

JEE Main 2023 25 Jan Shift 1 Question Paper with Solutions

Time Allowed :180 minutes	Maximum Marks :300	Total questions :90
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
 - (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
 - (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer.

Mathematics

Section-A

1. Let M be the maximum value of the product of two positive integers when their sum is 66. Let the sample space $S = \{x \in \mathbb{Z} : (66 - x)x \geq \frac{5}{9}M\}$ and the event $A = \{x \in S : x \text{ is a multiple of } 3\}$. Then $P(A)$ is equal to:

1. $\frac{15}{44}$
 2. $\frac{1}{3}$
 3. $\frac{7}{22}$
 4. $\frac{1}{2}$
-

2. Let $\vec{a}, \vec{b}, \vec{c}$ be three non-zero vectors such that $\vec{b} \cdot \vec{c} = 0$ and $\vec{a} \times \vec{b} = \frac{\vec{b} - \vec{c}}{2}$. If $\vec{d}$ is a vector such that $\vec{b} \cdot \vec{d} = \vec{a} \cdot \vec{b}$, then $(\vec{a} \times \vec{b}) \cdot (\vec{c} \times \vec{d})$ is equal to:

1. 1
 2. $\frac{1}{4}$
 3. 2
 4. $\frac{1}{2}$
-

3. Let $y = y(x)$ be the solution curve of the differential equation

$$\frac{dy}{dx} = \frac{y}{x}(1 + xy^2(1 + \log x)), \quad x > 0, y(1) = 3.$$

Then $\frac{y^2(x)}{9}$ is equal to:

1. $\frac{x^2}{5 - 2x^3(2 + \log x^3)}$

$$2. \frac{x^2}{2x^3(2+\log x^3)-3}$$

$$3. \frac{x^2}{3x^3(1+\log x^2)-2}$$

$$4. \frac{x^2}{7-3x^3(2+\log x^2)}$$

4. The value of

$$\lim_{n \rightarrow \infty} \frac{1 + 2 - 3 + 4 + 5 - 6 + \dots + (3n - 2) + (3n - 1) - 3n}{\sqrt{2n^4 + 4n + 3} - \sqrt{n^4 + 5n + 4}}$$

is:

$$1. \frac{\sqrt{2}+1}{2}$$

$$2. 3(\sqrt{2} + 1)$$

$$3. \frac{3}{2}(\sqrt{2} + 1)$$

$$4. \frac{3}{2}\sqrt{2}$$

5. The points of intersection of the line $ax + by = 0$, ($a \neq b$) and the circle $x^2 + y^2 - 2x = 0$ are $A(\alpha, 0)$ and $B(1, \beta)$. The image of the circle with AB as a diameter in the line $x + y + 2 = 0$ is:

$$1. x^2 + y^2 + 5x + 5y + 12 = 0$$

$$2. x^2 + y^2 + 3x + 5y + 8 = 0$$

$$3. x^2 + y^2 + 3x + 3y + 4 = 0$$

$$4. x^2 + y^2 - 5x - 5y + 12 = 0$$

6. The mean and variance of the marks obtained by the students in a test are 10 and 4 respectively. Later, the marks of one of the students is increased from 8 to 12. If the new mean of the marks is 10.2, then their new variance is equal to:

1. 4.04
 2. 4.08
 3. 3.96
 4. 3.92
-

7. Let

$$y(x) = (1+x)(1+x^2)(1+x^4)(1+x^8)(1+x^{16}).$$

Then $y' - y''$ at $x = -1$ is equal to:

1. 976
 2. 464
 3. 496
 4. 944
-

8. The vector $\vec{a} = -\hat{i} + 2\hat{j} + \hat{k}$ is rotated through a right angle, passing through the y-axis in its way, and the resulting vector is $\vec{b}$. Then the projection of $3\vec{a} + \sqrt{2}\vec{b}$ on $\vec{c} = 5\hat{i} + 4\hat{j} + 3\hat{k}$ is:

1. $3\sqrt{2}$

- 2. 1
 - 3. $\sqrt{6}$
 - 4. $2\sqrt{3}$
-

9. The minimum value of the function

$$f(x) = \int_0^2 e^{|k-t|} dt$$

is:

- 1. $2(e - 1)$
 - 2. $2e - 1$
 - 3. 2
 - 4. $e(e - 1)$
-

10. Consider the lines L_1 and L_2 given by

$$L_1 : \frac{x-1}{2} = \frac{y-3}{2} = \frac{z-2}{2}, \quad L_2 : \frac{x-2}{1} = \frac{y-2}{2} = \frac{z-3}{3}.$$

A line L_3 having direction ratios $1, -1, -2$ intersects L_1 and L_2 at the points P and Q respectively. Then the length of line segment PQ is:

- 1. $2\sqrt{6}$
- 2. $3\sqrt{2}$
- 3. $4\sqrt{3}$
- 4. 4

11. Let $x = 2$ be a local minima of the function

$$f(x) = 2x^4 - 18x^2 + 8x + 12, \quad x \in (-4, 4).$$

If M is the local maximum value of the function $f(x)$ in $(-4, 4)$, then M is:

1. $12\sqrt{6} - \frac{33}{2}$
 2. $12\sqrt{6} - \frac{31}{2}$
 3. $18\sqrt{6} - \frac{33}{2}$
 4. $18\sqrt{6} - \frac{31}{2}$
-

12. Let $z_1 = 2 + 3i$ and $z_2 = 3 + 4i$. The set

$$S = \{z \in \mathbb{C} : |z - z_1|^2 - |z - z_2|^2 = |z_1 - z_2|^2\}$$

represents a:

1. straight line with sum of its intercepts on the coordinate axes 14
 2. hyperbola with the length of the transverse axis 7
 3. straight line with the sum of its intercepts on the coordinate axes equals -18
 4. hyperbola with eccentricity 2
-

13. The distance of the point $(6, -2\sqrt{2})$ from the common tangent $y = mx + c$, $m > 0$, of the curves $x = 2y^2$ and $x = 1 + y^2$ is:

1. $\frac{1}{3}$

2. 5
 3. $\frac{14}{3}$
 4. $5\sqrt{3}$
-

14. Let S_1 and S_2 be respectively the sets of all $a \in \mathbb{R} - \{0\}$ for which the system of linear equations:

$$\begin{aligned}ax + 2ay - 3az &= 1, \\(2a + 1)x + (2a + 3)y + (a + 1)z &= 2, \\(3a + 5)x + (a + 5)y + (a + 2)z &= 3,\end{aligned}$$

has unique solution and infinitely many solutions. Then:

1. $n(S_1) = 2$ and S_2 is an infinite set
 2. S_1 is an infinite set and $n(S_2) = 2$
 3. $S_1 = \emptyset$ and $S_2 = \mathbb{R} - \{0\}$
 4. $S_1 = \mathbb{R} - \{0\}$ and $S_2 = \emptyset$
-

15. Let $f(x) = \int \frac{2x}{x^2+1}(x^2 + 3) dx$. If $f(3) = \frac{1}{2}(\log_e 5 - \log_e 6)$, then $f(4)$ is equal to:

1. $\frac{1}{2}(\log_e 17 - \log_e 19)$
2. $\log_e 17 - \log_e 18$
3. $\frac{1}{2}(\log_e 19 - \log_e 17)$
4. $\log_e 19 - \log_e 17$

16. The statement $(p \wedge (\sim q)) \Rightarrow (p \Rightarrow (\sim q))$ is:

1. Equivalent to $(\sim p) \vee (\sim q)$
 2. A tautology
 3. Equivalent to $p \vee q$
 4. A contradiction
-

17. Let $f : (0, 1) \rightarrow \mathbb{R}$ be a function defined by

$$f(x) = \frac{1}{1 - e^{-x}},$$

and

$$g(x) = (f(-x) - f(x)).$$

Consider two statements:

- (I) g is an increasing function in $(0, 1)$,
- (II) g is one-one in $(0, 1)$.

Then:

1. Only (I) is true
 2. Only (II) is true
 3. Neither (I) nor (II) is true
 4. Both (I) and (II) are true
-

18. The distance of the point $P(4, 6, -2)$ from the line passing through the point $(-3, 2, 3)$ and parallel to a line with direction ratios $3, 3, -1$ is equal to:

1. 3
 2. $\sqrt{6}$
 3. $2\sqrt{3}$
 4. $\sqrt{14}$
-

19. Let $x, y, z > 1$ and

$$A = \begin{bmatrix} 1 & \log_x y & \log_x z \\ \log_y x & 2 & \log_y z \\ \log_z x & \log_z y & 3 \end{bmatrix}.$$

Then $\text{adj}(\text{adj} A^2)$ is equal to:

1. 6^4
 2. 2^8
 3. 4^8
 4. 2^4
-

20. If a_r is the coefficient of x^{10-r} in the binomial expansion of $(1+x)^{10}$, then

$$\sum_{r=1}^{10} r^3 \left(\frac{a_r}{a_{r-1}} \right)^2 \text{ is equal to:}$$

1. 4895
 2. 1210
 3. 5445
 4. 3025
-

Section B

21: Number of Non-Empty Subsets with Sum Divisible by 3

Problem: Let $S = \{1, 2, 3, 5, 7, 10, 11\}$. The number of non-empty subsets of S such that the sum of their elements is divisible by 3 is ...

22. For some $a, b, c \in \mathbb{N}$, let $f(x) = ax - 3$ and $g(x) = x^b + c$, $x \in \mathbb{R}$. If $(f \circ g)^{-1}(x) = \left(\frac{x-7}{2}\right)^{1/3}$, then $(f \circ g)(ac) + (g \circ f)(b)$ is equal to ...

23. The vertices of a hyperbola H are $(\pm 6, 0)$ and its eccentricity is $\frac{\sqrt{5}}{2}$. Let N be the normal to H at a point in the first quadrant and parallel to the line $\sqrt{2}x + y = 2\sqrt{2}$. If d is the length of the line segment of N between H and the y-axis, then d^2 is equal to ...

24. Let $S = \left\{ \alpha : \log_2(9^{2\alpha-4} + 13) - \log_2\left(\frac{5}{2} \cdot 3^{2\alpha-4} + 1\right) = 2 \right\}$. Then the maximum value of β for which the equation

$$x^2 - 2 \left(\sum_{\alpha \in S} \alpha \right) x + \sum_{\alpha \in S} (\alpha + 1)^2 \beta = 0$$

has real roots, is ...

25. The constant term in the expansion of $\left(2x + \frac{1}{x^7} + 3x^2\right)^5$ is ...

26. Let A_1, A_2, A_3 be the three A.P. with the same common difference d and having their first terms as $A, A + 1, A + 2$, respectively. Let a, b, c be the 7th, 9th, and 17th terms of A_1, A_2, A_3 , respectively, such that

$$\begin{vmatrix} a & 7 & 1 \\ 2b & 17 & 1 \\ c & 17 & 1 \end{vmatrix} + 70 = 0.$$

If $a = 29$, then the sum of the first 20 terms of an AP whose first term is $c - a - b$ and common difference is $\frac{d}{12}$, is equal to ...

27. If the sum of all the solutions of

$$\tan^{-1} \left(\frac{2x}{1-x^2} \right) + \cot^{-1} \left(\frac{1-x^2}{2x} \right) = \frac{\pi}{3},$$

where $-1 < x < 1, x \neq 0$, is $\alpha - \frac{4}{\sqrt{3}}$, then α is equal to ...

28. Let the equation of the plane passing through the line

$$x - 2y - z - 5 = 0 \quad \text{and} \quad x + y + 3z - 5 = 0,$$

and parallel to the line

$$x + y + 2z - 7 = 0 \quad \text{and} \quad 2x + 3y + z - 2 = 0,$$

be $ax + by + cz = 65$. Then the distance of the point (a, b, c) from the plane $2x + 2y - z + 16 = 0$ is ...

29. Let x and y be distinct integers where $1 \leq x \leq 25$ and $1 \leq y \leq 25$. Then, the number of ways of choosing x and y , such that $x + y$ is divisible by 5, is ...

30. It the area enclosed by the parabolas $P_1 : 2y = 5x^2$ and $P_2 : x^2 - y + 6 = 0$ is equal to the area enclosed by P_1 and $y = \alpha x, \alpha > 0$, then α^3 is equal to ...

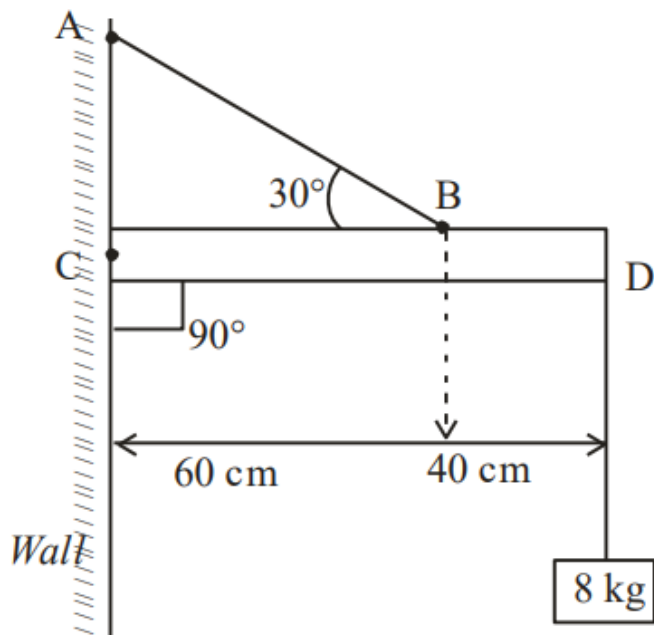
Physics

0.1 Section-A

31. Electron beam used in an electron microscope, when accelerated by a voltage of 20 kV, has a de-Broglie wavelength of λ_0 . If the voltage is increased to 40 kV, then the de-Broglie wavelength associated with the electron beam would be:

1. $3\lambda_0$
 2. $9\lambda_0$
 3. $\frac{\lambda_0}{2}$
 4. $\frac{\lambda_0}{\sqrt{2}}$
-

32. An object of mass 8 kg is hanging from one end of a uniform rod CD of mass 2 kg and length 1 m pivoted at its end C on a vertical wall. It is supported by a cable AB such that the system is in equilibrium. The tension in the cable is:



1. 240 N
2. 90 N
3. 300 N
4. 30 N

33. A Carnot engine with efficiency 50% takes heat from a source at 600 K. In order to increase the efficiency to 70%, keeping the temperature of the sink the same, the new temperature of the source will be:

1. 360 K
2. 1000 K
3. 900 K
4. 300 K

34. T is the time period of a simple pendulum on the Earth's surface. Its time period becomes xT when taken to a height R (equal to Earth's radius) above the Earth's surface. Then, the value of x will be:

1. 4
 2. 2
 3. $\frac{1}{2}$
 4. $\frac{1}{4}$
-

35. Assume that the Earth is a solid sphere of uniform density and a tunnel is dug along its diameter. When a particle is released in this tunnel, it executes a simple harmonic motion. The mass of the particle is 100 g. The time period of the motion of the particle will be (approximately):

1. 24 hours
 2. 1 hour 24 minutes
 3. 1 hour 40 minutes
 4. 12 hours
-

36. A car travels a distance of ' x ' with speed V_1 and then the same distance ' x ' with speed V_2 in the same direction. The average speed of the car is:

1. $\frac{V_1 V_2}{2(V_1 + V_2)}$
2. $\frac{V_1 + V_2}{2}$
3. $\frac{2x}{V_1 + V_2}$

4. $\frac{2V_1V_2}{V_1+V_2}$

37. A parallel plate capacitor has plate area 40 cm^2 and plate separation 2 mm . The space between the plates is filled with a dielectric medium of thickness 1 mm and dielectric constant 5 . The capacitance of the system is:

1. $24\epsilon_0 \text{ F}$
 2. $\frac{3}{10}\epsilon_0 \text{ F}$
 3. $\frac{10}{3}\epsilon_0 \text{ F}$
 4. $10\epsilon_0 \text{ F}$
-

38. The root mean square velocity of molecules of gas is:

1. Proportional to square root of temperature (T^2).
 2. Inversely proportional to square root of temperature ($\frac{1}{\sqrt{T}}$).
 3. Proportional to square root of temperature ($\sqrt{T}$).
 4. Proportional to temperature (T).
-

39. Match List I with List II:

List I	List II
A. Surface tension	I. Kg s^{-2}
B. Pressure	II. $\text{Kg m}^{-1}\text{s}^{-2}$
C. Viscosity	III. $\text{Kg m}^{-1}\text{s}^{-1}$
D. Impulse	IV. Kg m s^{-1}

40. In an LC oscillator, if values of inductance and capacitance become twice and eight times, respectively, then the resonant frequency of oscillator becomes x times its initial resonant frequency ω_0 . The value of x is:

1. $1/4$
 2. 16
 3. $1/16$
 4. 4
-

41. The ratio of the density of oxygen nucleus (^{16}O) and helium nucleus (^4He) is:

1. 4:1
 2. 8:1
 3. 1:1
 4. 2:1
-

42. A message signal of frequency 5 kHz is used to modulate a carrier signal of frequency 2 MHz. The bandwidth for amplitude modulation is:

1. 1 kHz
2. 20 kHz
3. 10 kHz

4. 2.5 kHz

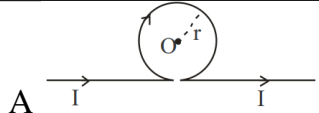
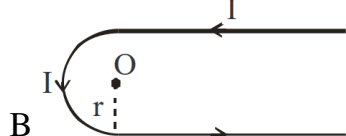
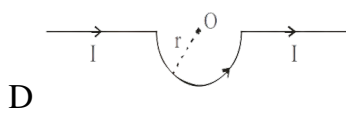
43. An electromagnetic wave is transporting energy in the negative z -direction. At a certain point and certain time, the direction of the electric field of the wave is along the positive y -direction. What will be the direction of the magnetic field at that point and instant?

1. Positive direction of x
 2. Negative direction of x
 3. Negative direction of y
 4. Negative direction of z
-

44. In Young's double-slit experiment, the position of the 5th bright fringe from the central maximum is 5 cm. The distance between slits and screen is 1 m, and the wavelength of used monochromatic light is 600 nm. The distance between the slits is:

1. 48 μm
 2. 12 μm
 3. 36 μm
 4. 46 μm
-

45. Match List I with List II:

List I (Current configuration)	List II (Magnetic field at point O)
 A	$B_0 = \frac{\mu_0 I}{4\pi r} [\pi + 2]$
 B	$B_0 = \frac{\mu_0 I}{4} \frac{1}{r}$
 C	$B_0 = \frac{\mu_0 I}{2\pi r} [\pi - 1]$
 D	$B_0 = \frac{\mu_0 I}{4\pi r} [\pi + 1]$

Choose the correct answer from the option given below:

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

46. Given below are two statements: one is labeled as Assertion A and the other is labeled as Reason R.

- **Assertion A:** Photodiodes are used in forward bias usually for measuring the light intensity.
- **Reason R:** For a p-n junction diode, at applied voltage V the current in the forward bias is more than the current in the reverse bias for $|V_z| > \pm V_0$, where V_0 is the threshold voltage and V_z is the breakdown voltage.

Options:

1. Both A and R are true and R is the correct explanation of A
2. Both A and R are true but R is NOT the correct explanation of A

- 3. A is false but R is true
 - 4. A is true but R is false
-

47. A solenoid of 1200 turns is wound uniformly in a single layer on a glass tube 2 m long and 0.2 m in diameter. The magnetic intensity at the center of the solenoid when a current of 2 A flows through it is:

- 1. $2.4 \times 10^3 \text{ A m}^{-1}$
 - 2. $1.2 \times 10^3 \text{ A m}^{-1}$
 - 3. 1 A m^{-1}
 - 4. $4.2 \times 10^3 \text{ A m}^{-1}$
-

48. A uniform metallic wire carries a current 2 A. When a 3.4 V battery is connected across it, the mass of the wire is $8.92 \times 10^{-3} \text{ kg}$, density is $8.92 \times 10^3 \text{ kg/m}^3$, and resistivity is $1.7 \times 10^{-8} \Omega \text{ m}$. The length of the wire is:

- 1. 6.8 m
 - 2. 10 m
 - 3. 5 m
 - 4. 100 m
-

49. A bowl filled with very hot soup cools from 98°C to 86°C in 2 minutes when the room temperature is 22°C . How long will it take to cool from 75°C to 69°C ?

1. 2 minutes
 2. 1.4 minutes
 3. 3 minutes
 4. 1 minute
-

50. A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40 m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be:

1. 45°
 2. 30°
 3. 53°
 4. 60°
-

51. A ray of light is incident from air on a glass plate having thickness $\sqrt{5}$ cm and refractive index $\sqrt{2}$. The angle of incidence of a ray is equal to the critical angle for glass-air interface. The lateral displacement of the ray when it passes through the plate is $< 10^{-2}$ cm:

(Given $\sin 15^\circ = 0.26$)

1. 0.52 cm
2. 0.45 cm
3. 0.48 cm
4. 0.50 cm

52. In the given circuit, the equivalent resistance between the terminal A and B is ____ Ω .

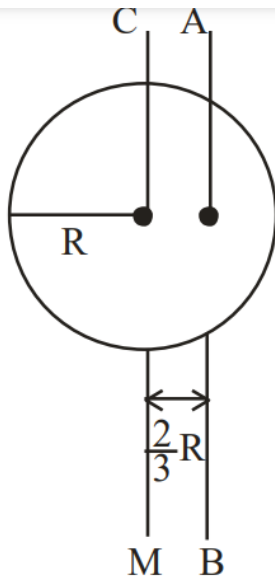
53. As shown in the figure, in an experiment to determine Young's modulus of a wire, the extension-load curve is plotted. The curve is a straight line passing through the origin and makes an angle of 45° with the load axis. The length of the wire is 62.8 cm and its diameter is 4 mm. The Young's modulus is found to be $x \times 10^{10} \text{ Nm}^{-2}$. The value of x is:

54. An object of mass m initially at rest on a smooth horizontal plane starts moving under the action of force $F = 2N$. In the process of its linear motion, the angle θ between the direction of force and horizontal varies as $\theta = kx$, where k is a constant and x is the distance covered by the object from its initial position. The expression of kinetic energy of the object will be $E = \frac{n}{k} \sin \theta$. The value of n is:

55. The wavelength of the radiation emitted is λ_0 when an electron jumps from the second excited state to the first excited state of the hydrogen atom. If the electron jumps from the third excited state to the second orbit of the hydrogen atom, the wavelength of the radiation emitted will be $\frac{20}{x} \lambda_0$. The value of x is:

56. I_{CM} is the moment of inertia of a circular disc about an axis (CM) passing through its center and perpendicular to the plane of the disc. I_{AB} is its moment of inertia about

an axis AB perpendicular to the plane and parallel to axis CM at a distance $\frac{2}{3}R$ from the center, where R is the radius of the disc. The ratio of I_{AB} and I_{CM} is $x : 9$. The value of x is:



57. The distance between two consecutive points with phase difference of 60° in a wave of frequency 500 Hz is 6.0 m. The velocity with which the wave is traveling is ___ km/s:

58. A uniform electric field of 10 N/C is created between two parallel charged plates (as shown in figure). An electron enters the field symmetrically between the plates with a kinetic energy of 5 eV. The length of each plate is 10 cm. The angle (θ) of deviation of the path of the electron as it comes out of the field is ____ (in degrees).

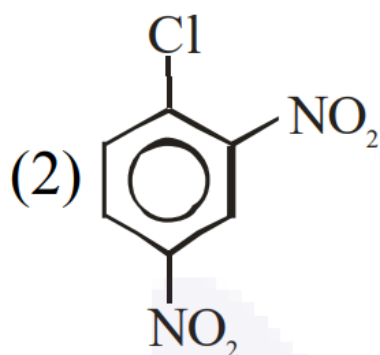
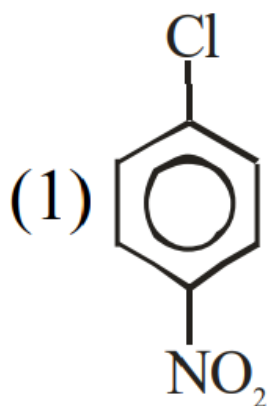
59. An LCR series circuit of capacitance 62.5 nF and resistance of $50\ \Omega$ is connected to an A.C. source of frequency 2.0 kHz. For maximum value of amplitude of current in the circuit, the value of inductance is ____ mH.

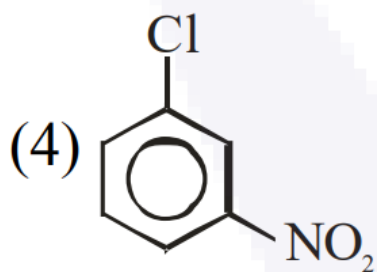
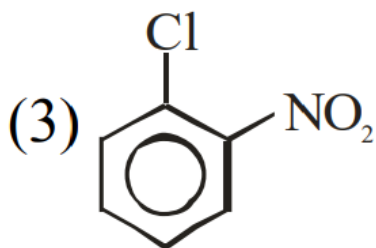
60. If $\vec{P} = 3\hat{i} + \sqrt{3}\hat{j} + 2\hat{k}$ and $\vec{Q} = 4\hat{i} + \sqrt{3}\hat{j} + 2.5\hat{k}$, the unit vector in the direction of $\vec{P} \times \vec{Q}$ is $\frac{1}{x}(\sqrt{3}\hat{i} + \hat{j} - 2\sqrt{3}\hat{k})$. The value of x is:

Chemistry

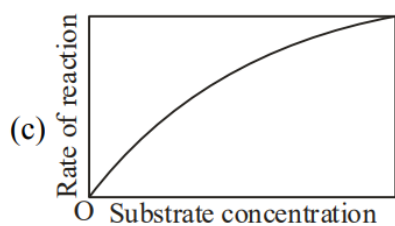
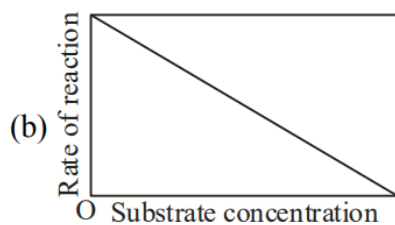
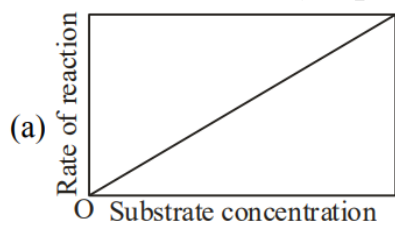
Section-A

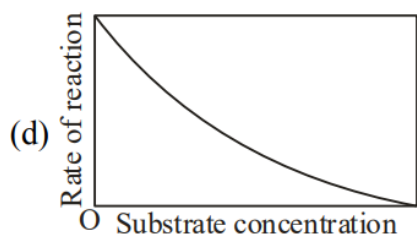
61. The compound which will have the lowest rate towards nucleophilic aromatic substitution on treatment with OH^- is:





62. The variation of the rate of an enzyme-catalyzed reaction with substrate concentration is correctly represented by which graph?

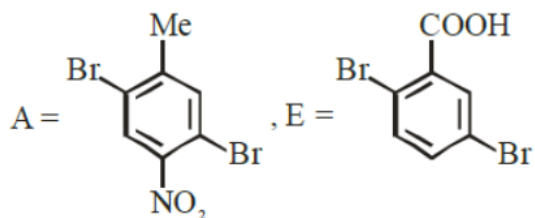
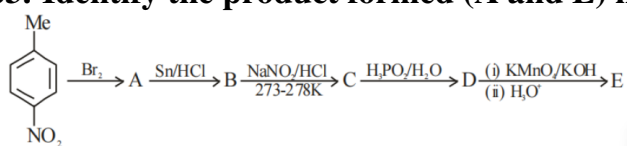




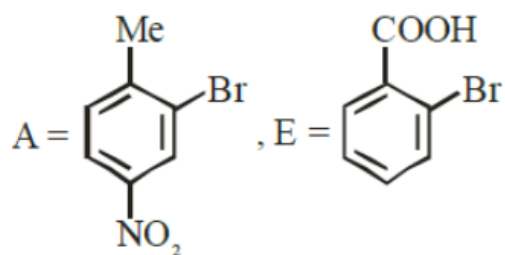
Options:

1. a
 2. b.
 3. c.
 4. d.
-

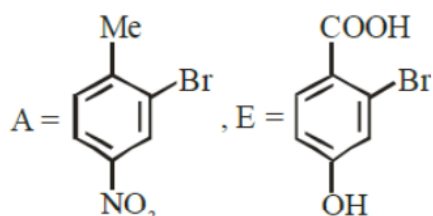
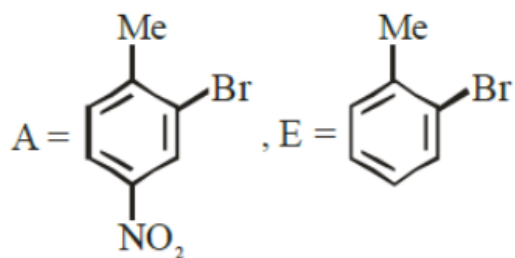
63. Identify the product formed (A and E) in the following reaction sequence:



1.



2.



64. Match List I with List II and choose the correct answer from the options given below:

List I (Elements)	List II (Colour imparted to the flame)
K	Brick Red
Ca	Violet
Sr	Apple Green
Ba	Crimson Red

1. A-II, B-I, C-III, D-IV
2. A-II, B-IV, C-I, D-III
3. A-II, B-I, C-IV, D-III
4. A-IV, B-III, C-II, D-I

65. Reaction of thionyl chloride with white phosphorus forms a compound [A], which on hydrolysis gives [B], a dibasic acid. [A] and [B] are respectively:

1. P_4O_6 and H_3PO_3
2. PCl_3 and H_3PO_3

3. PCl_5 and H_3PO_4

4. POCl_3 and H_3PO_4

66. A cubic solid is made up of two elements X and Y. Atoms of X are present on every alternate corner and one at the center of the cube. Y is at $\frac{1}{4}$ of the total faces. The empirical formula of the compound is:

1. $\text{X}_2\text{Y}_{1.5}$

2. $\text{X}_{2.5}\text{Y}$

3. $\text{XY}_{2.5}$

4. $\text{X}_{1.5}\text{Y}_2$

67. The radius of the 2nd orbit of Li^{2+} is x. The expected radius of the 3rd orbit of Be^{3+} is:

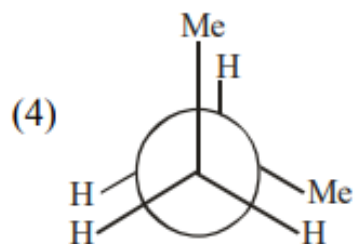
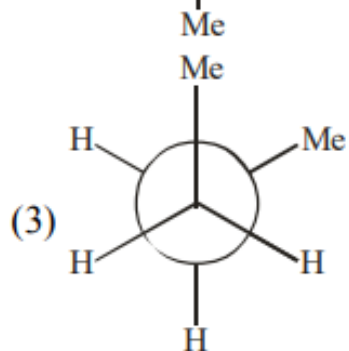
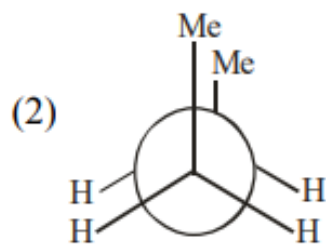
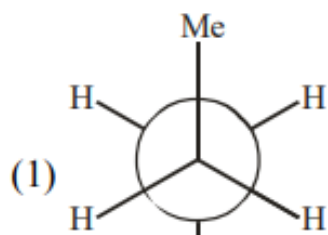
1. $\frac{9}{4}x$

2. $\frac{4}{9}x$

3. $\frac{27}{16}x$

4. $\frac{16}{27}x$

68. Which of the following conformations will be the most stable?



1. (1)

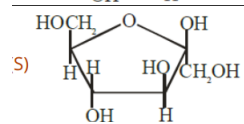
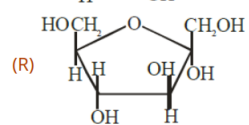
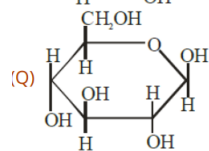
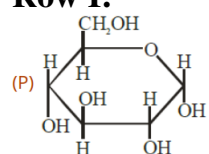
2. (2)

3. (3)

4. (4)

69. Match items of Row I with those of Row II:

Row I:



Row II:

- (i) α -D-(-)-Fructofuranose
- (ii) β -D-(-)-Fructofuranose
- (iii) α -D-(+)-Glucopyranose
- (iv) β -D-(+)-Glucopyranose

Correct Match:

- 1. (1) $P \rightarrow \text{iv}$, $Q \rightarrow \text{iii}$, $R \rightarrow \text{i}$, $S \rightarrow \text{ii}$
 - 2. (2) $P \rightarrow \text{i}$, $Q \rightarrow \text{ii}$, $R \rightarrow \text{iii}$, $S \rightarrow \text{iv}$
 - 3. (3) $P \rightarrow \text{iii}$, $Q \rightarrow \text{iv}$, $R \rightarrow \text{ii}$, $S \rightarrow \text{i}$
 - 4. (4) $P \rightarrow \text{iii}$, $Q \rightarrow \text{iv}$, $R \rightarrow \text{i}$, $S \rightarrow \text{ii}$
-

70. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: Acetal/Ketal is stable in basic medium.

Reason R: The high leaving tendency of alkoxide ion gives the stability to acetal/ketal in basic medium.

In the light of the above statements, choose the correct answer from the options given below:

- 1. Both A and R are true and R is the correct explanation of A
 - 2. Both A and R are true but R is NOT the correct explanation of A
 - 3. A is true but R is false
 - 4. A is false but R is true
-

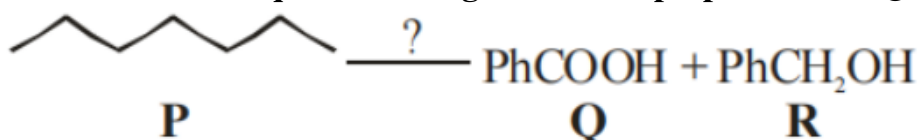
71. Inert gases have positive electron gain enthalpy. Its correct order is:

1. $\text{Xe} < \text{Kr} < \text{Ne} < \text{He}$
 2. $\text{He} < \text{Ne} < \text{Kr} < \text{Xe}$
 3. $\text{He} < \text{Xe} < \text{Kr} < \text{Ne}$
 4. $\text{He} < \text{Kr} < \text{Xe} < \text{Ne}$
-

72. Which one of the following reactions does not occur during the extraction of copper?

1. $2\text{Cu}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$
 2. $2\text{FeS} + 3\text{O}_2 \rightarrow 2\text{FeO} + 2\text{SO}_2$
 3. $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
 4. $\text{FeO} + \text{SiO}_2 \rightarrow \text{FeSiO}_3$
-

73. The correct sequence of reagents for the preparation of Q and R is:



1. (i) CrO_3 , 770 K, 20 atm; (ii) CrO_2Cl_2 , H^+ ; (iii) NaOH ; (iv) H_3O^+
 2. (i) CrO_2Cl_2 , H_3O^+ ; (ii) CrO_3 , 770 K, 20 atm; (iii) NaOH ; (iv) H_3O^+
 3. (i) KMnO_4 , OH^- ; (ii) MoO_3 , Δ ; (iii) NaOH ; (iv) H_3O^+
 4. (i) MoO_3 , Δ ; (ii) CrO_2Cl_2 , H_3O^+ ; (iii) NaOH ; (iv) H_3O^+
-

74. The correct order in aqueous medium of basic strength in case of methyl-substituted amines is:

1. $\text{Me}_2\text{NH} > \text{MeNH}_2 > \text{Me}_3\text{N} > \text{NH}_3$
 2. $\text{Me}_2\text{N} > \text{Me}_3\text{NH} > \text{MeNH}_2 > \text{NH}_3$
 3. $\text{NH}_3 > \text{Me}_3\text{N} > \text{MeNH}_2 > \text{Me}_2\text{NH}$
 4. $\text{Me}_3\text{N} > \text{Me}_2\text{NH} > \text{MeNH}_2 > \text{NH}_3$
-

75. 25-volume hydrogen peroxide means:

1. 1 L marketed solution contains 250 g of H_2O_2
 2. 1 L marketed solution contains 75 g of H_2O_2
 3. 1 L marketed solution contains 25 g of H_2O_2
 4. 1 L marketed solution contains 25 g of H_2O
-

76. Which of the following statements is incorrect for antibiotics?

1. An antibiotic must be a product of metabolism.
2. An antibiotic is a synthetic substance produced as a structural analogue of naturally occurring antibiotic.
3. An antibiotic should promote the survival of microorganisms.
4. An antibiotic should be effective in low concentrations.

77. Compound A reacts with NH_3Cl and forms B and C. Compound B reacts with H_2O and CO_2 to form C. The compounds A, B, and C are:

1. CaCl_2 , NH_3 , NH_4HCO_3
 2. CaCl_2 , NH_4^+ , $(\text{NH}_4)_2\text{CO}_3$
 3. $\text{Ca}(\text{OH})_2$, NH_3 , NH_4HCO_3
 4. $\text{Ca}(\text{OH})_2$, NH_4^+ , $(\text{NH}_4)_2\text{CO}_3$
-

78. Some reactions of NO_2 relevant to photochemical smog formation are:



Identify A, B, X, and Y:

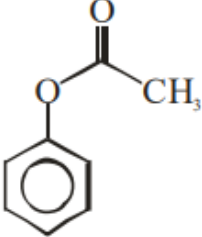
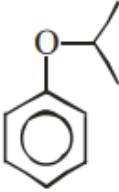
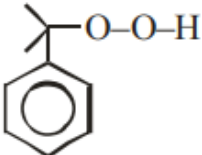
1. $\text{X} = \text{O}$, $\text{Y} = \text{NO}$, $\text{A} = \text{O}_2$, $\text{B} = \text{O}_3$
 2. $\text{X} = \text{N}_2\text{O}$, $\text{Y} = \text{O}$, $\text{A} = \text{O}_3$, $\text{B} = \text{NO}$
 3. $\text{X} = \frac{1}{2} \text{O}_2$, $\text{Y} = \text{NO}_2$, $\text{A} = \text{O}_3$, $\text{B} = \text{O}_2$
 4. $\text{X} = \text{NO}$, $\text{Y} = \text{O}$, $\text{A} = \text{O}_2$, $\text{B} = \text{N}_2\text{O}_3$
-

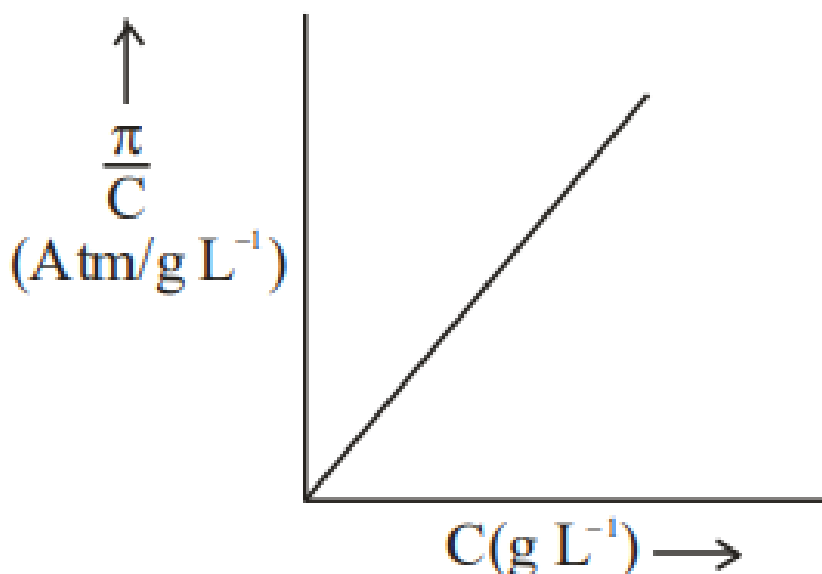
79. Match the List-I with List-II:

Cations (List-I)	Group Reaction (List-II)
P $\rightarrow$ Pb^{2+} , Cu^{2+}	(i) H_2S gas in presence of dilute HCl
Q $\rightarrow$ Al^{3+} , Fe^{3+}	(ii) $(\text{NH}_4)_2\text{CO}_3$ in presence of NH_4OH
R $\rightarrow$ Co^{2+} , Ni^{2+}	(iii) NH_4OH in presence of NH_4Cl
S $\rightarrow$ Ba^{2+} , Ca^{2+}	(iv) H_2S in presence of NH_4OH

- (1) P $\rightarrow$ i, Q $\rightarrow$ iii, R $\rightarrow$ ii, S $\rightarrow$ iv
 (2) P $\rightarrow$ iv, Q $\rightarrow$ ii, R $\rightarrow$ iii, S $\rightarrow$ i
 (3) P $\rightarrow$ iii, Q $\rightarrow$ i, R $\rightarrow$ iv, S $\rightarrow$ ii
 (4) P $\rightarrow$ i, Q $\rightarrow$ iii, R $\rightarrow$ iv, S $\rightarrow$ ii
-

80. In the cumene to phenol preparation in the presence of air, the intermediate is:

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



Section B

81. An athlete is given 100 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) for energy, which is equivalent to 1800 kJ of energy. If 50% of this energy is utilized for activities, the weight of extra water needed to perspire is g. (Nearest integer)

Given: Enthalpy of evaporation of water = 45 kJ/mol; molar masses: C = 12 g/mol, H = 1 g/mol, O = 16 g/mol.

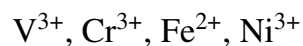
82. A litre of buffer solution contains 0.1 mole of each NH_3 and NH_4Cl . On addition of 0.02 mole of HCl, the pH of the solution is found to be $\times 10^{-3}$ (Nearest integer).

Given: $\text{pK}_b(\text{NH}_3) = 4.745$; $\log 2 = 0.301$; $\log 3 = 0.477$; $T = 298 \text{ K}$.

83. The osmotic pressure of solutions of PVC in cyclohexanone at 300 K are plotted on the graph. The molar mass of PVC is g mol^{-1} (Nearest integer).

Given: $R = 0.083 \text{ L atm K}^{-1} \text{ mol}^{-1}$

84. How many of the following metal ions have a similar value of spin-only magnetic moment in the gaseous state?



Given: Atomic numbers: V = 23, Cr = 24, Fe = 26, Ni = 28.

85. The density of a monobasic strong acid (Molar mass 24.2 g mol^{-1}) is 1.21 kg L^{-1} . The volume of its solution required for the complete neutralization of 25 mL of 0.24 M NaOH is $\text{-----} \times 10^{-3} \text{ mL}$ (Nearest integer).

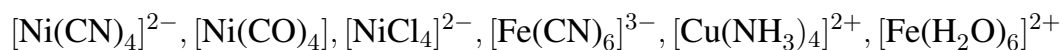
86. For the first-order reaction $A \rightarrow B$, the half-life is 30 min. The time taken for 75% completion of the reaction is ----- min (Nearest integer).

87. The total number of lone pairs of electrons on oxygen atoms of ozone is ----- .

88. In sulphur estimation, 0.471 g of an organic compound gave 1.4439 g of barium sulphate. The percentage of sulphur in the compound is ----- (Nearest Integer).

Given: Atomic masses: Ba = 137, S = 32, O = 16.

89. The number of paramagnetic species from the following is -----.



90. Consider the cell:



Given: $E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^\circ = 0.771 \text{ V}$, $E_{\text{H}^+/\text{H}_2}^\circ = 0 \text{ V}$, $T = 298 \text{ K}$.

If the potential of the cell is 0.712 V , the ratio of concentration of Fe^{2+} to Fe^{3+} is -----
(Nearest integer).
