JEE Main 2025 Jan 22 Shift 2 Question Paper

Time Allowed :3 Hour	Maximum Marks :300	Total Questions :75

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 75 questions. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 25 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 5 questions. 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. Let α_1 and β_1 be the distinct roots of $2x^2 + (\cos\theta)x - 1 = 0,\ \theta \in (0, 2\pi)$. If m and M are the minimum and the maximum values of $\alpha_1 + \beta_1$, then $16(M + m)$ equals:
(A) 25
(B) 24
(C) 17
(D) 27

2. Let α, β, γ and δ be the coefficients of x^7, x^5, x^3, x respectively in the expansion of $(x + \sqrt{x^3 - 1})^5 + (x - \sqrt{x^3 - 1})^5$, $x > 1$. If $\alpha u + \beta v = 18$, $\gamma u + \delta v = 20$, then $u + v$ equals:
(1) 4

(2) 8

(3) 3

(4) 5

3. Let $f(x) = \int_0^{x^2} \frac{t^2 - 8t + 15}{e^t} dt$, $x \in R$. Then the numbers of local maximum and local minimum points of f, respectively, are:
(1) 3 and 2

(2) 2 and 3

(3) 1 and 3

(4) 2 and 2

4. Let $A = \{1, 2, 3, 4\}$ and $B = \{1, 4, 9, 16\}$. Then the number of many-one functions $f : A \to B$ such that $1 \in f(A)$ is equal to:
(1) 127

(2) 139

(3) 163

(4) 151

5. The perpendicular distance of the line $\frac{x-1}{2} = \frac{y+2}{-1} = \frac{z+3}{2}$ from the point $P(2, -10, 1)$ is:
(1) $4\sqrt{3}$

(2) $5\sqrt{2}$

(3) $3\sqrt{5}$

(4) 6

6. Suppose that the number of terms in an A.P. is $2k, k \in N$. If the sum of all odd terms of the A.P. is 40, the sum of all even terms is 55, and the last term of the A.P. exceeds the first term by 27, then k is equal to:
(1) 8

(2) 6

(3) 5

(4) 4

7. Let a and b be two unit vectors such that the angle between them is $\frac{\pi}{3}$. If $\lambda\mathbf{a} + 2\mathbf{b}$ and $3\mathbf{a} - \lambda\mathbf{b}$ are perpendicular to each other, then the number of values of λ in $[-1, 3]$ is:
(1) 2

(2) 0

(3) 3

(4) 1

8. Let $P(4, 4\sqrt{3})$ be a point on the parabola $y^2 = 4ax$ and PQ be a focal chord of the parabola. If M and N are the foot of the perpendiculars drawn from P and

Q respectively on the directrix of the parabola, then the area of the quadrilateral PQMN is equal to:

(1) $\frac{263\sqrt{3}}{8}$

(2) $\frac{343\sqrt{3}}{8}$

(3) $\frac{34\sqrt{3}}{3}$

(4) $17\sqrt{3}$

9. If $\int \left(x\sin^{-1}x + \sin^{-1}x(1-x^2)^{3/2} + \frac{x}{1-x^2}\right)dx = g(x) + C$, where C is the constant of integration, then $g\left(\frac{1}{2}\right)$ equals:

(1) $\frac{\pi}{6}\sqrt{3}$

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

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

(4) $\frac{\pi}{6}\sqrt{2}$

10. If A and B are two events such that $P(A \cap B) = 0.1$**, and** $P(A|B)$ **and** $P(B|A)$ **are the roots of the equation** $12x^2 - 7x + 1 = 0$**, then the value of** $\frac{P(A \cup B)}{P(A \cap B)}$ **is:**

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

(2) $\frac{7}{4}$

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

(4) $\frac{9}{4}$

11. Let the curve $z(1+i) + \overline{z}(1-i) = 4$, $z \in C$**, divide the region** $|z-3| \leq 1$ **into two parts of areas** α **and** β**. Then** $|\alpha - \beta|$ **equals:**

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

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

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

(4) $1 + \frac{\pi}{6}$

12. The sum of all values of $\theta \in [0, 2\pi]$ **satisfying** $2\sin^2\theta = \cos 2\theta$ **and** $2\cos^2\theta = 3\sin\theta$ **is:**

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

(2) 4π

(3) π

(4) $\frac{5\pi}{6}$

13. If $x = f(y)$ is the solution of the differential equation

$$(1+y^2)+(x-2e^{\tan^{-1}y})\frac{dy}{dx}=0, \quad y\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right),$$

with $f(0)=1$, then $f\left(\frac{1}{\sqrt{3}}\right)$ is equal to:

(1) $e^{\frac{\pi}{3}}$

(2) $e^{\frac{\pi}{12}}$

(3) $e^{\frac{\pi}{6}}$

(4) $e^{\frac{\pi}{4}}$

14. If

$$\lim_{x\to\infty}\left(\frac{e}{1-e}\left(\frac{1}{e}-\frac{x}{1+x}\right)\right)^x=\alpha,$$

then the value of

$$\frac{\log_e\alpha}{1+\log_e\alpha}$$

equals:

(1) e^{-2}

(2) e^{-1}

(3) e

(4) e^2

15. Let

$$E:\frac{x^2}{a^2}+\frac{y^2}{b^2}=1, \quad a>b \quad \text{and} \quad H:\frac{x^2}{A^2}-\frac{y^2}{B^2}=1.$$

Let the distance between the foci of E and the foci of H be $2\sqrt{3}$. If $a-A=2$, and the ratio of the eccentricities of E and H is $\frac{1}{3}$, then the sum of the lengths of their latus rectums is equal to:

(1) 9

(2) 10

(3) 8

(4) 7

16. The area of the region enclosed by the curves $y=x^2-4x+4$ and $y^2=16-8x$ is:

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

(2) 8

(3) $\frac{8}{3}$

(4) 5

17. If the system of linear equations:

$$x + y + 2z = 6,$$

$$2x + 3y + az = a + 1,$$

$$-x - 3y + bz = 2b,$$

where $a, b \in R$, has infinitely many solutions, then $7a + 3b$ is equal to:
(1) 22

(2) 16

(3) 9

(4) 12

18. In a group of 3 girls and 4 boys, there are two boys B_1 and B_2. The number of ways in which these girls and boys can stand in a queue such that all the girls stand together, all the boys stand together, but B_1 and B_2 are not adjacent to each other, is:
(1) 144

(2) 120

(3) 72

(4) 96

19. Let a line pass through two distinct points $P(-2, -1, 3)$ and Q, and be parallel to the vector $3\hat{i} + 2\hat{j} + 2\hat{k}$. If the distance of the point Q from the point $R(1, 3, 3)$ is 5, then the square of the area of $\triangle PQR$ is equal to:
(1) 148

(2) 144

(3) 140

(4) 136

20. For a 3×3 matrix M, let trace(M) denote the sum of all the diagonal elements of M. Let A be a 3×3 matrix such that $|A| = \frac{1}{2}$ and trace$(A) = 3$. If $B =$ adj(adj$(2A)$), then the value of $|B| +$ trace(B) equals:
(1) 132

(2) 56

(3) 174

(4) 280

21. Let $A(6, 8)$, $B(10\cos\alpha, -10\sin\alpha)$, and $C(-10\sin\alpha, 10\cos\alpha)$ be the vertices of a triangle. If $L(a, 9)$ and $G(h, k)$ be its orthocenter and centroid respectively, then $5a - 3h + 6k + 100\sin 2\alpha$ is equal to _____.

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

$$\frac{dy}{dx} + \frac{xy}{x^2 - 1} = \frac{x^6 + 4x}{\sqrt{1 - x^2}}, \quad -1 < x < 1$$

such that $f(0) = 0$. If

$$6\int_{-1/2}^{1/2} f(x)dx = 2\pi - \alpha$$

then α^2 is equal to _____.

23. Let the distance between two parallel lines be 5 units and a point P lies between the lines at a unit distance from one of them. An equilateral triangle POR is formed such that Q lies on one of the parallel lines, while R lies on the other. Then $(QR)^2$ is equal to _____.

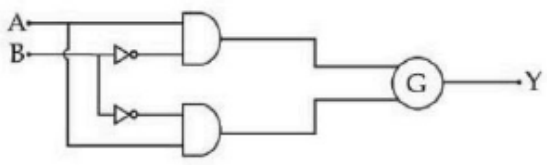
24. If

$$\sum_{r=1}^{30} r^2 \left(\binom{30}{r}\right)^2 = \alpha \times 2^{29},$$

then α is equal to _____.

25. Let $A = \{1, 2, 3\}$. The number of relations on A, containing $(1, 2)$ and $(2, 3)$, which are reflexive and transitive but not symmetric, is _____.

26. To obtain the given truth table, the following logic gate should be placed at G:



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

(1) AND Gate

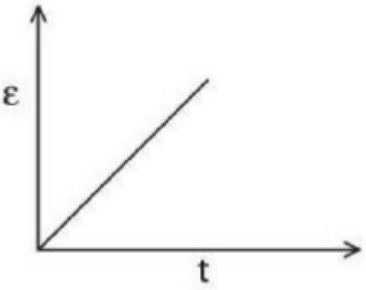
(2) OR Gate

(3) NOR Gate

(4) NAND Gate

27. A rectangular metallic loop is moving out of a uniform magnetic field region to a field-free region with a constant speed. When the loop is partially inside the magnetic field, the plot of the magnitude of the induced emf (ε) with time (t) is given by:

Options

1.


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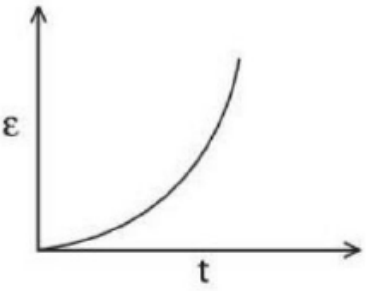

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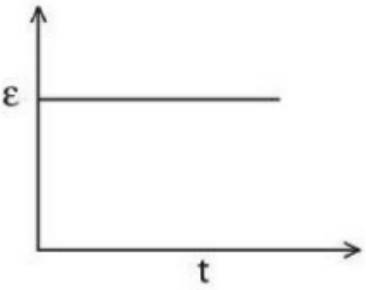

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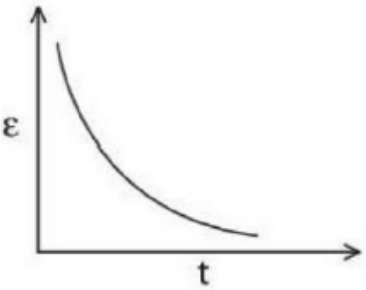


28. A light source of wavelength λ illuminates a metal surface, and electrons are ejected with a maximum kinetic energy of 2 eV. If the same surface is illuminated by a light source of wavelength $\frac{\lambda}{2}$, then the maximum kinetic energy of ejected electrons will be (The work function of the metal is 1 eV).

(1) 6 eV

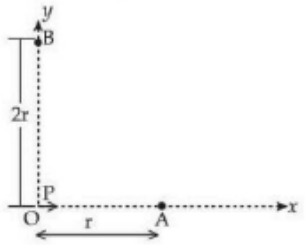
(2) 5 eV

(3) 2 eV

(4) 3 eV

29. For a short dipole placed at origin O, the dipole moment P is along the x-axis,

as shown in the figure. If the electric potential and electric field at A are V_0 and E_0 respectively, then the correct combination of the electric potential and electric field, respectively, at point B on the y-axis is given by:



(1) $\frac{V_0}{4}, \frac{E_0}{4}$

(2) $0, \frac{E_0}{16}$

(3) $\frac{V_0}{2}, \frac{E_0}{16}$

(4) $\frac{E_0}{8}$

30. An electron projected perpendicular to a uniform magnetic field B moves in a circle. If Bohr's quantization is applicable, then the radius of the electronic orbit in the first excited state is:

(1) $\sqrt{\frac{2h}{\pi eB}}$

(2) $\sqrt{\frac{4h}{\pi eB}}$

(3) $\sqrt{\frac{h}{\pi eB}}$

(4) $\sqrt{\frac{h}{2\pi eB}}$

31. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).

Assertion (A): In Young's double slit experiment, the fringes produced by red light are closer compared to those produced by blue light.

Reason (R): The fringe width is directly proportional to the wavelength of light.

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

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

(4) (A) is true, but (R) is false.

32. The maximum percentage error in the measurement of the density of a wire is:

Given, mass of wire = (0.60 ± 0.003) g, radius of wire = (0.50 ± 0.01) cm, length of wire = (10.00 ± 0.05)

(1) 7

(2) 5

(3) 4

(4) 8

33. Given are statements for certain thermodynamic variables:
(A) Internal energy, volume V, and mass M are extensive variables.
(B) Pressure P, temperature T, and density ρ are intensive variables.
(C) Volume V, temperature T, and density ρ are intensive variables.
(D) Mass M, temperature T, and internal energy are extensive variables.
Choose the correct answer from the options given below:
(1) (B) and (C) Only

(2) (C) and (D) Only

(3) (D) and (A) Only

(4) (A) and (B) Only

34. The torque due to the force $\left(2\hat{i} + \hat{j} + 2\hat{k}\right)$ about the origin, acting on a particle whose position vector is $\hat{i} + \hat{j} + \hat{k}$, would be:
(1) $\hat{i} + \hat{k}$

(2) $\hat{i} - \hat{k}$

(3) $\hat{i} + \hat{j} + \hat{k}$

(4) $\hat{j} + \hat{k}$

35. Which one of the following is the correct dimensional formula for the capacitance in F? M, L, T, and C stand for unit of mass, length, time, and charge.
(1) $[CM^{-1}L^{-2}T^{2}]$

(2) $[C^{2}M^{-1}L^{-2}T^{-2}]$

(3) $[C^{2}M^{-1}L^{2}T^{-2}]$

(4) $[C^{-2}M^{-1}L^{2}T^{-4}]$

36. A transparent film of refractive index 2.0 is coated on a glass slab of refractive index 1.45. What is the minimum thickness of transparent film to be coated for the maximum transmission of green light of wavelength 550 nm?
(1) 94.8 nm

(2) 275 nm

(3) 137.5 nm

(4) 68.7 nm

37. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
(A) A simple pendulum is taken to a planet with mass and radius 4 times and 2 times, respectively, compared to the Earth. The time period of the pendulum remains the same on Earth and the planet.
(R) The mass of the pendulum remains unchanged on Earth and the other planet.
In light of the above statements, choose the correct answer from the options given below:
(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).

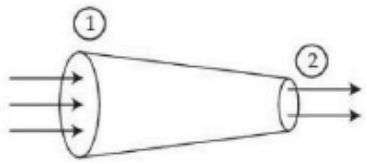
38. A small rigid spherical ball of mass M is dropped in a long vertical tube containing glycerine. The velocity of the ball becomes constant after some time. If the density of glycerine is half of the density of the ball, then the viscous force acting on the ball will be (consider g as acceleration due to gravity):
(1) $2Mg$

(2) Mg

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

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

39. A tube of length L is shown in the figure. The radius of cross section at point (1) is 2 cm and at the point (2) is 1 cm, respectively. If the velocity of water entering at point (1) is 2 m/s, then velocity of water leaving the point (2) will be:



(1) 4 m/s

(2) 6 m/s

(3) 8 m/s

(4) 2 m/s

40. A force $\mathbf{F} = 2\hat{i} + b\hat{j} + \hat{k}$ is applied on a particle and it undergoes a displacement $\mathbf{r} = \hat{i} - 2\hat{j} - \hat{k}$. What will be the value of b, if the work done on the particle is zero?
(1) $\frac{1}{2}$

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

(3) 0

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

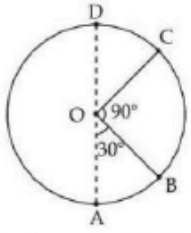
41. A ball of mass 100 g is projected with velocity 20 m/s at 60° with horizontal. The decrease in kinetic energy of the ball during the motion from point of projection to highest point is:
(1) Zero

(2) 5 J

(3) 20 J

(4) 15 J

42. A body of mass 100 g is moving in a circular path of radius 2 m on a vertical plane as shown in the figure. The velocity of the body at point A is 10 m/s. The ratio of its kinetic energies at point B and C is: (Take acceleration due to gravity as 10 m/s^2)



(Take acceleration due to gravity as 10 m/s^2)

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

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

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

(4) $\frac{2+\sqrt{2}}{3}$

43. For a diatomic gas, if $\gamma_1 = \frac{C_P}{C_V}$ for rigid molecules and $\gamma_2 = \frac{C_P}{C_V}$ for another diatomic molecules, but also having vibrational modes. Then, which one of the following options is correct? (where C_P and C_V are specific heats of the gas at constant pressure and volume)

(1) $\gamma_2 = \gamma_1$

(2) $\gamma_2 > \gamma_1$

(3) $2\gamma_2 = \gamma_1$

(4) $\gamma_2 < \gamma_1$

44. A series LCR circuit is connected to an alternating source of emf E. The current amplitude at resonance frequency is I_0. If the value of resistance R becomes twice of its initial value, then amplitude of current at resonance will be:

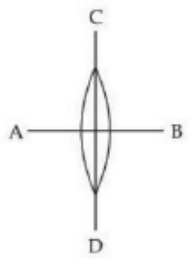
(1) $\frac{I_0}{2}$

(2) $2I_0$

(3) I_0

(4) $\frac{I_0}{\sqrt{2}}$

45. A symmetric thin biconvex lens is cut into four equal parts by two planes AB and CD as shown in the figure. If the power of the original lens is 4D, then the power of a part of the divided lens is:



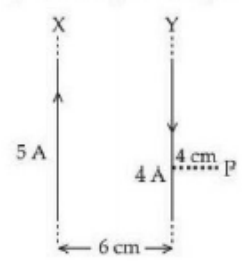
(1) D

(2) 8D

(3) 2D

(4) 4D

46. Two long parallel wires X and Y, separated by a distance of 6 cm, carry currents of 5 A and 4 A, respectively, in opposite directions as shown in the figure. Magnitude of the resultant magnetic field at point P at a distance of 4 cm from wire Y is 3×10^{-5} T. The value of x, which represents the distance of point P from wire X, is _____ cm. (Take permeability of free space as $\mu_0 = 4\pi \times 10^{-7}$ SI units.)



47. A tube of length 1m is filled completely with an ideal liquid of mass 2M, and closed at both ends. The tube is rotated uniformly in horizontal plane about one of its ends. If the force exerted by the liquid at the other end is F and the angular velocity of the tube is ω, then the value of α is _____ in SI units.

Solution:
The force F exerted by the liquid is related to the centripetal force required for the rotation. The centripetal force at a point at a distance r from the center is given by:

$$F_{\text{centripetal}} = mr\omega^2.$$

The total force exerted by the liquid is the sum of the forces over the length of the tube. Since the mass of the liquid is $2M$, and the force exerted is proportional to the square of the angular velocity, we have:

$$F = \alpha M\omega^2.$$

Therefore value of α is:

$$\boxed{\frac{F}{M\omega^2}}.$$

Quick Tip

For rotational motion, remember that the centripetal force depends on the mass, the radius of rotation, and the square of the angular velocity.

48. A proton is moving undeflected in a region of crossed electric and magnetic fields at a constant speed of 2×10^5 m/s. When the electric field is switched off, the proton moves along a circular path of radius 2 cm. The magnitude of electric field is $x \times 10^4$ N/C. The value of x is _____. (Take the mass of the proton as 1.6×10^{-27} kg).

Solution:
In the crossed electric and magnetic fields, the proton experiences a force due to both fields that keeps it moving undeflected. The magnetic force F_B and electric force F_E balance each other. The force due to the magnetic field is given by:

$$F_B = qvB,$$

where q is the charge of the proton, v is the speed, and B is the magnetic field.
The electric force is:

$$F_E = qE,$$

where E is the electric field.
At equilibrium, $F_B = F_E$, so:

$$qvB = qE \quad \Rightarrow \quad vB = E.$$

The proton moves along a circular path due to the magnetic field, so the centripetal force is:

$$F_{\text{centripetal}} = \frac{mv^2}{r}.$$

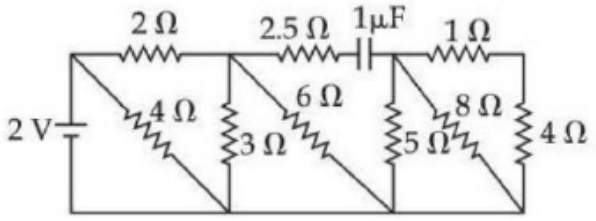
Figuring out this with the magnetic force F_B, we get:

$$\frac{mv^2}{r} = qvB \quad \Rightarrow \quad B = \frac{mv}{qr}.$$

Using the known values for the mass of the proton $m = 1.6 \times 10^{-27}\,\text{kg}$, radius $r = 0.02\,\text{m}$, and speed $v = 2 \times 10^5\,\text{m/s}$, we can find the electric field E using the relationship $E = vB$.
Therefore value of x is $\boxed{1}$.

> **Quick Tip**
>
> When a proton moves undeflected in crossed electric and magnetic fields, the forces due to the electric and magnetic fields are equal in magnitude and opposite in direction, allowing you to solve for the electric field and magnetic field.

49. The net current flowing in the given circuit is _____ A.



Solution:
The given circuit involves resistors and capacitors arranged in a certain way. To find the net current, we need to simplify the circuit and apply Kirchhoff's laws or Ohm's law, depending on the given values and configuration of the circuit.
After analyzing the circuit and applying Ohm's law, the net current I_{net} is calculated by:

$$I_{\text{net}} = \frac{V_{\text{total}}}{R_{\text{total}}},$$

where V_{total} is the total voltage applied to the circuit, and R_{total} is the total equivalent resistance of the circuit.
Based on the given values in the circuit, the net current is $\boxed{1}$ A.

> Quick Tip
>
> For circuits with resistors and capacitors, use Kirchhoff's current and voltage laws to Examine the flow of current. Use Ohm's law to calculate the current based on the total resistance and applied voltage.

50. A parallel plate capacitor of area $A = 16\,\text{cm}^2$ and separation between the plates $10\,\text{cm}$, is charged by a DC current. Consider a hypothetical plane surface of area $A_0 = 3.2\,\text{cm}^2$ inside the capacitor and parallel to the plates. At an instant, the current through the circuit is 6A. At the same instant the displacement current through A_0 is _____ mA.
Solution:
The displacement current $I_{\text{displacement}}$ is related to the rate of change of the electric flux through the surface A_0. As stated by Maxwell's equations, the displacement current is given by:

$$I_{\text{displacement}} = \epsilon_0 \frac{d\Phi_E}{dt},$$

where $\Phi_E = E \cdot A_0$ is the electric flux through the surface A_0, E is the electric field between the plates, and A_0 is the area of the hypothetical surface inside the capacitor. The electric field E is related to the charge Q on the plates by:

$$E = \frac{\sigma}{\epsilon_0} = \frac{Q}{\epsilon_0 A},$$

where $\sigma = \frac{Q}{A}$ is the surface charge density. For the displacement current, we use the fact that the total current I through the circuit is related to the rate of change of the charge:

$$I = \frac{dQ}{dt}.$$

Therefore rate of change of the charge $\frac{dQ}{dt}$ is the current through the circuit. Since the displacement current is proportional to the rate of change of the electric field, we have:

$$I_{\text{displacement}} = \frac{A_0}{A} I.$$

Given: - $A_0 = 3.2\,\text{cm}^2 = 3.2 \times 10^{-4}\,\text{m}^2$, - $A = 16\,\text{cm}^2 = 16 \times 10^{-4}\,\text{m}^2$, - $I = 6\,\text{A}$.
Substitute these values into the formula:

$$I_{\text{displacement}} = \frac{3.2 \times 10^{-4}}{16 \times 10^{-4}} \times 6 = \frac{3.2}{16} \times 6 = 1.2\,\text{A}.$$

Converting this to milliamps:

$$I_{\text{displacement}} = 1200\,\text{mA}.$$

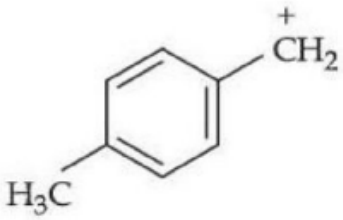
Therefore displacement current through A_0 is $\boxed{1200\,\text{mA}}$.

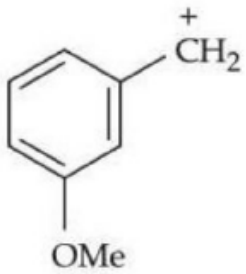
Quick Tip

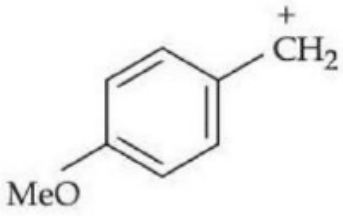
The displacement current is proportional to the rate of change of the electric flux. For a parallel plate capacitor, the displacement current is given by the ratio of the area of the hypothetical surface inside the capacitor to the total area, multiplied by the current through the circuit.

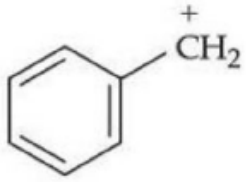
51. The most stable carbocation from the following is:

Options

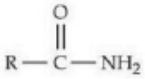
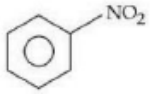
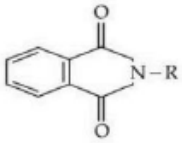
1. 

2. 

3. 

4. 

52. Match the Compounds (List - I) with the appropriate Catalyst/Reagents (List - II) for their reduction into corresponding amines.

List - I (Compounds)		List - II (Catalyst/Reagents)	
(A)		(I)	NaOH (aqueous)
(B)		(II)	H_2/Ni
(C)	$R-C\equiv N$	(III)	$LiAlH_4$, H_2O
(D)		(IV)	Sn, HCl

Choose the **correct** answer from the options given below :

Options

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

Correct Answer: (A)-(III), (B)-(II), (C)-(IV), (D)-(I) **Solution:**

1. (A) R-C=O-NH_2 (Amide):
   - To reduce an amide (R-C=O-NH_2) to an amine, we use LiAlH and HO (reagent III). LiAlH is a strong reducing agent that reduces amides to amines.
2. (B) $C_6H_5NO_2$ (Nitrobenzene):
   - Nitrobenzene is reduced to aniline using H/Ni (reagent II), which is a catalytic hydrogenation process.
3. (C) R-C $\equiv$ N (Nitrile):
   - Nitriles are reduced to amines using Sn and HCl (reagent IV), where the nitrile group is reduced to a primary amine.
4. (D) C_6H_5NH (Aniline):
   - Aniline undergoes reduction by NaOH (aqueous) (reagent I), which can be used to dealkylate aromatic amines under certain conditions.

therefore, the correct matching is:

$$\boxed{(A)-(III),(B)-(II),(C)-(IV),(D)-(I)}.$$

Quick Tip:

The reduction of functional groups like amides, nitro compounds, and nitriles can be accomplished with specific reducing agents such as LiAlH, H/Ni, and Sn/HCl respectively.

53. Given below are two statements:
Declaration (I): *Corrosion is an electrochemical phenomenon in which pure metal acts as an anode and impure metal as a cathode.*
Declaration (II): *The rate of corrosion is more in alkaline medium than in acidic medium.*
In the light of the above statements, choose the correct answer from the options given below:
(1) Both Statement I and Statement II are false

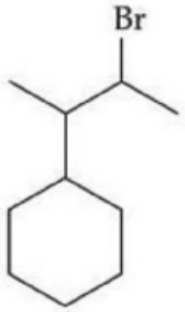
(2) Statement I is true but Statement II is false

(3) Both Statement I and Statement II are true

(4) The first statement is untrue but The second statement is accurate

54. When sec-butylcyclohexane reacts with bromine in the presence of sunlight, the major product is:

Options

1.


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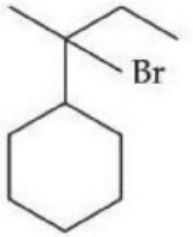
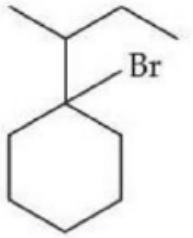
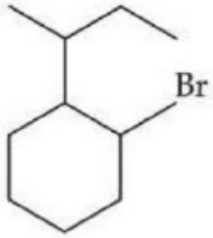


3.


4.


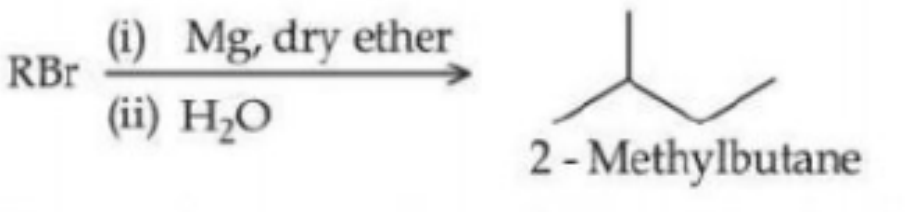
55. The molar solubility(s) of zirconium phosphate with molecular formula $Zr^{4+}PO_4^{3-}$ is given by relation:

Options

1. $\left(\frac{K_{sp}}{9612}\right)^{\frac{1}{3}}$
2. $\left(\frac{K_{sp}}{6912}\right)^{\frac{1}{7}}$
3. $\left(\frac{K_{sp}}{5348}\right)^{\frac{1}{6}}$
4. $\left(\frac{K_{sp}}{8435}\right)^{\frac{1}{7}}$

56. Determine the homoleptic complex(es) that is/are low spin.
(A) $[Fe(CN)_5NO]^{2-}$
(B) $[CoF_6]^{3-}$
(C) $[Fe(CN)_6]^{4-}$
(D) $[Co(NH_3)_6]^{3+}$
(E) $[Cr(H_2O)_6]^{2+}$
Choose the correct answer from the options given below:
(1) (C) and (D) only
(2) (B) and (E) only
(3) (A) and (C) only
(4) (C) only

57. The maximum number of RBr producing 2-methylbutane by above sequence of reactions is _____ (Consider the structural isomers only)



(1) 3

(2) 5

(3) 4

(4) 6

58. Given below are two statements:

Declaration (I): A spectral line will be observed for a $2p_x \rightarrow 2p_y$ transition.
Declaration (II): $2p_x$ and $2p_y$ are degenerate orbitals.
In the light of the above statements, choose the correct answer from the options given below:
(1) Both Statement I and Statement II are true

(2) The first statement is untrue but The second statement is accurate

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

(4) Both Statement I and Statement II are false

59. The alkane from below having two secondary hydrogens is:
(1) 2,2,4,4-Tetramethylhexane

(2) 2,2,3-Tetramethylpentane

(3) 4-Ethyl-3,4-dimethyloctane

(4) 2,2,4,5-Tetramethylheptane

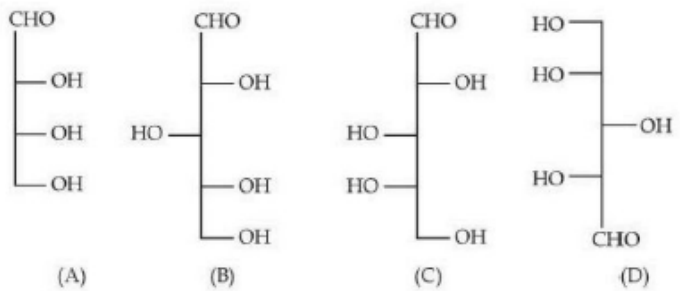
60. Match List - I with List - II.
List - I (Partial Derivatives) List - II (Thermodynamic Quantity)
(A) $\left(\frac{\partial G}{\partial T}\right)_P$ **(I)** C_p
(B) $\left(\frac{\partial H}{\partial T}\right)_P$ **(II)** $-S$
(C) $\left(\frac{\partial G}{\partial P}\right)_T$ **(III)** C_v
(D) $\left(\frac{\partial U}{\partial T}\right)_V$ **(IV)** V
In the light of the above statements, choose the correct answer from the options given below:
(1) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

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

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

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

61. Determine the number of structure/s from the following which can be correlated to D-glyceraldehyde.



(1) four

(2) three

(3) two

(4) one

62. Arrange the following compounds in increasing order of their dipole moment:
HBr, H_2S, NF_3, and CCl_3
(1) CCl_3 ¡ NF_3 ¡ HBr ¡ H_2S

(2) NF_3 ¡ HBr ¡ H_2S ¡ CCl_3

(3) H_2S ¡ HBr ¡ NF_3 ¡ CCl_3

(4) HBr ¡ H_2S ¡ NF_3 ¡ CCl_3

63. Given below are two statements:
Declaration (I): An element in the extreme left of the periodic table forms acidic oxides.
Declaration (II): Acid is formed during the reaction between water and oxide of a reactive element present in the extreme right of the periodic table.
In the light of the above statements, choose the correct answer from the options given below:
(1) Both Statement I and Statement II are false

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

(3) The first statement is untrue but The second statement is accurate

(4) Both Statement I and Statement II are true

64. Given below are two statements:
Declaration (I): Nitrogen, sulphur, halogen, and phosphorus present in an organic compound are detected by Lassaigne's Test.
Declaration (II): The elements present in the compound are converted from covalent form into ionic form by fusing the compound with Magnesium in Lassaigne's test.
In the light of the above statements, choose the correct answer from the options given below:
(1) Both Statement I and Statement II are false

(2) Both Statement I and Statement II are true

(3) The first statement is untrue but The second statement is accurate

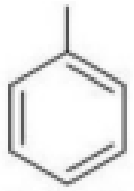
(4) Statement I is true but Statement II is false

65. The correct order of the following complexes in terms of their crystal field stabilization energies is:
(1) $[Co(NH_3)_6]^{2+} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_4]^{2+} < [Co(en)_3]^{3+}$
(2) $[Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_6]^{2+} < [Co(NH_3)_4]^{2+}$
(3) $[Co(NH_3)_4]^{2+} < [Co(NH_3)_6]^{2+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$
(4) $[Co(NH_3)_4]^{2+} < [Co(NH_3)_6]^{2+} < [Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+}$
66. Density of 3 M NaCl solution is 1.25 g/mL. The molality of the solution is:
(1) 2.79 m

(2) 1.79 m

(3) 3 m

(4) 2 m



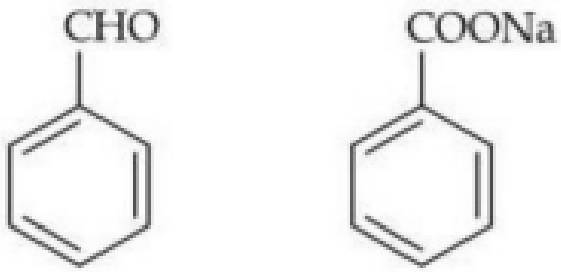
Toluene
(excess)

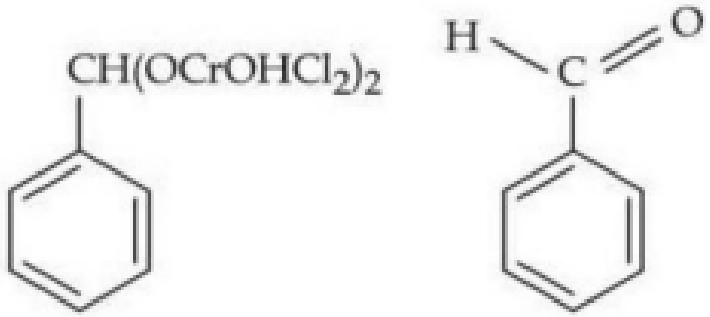
$\xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } CrO_2Cl_2,\ CS_2} \text{Filter} \longrightarrow \text{Residue (A)}$
(iii) $NaHSO_3$

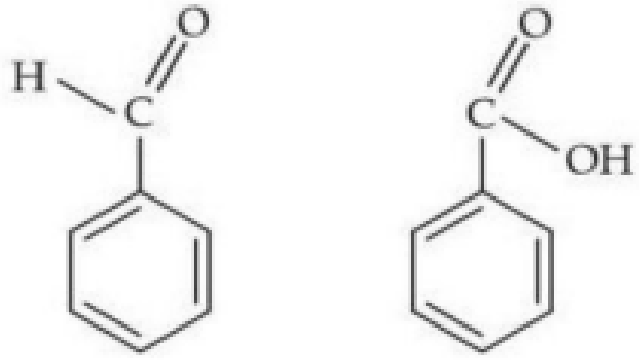
Residue (A) + HCl(dil) → Compound (B)

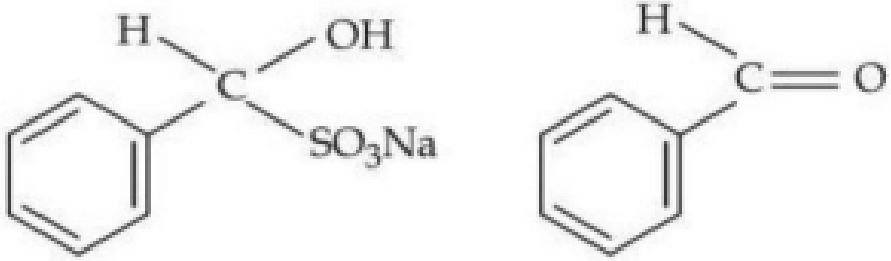
Structure of residue (A) and compound (B) formed respectively is :

[A] [B]

1. 

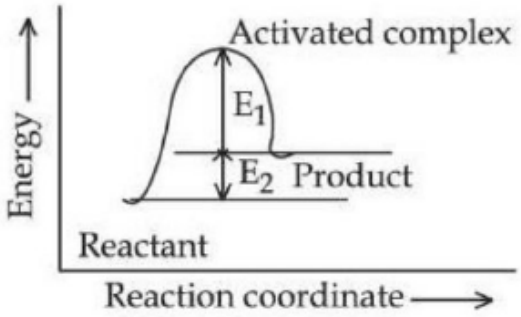
2. 

3. 

4. 

67.

68. Consider the given figure and choose the correct option:



(1) Activation energy of both forward and backward reaction is $E_1 + E_2$ and reactant is more stable than product.

(2) Activation energy of backward reaction is E_1 and product is more stable than reactant.

(3) Activation energy of forward reaction is $E_1 + E_2$ and product is less stable than reactant.

(4) Activation energy of forward reaction is $E_1 + E_2$ and product is more stable than reactant.

69. The species which does not undergo disproportionation reaction is:

(1) ClO_2^-

(2) ClO_4^-

(3) ClO_3^-

(4) ClO_2

70. The maximum covalency of a non-metallic group 15 element 'E' with the weakest E-E bond is:
(1) 6

(2) 5

(3) 3

(4) 4

71. Niobium (Nb) and ruthenium (Ru) have "x" and "y" number of electrons in their respective 4d orbitals. The value of $x + y$ is:
72. The compound with molecular formula C_6H_6, which gives only one monobromo derivative and takes up four moles of hydrogen per mole for complete hydrogenation has _____π electrons.

73. Consider the following cases of standard enthalpy of reaction (ΔH_f° in kJ mol^{-1}):

$$C_2H_6(g) + 7O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l) \quad \Delta H_1^\circ = -1550$$

$$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g) \quad \Delta H_2^\circ = -393.5$$

$$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(g) \quad \Delta H_3^\circ = -286$$

The magnitude of ΔH_f° of $C_2H_6(g)$ is _____ kJ mol^{-1} (Nearest integer).

74. The complex of Ni^{2+} ion and dimethyl glyoxime contains _____ number of Hydrogen (H) atoms.

75. 20 mL of 2 M NaOH solution is added to 400 mL of 0.5 M NaOH solution. The final concentration of the solution is _____ x 10^{-2} M. (Nearest integer)