along the x-axis, y-axis and z-axis respectively where $O(0, 0, 0)$ is the origin. If a line makes angles $\alpha,\beta,\gamma,\delta$ with body diagonals of a cube. Let $\hat{l}$ represents a unit vector along the line and unit vectors along the diagonals are $\hat{d}_1,\hat{d}_2,\hat{d}_3$ and $\hat{d}_4$. $[(\hat{l}\cdot\hat{d}_1)^2+(\hat{l}\cdot\hat{d}_2)^2+(\hat{l}\cdot\hat{d}_3)^2+(\hat{l}\cdot\hat{d}_4)^2]$ is_____. (where $[\cdot]$ represents Greatest Integer Function).

14. Let $X=({}^{10}C_1)^2+4({}^{10}C_2)^2+9({}^{10}C_3)^2+\ldots\ldots 100({}^{10}C_{10})^2$ where ${}^{10}C_r\ r\in\{1, 2,\ldots\ldots 10\}$ represents binomial coefficient. Then the value of $\frac{X}{221000}$ is _____.

SPACE FOR ROUGH WORK

SECTION - 3
MATRIX MATCH TYPE

This section contains **4 Single Choice Questions**. Each question has TWO (02) matching lists: List-I and List-II. The codes for the lists have 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** Choice is Correct.

15. Let $E_1 = \left(x \in R, x \notin \{-1, 1\} \text{ and } \frac{x^2}{x^2-1} \geq 0 \right)$ and $E_2 = \left\{ x \in E_1, \log_e \tan^{-1}\left(\frac{x^2}{x^2-1}\right) \text{ is a real number} \right\}$

Let $f : E_1 \to R$ be the function defined by $f(x) = \tan^{-1}\left(\frac{x^2}{x^2-1}\right)$

and $g : E_2 \to R$ be the function defined by $g(x) = \log_e \tan^{-1}\left(\frac{x^2}{x^2-1}\right)$

List-I		List-II	
(P)	The range of f is	**(1)**	$(0, \infty)$
(Q)	The range of g contains	**(2)**	$(1, \infty)$
(R)	The domain of f contains	**(3)**	$(-\infty, -1) \cup (1, \infty)$
(S)	The domain of g is	**(4)**	$\{0\}$
		(5)	$\{0\} \cup (\pi/4, \pi/2)$

The correct option is:

(A) (P) – (5), (Q) – (4, 5), (R) – (2, 3), (S) – (3)

(B) (P) – (5), (Q) – (4), (R) – (2, 3, 4), (S) – (3)

(C) (P) – (3), (Q) – (5), (R) – (2, 3, 4), (S) – (1, 2, 3)

(D) (P) – (3), (Q) – (4), (R) – (2, 3), (S) – (3)

16. In a class, a team has to be formed from a group of 8 boys $B_1, B_2, B_3, B_4, B_5, B_6, B_7, B_8$ and 6 girls $G_1, G_2, G_3, G_4, G_5, G_6$.

(i) Let N_1 be the number of ways of forming a team such that the team has 6 members having equal number of boys and girls.

(ii) Let N_2 be the number of ways of forming a team such that the team has 5 members having 2 boys and 3 girls.

(iii) Let N_3 be the number of ways of forming a team such that the team has 10 members having atleast 7 boys and atleast 2 girls.

(iv) Let N_4 be the number of ways of forming a team such that the team has 5 members having atleast 3 boys and such that both G_2 and B_3 are NOT in the team.

List-I		List-II	
(P)	The value of N_1 is	**(1)**	200
(Q)	The value of N_2 is	**(2)**	560
(R)	The value of N_3 is	**(3)**	1120
(S)	The value of N_4 is	**(4)**	546
		(5)	175
		(6)	350

The correct option is:

(A) (P) – (3), (Q) – (2), (R) – (5), (S) – (4) **(B)** (P) – (3), (Q) – (2), (R) – (6), (S) – (4)

(C) (P) – (3), (Q) – (1), (R) – (5), (S) – (6) **(D)** (P) – (2), (Q) – (3), (R) – (6), (S) – (5)

17. Let $E: \frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ when $b > a > 0$, be an ellipse in the xy-plane whose minor axis LM subtends an angle of 120° at one of its foci (Say N). Let the area of the triangle LMN be $\sqrt{3}$.

List-I		List-II	
(P)	The length of minor axis of E is	**(1)**	4
(Q)	The eccentricity of E is	**(2)**	$2\sqrt{3}$
(R)	The distance between the foci of E is	**(3)**	$\frac{1}{\sqrt{2}}$
(S)	The length of latus rectum of E is	**(4)**	$\frac{1}{2}$
		(5)	3
		(6)	2

The correct options is:

(A) (P) – (1), (Q) – (4), (R) – (6), (S) – (5) **(B)** (P) – (1), (Q) – (3), (R) – (6), (S) – (1)

(C) (P) – (2), (Q) – (4), (R) – (6), (S) – (5) **(D)** (P) – (2), (Q) – (3), (R) – (5), (S) – (5)

18. Let $f_1: R \to \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, $f_2: R \to R$, $f_3: R-\{0\} \to [-1,1]-\{0\}$, $f_4: R \to R$.

(i) $f_1(x)=\sin^{-1}\left(\frac{2x}{1+x^2}\right)$

(ii) $f_2(x)=\sqrt[3]{x^2|x|}+|x|-1$

(iii) $f_3(x)=\begin{cases}\frac{x}{2x^2+|x|} & , \quad x \neq 0 \\ 1 & , \quad x=0\end{cases}$

(iv) $f_4(x)=\text{sgn}(x)+\text{sgn}(-x)$ (where sgn(x) represents signum function)

List-I		List-II	
(P)	The function f_1 is	**(1)**	NOT continuous at $x = 0$
(Q)	The function f_2 is	**(2)**	Continuous at $x = 0$ and NOT differentiable at $x = 0$
(R)	The function f_3 is	**(3)**	Differentiable at $x = 0$ and its derivative is NOT continuous at $x = 0$
(S)	The function f_4 is	**(4)**	Differentiable at $x = 0$ and its derivative is continuous at $x = 0$

(A) (P) – (2), (Q) – (3), (R) – (1), (S) – (4) **(B)** (P) – (4), (Q) – (2), (R) – (1), (S) – (4)

(C) (P) – (4), (Q) – (1), (R) – (2), (S) – (3) **(D)** (P) – (1), (Q) – (2), (R) – (3), (S) – (4)

SPACE FOR ROUGH WORK