JEE Mains 30 January 2024 Shift 2 Question Paper

Mathematics Section A

1. Consider the system of linear equations

$x + y + z = 5, \quad x + 2y + 2z = 9, \quad x + 3y + \lambda z = \mu$**,where** $\lambda, \mu \in \mathbb{R}$**. Then, which of the following statements is NOT correct?**

(1) System has infinite number of solutions if $\lambda = 1$ and $\mu = 13$

(2) System is inconsistent if $\lambda = 1$ and $\mu \neq 13$

(3) System is consistent if $\lambda \neq 1$ and $\mu = 13$

(4) System has unique solution if $\lambda = 1$ and $\mu \neq 13$

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2. For $\alpha, \beta \in \left(0, \frac{\pi}{2}\right)$**, let** $3\sin(\alpha + \beta) = 2\sin(\alpha - \beta)$**, and a real number** k **be such that** $\tan\alpha = k\tan\beta$**. Then the value of** k **is equal to:**

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

(2) -5

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

(4) 5

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3. Let $A(10, 0)$ **and** $B(0, \beta)$ **be the points on the line** $5x + 7y = 50$**.**

Let the point P **divide the line segment** AB **internally in the ratio** $7 : 3$**. Let** $3x - 25 = 0$ **be a directrix of the ellipse** $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ **and the corresponding focus be** S**. If from** S**, the perpendicular on the x-axis passes through** P**, then the length of the latus rectum of** E **is equal to:**

(1) $\frac{25}{3}$

(2) $\frac{32}{9}$

(3) $\frac{25}{9}$

(4) $\frac{32}{5}$

4. Let $\vec{a} = i + \alpha j + \beta k, \alpha, \beta \in \mathbb{R}$. Let a vector $\vec{b}$ be such that the angle between $\vec{a}$ and $\vec{b}$ is $\frac{\pi}{4}$ and $|\vec{b}| = 6$. If $\vec{a} \times \vec{b} = 3\sqrt{2}$, then the value of $(\alpha^2 + \beta^2)|\vec{a} \times \vec{b}|^2$ is equal to:

(1) 90

(2) 75

(3) 95

(4) 85

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5. Let $f(x) = (x + 3)(x - 2)^2(x + 1), x \in [-4, 4]$. If M and m are the maximum and minimum values of f, respectively in [-4, 4], then the value of M - m is:

(1) 600

(2) 392

(3) 608

(4) 108

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6. Let a and b be two distinct positive real numbers. Let the 11th term of a GP, whose first term is a and third term is b, be equal to the p th term of another GP whose first term is a and fifth term is b. Then p is equal to:

(1) 20

(2) 25

(3) 21

(4) 24

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7. If $x^2 - y^2 + 2hxy + 2gx + 2fy + c = 0$ is the locus of a point that moves such that it is always equidistant from the lines$x + 2y + 7 = 0$ and $2x - y + 8 = 0$, then the value of $g + c + h - f$equals:

(1) 14

(2) 6

(3) 8

(4) 29

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8. Let $\vec{a}$ and $\vec{b}$ be two vectors such that $|\vec{b}| = 1$ and $|\vec{b} \times \vec{a}| = 2$. Then $|(\vec{b} \times \vec{a}) - \vec{b}|^2$ is equal to:

(1) 3

(2) 5

(3) 1

(4) 4

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9. Let $y = f(x)$ be a thrice differentiable function in $(-5, 5)$. Let the tangents to the curve $y = f(x)$ at $(1, f(1))$ and $(3, f(3))$ make angles $\frac{\pi}{6}$ and $\frac{\pi}{4}$, respectively, with the positive x-axis. If

$$2\int_{\frac{1}{\sqrt{3}}}^{1} \left((f'(t))^2 + 1\right) f''(t)\, dt = \alpha + \beta\sqrt{3}$$

where α and β are integers, then the value of $\alpha + \beta$ equals:

(1) -14

(2) 26

(3) -16

(4) 36

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10. Let P be a point on the hyperbola H: $\frac{x^2}{9} - \frac{y^2}{4} = 1$, in the first quadrant such that the area of the triangle formed by P and the two foci of H is $\sqrt{13}$. Then, the square of the distance of P from the origin is

(1) 18

(2) 26

(3) 22

(4) 24

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11. Bag A contains 3 white, 7 red balls, and bag B contains 3 white, 2 red balls. One bag is selected at random, and a ball is drawn from it. The probability of drawing the ball from bag A, if the ball drawn is white, is:

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

(2) $\frac{1}{9}$

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

(4) $\frac{3}{10}$

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12. Let $f : \mathbb{R} \to \mathbb{R}$ be defined by $f(x) = ae^{2x} + be^x + c$. If $f(0) = -1$, $f'(\log_e 2) = 21$, and

$$\int_0^{\log_e 4} (f(x) - cx)\, dx = \frac{39}{2},$$

then the value of $|a + b + c|$ equals:

(1) 16

(2) 10

(3) 12

(4) 8

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13. Let $L_1 : \vec{r} = (\hat{i} - \hat{j} + 2\hat{k}) + \lambda(\hat{i} - \hat{j} + 2\hat{k})$, $\lambda \in \mathbb{R}$, $L_2 : \vec{r} = (\hat{j} - \hat{k}) + \mu(3\hat{i} + \hat{j} + p\hat{k})$, $\mu \in \mathbb{R}$, and $L_3 : \vec{r} = \delta(\hat{i} + m\hat{j} - \hat{k})$, $\delta \in \mathbb{R}$ be three lines such that L_1 is perpendicular to L_2, and L_3 is perpendicular to both L_1 and L_2. Then the point which lies on L_3 is:

(1) $(-1, 7, 4)$

(2) $(-1, -7, 4)$

(3) $(1, 7, 4)$

(4) $(1, -7, 4)$

14. Let a and b be real constants such that the function f defined by

$$f(x) = \begin{cases} x^2 + 3x + a, & x \leq 1 \\ bx + 2, & x > 1 \end{cases}$$

is differentiable on $\mathbb{R}$. Then, the value of $\int_{-2}^{2} f(x)\,dx$ equals:

(1) $\frac{15}{6}$

(2) $\frac{19}{6}$

(3) 21

(4) 17

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15. Let $f : \mathbb{R} - \{0\} \to \mathbb{R}$ be a function satisfying

$$f\left(\frac{x}{y}\right) = \frac{f(x)}{f(y)}$$

for all x, y with $f(y) \neq 0$. If $f'(1) = 2024$, then:

(1) $xf'(x) - 2024f(x) = 0$

(2) $xf(x) + 2024f(x) = 0$

(3) $f(x) + xf'(x) = 2024$

(4) $xf(x) - 2023f(x) = 0$

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16. If z is a complex number, then the number of common roots of the equations $z^{1985} + z^{100} + 1 = 0$ and $z^2 + z + 1 = 0$ is:

(1) 1

(2) 2

(3) 0

(4) 3

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17. Suppose $2-p$, p, $2-\alpha$, α are the coefficients of four consecutive terms in the expansion of $(1+x)^n$. Then the value of $p^2-\alpha^2+6\alpha+2p$ equals:

(1) 4

(2) 10

(3) 8

(4) 6

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18. If the domain of the function $f(x)=\log_e\left(\frac{2x+3}{4x^2+x-3}\right)+\cos^{-1}\left(\frac{2x-1}{x+2}\right)$ is $(\alpha,\beta]$, then the value of $5\beta-4\alpha$ is equal to:

(1) 10

(2) 12

(3) 11

(4) 9

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19. Let $f:\mathbb{R}\to\mathbb{R}$ be a function defined by

$$f(x)=\frac{x}{(1+x^4)^{1/4}}$$

and $g(x)=f(f(f(x)))$. Then

$$18\int_{\sqrt[8]{3}}^{\sqrt[4]{3}} x^3 g(x)\,dx$$

equals:

(1) 33

(2) 36

(3) 42

(4) 39

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20. Let $R = \begin{pmatrix} x & 0 & 0 \\ 0 & y & 0 \\ 0 & 0 & z \end{pmatrix}$ be a non-zero 3×3 matrix, where

$$x = \sin\theta, \quad y = \sin\left(\theta + \frac{2\pi}{3}\right), \quad z = \sin\left(\theta + \frac{4\pi}{3}\right)$$

and $\theta \neq 0, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$. For a square matrix M, let trace(M) denote the sum of all the diagonal entri M. Then, among the statements:

1. Trace $(R) = 0$
2. If trace(adj(adj(R))) $= 0$, then R has exactly one non-zero entry.

Which of the following is true?

(1) Both (I) and (II) are true

(2) Neither (I) nor (II) is true

(3) Only (II) is true

(4) Only (I) is true

Section B

21. Let $Y = Y(X)$ be a curve lying in the first quadrant such that the area enclosed by the line

$$Y - y = Y'(x)(X - x)$$

and the coordinate axes, where (x, y) is any point on the curve, is always

$$A = -\frac{y^2}{2Y'(x)} + 1.$$

If $Y(1) = 1$, then $12Y(2)$ equals:

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22. Let a line passing through the point $(-1, 2, 3)$ intersect the lines

$$L_1 : \frac{x-1}{3} = \frac{y-2}{2} = \frac{z+1}{-2}$$

and

$$L_2 : \frac{x+2}{-3} = \frac{y-2}{4} = \frac{z-1}{-2}$$

at points $M(\alpha, \beta, \gamma)$ **and** $N(a, b, c)$**, respectively. Then the value of**

$$\frac{(\alpha+\beta+\gamma)^2}{a+b+c}$$

equals:

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23. Consider two circles $C_1 : x^2+y^2 = 25$ **and** $C_2 : (x-\alpha)^2+y^2 = 16$**, where** $\alpha \in (5, 9)$**. Let the angle between the two radii (one to each circle) drawn from one of the intersection points of** C_1 **and** C_2 **be**

$$\sin^{-1}\left(\frac{\sqrt{63}}{8}\right).$$

If the length of the common chord of C_1 **and** C_2 **is** β**, then the value of** $(\alpha\beta)^2$ **equals** _____ **.**

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24. Let

$$\alpha = \sum_{k=0}^{n} \frac{C_k^n}{k+1} \quad and \quad \beta = \sum_{k=0}^{n} \frac{C_k^n C_{k+1}^n}{k+2}.$$

If $5\alpha = 6$**, then** n **equals** _____ **.**

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25. Let S_n **be the sum of the first n terms of an arithmetic progression 3, 7, 11, ... If**

$$\frac{6}{n(n+1)} \sum_{k=1}^{n} S_k < 42,$$

then n **equals** _____ **.**

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26. In an examination of Mathematics paper, there are 20 questions of equal marks and the question paper is divided into three sections: A, B, and C. A student is required to

attempt total 15 questions taking at least 4 questions from each section. If section A has 8 questions, section B has 6 questions, and section C has 6 questions, then the total number of ways a student can select 15 questions is _____ .

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27. The number of symmetric relations defined on the set $\{1, 2, 3, 4\}$ which are not reflexive is _____.

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28. The number of real solutions of the equation

$$x(x^2 + 3x) + |x - 1| + 6|k - 2| = 0$$

is _____ .

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29. The area of the region enclosed by the parabola $(y-2)^2 = x-1$, the line $x-2y+4 = 0$, and the positive coordinate axes is _____.

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30. The variance σ^2 of the data is _____ .

x_i	0	1	5	6	10	12	17
f_i	3	2	3	2	6	3	3

Physics Section A

31. If 50 Vernier divisions are equal to 49 main scale divisions of a travelling microscope and one smallest reading of the main scale is 0.5 mm, the Vernier constant of the travelling microscope is:

(1) 0.1 mm

(2) 0.1 cm

(3) 0.01 cm

(4) 0.01 mm

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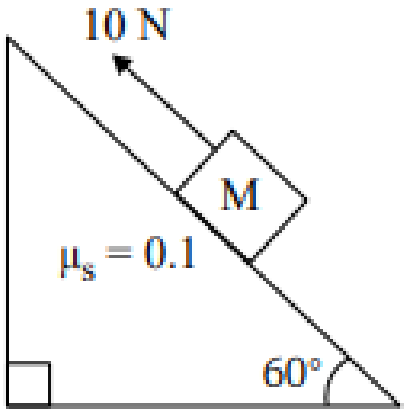
32. A block of mass 1 kg is pushed up a surface inclined to horizontal at an angle of 60° by a force of 10 N parallel to the inclined surface as shown in the figure. When the block is pushed up by 10 m along the inclined surface, the work done against frictional force is:



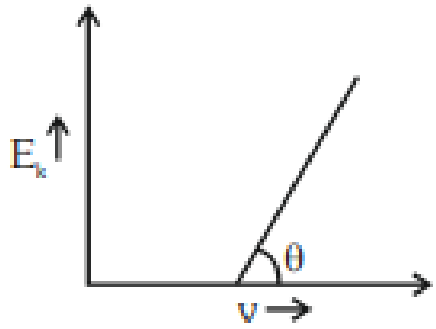
(1) $\sqrt{5}\,J$

(2) $5\,J$

(3) $5 \times 10^3\,J$

(4) $10\,J$

33. For the photoelectric effect, the maximum kinetic energy (E_k) of the photoelectrons is plotted against the frequency (v) of the incident photons as shown in the figure. The slope of the graph gives:



(1) Ratio of Planck's constant to electric charge

(2) Work function of the metal

(3) Charge of electron

(4) Planck's constant

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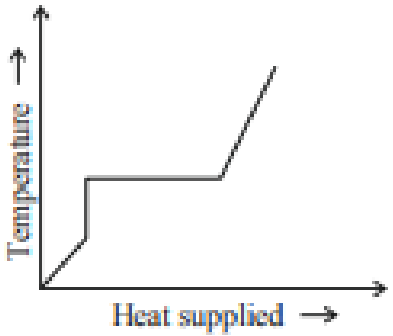
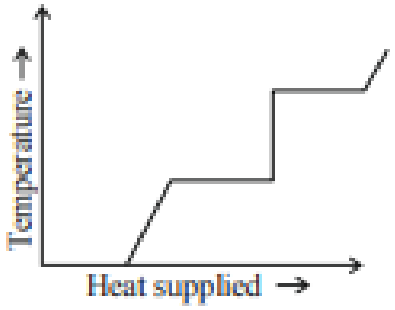
34. A block of ice at -10°C is slowly heated and converted to steam at 100°C. Which of the following curves represent the phenomenon qualitatively:

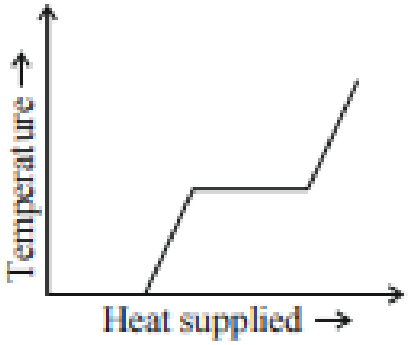
(1)



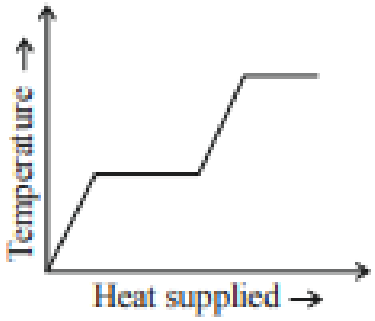
(3)



(2)



(4)



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35. In a nuclear fission reaction of an isotope of mass M, three similar daughter nuclei of same mass are formed. The speed of a daughter nuclei in terms of mass defect ΔM will be:

(1) $\sqrt{\frac{2c\Delta M}{M}}$

(2) $\frac{\Delta Mc^2}{3}$

(3) c$\sqrt{\frac{2\Delta M}{M}}$

(4) c$\sqrt{\frac{c\Delta M}{M}}$

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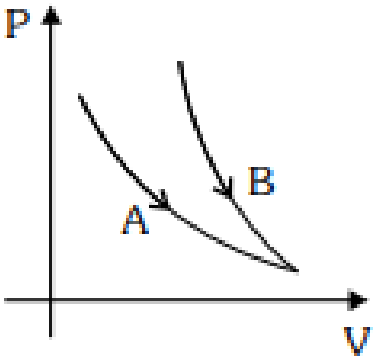
36. Choose the correct statement for processes A & B shown in the figure:



(1) $PV^n = k$ for process B and $PV = k$ for process A.

(2) $PV = k$ for process B and $T = k$ for process A.

(3) $P^{n-1} = k$ for process B and $T^n = k$ for process A.

(4) $T^n P^{n-1} = k$ for process A and $PV = k$ for process B.

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37. An electron revolving in the n^{th} Bohr orbit has magnetic moment μ. If μ_n is the value of μ, the value of x is:

(1) 2

(2) 1

(3) 3

(4) 0

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38. An alternating voltage $V(t) = 220 \sin 100t$ volt is applied to a purely resistive load of $50\,\Omega$. The time taken for the current to rise from half of the peak value to the peak value is:

(1) $5\,ms$

(2) $3.3\,ms$

(3) $7.2\,ms$

(4) $2.2\,ms$

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39. A block of mass 1 kg is placed on a surface having vertical cross section given by $y = \frac{x}{2}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is:

(1) $\frac{1}{4}\,m$

(2) $\frac{1}{2}\,m$

(3) $\frac{1}{6}\,m$

(4) $\frac{1}{3}\,m$

---

40. If the total energy transferred to a surface in time t is $6.48 \times 10^5\ J$, then the magnitude of the total momentum delivered to this surface for complete absorption will be:

(1) 2.46×10^{-3} kg m/s

(2) 2.16×10^{-3} kg m/s

(3) 1.58×10^{-3} kg m/s

(4) 4.32×10^{-3} kg m/s

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41. A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of emergent light is:

(1) $\frac{I_0}{4}$

(2) I_0

(3) $\frac{I_0}{2}$

(4) $\frac{I_0}{8}$

---

42. Escape velocity of a body from earth is 11.2 km/s. If the radius of a planet be one-third the radius of earth and mass be one-sixth that of earth, the escape velocity from the planet is:

(1) $11.2\,\text{km/s}$

(2) $8.4\,\text{km/s}$

(3) $4.2\,\text{km/s}$

(4) $7.9\,\text{km/s}$

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43. A particle of charge $-q$ and mass m moves in a circle of radius r around an infinitely long line charge of linear density $+\lambda$. Then the time period will be given as:

(1) $T^2 = \frac{4\pi m r^3}{2kq}$

(2) $T = 2\pi r\sqrt{\frac{m}{2kq}}$

(3) $T = \frac{1}{2\pi r}\sqrt{\frac{m}{2kq}}$

(4) $T = \frac{2kq}{m}$

---

44. If mass is written as $m = k\,c^p\,G^{-1/2}\,h^{1/2}$, then the value of P will be:

(1) $\frac{1}{2}$

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

(3) 2

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

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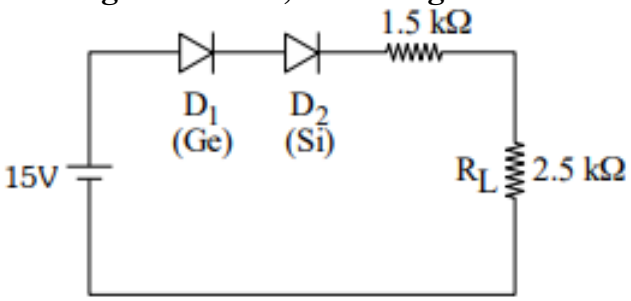
45. In the given circuit, the voltage across load resistance R_L is:



(1) $8.75\,V$

(2) $9.00\,V$

(3) $13.50\,V$

(4) $14.00\,V$

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46. If three moles of monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with two moles of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$, the value of the adiabatic exponent γ for the mixture is:

(1) 1.75

(2) 1.40

(3) 1.52

(4) 1.35

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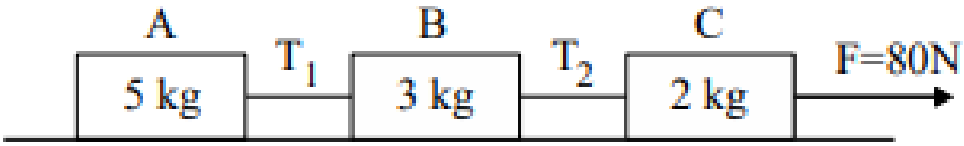
47. Three blocks A, B and C are pulled on a horizontal smooth surface by a force of $80\,N$ as shown in the figure.



The tensions T_1 and T_2 in the string are respectively:

(1) $40\,N, 64\,N$

(2) $60\,N, 80\,N$

(3) $88\,N, 96\,N$

(4) $80\,N, 100\,N$

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48. When a potential difference V is applied across a wire of resistance R, it dissipates energy at a rate W. If the wire is cut into two halves and these halves are connected mutually in parallel across the same supply, the energy dissipation rate will become:

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

(2) $\frac{1}{2}W$

(3) $2W$

(4) $4W$

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49. Match List I with List II:

List I	**List II**
A. Gauss's law	I. $\oint \mathbf{E} \times \mathbf{da} = \frac{1}{\epsilon_0} Q$
B. Faraday's law of electromagnetic induction	II. $\oint \mathbf{E} \times \mathbf{da} = 0$
C. Ampere's law	III. $\mathbf{E} \times \mathbf{di} = -\frac{d\Phi}{dt}$
D. Gauss's law for magnetism	IV. $\mathbf{B} \times \mathbf{da} = \mu_0 I$

Choose the correct answer from the options given below:

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

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50. Projectiles A and B are thrown at angles of 45° and 60° with vertical respectively from top of a 400 m high tower. If their ranges and times of flight are same, the ratio of their speeds of projection $v_A : v_B$ is:

(1) $1 : \sqrt{3}$

(2) $\sqrt{2} : 1$

(3) $1 : 2$

(4) $1 : \sqrt{2}$

Section B

51. A power transmission line feeds input power at $2.3\,kV$ to a step down transformer with its primary winding having 3000 turns. The output power is delivered at $230\,V$ by the transformer. The current in the primary of the transformer is 5 A and its efficiency is 90%. The winding of transformer is made of copper. The output current of transformer is _____ A.

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52. A big drop is formed by coalescing 1000 small identical drops of water. If E_1 be the total surface energy of 1000 small drops of water and E_2 be the surface energy of the single big drop of water, the ratio $E_1 : E_2$ is x : 1 where x = _____ .

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53. Two discs of moment of inertia $I_1 = 4\,kg\,m^2$ and $I_2 = 2\,kg\,m^2$ about their central axes & normal to their planes, rotating with angular speeds $10\,rad/s$ & $4\,rad/s$ respectively are brought into contact face to face with their axes of rotation coincident. The loss in kinetic energy of the system in the process is _____ J .

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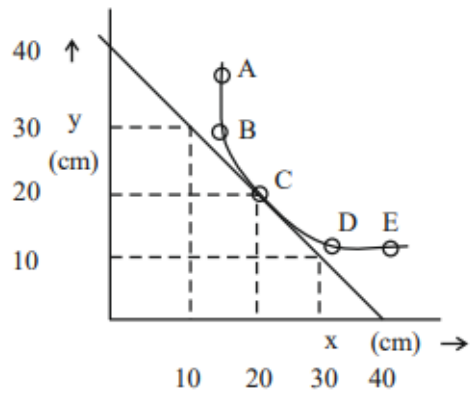
54. In an experiment to measure the focal length f of a convex lens, the magnitude of object distance x and the image distance y are measured with reference to the focal point of the lens. The y-x plot is shown in the figure. The focal length of the lens is _____ cm.



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55. A vector has magnitude same as that of A $= -3\hat{i}+4\hat{j}$ and is parallel to B $= 4\hat{i}+3\hat{j}$. The x and y components of this vector in the first quadrant are x and y respectively where $x =$ _____).

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56. The current of 5 A flows in a square loop of sides 1 m placed in air. The magnetic field at the center of the loop is $X\sqrt{2} \times 10^{-7}\,T$. The value of X = _____ .

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57. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 37° with each other. When suspended in a liquid of density $0.7\,g/cm^3$, the angle remains the same. If the density of the material of the sphere is $1.4\,g/cm^3$, the dielectric constant of the liquid is _____ $\left(\tan 37^\circ = \frac{3}{4}\right)$

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58. A simple pendulum is placed at a place where its distance from the earth's surface is equal to the radius of the earth. If the length of the string is 4 m, then the time period of small oscillations will be _____ s. [take $g = \pi^2\,ms^{-2}$]

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59. A point source is emitting sound waves of intensity $16 \times 10^{-8}\,Wm^{-2}$ at the origin. The difference in intensity (magnitude only) at two points located at distances of 2 m and 4 m from the origin respectively will be _____ $\times 10^{-8}\,Wm^{-2}$.

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60. Two resistances of $100\,\Omega$ and $200\,\Omega$ are connected in series with a battery of $4\,V$ and negligible internal resistance. A voltmeter is used to measure voltage across the $100\,\Omega$ resistance, which gives a reading of $1\,V$. The resistance of the voltmeter must be _____ Ω.

Chemistry Section A

61. Which among the following purification methods is based on the principle of "Solubility" in two different solvents?

(1) Column Chromatography

(2) Sublimation

(3) Distillation

(4) Differential Extraction

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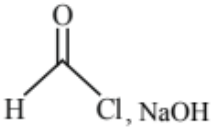
62. Salicylaldehyde is synthesized from phenol, when reacted with:

(1) 

(2) CO_2, $NaOH$

(3) CCl_3, $NaOH$

(4) HCl, $NaOH$

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63. Given below are two statements:

Statement I: High concentration of strong nucleophilic reagent with secondary alkyl halides which do not have bulky substituents will follow S_N2 mechanism.

Statement II: A secondary alkyl halide when treated with a large excess of ethanol follows S_N1 mechanism.

In the light of the above statements, choose the most appropriate from the questions given below:

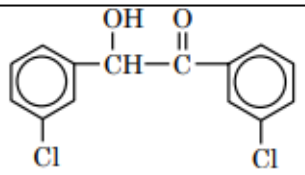
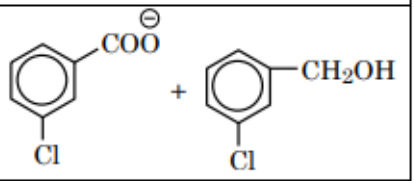
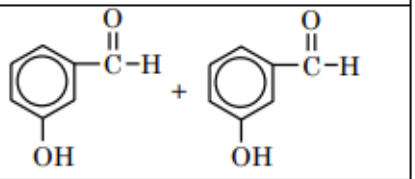
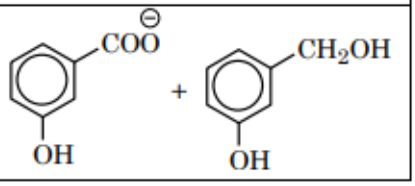
(1) Statement I is true but Statement II is false.

(2) Statement I is false but Statement II is true.

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

(4) Both Statement I and Statement II are true.

64. m**-chlorobenzaldehyde on treatment with 50% KOH solution yields:**

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

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

Assertion A: H_2Te is more acidic than H_2S.

Reason R: Bond dissociation enthalpy of H_2Te is lower than H_2S.

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

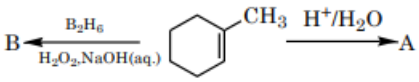
(1) Both A and R are true but R is NOT the correct explanation of A.

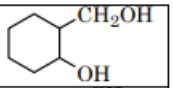
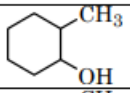
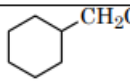
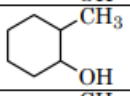
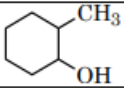
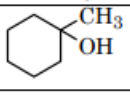
(2) Both A and R are true and R is the correct explanation of A.

(3) A is false but R is true.

(4) A is true but R is false.

66. Product A and B formed in the following set of reactions are:



(1)	A =  B = 
(2)	A =  B = 
(3)	A =  B = 
(4)	A =  B = 

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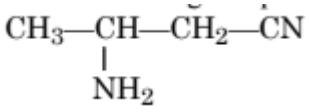
67. IUPAC name of the following compound is:



(1) 2-Aminopentanitrile

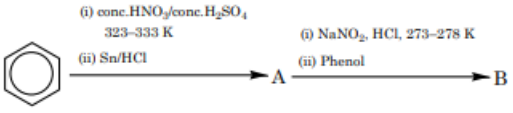
(2) 2-Aminobutanitrile

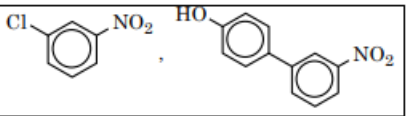
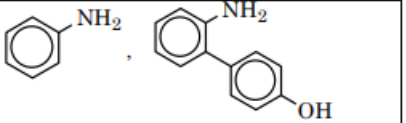
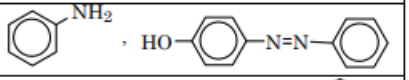
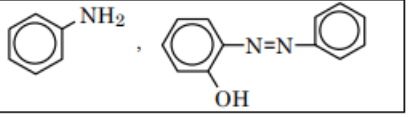
(3) 3-Aminobutanenitrile

(4) 3-Aminopropanenitrile

---

68. The products A and B formed in the following reaction scheme are respectively:



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

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69. The molecule/ion with square pyramidal shape is:

(1) $[Ni(CN)_6]^{2-}$

(2) PCl_5

(3) BrF_5

(4) PF_5

---

70. The orange colour of $K_2Cr_2O_7$ and purple colour of $KMnO_4$ is due to:

(1) Charge transfer transition in both.

(2) d $\rightarrow$ d transition in $KMnO_4$ and charge transfer transitions in $K_2Cr_2O_7$.

(3) d $\rightarrow$ d transition in $K_2Cr_2O_7$ and charge transfer transitions in $KMnO_4$.

(4) d $\rightarrow$ d transition in both.

---

71. Alkaline oxidative fusion of MnO_2 gives "A" which on electrolytic oxidation in alkaline solution produces B. A and B respectively are:

(1) Mn_2O_7 and MnO_2^-

(2) MnO_2 and MnO_2^-

(3) Mn_2O_7 and MnO_4^-

(4) MnO_2^- and Mn_2O_7

---

72. If a substance 'A' dissolves in solution of a mixture of 'B' and 'C' with their respective number of moles as $n_a, n_b,$ and n_c mole fraction of C in the solution is:

(1) $\frac{n_c}{n_a \times n_b \times n_c}$

(2) $\frac{n_c}{n_a + n_b + n_c}$

(3) $\frac{n_c}{n_a - n_b}$

(4) $\frac{n_b}{n_a + n_b}$

73. Given below are two statements:

Statement I: Along the period, the chemical reactivity of the element gradually increases from group 1 to group 18.

Statement II: The nature of oxides formed by group 1 element is basic while that of group 17 elements is acidic.

In the light of the above statements, choose the most appropriate from the questions given below:

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

(2) Statement I is true but Statement II is false.

(3) Statement I is false but Statement II is true.

(4) Both Statement I and Statement II are false.

---

74. The coordination geometry around the manganese in decacarbonylmanganese(0) is:

(1) Octahedral

(2) Trigonal bipyramidal

(3) Square pyramidal

(4) Square planar

---

75. Given below are two statements:

Statement I: Since fluorine is more electronegative than nitrogen, the net dipole moment of NF_3 is greater than NH_3.

Statement II: In NH_3, the orbital dipole due to lone pair and the dipole moment of NH bonds are in opposite direction, but in NF, the orbital dipole due to lone pair and dipole moments of

$N - F$ bonds are in the same direction.

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

(1) Statement I is true but Statement II is false.

(2) Both Statement I and Statement II are true.

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

(4) Statement I is false but Statement II is true.

---

76. The correct stability order of carbocations is:

(1) $(CH_3)_3C^+ > CH_3-\overset{+}{C}H_2 > (CH_3)_2\overset{+}{C}H > \overset{+}{C}H_3$

(2) $\overset{+}{C}H_3 > (CH_3)_2\overset{+}{C}H > CH_3-\overset{+}{C}H_2 > (CH_3)_3\overset{+}{C}$

(3) $(CH_3)_3\overset{+}{C} > (CH_3)_2\overset{+}{C}H > CH_3-\overset{+}{C}H_2 > \overset{+}{C}H_3$

(4) $\overset{+}{C}H_3 > CH_3-\overset{+}{C}H_2 > CH_3-\underset{\displaystyle CH_3}{\overset{+}{C}H} > (CH_3)C^+$

---

77. The solution from the following with highest depression in freezing point/lowest freezing point is:

(1) 180 g of acetic acid dissolved in water

(2) 180 g of acetic acid dissolved in benzene

(3) 180 g of benzoic acid dissolved in benzene

(4) 180 g of glucose dissolved in water

---

78. A and B formed in the following reactions are:

$$Cr_2O_7^{2-} + 4NaOH \rightarrow Na_2Cr_2O_4 + 2NaCl + 2H_2O$$

$$A + 2Cl_2 + 2H_2O \rightarrow B + 3H_2O$$

(1) $A = Na_2Cr_2O_4,\ B = CrO_3$

(2) $A = Na_2Cr_2O_4,\ B = Cr_2O_7$

(3) $A = Na_2Cr_2O_4,\ B = NaCrO_4$

(4) $A = Na_2Cr_2O_4,\ B = Cr_3O_8$

---

79. Choose the correct statements about the hydrides of group 15 elements.

A: The stability of the hydrides decreases in the order $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$.

B: The reducing ability of the hydrides increases in the order $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$.

C: Among the hydrides, NH_3 is strong reducing agent while BiH_3 is mild reducing agent.

D: The basicity of the hydrides increases in the order $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$.

Choose the most appropriate from the options given below:

(1) B and C only

(2) C and D only

(3) A and B only

(4) A and D only

---

80. Reduction potential of ions are given below:

$$ClO_3^- : E^\circ = 1.19\,V$$

$$IO_3^- : E^\circ = 1.65\,V$$

$$BrO_3^- : E^\circ = 1.74\,V$$

The correct order of their oxidising power is:

(1) $ClO_3^- > IO_3^- > BrO_3^-$

(2) $BrO_3^- > IO_3^- > ClO_3^-$

(3) $IO_3^- > ClO_3^- > BrO_3^-$

(4) $IO_3^- > BrO_3^- > ClO_3^-$

Section B

81. Number of complexes which show optical isomerism is _____ .

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82. NO_2**, required for a reaction is produced by decomposition of** N_2O_4 **in** CCl_4**, as by equation**

$$2N_2O_4 \rightleftharpoons 4NO_2 + O_2$$

The initial concentration of N_2O_4 **is 3 mol L**$^{-1}$ **and it is 2.75 mol L**$^{-1}$ **after 30 minutes. The rate of formation of** NO_2 **is** $x \times 10^{-3}$ **mol L**$^{-1}$ **min**$^{-1}$**, value of** x **is _____.**

---

83. Two reactions are given below:

$$2Fe^{3+} + 3O_2(g) \rightarrow Fe_2O_3(s), \quad \Delta H_f = -822\,\text{kJ / mol}$$

$$C(g) + \frac{1}{2}O_2(g) \rightarrow CO(g), \quad \Delta H_f = -110\,\text{kJ / mol}$$

Then enthalpy change for the following reaction:

$$3C(g) + Fe_2O_3(s) \rightarrow 2Fe(g) + 3CO(g), \quad \Delta H = ?$$

---

84. The total number of correct statements regarding the nucleic acids is _____ .

A. RNA is regarded as the reserve of genetic information.

B. DNA molecule self-duplicates during cell division.

C. DNA synthesizes proteins in the cell.

D. The message for the synthesis of particular proteins is present in DNA.

E. Identical DNA strands are transferred to daughter cells.

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85. The pH of an aqueous solution containing 1M benzoic acid (pK_a = 4.20) and 1M sodium benzoate is 4.5. The volume of benzoic acid solution in 300 mL of this buffer solution is _____ mL.

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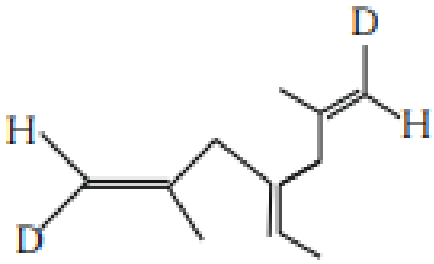
86. Number of geometrical isomers possible for the given structure is/are _____.



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87. Total number of species from the following which can undergo disproportionation reaction _____.

H_2O_2, ClO_3^-, P_4, Cl_2, Ag^+, F_2, NO_2, K

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88. Number of metal ions characterized by flame test among the following is _____.

Sr^{2+}, Ba^{2+}, Ca^{2+}, Cu^{2+}, Zn^{2+}, Co^{2+}, Fe^{2+}

89. 2-chlorobutane $+ Cl_2 \xrightarrow{h\nu} C_4H_7Cl_3$ (isomers)

Total number of optically active isomers shown by $C_4H_7Cl_3$, obtained in the above reaction is _____.

---

90. Number of spectral lines obtained in He^+ spectra, when an electron makes transition from fifth excited state to first excited state will be _____.