JEE Main 2023 29 Jan Shift 2 Question Paper

Time Allowed :180 minutes	**Maximum Marks :**300	**Total questions :**90

General Instructions

Read the following instructions very carefully and strictly follow them:

(A) The test is of 3 hours duration.

(B) The question paper consists of 90 questions. The maximum marks are 300.

(C) There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.

(D) 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.

1. The statement $B \Rightarrow ((\sim A) \vee B)$ is equivalent to:

(A) $B \Rightarrow (A \Rightarrow B)$

(B) $A \Rightarrow (A \Longleftrightarrow B)$

(C) $A \Rightarrow ((\sim A) \Rightarrow B)$

(D) $B \Rightarrow ((\sim A) \Rightarrow B)$

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2. Shortest distance between the lines

$$\frac{x-1}{2} = \frac{y+8}{-7} = \frac{z-4}{5} \quad \text{and} \quad \frac{x-1}{2} = \frac{y-2}{1} = \frac{z-6}{-3}$$

is:

(A) $2\sqrt{3}$

(B) $4\sqrt{3}$

(C) $3\sqrt{3}$

(D) $5\sqrt{3}$

---

3. If $\vec{a} = \hat{i} + 2\hat{k}, \vec{b} = \hat{i} + \hat{j} + \hat{k}, \vec{c} = 7\hat{i} - 3\hat{j} + 4\hat{k}$, and

$$\vec{r} \times \vec{b} + \vec{b} \times \vec{c} = 0 \quad \textbf{and} \quad \vec{r} \cdot \vec{a} = 0,$$

then $\vec{r} \cdot \vec{c}$ is equal to:

(A) 34

(B) 12

(C) 36

(D) 30

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4. Let $S = \{W_1, W_2, \ldots\}$ be the sample space associated with a random experiment. Let $P(W_n) = \frac{P(W_{n-1})}{2}$, $n \geq 2$. Let $A = \{2k + 3l; k, l \in \mathbb{N}\}$ and $B = \{W_n; n \in A\}$. Then $P(B)$ is equal to:

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

(B) $\frac{36}{64}$

(C) $\frac{11}{16}$

(D) $\frac{33}{32}$

5. The value of the integral

$$\int_1^2 \frac{t^4+1}{t^6+1}\,dt$$

is:

(A) $\tan^{-1}\left(\frac{1}{2}\right)+\frac{1}{3}\tan^{-1}(8)-\frac{\pi}{3}$

(B) $\tan^{-1}(2)-\frac{1}{3}\tan^{-1}(8)+\frac{\pi}{3}$

(C) $\tan^{-1}(2)+\frac{1}{3}\tan^{-1}(8)-\frac{\pi}{3}$

(D) $\tan^{-1}\left(\frac{1}{2}\right)-\frac{1}{3}\tan^{-1}(8)+\frac{\pi}{3}$

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6. Let K be the sum of the coefficients of the odd powers of x in the expansion of $(1+x)^{99}$. Let a be the middle term in the expansion of $\left(2+\frac{1}{\sqrt{2}}\right)^{200}$. If

$$\frac{{}^{200}C_{99}K}{a}=\frac{2^{\ell}m}{n},$$

where m and n are odd numbers, then the ordered pair (ℓ,n) is equal to:

(A) (50, 51)

(B) (51, 99)

(C) (50, 101)

(D) (51, 101)

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7. Let f and g be twice differentiable functions on $\mathbb{R}$ such that $f''(x)=g''(x)+6x$, $f'(1)=4g'(1)-3=9$, and $f(2)=3g(2)=12$. Which of the following is NOT true?

(A) $g(-2)-f(-2)=20$

(B) If $-1<x<2$, then $|f(x)-g(x)|<8$

(C) $|f'(x)-g'(x)|<6, -1<x<1$

(D) There exists $x\in[1,3/2]$ such that $f(x_1)=g(x_1)$

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8. The set of all values of $t\in\mathbb{R}$, for which the matrix

$$\begin{bmatrix} e^t & e^{-t}(\sin t-2\cos t) & e^{-t}(-2\sin t-\cos t) \\ e^t & e^{-t}(2\sin t+\cos t) & e^{-t}(\sin t-2\cos t) \\ e^t & e^{-t}\cos t & e^{-t}\sin t \end{bmatrix}$$

is invertible, is:

(A) $\{(2k+1)\frac{\pi}{2}, k \in \mathbb{Z}\}$

(B) $\{k\pi + \frac{\pi}{4}, k \in \mathbb{Z}\}$

(C) $\{k\pi, k \in \mathbb{Z}\}$

(D) $\mathbb{R}$

---

9. The area of the region $A = \{(x, y) : |\cos x - \sin x| \leq y \leq \sin x, 0 \leq x \leq \frac{\pi}{2}\}$ **is:**

(A) $1 - \frac{\sqrt{2}}{3} + \frac{\sqrt{5}}{3}$

(B) $\sqrt{5} + 2\sqrt{2} - 4.5$

(C) $\frac{\sqrt{2}}{3} + 1 - \frac{\sqrt{5}}{3}$

(D) $\sqrt{5} - 2\sqrt{2} + 1$

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10. The set of all values of λ **for which the equation** $\cos^2(2x) - 2\sin x - 2\cos(2x) = \lambda$ **holds is:**

(A) $[-2, -1]$

(B) $[-2, -\frac{3}{2}]$

(C) $[-1, -\frac{1}{2}]$

(D) $[-\frac{3}{2}, -1]$

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11. The letters of the word OUGHT are written in all possible ways and these words are arranged as in a dictionary, in a series. Then the serial number of the word TOUGH is:

(A) 89

(B) 84

(C) 86

(D) 79

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12. The plane $2x - y + z = 4$ **intersects the line segment joining the points** $A(a, -2, 4)$ **and** $B(2, b, -3)$ **at the point** C **in the ratio 2:1, and the distance of** C **from the origin is** $\sqrt{5}$**. If** $ab < 0$**, and** P **is the point** $(a - b, b, 2b - a)$**, then** CP^2 **is equal to:**

(A) $\frac{17}{3}$

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

(C) $\frac{73}{3}$

(D) $\frac{97}{3}$

---

13. Let $\vec{a} = 4\hat{i} + 3\hat{j}$, $b = 3\hat{i} - 4\hat{j} + 5\hat{k}$, and c be a vector such that $(\vec{a} \times \vec{b}) \cdot \vec{c} + 25 = 0$, $\vec{c} \cdot (\hat{i} + \hat{j} + \hat{k}) = 4$, and the projection of $\vec{c}$ on $\vec{a}$ is 1. Then the projection of $\vec{c}$ on $\vec{b}$ equals:

(A) $\frac{5}{\sqrt{2}}$

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

(C) $\frac{1}{\sqrt{5}}$

(D) $\frac{\sqrt{5}}{\sqrt{2}}$

---

14. If the lines $\frac{x-1}{1} = \frac{y-2}{2} = \frac{z+3}{1}$ and $\frac{x-a}{2} = \frac{y+2}{3} = \frac{z-3}{1}$ intersect at the point P, then the distance of the point P from the plane $z = a$ is:

(A) 16

(B) 28

(C) 10

(D) 22

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15. The value of the integral

$$\int_{1/2}^{2} \frac{\tan^{-1} x}{x}\, dx$$

is equal to:

(A) $\pi \log_e 2$

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

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

(D) $\frac{\pi}{2} \log_e 2$

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16. If the tangent at a point P on the parabola $y^2 = 3x$ is parallel to the line $x + 2y = 1$, and the tangents at the points Q and R on the ellipse $\frac{x^2}{4} + \frac{y^2}{1} = 1$ are perpendicular to the line $x - y = 2$, then the area of the triangle PQR is:

(A) $\frac{9}{\sqrt{2}}$

(B) $5\sqrt{3}$

(C) $\frac{3}{2}\sqrt{5}$

(D) $3\sqrt{5}$

---

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

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

If $y(2) = 2$, then $y(e)$ is equal to:

(A) $\frac{4+e^2}{4}$

(B) $\frac{1+e^2}{4}$

(C) $\frac{2+e^2}{2}$

(D) $\frac{1+e^2}{2}$

---

18. The number of 3-digit numbers that are divisible by either 3 or 4 but not divisible by 48 is:

(A) 472

(B) 432

(C) 507

(D) 400

---

19. Let R be a relation defined on $\mathbb{N}$ as aRb if $2a + 3b$ is a multiple of 5. Then R is:

(A) not reflexive

(B) transitive but not symmetric

(C) symmetric but not transitive

(D) an equivalence relation

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20. Consider a function $f : \mathbb{N} \to \mathbb{R}$ satisfying

$f(1) + 2f(2) + 3f(3) + \cdots + xf(x) = x(x + 1)f(x)$ **for $x \geq 2$, with $f(1) = 1$. Then $f(2022)$ is equal to:**

(A) 8200

(B) 8000

(C) 8400

(D) 8100

---

21. The total number of 4-digit numbers whose greatest common divisor with 54 is 2, is:

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22. A triangle is formed by the tangents at the point (2, 2) on the curves $y^2 = 2x$ and $x^2 + y^2 = 4x$, and the line $x + y + 2 = 0$. If r is the radius of its circumcircle, then r^2 is equal to:

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23. A circle with center $(2, 3)$ and radius 4 intersects the line $x + y = 3$ at points P and Q. If the tangents at P and Q intersect at $S(\alpha, \beta)$, then $4\alpha - 7\beta$ is equal to:

---

24. Let $a_1 = b_1 = 1$ and $a_n = a_{n-1} + (n-1)$, $b_n = b_{n-1} + a_{n-1}$, $\forall n \geq 2$. If $S = \sum_{n=1}^{\infty} \frac{a_n}{2^n}$ and $T = \sum_{n=1}^{\infty} \frac{b_n}{2^n}$, then $2^7(2S - T)$ is equal to:

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25. If the equation of the normal to the curve $y = \frac{x-a}{(x+b)(x-2)}$ at the point $(1, -3)$ is $x - 4y = 13$, then the value of $a + b$ is:

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26. Let A be a symmetric matrix such that $|A| = 2$ and

$$\begin{bmatrix} 3 & -2 \\ 2 & 1 \end{bmatrix} A = \begin{bmatrix} 1 & 2 \\ 2 & 7 \end{bmatrix}.$$

If the sum of the diagonal elements of A is s, then $\frac{\beta s}{\alpha^2}$ is equal to:

---

27. Let $\{a_k\}$ and $\{b_k\}, k \in \mathbb{N}$, be two G.P.s with common ratios r_1 and r_2, respectively, such that $a_1 = b_1 = 4$ and $r_1 < r_2$. Let $c_k = a_k + b_k, k \in \mathbb{N}$. If $c_2 = 5$ and $c_3 = 13$, then $\Sigma_{k=1}^{4} c_k - (12a_6 + 8b_4)$ is equal to:

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28. Let $X = \{11, 12, 13, \ldots, 41\}$ and $Y = \{61, 62, 63, \ldots, 91\}$ be two sets of observations. If $\bar{x}$ and $\bar{y}$ are their respective means and σ^2 is the variance of all observations in $X \cup Y$, then $|\bar{x} + \bar{y} - \sigma^2|$ is equal to:

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29. Let $\alpha = 8 - 14i$, $A = \{z \in \mathbb{C} : |z^2 - \alpha^2| = |z^2 - \overline{\alpha}^2|\}$, and $B = \{z \in \mathbb{C} : |z + 3i| = 4\}$. Then $\sum_{z \in A \cap B} (\operatorname{Re} z - \operatorname{Im} z)$ is equal to:

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30. Let $\alpha_1, \alpha_2, \ldots, \alpha_7$ be the roots of the equation $x^7 + 3x^5 - 13x^3 - 15x = 0$ and $|\alpha_1| \geq |\alpha_2| \geq \cdots \geq |\alpha_7|$. Then $\alpha_1\alpha_2 - \alpha_3\alpha_4 + \alpha_5\alpha_6$ is equal to:

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31. Substance A has atomic mass number 16 and half-life of 1 day. Another substance B has atomic mass number 32 and half-life of ½ day. If both A and B simultaneously start undergoing radioactivity at the same time with initial mass 320 g each, how many total atoms of A and B combined would be left after 2 days?

(1) 3.38×10^{24}

(2) 6.76×10^{24}

(3) 6.76×10^{23}

(4) 1.69×10^{24}

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32. At 300 K, the rms speed of oxygen molecules is $\frac{\alpha+5}{\alpha}$ times to that of its average speed in the gas. Then, the value of α will be (used $\pi = \frac{22}{7}$):

(1) 32

(2) 28

(3) 24

(4) 27

---

33. The ratio of de-Broglie wavelength of an α-particle and a proton accelerated from rest by the same potential is $\sqrt{m}$. The value of m is:

(1) 4

(2) 16

(3) 8

(4) 2

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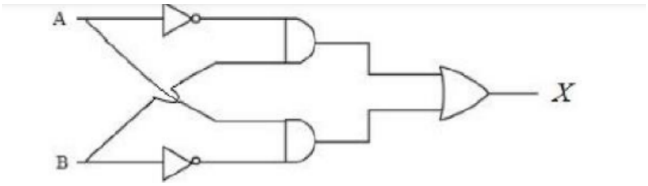
34. For the given logic gates combination, the correct truth table will be:



A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

(A)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

(B)

A	B	X
0	0	1
0	1	0
1	0	1
1	1	0

(C)

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

(D)

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35. The time taken by an object to slide down a 45° rough inclined plane is n times as it takes to slide down a perfectly smooth 45° inclined plane. The coefficient of kinetic friction between the object and the inclined plane is:

(1) $\sqrt{\frac{1}{1-n^2}}$

(2) $\sqrt{1-\frac{1}{n^2}}$

(3) $1+\frac{1}{n^2}$

(4) $1-\frac{1}{n^2}$

---

36. Force acts for 20 s on a body of mass 20 kg, starting from rest, after which the force ceases, and then the body describes 50 m in the next 10 s. The value of force will be:

(1) 40 N

(2) 5 N

(3) 20 N

(4) 10 N

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37. A fully loaded Boeing aircraft has a mass of 5.4×10^5 kg. Its total wing area is $500\,\text{m}^2$. It is in level flight with a speed of 1080 km/h. If the density of air (ρ) is $1.2\,\text{kg/m}^3$, the fractional increase in the speed of the air on the upper surface of the wing relative to the lower surface in percentage will be ($g = 10\,\text{m/s}^2$):

(1) 16%

(2) 6%

(3) 8%

(4) 10%

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38. Identify the correct statements from the following:

(A) Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket is negative.

(B) Work done by gravitational force in lifting a bucket out of a well by a rope tied to the bucket is negative.

(C) Work done by friction on a body sliding down an inclined plane is positive.

(D) Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity is zero.

(E) Work done by the air resistance on an oscillating pendulum is negative.

(1) B and E only

(2) A and C only

(3) B, D and E only

(4) B and D only

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39. An object moves at a constant speed along a circular path in a horizontal plane with the center at the origin. When the object is at $x = +2$ m, its velocity is $-4\hat{j}$ m/s. The object's velocity (v) and acceleration (a) at $x = -2$ m will be:

(1) $v = 4\hat{i}$ m/s, $a = 8\hat{j}$ m/s^2

(2) $v = 4\hat{j}$ m/s, $a = 8\hat{i}$ m/s^2

(3) $v = -4\hat{j}$ m/s, $a = 8\hat{i}$ m/s^2

(4) $v = -4\hat{i}$ m/s, $a = -8\hat{j}$ m/s^2

---

40. A point charge 2×10^{-2} C is moved from P to S in a uniform electric field of 30 N/C directed along the positive x-axis. If the coordinates of P and S are $(1, 2, 0)$ m and $(0, 0, 0)$ m, respectively, the work done by the electric field will be:

(1) 1200 mJ

(2) 600 mJ

(3) -600 mJ

(4) -1200 mJ

41. The modulation index for an A.M. wave having maximum and minimum peak-to-peak voltages of 14 mV and 6 mV respectively is:

(1) 1.4

(2) 0.4

(3) 0.2

(4) 0.6

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42. The electric current in a circular coil of four turns produces a magnetic induction of 32 T at its center. The coil is unwound and rewound into a circular coil of single turn. The magnetic induction at the center of the coil by the same current will be:

(1) 8 T

(2) 4 T

(3) 2 T

(4) 16 T

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43. With the help of a potentiometer, we can determine the value of the emf of a given cell. The sensitivity of the potentiometer is:

(A) Directly proportional to the length of the potentiometer wire

(B) Directly proportional to the potential gradient of the wire

(C) Inversely proportional to the potential gradient of the wire

(D) Inversely proportional to the length of the potentiometer wire

(1) B and D only

(2) A and C only

(3) A only

(4) C only

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44. A scientist is observing bacteria through a compound microscope. For better analysis and to improve its resolving power, he should:

(1) Increase the wavelength of the light

(2) Increase the refractive index of the medium between the object and the objective lens

(3) Decrease the focal length of the eyepiece

(4) Decrease the diameter of the objective lens

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45. Given below are two statements:

Statement I: Electromagnetic waves are not deflected by electric and magnetic fields.

Statement II: The amplitude of the electric field and the magnetic field in electromagnetic waves are related as $E_0 = \sqrt{\mu_0/\epsilon_0}\, B_0$.

Choose the correct answer:

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

(2) Both Statement I and Statement II are true

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

(4) Both Statement I and Statement II are false

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46. Heat energy of 184 kJ is given to ice of mass 600 g at -12°C. Specific heat of ice is 2222.3 J/kg/$^\circ$C and latent heat of ice is 336 kJ/kg.

(A) Final temperature of the system will be 0°C.

(B) Final temperature of the system will be greater than 0°C.

(C) The final system will have a mixture of ice and water in the ratio of 5:1.

(D) The final system will have a mixture of ice and water in the ratio of 1:5.

(E) The final system will have water only.

Choose the correct answer:

(1) A and D only

(2) B and D only

(3) A and E only

(4) A and C only

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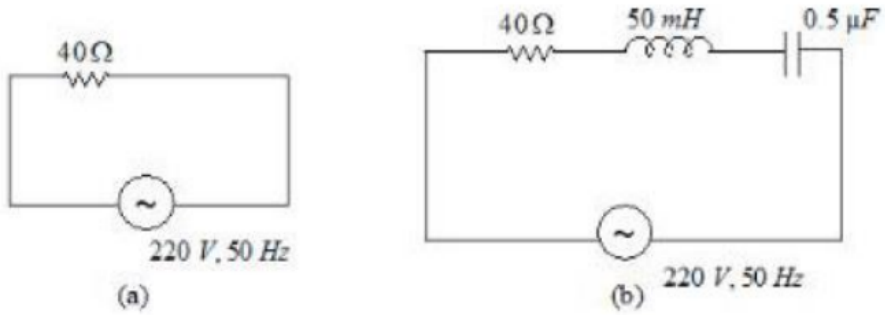
47. For the given figures, choose the correct option:



(1) The rms current in circuit (b) can never be larger than that in (a)

(2) The rms current in figure (a) is always equal to that in figure (b)

(3) The rms current in circuit (b) can be larger than that in (a)

(4) At resonance, current in (b) is less than that in (a)

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48. The time period of a satellite of Earth is 24 hours. If the separation between the Earth and the satellite is decreased to one-fourth of the previous value, then its new time period will become:

(1) 4 hours

(2) 6 hours

(3) 12 hours

(4) 3 hours

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49. The equation of a circle is given by $x^2 + y^2 = a^2$, where a is the radius. If the equation is modified to change the origin other than $(0, 0)$, then find out the correct dimensions of A and B in a new equation:

$$(x - At)^2 + \left(y - \frac{t}{B}\right)^2 = a^2.$$

The dimensions of t are given as $[T^{-1}]$.

(1) $A = [L^{-1}T], B = [LT^{-1}]$

(2) $A = [LT], B = [L^{-1}T^{-1}]$

(3) $A = [L^{-1}T^{-1}], B = [LT^{-1}]$

(4) $A = [L^{-1}T^{-1}], B = [LT]$

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50. A square loop of area $25\,\text{cm}^2$ has a resistance of $10\,\Omega$. The loop is placed in a uniform magnetic field of $40.0\,\text{T}$. The plane of the loop is perpendicular to the magnetic field. The work done in pulling the loop out of the magnetic field slowly and uniformly in 1.0 second will be:

(1) $2.5 \times 10^{-3}\,\text{J}$

(2) $1.0 \times 10^{-3}\,\text{J}$

(3) $1.0 \times 10^{-4}\,\text{J}$

(4) $5.0 \times 10^{-3}\,\text{J}$

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51. When two resistances R_1 and R_2 are connected in series and introduced into the left gap of a meter bridge and a resistance of 10 Ω is introduced into the right gap, a null point is found at 60 cm from the left side. When R_1 and R_2 are connected in parallel and introduced into the left gap, a resistance of 3 Ω is introduced into the right gap to get the null point at 40 cm from the left end. The product of R_1R_2 is _____ Ω^2:

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52. A particle of mass 100 g is projected at time $t = 0$ with a speed of $20\,\text{ms}^{-1}$ at an angle 45° to the horizontal. The magnitude of the angular momentum of the particle about the starting point at time $t = 2\,\text{s}$ is found to be $\sqrt{K}\,\text{kgm}^2/\text{s}$. The value of K is:

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53. In an experiment measuring the refractive index of a glass slab using a traveling microscope, the real thickness of the slab is measured as $5.25\,\text{mm}$ and the apparent thickness as $5.00\,\text{mm}$. The estimated uncertainty in the measurement of refractive index is $x \cdot 10^{-3}$, where x is:

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54. For a charged spherical ball, the electrostatic potential inside the ball varies with r as $V = 2ar^2 + b$. The volume charge density inside the ball is $-\lambda\alpha\varepsilon_0$. The value of λ is:

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55. A car is moving on a circular path of radius 600 m such that the magnitudes of the tangential acceleration and centripetal acceleration are equal. The time taken by the car to complete the first quarter of the revolution, if it is moving with an initial speed of 54 km/hr, is $t(1 - e^{-\pi/2})\,\text{s}$. The value of t is:

56. An inductor of inductance $2\,\mu$H is connected in series with a resistance, a variable capacitor, and an AC source of frequency 7 kHz. The value of capacitance for which maximum current is drawn into the circuit is $1/x$ F, where the value of x is:

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57. A metal block of base area $0.20\,\text{m}^2$ is placed on a table. A liquid film of thickness 0.25 mm is inserted between the block and the table. The block is pushed by a horizontal force of 0.1 N and moves with a constant speed. If the viscosity of the liquid is 5.0×10^{-3} Pl, the speed of the block is _____ $\times 10^{-3}$ m/s.

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58. A particle of mass 250 g executes simple harmonic motion under a periodic force $F = -25x$ N. The particle attains a maximum speed of 4 m/s during its oscillation. The amplitude of the motion is _____ cm.

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59. Unpolarised light is incident on the boundary between two dielectric media, whose dielectric constants are 2.8 (medium-1) and 6.8 (medium-2), respectively. To satisfy the condition such that the reflected and refracted rays are perpendicular to each other, the angle of incidence should be $\tan^{-1}(\sqrt{\mu_2/\mu_1})$. The value of θ is:

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60. A null point is found at 200 cm in a potentiometer when the cell in the secondary circuit is shunted by $5\,\Omega$. When a resistance of $15\,\Omega$ is used for shunting, the null point moves to 300 cm. The internal resistance of the cell is:

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61. Given below are two statements:

Statement I: The decrease in first ionization enthalpy from B to Al is much larger than that from Al to Ga.

Statement II: The *d* orbitals in Ga are completely filled.

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

(1) Statement I is incorrect but statement II is correct.

(2) Both the statements I and II are correct

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

(4) Both the statements I and II are incorrect

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62. Correct order of spin-only magnetic moment of the following complex ions is:

(Given At. No. Fe: 26, Co: 27)

(1) $[FeF_{]}^{3-} > [CoF_6]^{3-} > [Co(C_2O_4)_3]^{3-}$

(2) $[Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-} > [FeF_6]^{3-}$

(3) $[FeF_6]^{3-} > [Co(C_2O_4)_3]^{3-} > [CoF_6]^{3-}$

(4) $[CoF_6]^{3-} > [FeF_6]^{3-} > [Co(C_2O_4)_3]^{3-}$

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63. Match List-I and List-II:

List-I	List-II
A. Osmosis	I. Solvent molecules pass through semi-permeable membrane towards solvent side.
B. Reverse osmosis	II. Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes.
C. Electro osmosis	III. Solvent molecules pass through semi-permeable membrane towards solution side.
D. Electrophoresis	IV. Dispersion medium moves in an electric field.

Choose the correct answer from the options given below:

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

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

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

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

64. The set of correct statements is:

(i) Manganese exhibits +7 oxidation state in its oxide.

(ii) Ruthenium and Osmium exhibit +8 oxidation states in their oxides.

(iii) Sc shows +4 oxidation state which is oxidizing in nature.

(iv) Cr shows oxidizing nature in +6 oxidation state.

(1) (i) and (iii)

(2) (i), (ii) and (iv)

(3) (i) and (iii)

(4) (ii), (iii) and (iv)

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65. Match List-I and List-II:

List-I	List-II
A. Elastomeric polymer	I. Urea formaldehyde resin
B. Fibre polymer	II. Polystyrene
C. Thermosetting polymer	III. Polyester
D. Thermoplastic polymer	IV. Neoprene

Options:

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

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

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

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

---

66. An indicator 'X' is used for studying the effect of variation in concentration of iodide on the rate of reaction of iodide ion with H_2O_2 at room temperature. The indicator 'X' forms blue colored complex with compound 'A' present in the solution. The indicator 'X' and compound 'A' respectively are:

(1) Starch and iodine

(2) Methyl orange and H_2O_2

(3) Starch and H_2O_2

(4) Methyl orange and iodine

---

67. A doctor prescribed the drug Equanil to a patient. The patient was likely to have symptoms of which disease?

(1) Stomach ulcers

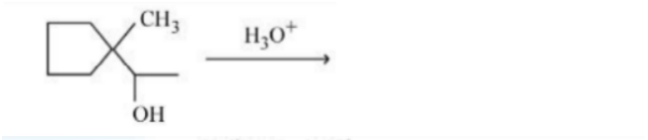
(2) Hyperacidity

(3) Anxiety and stress

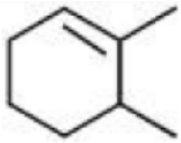
(4) Depression and hypertension

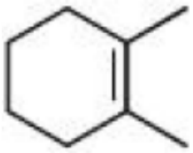
---

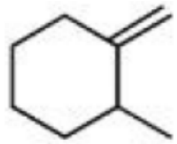
68. Find out the major product for the following reaction:



→ Major Product

(1) 

(2) 

(3) 

(4) 

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69. The one giving maximum number of isomeric alkenes on dehydrohalogenation reaction is (excluding rearrangement):

(1) 1-Bromo-2-methylbutane

(2) 2-Bromopropane

(3) 2-Bromopentane

(4) 2-Bromo-3,3-dimethylpentane

---

70. When a hydrocarbon A undergoes combustion in the presence of air, it requires 9.5 equivalents of oxygen and produces 3 equivalents of water. What is the molecular formula of A?

(1) C_8H_6

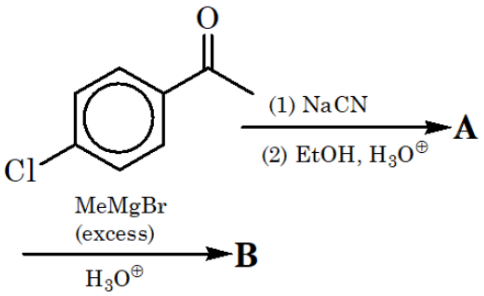
(2) C_9H_9

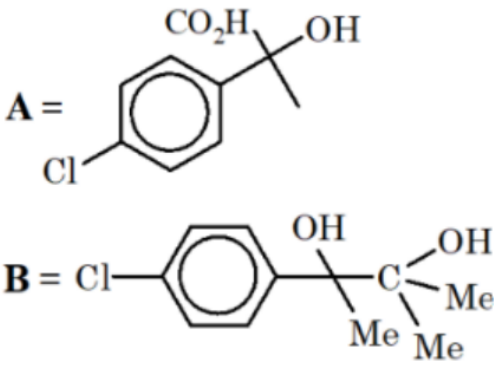
(3) C_6H_6

(4) C_9H_6

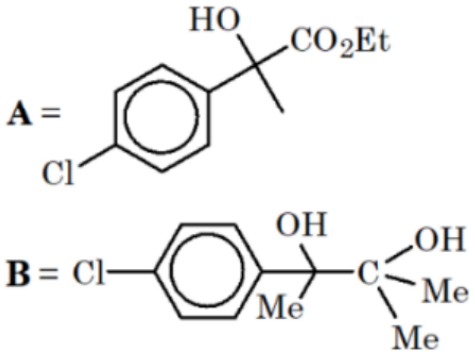
---

71. Find out the major products from the following reaction sequence:

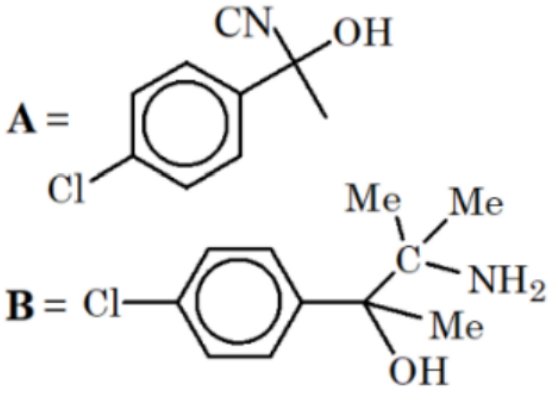




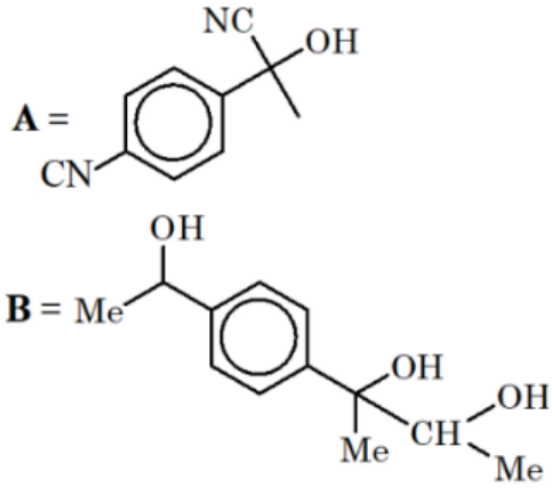
(A)



(B)



(C)



(D)

---

72. According to MO theory, the bond orders for O_2^-, CO, and NO^+, respectively, are:

(1) 1, 3, and 3

(2) 1, 3, and 2

(3) 1, 2, and 3

(4) 2, 3, and 3

---

73. A solution of CrO_3 in amyl alcohol has a ... colour:

(1) Green

(2) Orange-Red

(3) Yellow

(4) Blue

---

74. The concentration of dissolved oxygen in water for growth of fish should be more than X ppm, and biochemical oxygen demand in clean water should be less than Y ppm. X and Y in ppm are respectively:

(1) X Y

6 5

(2) X Y

4 8

(3) X Y

4 15

(4) X Y

6 12

---

75. Reaction of propanamide with Br_2/KOH (aq) produces:

(1) Ethyl nitrile

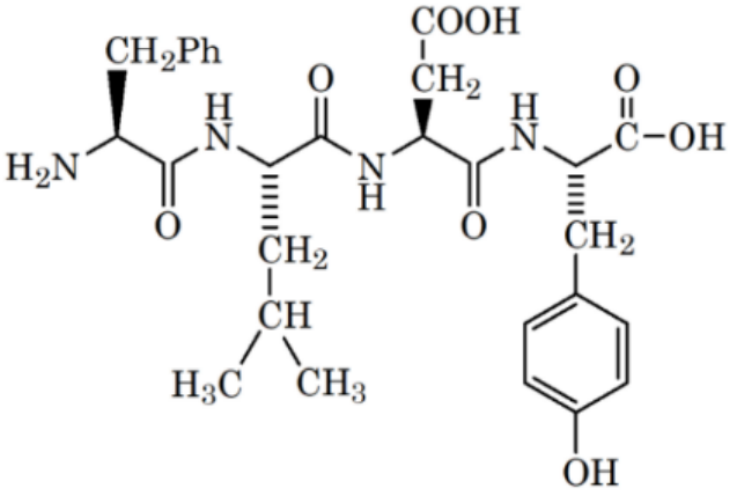
(2) Propylamine

(3) Propanenitrile

(4) Ethylamine

---

76. Following tetrapeptide can be represented as:



(F, L, D, Y, I, Q, P are one-letter codes for amino acids)

(1) FIQY

(2) FLDY

(3) YQLF

(4) PLDY

---

77. Which of the following relations are correct?

(A) $\Delta U = q + p\Delta V$

(B) $G = H - TS$

(C) $\Delta S = \frac{q_{\text{rev}}}{T}$

(D) $\Delta H = \Delta U - nRT$

Choose the most appropriate answer from the options given below:

(1) C and D only

(2) B and C only

(3) A and B only

(4) B and D only

---

78. The major component of which of the following ore is sulphide based mineral?

(1) Calamine

(2) Siderite

(3) Sphalerite

(4) Malachite

---

79. Given below are two statements:

Statement I: Nickel is being used as the catalyst for producing syn gas and edible fats.

Statement II: Silicon forms both electron-rich and electron-deficient hydrides.

Choose the most appropriate answer from the options given below:

(1) Both the statements I and II are correct

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

(3) Both the statements I and II are incorrect

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

---

80. Match List I with List II:

List I	List II
A. van't Hoff factor, i	I. Cryoscopic constant
B. k_f	II. Isotonic solutions
C. Solutions with same osmotic pressure	III. Normal molar mass / Abnormal Mass
D. Azeotropes	IV. Solutions with same composition of vapour above it

Choose the correct answer from the options given below:

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

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

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

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

81. On heating, $LiNO_3$ gives how many compounds among the following? Li_2O, N_2, O_2, $LiNO_2$, NO_2

---

82. At 298 K:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3,\ K_1 = 4 \times 10^5$$

$$N_2 + O_2 \rightleftharpoons 2NO,\ K_2 = 1.6 \times 10^{12}$$

$$H_2 + \frac{1}{2}O_2 \rightleftharpoons H_2O,\ K_3 = 1.0 \times 10^{13}$$

Based on the above equilibria, the equilibrium constant of the reaction:

$$2NH_3 + \frac{5}{2}O_2 \rightleftharpoons 2NO + 3H_2O$$

is $\ldots \times 10^{-33}$ (nearest integer).

---

83. For conversion of compound A $\rightarrow$ B, the rate constant of the reaction was found to be 4.6×10^{-5} L mol^{-1} s^{-1}. The order of the reaction is ...

---

84. Total number of acidic oxides among $N_2O_3, NO, N_2O, Cl_2O_7, SO_2, CO, CaO, Na_2O$ and NO_2 is ...

---

85. When 0.01 mol of an organic compound containing 60% carbon was burnt completely, 4.4 g of CO_2 was produced. The molar mass of the compound is ... g mol^{-1} (nearest integer).

---

86. The denticity of the ligand present in Fehling's reagent is ...

---

87. A metal M forms hexagonal close-packed structure. The total number of voids in 0.02 mol of it is $\ldots \times 10^{21}$ (Nearest integer). (Given $N_A = 6.02 \times 10^{23}$)

---

88. Assume that the radius of the first Bohr orbit of hydrogen atom is 0.6 Å. The radius of the third Bohr orbit of He^+ is ... picometer (Nearest integer).

---

89. The equilibrium constant for the reaction:

$Zn(s) + Sn^{2+}(aq) \rightleftharpoons Zn^{2+}(aq) + Sn(s)$

is 1×10^{20} at 298 K. The magnitude of standard electrode potential of Sn^{2+}/Sn if

$E^{\circ}_{Zn^{2+}/Zn} = -0.76\,V$ is $\ldots \times 10^{-2}\,V$ (Nearest integer).

---

90. The volume of HCl containing 73 g L^{-1}, required to completely neutralize NaOH obtained by reacting 0.69 g of metallic sodium with water, is ... mL (Nearest integer).
