VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Main - 6 | JEE-2024

Date: 18/12/2023 **Maximum Marks: 300**

Timing: 4:00 PM to 7:00 PM **Duration : 3.0 Hours**

General Instructions

1. The test is of **3 hours** duration and the maximum marks is **300.**
2. The question paper consists of **3 Parts** (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **two** sections (Section 1 & Section 2).
3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE CHOICE** is correct.
4. **Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. You will NOT be allowed to attempt the sixth question. If you wish to attempt any other question apart from the five already attempted, then you will have to delete any one response from the five previously answered and then proceed to answer the new one.**
   The answer to each question should be **rounded off to the nearest integer**.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
6. On completion of the test, the candidate must hand over the Answer Sheet to the **Invigilator** on duty in the Room/Hall. **However, the candidates are allowed to take away this Test Booklet with them**.

Marking Scheme

1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.

SYLLABUS:
PHYSICS : FULL SYLLABUS CLASS (XII)
CHEMISTRY : FULL SYLLABUS CLASS (XII)
MATHEMATICS : FULL SYLLABUS CLASS (XII)

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

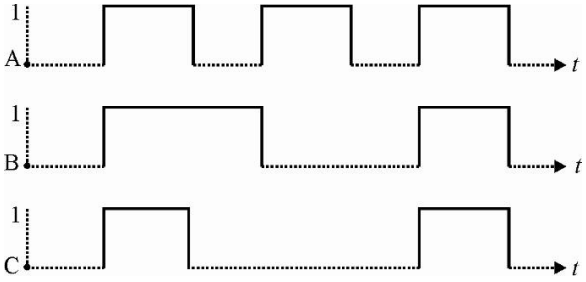
Candidate's Signature : _____ **Invigilator's Signature** _____

PART I : PHYSICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. The following figure shows a logic gate circuit with two inputs *A* and *B* and the output *C*. The voltage waveforms of *A*, *B* and *C* are as shown below.



The logic circuit gate is:

(A) OR gate **(B)** AND gate **(C)** NAND gate **(D)** NOR gate

2. Two long parallel straight conductors carry currents i_1 and $i_2 (i_1 > i_2)$. When the currents are in the same direction, the magnetic field at a point midway between the wires is $20\mu T$. If the direction of i_2 is reversed, field becomes $50\mu T$. The ratio of the currents i_1 / i_2 is:

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

3. When the rms voltages V_L, V_C and V_R are measured respectively across the inductor *L*, the capacitor *C* and the resistor *R* in a series *LCR* circuit connected to an *AC* source, it is found that the ratio $V_L : V_C : V_R = 1:2:3$. If the rms voltage of the AC source is 100 *V*, then V_R is close to :

(A) 50 *V* **(B)** 70 *V* **(C)** 90 *V* **(D)** 100 *V*

SPACE FOR ROUGH WORK

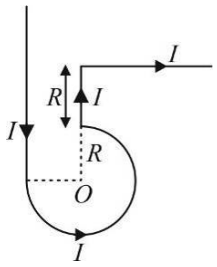
4. For an EM wave traveling along positive *x*-axis, the electric field vector at a point is $720\hat{j}$. Then magnetic field vector at the same point is:

(A) $2.4 \times 10^{-6}\,\hat{k}$ **(B)** $-2.4 \times 10^{-6}\,\hat{k}$ **(C)** $2.16 \times 10^{-5}\,\hat{k}$ **(D)** $-2.16 \times 10^{-5}\,\hat{k}$

5. If an electron jumps from third orbit to second orbit in hydrogen atom, then the wavelength of emitted photon will be:

(A) $\frac{36}{5R}$ **(B)** $\frac{5R}{36}$ **(C)** $\frac{4R}{34}$ **(D)** $\frac{34}{4R}$

6. A conducting wire carrying a current *I* is bent into the shape as shown.
The net magnetic field at the centre '*O*' of the circular arc of radius '*R*' is:



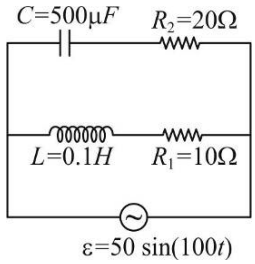
(A) $\frac{\mu_0 I}{2R}\left(\frac{1+3\pi}{\pi}\right)$ **(B)** $\frac{\mu_0 I}{4R}\left(\frac{1+3\pi}{\pi}\right)$

(C) $\frac{\mu_0 I}{8R}\left(\frac{1+3\pi}{\pi}\right)$ **(D)** $\frac{\mu_0 I}{8R}\left(\frac{2+3\pi}{\pi}\right)$

7. A particle moving with kinetic energy *E* has de Broglie wavelength λ If energy ΔE is added to its energy, the wavelength become $\lambda/2$. Value of ΔE is:

(A) $4E$ **(B)** $3E$ **(C)** $2E$ **(D)** E

8. In the circuit shown the average power developed in the resistor 'R_1' is:



(A) 31.25 W **(B)** 62.50 W

(C) 125 W **(D)** 250 W

SPACE FOR ROUGH WORK

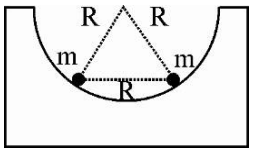
9. The path difference between two interfering waves at a point on the screen is $\lambda/6$ in an YDSE. The ratio of intensity at this point and that at the central bright fringe will be: (Assume that intensity due to each slit is same)

(A) 0.85 **(B)** 8.5 **(C)** 0.75 **(D)** 7.5

10. Two identical small balls each have a mass m and charge q. When placed in a hemispherical bowl of radius R with frictionless, non-conducting walls, the balls move and at equilibrium, the line joining the balls is horizontal and the distance between them is R (figure). Neglect any induced charge on the hemispherical bowl. Then the charge on each ball is: (Here, $K = \frac{1}{4\pi\varepsilon_0}$)

(A) $q = R\left(\frac{mg}{K\sqrt{3}}\right)^{1/2}$ **(B)** $q = R\left(R\frac{mg}{K\sqrt{3}}\right)^{1/2}$

(C) $q = R\left(\frac{\sqrt{3}mg}{K}\right)^{1/2}$ **(D)** $q = \left(R\frac{\sqrt{3}mg}{K}\right)^{1/2}$



11. Consider the following energies:

I. The minimum energy needed to excite a hydrogen atom from its ground state $= E_1$

II. Energy needed to ionize a hydrogen atom from ground state $= E_2$

III. Energy released in $^{235}U -$ fission $= E_3$

IV. Energy needed to remove a neutron from a $^{12}C_{\text{nucleus}} = E_4$

Choose correct statement:

(A) $E_1 < E_2 < E_3 < E_4$ **(B)** $E_1 < E_3 < E_2 < E_4$

(C) $E_1 < E_2 < E_4 < E_3$ **(D)** $E_2 < E_1 < E_4 < E_3$

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12. Four charged capacitors (No capacitor has zero charge) are connected in three different configurations as shown in the figure. Q_1, Q_2 and Q_3 represent the magnitude of the charge on each of the plate of capacitor of capacitance $4\mu F$ in figure-I, II and III respectively:

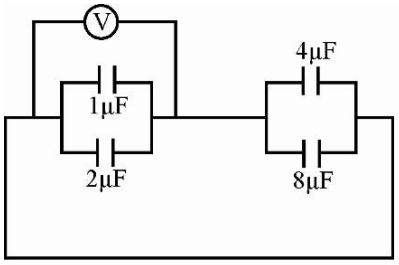


Figure-1

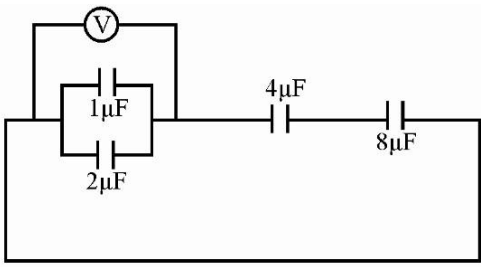


Figure-2

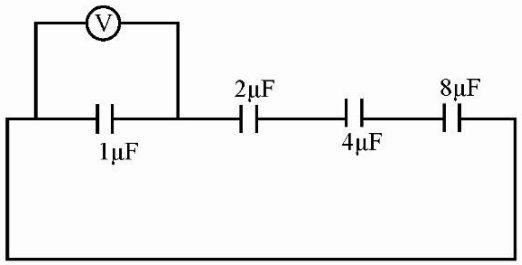
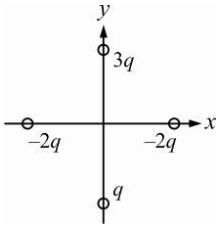


Figure-3

Choose the correct option:

(A) $Q_1 > Q_2 > Q_3$ **(B)** $Q_1 < Q_2 < Q_3$ **(C)** $Q_1 < Q_3 < Q_2$ **(D)** $Q_1 > Q_3 > Q_2$

13. 4 charges are placed each at a distance 'a' from origin. The dipole moment of configuration is:



(A) $2qa\hat{j}$ **(B)** $3qa\hat{j}$

(C) $2aq[\hat{i}+\hat{j}]$ **(D)** None of these

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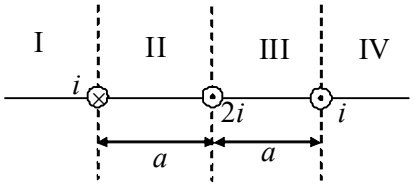
14. Three very long current carrying wires are placed parallel to each other and perpendicular to the plane of paper as shown in the figure. All the wires are equally spaced. The magnetic field will be zero at:



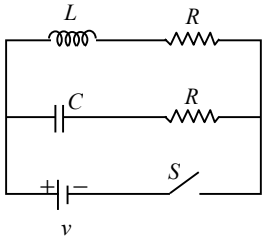
(A) Two points in region I

(B) One point in region I and one point in region II

(C) Two points in region III

(D) One point in region I and one point in region III

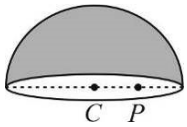
15. In the circuit switch S is closed at time $t = 0$, the current through C and L would be equal after a time 't' equal to $\left(\text{Given : } R = \sqrt{\frac{L}{C}}\right)$:

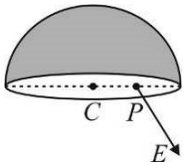


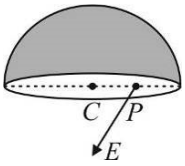
(A) RC **(B)** RL

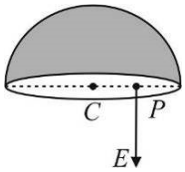
(C) $RC\ell n2$ **(D)** $\frac{R}{L\ \ell n2}$

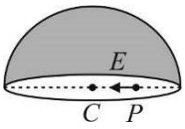
16. A thin non-conducting hemispherical shell contains a positive charge q on it, which is uniformly distributed on the shell. A point P lies on the diameter of shell as shown in figure. Then the direction of electric field at the point 'P' is:



(A) 

(B) 

(C) 

(D) 

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17. The main difference in the phenomenon of interference and diffraction is that:

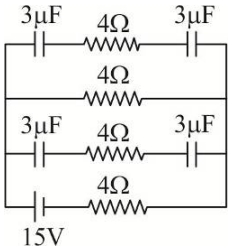
(A) diffraction is due to interaction of light from the same wave-front whereas interference is the interaction of waves from two isolated incoherent sources

(B) diffraction is due to interaction of light from same wavefront, whereas the interference is the interaction of two waves derived from the same wavefront

(C) diffraction is due to interaction of waves derived from the same source, whereas the interference is the bending of light from the same wavefront

(D) diffraction is caused by reflected waves from a source whereas interference is caused due to refraction of waves from a surface

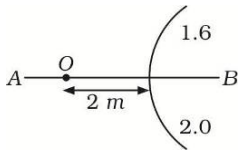
18. In the shown figure, the charge on each capacitor in the steady state will be:



(A) $3\mu C$ **(B)** $6\mu C$

(C) $9\mu C$ **(D)** $\frac{45}{4}\mu C$

19. In the figure shown a point object O is placed in air. A spherical boundary separates various media of radius of curvature 1.0 m. AB is principal axis. The refractive index above AB is 1.6 and below AB is 2.0. The separation between the images formed due to refraction at spherical surface is:



(A) 12 m **(B)** 20 m **(C)** 14 m **(D)** 10 m

20. A charge Q is distributed over three concentric spherical shells of radii a, b, c ($a < b < c$) such that their surface charge densities are equal to one another. The total potential at a point at distance r from their common centre, where $r < a$, would be:

(A) $\frac{Q(a+b+c)}{4\pi\varepsilon_0\left(a^2+b^2+c^2\right)}$ **(B)** $\frac{Q}{4\pi\varepsilon_0(a+b+c)}$

(C) $\frac{Q}{12\pi\varepsilon_0}\frac{ab+bc+ca}{abc}$ **(D)** $\frac{Q\left(a^2+b^2+c^2\right)}{4\pi\varepsilon_0\left(a^3+b^3+c^3\right)}$

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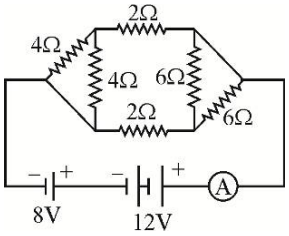
SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.
The answer to each question should be **rounded off to the nearest integer**.

1. In YDSE distance between the slits plane and screen is 1 *m* and distance between two slits is 5 *mm*. If slabs of thickness 2 *mm* and 1.5 *mm* having refractive index 1.5 and 1.4 are placed in front of two slits, the shift of central maximum (in mm) will be:

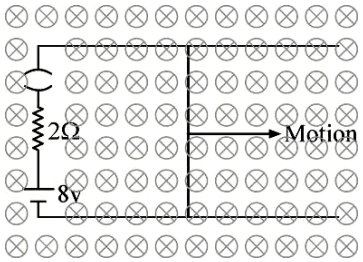
2. In the circuit shown, the ammeter readings (in Amperes) is _____.



3. A perfectly reflecting mirror has an area of $1\,cm^2$ Light energy is allowed to fall on it for 1 *h* at rate of $30\ W\,cm^{-2}$. The force that acts on the mirror is $x\times10^{-7}\,N$. Then the value of *x* is _____.

4. The separation between the plates of a parallel-plate capacitor is 2 *mm* and the area of its plates is $5\,cm^2$. If the capacitor is charged such that it has 0.01 J energy stored in it, the electrostatic force of attraction between its plates is _____ N.

5. Figure shows a conducting frame having battery and a resistance on which a movable resistance lens conductor of length of 0.5 *m* can slide. The whole arrangement is placed in a uniform magnetic field of $B = 0.4T$ directed perpendicular and into the plane of frame. Initially the circuit is open. When the key is inserted, the conductor begins to move. It is found that a force 0.5 *N*. has to be applied on the conductor to the left to keep it moving at constant speed to the right. The speed of the conductor (in m/s) is:



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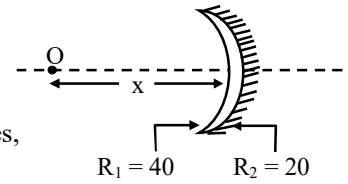
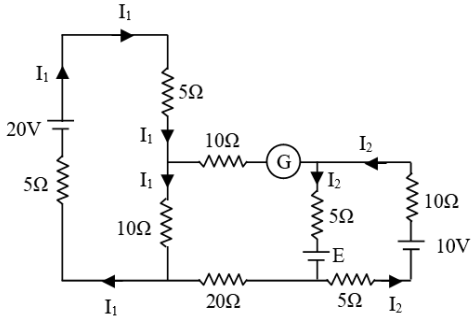
6. In a meter bridge experiment null point is obtained at 20 *cm* from one end of the wire when resistance X is balanced against another resistance Y. If $X < Y$, then where will be the new position of the null point (in *cm*) from the same end, if one decides to balances a resistance of $4X$ against Y?

7. Radii of curvature of a thin concavo-convex lens (refractive index = 1.5) are 40 *cm* (concave side) and 20 *cm* (convex side) as shown. The convex side of lens is silvered. The distance x (in *cm*) of the point object O lying on principal axis from the lens such that the object and its image coincides, is equal to _____.

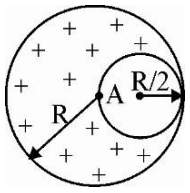


8. The 3 physical quantities are related as $x = \frac{a^3b^2}{c}$, if the percentage error in a, b, and c are $\pm 2\%$, $\pm 1\%$ and $\pm\ 4\%$, respectively, then percentage error in x is _____.

9. What should be value of E (in volts) for which galvanometer shows no deflection?



10. A solid sphere of radius 'R' has a cavity of radius $\frac{R}{2}$ as shown in figure. The solid part has a uniform volume charge density 'ρ' and cavity has no charge. The electric potential at point A (centre of solid sphere) is $\frac{x\rho R^2}{12\varepsilon_0}$, then x is _____.



SPACE FOR ROUGH WORK

PART II : CHEMISTRY	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. Which two bases are found as a hydrogen-bonded base pair in DNA?

(A) A and T **(B)** C and T **(C)** C and U **(D)** G and U

2. Match the Column:

	List-I		List-II
(P)	Hydrogen bond	**I.**	Dipeptide
(Q)	Amide bond	**II.**	Double strand helix structure
(R)	Glycosidic linkage	**III.**	Disaccharide
(S)	Phosphodiester linkage	**IV.**	Dinucleotide

(A) (P) – I, (Q) – II, (R) – III, (S) – IV **(B)** (P) – II, (Q) – I, (R) – III, (S) – IV

(C) (P) – II, (Q) – I, (R) – IV, (S) – III **(D)** (P) – III, (Q) – I, (R) – I, (S) – IV

3. A six-carbon organic compound containing oxygen is suspected of being either a secondary alcohol or a ketone. Which chemical or physical test would best distinguish between these two possibilities?

(A) Water solubility **(B)** Melting point

(C) Treatment with sodium bicarbonate **(D)** Treatment with acidic dichromate

4. **Statement I:** Phenol is million times more acidic than ethanol.

Statement II: Acidic strength of o-cresol and p-cresol is same.

(A) Statement I is true, and statement II is false

(B) Statement I is false, and statement II is true

(C) Both Statement I and statement II is false

(D) Both Statement I and statement II is true

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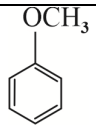
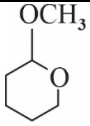
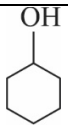
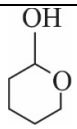
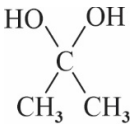
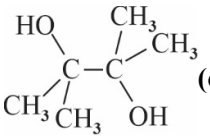
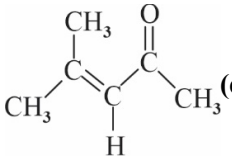
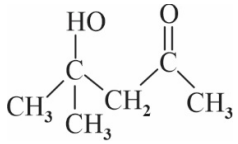
5. Match the items of list-I with items of list-II.

List-I (Organic Compound)		List-II (Reaction/Test)	
(P)		**I.**	Silver mirror with Tollen's reagent
(Q)		**II.**	Red colouration with ceric ammonium nitrate
(R)		**III.**	Readily reacts with water under acidic condition but not under basic condition.
(S)		**IV.**	Undergoes Friedel-crafts reaction.

(A) (P) – I, (Q) – II, (R) – III, (S) – IV **(B)** (P) – III, (Q) – IV, (R) – II, (S) – I

(C) (P) – IV, (Q) – III, (R) – II, (S) – I **(D)** (P) – IV, (Q) – III, (R) – I, (S) – II

6. Which compound can be form in the reaction of acetone (propanone) with aqueous base?

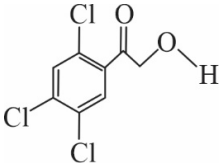
(a)  **(b)**  **(c)**  **(d)** 

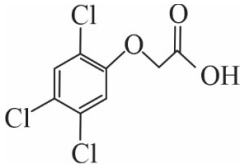
(A) Only (a) **(B)** Only (b) **(C)** (b), (c) and (d) **(D)** (a), (c) and (d)

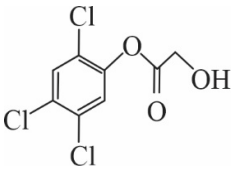
SPACE FOR ROUGH WORK

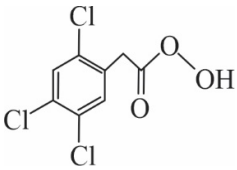
7. $1,2,4,5-\text{tetrachlorobenzene} \xrightarrow[\text{2. Acidify}]{\text{1. Heat with NaOH in methanol/}H_2O\text{ solvent under pressure}} X \xrightarrow[\text{2. Acidify}]{\text{1. Heat with NaOH and chloroethanoic acid at 140°C}} \text{2, 4, 5 - T}$

Correct structural formula of 2, 4, 5-T is:

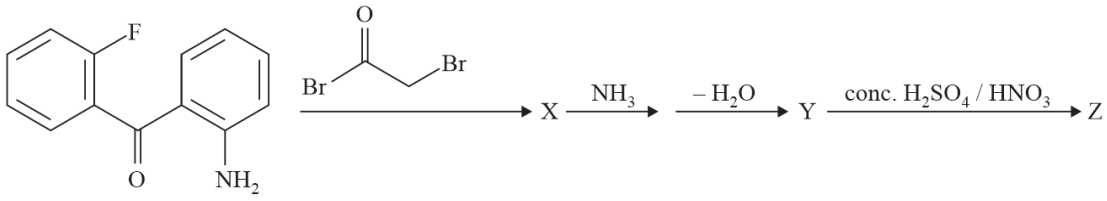
(A) 

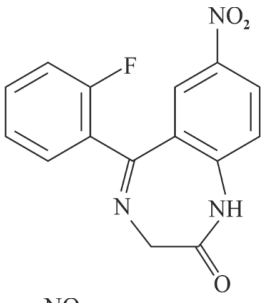
(B) 

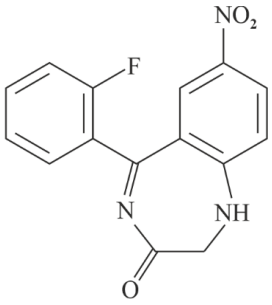
(C) 

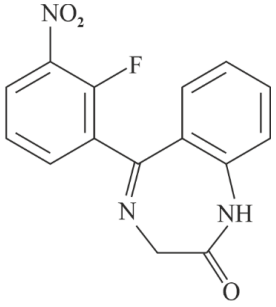
(D) 

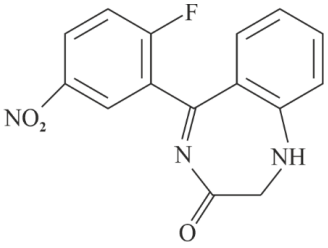
8. Identify product Z of the following sequence of reactions.



(A) 

(B) 

(C) 

(D) 

SPACE FOR ROUGH WORK

9. N_2 is a stable molecule and the N_4, molecule is unknown. P_4 is much more stable than molecular P_2. Which is the best explanation for this difference?

(A) N_2 has valence electrons only in bonding and nonbonding orbitals, while P_2 has some valence electrons in antibonding orbitals.

(B) The greater electronegativity of N compared to P stabilizes compounds with lower molar masses.

(C) The greater size of P compared to N results in decreased overlap in pi bonds.

(D) The preference of P to adopt smaller bond angles than N favors formation of tetrahedral P_4 molecules.

10. Which species has a normal boiling point closest to the normal boiling point of argon, Ar?

(A) H_2 **(B)** N_2 **(C)** F_2 **(D)** Cl_2

11. Match the Column:

	Element		**Group**
(P)	Moscovium	**I.**	Group 18 Element
(Q)	Tennessine	**II.**	Group 16 Element
(R)	Oganesson	**III.**	Group 15 Element
(S)	Livermorium	**IV.**	Group 17 Element

(A) (P) – I, (Q) – II, (R) – III, (S) – IV **(B)** (P) – II, (Q) – III, (R) – I, (S) – IV

(C) (P) – III, (Q) – IV, (R) – I, (S) – II **(D)** (P) – IV, (Q) – II, (R) – III, (S) – I

12. Which complex ion absorbs visible light of the longest wavelength?

(A) $[Co(NH_3)_6]^{3+}$ **(B)** $[Co(CN)_6]^{3-}$ **(C)** $[CoF_6]^{3-}$ **(D)** $[Co(NO_2)_6]^{3-}$

13. A four-coordinate transition metal complex $M(CO)_2BrCl$ can be isolated as two geometric isomers. With which geometries at the metal center is this observation consistent?

I. Square planar **II.** Tetrahedral

(A) I only **(B)** II only **(C)** Either I or II **(D)** Neither I nor II

SPACE FOR ROUGH WORK

14. When an aqueous solution of KI is electrolyzed, what forms at the anode?

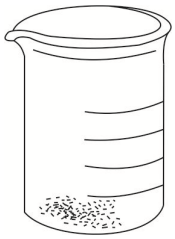
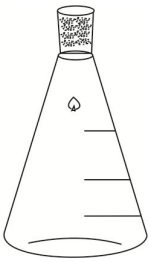
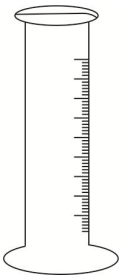
(A) O_2 **(B)** I_2 **(C)** K **(D)** H_2O

15. What is the K_{sp} of Hg_2Cl_2 at 298 K?

Half-Reaction	$E°, V(\text{at } 298\ K)$
$Hg_2^{2+} + 2e^- \rightarrow 2Hg(l)$	+ 0.80
$Hg_2Cl_2(s) + 2e^- \rightarrow 2Hg(l) + 2Cl^-(aq)$	+ 0.31

(A) 2.6×10^{-17} **(B)** 3.3×10^{-11} **(C)** 5.1×10^{-9} **(D)** 5.7×10^{-6}

16. Which 50-mL container would be most suitable for measuring and dispensing 35 mL of an aqueous solution?

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

17. A solution that may contain either 0.1 M $Ag^+(aq)$, 0.1M $Pb^{2+}(aq)$, or both, is treated with 1M aqueous HCl. A white precipitate forms which does not appear to dissolve in hot water. Which conclusion about the cations present may be drawn?

(A) Only Ag^+ is present

(B) Only Pb^{2+} is present

(C) Ag^+ is present, and Pb^{2+} may be present

(D) Pb^{2+} is present, and Ag^+ may be present

SPACE FOR ROUGH WORK

18. Hydrogen peroxide, $H_2O_2(aq)$, decomposes into water and oxygen. Adding a small amount of $FeCl_3(aq)$ increases the rate of gas evolution in this reaction. What is the best description of the role of $FeCl_3$?

(A) Transition state
(B) Reaction intermediate
(C) Heterogeneous catalyst
(D) Homogeneous catalyst

19. The reaction of tert-butyl bromide with azide ion in aqueous solution is proposed to proceed by the following mechanism:

$$(CH_3)_3CBr(aq) \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} (CH_3)_3C^+(aq) + Br^-(aq)$$

$$(CH_3)_3C^+(aq) + N_3^-(aq) \xrightarrow{k_2} (CH_3)_3CN_3(aq)$$

Assuming that $(CH_3)_3C^+(aq)$ achieves a steady-state concentration, but making no further assumptions about the relative magnitudes of the three rate constants, what is the rate law for this reaction?

(A) Rate = $k_1\left[(CH_3)_3CBr\right]$
(B) Rate = $k_2\left[(CH_3)_3CBr\right]\left[N_3\right]$
(C) Rate = $\dfrac{k_1k_2\left[(CH_3)_3CBr\right]\left[N_3^-\right]}{k_{-1}\left[Br^{-1}\right]}$
(D) Rate = $\dfrac{k_1k_2\left[(CH_3)_3CBr\right]\left[N_3^-\right]}{k_{-1}\left[Br^{-1}\right]+k_2\left[N_3^-\right]}$

20. Despite the fact that atomic radius generally increases with period, the palladium-chlorine distance in $[PdCl_4]^{2-}$ is essentially identical to the platinum-chlorine distance in $[PtCl_4]^{2-}(2.30\,Å)$. Which is the best explanation of why the two bond lengths are the same?

(A) The presence of the 14 lanthanides between Pd and Pt makes Pt unexpectedly small
(B) $[PdCl_4]^{2-}$ is tetrahedral, while $[PtCl_4]^{2-}$ is square planar and so has shorter bonds than expected.
(C) The metal-chlorine bonds are highly covalent and so are insensitive to the trend in atomic radius.
(D) The large negative charge on the complex ions makes the chloride-chloride repulsions, not the metal-chloride attractions, the dominant factor in determining the bond distance.

SPACE FOR ROUGH WORK

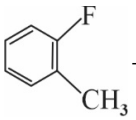
SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.

The answer to each question should be **rounded off to the nearest integer**.

1. Find the number of chiral carbon atoms in sucrose?

2. How many isomeric stable hydroxy compounds are possible for $C_4H_{10}O_4$?

3. 

$\xrightarrow[\substack{2.\ NaCN \\ 3.\ H_2SO_4(aq) \\ 4.\ SOCl_2 \\ 5.\ C_6H_6/AlCl_3 \\ 6.\ Phenylhydrazine}]{1.\ reflux\ Br_2\ UV\ light} M$

The product M formed in above series of reactions contain x number of halogen atoms and y number of nitrogen atoms. Find sum of x and y.

4. Chlorofluorocarbons such as A react with sodium metal to convert all the chlorine present into sodium chloride. The products from the reaction of sodium with 100.0 mL of gaseous A (at 1.00 bar and 25.0°C.) are dissolved in water and a few drops of sodium chromate solution are added. This solution is then titrated with 0.3540 M $AgNO_3$ solution until a bright red precipitate appears, which requires 22.79 mL of the titrant. How many chlorine atoms are there in a molecule of A?

5. A current of 0.15 A is passed through an aqueous solution of $K_2[PtCl_4]$. How long (in sec.) will it take to deposit 1.00 g Pt(s) (M_o = 200 g/mol)? (1F = 96,500 C/mol)

6. Consider the conversion of organic compound X into organic compound Y.

$$\underset{X}{\text{Diazoaminobenzene}} \xrightarrow[\text{Aniline(solvent)}]{\text{Aniline hydrochloride}} \underset{Y}{\text{Aniline yellow}}$$

Find the sum of N-N single bond and C-N single bond in X and Y.

SPACE FOR ROUGH WORK

7. The tetramminecopper(II) ion, $[Cu(NH_3)_4]^{2+}$, has a formation constant $K_f = 1.1 \times 10^{13}$. $x \times 10^{-3} M$ is the minimum concentration of free ammonia in solution required to ensure that at least 99.9% of the dissolved copper(II) ion is found in the form of its ammonia complex. Find the value of the x.

8. If elemental bromine is being formed according to the equation below at a rate of 0.056 Ms^{-1} then at $x \times 10^{-3} Ms^{-1}$ rate is bromide ion being consumed. Find the value of x.

$$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$$

9. How many of the following statements about complex ions of the transition metals are correct?

(A) The $[Cr(H_2O)_6]^{3+}$ ion is paramagnetic while the $[Sc(H_2O)_6]^{3+}$ ion is diamagnetic

(B) The $[CoF_6]^{3-}$ ion is paramagnetic while the $[Co(CN)_6]^{3-}$ ion is diamagnetic

(C) The $[NiCl_4]^{2-}$ ion and $[PtCl_4]^{2-}$ ion both are paramagnetic

(D) The $[CoCl_4]^{2-}$ ion is strongly colored while the $[ZnCl_4]^{2-}$ ion is colorless

(E) The MnO_4^- ion is strongly colored while the ReO_4^- ion is colorless

10. An experiment is carried out to determine the molar mass of a compound by the freezing point depression method using the equation

$$MM = 7.05 \frac{\text{mass solute}}{\Delta T \times \text{kg solvent}}$$

The data below are collected.

Mass of empty test tube	42.0g
Mass of test tube and solvent	73.6g
Mass of solute dissolved in solvent	2.000g
Freezing point of pure solvent	78.1°C
Freezing point of solution	77.6°C

How many significant figures can be reported for the molar mass of the solute?

SPACE FOR ROUGH WORK

PART III : MATHEMATICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (A), (B), (C) and (D), out of which ONLY ONE CHOICE is correct.

1. A and B are two non-singular square matrices of each 3×3 such that $AB = A$ and $BA = B$ and $|A + B| \neq 0$, then :

(A) $|A + B| = 0$ **(B)** $|A + B| = 8$ **(C)** $|A - B| = 1$ **(D)** $|A + B| = 2$

2. The line $\frac{x-2}{3} = \frac{y+1}{2} = \frac{z-1}{-1}$ intersects the curve $xy = c^2, z = 0$ if c is equal to :

(A) ± 1 **(B)** $\pm \frac{1}{3}$ **(C)** $\pm \sqrt{5}$ **(D)** ± 2

3. The range of the function $f(x) = cos^{-1} x + tan^{-1} x$ is :

(A) $\left[\frac{\pi}{4}, \frac{3\pi}{4}\right]$ **(B)** $\left[\frac{\pi}{2}, \frac{3\pi}{2}\right]$ **(C)** $\left[\frac{\pi}{3}, \frac{5\pi}{4}\right]$ **(D)** $\left[\frac{\pi}{4}, \frac{5\pi}{4}\right]$

4. **Statement 1 :** Let $I_n = \int_0^1 \left(1 - x^5\right)^n dx$. Then $\frac{I_{10}}{I_{11}} = \frac{55}{54}$.

Statement 2 : If $u(x)$ and $v(x)$ are differentiable functions then $\int uv\,dx = u\int v\,dx - \int\left(\frac{du}{dx}\int v\,dx\right)dx$.

(A) Statement-1 is True, Statement-2 is True and Statement-2 is a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True and Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False

(D) Statement-1 is False, Statement-2 is True

SPACE FOR ROUGH WORK

5. A 5×5 match the column has 5 questions and 5 options to be matched with only one correct alternative for each question. Find the probability that a student will get 3 or more correct answers just by guessing.

(A) $\frac{1}{24}$ **(B)** $\frac{11}{120}$ **(C)** $\frac{1}{12}$ **(D)** $\frac{23}{24}$

6. Let $f: R \to R$ be such that $f(a)=1,\ f'(a)=2$ then $\lim\limits_{x\to 0}\left(\frac{f^2(a+x)}{f(a)}\right)^{1/x}$ is :

(A) e^2 **(B)** e^4 **(C)** e^{-4} **(D)** $1/e$

7. Let $f(x)$ is a continuous function $f: R \to R$ satisfying $f(0)=1$ *and* $f(2x)-f(x)=x\ \forall\, x>0,$ then the value of $f(3)$ is :

(A) 2 **(B)** 3 **(C)** 4 **(D)** 5

8. $\int\left(\sin(101x).\sin^{99}x\right)dx$ equals :

(A) $\frac{\sin(100x)(\sin x)^{100}}{100}+C$ **(B)** $\frac{\cos(100x)(\sin x)^{100}}{100}+C$

(C) $\frac{\cos(100x)(\cos x)^{100}}{100}+C$ **(D)** $\frac{\sin(100x)(\cos x)^{100}}{100}+C$

9. If $\vec{a}$ *and* $\vec{b}$ are two vectors such that $|\vec{a}|=1, |\vec{b}|=4, \vec{a}.\vec{b}=2.$ If $\vec{c}=\left(2\vec{a}\times\vec{b}\right)-3\vec{b},$ then the angle between $\vec{b}$ and $\vec{c}$ is :

(A) $\frac{\pi}{3}$ **(B)** $\frac{\pi}{6}$ **(C)** $\frac{3\pi}{4}$ **(D)** $\frac{5\pi}{6}$

10. Let $\vec{a}=a_1\hat{i}+a_2\hat{j}+a_3\hat{k}, \vec{b}=b_1\hat{i}+b_2\hat{j}+b_3\hat{k}$ and $\vec{c}=\vec{c}_1\hat{i}+\vec{c}_2\hat{j}+\vec{c}_3\hat{k}$ be three non-zero vectors such that $\vec{c}$ is a unit vector perpendicular to both $\vec{a}$ and $\vec{b}$. If the angle between $\vec{a}$ and $\vec{b}$ is $\pi/6,$ then $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}^2$ is equal to:

(A) 0 **(B)** 1

(C) $\frac{1}{4}\left(a_1^2+a_2^2+a_3^2\right)\left(b_1^2+b_2^2+b_3^2\right)$ **(D)** $\frac{3}{4}\left(a_1^2+a_2^2+a_3^2\right)\left(b_1^2+b_2^2+b^2\right)\left(c_1^2+c_2^2+c_3^2\right)$

SPACE FOR ROUGH WORK

11. The general solution of the differential equation $\frac{xdx+ydy}{ydx-xdy}=x^2+2y^2+\frac{y^4}{x^2}$, is :

(A) $\frac{2x}{y}+\frac{1}{\left(x^2+y^2\right)}=C$ **(B)** $\frac{2y}{x}+\frac{1}{\left(x^2+y^2\right)}=C$

(C) $\frac{2x}{y}-\frac{1}{\left(x^2+y^2\right)}=C$ **(D)** $\frac{2y}{x}-\frac{1}{\left(x^2+y^2\right)}=C$

12. The value of $\int\frac{dx}{x^{1/5}\left(1+x^{4/5}\right)^{1/2}}$ is equal to :

(A) $\frac{5}{2}\left(1+x^{4/5}\right)^{1/2}+C$ **(B)** $\frac{1}{2}\left(1+x^{4/5}\right)^{1/2}+C$

(C) $x^{4/5}\left(1+x^{4/5}\right)^{1/2}+C$ **(D)** None of these

13. If $f\left(x\right)=x+tan\,x$; $x\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ and f is inverse of g, then $g'\left(x\right)$ is equal to :

(A) $\frac{1}{1+\left[g\left(x\right)-x\right]^2}$ **(B)** $\frac{1}{2-\left[g\left(x\right)-x\right]^2}$

(C) $\frac{1}{2+\left[g\left(x\right)-x\right]^2}$ **(D)** None of these

14. Solution of the differential equation $\frac{dy}{dx}=\frac{y(x-y\ln y)}{x(x\ln x-y)}$ is:

(A) $\frac{x\ln x+y\ln y}{xy}=c$ **(B)** $\frac{x\ln x-y\ln y}{xy}=c$

(C) $\frac{\ln x}{x}+\frac{\ln y}{y}=c$ **(D)** $\frac{\ln x}{x}-\frac{\ln y}{y}=c$

15. The domain of the function $f(x)=\sqrt{\sin^{-1}x+\cos^{-1}\sqrt{1-x^2}}$ is :

(A) [– 1, 1] **(B)** [0, 1] **(C)** [– 1, 0] **(D)** [0, 2]

SPACE FOR ROUGH WORK

16. $\int\left(\frac{\ln x-1}{(\ln x)^2+1}\right)^2 dx$ is equal to :

(A) $\frac{x}{x^2+1}+c$ **(B)** $\frac{\ln x}{(\ln x)^2+1}$ **(C)** $\frac{x}{(\ln x)^2+1}+c$ **(D)** $e^x\left(\frac{x}{x^2+1}\right)+c$

17. Area bounded by $|y| = x + 1$, parabola $x^2 = 8y$ and x axis is :

(A) $\frac{\left(5-2\sqrt{6}\right)^2}{2}+\frac{\left(4-2\sqrt{6}\right)^3}{24}$ **(B)** $\frac{\left(5-2\sqrt{6}\right)^2}{2}-\frac{\left(4-2\sqrt{6}\right)^3}{24}$

(C) $\frac{\left(5-2\sqrt{6}\right)^3}{2}+\frac{\left(4-2\sqrt{6}\right)^3}{24}$ **(D)** $\frac{\left(5+2\sqrt{6}\right)^2}{2}+\frac{\left(4-2\sqrt{6}\right)^3}{24}$

18. The direction cosines of the projection of the line $\frac{1}{2}(x-1)=-y=z+2$ on the plane $2x + y - 3z = 4$ are :

(A) $\left(\frac{2}{\sqrt{6}},\frac{-1}{\sqrt{6}},\frac{1}{\sqrt{6}}\right)$ **(B)** $\left(\frac{-2}{\sqrt{6}},\frac{1}{\sqrt{6}},\frac{1}{\sqrt{6}}\right)$ **(C)** $\left(\frac{2}{\sqrt{6}},\frac{1}{\sqrt{6}},\frac{-1}{\sqrt{6}}\right)$ **(D)** None of these

19. A and B are two events such that P(A) = 0.2 and P(A∪B) = 0.7. If A and B are independent events then P(B′) equals :

(A) 2/7 **(B)** 7/9 **(C)** 3/8 **(D)** 1/10

20. Four die are thrown simultaneously. The probability that 4 and 3 appear on two of the die given that 5 and 6 have appeared on other two die is :

(A) $\frac{1}{6}$ **(B)** $\frac{1}{36}$ **(C)** $\frac{12}{151}$ **(D)** $\frac{2}{51}$

SPACE FOR ROUGH WORK

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted.
The answer to each question should be **rounded off to the nearest integer**.

1. The maximum value of $f(x) = x^3 - 3x$ subject to $x^4 + 36 \le 13x^2$ is _____.

2. The area bounded by the curves $y = ln\, x,\quad y = ln\,|x|,\quad y = |ln\, x|$ and $y = |ln\,|x||$ is_____.

3. If $f(x) = (x-1)^{100}(x-2)^{2(99)}(x-3)^{3(98)}...(x-100)^{100}$, then the value of $\frac{f'(101)}{f(101)}$ is_____.

4. The number of solutions of the equation $\sin \pi x = |\ln |x||$ is _____.

5. If $f(x)f(y) + 2 = f(x) + f(y) + f(xy)\ \forall\, x, y \in R$ and $f(1) = f'(1) = 2$, then $f(2)$ is equal to _____.

SPACE FOR ROUGH WORK

6. Number of points in (–1, 10) where the function $f(x) = x^2 |\sin \pi x|$ is non derivable:

7. Let A is a square matrix such that $A^2 = A$ and $(I + A)^6 = I + kA$ then $k =$

8. If A and B are square matrices of order 3 × 3, $|A| = 2, |B| = 1$ then $|A^{-1}.Adj(B^{-1}).Adj(2A^{-1})| =$

9. The distance of the point $P(3, 8, 2)$ from the line $\frac{x-1}{2} = \frac{y-3}{4} = \frac{z-2}{3}$ measured parallel to the plane $3x + 2y - 2z = 0$ is _____.

10. The complete set of values of x which satisfies equation $2\tan^{-1} 2x = \sin^{-1} \frac{4x}{1+4x^2}$ is $[-a, a]$, then the value of $2a$ is _____.

SPACE FOR ROUGH WORK

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