JEE Main - 2024

1st FEBRUARY 2024 (Morning Shift)

General Instructions

1. The test is of **3 hours** duration and the maximum marks is **300.**

2. The question paper consists of **3 Subjects** (Subject I: **Mathematics**, Subject II: **Physics**, Subject III: **Chemistry**). Each Part has **two** sections (Section 1 & Section 2).

3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices (1), (2), (3) and (4), 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.

SUBJECT I : MATHEMETICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

1. Let $S = \left\{ x \in R : (\sqrt{3} + \sqrt{2})^x + (\sqrt{3} - \sqrt{2})^x = 10 \right\}$. Then the number of elements in S is:

    (1)   0   **(2)**   4   **(3)**   1   **(4)**   2

2. If $5f(x) + 4f\left(\dfrac{1}{x}\right) = x^2 - 2, \forall\, x \neq 0$ and $y = 9x^2 f(x)$, then y is strictly increasing in:

    (1) $\left(-\dfrac{1}{\sqrt{5}}, 0\right) \cup \left(0, \dfrac{1}{\sqrt{5}}\right)$ **(2)** $\left(-\dfrac{1}{\sqrt{5}}, 0\right) \cup \left(\dfrac{1}{\sqrt{5}}, \infty\right)$

    (3) $\left(0, \dfrac{1}{\sqrt{5}}\right) \cup \left(\dfrac{1}{\sqrt{5}}, \infty\right)$ **(4)** $\left(-\infty, \dfrac{1}{\sqrt{5}}\right) \cup \left(0, \dfrac{1}{\sqrt{5}}\right)$

3. Let 3, a, b, c be in A.P. and 3, $a - 1$, $b + 1$, $c + 9$ be in G.P. Then, the arithmetic mean of a, b and c is:

    (1)   13   **(2)**   11   **(3)**   −4   **(4)**   −1

4. The area enclosed by the curves $xy + 4y = 16$ and $x + y = 6$ is equal to:

    (1) $30 - 28\log_e 2$ **(2)** $30 - 32\log_e 2$ **(3)** $28 - 30\log_e 2$ **(4)** $32 - 30\log_e 2$

5. A bag contains 8 balls, whose colours are either white or black. 4 balls are drawn at random without replacement and it was found that 2 balls are white and other 2 balls are black. The probability that the bag contains equal number of white and black balls is:

    (1) $\dfrac{2}{7}$ **(2)** $\dfrac{1}{5}$ **(3)** $\dfrac{1}{7}$ **(4)** $\dfrac{2}{5}$

6. Let $f : R \to R$ and $g : R \to R$ be defined as $f(x) = \begin{cases} \log_e x &, \ x > 0 \\ e^{-x} &, \ x \leq 0 \end{cases}$ and $g(x) = \begin{cases} x &, \ x \geq 0 \\ e^x &, \ x < 0 \end{cases}$. Then, $gof : R \to R$ is:

    (1) neither one-one nor onto   **(2)** both one-one and onto

    (3) onto but not one-one   **(4)** one-one but not onto

7. If n is the number of ways five different employees can sit into four indistinguished offices where any office may have any number of persons including zero, then n is equal to:

    (1)   43   **(2)**   51   **(3)**   47   **(4)**   53

8. Let $f : R \to R$ be defined as:

$$f(x) = \begin{cases} \dfrac{a - b\cos 2x}{x^2} &; \ x < 0 \\ x^2 + cx + 2 &; \ 0 \leq x \leq 1 \\ 2x + 1 &; \ x > 1 \end{cases}$$

If f is continuous everywhere in R and m is the number of points where f is NOT differentiable then $m + a + b + c$ equals:

    (1)   2   **(2)**   4   **(3)**   1   **(4)**   3

9. The value of the integral $\displaystyle\int_{0}^{\pi/4} \frac{x \, dx}{\sin^4(2x) + \cos^4(2x)}$ equals:

(1) $\dfrac{\sqrt{2}\pi^2}{8}$ (2) $\dfrac{\sqrt{2}\pi^2}{16}$ (3) $\dfrac{\sqrt{2}\pi^2}{64}$ (4) $\dfrac{\sqrt{2}\pi^2}{32}$

10. If $A = \begin{bmatrix} \sqrt{2} & 1 \\ -1 & \sqrt{2} \end{bmatrix}$, $B = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$, $C = ABA^T$ and $X = A^T C^2 A$, then det X is equal to:

(1) 27 (2) 729 (3) 891 (4) 243

11. If the system of equations

$$2x + 3y - z = 5$$
$$x + \alpha y + 3z = -4$$
$$3x - y + \beta z = 7$$

has infinitely many solutions, then $13\alpha\beta$ is equal to _____.

(1) 1120 (2) 1110 (3) 1220 (4) 1210

12. Let $y = y(x)$ be the solution of the differential equation $\dfrac{dy}{dx} = 2x(x+y)^3 - x(x+y) - 1$, $y(0) = 1$. Then,

$\left(\dfrac{1}{\sqrt{2}} + y\left(\dfrac{1}{\sqrt{2}}\right) \right)^2$ equal:

(1) $\dfrac{2}{1+\sqrt{e}}$ (2) $\dfrac{4}{4+\sqrt{e}}$ (3) $\dfrac{1}{2-\sqrt{e}}$ (4) $\dfrac{3}{3-\sqrt{e}}$

13. Let $\vec{a} = -5\hat{i} + \hat{j} - 3\hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - 4\hat{k}$ and $\vec{x} = \left(\left((\vec{a} \times \vec{b}) \times \hat{i} \right) \times \hat{i} \right) \times \hat{i}$. Then $\vec{c} \cdot (-\hat{i} + \hat{j} + \hat{k})$ is equal to:

(1) -15 (2) -12 (3) -13 (4) -10

14. Let $C : x^2 + y^2 = 4$ and $C' : x^2 + y^2 - 4\lambda x + 9 = 0$ be two circles. If the set of all values of λ so that the circles C and C' intersect at two distinct points, is $R - [a, b]$, then the point $(8a + 12, 16b - 20)$ lies on the curve:

(1) $x^2 - 4y^2 = 7$ (2) $6x^2 + y^2 = 42$

(3) $5x^2 - y = -11$ (4) $x^2 + 2y^2 - 5x + 6y = 3$

15. Let $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$, $a > b$ be an ellipse, whose eccentricity is $\dfrac{1}{\sqrt{2}}$ and the length of the latusrectum is $\sqrt{14}$.

Then the square of the eccentricity of $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = 1$ is:

(1) $\dfrac{5}{2}$ (2) 3 (3) $\dfrac{7}{2}$ (4) $\dfrac{3}{2}$

16. Let $S = \left\{ z \in C : |z - 1| = 1 \text{ and } (\sqrt{2} - 1)(z + \bar{z}) - i(z - \bar{z}) = 2\sqrt{2} \right\}$. Let $z_1, z_2 \in S$ be such that $|z_1| = \max_{z \in S} |z|$

and $|z_2| = \min_{z \in S} |z|$. Then $|\sqrt{2} z_1 - z_2|^2$ equals:

(1) 4 (2) 2 (3) 1 (4) 3

17. If $\tan A = \dfrac{1}{\sqrt{x(x^2 + x + 1)}}$, $\tan B = \dfrac{\sqrt{x}}{\sqrt{x^2 + x + 1}}$ and $\tan C = (x^{-3} + x^{-2} + x^{-1})^{1/2}$, $0 < A, B, C < \dfrac{\pi}{2}$, then $A + B$ is equal to:

(1) C (2) $\pi - C$ (3) $\dfrac{\pi}{2} - C$ (4) $2\pi - C$

18. Let the median and the mean deviation about the median of 7 observation 170, 125, 230, 190, 210, a, b be 170 and $\dfrac{205}{7}$ respectively. Then the mean deviation about the mean of these 7 observations is:

(1) 28 **(2)** 30 **(3)** 31 **(4)** 32

19. If the shortest distance between the lines $\dfrac{x - \lambda}{-2} = \dfrac{y - 2}{1} = \dfrac{z - 1}{1}$ and $\dfrac{x - \sqrt{3}}{1} = \dfrac{y - 1}{-2} = \dfrac{z - 2}{1}$ is 1, then the sum of all possible values of λ is:

(1) $-2\sqrt{3}$ **(2)** 0 **(3)** $3\sqrt{3}$ **(4)** $2\sqrt{3}$

20. For $0 < \theta < \dfrac{\pi}{2}$, if the eccentricity of the hyperbola $x^2 - y^2 \operatorname{cosec}^2 \theta = 5$ is $\sqrt{7}$ times eccentricity of the ellipse $x^2 \operatorname{cosec}^2 \theta + y^2 = 5$, then the value of θ is:

(1) $\dfrac{\pi}{4}$ **(2)** $\dfrac{5\pi}{12}$ **(3)** $\dfrac{\pi}{6}$ **(4)** $\dfrac{\pi}{3}$

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**.

21. Let 3, 7, 11, 15, ..., 403 and 2, 5, 8, 11, ..., 404 be two arithmetic progressions. Then the sum, of the common terms in them, is equal to _____.

22. Let the line $L : \sqrt{2x} + y = \alpha$ pass through the point of the intersection P (in the first quadrant) of the circle $x^2 + y^2 = 3$ and the parabola $x^2 = 2y$. Let the line L touch two circles C_1 and C_2 of equal radius $2\sqrt{3}$. If the centres Q_1 and Q_2 of the circles C_1 and C_2 lie on the y-axis, then the square of the area of the triangle PQ_1Q_2 is equal to _____.

23. If $\displaystyle \int_{-\pi/2}^{\pi/2} \frac{8\sqrt{2}\cos dx}{(1 + e^{\sin x})(1 + \sin^4 x)} = \alpha\pi + \beta\log_e(3 + 2\sqrt{2})$, where α, β are integers, then $\alpha^2 + \beta^2$ equals _____.

24. Let $A = \{1, 2, 3, ..., 20\}$. Let R_1 and R_2 two relation on A such that,

$R_1 = \{(a, b) : b \text{ is divisible by } a\}$

$R_2 = \{(a, b) : a \text{ is an internal multiple of } b\}$

Then, number of elements in $R_1 - R_2$ is equal to _____.

25. Let the line of the shortest distance between the lines $L_1 : \vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}) + \lambda(\hat{i} - \hat{j} + \hat{k})$ and $L_2 : \vec{r} = (4\hat{i} + 5\hat{j} + 6\hat{k}) + \mu(\hat{i} + \hat{j} - \hat{k})$ intersect L_1 and L_2 at P and Q respectively. If (α, β, γ) is the mid point of the line segment PQ, then $2(\alpha + \beta + \gamma)$ is equal to _____.

26. If the coefficient of x^{30} in the expansion of $\left(1 + \dfrac{1}{x}\right)^6 (1 + x^2)^7 (1 - x^3)^8; x \neq 0$ is α, then $|\alpha|$ equals ____.

27. Let $P = \{z \in C : |z + 2 - 3i| \leq 1\}$ and $Q = \{z \in C : z(1 + i) + \bar{z}(1 - i) \leq -8\}$. Let in $P \cap Q$, $|z - 3 + 2i|$ be maximum and minimum at z_1 and z_2 respectively. If $|z_1|^2 + 2|z_2|^2 = \alpha + \beta\sqrt{2}$, where α, β integers, then $\alpha + \beta$ equals _____.

28. The number of elements in the set $S = \{(x, y, z) : x, y, z \in Z, x + 2y + 3z = 42, x, y, z \geq 0\}$ equals _____.

29. If $x = x(t)$ is the solution of the differential equation $(t + 1)dx = (2x + (t + 1)^4)dt, x(0) = 2$, then, $x(1)$ equals _____.

30. Let $\{x\}$ denote the fractional part of x and $f(x) = \dfrac{\cos^{-1}(1 - \{x\}^2)\sin^{-1}(1 - \{x\})}{\{x\} - \{x\}^3}$, $x \neq 0$. If L and R respectively denotes the left hand limit and the right hand limit of $f(x)$ at $x = 0$, then $\dfrac{32}{\pi^2}(L^2 + R^2)$ is equal to_____.

| SUBJECT II : PHYSICS		MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

31. A galvanometer has a resistance of $50\,\Omega$ and it allows maximum current of 5 *mA*. It can be converted into voltmeter to measure upto 100 *V* by connecting in series a resistor of resistance:

(1) $5975\,\Omega$　　(2) $20050\,\Omega$　　(3) $19500\,\Omega$　　(4) $19950\,\Omega$

32. In the given circuit if the power rating of Zener diode is 10 *mW*, the value of series resistance R_s to regulate the input unregulated supply is:
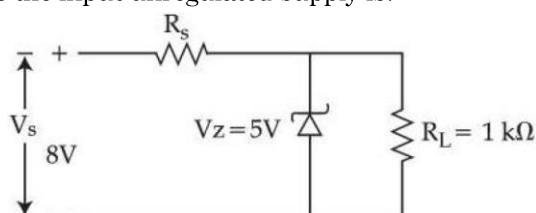
(1) $10\,k\Omega$　　(2) $1\,k\Omega$　　(3) $10\,\Omega$　　(4) $5\,k\Omega$

33. In series LCR circuit, the capacitance is changed from C to $4C$. To keep the resonance frequency unchanged, the new inductance should be:

(1) reduced by $\dfrac{1}{4}L$　　　　　　(2) reduced by $\dfrac{3}{4}L$

(3) increased to $4\,L$　　　　　　(4) increased by $2\,L$

34. The dimensional formula of angular impulse is:

(1) $[ML^{-2}T^{-1}]$　　(2) $[ML^{2}T^{-2}]$　　(3) $[ML^{2}T^{-1}]$　　(4) $[MLT^{-1}]$

35. If R is the radius of the earth and the acceleration due to gravity on the surface of earth is $g = \pi^2\,m/s^2$, then the length of the second's pendulums at a height $h = 2R$ from the surface of earth will be:

(1) $\dfrac{4}{9}m$　　(2) $\dfrac{2}{9}m$　　(3) $\dfrac{1}{9}m$　　(4) $\dfrac{8}{9}m$

36. The de-Broglie wavelengths of a proton and an α particle are λ and 2λ respectively. The ratio of the velocities of proton and α particle will be:

(1) $8:1$　　(2) $4:1$　　(3) $1:2$　　(4) $1:8$

37. Consider a block and trolley system as shown in figure. If the coefficient of kinetic friction between the trolley and the surface is 0.04, the acceleration of the system in ms^{2-} is: (Consider that the string is massless and unstretchable and the pulley is also massless and frictionless):
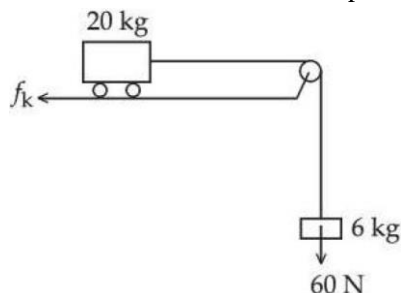
(1) 3　　(2) 1.2　　(3) 4　　(4) 2

38. A ball of mass 0.5 *kg* is attached to a string of length 50 *cm*. The ball is rotated on a horizontal circular path about its vertical axis. The maximum tension that the string can bear is 400 *N*. The maximum possible value of angular velocity of the ball in *rad/s* is:

    (1)   1000   **(2)**   1600   **(3)**   40   **(4)**   20

39. Two moles a monoatomic gas is mixed with six moles of diatomic gas. The molar specific heat of the mixture at constant volume is:

    (1) $\dfrac{7}{4}R$ **(2)** $\dfrac{9}{4}R$ **(3)** $\dfrac{3}{2}R$ **(4)** $\dfrac{5}{2}R$

40. A parallel plate capacitor has a capacitance $C = 200\,pF$. It is connected to 230 *V* ac supply with an angular frequency 300 *rad/s*. The rms value of conduction current in the circuit and displacement current in the capacitor respectively are:

    (1) $1.38\,\mu A$ and $1.38\,\mu A$ **(2)** $13.8\,\mu A$ and $138\,\mu A$

    (3) $14.3\,\mu A$ and $143\,\mu A$ **(4)** $13.8\,\mu A$ and $13.8\,\mu A$

41. The minimum energy required by a hydrogen atom in ground state to emit radiation in Balmer series is nearly:

    (1)   13.6 *eV*   **(2)**   1.9 *eV*   **(3)**   12.1 *eV*   **(4)**   1.5 *eV*

42. The pressure and volume of an ideal gas are related as $PV^{3/2} = K$ (constant). The work done when the gas is taken from state $A(P_1, V_1, T_1)$ to state $B(P_2, V_2, T_2)$ is:

    (1) $2(P_2\sqrt{V_2} - P_1\sqrt{V_1})$ **(2)** $2(P_1 V_1 - P_2 V_2)$

    (3) $2(P_2 V_2 - P_1 V_1)$ **(4)** $2(\sqrt{P_1}V_1 - \sqrt{P_2}V_2)$

43. The radius (*r*), length (*l*) and resistance (*R*) of a metal wire was measured in the laboratory as

$r = (0.35 \pm 0.05)\,cm$

$R = (100 \pm 10)\,ohm$

$l = (15 \pm 0.2)\,cm$

The percentage error in resistivity of the material of the wire is:

    (1)   35.6%   **(2)**   37.3%   **(3)**   39.9%   **(4)**   25.6%

44. A particle moving in a circle of radius R with uniform speed takes time T to complete one revolution. If this particle is projected with the same speed at an angle θ to the horizontal, the maximum height attained by it is equal to $4R$. The angle of projection θ is then given by:

    (1) $\sin^{-1}\left[\dfrac{\pi^2 R}{2gT^2}\right]^{1/2}$ **(2)** $\sin^{-1}\left[\dfrac{2gT^2}{\pi^2 R}\right]^{1/2}$

    (3) $\cos^{-1}\left[\dfrac{2gT^2}{\pi^2 R}\right]^{1/2}$ **(4)** $\cos^{-1}\left[\dfrac{\pi R}{2gT^2}\right]^{1/2}$

45. A monochlromatic light of wavelength 6000 Å is incident on the single slit of width 0.01 *mm*. If the diffraction pattern is formed at the focus of the convex lens of focal length 20 *cm*, the linear width of the central maximum is:

    (1)   120 *mm*   **(2)**   12 *mm*   **(3)**   60 *mm*   **(4)**   24 *mm*

46. 10 divisions on the main scale of a vernier calliper coincide with 11 divisions on the Vernier scale. If each division on the main scale is of 5 units, the least count of the instrument is:

    (1) $\dfrac{5}{11}$ **(2)** $\dfrac{10}{11}$ **(3)** $\dfrac{1}{2}$ **(4)** $\dfrac{50}{11}$

47. With rise in temperature, the Young's modulus of elasticity:

(1) increases

(2) changes erratically

(3) decreases

(4) remains unchanged

48. A simple pendulum of length 1 m has a wooden bob of mass 1 kg. It is struck by a bullet of mass $10^{-2}\,kg$ moving with a speed of $2 \times 10^2\,ms^{-1}$. The bullet gets embedded into the bob. The height to which the bob rises before swinging back is: [Use : $g = 10m/s^2$]

(1) 0.30 m **(2)** 0.40 m **(3)** 0.20 m **(4)** 0.35 m

49. The reading in the ideal voltmeter (*V*) shown in the given circuit diagram is:
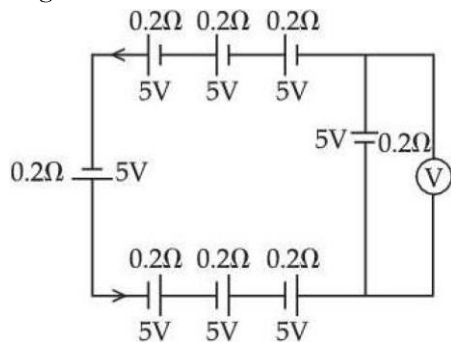
(1) 0 V **(2)** 3 V **(3)** 5 V **(4)** 10 V

50. Two identical capacitors have same capacitance *C*. One of them is charged to the potential *V* and other to the potential 2 *V.* The negative ends of both are connected together. When the positive ends are also joined together, the decrease in energy of the combined system is:

(1) $\dfrac{3}{4}CV^2$ **(2)** $\dfrac{1}{4}CV^2$ **(3)** $\dfrac{1}{2}CV^2$ **(4)** $2\,CV^2$

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**.

51. A particle is moving in one dimension (along x axis) under the action of a variable force. It's initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as $x = -3t^2 + 18t^2 + 16t$, where x is in m and t is in s. The velocity of the particle when its acceleration becomes zero is _____ m/s.

52. A tuning fork resonates with a sonometer wire of length 1 m stretched with tension of 6 N. When the tension in the wire is changed to 54 N, the same tuning fork produces 12 beats per second with it. The frequency of the tuning fork is _____ Hz.

53. A plane is in level flight at constant speed and each of its two wings has an area of $40\,m^2$. If the speed of the air is 180 km/h over the lower wing surface and 252 km/h over the upper wing surface, the mass of the plane is _____ kg. [Take air density to be $1\,kg\,m^{-3}$ and $g = 10\,ms^{-2}$]

54. A regular polygon of 6 sides is formed by bending a wire of length 4π meter. If an electric current of $4\pi\sqrt{3}\,A$ is flowing through the sides of the polygon, the magnetic field at the centre of the polygon would be $x \times 10^{-7}\,T$. The value of x is _____.

55. The current in a conductor is expressed as $I = 3t^2 + 4t^3$, where I is in Ampere and t is in second. The amount of electric charge that flows through a section of the conductor during $t = 1s$ to $t = 2s$ is _____ C.

56. The distance between object and its 3 times magnified virtual image as produced by a convex lens is 20 cm. The focal length of the lens used is _____ cm.

57. The identical spheres each of mass 2 M are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 4 m each. Taking point of intersection of these two sides as origin, the magnitude of position vector of the centre of mass of the system is $\dfrac{4\sqrt{2}}{x}$, where the value of x is_____.

58. A rectangular loop of sides 12 cm and 5 cm, with its sides parallel to the x-axis and y-axis respectively, moves with a velocity of 5 cm/s in the positive x axis direction, in a space containing a variable magnetic field in the positive z direction. The field has a gradient of $10^{-3}\,T/cm$ along the negative x direction and it is decreasing with time at the rate of $10^{-3}\,T/s$. If the resistance of the loop is $6\,m\Omega$, the power dissipated by the loop as heat is _____ $\times 10^{-9}\,W$.

59. The radius of a nucleus of mass number 64 is 4.8 fermi. Then the mass number of another nucleus having radius of 4 fermi is $\dfrac{1000}{x}$, where x is _____.

60. Two identical charged spheres are suspended by strings of equal lengths. The string make an angle θ with each other. When suspended in water the angle remains the same. If density of the material of the sphere is 1.5 g/cc, the dielectric constant of water will be _____. [Take density of water = 1 g/cc]

SUBJECT III : CHEMISTRY	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

61. Which of the following compound will most easily be attacked by an electrophile?

(1) [benzene with OH]   (2) [benzene with Cl]   (3) [benzene with CH_3]   (4) [benzene]
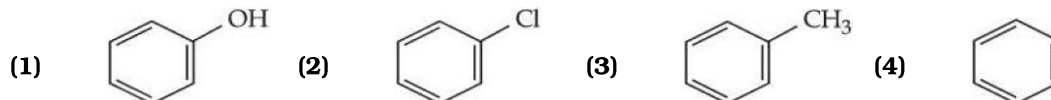
62. In case of isoelectronic species the size of F^-, Ne and Na^+ is affected by:

  (1) None of the factors because their size is the same

  (2) Electron-electron interaction in the outer orbitals

  (3) Principal quantum number (n)

  (4) Nuclear charge (z)

63. Which of the following reactions are disproportionation reactions?

  (A) $Cu^+ \rightarrow Cu^{2+} + Cu$

  (B) $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

  (C) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$

  (D) $2MnO_4^- + 3Mn^{2+} + 2H_2O \rightarrow 5MnO_2 + 4H^+$

  Choose the correct answer from the options given below:

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

64. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentration 0.1 M, 0.01 M, 0.001 M, respectively. The value of van't Hoff factor (i) for these solutions will be in the order:

  (1) $i_A < i_C < i_B$ **(2)** $i_A < i_B < i_C$ **(3)** $i_A > i_B > i_C$ **(4)** $i_A = i_B = i_C$

65. Match List-I with List-II.

	List-I (Reactions)		List-II (Reagents)
(A)	$CH_3(CH_2)_5 - \underset{\underset{O}{\|\|}}{C} - OC_2H_5 \rightarrow CH_3(CH_2)_5CHO$	**(I)**	CH_3MgBr, H_2O
(B)	$C_6H_5COC_6H_5 \rightarrow C_6H_5CH_2C_6H_5$	**(II)**	$Zn(Hg)$ and conc. HCl
(C)	$C_6H_5CHO \rightarrow C_6H_5CH(OH)CH_3$	**(III)**	$NaBH_4, H^+$
(D)	$CH_3COCH_2COOC_2H_5 \rightarrow CH_3\underset{\underset{H}{\|}}{C}(OH)CH_2COOC_2H_5$	**(IV)**	$DIBAL - H, H_2O$

Choose the **correct** answer from the options given below:

  (1) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)   **(2)** (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

  (3) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)   **(4)** (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

66. Ionic reactions with organic compounds proceed through:

  (A) homolytic bond cleavage   **(B)** heterolytic bond cleavage

  (C) free radical formation   **(D)** primary free radical

  (E) secondary free radical

  Choose the **correct** answer from the options given below:

  (1) (D) and (E) only   **(2)** (A) only

  (3) (C) only   **(4)** (B) only

67. In acidic medium, $K_2Cr_2O_7$ shows oxidising action as represented in the half reaction:

$$Cr_2O_7^{2-} + XH^+ + Ye^{\ominus} \rightarrow 2A + ZH_2O$$
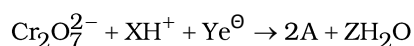
X, Y, Z and A respectively are:

(1) 8, 6, 4 and Cr_2O_3

(2) 8, 4, 6 and Cr_2O_3

(3) 14, 6, 7 and Cr^{3+}

(4) 14, 7, 6 and Cr^{3+}

68. Choose the correct option for free expansion of an ideal gas under adiabatic condition from the following:

(1) q = 0, ΔT < 0, w ≠ 0

(2) q = 0, ΔT = 0, w = 0

(3) q = 0, ΔT ≠ 0, w = 0

(4) q ≠ 0, ΔT = 0, w = 0

69. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : Haloalkanes react with KCN to form alkyl cyanides as a main product while with AgCN form isocyanide as the main product.

Reason (R) : KCN and AgCN both are highly ionic compounds.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

(2) **(A)** is not correct **(R)** is correct

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

(4) **(A)** is correct **(R)** is not correct

70. Given below are two statements:

Statement (I) : A solution of $[Ni(H_2O)_6]^{2+}$ is green in colour.

Statement (II) : A solution of $[Ni(CN)_4]^{2-}$ is colourless.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **Statement I** and **Statement II** are correct

(2) Both **Statement I** and **Statement II** are incorrect

(3) **Statement I** is correct but **Statement II** is incorrect

(4) **Statement I** is incorrect but **Statement II** is correct

71. Given below are two statements:

Statement (I) : Potassium hydrogen phthalate is primary standard for standardisation of sodium hydroxide solution.

Statement (II) : In this titration phenolphthalein can be used as indicator.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **Statement I** and **Statement II** are incorrect

(2) **Statement I** is incorrect but **Statement II** is correct

(3) **Statement I** is correct but **Statement II** is incorrect

(4) Both **Statement I** and **Statement II** are correct

72. Given below are two statements:

Statement (I) : The NH_2 group in aniline is ortho and para directing and powerful activating group.

Statement (II) : Aniline does not undergo Friedel-Craft's reaction (alkylation and acylation).

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **Statement I** and **Statement II** are correct

(2) **Statement I** is incorrect but **Statement II** is correct

(3) **Statement I** is correct but **Statement II** is incorrect

(4) Both **Statement I** and **Statement II** are incorrect

73. Which of the following complex is homoleptic?

(1) $[Fe(NH_3)_4Cl_2]^+$ **(2)** $[Ni(CN)_4]^{2-}$

(3) $[Co(NH_3)_4Cl_2]^+$ **(4)** $[Ni(NH_3)_2Cl_2]$

74. Given below are two statements:

Statement (I) : Aminobenzene and aniline are same organic compounds.

Statement (II) : Aminobenzene and aniline are different organic compounds.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) **Statement I** is correct but **Statement II** is incorrect

(2) Both **Statement I** and **Statement II** are incorrect

(3) **Statement I** is incorrect but **Statement II** is correct

(4) Both **Statement I** and **Statement II** are correct

75. Given below are two statements : one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : PH_3 has lower boiling point the NH_3.

Reason (R) : In liquid state NH_3 molecules are associated through vander Waal's forces, but PH_3 molecules are associated through hydrogen bonding.

In the light of the above statements, choose the **most appropriate** answer from the options given below:

(1) Both **(A)** and **(R)** are correct and **(R)** is the correct explanation of **(A)**

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

(3) **(A)** is correct **(R)** is not correct

(4) **(A)** is not correct **(R)** is correct

76. In Kjeldahl's method for estimation of nitrogen, $CuSO_4$ acts as:

(1) reducing agent   **(2)** hydrolysis agent

(3) catalytic agent   **(4)** oxidizing agent

77. If one strand of a DNA has the sequence ATGCTTCA, sequence of the bases in complementary stand is:

(1) GTACTTAC   **(2)** TACGAAGT   **(3)** CATTAGCT   **(4)** ATGCGACT

78. Identify A and B in the following sequence of reaction:
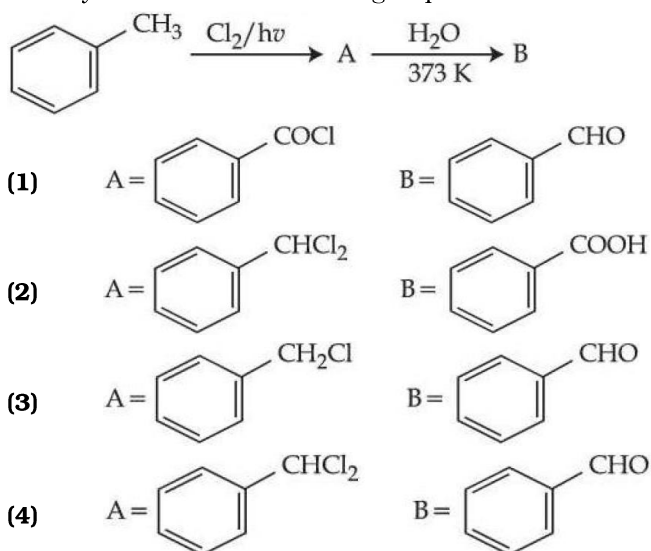
79. Arrange the bonds in order of increasing ionic character in the molecules
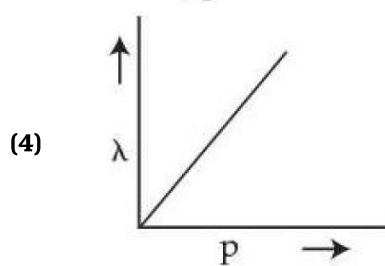
LiF, K_2O, N_2, SO_2 and ClF_3
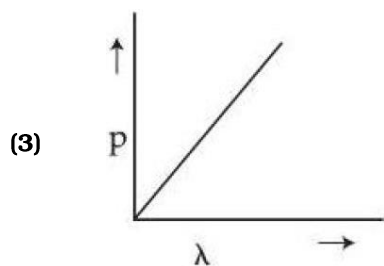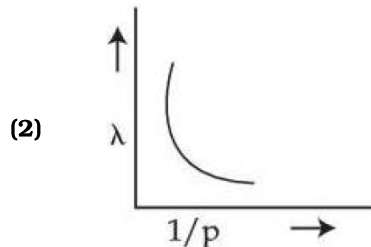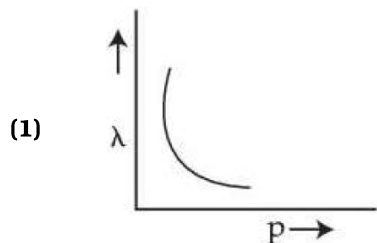
(1) $N_2 < SO_2 < ClF_3 < K_2O < LiF$

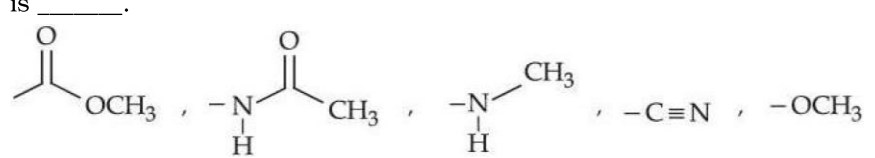(2) $LiF < K_2O < ClF_3 < SO_2 < N_2$

(3) $N_2 < ClF_3 < SO_2 < K_2O < LiF$

(4) $ClF_3 < N_2 < SO_2 < K_2O < LiF$

80. According to the wave-particle duality of matter by de-Broglie, which of the following graph plot presents most appropriate relationship between wavelength of electron (λ) and momentum of electron (p)?

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**.

81. The number of molecules/ion/s having trigonal bipyramidal shape is _____.

PF_5, BrF_5, PCl_5, $[PtCl_4]^{2-}$, BF_3, $Fe(CO)_5$

82. Number of optical isomers for 2-chlorobutane _____.

83. Consider the following reaction:

$3PbCl_2 + 2(NH_4)_3PO_4 \rightarrow Pb_3(PO_4)_2 + 6NH_4Cl$

If 72 mmol of $PbCl_2$ is mixed with 50 mmol of $(NH_4)_3PO_4$, then the amount of $Pb_3(PO_4)_2$ formed is _____ mmol. (Nearest integer)

84. Among the following oxides of p-block elements, number of oxides having amphoteric nature is _____.

Cl_2O_7, CO, PbO_2, N_2O, NO, Al_2O_3, SiO_2, N_2O_5, SnO_2

85. The potential for the given half cell at 298 K is (–) _____ $\times 10^{-2}$ V.

$2H^+(aq) + 2e^- \rightarrow H_2(g)$

$[H^+] = 1M$, $P_{H_2} = 2$ atm

[Given : 2.303 RT/F = 0.06 V, log 2 = 0.3]

86. The lowest oxidation number of an atom in a compound A_2B is –2. The number of electrons in its valence shell is _____.

87. The ratio of $\dfrac{^{14}C}{^{12}C}$ in a piece of word is $\dfrac{1}{8}$ part that of atmosphere. If half life of ^{14}C is 5730 years, the age of wood sample is _____ years.

88. Total number of deactivating groups in aromatic electrophilic substitution reaction among the following is _____.

89. The number of white coloured salts, among the following is _____.

(a)	$SrSO_4$	**(b)**	$Mg(NH_4)PO_4$	**(c)**	$BaCrO_4$	**(d)**	$Mn(OH)_2$
(e)	$PbSO_4$	**(f)**	$PbCrO_4$	**(g)**	AgBr	**(h)**	PbI_2
(i)	CaC_2O_4	**(j)**	$[Fe(OH)_2(CH_3COO)]$				

90. K_a for CH_3COOH is 1.8×10^{-5} and K_b for NH_4OH is 1.8×10^{-5}. The pH of ammonium acetate solution will be _____.