JEE Mains 4 April 2024 Shift 1 Question Paper

Mathematics Section A

1. Let $f : \mathbb{R} \to \mathbb{R}$ be a function given by:

$$f(x) = \begin{cases} \frac{1-\cos 2x}{x^2}, & x < 0 \\ \frac{\beta\sqrt{1-\cos x}}{x}, & x > 0 \end{cases}$$

If f is continuous at $x = 0$, then $\alpha^2 + \beta^2$ is equal to:

(1) 48

(2) 12

(3) 4

(4) 6

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2. Three urns A, B, and C contain 7 red, 5 black; 5 red, 7 black; and 6 red, 6 black balls, respectively. One of the urns is selected at random, and a ball is drawn from it. If the ball drawn is black, then the probability that it is drawn from urn A is:

(1) $\frac{4}{17}$

(2) $\frac{5}{18}$

(3) $\frac{5}{16}$

(4) $\frac{6}{17}$

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3. The vertices of a triangle are $A(-1, 3)$, $B(-2, 2)$, and $C(3, -1)$. A new triangle is formed by shifting the sides of the triangle by one unit inwards. Then the equation of the side of the new triangle nearest to the origin is:

(1) $x - y - \left(2 + \sqrt{2}\right) = 0$

(2) $-x + y - \left(2 - \sqrt{2}\right) = 0$

(3) $x + y - \left(2 - \sqrt{2}\right) = 0$

(4) $x + y + \left(2 - \sqrt{2}\right) = 0$

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4. If the solution $y = y(x)$ of the differential equation $(x^4 + 2x^3 + 3x^2 + 2x + 2)\,dy = (2x^2 + 2x + 3)\,dx$ satisfies $y(-1) = -\frac{\pi}{4}$, then $y(0)$ is equal to:

(1) $-\frac{\pi}{12}$

(2) 0

(3) $\frac{\pi}{4}$

(4) $\frac{\pi}{2}$

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5. Let the sum of the maximum and the minimum values of the function $f(x) = \frac{2x^2-3x+8}{2x^2+3x+8}$ be $\frac{m}{n}$, where $\gcd(m, n) = 1$. Then $m + n$ is equal to:

(1) 182

(2) 217

(3) 195

(4) 201

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6. One of the points of intersection of the curves $y = 1 + 3x - 2x^2$ and $y = \frac{1}{x}$ is $\left(\frac{1}{2}, 2\right)$. Let the area of the region enclosed by these curves be

$$\frac{1}{24}\left(\ell\sqrt{5} + m\right) - n\ln\left(1 + \sqrt{5}\right),$$

where $\ell, m, n \in \mathbb{N}$. Then $\ell + m + n$ is equal to

1. 32
2. 30
3. 29
4. 31

7. If the system of equations

$$x + \left(\sqrt{2}\sin\alpha\right) y + \left(\sqrt{2}\cos\alpha\right) z = 0$$

$$x + (\cos\alpha)y + (\sin\alpha)z = 0$$

$$x + (\sin\alpha)y - (\cos\alpha)z = 0$$

has a non-trivial solution, then $\alpha \in \left(0, \frac{\pi}{2}\right)$ is equal to:

(1) $\frac{3\pi}{4}$

(2) $\frac{7\pi}{24}$

(3) $\frac{5\pi}{24}$

(4) $\frac{11\pi}{24}$

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8. There are 5 points P_1, P_2, P_3, P_4, P_5 on the side AB, excluding A and B, of a triangle ABC. Similarly, there are 6 points $P_6, P_7, \ldots, P_{11}$ on the side BC and 7 points $P_{12}, P_{13}, \ldots, P_{18}$ on the side CA of the triangle. The number of triangles that can be formed using the points $P_1, P_2, \ldots, P_{18}$ as vertices is:

(1) 776

(2) 751

(3) 796

(4) 771

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9. Let $f(x) = \begin{cases} -x, & -2 \le x < 0 \\ x - 2, & 0 < x \le 2 \end{cases}$ and $h(x) = f(x) + |f(x)|$. Then $\int_{-2}^{2} h(x)\,dx$ is equal to:

(1) 2

(2) 4

(3) 1

(4) 6

10. The sum of all rational terms in the expansion of

$$\left(\frac{1}{2^5}+\frac{1}{5^3}\right)^{15}$$

is equal to:

1. 3133
2. 633
3. 931
4. 6131

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11. Let a unit vector which makes an angle of 60° with $2\mathbf{i}+2\mathbf{j}-\mathbf{k}$ and an angle of 45° with $\mathbf{i}-\mathbf{k}$ be $\vec{C}$. Then $\vec{C}+\left(-\frac{1}{2}\mathbf{i}+\frac{1}{3\sqrt{2}}\mathbf{j}-\frac{\sqrt{2}}{3}\mathbf{k}\right)$ is:

1. $-\frac{\sqrt{2}}{3}\mathbf{i}+\frac{\sqrt{2}}{3}\mathbf{j}+\left(\frac{1}{2}+\frac{2\sqrt{2}}{3}\right)\mathbf{k}$
2. $\frac{\sqrt{2}}{3}\mathbf{i}+\frac{1}{3\sqrt{2}}\mathbf{j}-\frac{1}{2}\mathbf{k}$
3. $\left(\frac{1}{\sqrt{3}}+\frac{1}{2}\right)\mathbf{i}+\left(\frac{1}{\sqrt{3}}-\frac{1}{3\sqrt{2}}\right)\mathbf{j}+\left(\frac{1}{\sqrt{3}}+\frac{\sqrt{2}}{3}\right)\mathbf{k}$
4. $\frac{\sqrt{2}}{3}\mathbf{i}-\frac{1}{2}\mathbf{k}$

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12. Let the first three terms 2, p, and q, with $q \neq 2$, of a G.P. be respectively the 7^{th}, 8^{th}, and 13^{th} terms of an A.P. If the 5^{th} term of the G.P. is the n^{th} term of the A.P., then n is equal to:

(1) 151

(2) 169

(3) 177

(4) 163

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13. Let $a, b \in \mathbb{R}$. Let the mean and the variance of 6 observations $-3, 4, 7, -6, a, b$ be 2 and 23, respectively. The mean deviation about the mean of these 6 observations is:

(1) $\frac{13}{3}$

(2) $\frac{16}{3}$

(3) $\frac{11}{3}$

(4) $\frac{14}{3}$

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14. If 2 and 6 are the roots of the equation $ax^2 + bx + 1 = 0$, then the quadratic equation, whose roots are $\frac{1}{2a+b}$ and $\frac{1}{6a+b}$, is:

(1) $2x^2 + 11x + 12 = 0$

(2) $4x^2 + 14x + 12 = 0$

(3) $x^2 + 10x + 16 = 0$

(4) $x^2 + 8x + 12 = 0$

---

15. Let α and β be the sum and the product of all the non-zero solutions of the equation $(\overline{z})^2 + |z| = 0$, $z \in \mathbb{C}$. Then $4(\alpha^2 + \beta^2)$ is equal to:

1. 6
2. 4
3. 8
4. 2

---

16. Let the point, on the line passing through the points $P(1, -2, 3)$ and $Q(5, -4, 7)$, farther from the origin and at a distance of 9 units from the point P, be (α, β, γ). Then $\alpha^2 + \beta^2 + \gamma^2$ is equal to:

(1) 155

(2) 150

(3) 160

(4) 165

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17. A square is inscribed in the circle $x^2 + y^2 - 10x - 6y + 30 = 0$. One side of this square is parallel to $y = x + 3$. If (x_i, y_i) are the vertices of the square, then $\sum(x_i^2 + y_i^2)$ is equal to:

(1) 148

(2) 156

(3) 160

(4) 152

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18. If the domain of the function $\sin^{-1}\left(\frac{3x-22}{2x-19}\right) + \log_e\left(\frac{3x^2-8x+5}{x^2-3x-10}\right)$ is (α, β), then $3\alpha + 10\beta$ is equal to:

(1) 97

(2) 100

(3) 95

(4) 98

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19. Let $f(x) = x^5 + 2e^{x/4}$ for all $x \in \mathbb{R}$. Consider a function $g(x)$ such that $(g \circ f)(x) = x$ for all $x \in \mathbb{R}$. Then the value of $8g'(2)$ is:

1. 16
2. 4
3. 8
4. 2

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20. Let $\alpha \in (0, \infty)$ **and**

$$A = \begin{bmatrix} 1 & 2 & \alpha \\ 1 & 0 & 1 \\ 0 & 1 & 2 \end{bmatrix}.$$

If $\det(\textbf{adj}(2A - A^T) \cdot \textbf{adj}(A - 2A^T)) = 2^8$**, then** $(\det(A))^2$ **is equal to:**

1. 1
2. 49
3. 16
4. 36

Section B

21. If

$$\lim_{x \to 1} \frac{(5x+1)^{1/3} - (x+5)^{1/3}}{(2x+3)^{1/2} - (x+4)^{1/2}} = \frac{m\sqrt{5}}{n(2n)^{2/3}},$$

where $\gcd(m, n) = 1$**, then** $8m + 12n$ **is equal to:**

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22. In a survey of 220 students of a higher secondary school, it was found that at least 125 and at most 130 students studied Mathematics; at least 85 and at most 95 studied Physics; at least 75 and at most 90 studied Chemistry; 30 studied both Physics and Chemistry; 50 studied both Chemistry and Mathematics; 40 studied both Mathematics and Physics; and 10 studied none of these subjects. Let m **and** n **respectively be the least and the most number of students who studied all the three subjects. Then** $m + n$ **is equal to:**

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23. Let the solution $y = y(x)$ **of the differential equation**

$$\frac{dy}{dx} - y = 1 + 4\sin x$$

satisfy $y(\pi) = 1$**. Then** $y\left(\frac{\pi}{2}\right) + 10$ **is equal to:**

24. If the shortest distance between the lines

$$\frac{x+2}{2}=\frac{y+3}{3}=\frac{z-5}{4} \quad \text{and} \quad \frac{x-3}{1}=\frac{y-2}{-3}=\frac{z+4}{2}$$

is

$$\frac{38}{3\sqrt{5}}k \quad \text{and} \quad \int_0^k [x^2]\,dx = \alpha - \sqrt{\alpha},$$

where $[x]$ denotes the greatest integer function, then $6\alpha^3$ is equal to:

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25. Let A be a square matrix of order 2 such that $|A| = 2$ and the sum of its diagonal elements is -3. If the points (x, y) satisfying

$$A^2 + xA + yI = 0$$

lie on a hyperbola, whose transverse axis is parallel to the x-axis, eccentricity is e and the length of the latus rectum is ℓ, then $e^4 + \ell^4$ is equal to:

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26. Let

$$a = 1 + \frac{2C_2}{3!} + \frac{3C_2}{4!} + \frac{4C_2}{5!} + \ldots,$$

$$b = 1 + \frac{1C_0 + 1C_1}{1!} + \frac{2C_0 + 2C_1 + 2C_2}{2!} + \frac{3C_0 + 3C_1 + 3C_2 + 3C_3}{3!} + \ldots.$$

Then $\frac{2b}{a^2}$ is equal to:

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27. Let A be a 3×3 matrix of non-negative real elements such that

$$A\begin{bmatrix}1\\1\\1\end{bmatrix} = 3\begin{bmatrix}1\\1\\1\end{bmatrix}.$$

Then the maximum value of $\det(A)$ is:

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28. Let the length of the focal chord PQ of the parabola $y^2 = 12x$ be 15 units. If the distance of PQ from the origin is p, then $10p^2$ is equal to:

29. Let ABC be a triangle of area $15\sqrt{2}$ and the vectors

$$\overrightarrow{AB} = \mathbf{i} + 2\mathbf{j} - 7\mathbf{k}, \quad \overrightarrow{BC} = a\mathbf{i} + b\mathbf{j} + c\mathbf{k}, \quad \text{and} \quad \overrightarrow{AC} = 6\mathbf{i} + d\mathbf{j} - 2\mathbf{k}, \quad d > 0.$$

Then the square of the length of the largest side of the triangle ABC is:

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30. If

$$\int_0^{\frac{\pi}{4}} \frac{\sin^2 x}{1 + \sin x \cos x} dx = \frac{1}{a} \log_e \left(\frac{a}{3}\right) + \frac{\pi}{b\sqrt{3}},$$

where $a, b \in \mathbb{N}$, then $a + b$ is equal to:

Physics Section A

31. An electron is projected with uniform velocity along the axis inside a current-carrying long solenoid. Then:

(1) The electron will be accelerated along the axis.

(2) The electron will continue to move with uniform velocity along the axis of the solenoid.

(3) The electron path will be circular about the axis.

(4) The electron will experience a force at 45° to the axis and execute a helical path.

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32. The electric field in an electromagnetic wave is given by

$$\vec{E} = \hat{i}40 \cos\omega \left(t - \frac{z}{c}\right) \text{ NC}^{-1}.$$

The magnetic field induction of this wave is (in SI unit):

1. $\vec{B} = \hat{i}\frac{40}{c} \cos\omega \left(t - \frac{z}{c}\right)$
2. $\vec{B} = \hat{j}40 \cos\omega \left(t - \frac{z}{c}\right)$
3. $\vec{B} = \hat{k}\frac{40}{c} \cos\omega \left(t - \frac{z}{c}\right)$
4. $\vec{B} = \hat{j}\frac{40}{c} \cos\omega \left(t - \frac{z}{c}\right)$

33. Which of the following nuclear fragments corresponding to nuclear fission between neutron $({}^{1}_{0}\text{n})$ and uranium isotope $({}^{235}_{92}\text{U})$ is correct:

(1) ${}^{144}_{56}\text{Ba} + {}^{89}_{36}\text{Kr} + 4\,{}^{1}_{0}\text{n}$

(2) ${}^{140}_{56}\text{Xe} + {}^{94}_{38}\text{Sr} + 3\,{}^{1}_{0}\text{n}$

(3) ${}^{153}_{51}\text{Sb} + {}^{99}_{41}\text{Nb} + 3\,{}^{1}_{0}\text{n}$

(4) ${}^{144}_{56}\text{Ba} + {}^{89}_{36}\text{Kr} + 3\,{}^{1}_{0}\text{n}$

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34. In an experiment to measure focal length (f) of convex lens, the least counts of the measuring scales for the position of object (u) and for the position of image (v) are Δu and Δv, respectively. The error in the measurement of the focal length of the convex lens will be:

(1) $\frac{\Delta u}{u} + \frac{\Delta v}{v}$

(2) $f^2\left[\frac{\Delta u}{u^2} + \frac{\Delta v}{v^2}\right]$

(3) $f^2\left[\frac{\Delta u}{v^2} + \frac{\Delta v}{u^2}\right]$

(4) $f^2\left[\frac{\Delta u}{v} + \frac{\Delta v}{u}\right]$

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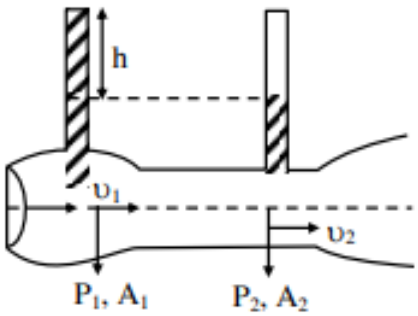
35. Given below are two statements:

Statement I: When speed of liquid is zero everywhere, pressure difference at any two points depends on equation $P_1 - P_2 = \rho g(h_2 - h_1)$.

Statement II: In a venturi tube shown, $2gh = v_2^2 - v_1^2$.



In the light of the above statements, choose the most appropriate answer from the op-

tions given below:

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

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

(3) Both Statement I and Statement II are incorrect.

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

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36. The resistances of the platinum wire of a platinum resistance thermometer at the ice point and steam point are $8\,\Omega$ and $10\,\Omega$ respectively. After inserting it in a hot bath of temperature 400°C, the resistance of platinum wire is:

(1) $1\,\Omega$

(2) $16\,\Omega$

(3) $8\,\Omega$

(4) $10\,\Omega$

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37. A metal wire of uniform mass density having length L and mass M is bent to form a semicircular arc, and a particle of mass m is placed at the center of the arc. The gravitational force on the particle by the wire is:

(1) $\frac{GMm\pi}{2L^2}$

(2) 0

(3) $\frac{GmM\pi^2}{L^2}$

(4) $\frac{2GMm\pi}{L^2}$

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38. On Celsius scale, the temperature of a body increases by 40°C. The increase in temperature on Fahrenheit scale is:

(1) 70°F

(2) 68°F

(3) 72°F

(4) 75°F

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39. An effective power of a combination of 5 identical convex lenses which are kept in contact along the principal axis is 25 D. Focal length of each of the convex lenses is:

(1) 20 cm

(2) 50 cm

(3) 500 cm

(4) 25 cm

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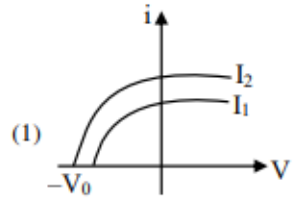
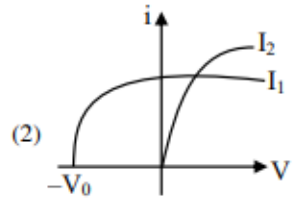
40. Which figure shows the correct variation of applied potential difference V with photoelectric current I at two different intensities of light $(I_1 < I_2)$ of same wavelength:

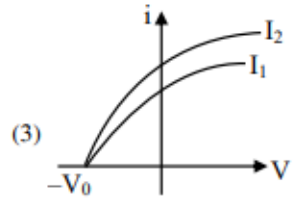
(1)



(2)



(3)



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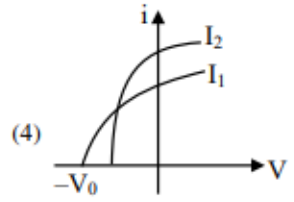
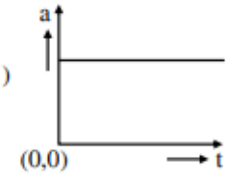
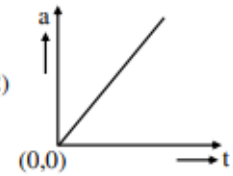
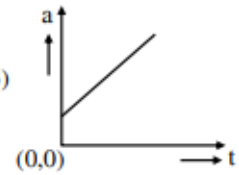
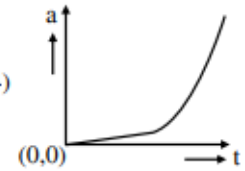


41. A wooden block, initially at rest on the ground, is pushed by a force which increases linearly with time t. Which of the following curves best describes the acceleration of the block with time:

(1) 

(2) 

(3) 

(4) 

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42. If a rubber ball falls from a height h and rebounds up to the height of $h/2$, the percentage loss of total energy of the initial system as well as velocity of the ball before it strikes the ground, respectively, are:

(1) 50%, $\sqrt{\frac{gh}{2}}$

(2) 50%, $\sqrt{gh}$

(3) 40%, $\sqrt{2gh}$

(4) 50%, $\sqrt{2gh}$

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43. The equation of a stationary wave is:

$$y = 2a \sin\left(\frac{2\pi nt}{\lambda}\right) \cos\left(\frac{2\pi x}{\lambda}\right)$$

Which of the following is NOT correct:

(1) The dimensions of nt is [L]

(2) The dimensions of n is [LT^{-1}]

(3) The dimensions of n/λ is [T]

(4) The dimensions of x is [L]

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44. A body travels 102.5 m in the n^{th} second and 115.0 m in the $(n+2)^{th}$ second. The acceleration is:

(1) $9\ m/s^2$

(2) $6.25\ m/s^2$

(3) $12.5\ m/s^2$

(4) $5\ m/s^2$

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45. To measure the internal resistance of a battery, a potentiometer is used. For $R = 10\,\Omega$, the balance point is observed at $\ell = 500$ cm and for $R = 1\,\Omega$ the balance point is observed at $\ell = 400$ cm. The internal resistance of the battery is approximately:

1. 0.2 Ω
2. 0.4 Ω
3. 0.1 Ω
4. 0.3 Ω

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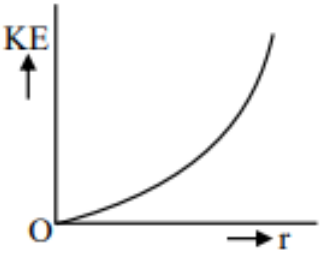
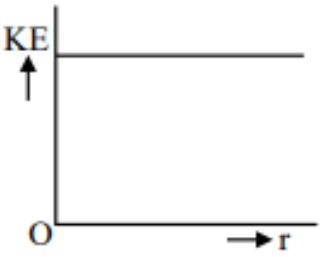
46. An infinitely long positively charged straight thread has a linear charge density $\lambda\ Cm^{-1}$. An electron revolves along a circular path having its axis along the length of the wire. The graph that correctly represents the variation of the kinetic energy of the electron as a function of the radius of the circular path from the wire is:

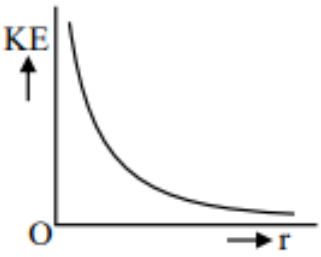
(1)



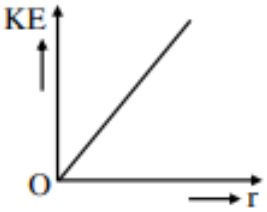
(2)



(3)



(4)



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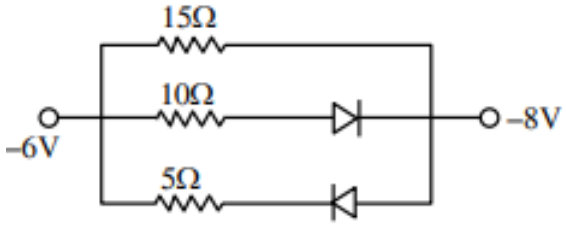
47. The value of net resistance of the network as shown in the given figure is:



(1) $\frac{5}{2}\,\Omega$

(2) $\frac{15}{4}\,\Omega$

(3) $6\,\Omega$

(4) $\frac{30}{11}\,\Omega$

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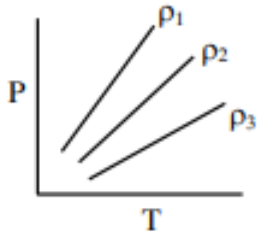
48. P-T diagram of an ideal gas having three different densities ρ_1, ρ_2, ρ_3 (in three different cases) is shown in the figure. Which of the following is correct:



(1) $\rho_2 < \rho_3$

(2) $\rho_1 > \rho_2$

(3) $\rho_1 < \rho_2$

(4) $\rho_1 = \rho_2 = \rho_3$

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49. The coordinates of a particle moving in the x-y plane are given by:

$$x = 2 + 4t, \quad y = 3t + 8t^2.$$

The motion of the particle is:

(1) Non-uniformly accelerated.

(2) Uniformly accelerated having motion along a straight line.

(3) Uniform motion along a straight line.

(4) Uniformly accelerated having motion along a parabolic path.

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50. In an AC circuit, the instantaneous current is zero, when the instantaneous voltage is maximum. In this case, the source may be connected to:

A. Pure inductor.

B. Pure capacitor.

C. Pure resistor.

D. Combination of an inductor and capacitor.

Choose the correct answer from the options given below:

(1) A, B, and C only

(2) B, C, and D only

(3) A and B only

(4) A, B, and D only

Section B

51. An infinite plane sheet of charge having uniform surface charge density $+\sigma$ C/m^2 is placed on the x-y plane. Another infinitely long line charge having uniform linear charge density $+\lambda_e$ C/m is placed at $z = 4$ m plane and parallel to the y-axis. If the magnitude values $|\sigma| = 2|\lambda_e|$ then at point $(0, 0, 2)$, the ratio of magnitudes of electric field values due to sheet charge to that of line charge is $\pi\sqrt{n} : 1$. The value of n is _____ .

---

52. A hydrogen atom changes its state from $n = 3$ to $n = 2$. Due to recoil, the percentage change in the wavelength of emitted light is approximately 1×10^{-n}. The value of n is:

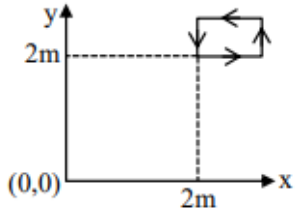
Given: $Rhc = 13.6$ eV, $hc = 1242$ eV nm, $h = 6.6 \times 10^{-34}$ J s, mass of the hydrogen atom $= 1.6 \times 10^{-27}$ kg.

---

53. The magnetic field existing in a region is given by

$$\vec{B} = 0.2(1 + 2x)\hat{k}\,\text{T}.$$

A square loop of edge 50 cm carrying 0.5 A current is placed in the x-y plane with its edges parallel to the x- and y-axes, as shown in the figure. The magnitude of the net magnetic force experienced by the loop is _____ mN.



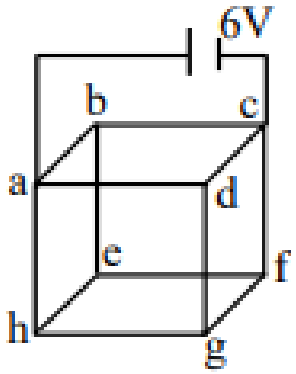
54. An alternating current at any instant is given by

$$i = \left(6 + \sqrt{56}\sin\left(100\pi t + \frac{\pi}{3}\right)\right) \text{ A}.$$

The rms value of the current is _____ A.

---

55. Twelve wires each having resistance $2\,\Omega$ are joined to form a cube. A battery of 6 V emf is joined across point a and c. The voltage difference between e and f is _____ V.



---

56. A soap bubble is blown to a diameter of 7 cm. 36960 erg of work is done in blowing it further. If the surface tension of the soap solution is 40 dyne/cm, the new radius is _____ cm. Take $\pi = \frac{22}{7}$.

---

57. Two wavelengths λ_1 and λ_2 are used in Young's double slit experiment. $\lambda_1 = 450$ nm and $\lambda_2 = 650$ nm. The minimum order of fringe produced by λ_2 which overlaps with the fringe produced by λ_1 is n. The value of n is _____.

---

58. An elastic spring under tension of 3 N has a length a. Its length is under tension 2 N

is b. For its length $(3a - 2b)$, the value of tension will be _____ N.

---

59. Two forces $\vec{F}_1$ and $\vec{F}_2$ are acting on a body. One force has magnitude three times that of the other force, and the resultant of the two forces is equal to the force of larger magnitude. The angle between $\vec{F}_1$ and $\vec{F}_2$ is $\cos^{-1}\left(-\frac{1}{n}\right)$. The value of $|n|$ is _____.

---

60. A solid sphere and a hollow cylinder roll up without slipping on the same inclined plane with the same initial speed v. The sphere and the cylinder reach up to maximum heights h_1 and h_2, respectively, above the initial level. The ratio $h_1 : h_2$ is $\frac{n}{10}$. The value of n is _____.

Chemistry Section A

61. What pressure (bar) of H_2 would be required to make the emf of the hydrogen electrode zero in pure water at $25°$C?

(1) 10^{-14}

(2) 10^{-7}

(3) 1

(4) 0.5

---

62. The correct sequence of ligands in the order of decreasing field strength is:

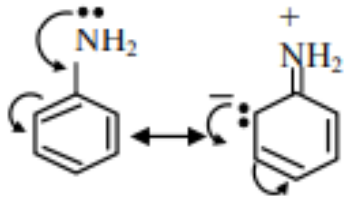
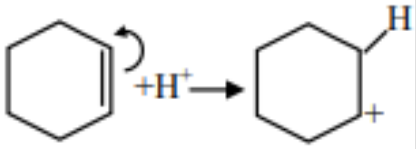
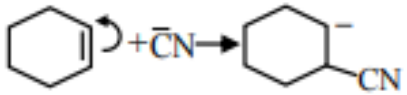
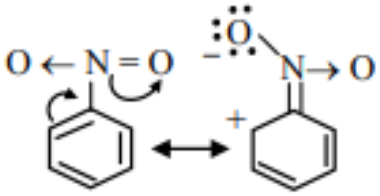
(1) $CO > H_2O > F^- > S^{2-}$

(2) $OH^- > F^- > NH_3 > CN^-$

(3) $NCS^- > EDTA^{4-} > CN^- > CO$

(4) $S^{2-} > OH^- > EDTA^{4-} > CO$

63. Match List - I with List - II:

List - I Mechanism steps		List - II Effect	
(A)		(I)	– E effect
(B)		(II)	– R effect
(C)		(III)	+ E effect
(D)		(IV)	+ R effect

Choose the correct answer from the options given below:

(1) (A) – (IV), (B) – (III), (C) – (I), (D) – (II)

(2) (A) – (III), (B) – (I), (C) – (II), (D) – (IV)

(3) (A) – (II), (B) – (IV), (C) – (III), (D) – (I)

(4) (A) – (I), (B) – (II), (C) – (IV), (D) – (III)

64. What will be the decreasing order of basic strength of the following conjugate bases?

OH^-, RO^-, CH_3COO^-, Cl^-

(1) $Cl^- > OH^- > RO^- > CH_3COO^-$

(2) $RO^- > OH^- > CH_3COO^- > Cl^-$

(3) $OH^- > RO^- > CH_3COO^- > Cl^-$

(4) $Cl^- > RO^- > OH^- > CH_3COO^-$

---

65. In the precipitation of the iron group (III) in qualitative analysis, ammonium chloride is added before adding ammonium hydroxide to:

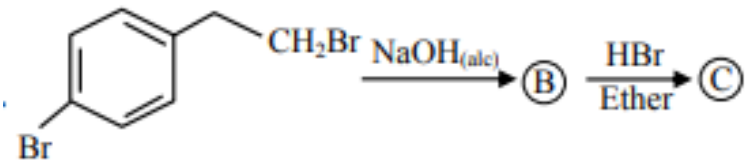
(1) Prevent interference by phosphate ions

(2) Decrease concentration of OH^- ions

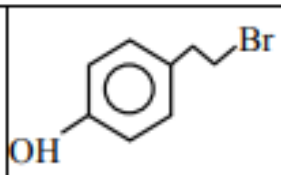
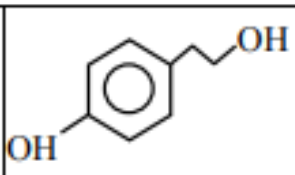
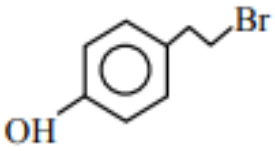
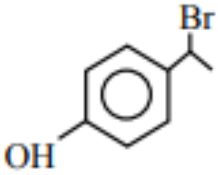
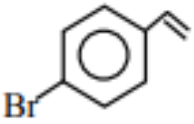
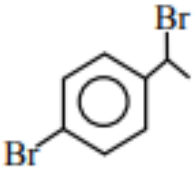
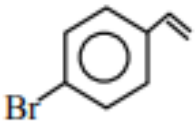
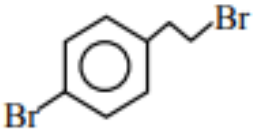
(3) Increase concentration of Cl^- ions

(4) Increase concentration of NH_4^+ ions

66.



Identify B and C and how are A and C related?

	(B)	(C)	
(1)			functional group isomers
(2)			Derivative
(3)			position isomers
(4)			chain isomers

---

67. One of the commonly used electrodes is the calomel electrode. Under which of the following categories does the calomel electrode come?

(1) Metal – Insoluble Salt – Anion electrodes

(2) Oxidation – Reduction electrodes

(3) Gas – Ion electrodes

(4) Metal ion – Metal electrodes

---

68. Number of complexes from the following with even number of unpaired d-electrons is _____ .

$[V(H_2O)_6]^{3+}$, $[Cr(H_2O)_6]^{2+}$, $[Fe(H_2O)_6]^{3+}$, $[Ni(H_2O)_6]^{3+}$, $[Cu(H_2O)_6]^{2+}$

[Given atomic numbers: V = 23, Cr = 24, Fe = 26, Ni = 28, Cu = 29]

(1) 2

(2) 4

(3) 5

(4) 1

---

69. Which one of the following molecules has maximum dipole moment?

(1) NF_3

(2) CH_4

(3) NH_3

(4) PF_5

---

70. Number of molecules/ions from the following in which the central atom is involved in sp^3 hybridization is _____ .

$$NO_3^-,\ BCl_3,\ ClO_2^-,\ ClO_3^-$$

(1) 2

(2) 4

(3) 3

(4) 1

---

71. Which among the following is incorrect statement?

(1) Electromeric effect dominates over inductive effect

(2) The electromeric effect is a temporary effect

(3) The organic compound shows electromeric effect in the presence of the reagent only

(4) Hydrogen ion (H^+) shows negative electromeric effect

72. Given below are two statements:

Statement I: Acidity of α-hydrogens of aldehydes and ketones is responsible for Aldol reaction.

Statement II: Reaction between benzaldehyde and ethanol will **NOT** give Cross – Aldol product.

In the light of 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 incorrect but Statement II is correct.

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

---

73. Which of the following nitrogen-containing compounds does not give Lassaigne's test?

(1) Phenyl hydrazine

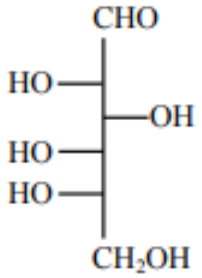
(2) Glycine

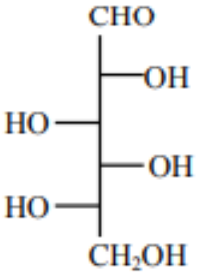
(3) Urea

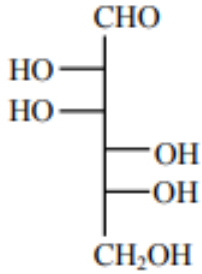
(4) Hydrazine

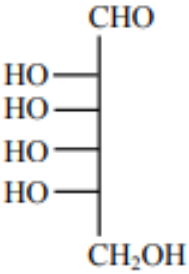
---

74. Which of the following is the correct structure of L-Glucose?

(1) 

(2) 

(3) 

(4) 

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75. The element which shows only one oxidation state other than its elemental form is:

(1) Cobalt

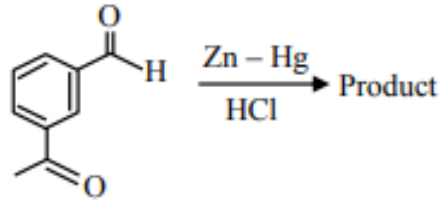
(2) Scandium

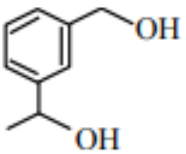
(3) Titanium

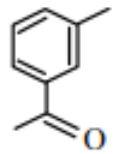
(4) Nickel

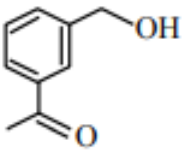
---

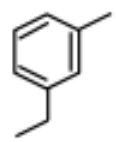
76. Identify the product in the following reaction:



(1) 

(2) 

(3) 

(4) 

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77. Number of elements from the following that CANNOT form compounds with valencies which match with their respective group valencies is _____ .

B, C, N, S, O, F, P, Al, Si

(1) 7

(2) 5

(3) 6

(4) 3

---

78. The Molarity (M) of an aqueous solution containing 5.85 g of NaCl in 500 mL water is:

(Given: Molar Mass of Na = 23 and Cl = 35.5 g mol^{-1})

(1) 20

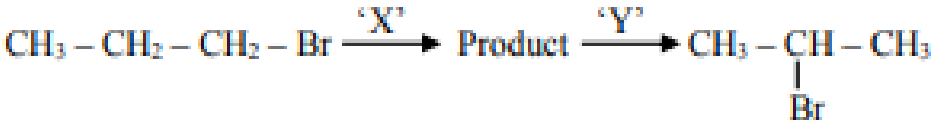
(2) 0.2

(3) 2

(4) 4

---

79. Identify the correct set of reagents or reaction conditions 'X' and 'Y' in the following set of transformation.



(1) X = conc. alc. NaOH, 80°C, Y = $Br_2/CHCl_3$

(2) X = dil. aq. NaOH, 20°C, Y = HBr/acetic acid

(3) X = conc. alc. NaOH, 80°C, Y = HBr/acetic acid

(4) X = dil. aq. NaOH, 20°C, Y = $Br_2/CHCl_3$

---

80. The correct order of first ionization enthalpy values of the following elements is:

(A) O

(B) N

(C) Be

(D) F

(E) B

Choose the correct answer from the options given below:

1) B < D < C < E < A

2) E < C < A < B < D

3) C < E < A < B < D

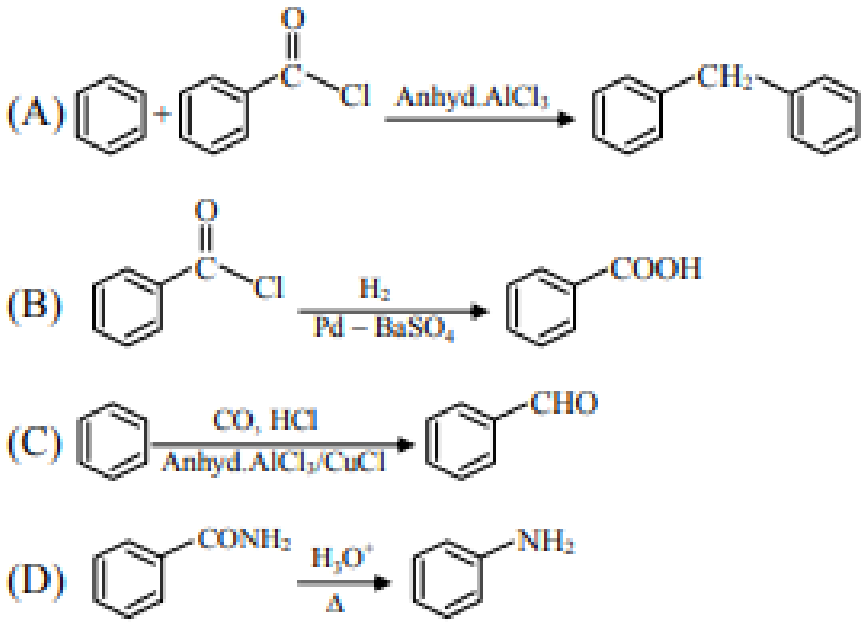
4) A < B < D < C < E

Section B

81. The enthalpy of formation of ethane (C_2H_6) from ethylene by addition of hydrogen where the bond energies of C–H, C–C, H–H are 414 kJ, 347 kJ, 615 kJ, and 435 kJ respectively is: _____ kJ.

---

82. The number of correct reaction(s) among the following is _____ .



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83. X g of ethylamine is subjected to reaction with $NaNO_2$/HCl followed by water; evolved dinitrogen gas which occupied 2.24 L volume at STP. X is _____ $\times 10^{-1}$ g.

---

84. The de-Broglie's wavelength of an electron in the 4th orbit is _____ πa_0. (a_0 = Bohr's radius)

---

85. Only 2 mL of $KMnO_4$ solution of unknown molarity is required to reach the end point of a titration of 20 mL of oxalic acid (2 M) in acidic medium. The molarity of $KMnO_4$ solution should be _____ M.

---

86. Consider the following reaction

$$MnO_2 + KOH + O_2 \rightarrow A + H_2O.$$

Product 'A' in neutral or acidic medium disproportionates to give products 'B' and 'C' along with water. The sum of spin-only magnetic moment values of B and C is _____ BM. (nearest integer)

(Given atomic number of Mn is 25)

---

87. Consider the following transformation involving first-order elementary reaction in each step at constant temperature as shown below.

$$A + B \underset{\text{Step 3}}{\overset{\text{Step 1}}{\rightleftharpoons}} C \xrightarrow{\text{Step 2}} P$$

Some details of the above reaction are listed below.

Step	Rate constant (sec^{-1})	Activation energy (kJ mol^{-1})
1	k_1	300
2	k_2	200
3	k_3	E_{a3}

If the overall rate constant of the above transformation (K) is given as $K = \frac{k_1 k_2}{k_3}$ and the overall activation energy (E_a) is 400 kJ mol^{-1}, then the value of E_{a3} is _____ kJ mol^{-1} (nearest integer).

---

88. 2.5 g of a non-volatile, non-electrolyte is dissolved in 100 g of water at 25°C. The solution showed a boiling point elevation by 2°C. Assuming the solute concentration is negligible with respect to the solvent concentration, the vapour pressure of the resulting aqueous solution is _____ mm of Hg (nearest integer).

(Given: Molal boiling point elevation constant of water (K_b) = 0.52 K kg mol^{-1}, 1 atm pressure = 760 mm of Hg, molar mass of water = 18 g mol^{-1})

---

89. The number of different chain isomers for C_7H_{16} is _____ .

---

90. Number of molecules/species from the following having one unpaired electron is ---------- .

$$O_2, \quad O_2^+, \quad NO, \quad CN^-, \quad O_2^{2-}$$
