VMC Vidyamandir Classes SINCE 1986
IIT JEE | MEDICAL | FOUNDATION

CODE A

JEE Main-1 | JEE-2024

Date: 29/05/2023 **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.

Name of the Candidate (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

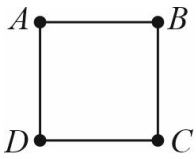
Candidate's Signature : _____ **Invigilator's Signature** _____

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. Equal charges q are placed at the four corners A, B, C, D of a square of length a. The magnitude of the force on the charge at B will be:



(A) $\dfrac{3q^2}{4\pi\varepsilon_0 a^2}$ **(B)** $\dfrac{(\sqrt{2}+1)q^2}{4\pi\varepsilon_0 a^2}$

(C) $\left(\dfrac{1+2\sqrt{2}}{2}\right)\dfrac{q^2}{4\pi\varepsilon_0 a^2}$ **(D)** $\left(2+\dfrac{1}{\sqrt{2}}\right)\dfrac{q^2}{4\pi\varepsilon_0 a^2}$

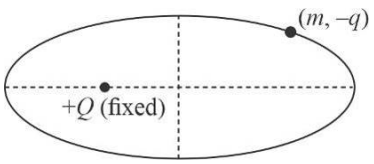
2. Three point charges $(+q,\ +4q,\ -5q)$ are placed at vertices of an equilateral triangle of side a.
Total dipole moment of system will be:

(A) $10aq$ **(B)** Zero **(C)** $4aq$ **(D)** $\sqrt{21}\,aq$

3. A point charge 'q' is placed at centre of base of hemisphere. Flux due to this charge through hemisphere will be:

(A) $\dfrac{q}{8\in_0}$ **(B)** $\dfrac{q}{\in_0}$ **(C)** $\dfrac{q}{2\in_0}$ **(D)** $\dfrac{q}{4\in_0}$

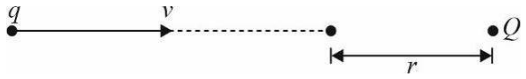
4. A positive point charge $+Q$ is fixed in space. A negative point charge $-q$ of mass m revolves around fixed charge in an elliptical orbit. The fixed charge $+Q$ is at one focus of the ellipse. The only force acting on negative charge is the electrostatic force due to positive charge. Then which of the following statements is true:



(A) Linear momentum of negative point charge is conserved
(B) Angular momentum of negative point charge about fixed positive charge is conserved
(C) Total kinetic energy of negative point charge is conserved
(D) Electrostatic potential energy of system of both point charges is conserved

SPACE FOR ROUGH WORK

5. A charged particle q is shot from a large distance towards another charged particle Q which is fixed, with a speed v. It approaches Q up to a closest distance r and then returns. If q were given a speed $2v$, then closest distance of approach would be:

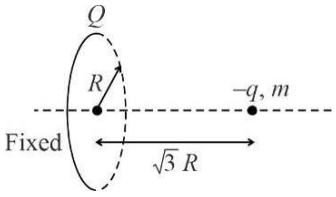


(A) r **(B)** $2r$ **(C)** $\frac{r}{2}$ **(D)** $\frac{r}{4}$

6. Let $\rho(r)=\frac{Q}{\pi R^4}r$ be the volume charge density for a non-conducting solid sphere of radius R. For a point 'P' inside the sphere of distance r_1 from the centre of the sphere, the magnitude of electric field is given as:

(A) $\frac{Q}{4\pi\in_0 r_1^2}$ **(B)** $\frac{Qr_1^2}{4\pi\in_0 R^4}$ **(C)** $\frac{Qr_1^2}{3\pi\in_0 R^4}$ **(D)** 0

7. A particle having a charge $-q$ and mass m is released with negligible speed from a distance $\sqrt{3}R$ on the axis of a fixed uniformly charged ring of charge Q and radius R. Velocity of the particle when it reaches the centre of the ring will be:

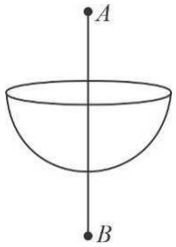


(A) $\sqrt{\frac{2kQq}{mR}}$ **(B)** $2\sqrt{\frac{2kQq}{mR}}$

(C) $\sqrt{\frac{kQq}{2mR}}$ **(D)** $\sqrt{\frac{kQq}{mR}}$

SPACE FOR ROUGH WORK

8. The diagram shows a uniformly charged non-conducting hemisphere of radius R. It has volume charge density ρ. If the electric field at a point $2R$ distance above its centre is E, then the electric field at the point which is $2R$ below its centre is:



(A) $\rho R/6\varepsilon_0 + E$ **(B)** $\rho R/12\varepsilon_0 - E$

(C) $-\rho R/6\varepsilon_0 + E$ **(D)** $\rho R/24\varepsilon_0 + E$

9. 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) $\dfrac{Q(a^2+b^2+c^2)}{4\pi\varepsilon_0(a^3+b^3+c^3)}$ **(B)** $\dfrac{Q}{4\pi\varepsilon_0(a+b+c)}$

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

10. **Statement-I:** Potential decreases on moving along the direction of electric field.

Statement-II: Potential at a point is the work done against electric field in bringing a unit positive charge very slowly from infinity to that point.

(A) Both Statement I and Statement II are false

(B) Statement I is true but Statement II is false

(C) Both Statement I and Statement II are true

(D) Statement I is false but Statement II is true

11. A thin circular ring of radius R is charged such that one semi-circular half has linear charge density $+\lambda$ and the other semi-circular half has linear charge density $-\lambda$. The magnitude of electric field at the centre of the ring is:

(A) $\dfrac{2\lambda}{\pi\varepsilon_0 R^2}$ **(B)** $\dfrac{\lambda}{\pi\varepsilon_0 R^2}$ **(C)** $\dfrac{2\lambda}{\pi\varepsilon_0 R}$ **(D)** $\dfrac{\lambda}{\pi\varepsilon_0 R}$

SPACE FOR ROUGH WORK

12. The maximum electric field intensity on the axis of a uniformly charged ring of charge q and radius R will be :

(A) $\frac{1}{4\pi \in_0} \cdot \frac{q}{3\sqrt{3}R^2}$ **(B)** $\frac{1}{4\pi \in_0} \cdot \frac{2q}{3R^2}$

(C) $\frac{1}{4\pi \in_0} \cdot \frac{2q}{3\sqrt{3}R^2}$ **(D)** $\frac{1}{4\pi \in_0} \cdot \frac{3q}{2\sqrt{2}R^2}$

13. **Assertion-A:** Net Flux crossing through a closed surface is independent of the location of charge within the surface.

Reason-R: Upon displacement of charges within a closed surface, $\vec{E}$ at any point on the surface does not change.

(A) Both A and R are true but R is not the correct explanation of A

(B) A is true but R is false

(C) Both A and R are true and R is the correct explanation of A

(D) A is false but R is true

14. **Statement-I:** No work is required to move a test charge between any two points on an equipotential surface.

Statement-II: Electric lines of force and the equipotential surfaces are mutually perpendicular to each other.

(A) Statement-1 is true, statement-2 is true, statement-2 is the correct explanation of statement-I

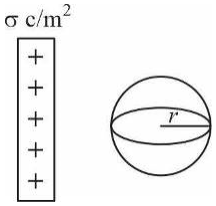
(B) Statement-I is true, statement-II is true, statement-II is not correct explanation of statement-I

(C) Statement-I is true, statement-II is false

(D) Statement-I is false, statement-II is true

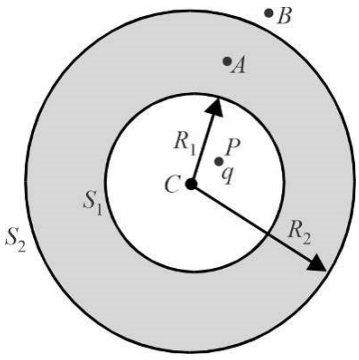
SPACE FOR ROUGH WORK

15. The electric potential energy stored in spherical volume due to electric field of infinite non-conducting sheet is:



(A) $\frac{4\pi\sigma^2 r^3}{6\varepsilon_0}$ **(B)** $\frac{2\pi\sigma^2 r^3}{6\varepsilon_0}$ **(C)** $\frac{\pi\sigma^2 r^3}{6\varepsilon_0}$ **(D)** $\frac{9\pi\sigma^3 r^2}{\varepsilon_0}$

16. An uncharged conductor of inner radius R_1 and outer radius R_2 contains a point charge q placed at point P (not at the centre) as shown in figure. Which of the following statements is(are) correct?



(I) $V_A = \frac{Kq}{R_2}$

(II) $E_A = O$

(III) $\vec{E}_B = \frac{Kq}{(CB)^2}\widehat{CB}$

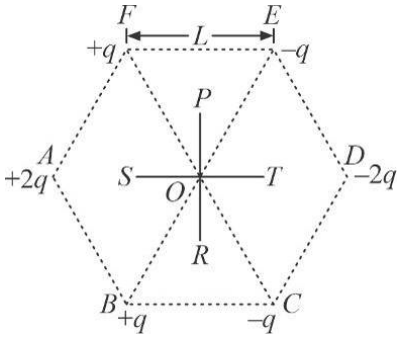
(IV) Force on charge Q, if it is placed at B will be $\vec{F} = \frac{KQq}{(PB)^2}\widehat{PB}$

(A) I, II are correct **(B)** II, IV are correct

(C) I, II, III are correct **(D)** I, II, III, IV are correct

SPACE FOR ROUGH WORK

17. Six point charges are kept at the vertices of a regular hexagon of side L and centre O, as shown in the figure. Given that $C = \frac{1}{4\pi\varepsilon_0}\frac{q}{L^2}$, which of the following statements is/are correct?



(I) The electric field at O is $6C$ along OD

(II) The potential at O at zero

(III) The potential at all points on the line PR is same

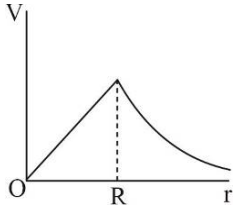
(IV) The potential at all points on the line ST is same

(A) (I), (II), (III) are correct **(B)** All are correct

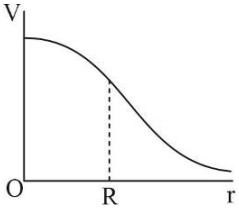
(C) (I), (IV) are correct **(D)** (II) and (IV) are correct

18. Which of the following graphs may be showing variation of electrostatic potential (V) due to a uniform solid sphere of charge as function of distance from centre of the sphere (r)? (R = Radius of the sphere)

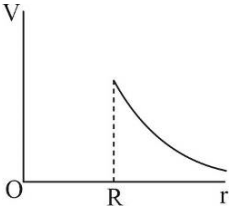
(A)



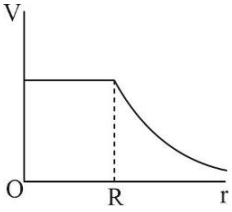
(B)



(C)

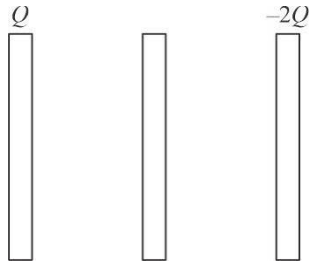


(D)



SPACE FOR ROUGH WORK

19. Three identical metal plates with large surface areas are kept parallel to each other as shown in figure. The leftmost plate is given charge Q, the rightmost given charge $-2Q$ and the middle one remains neutral. Then:

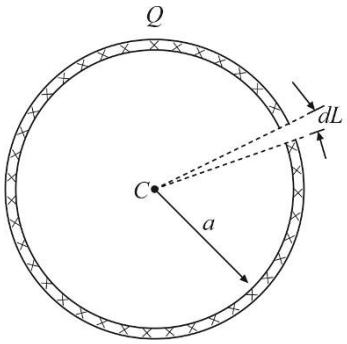


Column-I		Column-II	
(i)	The charge appearing on outer surface of the rightmost plate	**(a)**	$+\frac{Q}{2}$
(ii)	The charge appearing on outer surface of the leftmost plate	**(b)**	$-\frac{Q}{2}$
(iii)	The charge appearing on left surface of the middle plate	**(c)**	$-\frac{3Q}{2}$
(iv)	The charge appearing on right surface of the middle plate	**(d)**	$\frac{3Q}{2}$

(A) (i) – (a), (ii) – (b), (iii) – (c), (iv) – (d) **(B)** (i) – (b), (ii) – (b), (iii) – (c), (iv) – (d)

(C) (i) – (b), (ii) – (c), (iii) – (d), (iv) – (a) **(D)** (i) – (c), (ii) – (d), (iii) – (a), (iv) – (b)

20. A circular thin, non conducting wire-loop of radius a, carries a total charge 'Q' distributed uniformly over its length. An elemental length 'dL' of the wire is cut off. Find the electric field at the centre 'C' due to the remaining wire.



(A) Zero **(B)** $\frac{Q\,dL}{4\pi\varepsilon_0\,a^3}$

(C) $\frac{Q\,dL}{8\pi\varepsilon_0\,a^3}$ **(D)** $\frac{Q\,dL}{8\pi^2\varepsilon_0\,a^3}$

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. In a region of space, a uniform electric field $\vec{E} = (6\hat{i} + 2\hat{j} + 5\hat{k})V/m$ is present. The electric flux passing through a surface in *xy* plane having area $100\,m^2$ is _____ (in *Vm*).

2. 64 identical small drops are charged to 5 volts each. If they all coalesce to form a single large drop, then the potential of large drop becomes *x* Volts. The value of *x* is _____.

3. A dipole comprises of two charged particles of identical magnitude *q* and opposite in nature. The mass '*m*' of the positive charged particle is half of the mass of the negative charged particle. The two charges are separated by a distance '*l*'. If the dipole is placed in a uniform electric field '$\vec{E}$' in such a way that dipole axis makes a very small angle with the electric field. '$\vec{E}$'. The angular frequency of the oscillations of the dipole when released is given by $\sqrt{\frac{nqE}{4ml}}$, then *n* is_____.

4. Charge is uniformly distributed with density ρ in a cylindrical region of radius *R* and infinite length. The magnitude of electric field at distance $\frac{R}{2}$ and 2*R* from the axis of the cylinder is E_1 and E_2 respectively. The ratio $\frac{E_1}{E_2}$ is equal to _____.

SPACE FOR ROUGH WORK

5. Positive charge Q is distributed uniformly over a circular ring of radius a. A particle having mass m and a negative charge $-q$, is placed on its axis at a distance y from the centre. Assuming $y << a$, time period of oscillation, of the particle if it is released from rest is $n\left[\frac{\pi^3\varepsilon_0 ma^3}{Q\times q}\right]^{1/2}$, where n is_____. (Neglect gravity)

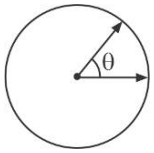
6. A positive charge q is placed in front of a neutral conducting solid cube at a distance d from its centre. The electric field at the centre of the cube due to the charges induced on its surface is $\frac{nKq}{d^2}$, where n is ___.

7. Electric field on the axis of a small electric dipole at a distance r is $\vec{E}_1$ and at a distance $2r$ on a line of perpendicular bisector electric field is $\vec{E}_2$. Then $|E_2| = \frac{|E_1|}{n}$, where n is _____.

SPACE FOR ROUGH WORK

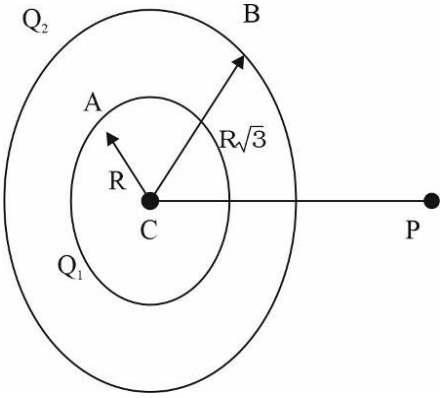
8. The linear charge density on a dielectric ring of radius R is varying with θ as $\lambda = \lambda_0 \cos(\theta/2)$.

The potential at the centre of the ring is $\frac{n\lambda_0}{4\pi\varepsilon_0}$, where n is _____.



9. Two spheres A and B of radius 4cm and 6cm are given charges of $80\mu C$ and $40\mu C$ respectively. If they are connected by a fine wire, the amount of charge flowing from one to the other is_____ (in μC).

10. In the shown figure two uniformly charged rings A and B of radii R and $R\sqrt{3}$ having charges Q_1 and Q_2 respectively are concentric with centre C and are coplanar. A point P is on the axis of the rings at a distance $CP = R$. At point P, electric field is zero. The ratio $\left|\frac{Q_1}{Q_2}\right|$ is $\frac{1}{n\sqrt{2}}$, where n 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.

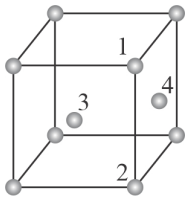
1. First three nearest neighbour distances for primitive cubic lattice are respectively (edge length of unit cell = a).

(A) a, $\sqrt{2}$a, $\sqrt{3}$a, **(B)** $\sqrt{3}$a, $\sqrt{2}$a, a **(C)** a, $\sqrt{2}$a, 2a **(D)** a, $\sqrt{3}$a, 2a

2. Which of the crystal systems contains the maximum number of Bravais lattices?

(A) Cubic **(B)** Hexagonal **(C)** Triclinic **(D)** Orthorhombic

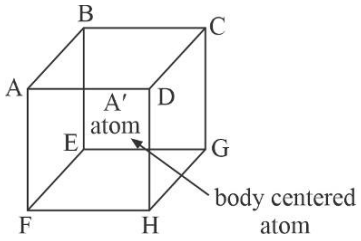
3. In an fcc cell atoms are numbered as shown below. The atoms not touching each other are (atom numbered 3 is face centre of front face).



(A) 3 and 4 **(B)** 1 and 3 **(C)** 1 and 2 **(D)** 2 and 4

SPACE FOR ROUGH WORK

4. In body centred cubic lattice given below, the three distances AB, AC, and AA' are:



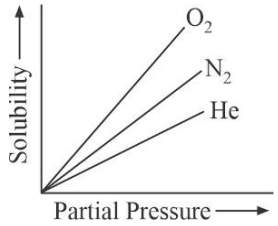
(A) $a, \sqrt{2}a, \frac{\sqrt{3}a}{2}$ **(B)** $a, \frac{\sqrt{3}a}{2}, \sqrt{2}a$ **(C)** $\frac{\sqrt{3}a}{2}, \sqrt{2}a, a$ **(D)** $a, \frac{a}{\sqrt{2}}, \frac{\sqrt{3}a}{2}$

5. Which condition is not satisfied by an ideal solution?

(A) $\Delta_{mix}H = 0$ **(B)** $\Delta_{mix}V = 0$

(C) $\Delta_{mix}S = 0$ **(D)** Obeyance of Raoult's law

6. Molar solubility of helium, nitrogen and oxygen are plotted against partial pressure of the gas at constant temperature. Henry's law constant for these gases will lie in following sequence?



(A) $O_2 > N_2 > He$

(B) $O_2 < N_2 < He$

(C) $O_2 = N_2 = He$

(D) $O_2 > N_2 < He$

7. An aqueous solution freezes at –2.55°C. What is its boiling point $(K_{b(H_2O)} = 0.52\ K\ m^{-1}$, $K_{f(H_2O)} = 1.86\ K\ m^{-1})$?

(A) 107.0°C **(B)** 100.6°C **(C)** 100.1°C **(D)** 100.7°C

SPACE FOR ROUGH WORK

8. The degree of dissociation α of a weak electrolyte is: Where n is the number of ions given by 1 mol of electrolyte.

(A) $\frac{i-1}{n+1}$ **(B)** $\frac{i-1}{n-1}$ **(C)** $\frac{n-1}{i-1}$ **(D)** $\frac{n+1}{i-1}$

9. Following statements are given regarding solids. Identify correct statements.

(I) Cristoballite (SiO_2) is molecular solid

(II) Fullerene is molecular solid

(III) Dry ice is polar molecular solid

(IV) Solid HI is ionic solid

Which is the correct option?

(A) I, III IV **(B)** I, II **(C)** II only **(D)** I, II, III, IV

10. Following crystal systems are given:

(I) Monoclinic **(II)** Rhombohedral **(III)** Triclinic **(IV)** Hexagonal

In which of the following systems interfacial angles $\alpha = \gamma = 90°$ and $\beta \neq 90°$?

(A) I, II **(B)** Only I **(C)** III, IV **(D)** II, III

11. For a solution containing non-volatile solute, following statements are given:

(I) The vapour pressure of a solute is zero

(II) Vapour pressure of solution = Vapour pressure of pure solvent

(III) Vapour pressure of solution = Vapour pressure of solvent in solution

Which is the correct option?

(A) II and III are correct **(B)** I and II are correct

(C) I and III are correct **(D)** Only I is correct

SPACE FOR ROUGH WORK

12. This section contains questions each with two column-I and column-II. Match the items given in column-I with that in column-II:

Column-I Elements of symmetry (For a cube)		Column-II	
(i)	C_3 axis	**(a)**	Passes through two face centres and body centre
(ii)	C_4 axis (tetrad axis)	**(b)**	Passes through two corners and body centre
(iii)	Rectangular plane	**(c)**	Passes through two edge centre and body centre
(iv)	C_2 axis	**(d)**	Passes through four face centre, body centre and four edge centre

(A) (i) – (b), (ii) – (a), (iii) – (d), (iv) – (c) **(B)** (i) – (a), (ii) – (b), (iii) – (c), (iv) – (d)

(C) (i) – (a), (ii) – (c), (iii) – (d), (iv) – (b) **(D)** (i) – (d), (ii) – (c), (iii) – (b), (iv) – (a)

13. Match the following:

Column-I		Column-II	
(i)	Potassium sulphate	**(a)**	Soft and conductor
(ii)	Tin	**(b)**	Hard and conductor
(iii)	Graphite	**(c)**	Hard and insulator
(iv)	Silicon carbide	**(d)**	Conductor in molten state

(A) (i) – (c), (ii) – (b), (iii) – (a), (iv) – (d) **(B)** (i) – (d), (ii) – (a), (iii) – (c), (iv) – (b)

(C) (i) – (d), (ii) – (b), (iii) – (a), (iv) – (c) **(D)** (i) – (c), (ii) – (d), (iii) – (c), (iv) – (b)

14. Given below in column I are the solutions formed by two liquid. Choose the correct nature given in column II.

Column-I		Column-II	
(i)	$H_2O + H_2SO_4$	**(a)**	Positive Deviation.
(ii)	$C_6H_6 + H_2O$	**(b)**	Ideal Solution
(iii)	$C_2H_5Br + C_2H_5I$	**(c)**	Negative deviation
(iv)	$C_2H_5OH + H_2O$	**(d)**	Immiscible mixture

(A) (i) – (a), (ii) – (b), (iii) – (c), (iv) – (d) **(B)** (i) – (b), (ii) – (c), (iii) – (d), (iv) – (a)

(C) (i) – (d), (ii) – (c), (iii) – (a), (iv) – (b) **(D)** (i) – (c), (ii) – (d), (iii) – (b), (iv) – (a)

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15. **Assertion-A:** Effective number of atoms in fcc structure is double than that a crystal having bcc structure.

Reason -R: Packing fraction for fcc structure is double that of bcc structure.

(A) Both A and R are true but R is not the correct explanation of A

(B) A is true but R is false

(C) Both A and R are true and R is the correct explanation of A

(D) A is false but R is true

16. **Statement-I:** In rock salt structure, all the octahedral voids in the close packing of anions are occupied by cations.

Statement-II: In rock salt structure, the distance of closest approach between two anions is equal to the face diagonal of unit cell.

(A) Both Statement I and Statement II are false

(B) Statement I is true but Statement II is false

(C) Both Statement I and Statement II are true

(D) Statement I is false but Statement II is true

17. **Statement-I:** A mixture of cyclohexane and ethanol shows +ve deviation from Raoult's law.

Statement-II: A mixture of benzene and carbon tetrachloride shows +ve deviation from Raoult's law.

(A) Both Statement I and Statement II are false

(B) Statement I is true but Statement II is false

(C) Both Statement I and Statement II are true

(D) Statement I is false but Statement II is true

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18. **Assertion-A:** Boric acid has layer structure in which planar BO_3 units are joined by hydrogen bonds.

Reason-R: Boric acid belong to the most unsymmetrical crystal system.

(A) Both A and R are true but R is not the correct explanation of A

(B) A is true but R is false

(C) Both A and R are true and R is the correct explanation of A

(D) A is false but R is true

19. **Assertion-A:** Addition of HgI_2 to KI(aq.) shows an increase in freezing point.

Reason-R: HgI_2 (insoluble) reacts with KI(aq.) to form complex $K_2[HgI_4]$ and thus, number of particles present in solution decreases.

(A) Both A and R are true but R is not the correct explanation of A

(B) A is true but R is false

(C) Both A and R are true and R is the correct explanation of A

(D) A is false but R is true

20. **Assertion-A:** Ice melts earlier if NaCl is poured on it.

Reason-R: The freezing point of water is lowered on addition of NaCl.

(A) Both A and R are true but R is not the correct explanation of A

(B) A is true but R is false

(C) Both A and R are true and R is the correct explanation of A

(D) A is false but R is true

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. 12.2 g of benzoic acid $(M_W = 122)$ in 100 g water has elevation in boiling point of 0.27. $K_b = 0.54\ K\ kg\ mol^{-1}$. If there is 100% degree of association, then the number of molecules of benzoic acid in associated state is:

2. The osmotic pressure of urea solution at 10°C is 200 mm of Hg and becomes 150.3 mm of Hg when it is diluted and temperature raised to 25°C. The extent of dilution is $x \times 10^{-1}$ times of initial solution. Find x.

3. The total number of colligative properties are:

4. If a solid $A^{\oplus}B^{\ominus}$ having ZnS structure is heated so that the ions along two of the axis passing through the face centre particles are lost and bivalent ion (Z) enters here to maintain the electrical neutrality, so that the new formula unit becomes, $A_xB_yZ_c$, report the value of $x + y + c$. (If given that in ZnS, S^{2-} ions forms ccp lattice and 50% of tetrahedral voids occupied by Zn^{2+}.)

5. Find the coordination number of $Na^{\oplus}$ in Na_2O. Here O^{2-} ions forms a ccp lattice.

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6. If the number of hexagonal faces is x and the number of square faces is y that are present in a truncated octahedron then find $x \times y$.

7. Packing efficiency of cubic lattice of diamond is _____.

8. Liquids A and B form ideal solution over the entire range of composition. At temperature T, equimolar binary solution of liquids A and B has vapour pressure 45 Torr. At the same temperature, a new solution of A and B having mole fractions x_A and x_B, respectively, has vapour pressure of 22.5 Torr. Value of x_A/x_B in the new solution is _____.
(Given that the vapour pressure of pure liquid A is 20 Torr. at temperature T).

9. The osmotic pressure of a solution containing 40 g of solute (molecular mass 246) per litre at 27°C is ($R = 0.082$ atm L mol^{-1}).

10. When molten zinc is cooled to solid state, it assumes hcp structure. Then the number of nearest neighbours of zinc atom will be:

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 function $f(x)=\sqrt{1-2x}+x$ is defined from $D_1 \to D_2$ and is onto. If the set D_1 is the domain, then the set D_2 is:

(A) $\left(-\infty, \frac{1}{2}\right]$ **(B)** $(-\infty, 2)$ **(C)** $(-\infty, 1)$ **(D)** $(-\infty, 1]$

2. Let $F(x)=\begin{cases} x|x| & \text{if} \quad x \le -1 \\ [1+x]+[1-x] & \text{if} \quad -1 < x < 1 \\ -x|x| & \text{if} \quad x \ge 1 \end{cases}$ where $[x]$ denotes the greatest integer function then $F(x)$ is:

(A) Even **(B)** Odd

(C) Neither odd nor even **(D)** Even as well as odd

3. Let $f(x)=x^2-4x+3$. If $|f(x)|>-f(x)$, then the true set of values of x, is:

(A) $(1, 3)$ **(B)** $(1, 3]$

(C) $(-\infty, 1) \cup (3, \infty)$ **(D)** $(-\infty, 1] \cup (3, \infty)$

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4. Which of the following are odd function?

(i) $f(x)=\dfrac{x}{1+|x|}$

(ii) $f(x)=x^2\log\left(\sqrt{x^6+1}+x^3\right)$

(iii) $f(x)=\dfrac{2^x-1}{2^x+1}g(x)$, where $g(x)$ is an even function defined for $x\in R$

(iv) $\phi(x)=(f(x)+f(-x))(g(x)-g(-x))$

(A) (i) and (ii) only **(B)** (i) and (iii) only

(C) (i) and (iv) only **(D)** All of these

5. Solution set of the inequality $2-\log_2(x^2+3x)\geq 0$ is:

(A) $[-4,1]$ **(B)** $[-4,-3)\cup(0,1]$

(C) $(-\infty,-3)\cup(1,\infty)$ **(D)** $(-\infty,-4)\cup[1,\infty)$

6. The maximum value of $(7\cos\theta+24\sin\theta)\times(7\sin\theta-24\cos\theta)$ for every, $\theta\in R$ is:

(A) 25 **(B)** 625 **(C)** $\dfrac{625}{2}$ **(D)** $\dfrac{625}{4}$

7. Let $f(x)=||x^2-4x+3|-2|$. Which of the following is INCORRECT?

(A) $f(x)=m$ has exactly two real solutions of different sign $\forall\ m>2$

(B) $f(x)=m$ has exactly two real solutions $\forall\ m\in(2,\infty)\cup\{0\}$

(C) $f(x)=m$ has no solutions $\forall\ m<2$

(D) $f(x)=m$ has four distinct real solutions $\forall\ m\in(0,1)$

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8. The fundamental period of the function $f(x)=\sin 2\pi x+\sin\left(\frac{\pi x}{3}\right)+\sin\left(\frac{\pi x}{5}\right)$ is:

(A) 2 **(B)** 6 **(C)** 15 **(D)** 30

9. One root of the equation $\cos x+x=0$ lies in the interval:

(A) $\left(0, \frac{\pi}{2}\right)$ **(B)** $\left(-\frac{\pi}{2}, 0\right)$ **(C)** $\left(\frac{\pi}{2}, \pi\right)$ **(D)** $\left(\pi, \frac{3\pi}{2}\right)$

10. The value of $\tan^6\frac{\pi}{9}-33\tan^4\frac{\pi}{9}+27\tan^2\frac{\pi}{9}$ is equal to:

(A) $\tan\frac{\pi}{3}$ **(B)** $\tan^2\frac{\pi}{3}$ **(C)** $\tan\frac{\pi}{6}$ **(D)** $\tan^2\frac{\pi}{6}$

11. If $f(x+ay, x-ay)=axy,$ then $f(x, y)=.$

(A) xy **(B)** $x^2-a^2y^2$ **(C)** $\frac{x^2-y^2}{4}$ **(D)** $\frac{x^2-y^2}{a^2}$

12. The range of $f(x)=4^x+2^x+1$ is:

(A) $(0, \infty)$ **(B)** $(1, \infty)$ **(C)** $(2, \infty)$ **(D)** $(3, \infty)$

13. If $f(x)$ and $g(x)$ are two functions with $g(x)=x-\frac{1}{x}$ and $fog(x)=x^3-\frac{1}{x^3},$ then $f(x)$ is:

(A) x^3+3x **(B)** $x^2-\frac{1}{x^2}$ **(C)** $1+\frac{1}{x^2}$ **(D)** $3x^2+\frac{3}{x}$

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14. The domain and range of $f(x)=\sin\left\{\log\left(\frac{\sqrt{4-x^2}}{1-x}\right)\right\}$ are respectively:

(A) (–2, 1) and [–1, 1] **(B)** (1, 3) and [–1, 1]

(C) [–2, 1] and [–1, 1] **(D)** $(0,\infty)$ and $[-1,1]$

15. If $\sin\theta+\cos\theta=\frac{1}{5}$ and $0<\theta<\pi$, then $\tan\theta$ is:

(A) $-\frac{4}{3}$ **(B)** $-\frac{3}{4}$ **(C)** $\frac{3}{4}$ **(D)** $\frac{4}{3}$

16. Which of the following is NOT periodic?

(A) $\text{sgn}(e^{-x})$ **(B)** $\sin^2 x+|\sin x|$

(C) Minimum ($|x|$, $\sin x$) **(D)** $2[-x]+\left[x+\frac{1}{2}\right]+\left[x-\frac{1}{2}\right]-|x|$

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17. The ratio $\dfrac{\sin\frac{2\pi}{7}+\sin\frac{4\pi}{7}-\sin\frac{6\pi}{7}}{\sin\frac{\pi}{7}\sin\frac{3\pi}{7}\sin\frac{5\pi}{7}}$ is equal to:

(A) $\frac{1}{4}$ **(B)** 1 **(C)** 2 **(D)** 4

18. Total number of solutions of $\cos x=\sqrt{1-\sin 2x}$ in $[0, 2\pi]$, is equal to:

(A) 2 **(B)** 3 **(C)** 5 **(D)** None of these

19. Let $f(x)=\sin x+\sin(x\sqrt{3})$. Then, which of the following is true?

(A) Maximum value of $f(x)$ is not 2

(B) Maximum value of $f(x)$ is –2

(C) $f(x)$ is periodic function with period $2\sqrt{3}\pi$

(D) $f(x)>0\ \ \forall\ x\in R$

20. If $af(x)+bf\left(\frac{1}{x}\right)=x-1,\ x\neq 0$ and $a\neq b$, then for $(a, b)\equiv(100, 50)$, $[f(2)]$ is equal to, (where [.] represents G.I.F.)

(A) 1 **(B)** 2 **(C)** 3 **(D)** 0

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. If $P_n = \cos^n x + \sin^n x$, then $2P_6 - 3P_4 + 1 =$

2. Let $[x]$ denote the greatest integer in x. Then in the interval [0, 3] the number of solutions of the equation, $x^2 - 3x + [x] = 0$ is _____.

3. The number of (x, y) satisfying $|\tan \pi y| + (\sin \pi x)^2 = 0$ and $x^2 + y^2 \le 2$ is equal to _____.

4. Let $f(x) = \begin{cases} x & , \quad -2 \le x \le -1 \\ x^2 + 2x & , \quad -1 < x \le 0 \\ 2x - x^2 & , \quad 0 < x \le 1 \\ 2 - x & , \quad 1 < x \le 2 \end{cases}$

Find the number of integers in the range of $f(x)$.

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5. Let $g(x) = 1 + x - [x]$, where [.], is GIF and $f(x) = \text{sgn}(x)$. Then for all x, $f(g(x))$ is equal to:

6. The number of integers in range of $y = \dfrac{\cos 3x}{\cos x}$ are _____. (x is not an odd multiple of $\dfrac{\pi}{2}$)

7. The fundamental period of
$f(x) = x + a - [x + b] + \sin \pi x + \cos 2\pi x + \sin 3\pi x + \cos 4\pi x + ... + \sin(2n-1)\pi x + \cos 2n\pi x$ for every $a, b \in R$ (where, [.] denotes greatest integer function), is _____.

8. If the interval x satisfying the equation $[x] + [-x] = \dfrac{\log_3(x-2)}{|\log_3(x-2)|}$ is (a, b), then $a + b$ = _____. (where [.], is GIF)

9. Suppose that $f(x)$ is a function of the form $f(x) = \dfrac{ax^8 + bx^6 + cx^4 + dx^2 + 15x + 1}{x}, (x \neq 0)$.
If $f(5) = 2$, then the value of $f(-5)$ is _____.

10. If $f(3x+2) + f(3x+29) = 0 \;\; x \in R,$ then the fundamental period of $f(x)$ is:

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