JEE Main 2023 Jan 30 Shift 2 Question Paper

Time Allowed :1 Hour	**Maximum Marks :**100	**Total Questions :**30

General Instructions

Read the following instructions very carefully and strictly follow them:

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

1. Consider the following statements:
P: I have fever
Q: I will not take medicine
R: I will take rest
The statement "If I have fever, then I will take medicine and I will take rest" is equivalent to:
Options:
(1) $(\neg P \vee Q) \wedge (\neg P \vee R)$
(2) $(\neg P \vee Q) \wedge (\neg P \vee \neg R)$
(3) $P \vee Q) \wedge (\neg P \vee R)$
(4) $P \vee Q) \wedge (P \vee \neg R)$

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2. Let A be a point on the x-axis. Common tangents are drawn from A to the curves $x^2 + y^2 = 8$ and $y^2 = 16x$. If one of these tangents touches the two curves at Q and R, then $(QR)^2$ is equal to:
Options:
(1) 64
(2) 76
(3) 81
(4) 72

---

3. Let q be the maximum integral value of p in $[0, 10]$ for which the roots of the equation $x^2 - px + \frac{5p}{4} = 0$ are rational. Then the area of the region $(x, y) : 0 \leq y \leq (x - q)^2, 0 \leq x \leq q$ is:

Options:

(1) 243

(2) 25

(3) 125/3

(4) 164

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4. If the functions $f(x) = \frac{x^3}{3} + 2bx + ax^2/2$ and $g(x) = \frac{x^3}{3} + ax + bx^2$, a not equal 2b have a common extreme point, then $a + 2b + 7$ is equal to:

Options:

(1) 4

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

(3) 3

(4) 6

---

5. The range of the function $f(x) = \sqrt{3 - x} + \sqrt{2 + x}$ is:

Options:

(1) $\left[\sqrt{5}, \sqrt{10}\right]$

(2) $\left[2\sqrt{2}, \sqrt{11}\right]$

(3) $\left[\sqrt{5}, \sqrt{13}\right]$

(4) $\left[\sqrt{2}, \sqrt{7}\right]$

---

6. The solution of the differential equation $\frac{dy}{dx} = -\frac{x^2+3y^2}{3x^2+y^2}, y(1) = 0$ is:

Options:

(1) $\log_e |x + y| - \frac{xy}{(x+y)^2} = 0$

(2) $\log_e |x + y| + \frac{xy}{(x+y)^2} = 0$

(3) $\log_e |x + y| + \frac{2xy}{(x+y)^2} = 0$

(4) $\log_e |x + y| - \frac{2xy}{(x+y)^2} = 0$

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7. Let $x = (8\sqrt{3} + 13)^{13}$ and $y = (7\sqrt{2} + 9)^9$. If $[t]$ denotes the greatest integer $\leq t$, then:

Options:

(1) $[x] + [y]$ is even

(2) $[x]$ is odd but $[y]$ is even

(3) $[x]$ is even but $[y]$ is odd

(4) $[x]$ and $[y]$ are both odd

---

8. A vector v in the first octant is inclined to the x-axis at 60°, to the y-axis at 45°, and to the z-axis at an acute angle. If a plane passing through the points $(\sqrt{2}, -1, 1)$ and (a, b, c), is normal to v, then:
Options:
(1) $\sqrt{2}a + b + c = 1$
(2) $a + b + \sqrt{2}c = 1$
(3) $a + \sqrt{2}b + c = 1$
(4) $\sqrt{2}a - b + c = 1$

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9. Let f, g, and h be the real-valued functions defined on R as follows:

$$f(x) = \begin{cases} x/|x| & \text{if } x \neq 0 \\ 1 & \text{if } x = 0 \end{cases}, \quad g(x) = \begin{cases} \sin(x+1)/(x+1) & \text{if } x \neq -1 \\ 1 & \text{if } x = -1 \end{cases}$$

$$h(x) = 2[x] - [f(x)]$$

where [x] is the greatest integer x. Then the Then the value of $\lim_{x \to -1} h(x)$ is:
Options:
(1) 1
(2) sin(1)
(3) -1
(4) 0

---

10. The number of ways of selecting two numbers a and b, $a \in \{2, 4, 6, \ldots, 100\}$ and $b \in \{1, 3, 5, \ldots, 99\}$ such that 2 is the remainder when $a + b$ is divided by 23 is:
Options:
(1) 186
(2) 54
(3) 108
(4) 268

---

11. If P is a 3×3 real matrix such that $P^T = aP + (a-1)I$, where $a > 1$, then:
Options:
(1) P is a singular matrix
(2) $|\text{Adj}P| > 1$
(3) $|\text{Adj}P| = \frac{1}{2}$
(4) $|\text{Adj}P| = 1$

---

12. Let a and b be vectors such that $\mathbf{a} = \mathbf{i} + 2\mathbf{j} - 3\mathbf{k}$ and $\mathbf{b} = \mathbf{i} - \lambda\mathbf{j} + 2\mathbf{k}$. If $(\mathbf{a} + \mathbf{b}) \times (\mathbf{a} \times \mathbf{b}(a - b))$ = 8i - 40j - 24k , then $\mathbf{a} \cdot (\mathbf{a} \times \mathbf{b})$ is equal to:
Options:
(1) 140
(2) 132
(3) 144
(4) 136

---

13. Let a and b be two vectors. Let $|\mathbf{a}| = 1$, $|\mathbf{b}| = 4$ and $\mathbf{a} \cdot \mathbf{b} = 2$. If $\mathbf{c} = (2\mathbf{a} \times \mathbf{b}) - 3\mathbf{b}$, then the value of $\mathbf{b} \cdot \mathbf{c}$ is:
Options:
(1) -24
(2) -48
(3) -84
(4) -60

---

14. Let $a_1, a_2, \ldots, a_{2022}$ be consecutive natural numbers. Then $\tan^{-1}\left(\frac{1}{1+a_1}\right) + \tan^{-1}\left(\frac{1}{1+a_2}\right) + \ldots + \tan^{-1}\left(\frac{1}{1+a_{2022}}\right)$ is equal to:
Options:
(1) $\frac{\pi}{4} - \cot^{-1}(2022)$
(2) $\cot^{-1}(2022) - \frac{\pi}{4}$
(3) $\tan^{-1}(2022) - \frac{\pi}{4}$
(4) $\frac{\pi}{4} - \tan^{-1}(2022)$

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15. The parabolas $ax^2 + 2bx + cy = 0$ and $dx^2 + 2ex + fy = 0$ intersect on the line $y = 1$. If a, b, c, d, e, f are positive real numbers and a, b, c are in G.P., then
Options:
(1) d, e, f are in A.P.
(2) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in G.P.
(3) $\frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in A.P.
(4) d, e, f are in G.P.

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16. If a plane passes through the points $(-1, k, 0)$, $(2, k, -1)$, and $(1, 1, 2)$ and is parallel to the line $\frac{x-1}{1} = \frac{2y+1}{2} = \frac{z+1}{-1}$, then the value of $\frac{k^2+1}{(k-1)(k-2)}$ is:
Options:
(1) $\frac{17}{5}$
(2) $\frac{5}{17}$
(3) $\frac{6}{13}$
(4) $\frac{13}{6}$

17. Let $a, b, c > 1$, and a^3, b^3 and c^3 be in A.P. If $\log_a b$ and $\log_b c$ are in G.P., If the sum of first 20 terms of an A.P., whose first term is a+4b+c/3 and the common difference is a-8b c/10 is -444, then abc is equal tothen abc is equal to:
Options:
(1) 343
(2) 216
(3) 343/8
(4) 125/8

---

18. Let S be the set of all values of a for which the mean deviation about the mean of 100 consecutive positive integers $a_1, a_2, \ldots, a_{100}$ is 25. Then S is:
Options:
(1) ϕ
(2) $\{99\}$
(3) N
(4) $\{9\}$

---

19. For n in N, evaluate the limit:
$\lim_{n\to\infty} \frac{3}{n}\left\{4 + \left(2+\frac{1}{n}\right)^2 + \left(2+\frac{2}{n}\right)^2 + \cdots + \left(3-\frac{1}{n}\right)^2\right\}$ **Options:**
(1)12
(2)$\frac{19}{3}$
(3) 0
(4) 19

---

20. For $\alpha, \beta \in R$, suppose the system of linear equations

$$x - y + z = 5$$
$$2x + 2y + \alpha z = 8$$
$$3x - y + 4z = \beta$$

has infinitely many solutions. Then α and β are the roots of:
Options:
(1) $x^2 - 10x + 16 = 0$
(2) $x^2 + 18x + 56 = 0$
(3) $x^2 + 18x + 56 = 0$
(4) $x^2 + 14x + 24 = 0$

---

21. If the 50^{th} root of a number x is 12 and the 50^{th} root of another number y is 18, then the remainder obtained on dividing $x + y$ by 25 is:

---

22. Let $A = \{1, 2, 3, 5, 8, 9\}$. Then the number of possible functions $f : A \to A$ such that $f(m \cdot n) = f(m) \cdot f(n)$ for every $m, n \in A$ with $m \cdot n \in A$ is equal to:

---

23. Let $P(a, b)$ and $Q(a_2, b_2)$ be two distinct points on a circle with center $C(\sqrt{2}, \sqrt{3})$. If the origin O is the origin and OC is perpendicular to both CP and CQ. If the area of the triangle OCP is $\frac{\sqrt{35}}{2}$, then $a_1^2 + a_2^2 + b_1^2 + b_2^2$ is equal to:

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24. The 8th common term of the sequence $S_1 = 3 + 7 + 11 + 15 + \ldots$ and $S_2 = 1 + 6 + 11 + 16 + \ldots$ is:

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25. Let a line L pass through the point $P(2, 3, 1)$ and be parallel to the line $x = \frac{y+2}{-2} = \frac{z-2}{-2}$. If the distance of L from the point $(5, 3, 8)$ is α, then $3\alpha^2$ is equal to:

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26. If $\int \sqrt{\sec 2x - 1}\, dx = \alpha \log |\cos 2x| + \beta + \frac{\sqrt{\cos 2x}(1+cos1/\beta x}{+} C$, then $\beta - \alpha$ is equal to:

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27. If the value of real number $a > 0$ for which $x^2 - 5ax + 1 = 0$ and $x^2 - 3ax - 5 = 0$ have a common real root is $\sqrt{\frac{2\beta}{3}}$, then β is equal to:

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28. The number of seven-digit odd numbers that can be formed using all the seven digits 1, 2, 2, 2, 3, 3, 5 is:

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29. A bag contains six balls of different colours. Two balls are drawn in succession with replacement. The probability that both the balls are of the same colour is p. The next four balls are drawn in succession with replacement and the probability that exactly three balls are of the same colour is q. If $p : q = m : n$, where m and n are coprime, then $m + n$ is equal to:

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30. Let A be the area of the region $\{(x, y) : y \geq x^2, y \geq (1 - x)^2, y \leq 2x(1 - x)\}$. Then $540A$ is equal to:

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31. A block of mass $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is:

Options:

(1) 20 N

(2) 25 N

(3) 10 N

(4) 15 N

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32. A flask contains hydrogen and oxygen in the ratio of 2:1 by mass at temperature $27^\circ C$. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is:

Options:

(1) 2:1

(2) 1:1

(3) 1:4

(4) 4:1

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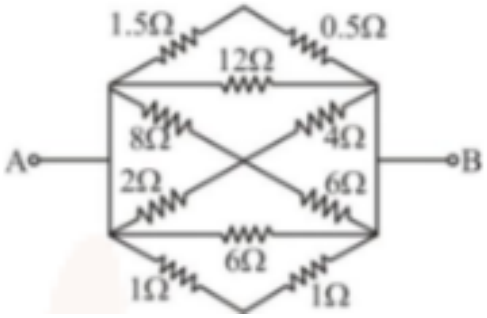
33. The equivalent resistance between A and B is:



Options:

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

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

(3) $3/2\Omega$

(4) $1/3\Omega$

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

Assertion A: The nuclear density of nuclides $^{10}_{5}$B, $^{6}_{3}$Li, $^{56}_{26}$Fe, $^{20}_{10}$Ne, and $^{209}_{83}$Bi can be arranged as $\rho^N_{\text{Bi}} > \rho^N_{\text{Fe}} > \rho^N_{\text{Ne}} > \rho^N_{\text{B}} > \rho^N_{\text{Li}}$..

Reason R: The radius R of a nucleus is related to its mass number A as $R = R_0 A^{1/3}$, where R_0 is a constant.

Options:

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

(2) A is false but R is true

(3) A is true but R is false
(4) Both A and R are true but R is the correct explanation of A

---

35. A thin prism P_1 with an angle of 6° and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is:
Options:
(1) 6°
(2) 1.3°
(3) 7.8°
(4) 4.5°

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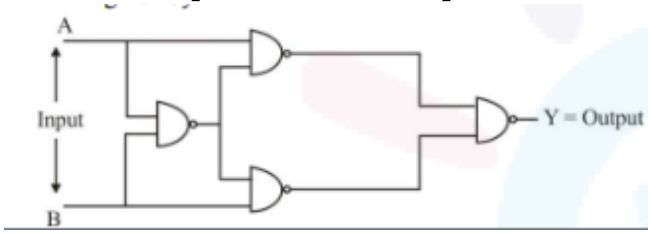
36. The output Y for the inputs A and B of the circuit is given by:



Truth table of the shown circuit is:

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

---

37. A vehicle travels 4 km with a speed of 3 km/h and another 4 km with a speed of 5 km/h, then its average speed is:

Options:

(1) 4.25 km/h

(2) 3.50 km/h

(3) 4.00 km/h

(4) 3.75 km/h

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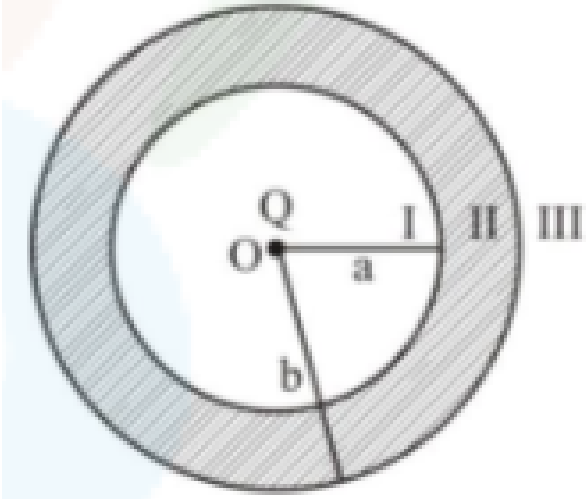
38. As shown in the figure, a point charge Q is placed at the center of a conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II, and III is given by:



Options:

(1) $E_I = 0$, $E_{II} = 0$, $E_{III} \neq 0$

(2) $E_I \neq 0$, $E_{II} = 0$, $E_{III} \neq 0$

(3) $E_I \neq 0$, $E_{II} = 0$, $E_{III} = 0$

(4) $E_I = 0$, $E_{II} = 0$, $E_{III} = 0$

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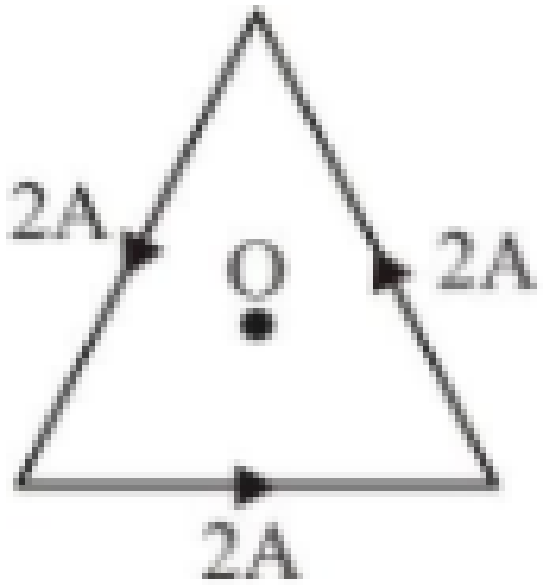
39. As shown in the figure, a current of 2A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid O of the triangle is:



Options:
(1) $4\sqrt{3} \times 10^{-4}\,\mathrm{T}$
(2) $4\sqrt{3} \times 10^{-5}\,\mathrm{T}$
(3) $\sqrt{3} \times 10^{-4}\,\mathrm{T}$
(4) $3\sqrt{3} \times 10^{-5}\,\mathrm{T}$

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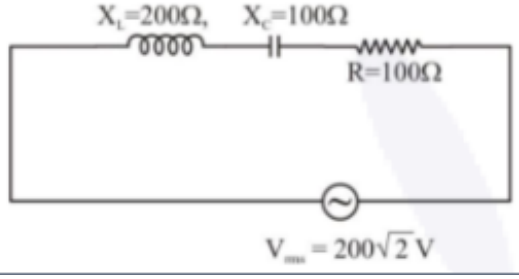
40. In the given circuit, the rms value of current I_{rms} through the resistor R is:



Options:
(1) 2A
(2) $\frac{1}{2}A$
(3) 20A
(4) $2\sqrt{2}A$

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41. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 m/s each. The recoil velocity of the gun is:
Options:
(1) 0.02 m/s
(2) 2.5 m/s
(3) 1.5 m/s
(4) 0.6 m/s

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

Assertion A: Efficiency of a reversible engine will be highest at -273°C temperature of cold reservoir.

Reason R: The efficiency of Carnot's engine depends not only on the temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given by $\eta = 1 - \frac{T_2}{T_1}$.

Options:

(1) A is true but R is false

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

(3) A is false but R is true

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

---

43. Match List I with List II.

List I	**List II**
A: Torque	I: kg $m^{-1}s^{-2}$
B: Energy density	II: kg ms^{-1}
C: Pressure gradient	III: kg m^{-2} s^{-2}
D: Impulse	IV: kg m^2s^{-2}

Options:

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

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

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

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

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44. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio ω_2/ω_1 is:

Options:

(1) $\sqrt{2}$

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

(3) 2

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

---

45. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\frac{V_1}{V_2}$ is equal to:

Options:
(1) 3
(2) $\frac{9}{4}$
(3) $\frac{3}{2}$
(4) 4

---

46. Match List I with List II.

Matching Table:

List I	**List II**
A: Attenuation	I: Combination of a receiver and transmitter
B: Transducer	II: Process of retrieval of information from the carrier wave at received end
C: Demodulation	III: Converts one form of energy into another
D: Repeater	IV: Loss of strength of a signal while propagating through a medium

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

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47. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively is:
Options:
(1) 1:2
(2) 1:4
(3) 1:5
(4) 1:3

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48. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If the same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire 'B' will be:
Options:
(1) $6.06 \times 10^{-2} mm$
(2) $2.77 \times 10^{-2} mm$
(3) $3.0 \times 10^{-2} mm$

(4)$6.9 \times 10^{-2} mm$

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49. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be:
Options:
(1) $2\sqrt{gR}$
(2) $\sqrt{gR}$
(3) $\frac{gR}{\sqrt{2}}$
(4) $\sqrt{2gR}$

---

50. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is:
Options:
(1) $\frac{1W}{2\pi m^2}$
(2) $\frac{1W}{40\pi m^2}$
(3) $\frac{1W}{10\pi m^2}$
(4) $\frac{1W}{20\pi m^2}$

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51. A faulty thermometer reads 5°C in melting ice and 95°C in steam. The correct temperature on absolute scale will be K when the faulty thermometer reads 41°C.
Correct Answer: 313

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52. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is:

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53. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 - x^2$. The time period of oscillations is $\frac{X}{7}$S. The value of x is:

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54. In a Young's double slit experiment, the intensities at two points, for the path difference $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$, are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each of the individual slits, then $(I_1 + I_2)/(I_o) = \ldots/$

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55. A radioactive nucleus decays by two different processes. The half life of the first process is 5 minutes and that of the second process is 30s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$. The value of α is:

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56. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4s is $\frac{1}{3}\alpha^2\sqrt{P}$ m. The value of α will be:

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57. As shown in the figure, a cuboid lies in a region with electric field $\mathbf{E} = 2x^2\mathbf{i} - 4y\mathbf{j} + 6\mathbf{k}$ N/C. The magnitude of charge within the cuboid is $n\epsilon_0$ C. The value of n is:

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58. In an ac generator, a rectangular coil of 100 turns each having area 14×10^{-2} m^2 is rotated at 360 rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be:

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59. A stone tied to a 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of the stone is $\frac{1936}{x}$ m/s^2. The value of x is:

---

60. A uniform disc of mass 0.5 kg and radius r is projected with velocity 18 m/s on a rough horizontal surface. It starts off with a purely sliding motion and after 2s it acquires a purely rolling motion. The total kinetic energy of the disc after 2s will be:

---

61. Which of the following reaction is correct?
Options:
(1) 2LiNO3 $\rightarrow 2LiNO2 + O2$
(2)$4LiNO3 \rightarrow 2Li2O + 2N2O4 + O2$
(3)$4LiNO3 \rightarrow 2Li2O + 4NO2 + O2$
(4)$2LiNO3 \rightarrow 2Li + 2NO2 + O2$

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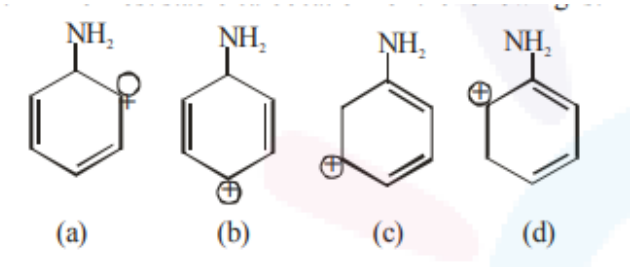
62. The most stable carbocation for the following is:
Options:



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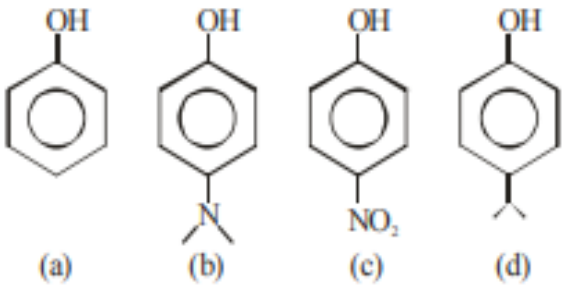
63. The correct order of pKa values for the following compounds is:



Options:

(a) $c > a > d > b$
(b) $b > d > a > c$
(c) $b > a > d > c$
(d) $a > b > c > d$

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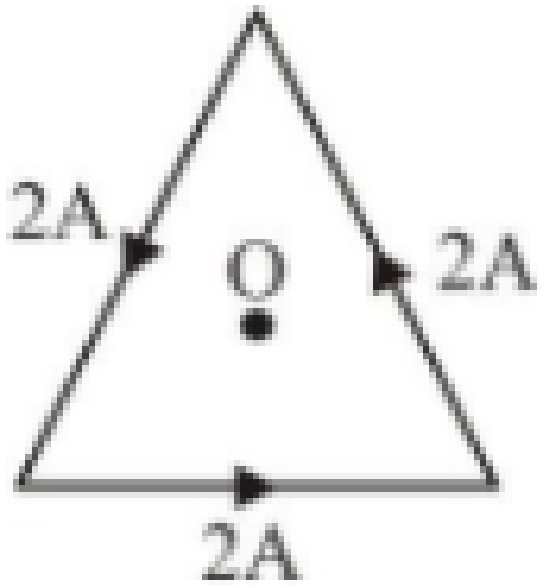
64. Decreasing order towards SN1 reaction for the following compounds is:



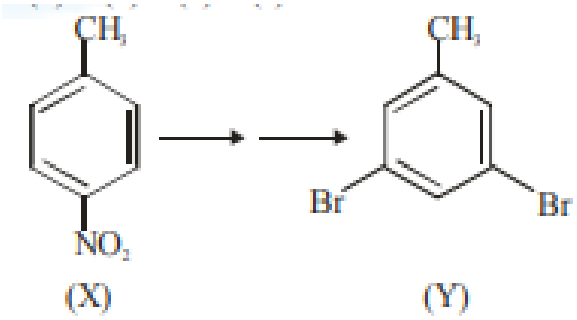
Options:

(a) $a > c > d > b$

(b) $a > b > c > d$
(c) $b > d > c > a$
(d) $d > b > c > a$

---

65. In the above conversion of compound (X) to product (Y), the sequence of reagents to be used will be:



Options:
(a) (i) Br2, Fe (ii) Fe, H+ (iii) LiAlH4
(b) (i) Br2(aq) (ii) LiAlH4 (iii) H3O+
(c) (i) Fe, H+ (ii) Br2(aq) (iii) HNO2 (iv) CuBr
(d) (i) Fe, H (ii) Br2(aq) (iii) HNO2 (iv) H3PO2

---

66. Maximum number of electrons that can be accommodated in shell with $n = 4$ are:
Options:
(1) 16
(2) 32
(3) 50
(4) 72

---

67. Match List I (Complexes) with List II (Hybridisation):

List I (Complexes)	List II (Hybridisation)
(A) [Ni(CO)4]	I. sp^3
(B) $[Cu(NH3)4]^{2}+$	II. dsp^2
(C) $[Fe(NH3)6]^{2}+$	III. sp^3d^2
(D) $[Fe(H2O)6]^{2}+$	IV. d^2sp^3

Options:
(a) A – II, B – I, C – III, D – IV
(b) A – I, B – II, C – III, D – IV
(c) A – II, B – I, C – IV, D – III

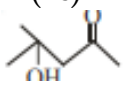
(d) A – I, B – II, C – IV, D – III

---

68. The Cl - Co - Cl bond angle values in a fac-[Co(NH3)3Cl3] complex is/are:
Options:
(1) 90° & 180°
(2) 90°
(3) 180°
(4) 90° & 120°

---

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

Assertion (A):  can be easily reduced using Zn-Hg/HCl to OH.

Reason (R): Zn-Hg/HCl is used to reduce carbonyl group to -CH2- group.
Options:
(1) A is false but R is true
(2) A is true but R is false
(3) Both A and R are true but R is not the correct explanation of A
(4) Both A and R are true and R is the correct explanation of A

---

70. Chlorides of which metal are soluble in organic solvents:
Options:
(1) Ca
(2) Mg
(3) K
(4) Be

71. Given below are two statements:
Assertion (A): Antihistamines do not affect the secretion of acid in the stomach.
Reason (R): Antiallergic and antacid drugs work on different receptors.
Choose the correct answer from the options below:
Options:
(1) A is false but R is true
(2) Both A and R are true and R is the correct explanation of A
(3) A is true but R is false
(4) Both A and R are true but R is not the correct explanation of A

---

72. The wave function (Ψ) of 2s is given by:

$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}}(1/a_0)^{1/2}\left(2 - \frac{r}{a_0}\right)e^{-\frac{r}{2a_0}}At$$

r = r_0, radial node is formed. Thus, r_0 in terms of a_0 is:

Options:
(1) $r_0 = a_0$
(2) $r_0 = 4a_0$
(3) $r_0 = \frac{a_0}{2}$
(4) $r_0 = 2a_0$

---

73. $KMnO_4$ oxidises I^- in acidic and neutral/faintly alkaline solutions, respectively, to:
Options:
(1) I_2 and IO_3^-
(2) IO_3^- and I_2
(3) IO_3^- and IO_3^-
(4) I_2 and I_2

74. Bond dissociation energy of E–H bond of the "H_2E" hydrides of group 16 elements follows order:
Options:
(A) O
(B) S
(C) Se
(D) Te
(1) A > B > C > D
(2) A > B > D > C
(3) B > A > D > C
(4) D > C > B > A

---

75. The water quality of a pond was analysed, and its BOD was found to be 4. The pond has:
Options:
(1) Highly polluted water
(2) Water has high fluoride compounds
(3) Very clean water
(4) Slightly polluted water

---

76. Match List I with List II:

List I (Mixture)	List II (Separation Technique)
(A) $CHCl_3$ + $C_6H_5NH_2$	I Steam distillation
(B) C_6H_{14} + C_5H_{12}	II Differential extraction
(C) $C_6H_5NH_2$ + H_2O	III Distillation
(D) Organic compound in H_2O	IV Fractional distillation

Options:

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

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

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

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

---

77. Boric acid is solid, whereas BF_3 is a gas at room temperature because of:

Options:

(1) Strong ionic bond in Boric acid

(2) Strong van der Waal's interaction in Boric acid

(3) Strong hydrogen bond in Boric acid

(4) Strong covalent bond in BF_3

---

18. Given below are two statements:

Statement I: During Electrolytic refining, the pure metal is made to act as anode and its impure metallic form is used as cathode.

Statement II: During the Hall-Héroult electrolysis process, purified Al_2O_3 is mixed with Na_3AlF_6 to lower the melting point of the mixture.

Choose the most appropriate answer from the options given below:

Options:

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

(2) Both Statement I and Statement II are incorrect

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

(4) Both Statement I and Statement II are correct

---

79. Formula for Nessler's reagent is:

Options:

(1) KHg_2I_2

(2) $KHgI_3$

(3) K_2HgI_4

(4) HgI_2

---

80. 1 L, 0.02 M solution of $[Co(NH_3)_5SO_4]Br$ is mixed with 1 L, 0.02 M solution of $[Co(NH_3)_5Br]SO_4$. The resulting solution is divided into two equal parts (X) and treated with excess $AgNO_3$ solution and $BaCl_2$ solution, respectively, as shown below:

$$1\text{ L Solution (X)} + \text{AgNO}_3\text{ solution (excess)} \rightarrow Y$$
$$1\text{ L Solution (X)} + \text{BaCl}_2\text{ solution (excess)} \rightarrow Z$$

The number of moles of Y and Z, respectively, are:

Options:

(1) 0.02, 0.02
(2) 0.01, 0.01
(3) 0.02, 0.01
(4) 0.01, 0.02

---

81. 1 mole of ideal gas is allowed to expand reversibly and adiabatically from a temperature of 27°C. The work done is 3 kJ mol^{-1}. The final temperature of the gas is ___ K (Nearest integer). Given $C_v = 20\,\text{J mol}^{-1}\text{K}^{-1}$.

---

82. Iron oxide FeO crystallises in a cubic lattice with a unit cell edge length of 5.0Å. If the density of FeO in the crystal is 4.0 g cm^{-3}, then the number of FeO units present per unit cell is __ (Nearest integer).

Given: Molar masses of Fe and O are 56 and 16 g mol^{-1}, respectively. $N_A = 6.0 \times 10^{23}\,\text{mol}^{-1}$.

---

83. An organic compound undergoes first-order decomposition. If the time taken for 60% decomposition is 540 s, then the time required for 90% decomposition will be _____ s (Nearest integer).

Given: $\ln 10 = 2.3$, $\log 2 = 0.3$.

---

84. Lead storage battery contains 38% by weight solution of H_2SO_4. The van't Hoff factor is 2.67 at this concentration. The temperature in Kelvin at which the solution in the battery will freeze is __ (Nearest integer).

Given: $K_f = 1.8\,\text{kg mol}^{-1}$.

---

85. Consider the following equation:

$$2\text{SO}_2(g) + \text{O}_2(g) 2\text{SO}_3(g), \Delta H = -190\,\text{kJ}.$$

The number of factors which will increase the yield of SO_3 at equilibrium from the following is _____:

Factors:

- A. Increasing temperature
- B. Increasing pressure

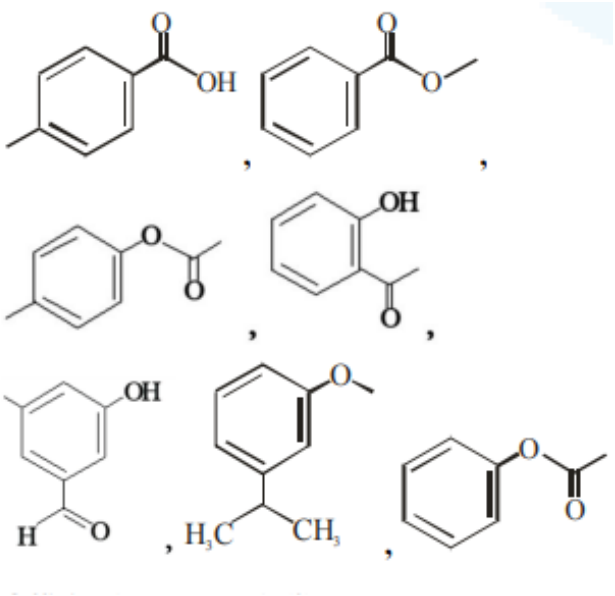
- C. Adding more SO_2
- D. Adding more O_2
- E. Addition of catalyst

---

86. The graph of log $\frac{x}{m}$ vs log p for an adsorption process is a straight line inclined at an angle of 45° with intercept equal to 0.6020. The mass of gas adsorbed per unit mass of adsorbent at the pressure of 0.4 atm is __ $\times 10^{-1}$ (Nearest integer). Given: $\log 2 = 0.3010$.

---

87. Number of compounds from the following which will not dissolve in cold $NaHCO_3$ and NaOH solutions but will dissolve in hot NaOH solution is __.



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88. A short peptide on complete hydrolysis produces 3 moles of glycine (G), 2 moles of leucine (L), and 2 moles of valine (V) per mole of peptide. The number of peptide linkages in it are _____.

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89. The strength of 50 volume solution of hydrogen peroxide is _____ g/L (Nearest integer). Given: Molar mass of H_2O_2 = 34 g mol^{-1}, Molar volume of gas at STP = 22.7 L.

---

90. The electrode potential of the following half-cell at 298 K:

X — $\mathbf{X}^{2+}\,(0.001\,\mathbf{M})\|Y^{2+}\,(0.01\,\mathbf{M})|Y$ **is** _____ $\times 10^{-2}$

V (Nearest integer).