JEE

2025

JEE MAINS

ALL 10 SETS

PHYSICS

CHEMISTRY

MATHEMATICS

StudentBro Pvt. Ltd.

JEE : Paper Set (2025)

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JEE

Total Marks : 300

22 Jan 2025 Shift 1

Mathematics

* SECTION - A [80]

1. The number of non-empty equivalence relations on the set {1,2,3} is:
(A) 6 (B) 7 (C) 5 (D) 4

2. Let $f: R \to R$ be a twice differentiable function such that $f(x+y) = f(x)f(y)$ for all $x, y \in R$. If $f'(0) = 4a$ and f staisfies $f''(x) - 3af'(x) - f(x) = 0$, $a > 0$, then the area of the region
$R = \{(x,y) \mid 0 \le y \le f(ax), 0 \le x \le 2\}$ is :
(A) $e^2 - 1$ (B) $e^4 + 1$ (C) $e^4 - 1$ (D) $e^2 + 1$

3. Let the triangle PQR be the image of the triangle with vertices $(1,3), (3,1)$ and $(2,4)$ in the line $x + 2y - 2$. If the centroid of $\triangle PQR$ is the point (α, β), then $15(\alpha - \beta)$ is equal to :
(A) 24 (B) 19 (C) 21 (D) 22

4. Let z_1, z_2 and z_3 be three complex numbers on the circle $|z| = 1$ with $\arg(z_1) = \frac{-\pi}{4}, \arg(z_2) = 0$ and $\arg(z_3) = \frac{\pi}{4}$. If $|z_1\bar{z}_2 + z_2\bar{z}_3 + z_3\bar{z}_1|^2 = \alpha + \beta\sqrt{2}, \alpha, \beta \in Z$, then the value of $\alpha^2 + \beta^2$ is :
(A) 24 (B) 41 (C) 31 (D) 29

5. Using the principal values of the inverse trigonometric functions the sum of the maximum and the minimum values of $16\left(\left(\sec^{-1}x\right)^2 + \left(\text{cosec}^{-1}x\right)^2\right)$ is :
(A) $24\pi^2$ (B) $18\pi^2$ (C) $31\pi^2$ (D) $22\pi^2$

6. A coin is tossed three times. Let X denote the number of times a tail follows a head. If μ and σ^2 denote the mean and variance of X, then the value of $64\left(\mu + \sigma^2\right)$ is :
(A) 51 (B) 48 (C) 32 (D) 64

7. Let $a_1, a_2, a_3, \ldots$ be a G.P. of increasing positive terms. If $a_1a_5 = 28$ and $a_2 + a_4 = 29$, the a_6 is equal to
(A) 628 (B) 526 (C) 784 (D) 812

8. Let $L_1 : \frac{x-1}{2} = \frac{y-2}{3} = \frac{z-3}{4}$ and $L_2 : \frac{x-2}{3} = \frac{y-4}{4} = \frac{z-5}{5}$ be two lines. Then which of the following points lies on the line of the shortest distance between L_1 and L_2 ?

(A) $\left(-\frac{5}{3}, -7, 1\right)$ (B) $\left(2, 3, \frac{1}{3}\right)$ (C) $\left(\frac{8}{3}, -1, \frac{1}{3}\right)$ (D) $\left(\frac{14}{3}, -3, \frac{22}{3}\right)$

9. The product of all solutions of the equation $e^{5(\log_e x)^2+3} = x^8, x > 0$, is :

(A) $e^{8/5}$ (B) $e^{6/5}$ (C) e^2 (D) e

10. If $\sum_{r=1}^{n} T_r = \frac{(2n-1)(2n+1)(2n+3)(2n+5)}{64}$, then $\lim_{n\to\infty} \sum_{r=1}^{n} \left(\frac{1}{T_r}\right)$ is equal to:

(A) 1 (B) 0 (C) $\frac{2}{3}$ (D) $\frac{1}{3}$

11. From all the English alphabets, five letters are chosen and are arranged in alphabetical order. The total number of ways, in which the middle letter is ' M ', is :

(A) 14950 (B) 6084 (C) 4356 (D) 5148

12. Let $x = x(y)$ be the solution of the differential equation $y^2 dx + \left(x - \frac{1}{y}\right) dy = 0$. If $x(1) = 1$, then $x\left(\frac{1}{2}\right)$ is :

(A) $\frac{1}{2} + e$ (B) $\frac{1}{2} + e$ (C) $3 - e$ (D) $3 + e$

13. Let the parabola $y = x^2 + px - 3$, meet the coordinate axes at the points P, Q and R . If the circle C with centre at $(-1, -1)$ passes through the points P, Q and R, then the area of $\triangle PQR$ is :

(A) 4 (B) 6 (C) 7 (D) 5

14. A circle C of radius 2 lies in the second quadrant and touches both the coordinate axes. Let r be the radius of a circle that has centre at the point $(2, 5)$ and intersects the circle C at exactly two points. If the set of all possible values of r is the interval (α, β), then $3\beta - 2\alpha$ is equal to :

(A) 15 (B) 14 (C) 12 (D) 10

15. Let for $f(x) = 7\tan^3 x + 7\tan^6 x - 3\tan^4 x - 3\tan^2 x$, $I_1 = \int_0^{\pi/4} f(x)dx$ and $I_2 = \int_0^{\pi/4} x f(x)dx$. Then $7I_1 + 12I_2$ is equal to:

(A) 2π (B) π (C) 1 (D) 2

16. Let $f(x)$ be a real differentiable function such that $f(0) = 1$ and $f(x+y) = f(x)f'(y) + f'(x)f(y)$ for all $x, y \in R$. Then $\sum_{n=1}^{1\infty 0} \log_e f(n)$ is equal to :

(A) 2384 (B) 2525 (C) 5220 (D) 2406

17. Let $A=\{1,2,3,\ldots\ldots,10\}$ and
$B=\left\{\frac{m}{n}: m,n\in A, m<n \text{ and } \gcd(m,n)=1\right\}$.
Then $n(B)$ is equal to :
(A) 31 (B) 36 (C) 37 (D) 29

18. The area of the region, inside the circle $(x-2\sqrt{3})^2+y^2=12$ and outside the parabola $y^2=2\sqrt{3}x$ is
(A) $6\pi-8$ (B) $3\pi-8$ (C) $6\pi-16$ (D) $3\pi+8$

19. Two balls are selected at random one by one without replacement from a bag containing 4 white and 6 black balls. If the probability that the first selected ball is black, given that the second selected ball is also black, is $\frac{m}{n}$, where $\gcd(m,n)=1$, then $m+n$ is equal to :
(A) 14 (B) 4 (C) 11 (D) 13

20. Let the foci of a hyperbola be $(1,14)$ and $(1,-12)$. If it passes through the point $(1,6)$, then the length of its latus-rectum is :
(A) $\frac{25}{6}$ (B) $\frac{24}{5}$ (C) $\frac{288}{5}$ (D) $\frac{144}{5}$

*** SECTION - B** **[20]**

21. Let the function, $f(x)=\begin{cases}-3ax^2-2, & x<1\\ a^2+bx, & x\geq 1\end{cases}$
Be differentiable for all $x\in R$, where $a>1, b\in R$. If the area of the region enclosed by $y=f(x)$ and the line $y=-20$ is $\alpha+\beta\sqrt{3}, \alpha,\beta,\in Z$, then the value of $\alpha+\beta$ is

22. If $\sum_{r=0}^{5}\frac{{}^{11}C_{2r+1}}{2r+2}=\frac{m}{n}, \gcd(m,n)=1$, then $m-n$ is equal to .

23. Let A be a square matrix of order 3 such that $\det(A)=-2$ and $\det(3\,\text{adj}(-6\,\text{adj}(3A)))=2^{n+\pi}\cdot 3^{mn}$, $m>n$. Then $4m+2n$ is equal to .

24. Let $L_1: \frac{x-1}{3}=\frac{y-1}{-1}=\frac{z+1}{0}$ and
$L_2: \frac{x-2}{2}-\frac{y}{0}-\frac{z+4}{\alpha}, \alpha\in R$, be two lines, which intersect at the point B. If P is the foot of perpendicular from the point $A(1,1,-1)$ on L_2, then the value of $26\alpha(PB)^2$ is ._____

25. Let $\vec{c}$ be the projection vector of $\vec{b}=\lambda\hat{i}+4\hat{k}, \lambda>0$, on the vector $\vec{a}=\hat{i}+2\hat{j}+2\hat{k}$.
If $|\vec{a}+\vec{c}|=7$, then the area of the parallelogram formed by the vectors $\vec{b}$ and $\vec{c}$ is _____ .

Physics

*** SECTION - A** **[80]**

26. Given below are two statements :

Statement I : In a vernier callipers, one vernier scale division is always smaller than one main scale division.

Statement II : The vernier constant is given by one main scale division multiplied by the number of vernier scale division.

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

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

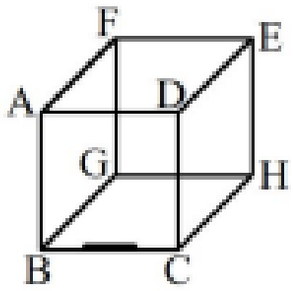
(B) Statement I is true but Statement II is false.

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

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

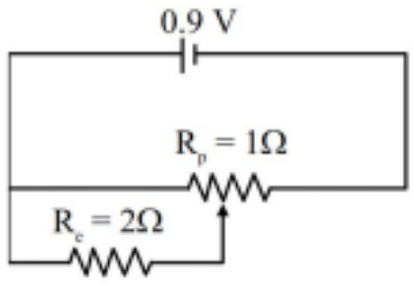
27. A line charge of length $\frac{a}{2}$ is kept at the center of an edge BC of a cube ABCDEFGH having edge length ' a ' as shown in the figure. If the density of line is $\lambda.C$ per unit length, then the total electric flux through all the faces of the cube will be _____ .

(Take, ϵ_0 as the free space permittivity)



(A) $\frac{\lambda a}{8\in_0}$ (B) $\frac{\lambda a}{16\epsilon_0}$ (C) $\frac{\lambda a}{2\epsilon_0}$ (D) $\frac{\lambda a}{4\epsilon_0}$

28.



Sliding contact of a potentiometer is in the middle of the potentiometer wire having resistance $R_p = 1\Omega$ as shown in the figure. An external resistance of $R_e = 2\Omega$ is connected via the sliding contact.

(A) 0.3 A (B) 1.35 A (C) 1.0 A (D) 0.9 A

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

Assertion (A) : If Young's double slit experiment is performed in an optically

denser medium than air, then the consecutive fringes come closer.

Reason (R) : The speed of light reduces in an optically denser medium than air while its frequency does not change.

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

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

(B) (A) is false but (R) is true.

(C) Both (A) and (R) are true but (R) is not the correct explanation of (A)

(D) (A) is true but (R) is false.

30. Two spherical bodies of same materials having radii 0.2 m and 0.8 m are placed in same atmosphere. The temperature of the smaller body is 800 K and temperature of bigger body is 400 K . If the energy radiate from the smaller body is E, the energy radiated from the bigger body is (assume, effect of the surrounding to be negligible)

(A) 256 E (B) E (C) 64 E (D) 16 E

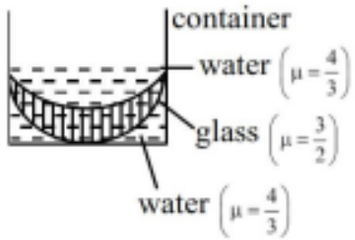
31. An amount of ice of mass $10^{-3}kg$ and temperature $-10^{\circ}C$ is transformed to vapour of temperature 110° by applying heat. The total amount of work required for this conversion is, (Take, specific heat of ice $= 2100Jkg^{-1}K^{-1}$, specific heat of water $= 4180Jkg^{-1}K^{-1}$, specific heat of steam $= 1920Jkg^{-1}K^{-1}$, Latent heat of ice $= 3.35 \times 10^{5}Jkg^{-1}$ and Latent heat of steam $= 2.25 \times 10^{6}Jkg^{-1}$)

(A) 3022 J (B) 3043 J (C) 3003 J (D) 3024 J

32. An electron in the ground state of the hydrogen atom has the orbital radius of $5.3 \times 10^{-11}m$ while that for the electron in third excited state is $8.48 \times 10^{-10}m$. The ratio of the de Broglie wavelengths of electron in the ground state to that in excited state is

(A) 4 (B) 9 (C) 3 (D) 16

33. In the diagram given below, there are three lenses formed. Considering negligible thickness of each of them as compared to $[R_1]$ and $[R_2]$, i.e., the radii of curvature for upper and lower surfaces of the glass lens, the power of the combination is

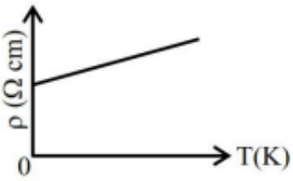


(A) $-\frac{1}{6}\left(\frac{1}{|R_1|}+\frac{1}{|R_2|}\right)$ (B) $-\frac{1}{6}\left(\frac{1}{|R_1|}-\frac{1}{|R_2|}\right)$

(C) $\frac{1}{6}\left(\frac{1}{|R_1|}+\frac{1}{|R_2|}\right)$ (D) $\frac{1}{6}\left(\frac{1}{|R_1|}-\frac{1}{|R_2|}\right)$

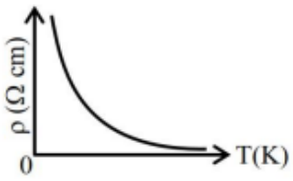
34. An electron is made to enters symmetrically between two parallel and equally but oppositely charged metal plates, each of 10 cm length. The electron emerges out of the field region with a horizontal component of velocity $10^6 m/s$. If the magnitude of the electric between the plates is 9.1 V/cm, then the vertical component of velocity of electron is
(mass of electron $= 9.1 \times 10^{-31} kg$ and charge of electron $= 1.6 \times 10^{-19} C$)
(A) $1 \times 10^6 m/s$ (B) 0 (C) $16 \times 10^6 m/s$ (D) $16 \times 10^4 m/s$

35. Which of the following resistivity (ρ) v/s temperature (T) curves is most suitable to be used in wire bound standard resistors?
(A)

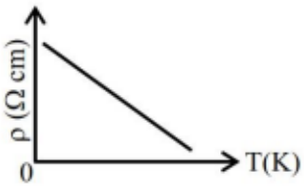


(B)

(C)



(D)

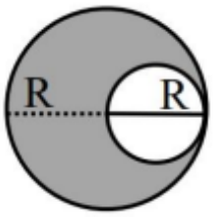


36. A closed organ and an open organ tube filled by two different gases having same bulk modulus but different densities ρ_1 and ρ_2 respectively. The frequency of 9^a harmonic of closed tube is identical with 4^{th} harmonic of open tube. If the

length of the closed tube is 10 cm and the density ratio of the gases is $\rho_1 : \rho_2 = 1 : 16$, then the length of the open tube is :

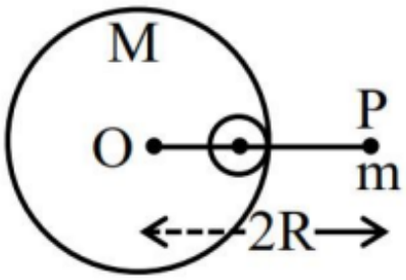
(A) $\frac{20}{7} cm$ (B) $\frac{15}{7} cm$ (C) $\frac{20}{9} cm$ (D) $\frac{15}{9} cm$

37. A uniform circular disc of radius ' R ' and mass ' M ' is rotating about an axis perpendicular to its plane and passing through its centre. A small circular part of radius $R/2$ is removed from the original disc as shown in the figure. Find the moment of inertia of the remaining part of the original disc about the axis as given above.



(A) $\frac{7}{32} MR^2$ (B) $\frac{9}{32} MR^2$ (C) $\frac{17}{32} MR^2$ (D) $\frac{13}{32} MR^2$

38. A small point of mass m is placed at a distance $2R$ from the centre ' O ' of a big uniform solid sphere of mass M and radius R . The gravitational force on ' m ' due to M is F_1. A spherical part of radius $R/3$ is removed from the big sphere as shown in the figure and the gravitational force on m due to remaining part of M is found to be F_2. The value of ratio $F_1 : F_2$ is



(A) $16 : 9$ (B) $11 : 10$ (C) $12 : 11$ (D) $12 : 9$

39. The work functions of cesium (Cs) and lithium (Li) metals are 1.9 eV and 2.5 eV , respectively. If we incident a light of wavelength 550 nm on these two metal surface, then photo-electric effect is possible for the case of

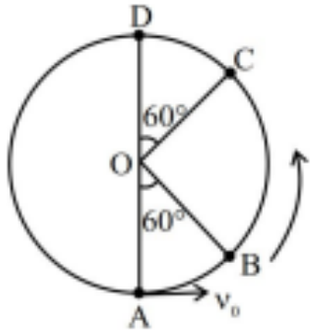
(A) Li only (B) Cs only (C) Neither Cs nor Li (D) Both Cs and Li

40. If B is magnetic field and $_0$ is permeability of free space, then the dimensions of (B/μ_0) is

(A) $MT^{-2}A^{-1}$ (B) $L^{-1}A$ (C) $LT^{-2}A^{-1}$ (D) $ML^2T^{-2}A^{-1}$

41. A bob of mass m is suspended at a point O by a light string of length l and left to perform vertical motion (circular) as shown in figure. Initially, by applying horizontal velocity v_0 at the point ' A '. the string becomes slack when, the bob reaches at the point ' D '. The ratio of the kinetic energy of the bob at the points

B and C is _____



(A) 2 (B) 1 (C) 4 (D) 3

42. Given below are two statements :

Statement-I : The equivalent emf of two nonideal batteries connected in parallel is smaller than either of the two emfs.

Statement-II : The equivalent internal resistance of two nonideal batteries connected in parallel is smaller than the internal resistance of either of the two batteries.

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

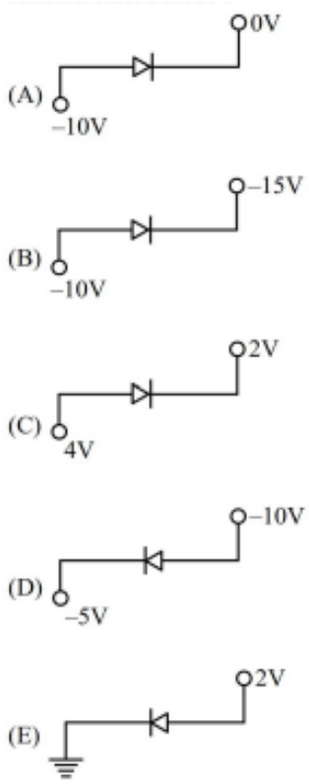
(A) Statement-I is true but Statement-II is false

(B) Both Statement-I and Statement-II are false

(C) Both Statement-I and Statement-II are true

(D) Statement-I is false but Statement-II is true

43. Which of the following circuits represents a forward biased diode?



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

(A) (B), (D) and (E) only (B) (A) and (D) only (C) (B), (C) and (E) only (D) (C) and (E) only

44. A parallel-plate capacitor of capacitance $40\mu F$ is connected to a 100 V power supply. Now the intermediate space between the plates is filled with a dielectric material of dielectric constant $K = 2$. Due to the introduction of dielectric material, the extra charge and the change in the electrostatic energy in the capacitor, respectively, are -

(A) 2 mC and 0.2 J (B) 8 mC and 2.0 J (C) 4 mC and 0.2 J (D) 2 mC and 0.4 J

45. Given is a thin convex lens of glass (refractive index μ) and each side having radius of curvature R . One side is polished for complete reflection. At what distance from the lens, an object be placed on the optic axis so that the image gets formed on the object itself.

(A) R/μ (B) $R/(2\mu - 3)$ (C) μR (D) $R/(2\mu - 1)$

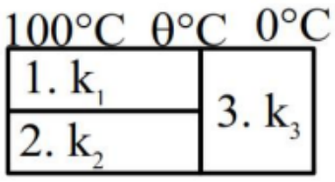
*** SECTION - B** **[20]**

46. Two soap bubbles of radius 2 cm and 4 cm , respectively, are in contact with each other. The radius of curvature of the common surface, in cm , is _____ .

47. The driver sitting inside a parked car is watching vehicles approaching from behind with the help of his side view mirror, which is a convex mirror with radius of curvature $R = 2m$. Another car approaches him from behind with a uniform speed of $90km/hr$. When the car is at a distance of 24 m from him, the

magnitude of the acceleration of the image of the side view mirror is ' a '. The value of 100a is _____ m/s^2.

48. Three conductions of same length having thermal conductivity k_1, k_2 and k_3 are connected as shown in figure.



Area of cross sections of 1^{14} and 2^{rad} conductor are same and for 3^{nd} conductor it is double of the $1^{s}t$ conductor. The temperatures are given in the figure. In steady state condition, the value of θ is _____ $^{\circ}C$.
(Given : $k_1 = 60Js^{-1}m^{-1}K^{-1}, k_2 = 120Js^{-1}m^{-1}K^{-1}, k_3 = 135Js^{-1}m^{-1}K^{-1}$)

49. The position vectors of two 1 kg particles, (A) and (B), are given by $\vec{r}_A = \left(\alpha_1 t^2 \hat{i} + \alpha_2 \hat{t} + \alpha_3 t \hat{k}\right) m$ and $\vec{r}_B = \left(\beta_1 t \hat{i} + \beta_2 t^2 \hat{j} + \beta_3 t \hat{k}\right) m$, respectively; $(\alpha_1 = 1m/s^2, \alpha_2 = 3nm/s, \alpha_3 = 2m/s, \beta_1 = 2m/s$, $\beta_2 = -1m/s^2, \beta_3 = 4pm/s$), where t is time, n and p are constants, At $t = 1s$, $\left|\vec{V}_A\right| = \left|\vec{V}_B\right|$ and velocities $\vec{V}_A$ and $\vec{V}_B$ of the particles are orthogonal to each other. At $t = 1s$, the magnitude of angular momentum of particle (A) with respect to the position of particle (B) is $\sqrt{L} kgm^2s^{-1}$. The value of L is _____ .

50. A particle is projected at an angle of 30° from horizontal at a speed of $60m/s$. The height traversed by the particle in the first second is h_0 and height traversed in the last second, before it reaches the maximum height, is h_1. The ratio $h_0 : h_1$ is _____
[Take, $g = 10m/s^2$]

Chemistry

*** SECTION - A** **[80]**

51. A solution of aluminium chloride is electrolysed for 30 minutes using a current of 2 A . The amount of the aluminium deposited at the cathode is _____ .
[Given : molar mass of aluminium and chlorine are $27gmol^{-1}$ and $35.5gmol^{-1}$ respectively, Faraday constant $= 96500Cmol^{-1}$].
(A) 1.660 g (B) 1.007 g (C) 0.336 g (D) 0.441 g

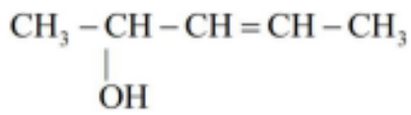
52. Which of the following statement is not true for radioactive decay ?
(A) Amount of radioactive substance remained after three half lives is $\frac{1}{8}$ th of original amount.

(B) Decay constant does not depend upon temperature.

(C) Decay constant increases with increase in temperature.

(D) Half life is $\ln 2$ times of $\frac{1}{\text{rate constant}}$.

53. How many different stereoisomers are possible for the given molecule?



(A) 3 (B) 1 (C) 2 (D) 4

54. Which of the following electronegativity order is **incorrect**?

(A) $Al < Mg < B < N$ (B) $Al < Si < C < N$

(C) $Mg < Be < B < N$ (D) S < Cl < O < F

55. Lanthanoid ions with $4f^7$ configuration are :

(A) Eu^{2+}

(B) Gd^{3-}

(C) Eu^{3+}

(D) Tb^{3+}

(E) Sm^{2+}

Choose the correct answer from the options given below :

(A) (A) and (B) only (B) (A) and (D) only (C) (B) and (E) only (D) (B) and (C) only

56. Match List-I with List-II

List-1		List-II	
(A)	$Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$	(I)	Ionisation Enthalpy
(B)	B < C < O < N	(II)	Metallic character
(C)	B < Al < Mg < K	(III)	Electronegativity
(D)	Si < P < S < Cl	(IV)	Ionic radii

Choose the correct answer from the options given below :

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

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

57. Which of the following acids is a vitamin ?

(A) Adipic acid (B) Aspartic acid (C) Ascorbic acid (D) Saccharic acid

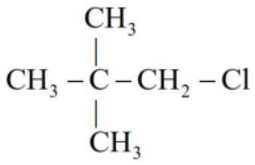
58. A liquid when kept inside a thermally insulated closed vessel at $25^{\circ}C$ was mechanically stirred from outside. What will be the correct option for the following thermodynamic parameters ?

(A) $\Delta U > 0, q = 0, w > 0$ (B) $\Delta U = 0, q = 0, w = 0$

(C) $\Delta U < 0, q = 0, w > 0$ (D) $\Delta U = 0, q < 0, w > 0$

59. Radius of the first excited state of Helium ion is given as :
$a_0 \rightarrow$ radius of first stationary state of hydrogen atom.
(A) $r = \frac{a_0}{2}$ (B) $r = \frac{a_0}{4}$ (C) $r = 4a_0$ (D) $r = 2a_0$

60. Given below are two statements :
Statement I : $CH_3 - O - CH_2 - Cl$ will undergo S_N1 reaction though it is a primary halide.
Statement II :

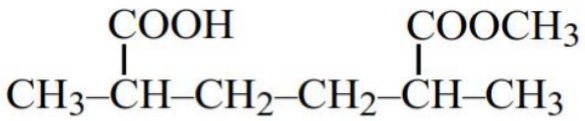


will not undergo S_N2 reaction very easily though it is a primary halide.
In the light of the above statements, choose the **most appropriate answer** from the options given below :
(A) Statement I is incorrect but Statement II is correct.
(B) Both Statement I and Statement II are incorrect
(C) Statement I is correct but Statement II is incorrect
(D) Both Statement I and Statement II are correct.

61. Given below are two statements :
Statement I : One mole of propyne reacts with excess of sodium to liberate half a mole of H_2 gas.
Statement II : Four g of propyne reacts with $NaNH_2$ to liberate NH_3 gas which occupies 224 mL at STP.
In the light of the above statements, choose the **most appropriate answer** from the options given below:
(A) **Statement I** is correct but **Statement II** is incorrect.
(B) Both **Statement I** and **Statement II** are incorrect
(C) **Statement I** is incorrect but **Statement II** is correct
(D) Both **Statement I** and **Statement II** are correct.

62. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm . Some of CO_2 is converted into CO on addition of graphite. If total pressure at equilibrium is 0.8 atm , then K_p is :
(A) 0.18 atm (B) 1.8 atm (C) 0.3 atm (D) 3 atm .

63. The IUPAC name of the following compound is :



(A) 2-Carboxy-5-methoxycarbonylhexane.

(B) Methyl-6-carboxy-2,5-dimethylhexanoate.

(C) Methyl-5-carboxy-2-methylhexanoate.

(D) 6-Methoxycarbonyl-2,5-dimethylhexanoic acid.

64. Which of the following electrolyte can be sued to obtain $H_2S_2O_8$ by the process of electrolysis?

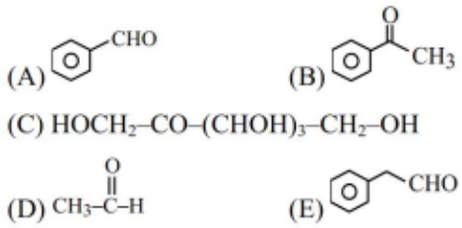
(A) Dilute solution of sodium sulphate

(B) Dilute solution of sulphuric acid

(C) Concentrated solution of sulphuric acid

(D) Acidified dilute solution of sodium sulphate.

65. The compounds which give positive Fehling's test are:



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

(A) (A), (C) and (D) Only

(B) (D) and (E) Only

(C) (C), (D) and (E) Only

(D) (A), (B) and (C) Only

66. In which of the following complexes the CFSE, Δ_0 will be equal to zero?

(A) $[Fe(NH_3)_6]Br_2$

(B) $[Fe(en)_3]Cl_3$

(C) $K_4[Fe(CN)_6]$

(D) $K_3[Fe(SCN)_6]$

67. Arrange the following solutions in order of their increasing boiling points.

(i) $10^{-4}MNaCl$

(ii) $10^{-4}M$ Urea

(iii) $10^{-3}MNaCl$

(iv) $10^{-2}MNaCl$

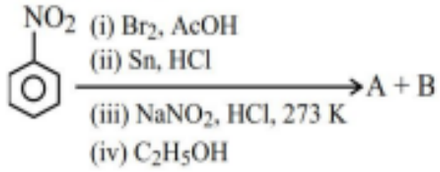
(A) (ii) < (i) < (iii) < (iv)

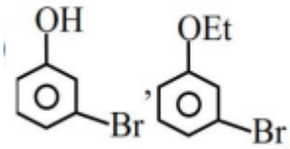
(B) (ii) < (i) $\cong$ (iii) < (iv)

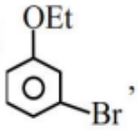
(C) (i) < (ii) < (iii) < (iv)

(D) (iv) $<$ (iii) < (i) < (ii)

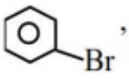
68. The products formed in the following reaction sequence are :



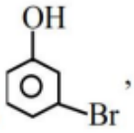
(A) 

(B) 

, CH_3–COOH

(C) 

, CH_3–CHO

(D) 

, CH_3–CHO

69. From the magnetic behaviour of $[NiCl_4]^{2-}$ (paramagnetic) and $[Ni(CO)_4]$ (diamagnetic), choose the correct geometry and oxidation state.

(A) $[NiCl_4]^{2-}$: Ni^{II}, square planar $[Ni(CO)_4]$: $Ni(0)$, square planar

(B) $[NiCl_4]^{2-}$: Ni'', tetrahedral $[Ni(CO)_4]$: $Ni(0)$, tetrahedral

(C) $[NiCL_4]^{2-}$: Ni^{II} , tetrahedral $[Ni(CO)_4]$: Ni^{ill} , square planar

(D) $[NiCl_4]^{2-}$: $Ni(0)$, tetrahedral $[Ni(CO)_4]$: $Ni(0)$, square planar

70. The incorrect statements regarding geometrical isomerism are :

(A) Propene shows geometrical isomerism.

(B) Trans isomer has identical atoms/groups on the opposite sides of the double bond.

(C) Cis-but-2-ene has higher dipole moment than trans-but-2-ene.

(D) 2-methylbut-2-ene shows two geometrical isomers.

(E) Trans-isomer has lower melting point that cis isomer.

Choose the CORRECT answer from the options given below :

(A) (A), (D) and (E) only (B) (C), (D) and (E) only (C) (B) and (C) only (D) (A) and (E) only

*** SECTION - B** **[20]**

71. Some CO_2 gas was kept in a sealed container at a pressure of 1 atm and at 273 K . This entire amount of CO_2 gas was later passed through an aqueous solution

of $Ca(OH)_2$. The excess unreacted $Ca(OH)_2$ was later neutralized with 0.1 M of 40 mL HCl . If the volume of the sealed container of CO_2 was x , then x is _____ cm^3 (nearest integer).

[Given : The entire amount of $CO_2(g)$ reacted with exactly half the initial amount of $Ca(OH)_2$ present in the aqueous solution.]

72. In Carius method for estimation of halogens, 180 mg of an organic compound produced 143.5 mg of AgCl . The percentage composition of chlorine in the compound is _____ %.

[Given : molar mass in $gmol^{-1}$ of Ag : 108, $Cl = 35.5$]

73. The number of molecules/ions that show linear geometry among the following is _____ .

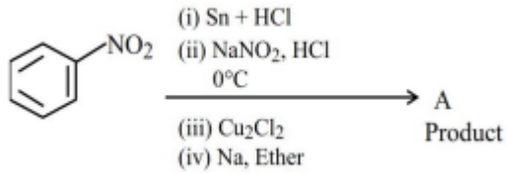
$SO_2, BeCl_2, CO_2, N_3^-, NO_2, F_2O, XeF_2, NO_2^+, I_3^-, O_3$

74. $A \rightarrow B$

The molecule A changes into its isomeric form B by following a first order kinetics at a temperature of 1000 K . If the energy barrier with respect to reactant energy for such isomeric transformation is $191.48 kJmol^{-1}$ and the frequency factor is 10^{20}, the time required for 50%, molecules of A to become B is _____ picoseconds (nearest integer).

$\left[R = 8.314 JK^{-1}mol^{-1}\right]$

75. Consider the following sequence of reactions :



Molar mass of the product formed (A) is _____ $gmol^{-1}$.

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JEE

Total Marks : 300

22 Jan 2025 Shift 2

Mathematics

* SECTION - A [80]

1. Let α, β, γ and δ be the coefficients of x^7, x^5, x^3 and x respectively in the expansion of $\left(x+\sqrt{x^3-1}\right)^5+\left(x-\sqrt{x^3-1}\right)^5, x>1$. If u and v satisfy the equations

$\alpha u+\beta v=18,$

$\gamma u+\delta v=20,$

then $u+v$ equals :

(A) 5 (B) 4 (C) 3 (D) 8

2. 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 :

(A) 144 (B) 72 (C) 96 (D) 120

3. 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 perpendiculars drawn from P and Q respectively on the directrix of the parabola, then the area of the quadrilateral PQMN is equal to:

(A) $\frac{263\sqrt{3}}{8}$ (B) $17\sqrt{3}$ (C) $\frac{343\sqrt{3}}{8}$ (D) $\frac{34\sqrt{3}}{3}$

4. 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 $B=\text{adj}(\text{adj}(2A))$, then the value of $|B|+$ trace (B) equals:

(A) 56 (B) 132 (C) 174 (D) 280

5. Suppose that the number of terms in an A.P. is 2 k, $k\in N$. 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

(A) 5 (B) 8 (C) 6 (D) 4

6. Let a line pass through two distinct points $P(-2,-1,3)$ and Q, and be parallel to the vector $3\hat{i}+2\hat{j}+2k$. 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:

(A) 136 (B) 140 (C) 144 (D) 148

7. If $\lim_{x\to\infty}\left(\left(\frac{e}{1-e}\right)\left(\frac{1}{e}-\frac{x}{1+x}\right)\right)^{x}=\alpha$, then the value of $\frac{\log_e \alpha}{1+\log_e \alpha}$ equals :

(A) e (B) e^{-2} (C) e^{2} (D) e^{-1}

8. 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 :

(A) 2 and 3 (B) 3 and 2 (C) 1 and 3 (D) 2 and 2

9. 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:

(A) 6 (B) $5\sqrt{2}$ (C) $3\sqrt{5}$ (D) $4\sqrt{3}$

10. If $x=f(y)$ is the solution of the differential equation $\left(1+y^2\right)+\left(x-2e^{\tan^{-1}y}\right)\frac{dy}{dx}=0, y\in\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ with $f(0)=1$, then $f\left(\frac{1}{\sqrt{3}}\right)$ is equal to :

(A) $e^{\pi/4}$ (B) $e^{\pi/12}$ (C) $e^{\pi/3}$ (D) $e^{\pi/6}$

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

(A) $\frac{\pi}{6}\sqrt{\frac{e}{2}}$ (B) $\frac{\pi}{4}\sqrt{\frac{e}{2}}$ (C) $\frac{\pi}{6}\sqrt{\frac{e}{3}}$ (D) $\frac{\pi}{4}\sqrt{\frac{e}{3}}$

12. Let α_0 and β_0 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 $\alpha_0^4+\beta_0^4$, then $16(M+m)$ equals :

(A) 24 (B) 25 (C) 27 (D) 17

13. 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 :

(A) 127 (B) 151 (C) 163 (D) 139

14. 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 :

(A) 9 (B) 12 (C) 16 (D) 22

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

(A) 3 (B) 2 (C) 1 (D) 0

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

(A) 10 (B) 7 (C) 8 (D) 9

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

(A) $\frac{5}{3}$ (B) $\frac{4}{3}$ (C) $\frac{9}{4}$ (D) $\frac{7}{4}$

18. 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

(A) $\frac{\pi}{2}$ (B) 4π (C) $\frac{5\pi}{6}$ (D) π

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

(A) $1+\frac{\pi}{2}$ (B) $1+\frac{\pi}{3}$ (C) $1+\frac{\pi}{4}$ (D) $1+\frac{\pi}{6}$

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

(A) $\frac{8}{3}$ (B) $\frac{4}{3}$ (C) 5 (D) 8

*** SECTION - B** **[20]**

21. Let $y=f(x)$ be the solution of the differential equation $\frac{dy}{dx}+\frac{xy}{x^2-1}=\frac{x^6+4x}{\sqrt{1-x^2}}$, -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 _____.

22. Let $A(6,8), B(10\cos\alpha, -10 \quad \sin\alpha)$ 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 _____.

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

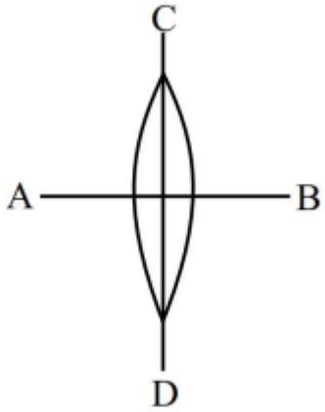
24. If $\sum_{r=1}^{30} \frac{r^2\left({}^{30}C_r\right)^2}{{}^{30}C_{r-1}}=\alpha \times 2^{29}$, then α is equal to _____ .

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 _____.

Physics

*** SECTION - A** **[80]**

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



part of the divided lens is

(A) 8D (B) 4D (C) D (D) 2D

27. 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)

(A) $\frac{3}{2}Mg$ (B) $\frac{Mg}{2}$ (C) Mg (D) 2 Mg

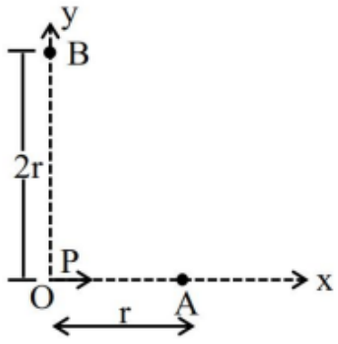
28. The maximum percentage error in the measurment of density of a wire is
[Given, mass of wire $= (0.60 \pm 0.003)g$
radius of wire $= (0.50 \pm 0.01)cm$
length of wire $(10.00 \pm 0.05)cm$]

(A) 4 (B) 5 (C) 8 (D) 7

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

(A) I_0 (B) $\frac{I_0}{2}$ (C) $\frac{I_0}{\sqrt{2}}$ (D) $2I_0$

30. For a short dipole placed at origin O , the dipole moment P is along 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



(A) $\frac{V_0}{2}$ and $\frac{E_0}{16}$ (B) zero and $\frac{E_0}{8}$ (C) zero and $\frac{E_0}{16}$ (D) V_0 and $\frac{E_0}{4}$

31. 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,

(A) $[F] = \left[C^2 M^{-2} L^2 T^2\right]$ (B) $[F] = \left[C M^{-2} L^{-2} T^{-2}\right]$

(C) $[F] = \left[C M^{-1} L^{-2} T^2\right]$ (D) $[F] = \left[C^2 M^{-1} L^{-2} T^2\right]$

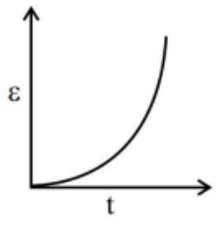
32. An electron projected perpendicular to a uniform magnetic field B moves in a circle. If Bohr's quantization is applicable, then the radius of the electronic orbit in the first excited state is :

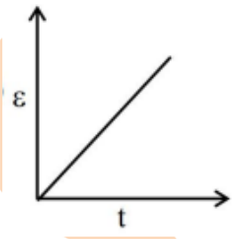
(A) $\sqrt{\frac{2h}{\pi eB}}$ (B) $\sqrt{\frac{4h}{\pi eB}}$ (C) $\sqrt{\frac{h}{2\pi eB}}$ (D) $\sqrt{\frac{h}{\pi eB}}$

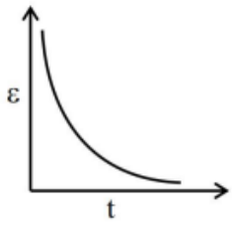
33. For a diatomic gas, if $\gamma_1 = \left(\frac{Cp}{Cv}\right)$ for rigid molecules and $\gamma_2 = \left(\frac{Cp}{Cv}\right)$ for another diatomic molecules, but also having vibrational modes. Then, which one of the following options is correct ?
(Cp and Cv are specific heats of the gas at constant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

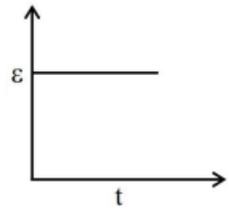
(A) $\gamma_2 > \gamma_1$ (B) $\gamma_2 = \gamma_1$ (C) $2\gamma_2 = \gamma_1$ (D) $\gamma_2 < \gamma_1$

34. 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 magnate field, the plot of magnitude of induced emf (ε) with time (t) is given by

(A) 

(B) 

(C) 

(D) 

35. A light source of wavelength λ illuminates a metal surface and electrons are ejected with 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 metal is 1 eV)

(A) 2 eV (B) 6 eV (C) 5 eV (D) 3 eV

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

Assertion (A) : A simple pendulum is taken to a planet of mass and radius, 4 times and 2 times, respectively, than the Earth. The time period of the pendulum remains same on earth and the planet.

Reason (R) : The mass of the pendulum remains unchanged at Earth and the other planet. In the light of the above statements, choose the **correct** answer from the options given below :

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

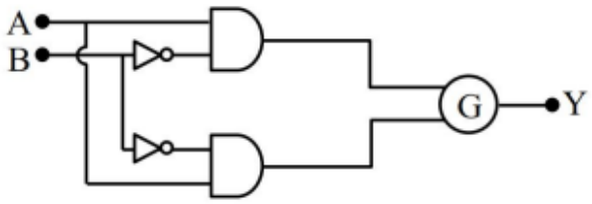
(B) (A) is true but (R) is false

(C) (A) is false but (R) is true

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

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

(A) $\hat{i}-\hat{j}+\hat{k}$ (B) $\hat{i}+\hat{k}$ (C) $\hat{i}-\hat{k}$ (D) $\hat{j}-\hat{k}$

38. 

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

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

(A) NOR Gate (B) AND Gate (C) NAND Gate (D) OR Gate

39. A force $\vec{F}=2\hat{i}+b\hat{j}+\hat{k}$ is applied on a particle and it undergoes a displacement $\hat{i}-2\hat{j}-\hat{k}$. What will be the value of b, if work done on the particle is zero.

(A) 0 (B) $\frac{1}{2}$ (C) $\frac{1}{3}$ (D) 2

40. Given below are two statements. On is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

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

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

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

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

(B) (A) is false but (R) is true.

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

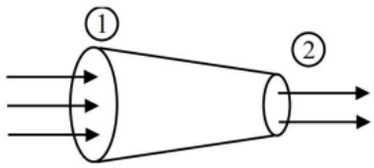
(D) (A) is true but (R) is false.

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

(A) 20 J (B) 15 J (C) zero (D) 5 J

42. 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 . [Assume that the light is incident nearly perpendicular to the glass surface.]

(A) 94.8 nm (B) 68.7 nm (C) 137.5 nm (D) 275 nm

43. 

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

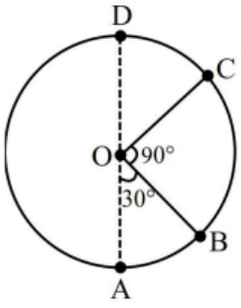
(A) $2m/s$ (B) $4m/s$ (C) $6m/s$ (D) $8m/s$

44. 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 points given below :

(A) (C) and (D) only (B) (D) and (A) only

(C) (A) and (B) only (D) (B) and (C) only

45. A body of mass 100 g is moving in circular path of radius 2 m on vertical plane as shown in figure. The velocity of the body at point A is $10m/s$. The ratio of its kinetic energies at point B and C is :



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

(A) $\frac{2+\sqrt{3}}{3}$ (B) $\frac{2+\sqrt{2}}{3}$ (C) $\frac{3+\sqrt{3}}{2}$ (D) $\frac{3-\sqrt{2}}{2}$

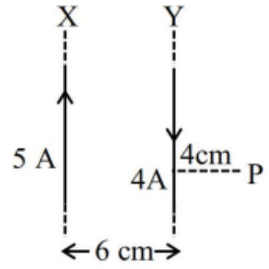
*** SECTION - B** **[20]**

46. A proton is moving undeflected in a region of crossed electric and magnetic fields at a constant speed of $2 \times 10^5 ms^{-1}$. 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 $= 1.6 \times 10^{-27} kg$.

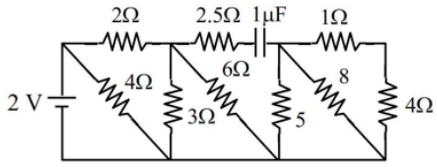
47. Two long parallel wires X and Y, separated by a distance of 6 cm, carry currents of 5 A and 4 A, respectively, in opposite directions as shown in the figure. Magnitude of the resultant magnetic field at point P at a distance of 4 cm from wire Y is $x \times 10^{-5} T$. The value of x is _____. Take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



48. A parallel plate capacitor of area $A = 16 cm^2$ and separation between the plates 10 cm, is charged by a DC current. Consider a hypothetical plane surface of area $A_0 = 3.2 cm^2$ inside the capacitor and parallel to the plates. At an instant, the current through the circuit is 6 A . At the same instant the displacement current through A_0 is _____ mA .

49. 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 then angular velocity of the tube is $\sqrt{\frac{F}{\alpha M}}$ in SI unit. The value of α is _____.

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



Chemistry

*** SECTION - A** **[80]**

51. Arrange the following compounds in increasing order of their dipole moment :

HBr, H_2S, NF_3 and $CHCl_3$

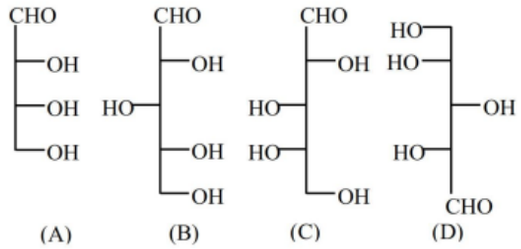
(A) $NF_3 < HBr < H_2S < CHCl_3$

(B) $HBr < H_2S < NF_3 < CHCl_3$

(C) $H_2S < HBr < NF_3 < CHCl_3$

(D) $CHCl_3 < NF_3 < HBr < H_2S$

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

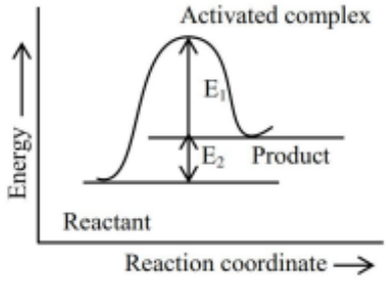


(A) three (B) two (C) four (D) one

53. The maximum covalency of a non-metallic group 15 element 'E' with weakest $E-E$ bond is :

(A) 5 (B) 3 (C) 6 (D) 4

54. Consider the given figure and choose the **correct** option :



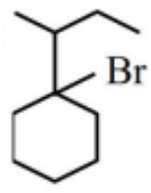
(A) Activation energy of backward reaction is E_1 and product is more stable than reactant.

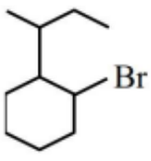
(B) Activation energy of forward reaction is $E_1 + E_2$ and product is more stable than reactant.

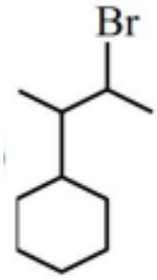
(C) Activation energy of forward reaction is $E_1 + E_2$ and product is less stable than reactant.

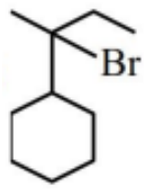
(D) Activation energy of both forward and backward reaction is $E_1 + E_2$ and reactant is more stable than product.

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

(A) 

(B) 

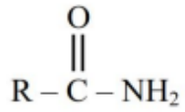
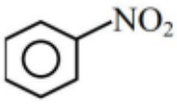
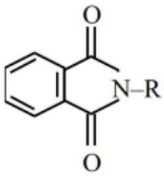
(C) 

(D) 

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

(A) ClO_2^- (B) ClO_4^- (C) ClO^- (D) ClO_3^-

57. 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)		NaOH (aqueous)
(B)		H_2/Ni
(C)	$R-C\equiv N$	$LiAlH_4, H_2O$
(D)		Sn, HCl

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

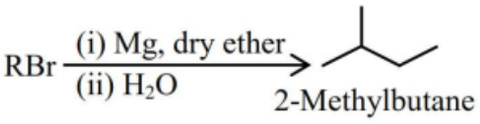
(A) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

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

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

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

58.



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

(A) 4 (B) 5 (C) 3 (D) 1

59. 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

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

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

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

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

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

60. The correct order of the following complexes in terms of their crystal field stabilization energies is :

(A) $[Co(NH_3)_4]^{2+} < [Co(NH_3)_6]^{2+} \leq [Co(en)_3]^{3+} \leq [Co(NH_3)_6]^{3+}$

(B) $[Co(NH_3)_4]^{2+} < [Co(NH_3)_6]^{2+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

(C) $[Co(NH_3)_6]^{2+} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_4]^{2+} < [Co(en)_3]^{3+}$

(D) $[Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+} < [Co(NH_3)_6]^{2+} < [Co(NH_3)_4]^{2+}$

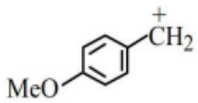
61. Density of 3 M NaCl solution is $1.25 g/mL$. The molality of the solution is :

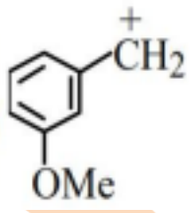
(A) 1.79 m (B) 2 m (C) 3 m (D) 2.79 m

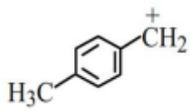
62. The molar solubility(s) of zirconium phosphate with molecular formula $\left(Zr^{4+}\right)_3\left(PO_4^{3-}\right)_4$ is given by relation :

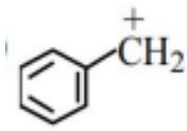
(A) $\left(\frac{K_{sp}}{6912}\right)^{\frac{1}{7}}$ (B) $\left(\frac{K_{sp}}{5348}\right)^{\frac{1}{6}}$ (C) $\left(\frac{K_{sp}}{8435}\right)^{\frac{1}{7}}$ (D) $\left(\frac{K_{sp}}{9612}\right)^{\frac{1}{3}}$

63. The most stable carbocation from the following is :

(A) 

(B) 

(C) 

(D) 

64. Given below are two statements :

Statement (I) : An element in the extreme left of the periodic table forms acidic oxides.

Statement (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 :

(A) Statement-I is false but Statement-II is true.

(B) Both Statement-I and Statement-II are false.

(C) Statement-I is true but Statement-II is false.

(D) Both Statement-I and Statement-II are true.

65. Given below are two statements :

Statement (I) : A spectral line will be observed for a $2p_x \rightarrow 2p_y$ transition.

Statement (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 :

(A) Both Statement-I and Statement-II are true.

(B) Both Statement-I and Statement-II are false.

(C) Statement-I is true but Statement-II is false

(D) Statement-I is false but Statement-II is true.

66. Given below are two statement :

Statement (I) : Nitrogen, sulphur, halogen and phosphorus present in an organic compound are detected by Lassaigne's Test.

Statement (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 :

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

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

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

67. Identify the homoleptic complex(es) that is/are low spin.

(A) $[Fe(CN)_5NO]^{2-}$

(B) $[CoF_6]^{3-}$

(C) $[Fe(CN)_6]^{+}$

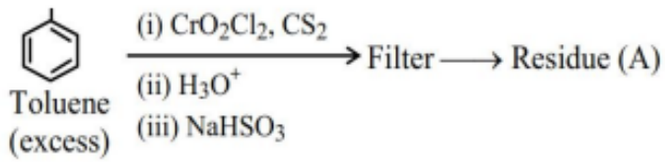
(D) $[Co(NH_3)_6]^{3+}$

(E) $[Cr(H_2O)_6]^{2+}$

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

(A) (B) and (E) only (B) (A) and (C) only (C) (C) and (D) only (D) (C) only

68.



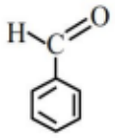
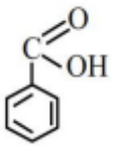
Residue (A) + HCl (dil.) $\rightarrow$ Compound (B)

Structure of residue (A) and compound (B)

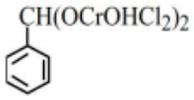
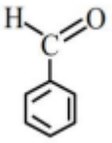
Formed respectively is :

(A)

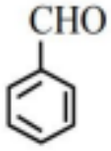
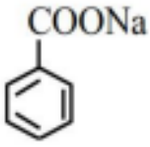
	[A]	[B]

(1)		

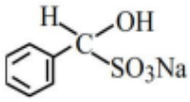
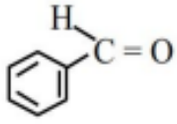
(B)

	[A]	[B]
(2)		

(C)

	[A]	[B]
(3)		

(D)

	[A]	[B]
(4)		

69. Given below are two statements :

Statement (I) : Corrosion is an electrochemical phenomenon in which pure metal acts as an anode and impure metal as a cathode.

Statement (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 :

(A) Both Statement I and Statement II are false

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

(C) Both Statement I and Statement II are true

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

70. The alkane from below having two secondary hydrogens is :

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

(B) 2,2,4,4-Tetramethylhexane

(C) 2,2,3,3-Tetramethylpentane

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

*** SECTION - B** **[20]**

71. 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.

72. Niobium (Nb) and ruthenium (Ru) have "x" and "y" number of electrons in their respective $4d$ orbitals. The value of $x+y$ is _____

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

74. Consider the following cases of standard enthalpy of reaction $(\Delta H_r^o$ in $kJmol^{-1})$

$$C_2H_6(g)+\frac{7}{2}O_2(g)\rightarrow 2CO_2(g)+3H_2O(\ell)\Delta H_1^{\circ}=-1550$$

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

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

The magnitude of $\Delta H^o_{fC_2H_6(g)}$ is _____ $kJmol^{-1}$ (Nearest integer).

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 _____$\times 10^{-2}M$. (Nearest integer).

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JEE

Total Marks : 288

23 Jan 2025 Shift 1

Mathematics

* SECTION - A

[80]

1. The value of $\int_{e^2}^{e^4} \frac{1}{x}\left(\frac{e^{\left((\log_e x)^2+1\right)^{-1}}}{e^{\left((\log_e x)^2+1\right)^{-1}}+e^{\left((6-\log_e x)^2+1\right)^{-1}}}\right)dx$ is

(A) $\log_c 2$ (B) 2 (C) 1 (D) e^2

2. Let $I(x)=\int \frac{dx}{(x-11)^{\frac{11}{13}}(x+15)^{\frac{15}{13}}}$.

If $I(37)-I(24)=\frac{1}{4}\left(\frac{1}{b^{\frac{1}{13}}}-\frac{1}{c^{\frac{1}{13}}}\right), b,c\in N$, then $3(b+c)$ is equal to

3. If the function

$$f(x)=\begin{cases}\frac{2}{x}\{\sin(k_1+1)x+\sin(k_2-1)x\} & ,x<0\\ 4 & ,x=0\\ \frac{2}{x}\log_e\left(\frac{2+k_1x}{2+k_2x}\right) & ,x>0\end{cases}$$

is continuous at $x=0$, then ${k_1}^2+{k_2}^2$ is equal to

(A) 8 (B) 20 (C) 5 (D) 10

4. If the line $3x-2y+12=0$ intersects the parabola $4y=3x^2$ at the points A and B, then at the vertex of the parabola, the line segment AB subtends an angle equal to

(A) $\tan^{-1}\left(\frac{11}{9}\right)$ (B) $\frac{\pi}{2}-\tan^{-1}\left(\frac{3}{2}\right)$ (C) $\tan^{-1}\left(\frac{4}{5}\right)$ (D) $\tan^{-1}\left(\frac{9}{7}\right)$

5. Let a curve $y=f(x)$ pass through the points $(0,5)$ and $(\log_c 2,k)$. If the curve satisfies the differential equation $2(3+y)e^{2x}dx-\left(7+e^{2x}\right)dy=0$, then k is equal to

(A) 16 (B) 8 (C) 32 (D) 4

6. Let $f(x)=\log_c x$ and $g(x)=\frac{x^4-2x^3+3x^2-2x+2}{2x^2-2x+1}$.Then the domain of fog is

(A) R (B) $(0,\infty)$ (C) $[0,\infty)$ (D) $[1,\infty)$

7. Let the arc AC of a circle subtend a right angle at the centre O . If the point B on the arc AC , divides the arc AC such that $\frac{\text{length of arc } AB}{\text{length of arc } BC}=\frac{1}{5}$, and $\overrightarrow{OC}=\alpha\overrightarrow{OA}+\beta\overrightarrow{OB}$, then $\alpha=\sqrt{2}(\sqrt{3}-1)\beta$ is equal to

(A) $2-\sqrt{3}$ (B) $2\sqrt{3}$ (C) $5\sqrt{3}$ (D) $2+\sqrt{3}$

8. If the first term of an A.P. is 3 and the sum of its first four terms is equal to one-fifth of the sum of the next four terms, then the sum of the first 20 terms is equal to

(A) -1200 (B) -1080 (C) -1020 (D) -120

9. Let P be the foot of the perpendicular from the point $Q(10,-3,-1)$ on the line $\frac{x-3}{7}=\frac{y-2}{-1}=\frac{z+1}{-2}$. Then the area of the right angled triangle PQR, where R is the point $(3,-2,1)$, is

(A) $9\sqrt{15}$ (B) $\sqrt{30}$ (C) $8\sqrt{15}$ (D) $3\sqrt{30}$

10. Let $\left|\frac{\bar{z}-i}{2\bar{z}+i}\right|=\frac{1}{3}, z\in C$, be the equation of a circle with center at C . If the area of the triangle, whose vertices are at the points $(0,0), C$ and $(\alpha,0)$ is 11 square units, then α^2 equals

(A) 100 (B) 50 (C) $\frac{121}{25}$ (D) $\frac{81}{25}$

11. Let $R=\{(1,2),(2,3),(3,3)\}$ be a relation defined on the set $\{1,2,3,4\}$. Then the minimum number of elements, needed to be added in R so the R becomes an equivalence relation, is :

(A) 10 (B) 8 (C) 9 (D) 7

12. The number of words, which can be formed using all the letters of the word "DAUGHTER", so that all the vowels never come together, is

(A) 34000 (B) 37000 (C) 36000 (D) 35000

13. Let the area of a $\triangle PQR$ with vertices $P(5,4), Q(-2,4)$ and $R(a,b)$ be 35 square units. If its orthocenter and centroid are $O\left(2,\frac{14}{5}\right)$ and $C(c,d)$ respectively, then $c+2d$ is equal to

(A) $\frac{7}{3}$ (B) 3 (C) 2 (D) $\frac{8}{3}$

14. If $\frac{\pi}{2}\le x\le\frac{3\pi}{4}$, then $\cos^{-1}\left(\frac{12}{13}\cos x+\frac{5}{13}\sin x\right)$ is equal to

(A) $x-\tan^{-1}\frac{4}{3}$ (B) $x-\tan^{-1}\frac{5}{12}$ (C) $x+\tan^{-1}\frac{4}{5}$ (D) $x+\tan^{-1}\frac{5}{12}$

15. The value of $(\sin 70^\circ)(\cot 10^\circ \cot 70^\circ-1)$ is

(A) 1 (B) 0 (C) $3/2$ (D) $2/3$

16. Marks obtains by all the students of class 12 are presented in a frequency distribution with classes of equal width. Let the median of this grouped data be 14 with median class interval 12-18 and median class frequency 12. If the number of students whose marks are less than 12 is 18 , then the total number of students is

(A) 48 (B) 44 (C) 40 (D) 52

17. Let the position vectors of the vertices A, B and C of a tetrahedron ABCD be $\hat{i}+2\hat{j}+\hat{k}, \hat{i}+3\hat{j}-2\hat{k}$ and $2\hat{i}+\hat{j}-\hat{k}$ respectively. The altitude from the vertex D to the opposite face ABC meets the median line segment through A of the triangle ABC at the point E. If the length of AD is $\frac{\sqrt{110}}{3}$ and the volume of the tetrahedron is $\frac{\sqrt{805}}{6\sqrt{2}}$, then the position vector of E is

(A) $\frac{1}{2}(\hat{i}+4\hat{j}+7\hat{k})$ (B) $\frac{1}{12}(7\hat{i}+4\hat{j}+3\hat{k})$ (C) $\frac{1}{6}(12\hat{i}+12\hat{j}+\hat{k})$ (D) $\frac{1}{6}(7\hat{i}+12\hat{j}+\hat{k})$

18. If A, B and $\left(\text{adj}\left(A^{-1}\right)+\text{adj}\left(B^{-1}\right)\right)$ are non-singular matrices of same order, then the inverse of $A\left(\text{adj}\left(A^{-1}\right)+\text{adj}\left(B^{-1}\right)\right)^{-1}B$, is equal to

(A) $AB^{-1}+A^{-1}B$

(B) $\text{adj}\left(B^{-1}\right)+\text{adj}\left(A^{-1}\right)$

(C) $\frac{1}{|AB|}(\text{adj}(B)+\text{adj}(A))$

(D) $\frac{AB^{-1}}{|A|}+\frac{BA^{-1}}{|B|}$

19. If the system of equations

$(\lambda-1)x+(\lambda-4)y+\lambda z=5$
$\lambda x+(\lambda-1)y+(\lambda-4)z=7$
$(\lambda+1)x+(\lambda+2)y-(\lambda+2)z=9$

has infinitely many solutions, then $\lambda^2+\lambda$ is equal to

(A) 10 (B) 12 (C) 6 (D) 20

20. One die has two faces marked 1 , two faces marked 2 , one face marked 3 and one face marked 4. Another die has one face marked 1 , two faces marked 2 , two faces marked 3 and one face marked 4. The probability of getting the sum of numbers to be 4 or 5 , when both the dice are thrown together, is

(A) $\frac{1}{2}$ (B) $\frac{3}{5}$ (C) $\frac{2}{3}$ (D) $\frac{4}{9}$

* SECTION - B [20]

21. If the area of the larger portion bounded between the curves $x^2+y^2=25$ and $y=|x-1|$ is $\frac{1}{4}(b\pi+c)$, $b, c \in N$, then $b+c$ is equal to

22. The sum of all rational terms in the expansion of $\left(1+2^{1/3}+3^{1/2}\right)^6$ is equal to _____.

23. Let the circle C touch the line $x-y+1=0$, have the centre on the positive x-axis, and cut off a chord of length $\frac{4}{\sqrt{13}}$ along the line $-3x+2y=1$. Let H be the hyperbola $\frac{x^2}{\alpha^2}-\frac{y^2}{\beta^2}=1$, whose one of the foci is the centre of C and the length of the transverse axis is the diameter of C . Then $2\alpha^2+3\beta^2$ is equal to _____.

24. If the set of all values of a, for which the equation $5x^3 - 15x - a = 0$ has three distinct real roots, is the interval (α, β), then $\beta - 2\alpha$ is equal to _____.

25. If the equation $a(b-c)x^2 + b(c-a)x + c(a-b) = 0$ has equal roots, where $a + c = 15$ and $b = \frac{36}{5}$, then $a^2 + c^2$ is equal to _____.

Physics

*** SECTION - A** **[80]**

26. Regarding self-inductance :
A : The self-inductance of the coil depends on its geometry.
B : Self-inductance does not depend on the permeability of the medium.
C : Self-induced e.m.f. opposes any change in the current in a circuit.
D : Self-inductance is electromagnetic analogue of mass in mechanics.
E : Work needs to be done against self-induced e.m.f. in establishing the current.
Choose the correct answer from the options given below:
(A) A, B, C, D only (B) A, C, D, E only (C) A, B, C, E only (D) B, C, D, E only

27. A light hollow cube of side length 10 cm and mass 10 g , is floating in water. It is pushed down and released to execute simple harmonic oscillations. The time period of oscillations is $y\pi \times 10^{-2} s$, where the value of y is (Acceleration due to gravity, $g = 10 m/s^2$, density of water $= 10^3 kg/m^3$)
(A) 2 (B) 6 (C) 4 (D) 1

28. Given below are two statements :
Statement - I : The hot water flows faster than cold water.
Statement-II : Soap water has higher surface tension as compared to fresh water.
In the light above statements, choose the correct answer from the options given below
(A) Statement-I is false but Statement II is true
(B) Statement-I is true but Statement II is false
(C) Both Statement-I and Statement-II are true
(D) Both Statement-I and Statement-II are false

29. A sub-atomic particle of mass $10^{-30} kg$ is moving with a velocity $2.21 \times 10^6 m/s$. Under the matter wave consideration, the particle will behave closely like _____. $\left(h = 6.63 \times 10^{-34} J.s\right)$
(A) Infra-red radiation (B) X-rays (C) Gamma rays (D) Visible radiation

30. A spherical surface of radius of curvature R, separates air from glass (refractive index $= 1.5$). The centre of curvature is in the glass medium. A point object ' O '

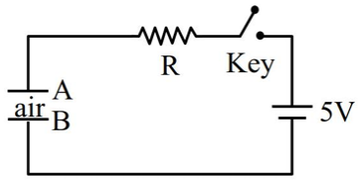
placed in air on the optic axis of the surface, so that its real image is formed at ' I ' inside glass. The line OI intersects the spherical surface at P and $PO = PI$. The distance PO equals to-

(A) $5R$ (B) $3R$ (C) $2R$ (D) 1.5 R

31. A radioactive nucleus n_2 has 3 times the decay constant as compared to the decay constant of another radioactive nucleus n_1. If initial number of both nuclei are the same, what is the ratio of number of nuclei of n_2 to the number of nuclei of n_1, after one half-life of n_1 ?

(A) $1/4$ (B) $1/8$ (C) 4 (D) 8

32. Identify the valid statements relevant to the given circuit at the instant when the key is closed.



A. There will be no current through resistor R.
B. There will be maximum current in the connecting wires.
C. Potential difference between the capacitor plates A and B is minimum.
D. Charge on the capacitor plates is minimum.Choose the correct answer from the options given below :

(A) C, D only (B) B, C, D only (C) A, C only (D) A, B, D only

33. The position of a particle moving on x-axis is given by $x(t) = A\sin t + B\cos^2 t + Ct^2 + D$, where t is time. The dimension of $\frac{ABC}{D}$ is-

(A) L (B) L^3T^{-2} (C) L^2T^{-2} (D) L^2

34. Match the list - i with list - ii

LIST - I	LIST - II
A. Pressure varies inversely with volume of an ideal gas.	I.Adiabatic process
B. Heat absorbed goes partly to increase internal energy and partly to do work.	II. Isochoric process
C. Heat is neither absorbed nor released by a system	III. Isothermal process
D.No work is done on or by a gas	IV. Isobaric brocess

Choose the correct answer from the option given below :

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

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

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

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

35. Consider a moving coil galvanometer (MCG) :

A : The torsional constant in moving coil galvanometer has dimensions $[ML^2T^{-2}]$

B : Increasing the current sensitivity may not necessarily increase the voltage sensitivity.

C : If we increase number of turns (N) to its double $(2N)$, then the voltage sensitivity doubles.

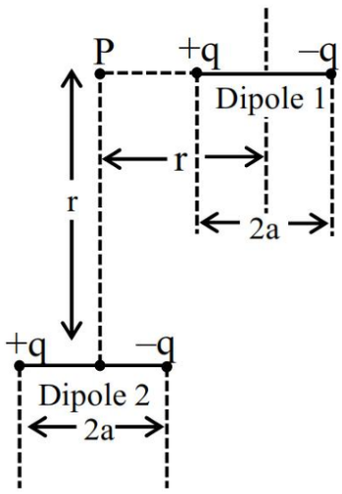
D : MCG can be converted into an ammeter by introducing a shunt resistance of large value in parallel with galvanometer.

E : Current sensitivity of MCG depends inversely on number of turns of coil.

Choose the correct answer from the options given below :

(A) A, B only (B) A, D, only (C) B, D, E only (D) A, B, E only

36. A point particle of charge Q is located at P along the axis of an electric dipole 1 at a distance r as shown in the figure. The point P is also on the equatorial plane of a second electric dipole 2 at a distance r. The dipoles are made of opposite charge q separated by a distance 2 a . For the charge particle at P not to experience any net force, which of the following correctly describes the situation ?



(A) $\frac{a}{r}-20$ (B) $\frac{a}{r}\sim 10$ (C) $\frac{a}{r}\sim 0.5$ (D) $\frac{a}{r}\sim 3$

37. A gun fires a lead bullet of temperature 300 K into a wooden block. The bullet having melting temperature of 600 K penetrates into the block and melts down. If the total heat required for the process is 625 J , then the mass of the bullet is _____ grams.

(Latent heat of fusion of lead $=2.5\times 10^4 JKg^{-1}$ and specific heat capacity of lead $=125 JKg^{-1}K^{-1}$)

(A) 20 (B) 15 (C) 10 (D) 5

38. What is the lateral shift of a ray refracted through a parallel-sided glass slab of thickness ' h ' in terms of the angle of incidence ' i ' and angle of refraction ' r ',

if the glass slab is placed in air medium ?

(A) $\frac{h\tan(i-r)}{\tan r}$ (B) $\frac{h\cos(i-r)}{\sin r}$ (C) h (D) $\frac{h\sin(i-r)}{\cos r}$

39. A solid sphere of mass ' m ' and radius ' r ' is allowed to roll without slipping from the highest point of an inclined plane of length ' L ' and makes an angle 30° with the horizontal. The speed of the particle at the bottom of the plane is v_1. If the angle of inclination is increased to 45° while keeping L constant. Then the new speed of the sphere at the bottom of the plane is v_2. The ratio of ${v_1}^2 : {v_2}^2$ is

(A) $1:\sqrt{2}$ (B) $1:3$ (C) $1:2$ (D) $1:\sqrt{3}$

40. Refer to the circuit diagram given in the figure, which of the following observation are correct?

A. Total resistance of circuit is 6Ω.

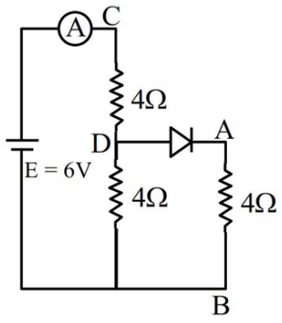
B. Current in Ammeter is 1 A

C. Potential across AB is 4 Volts.

D. Potential across CD is 4 Volts.

E. Total resistance of the circuit is 8Ω.

Choose the correct answer from the options given below:



(A) A, B and D only (B) A, C and D only (C) B, C and E only (D) A, B and C only

41. The electric flux is $\phi = \alpha\sigma + \beta\lambda$ where λ and σ are linear and surface charge density, respectively, $\left(\frac{\alpha}{\beta}\right)$ represents

(A) charge (B) electric field (C) displacement (D) area

42. Given a thin convex lens (refractive index μ_2), kept in a liquid (refractive index $\mu_1, \mu_1 < \mu_2$) having radii of curvature $|R_1|$ and $|R_2|$. Its second surface is silver polished. Where should an object be placed on the optic axis so that a real and inverted image is formed at the same place?

(A) $\frac{\mu_1|R_1|\cdot|R_2|}{\mu_2(|R_1|+|R_2|)-\mu_1|R_1|}$ (B) $\frac{\mu_1|R_1|\cdot|R_2|}{\mu_2(|R_1|+|R_2|)-\mu_1|R_2|}$ (C) $\frac{\mu_1|R_1|\cdot|R_2|}{\mu_2(2|R_1|+|R_2|)-\mu_1\sqrt{|R_1|\cdot|R_2|}}$ (D) $\frac{(\mu_2+\mu_1)|R_1|}{(\mu_2-\mu_1)}$

43. The electric field of an electromagnetic wave in free space is

$\vec{E} = 57\cos\left[7.5\times10^6 t - 5\times10^{-3}(3x+4y)\right]$

$(4\hat{i}-3\hat{j})N/C$

The associated magnetic field in Tesla is-

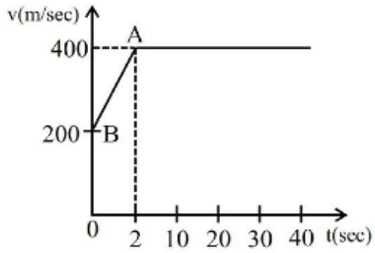
(A) $\vec{B}=\frac{57}{3\times10^8}\cos\left[7.5\times10^6t-5\times10^{-3}(3x+4y)\right](5\hat{k})$

(B) $\vec{B}=\frac{57}{3\times10^8}\cos\left[7.5\times10^6t-5\times10^{-3}(3x+4y)\right](\hat{k})$

(C) $\vec{B}=-\frac{57}{3\times10^8}\cos\left[7.5\times10^6t-5\times10^{-3}(3x+4y)\right](5\hat{k})$

(D) $\vec{B}=-\frac{57}{3\times10^8}\cos\left[7.5\times10^6t-5\times10^{-3}(3x+4y)\right]\quad(\hat{k})$

44. The motion of an airplane is represented by velocity-time graph as shown below. The distance covered by airplane in the first 30.5 second is _____ km .



(A) 9 (B) 6 (C) 3 (D) 12

45. Consider a circular disc of radius 20 cm with centre located at the origin. A circular hole of a radius 5 cm is cut from this disc in such a way that the edge of the hole touches the edge of the disc. The distance of centre of mass of residual or remaining disc from the origin will be-

(A) 2.0 cm (B) 0.5 cm (C) 1.5 cm (D) 1.0 cm

*** SECTION - B** **[8]**

46. A positive ion A and a negative ion B has charges $6.67\times10^{-19}C$ and $9.6\times10^{-10}C$, and masses $19.2\times10^{-27}kg$ and $9\times10^{-27}kg$ respectively. At an instant, the ions are separated by a certain distance r. At that instant the ratio of the magnitudes of electrostatic force to gravitational force is $P\times10^{-13}$, where the value of P is _____ .

(Take $\frac{1}{4\pi\varepsilon_0}=9\times10^9Nm^2C^{-1}$ and universal gravitational constant as $6.67\times10^{-11}Nm^2kg^{-2}$)

47. Two particles are located at equal distance from origin. The position vectors of those are represented by $\vec{A}=2\hat{i}+3n\hat{j}+2\hat{k}$ and $\vec{B}=2\hat{i}-2\hat{j}+4p\hat{k}$, respectively. If both the vectors are at right angle to each other, the value of n^{-1} is_____.

Chemistry

*** SECTION - A** **[80]**

48. The element that does not belong to the same period of the remaining elements (modern periodic table) is:

(A) Palladium (B) Iridium (C) Osmium (D) Platinum

49. Heat treatment of muscular pain involves radiation of wavelength of about 900 nm . Which spectral line of H atom is suitable for this ?

Given: Rydberg constant

$R_H = 10^5 cm^{-1}, h = 6.6 \times 10^{-34} Js, c = 3 \times 10^8 m/s)$

(A) Paschen series, $\infty \rightarrow 3$

(B) Lyman series, $\infty \rightarrow 1$

(C) Balmer series, $\infty \rightarrow 2$

(D) Paschen series, $5 \rightarrow 3$

50. The incorrect statements among the following is

(A) PH_3 shows lower proton affinity than NH_3.

(B) PF_3 exists but NF_5 does not.

(C) NO_2 can dimerise easily.

(D) SO_2 can act as an oxidizing agent, but not as a reducing agent.

51. $CrCl_3 \cdot xNH_3$ can exist as a complex. 0.1 molal aqueous solution of this complex shows a depression in freezing point of $0.558^\circ C$. Assuming 100% ionisation of this complex and coordination number of Cr is 6 , the complex will be (Given $K_f = 1.86 Kkgmol^{-1}$)

(A) $[Cr(NH_3)_6]Cl_3$ (B) $[Cr(NH_3)_4Cl_2]Cl$ (C) $[Cr(NH_3)_5Cl]Cl_2$ (D) $[Cr(NH_3)_3Cl_3]$

52. $FeO_4^{2-} \xrightarrow{+2.0V} Fe^{3+} \xrightarrow{0.8V} Fe^{2+} \xrightarrow{-0.5V} Fe^0$ In the above diagram, the standard electrode potentials are given in volts (over the arrow). The value of $E^{\Theta}_{FeO_4^{2-}/Fe^{2+}}$ is

(A) 1.7 V (B) 1.2 V (C) 2.1 V (D) 1.4 V

53. Match the list - I with list - II

LIST-I Name reaction		**LIST-II Product obtainable**	
A.	Swarts reaction	I.	Ethyl benzene
B.	Sandmeyer's reaction	II.	Ethyl iodide
C.	Wurtz Fittig reaction	III.	Cyanobenzene
D.	Finkelstein reaction	IV.	Ethyl fluoride

Choose the correct answer from the option given below :

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

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

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

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

54. Given below are two statements :

Statement I : Fructose does not contain an aldehydic group but still reduces Tollen's reagent

Statement II : In the presence of base, fructose undergoes rearrangement to give glucose.In the light of the above statements, choose the correct answer from the options given below

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

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

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

55. $2.8 \times 10^{-3} mol$ of CO_2 is left after removing 10^{21} molecules from its ' x ' mg sample. The mass of CO_2 taken initially is
Given : $N_A = 6.02 \times 10^{23} mol^{-1}$

(A) 196.2 mg (B) 98.3 mg (C) 150.4 mg (D) 48.2 mg

56. Ice at $-5^{\circ}C$ is heated to become vapor with temperature of $110^{\circ}C$ at atmospheric pressure. The entropy change associated with this process can be obtained from :

(A) $\int_{268K}^{383K} C_p dT + \frac{\Delta H_{\text{melting}}}{273} + \frac{\Delta H_{\text{boiling}}}{373}$

(B) $\int_{268K}^{273K} \frac{C_{p,m}}{T} dT + \frac{\Delta H_m, \text{fusion}}{T_f} + \frac{\Delta H_{m, \text{vaporisation}}}{T_b} + \int_{273K}^{373K} \frac{C_{p,m} dT}{T} + \int_{373K}^{383K} \frac{C_{p,m} dT}{T}$

(C) $\int_{268K}^{383K} C_p dT + \frac{q_{rev}}{T}$

(D) $\int_{268K}^{273K} C_{p,m} dT + \frac{\Delta H_m, \text{fusion}}{T_f} + \frac{\Delta H_{m, \text{vaporisation}}}{T_b} + \int_{273K}^{373K} C_{p,m} dT + \int_{373K}^{383K} C_{p,m} dT$

57. The d-electronic configuration of an octahedral $Co(II)$ complex having magnetic moment of 3.95 BM is :

(A) $t_{2g}^6 e_g^1$ (B) $t_{2g}^3 e_g^0$ (C) $t_{2g}^5 e_g^2$ (D) $e^4 t_2^3$

58. The complex that shows Facial - Meridional isomerism is

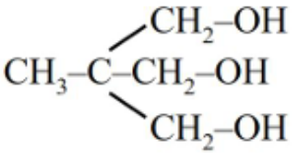
(A) $[Co(NH_3)_3 Cl_3]$ (B) $[Co(NH_3)_4 Cl_2]^+$ (C) $[Co(en)_3]^{3+}$ (D) $[Co(en)_2 Cl_2]^+$

59. The major product of the following reaction is :

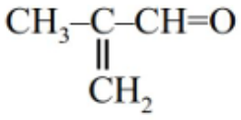
$$CH_3CH_2CH=O \xrightarrow[\text{reflux}]{\text{excess } HCHO,\ \text{alkali}} ?$$

(A) $CH_3 - CH_2$
$-CH_2 - OH$

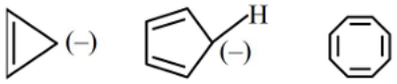
(C)



(D)



60. The correct stability order of the following species/molecules is :



p q r

(A) $q > r > p$ (B) $r > q > p$ (C) $q > p > r$ (D) $p > q > r$

61. Propane molecule on chlorination under photochemical condition gives two di-chloro products, " x " and " y ". Amongst " x " and " y ", " x " is an optically active molecule. How many tri-chloro products (consider only structural isomers) will be obtained from " x " when it is further treated with chlorine under the photochemical condition?

(A) 4 (B) 2 (C) 5 (D) 3

62. What amount of bromine will be required to convert 2 g of phenol into 2, 4, 6-tribromophenol ? (Given molar mass in $gmol^{-1}$ of C, H, O, Br are $12, 1, 16, 80$ respectively)

(A) 10.22 g (B) 6.0 g (C) 4.0 g (D) 20.44 g

63. The correct set of ions (aqueous solution) with same colour from the following is :

(A) V^{2+}, Cr^{3+}, Mn^{3+} (B) Zn^{2+}, V^{3+}, Fe^{3+} (C) Ti^{4+}, V^{4+}, Mn^{2+} (D) $Sc^{3+}, Ti^{3+}, Cr^{2+}$

64. Given below are two statements :

Statement I : In Lassaigne's test, the covalent organic molecules are transformed into ionic compounds.

Statement II : The sodium fusion extract of an organic compound having N and S gives prussian blue colour with $FeSO_4$ and $Na_4[Fe(CN)_6]$In the light of the above statements, choose the correct answer from the options given below

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

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

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

65. Which of the following happens when NH_4OH is added gradually to the solution containing $1MA^{2+}$ and $1MB^{3+}$ ions ?

Given : $K_{sp}\ [A(OH)_2] = 9 \times 10^{-10}$ and

$K_{sp}\ [B(OH)_3] = 27 \times 10^{-18}$ at $298K$

(A) $B(OH)_3$ will precipitate before $A(OH)_2$

(B) $A(OH)_2$ and $B(OH)_3$ will precipitate together

(C) $A(OH)_2$ will precipitate before $B(OH)_3$

(D) Both $A(OH)_2$ and $B(OH)_3$ do not show precipitation with NH_4OH

66. Match the list - i with list - ii

LIST - I (Classification of molecules,based on octet rule)		LIST - II (Example)	
A.	Molecules obeying octet rule	I.	NO,NO_(2)
B.	Molecules with incomplete octet	II.	BCl_(3),AlCl_(3)
C.	Molecules with incomplete octet with odd electron	III.	H_(2)SO_(4),PCl_(5)
D.	Molecules with expanded octet	IV.	CCl_(4),CO_(2)

choose the correct answer from the questions given below :

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

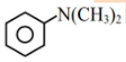
(B) A-III, B-II, C-I, D-IV

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

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

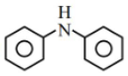
67. Which among the following react with Hinsberg's reagent?

(A) 

(2) 

(C) $CH_3–NH_2$

(4) $N(CH_3)_3$

(E) 

Choose the correct answer from the options given below :

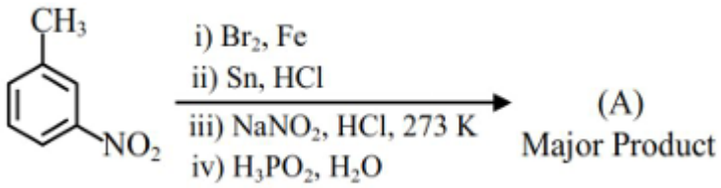
(A) B and D only (B) C and D only (C) A, B and E only (D) A, C and E only

*** SECTION - B** **[20]**

68. If 1 mM solution of ethylamine produces $pH = 9$, then the ionization constant (K_b) of ethylamine is 10^{-x}. The value of x is _____ (nearest integer).
[The degree of ionization of ethylamine can be neglected with respect to unity.]

69. During "S" estimation, 160 mg of an organic compound gives 466 mg of barium sulphate. The percentage of Sulphur in the given compound is _____ %.
(Given molar mass in $gmol^{-1}$ of $Ba:137, S:32$, O:16)

70. Consider the following sequence of reactions to produce major product (A)



Molar mass of product (A) is _____ $gmol^{-1}$.
(Given molar mass in $gmol^{-1}$ of $C:12, H:1$,
$O:16, Br:80, N:14, P:31$)

71. For the thermal decomposition of $N_2O_5(g)$ at constant volume, the following table can be formed, for the reaction mentioned below :
$2N_2O_5(g) \rightarrow 2N_2O_4(g) + O_2(g)$

S.No.	Time/s	Total pressure / (atm)
1	0	0.6
2	100	('X')

$x =$ _____ $\times 10^{-3} atm$ [nearest integer] Given : Rate constant for the reaction is $4.606 \times 10^{-2} s^{-1}$.

72. The standard enthalpy and standard entropy of decomposition of N_2O_4 to NO_2 are $55.0 kJmol^{-1}$ and $175.0 J/K/mol$ respectively. The standard free energy change for this reaction at $25^{\circ}C$ in $Jmol^{-1}$ is _____ (Nearest integer)

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JEE

Total Marks : 300

23 Jan 2025 Shift 2

Mathematics

* SECTION - A [80]

1. If in the expansion of $(1+x)^p(1-x)^q$, the coefficients of x and x^2 are 1 and -2, respectively, then p^2+q^2 is equal to :

(A) 8 (B) 18 (C) 13 (D) 20

2. Let $A=\{(x,y)\in R\times R:|x+y|\geq 3\}$ and $B=\{(x,y)\in R\times R:|x|+|y|\leq 3\}$.
If $C=\{(x,y)\in A\cap B:x=0$ or $y=0\}$, then $\sum_{(x,y)\in C}|x+y|$ is :

(A) 15 (B) 18 (C) 24 (D) 12

3. The system of equations

$x+y+z=6$
$x+2y+5z=9$
$x+5y+\lambda z=\mu$
has no solution if

(A) $\lambda=17,\mu\neq 18$ (B) $\lambda\neq 17,\mu\neq 18$ (C) $\lambda=15,\mu\neq 17$ (D) $\lambda=17,\mu=18$

4. Let $\int x^3\sin x dx=g(x)+C$, where C is the constant of integration.
If $8\left(g\left(\frac{\pi}{2}\right)+g'\left(\frac{\pi}{2}\right)\right)=\alpha\pi^3+\beta\pi^2+\gamma,\alpha,\beta,\gamma\in Z$,
Then $\alpha+\beta-\gamma$ equals :

(A) 55 (B) 47 (C) 48 (D) 62

5. A rod of length eight units moves such that its ends A and B always lie on the lines $x-y+2=0$ and $y+2=0$, respectively. If the locus of the point P, that divides the rod AB internally in the ratio $2:1$ is $9\left(x^2+\alpha y^2+\beta xy+\gamma x+28y\right)-76=0$, then $\alpha-\beta-\gamma$ is equal to :

(A) 24 (B) 23 (C) 21 (D) 22

6. The distance of the line $\frac{x-2}{2}=\frac{y-6}{3}=\frac{z-3}{4}$ from the point $(1,4,0)$ along the line $\frac{x}{1}=\frac{y-2}{2}=\frac{z+3}{3}$ is :

(A) $\sqrt{17}$ (B) $\sqrt{14}$ (C) $\sqrt{15}$ (D) $\sqrt{13}$

7. Let the point A divide the line segment joining the points $P(-1,-1,2)$ and $Q(5,5,10)$ internally in the ratio $r:1(r>0)$. If O is the origin and

$(\overrightarrow{OQ} \cdot \overrightarrow{OA}) - \frac{1}{5}|\overrightarrow{OP} \times \overrightarrow{OA}|^2 = 10$, then the value of r is :

(A) 14 (B) 3 (C) $\sqrt{7}$ (D) 7

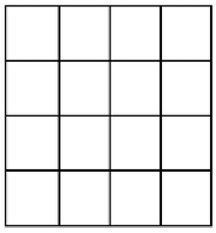
8. If the area of the region $\{(x,y) : -1 \leq x \leq 1, 0 \leq y \leq a + e^{|x|} - e^{-x}, a > 0\}$ is $\frac{e^2+8e+1}{e}$, then the value of a is :

(A) 7 (B) 6 (C) 8 (D) 5

9. A spherical chocolate ball has a layer of ice-cream of uniform thickness around it. When the thickness of the ice-cream layer is 1 cm , the ice-cream melts at the rate of $81cm^3/min$ and the thickness of the ice-cream layer decreases at the rate of $\frac{1}{4\pi}cm/min$. The surface area (in cm^2) of the chocolate ball (without the ice-cream layer) is :

(A) 225π (B) 128π (C) 196π (D) 256π

10. A board has 16 squares as shown in the figure :



out of these 16 squares, two squares are chosen at random. the probality that they have no side in common is :

(A) $\frac{4}{5}$ (B) $\frac{7}{10}$ (C) $\frac{3}{5}$ (D) $\frac{23}{30}$

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

$y = \left(x - y\frac{dx}{dy}\right)\sin\left(\frac{x}{y}\right), y > 0$ and $x(1) = \frac{\pi}{2}$.

Then $\cos(x(2))$ is equal to :

(A) $1 - 2(\log_c 2)^2$ (B) $2(\log_c 2)^2 - 1$ (C) $2(\log_e 2) - 1$ (D) $1 - 2(\log_e 2)$

12. Let the range of the function $f(x) = 6 + 16\cos x \cdot \cos\left(\frac{\pi}{3} - x\right) \cdot \cos\left(\frac{\pi}{3} + x\right) \cdot \sin 3x \cdot \cos 6x, x \in R$ be $[\alpha, \beta]$. Then the distance of the point (α, β) from the line $3x + 4y + 12 = 0$ is :

(A) 11 (B) 8 (C) 10 (D) 9

13. Let the shortest distance from $(a,0), a > 0$, to the parabola $y^2 = 4x$ be 4 . Then the equation of the circle passing through the point $(a,0)$ and the focus of the parabola, and having its centre on the axis of the parabola is:

(A) $x^2 + y^2 - 6x + 5 = 0$

(B) $x^2 + y^2 - 4x + 3 = 0$

(C) $x^2 + y^2 - 10x + 9 = 0$

(D) $x^2 + y^2 - 8x + 7 = 0$

14. Let $X = R \times R$. Define a relation R on X as:
$(a_1, b_1) R (a_2, b_2) \Leftrightarrow b_1 = b_2$.
Statement - I : R is an equivalence relation.
Statement - II : For some $(a,b) \in X$, the set $S = \{(x,y) \in X : (x,y) R (a,b)\}$ represents a line parallel to $y = x$.In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement-I and Statement-II are false.

(B) Statement-I is true but Statement-II is false.

(C) Both Statement-I and Statement-II are true.

(D) Statement-I is false but Statement-II is true.

15. The length of the chord of the ellipse $\frac{x^2}{4} + \frac{y^2}{2} = 1$, whose mid-point is $\left(1, \frac{1}{2}\right)$, is:

(A) $\frac{2}{3}\sqrt{15}$ (B) $\frac{5}{3}\sqrt{15}$ (C) $\frac{1}{3}\sqrt{15}$ (D) $\sqrt{15}$

16. Let $A = [a_{ij}]$ be a 3×3 matrix such that $A \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, A \begin{bmatrix} 4 \\ 1 \\ 3 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ and $A \begin{bmatrix} 2 \\ 1 \\ 2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$, then a_{23} equals:

(A) -1 (B) 0 (C) 2 (D) 1

17. The number of complex numbers z, satisfying $|z| = 1$ and $\left|\frac{z}{\bar{Z}} + \frac{\bar{z}}{z}\right| = 1$, is :

(A) 6 (B) 4 (C) 10 (D) 8

18. If the square of the shortest distance between the lines $\frac{x-2}{1} = \frac{y-1}{2} = \frac{z+3}{-3}$ and $\frac{x+1}{2} = \frac{y+3}{4} = \frac{z+5}{-5}$ is $\frac{m}{n}$, where m, n are coprime numbers, then $m+n$ is equal to:

(A) 6 (B) 9 (C) 21 (D) 14

19. If $I = \int_0^{\frac{\pi}{2}} \frac{\sin^{\frac{3}{2}} x}{\sin^{\frac{3}{2}} x + \cos^{\frac{3}{2}} x} dx$, then $\int_0^{21} \frac{x \sin x \cos x}{\sin^4 x + \cos^4 x} dx$ equals:

(A) $\frac{\pi^2}{16}$ (B) $\frac{\pi^2}{4}$ (C) $\frac{\pi^2}{8}$ (D) $\frac{\pi^2}{12}$

20. $\lim_{x \to \infty} \frac{(2x^2 - 3x + 5)(3x-1)^{\frac{x}{2}}}{(3x^2 + 5x + 4)\sqrt{(3x+2)^x}}$ is equal to:

(A) $\frac{2}{\sqrt{3e}}$ (B) $\frac{2e}{\sqrt{3}}$ (C) $\frac{2e}{3}$ (D) $\frac{2}{3\sqrt{e}}$

* SECTION - B [20]

21. The number of ways, 5 boys and 4 girls can sit in a row so that either all the boys sit together or no two boys sit together, is _____.

22. Let α, β be the roots of the equation $x^2 - ax - b = 0$ with $\text{Im}(\alpha) < \text{Im}(\beta)$. Let $P_n = \alpha^n - \beta^n$. If $P_3 = -5\sqrt{7}i$, $P_4 = -3\sqrt{7}i$, $P_5 = 11\sqrt{7}i$ and $P_6 = 45\sqrt{7}i$, then $|\alpha^4 + \beta^4|$ is equal to _____ .

23. The focus of the parabola $y^2 = 4x + 16$ is the centre of the circle C of radius 5 . If the values of λ, for which C passes through the point of intersection of the lines $3x - y = 0$ and $x + \lambda y = 4$, are λ_1 and $\lambda_2, \lambda_1 < \lambda_2$, then $12\lambda_1 + 29\lambda_2$ is equal to _____.

24. The variance of the numbers $8, 21, 34, 47, \ldots, 320$, is _____.

25. The roots of the quadratic equation $3x^2 - px + q = 0$ are 10^{th} and 11^{th} terms of an arithmetic progression with common difference $\frac{3}{2}$. If the sum of the first 11 terms of this arithmetic progression is 88 , then $q - 2q$ is equal to _____ .

Physics

*** SECTION - A** **[80]**

26. A ball having kinetic energy KE , is projected at an angle of 60° from the horizontal. What will be the kinetic energy of ball at the highest point of its flight?

(A) $\frac{(KE)}{8}$ (B) $\frac{(KE)}{4}$ (C) $\frac{(KE)}{16}$ (D) $\frac{(KE)}{2}$

27. Two charges $7\mu c$ and $-4\mu c$ are placed at (-7 cm , $0,0$) and ($7cm, 0, 0$) respectively. Given, $\epsilon_0 = 8.85 \times 10^{-12} C^2 N^{-1} m^{-2}$, the electrostatic potential energy of the charge configuration is :

(A) -1.5 J (B) -2.0 J (C) -1.2 J (D) -1.8 J

28. The refractive index of the material of a glass prism is $\sqrt{3}$. The angle of minimum deviation is equal to the angle of the prism. What is the angle of the prism?

(A) 50° (B) 60° (C) 58° (D) 48°

29. The equation of a transverse wave travelling along a string is $y(x,t) = 4.0 \sin\left[20 \times 10^{-3} x + 600t\right] mm$, where x is in the mm and t is in second. The velocity of the wave is :

(A) $+30 m/s$ (B) $-60 m/s$ (C) $-30 m/s$ (D) $+60 m/s$

30. The energy of a system is given as $E(t) = \alpha^3 e^{-\beta t}$, where t is the time and $\beta = 0.3 s^{-1}$. The errors in the measurement of α and t are 1.2% and 1.6%, respectively. At $t = 5s$, maximum percentage error in the energy is :

(A) 4% (B) 11.6% (C) 6% (D) 8.4%

31. In photoelectric effect an em-wave is incident on a metal surface and electrons are ejected from the surface. If the work function of the metal is 2.14 eV and

stopping potential is 2 V , what is the wavelength of the em-wave?
(Given hc $= 1242eVnm$ where h is the Planck's constant and c is the speed of light in vaccum.)

(A) 400 nm (B) 600 nm (C) 200 nm (D) 300 nm

32. A circular disk of radius R meter and mass M kg is rotating around the axis perpendicular to the disk. An external torque is applied to the disk such that $\theta(t) = 5t^2 - 8t$, where $\theta(t)$ is the angular position of the rotating disc as a function of time t.
How much power is delivered by the applied torque, when $t = 2s$?

(A) $60MR^2$ (B) $72MR^2$ (C) $108MR^2$ (D) $8MR^2$

33. Water flows in a horizontal pipe whose one end is closed with a valve. The reading of the pressure gauge attached to the pipe is P_1. The reading of the pressure gauge falls to P_2 when the valve is opened. The speed of water flowing in the pipe is proportional to

(A) $\sqrt{P_1 - P_2}$ (B) $(P_1 - P_2)^2$ (C) $(P_1 - P_2)^4$ (D) $P_1 - P_2$

34. Match list - i with list - ii.

LIST – I	LIST - II
(A) Permeability of free space	(I) $[ML^2T^{-2}]$
(B) Magnetic field	(II) $[MT^{-2}A^{-1}]$
(C) Magnetic moment	(III) $[MLT^{-2}A^{-2}]$
(D) Torsional constant	(IV) $[L^2A]$

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

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

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

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

35. If a satellite orbiting the Earth is 9 times closer to the Earth than the Moon, what is the time period of rotation of the satellite? Given rotational time period of Moon $= 27$ days and gravitational attraction between the satellite and the moon is neglected.

(A) 1 day (B) 81 days (C) 27 days (D) 3 days

36. Two point charges $-4\mu c$ and $4\mu c$, constituting an electric dipole, are placed at $(-9,0,0)cm$ and $(9,0,0)cm$ in a uniform electric field of strength $10^4 NC^{-1}$. The work done on the dipole in rotating it from the equilibrium through 180° is :

(A) 14.4 Mj (B) 18.4 mJ (C) 12.4 mJ (D) 16.4 Mj

37. A galvanometer having a coil of resistance 30Ω need 20 mA of current for full-scale deflection. If a maximum current of 3 A is to be measured using this

galvanometer, the resistance of the shunt to be added to the galvanometer should be $\frac{30}{X}\Omega$, where X is

(A) 447 (B) 298 (C) 149 (D) 596

38. The width of one of the two slits in Young's double slit experiment is d while that of the other slit is xd . If the ratio of the maximum to the minimum intensity in the interference pattern on the screen is $9:4$ then what is the value of x ? (Assume that the field strength varies according to the slit width.)

(A) 2 (B) 3 (C) 5 (D) 4

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

Assertion (A) : The binding energy per nucleon is found to be practically independent of the atomic number A , for nuclei with mass numbers between 30 and 170.

Reason (R): Nuclear force is long range.

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

(A) (A) is false but (R) is true

(B) (A) is true but (R) is false

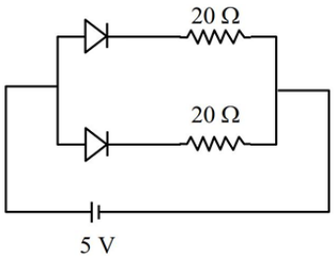
(C) Both (A) and (R) are true and (R) is the correct explanation of (A)

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

40. Water of mass m gram is slowly heated to increase the temperature from T_1 to T_2. The change in entropy of the water, given specific heat of water is $1Jkg^{-1}K^{-1}$, is :

(A) zero (B) $m(T_2-T_1)$ (C) $m\ln\left(\frac{T_1}{T_2}\right)$ (D) $m\ln\left(\frac{T_2}{T_1}\right)$

41. What is the current through the battery in the circuit shown below?

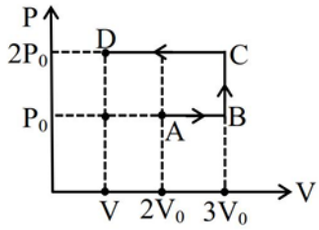


(A) 1.0 A (B) 1.5 A (C) 0.5 A (D) 0.25 A

42. A plane electromagnetic wave of frequency20 MHz travels in free space along the $+x$ direction. At a particular point in space and time, the electric field vector of the wave is $E_y = 9.3Vm^{-1}$. Then, the magnetic field vector of the wave at that point is-

(A) $B_z = 9.3\times10^{-8}T$ (B) $B_z = 1.55\times10^{-8}T$

(C) $B_z = 6.2 \times 10^{-8} T$ (D) $B_z = 3.1 \times 10^{-8} T$

43. 

Using the given P-V diagram, the work done by an ideal gas along the path ABCD is -

(A) $4P_0V_0$ (B) $3P_0V_0$ (C) $-4P_0V_0$ (D) $-3P_0V_0$

44. A concave mirror of focal length f in air is dipped in a liquid of refractive index μ. Its focal length in the liquid will be :

(A) $\frac{f}{\mu}$ (B) $\frac{f}{(\mu-1)}$ (C) μf (D) f

45. A massless spring gets elongated by amount x_1 under a tension of 5 N . Its elongation is x_2 under the tension of 7 N . For the elongation of $(5x_1 - 2x_2)$, the tension in the spring will be,

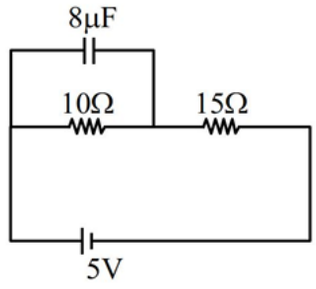
(A) 15 N (B) 20 N (C) 11 N (D) 39 N

*** SECTION - B** **[20]**

46. An air bubble of radius 1.0 mm is observed at a depth of 20 cm below the free surface of a liquid having surface tension $0.095 J/m^2$ and density $10^3 kg/m^3$. The difference between pressure inside the bubble and atmospheric pressure _____ N/m^2. (Take $g = 10 m/s^2$)

47. A satellite of mass $\frac{M}{2}$ is revolving around earth in a circular orbit at a height of $\frac{R}{3}$ from earth surface. The angular momentum of the satellite is $M\sqrt{\frac{GMR}{x}}$. The value of x is _____ , where M and R are the mass and radius of earth, respectively. (G is the gravitational constant)

48. At steady state the charge on the capacitor, as shown in the circuit below, is μC.



49. A time varying potential difference is applied between the plates of a parallel plate capacitor of capacitance $2.5 \mu F$. The dielectric constant of the medium between the capacitor plates is 1 . It produces an instantaneous displacement

current of 0.25 mA in the intervening space between the capacitor plates, the magnitude of the rate of change of the potential difference will be _____ Vs^{-1}.

50. In a series LCR circuit, a resistor of 300Ω, a capacitor of 25 nF and an inductor of 100 mH are used. For maximum current in the circuit, the angular frequency of the ac source is $\times 10^4$ radians s^{-1}.

Chemistry

*** SECTION - A** **[80]**

51.

	ΔH	ΔS	Temperature	Spontaneity
(A)	+	–	any T	Non spontaneous
(B)	+	+	low T	spontaneous
(C)	–	–	low T	Non spontaneous
(D)	–	+	any T	spontaneous

(A) (B) and (D) only (B) (A) and (D) only (C) (B) and (C) only (D) (A) and (C) only

52. Standard electrode potentials for a few half cells are mentioned below :

$E^o_{Cu^{2+}/Cu} = 0.34V, E^o_{Zn^{2+}/Zn} = -0.76V$

$E^o_{Ag^+/Ag} = 0.80V, E^o_{Mg^{2+}/Mg} = -2.37V$

Which one of the following cells gives the most negative value of ΔG^o ?

(A) $Zn\left|Zn^{2+}(1M)\right\|Ag^+(1M)\left|Ag\right.$

(B) $Zn\left|Zn^{2+}(1M)\right|\left|Mg^{2+}(1M)\right|Mg$

(C) $Ag\left|Ag^+(1M)\right|\left|Mg^{2+}(1M)\right|Mg$

(D) $Cu\left|Cu^{2+}(1M)\right\|Ag^+(1M)\left|Ag\right.$

53. The α-Helix and β - Pleated sheet structures of protein are associated with its:

(A) quaternary structure

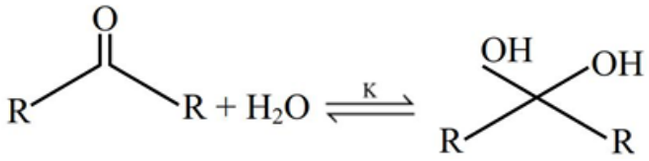
(B) primary structure

(C) secondary structure

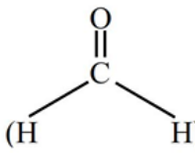
(D) tertiary structure

54. Given below are two statements:

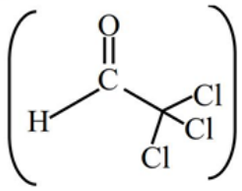
Consider the following reaction



Statement (I) : In the case of formaldehyde


(H H), K is about 2280, due to small substituents, hydration is faster.

Statement (II) : In the case of trichloro

acetaldehyde  , K is about 2000 due to - I effect of - Cl .

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

(A) Statement I true but Statement II is false

(B) Both Statement I and Statement II are true

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

(D) Both Statement I and Statement II are false

55. Consider the reaction

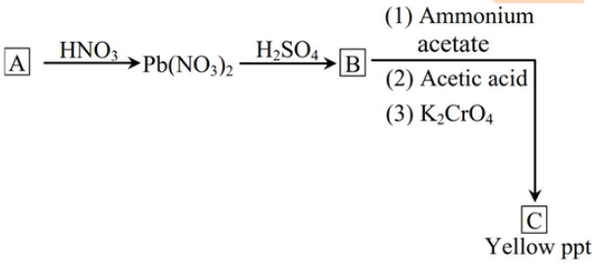
$X_2Y(g) \rightleftharpoons X_2(g) + \frac{1}{2}Y_2(g)$

The equation representing correct relationship between the degree of dissociation (x) of $X_2Y(g)$ with its equilibrium constant Kp is _____.

Assume x to be very very small.

(A) $x = \sqrt[3]{\frac{2Kp}{p}}$ (B) $x = \sqrt[3]{\frac{2Kp^2}{p}}$ (C) $x = \sqrt[3]{\frac{Kp}{2p}}$ (D) $x = \sqrt[3]{\frac{Kp}{p}}$

56. Identify A, B and C in the given below reaction sequence



(A) $PbCl_2, PbSO_4, PbCrO_4$

(B) $PbS, PbSO_4, PbCrO_4$

(C) $PbS, PbSO_4, Pb(CH_3COO)_2$

(D) $PbCl_2, Pb(SO_4)_2, PbCrO_4$

57. Given below are two statements:

Statement (I) : The boiling points of alcohols and phenols increase with increase in the number of C -atoms.

Statement (II) : The boiling points of alcohols and phenols are higher in

comparison to other class of compounds such as ethers, haloalkanes.

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

(A) Both Statement I and Statement II are false

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

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

(D) Both Statement I and Statement II are true

58. When a non-volatile solute is added to the solvent, the vapour pressure of the solvent decreases by 10 mm of Hg . The mole fraction of the solute in the solution is 0.2 . What would be the mole fraction of the solvent if decrease in vapour pressure is 20 mm of Hg ?

(A) 0.6 (B) 0.4 (C) 0.2 (D) 0.8

59. Given below are two statements:Statement (I): For a given shell, the total number of allowed orbitals is given by n^2.

Statement (II) : For any subshell, the spatial orientation of the orbitals is given by $-l$ to $+l$ values including zero.

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

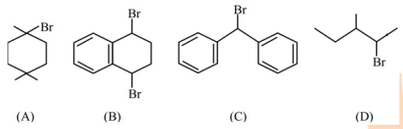
(A) Statement I is true but Statement II is false

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

(C) Both Statement I and Statement II are true

(D) Both Statement I and Statement II are false

60. The ascending order of relative rate of solvolysis of following compounds is



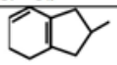
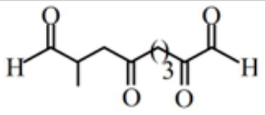
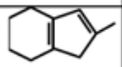
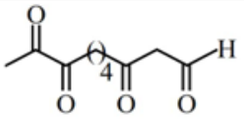
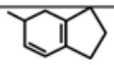
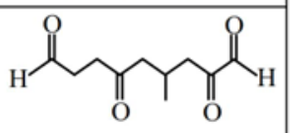
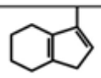
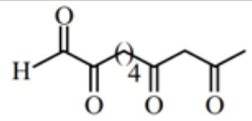
(A) (D)< (A) < (B) < (C)

(B) $(C) < (B) < (A) < (D)$

(C) (D) < (B) < (A) < (C)

(D) $(C) < (D) < (B) < (A)$

61. Match list - i with list - ii

List - I (Isomers of $C_{10}H_{14}$)		List - II (Ozonolysis product)	
(A)		(I)	
(B)		(II)	
(C)		(III)	
(D)		(IV)	

choose the correct answer from the option given below :

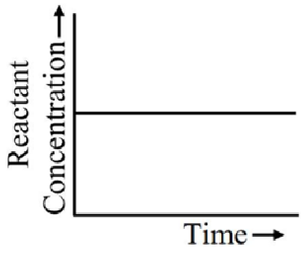
(A) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

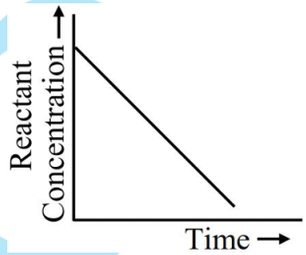
(B) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

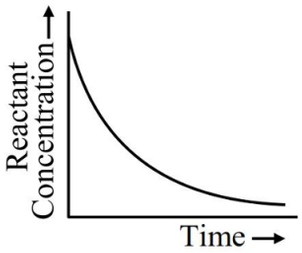
(C) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

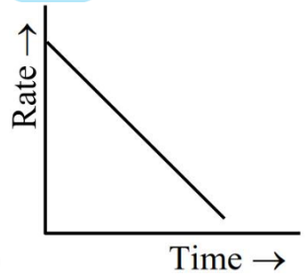
(D) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

62. Which of the following graphs most appropriately represents a zero order reaction?

(A) 

(B) 

(C) 

(D) 

63. Match list - i with list - ii.

List - I		List - II	
(A)	Bronze	(I)	Cu,Ni
(B)	Brass	(II)	Fe,Cr,Ni,C
(C)	UK silver coin	(III)	Cu,Zn
(D)	Stainless Steel	(IV)	Cu,Sn

choose the correct answer from the options given below :

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

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

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

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

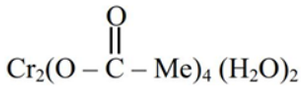
64. Identify the coordination complexes in which the central metal ion has d^4 configuration.

(A) $[FeO_4]^{2-}$

(B) $[Mn(CN)_6]^{3-}$

(C) $[Fe(CN)_6]^{3-}$

(D)



(E) $[NiF_6]^{2-}$

Choose the correct answer from the options given below :

(A) (C) and (E) only

(B) (B), (C) and (D) only

(C) (B) and (D) only

(D) (A), (B) and (E) only

65. Given below are the atomic numbers of some group 14 elements. The atomic number of the element with lowest melting point is :

(A) 14 (B) 6 (C) 82 (D) 50

66. pH of water is 7 at $25^\circ C$. If water is heated to $80^\circ C$, it's pH will :

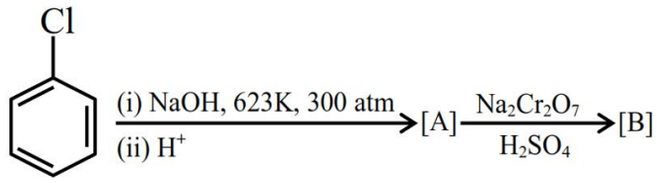
(A) Decrease

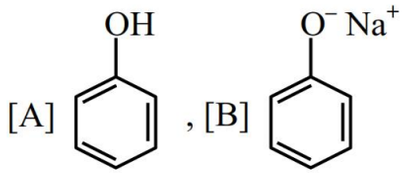
(B) Remains the same

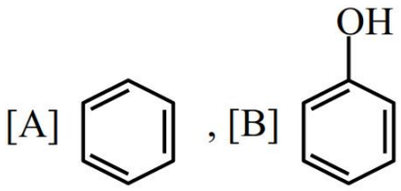
(C) H^+concentration increases, OH^-concentration decreases

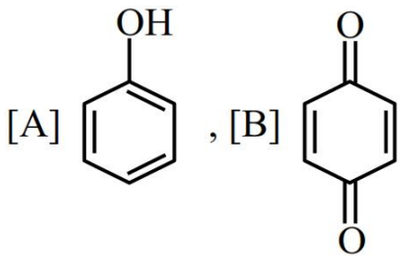
(D) Increase

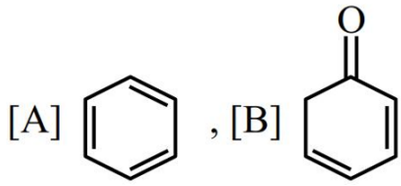
67. Identify the products $[A]$ and $[B]$, respectively in the following reaction :



(A) 

(B) 

(C) 

(D) 

68. Consider a binary solution of two volatile liquid components 1 and $2x_1$ and y_1 are the mole fractions of component 1 in liquid and vapour phase, respectively. The slope and intercept of the linear plot of $\frac{1}{x_1}$ vs $\frac{1}{y_1}$ are given respectively as :

(A) $\frac{P_1^0}{P_2^0}, \frac{P_2^0-P_1^0}{P_2^0}$ (B) $\frac{P_2^0}{P_1^0}, \frac{P_1^0-P_2^0}{P_2^0}$ (C) $\frac{P_1^0}{P_2^0}, \frac{P_1^0-P_2^0}{P_2^0}$ (D) $\frac{P_2^0}{P_1^0}, \frac{P_2^0-P_1^0}{P_2^0}$

69. Given below are two statements about X-ray spectra of elements :
Statement (I) : A plot of $\sqrt{v}(v =$ frequency of X-rays emitted) vs atomic mass is a straight line.
Statement (II) : A plot of $v(v =$ frequency of X-rays emitted) vs atomic number is a straight line. In the light of the above statements choose the correct answer from the options given below :

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

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

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

70. Consider the following reactions

$$K_2Cr_2O_7 \xrightarrow[-H_2O]{KOH} [A] \xrightarrow[-H_2O]{H_2SO_4} [B] + K_2SO_4$$

The products [A] and [B], respectively are :

(A) $K_2Cr(OH)_6$ and Cr_2O_3

(B) K_2CrO_4 and Cr_2O_3

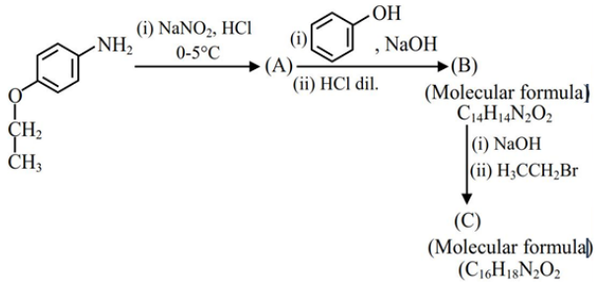
(C) K_2CrO_4 and $K_2Cr_2O_7$

(D) K_2CrO_4 and CrO

*** SECTION - B** **[20]**

71. 0.01 mole of an organic compound (X) containing 10% hydrogen, on complete combustion produced $0.9gH_2O$. Molar mass of (X) is _____) $gmol^{-1}$.

72. Consider the following sequence of reactions.



Total number of sp^3 hybridised carbon atoms in the major product C formed is _____ .

73. When 81.0 g of aluminium is allowed to react with 128.0 g of oxygen gas, the mass of aluminium oxide produced in grams is _____. (Nearest integer)
Given :
Molar mass of Al is $27.0gmol^{-1}$
Molar mass of O is $16.0gmol^{-1}$

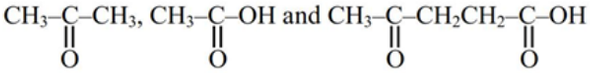
74. The bond dissociation enthalpy of $X_2\Delta H^{\circ}_{\text{bond}}$ calculated from the given data is _____ $kJmol^{-1}$. (Nearest integer)

$M^+X^-(s) \rightarrow M^+(g) + X^-(g)\Delta H^{\circ}_{\text{lattice}} = 800kJmol^{-1}$
$M(s) \rightarrow M(g)\Delta H^{\circ}_{\text{sub}} = 100kJmol^{-1}$
$M(g) \rightarrow M^+(g)^- + e^-(g)\Delta H^{\circ}_i = 500kJmol^{-1}$

$X(g) + e^-(g) \rightarrow X^-(g)\Delta H^{\circ}_{eg} = -300kJmol^{-1}$
$M(s) + \frac{1}{2}X_2(g) \rightarrow M^+X^-(s)\Delta H^{\circ}_f = -400kJmol^{-1}$

[Given : M^+X^- is a pure ionic compound and X forms a diatomic molecule X_2 is gaseous state]

75. A compound ' X ' absorbs 2 moles of hydrogen and ' X ' upon oxidation with $KMnO_4 \mid H^+$ gives



The total number of σ bonds present in the compound ' X ' is _____.

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JEE

Total Marks : 300

24 Jan 2025 Shift 1

Mathematics

* SECTION - A [80]

1. Let $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = 3\hat{i} + \hat{j} - \hat{k}$ and $\vec{c}$ be three vectors such that $\vec{c}$ is coplanar with $\vec{a}$ and $\vec{b}$. If the vector $\vec{c}$ is perpendicular to $\vec{b}$ and $\vec{a} \cdot \vec{c} = 5$, then $|\vec{c}|$ is equal to

(A) $\frac{1}{3\sqrt{2}}$ (B) 18 (C) 16 (D) $\sqrt{\frac{11}{6}}$

2. In $I(m,n) = \int_0^1 x^{m-1}(1-x)^{n-1}dx, m,n > 0$, then $I(9,14) + I(10,13)$ is

(A) $I(9,1)$ (B) $I(19,27)$ (C) $I(1,13)$ (D) $I(9,13)$

3. Let $f : \mathbb{R} - \{0\} \to \mathbb{R}$ be a function such that $f(x) - 6f\left(\frac{1}{x}\right) = \frac{35}{3x} - \frac{5}{2}$. If the $\lim_{x\to 0}\left(\frac{1}{\alpha x} + f(x)\right) = \beta$; $\alpha, \beta \in \mathbb{R}$, then $\alpha + 2\beta$ is equal to

(A) 3 (B) 5 (C) 4 (D) 6

4. Let $S_n = \frac{1}{2} + \frac{1}{6} + \frac{1}{12} + \frac{1}{20} + \ldots$ upto n terms. If the sum of the first six terms of an A.P. with first term ^{-}p and common difference p is $\sqrt{2026\, S_{2025}}$, then the absolute difference between 20^{th} and 15^{th} terms of the A.P. is

(A) 25 (B) 90 (C) 20 (D) 45

5. Let $f(x) = \frac{2^{x+2}+16}{2^{2x+1}+2^{x+4}+32}$. Then the value of $8\left(f\left(\frac{1}{15}\right) + f\left(\frac{2}{15}\right) + \ldots + f\left(\frac{59}{15}\right)\right)$ is equal to

(A) 118 (B) 92 (C) 102 (D) 108

6. If α and β are the roots of the equation $2z^2 - 3z - 2i = 0$, where $i = \sqrt{-1}$, then $\mathrm{Re}\left(\frac{\alpha^{19}+\beta^{19}+\alpha^{11}+\beta^{11}}{\alpha^{15}+\beta^{15}}\right) \cdot \mathrm{Im}\left(\frac{\alpha^{19}+\beta^{19}+\alpha^{11}+\beta^{11}}{\alpha^{15}+\beta^{15}}\right)$ is equal to

(A) 398 (B) 312 (C) 409 (D) 441

7. $\lim_{x\to 0} \mathrm{cosec}\, x\left(\sqrt{2\cos^2 x + 3\cos x} - \sqrt{\cos^2 x + \sin x + 4}\right)$ is

(A) 0 (B) $\frac{1}{2\sqrt{5}}$ (C) $\frac{1}{\sqrt{15}}$ (D) $-\frac{1}{2\sqrt{5}}$

8. Let in a $\triangle ABC$, the length of the side AC be 6, the vertex B be $(1,2,3)$ and the vertices A, C lie on the line $\frac{x-6}{3} = \frac{y-7}{2} = \frac{z-7}{-2}$. Then the area (in sq. units) of $\triangle ABC$ is

(A) 42 (B) 21 (C) 56 (D) 17

9. Let $y=y(x)$ be the solution of the differential equation $\left(xy-5x^2\sqrt{1+x^2}\right)dx+\left(1+x^2\right)dy=0$, $y(0)=0$. Then $y(\sqrt{3})$ is equal to

(A) $\frac{5\sqrt{3}}{2}$ (B) $\sqrt{\frac{14}{3}}$ (C) $2\sqrt{2}$ (D) $\sqrt{\frac{15}{2}}$

10. Let the product of the focal distances of the point $\left(\sqrt{3},\frac{1}{2}\right)$ on the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,(a>b)$, be $\frac{7}{4}$. Then the absolute difference of the eccentricities of two such ellipses is

(A) $\frac{3-2\sqrt{2}}{3\sqrt{2}}$ (B) $\frac{1-\sqrt{3}}{\sqrt{2}}$ (C) $\frac{3-2\sqrt{2}}{2\sqrt{3}}$ (D) $\frac{1-2\sqrt{2}}{\sqrt{3}}$

11. A and B alternately throw a pair of dice. A wins if he throws a sum of 5 before B throws a sum of 8 , and B wins if he throws a sum of 8 before A throws a sum of 5 . The probability, that A wins if A makes the first throw, is

(A) $\frac{9}{17}$ (B) $\frac{9}{19}$ (C) $\frac{8}{17}$ (D) $\frac{8}{19}$

12. Consider the region $R=\left\{(x,y):x\le y\le 9-\frac{11}{3}x^2,x\ge 0\right\}$. The area, of the largest rectangle of sides parallel to the coordinate axes and inscribed in R, is :

(A) $\frac{625}{111}$ (B) $\frac{730}{119}$ (C) $\frac{567}{121}$ (D) $\frac{821}{123}$

13. The area of the region $\left\{(x,y):x^2+4x+2\le y\le|x+2|\right\}$ is equal to

(A) 7 (B) $24/5$ (C) $20/3$ (D) 5

14. For a statistical data $x_1,x_2,\ldots,x_{10}$ of 10 values, a student obtained the mean as 5.5 and $\sum_{i=1}^{10}x_i^2=371$. He later found that he had noted two values in the data incorrectly as 4 and 5 , instead of the correct values 6 and 8 , respectively. The variance of the corrected data is

(A) 7 (B) 4 (C) 9 (D) 5

15. Let circle C be the image of $x^2+y^2-2x+4y-4=0$ in the line $2x-3y+5=0$ and A be the point on C such that OA is parallel to x-axis and A lies on the right hand side of the centre O of C. If $B(\alpha,\beta)$, with $\beta<4$, lies on C such that the length of the arc AB is $(1/6)^{\text{th}}$ of the perimeter of C , then $\beta-\sqrt{3}\alpha$ is equal to

(A) 3 (B) $3+\sqrt{3}$ (C) $4-\sqrt{3}$ (D) 4

16. For some $n\ne 10$, let the coefficients of the 5^{th} ,6^{th} and 7^{th} terms in the binomial expansion of $(1+x)^{n+4}$ be in A.P. Then the largest coefficient in the expansion of $(1+x)^{n+4}$ is :

(A) 70 (B) 35 (C) 20 (D) 10

17. The product of all the rational roots of the equation $\left(x^2-9x+11\right)^2-(x-4)(x-5)=3$, is equal to :

(A) 14 (B) 7 (C) 28 (D) 21

18. Let the line passing through the points $(-1,2,1)$ and parallel to the line $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z}{4}$ intersect the line $\frac{x+2}{3}=\frac{y-3}{2}=\frac{z-4}{1}$ at the point P. Then the distance of P from the point $\mathrm{Q}(4,-5,1)$ is :

(A) 5 (B) 10 (C) $5\sqrt{6}$ (D) $5\sqrt{5}$

19. Let the lines $3x-4y-=0, 8x-11y-33=0$, and $2x-3y+\lambda=0$ be concurrent. If the image of the point $(1,2)$ in the line $2\mathrm{x}-3\mathrm{y}+\lambda=0$ is $\left(\frac{57}{13},\frac{-40}{13}\right)$, then $|\alpha\lambda|$ is equal to :

(A) 84 (B) 91 (C) 113 (D) 101

20. If the system of equations $2\mathrm{x}-\mathrm{y}+\mathrm{z}=4$ $5x+\lambda y+3z=12$ $100\mathrm{x}-47\mathrm{y}+\mu\mathrm{z}=212$, has infinitely many solutions, then $\mu-2\lambda$ is equal to

(A) 56 (B) 59 (C) 55 (D) 57

*** SECTION - B** **[20]**

21. Let f be a differentiable function such that $2(x+2)^2 f(x)-3(x+2)^2=10\int_0^x (t+2)f(t)dt$, $x\geq 0$. Then $f(2)$ is equal to _____ .

22. If for some $\alpha,\beta;\alpha\leq\beta,\alpha+\beta=8$ and $\sec^2\left(\tan^{-1}\alpha\right)+\mathrm{cosec}^2\left(\cot^{-1}\beta\right)=36$, then $\alpha^2+\beta$ is _____ .

23. The number of 3-digit numbers, that are divisible by 2 and 3 , but not divisible by 4 and 9 , is

24. Let be a 3×3 matrix such that $\mathrm{X}^{\mathrm{T}}\mathrm{AX}=\mathrm{O}$ for all nonzero 3×1 matrices $X=\begin{bmatrix}x\\y\\z\end{bmatrix}$. If $\mathrm{A}\begin{bmatrix}1\\1\\1\end{bmatrix}=\begin{bmatrix}1\\4\\-5\end{bmatrix}$, $\mathrm{A}\begin{bmatrix}1\\2\\1\end{bmatrix}=\begin{bmatrix}0\\4\\-8\end{bmatrix}$, and $\det(\mathrm{adj}(2(\mathrm{A}+\mathrm{I})))=2^{\alpha}3^{\beta}5^{\gamma},\alpha,\beta,\gamma,\in\mathrm{N}$, then $\alpha^2+\beta^2+\gamma^2$ is

25. Let $S=\{p_1,p_2\ldots\ldots,p_{10}\}$ be the set of first ten prime numbers. Let $\mathrm{A}=\mathrm{S}\cup\mathrm{P}$, where P is the set of all possible products of distinct element of S . Then the number of all ordered pairs (x,y), $x\in S$, $y\in A$, such that x divides y, is _____ .

Physics

*** SECTION - A** **[80]**

26. Consider a parallel plate capacitor of area A (of each plate) and separation 'd' between the plates. If E is the electric field and ε_0 is the permittivity of free space between the plates, then potential energy stored in the capacitor is :-

(A) $\frac{1}{2}\varepsilon_0\mathrm{E}^2\mathrm{Ad}$ (B) $\frac{3}{4}\varepsilon_0\mathrm{E}^2\mathrm{Ad}$ (C) $\frac{1}{4}\varepsilon_0\mathrm{E}^2\mathrm{Ad}$ (D) $\varepsilon_0\mathrm{E}^2\mathrm{Ad}$

27. What is the relative decrease in focal length of a lens for an increase in optical power by 0.1 D from 2.5 D? ['D' stands for dioptre]

(A) 0.04 (B) 0.40 (C) 0.1 (D) 0.01

28. An air bubble of radius 0.1 cm lies at a depth of 20 cm below the free surface of a liquid of density $1000\,\mathrm{kg/m^3}$. If the pressure inside the bubble is $2100\,\mathrm{N/m^2}$ greater than the atmospheric pressure, then the surface tension of the liquid in SI unit is (use $\mathrm{g} = 10\,\mathrm{m/s^2}$)

(A) 0.02 (B) 0.1 (C) 0.25 (D) 0.05

29. For an experimental expression $\mathrm{y} = \frac{32.3 \times 1125}{27.4}$, where all the digits are significant. Then to report the value of y we should write :-

(A) $y = 1326.2$ (B) $y = 1326.19$ (C) $y = 1326.186$ (D) $y = 1330$

30. During the transition of electron from state A to state C of a Bohr atom, the wavelength of emitted radiation is 2000 Å and it becomes 6000 Å when the electron jumps from state B to state C. Then the wavelength of the radiation emitted during the transition of electrons from state A to state B is :-

(A) 3000 Å (B) 6000 Å (C) 4000 Å (D) 2000 Å

31. Consider the following statements :

A. The junction area of solar cell is made very narrow compared to a photo diode.

B. Solar cells are not connected with any external bias.

C. LED is made of lightly doped p-n junction.

D. Increase of forward current results in continuous increase of LED light intensity.

E. LEDs have to be connected in forward bias for emission of light.

(A) B, D, E Only (B) A, C Only (C) A, C, E Only (D) B, E Only

32. The amount of work done to break a big water drop of radius ' R ' into 27 small drops of equal radius is 10 J . The work done required to break the same big drop into 64 small drops of equal radius will be :-

(A) 15 J (B) 10 J (C) 20 J (D) 5 J

33. An object of mass ' m ' is projected from origin in a vertical xy plane at an angle 45° with the x -axis with an initial velocity $\mathrm{v_0}$. The magnitude and direction of the angular momentum of the object with respect to origin, when it reaches at the maximum height, will be [g is acceleration due to gravity]

(A) $\frac{mv_0^3}{2\sqrt{2}g}$ along negative z-axis

(B) $\frac{mv_0^3}{2\sqrt{2}g}$ along positive z-axis

(C) $\frac{mv_0^3}{4\sqrt{2}g}$ along positive z-axis

(D) $\frac{mv_0^3}{4\sqrt{2}g}$ along negative z-axis

34. The Young's double slit interference experiment is performed using light consisting of 480 nm and 600 nm wavelengths to form interference patterns. The least number of the bright fringes of 480 nm light that are required for the first coincidence with the bright fringes formed by 600 nm light is :-

(A) 4 (B) 8 (C) 6 (D) 5

35. A car of mass ' m ' moves on a banked road having radius ' r ' and banking angle θ. To avoid slipping from banked road, the maximum permissible speed of the car is v_0. The coefficient of friction μ between the wheels of the car and the banked road is :-

(A) $\mu = \frac{v_0^2 + rg\tan\theta}{\mathrm{rg} - v_0^2\tan\theta}$ (B) $\mu = \frac{v_0^2 + rg\tan\theta}{rg + v_0^2\tan\theta}$

(C) $\mu = \frac{v_0^2 - rg\tan\theta}{rg + v_0^2\tan\theta}$ (D) $\mu = \frac{v_0^2 - rg\tan\theta}{\mathrm{rg} - v_0^2\tan\theta}$

36. A uniform solid cylinder of mass ' m ' and radius ' r ' rolls along an inclined rough plane of inclination 45°. If it starts to roll from rest from the top of the plane then the linear acceleration of the cylinder axis will be :-

(A) $\frac{1}{\sqrt{2}}$ g (B) $\frac{1}{3\sqrt{2}}$ g (C) $\frac{\sqrt{2}g}{3}$ (D) $\sqrt{2}g$

37. A thin plano convex lens made of glass of refractive index 1.5 is immersed in a liquid of refractive index 1.2 . When the plane side of the lens is silver coated for complete reflection, the lens immersed in the liquid behaves like a concave mirror of focal length 0.2 m . The radius of curvature of the curved surface of the lens is :-

(A) 0.15 m (B) 0.10 m (C) 0.20 m (D) 0.25 m

38. A particle is executing simple harmonic motion with time period 2 s and amplitude 1 cm . If D and d are the total distance and displacement covered by the particle in 12.5 s , then $\frac{\mathrm{D}}{\mathrm{d}}$ is :-

(A) $\frac{15}{4}$ (B) 25 (C) 10 (D) $\frac{16}{5}$

39. A satellite is launched into a circular orbit of radius ' R ' around the earth. A second statellite is launched into an orbit of radius 1.03 R . The time period of revolution of the second satellite is larger than the first one approximately by :-

(A) 3% (B) 4.5% (C) 9% (D) 2.5%

40. A plano-convex lens having radius of curvature of first surface 2 cm exhibits focal length of f_1 in air. Another plano-convex lens with first surface radius of curvature 3 cm has focal length of f_2 when it is immersed in a liquid of refractive index 1.2. If both the lenses are made of same glass of refractive index 1.5 , the ratio of f_1 and f_2 will be :-

(A) $3:5$ (B) $1:3$ (C) $1:2$ (D) $2:3$

41. An alternating current is given by $I = I_A \sin\omega t + I_B \cos\omega t$. The r.m.s. current will be :-

(A) $\sqrt{I_A^2 + I_B^2}$

(B) $\frac{\sqrt{I_A^2+I_B^2}}{2}$

(C) $\sqrt{\frac{I_A^2+I_B^2}{2}}$

(D) $\frac{|I_A+I_B|}{\sqrt{2}}$

42. An electron of mass ' m ' with an initial velocity $\vec{v} = v_0\hat{i}\,(v_0 > 0)$ enters an electric field $\vec{E} = -E_0\hat{k}$. If the initial de Broglie wavelength is λ_0, the value after time t would be :-

(A) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

(B) $\frac{\lambda_0}{\sqrt{1-\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

(C) λ_0

(D) $\lambda_0\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}$

43. A parallel plate capacitor was made with two rectangular plates, each with a length of $l = 3$ cm and breath of $b = 1$ cm. The distance between the plates is 3μ m. Out of the following, which are the ways to increase the capacitance by a factor of 10 ?

A. $l = 30$ cm, $b = 1$ cm, $d = 1\mu$ m

B. $l = 3$ cm, $b = 1$ cm, $d = 30\mu$ m

C. $l = 6$ cm, $b = 5$ cm, $d = 3\mu$ m

D. $l = 1$ cm, $b = 1$ cm, $d = 10\mu$ m

E. $l = 5$ cm, $b = 2$ cm, $d = 1\mu$ m

Choose the correct answer from the options given below :

(A) C and E only (B) B and D only (C) A only (D) C only

44. A force $F = \alpha + \beta x^2$ acts on an object in the x -direction. The work done by the force is 5 J when the object is displaced by 1 m . If the constant $\alpha = 1$ N then β will be

(A) $15\ N/m^2$ (B) $10\ N/m^2$ (C) $12\ N/m^2$ (D) $8\ N/m^2$

45. An ideal gas goes from an initial state to final state. During the process, the pressure of gas increases linearly with temperature.

A. The work done by gas during the process is zero.

B. The heat added to gas is different from change in its internal energy.

C. The volume of the gas is increased.

D. The internal energy of the gas is increased.

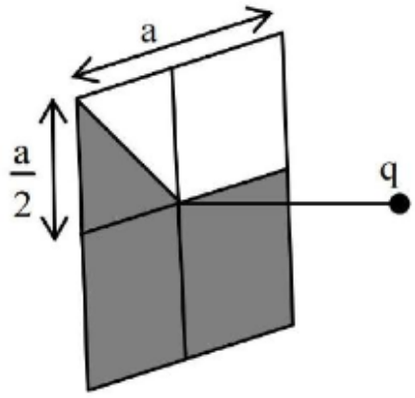
E. The process is isochoric (constant volume process)

Choose the correct answer from the options given below :-

(A) A, B, C, D Only (B) A, D, E Only (C) E Only (D) A, C Only

*** SECTION - B** **[20]**

46. A square loop of sides $\mathrm{a}=1\ \mathrm{m}$ is held normally in front of a point charge $\mathrm{q}=1\mathrm{C}$. The flux of the electric field through the shaded region is $\frac{5}{\mathrm{p}} \times \frac{1}{\varepsilon_0} \frac{\mathrm{Nm}^2}{\mathrm{C}}$, where the value of p is _____ .



47. The least count of a screw guage is 0.01 mm . If the pitch is increased by 75% and number of divisions on the circular scale is reduced by 50%, the new least count will be _____ $\times 10^{-3}\ \mathrm{mm}$.

48. A wire of resistance 9 is bent to form an equilateral triangle. Then the equivalent resistance across any two vertices will be _____ ohm.

49. A current of 5 A exists in a square loop of side $\frac{1}{\sqrt{2}}\ \mathrm{m}$. Then the magnitude of the magnetic field B at the centre of the square loop will be $p \times 10^{-6}\ \mathrm{T}$. where, value of p is _____ .
[Take $\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T\ mA^{-1}}$].

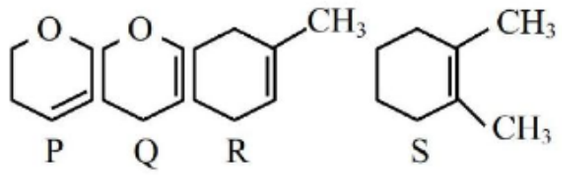
50. The temperature of 1 mole of an ideal monoatomic gas is increased by $50^{\circ}\mathrm{C}$ at constant pressure. The total heat added and change in internal energy are E_1 and E_2, respectively. If $\frac{E_1}{E_2} = \frac{x}{9}$ then the value of x is _____ .

Chemistry

*** SECTION - A** **[80]**

51. For the given cell
$\mathrm{Fe}^{2+}(\mathrm{eq}) + \mathrm{Ag}^{+}(\mathrm{aq}) \rightarrow \mathrm{Fe}^{3+}(\mathrm{aq}) + \mathrm{Ag}(\mathrm{s})$
The standard cell potential of the above reaction is Given :
$\mathrm{Ag}^{+} + \mathrm{e}^{-} \rightarrow \mathrm{Ag}$
$\mathrm{E}^0 = \mathrm{xV}$
$\mathrm{Fe}^{2+} + 2\mathrm{e}^{-} \rightarrow \mathrm{Fe}$
$\mathrm{E}^0 = \mathrm{yV}$
$\mathrm{Fe}^{3+} + 3\mathrm{e}^{-} \rightarrow \mathrm{Fe}$
$\mathrm{E}^0 = \mathrm{zV}$
(A) $x+y-z$ (B) $x+2y-3z$ (C) $y-2x$ (D) $x+2y$

52. Following are the four molecules "P", "Q", "R" and "S". Which one among the four molecules will react with $H-Br(aq)$ at the fastest rate ?



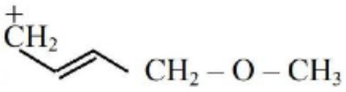
(A) S (B) Q (C) R (D) P

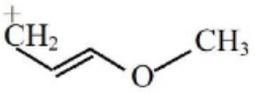
53. One mole of the octahedral complex compound $Co(NH_3)_5Cl_3$ gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with excess of $AgNO_3$ solution to yield two moles of $AgCl_{(s)}$. The structure of the complex is :

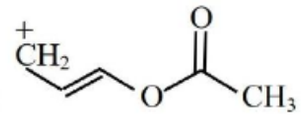
(A) $[Co(NH_3)_5Cl]Cl_2$ (B) $[Co(NH_3)_4Cl]\cdot Cl_2\cdot NH_3$

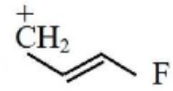
(C) $[Co(NH_3)_4Cl_2]Cl\cdot NH_3$ (D) $[Co(NH_3)_3Cl_3]\cdot 2NH_3$

54. Which one of the carbocations from the following is most stable ?

(1) 

(2) 

(3) 

(4) 

55. Which of the following linear combination of atomic orbitals will lead to formation of molecular orbitals in homonuclear diatomic molecules [internuclear axis in z-direction] ?

A. $2p_z$ and $2p_x$

B. 2 s and $2p_x$

C. $3d_{xy}$ and $3d_{x^2-y^2}$

D. 2 s and $2p_z$

E. $2p_z$ and $3d_{x^2-y^2}$

(A) E Only (B) A and B Only (C) D Only (D) C and D Only

56. Which of the following ions is the strongest oxidizing agent ? (Atomic Number of $Ce=58, Eu=63, Tb=65, Lu=71$]

(A) Lu^{3+} (B) Eu^{2+} (C) Tb^{4+} (D) Ce^{3+}

57. Ksp for $Cr(OH)_3$ is 1.6×10^{-30}. What is the molar solubility of this salt in water?

(A) $\sqrt[4]{\frac{1.6\times10^{-30}}{27}}$

(B) $\frac{1.8\times10^{-30}}{27}$

(C) $\sqrt[5]{1.8 \times 10^{-30}}$

(D) $\sqrt[2]{1.6 \times 10^{-30}}$

58. Let us consider an endothermic reaction which is non-spontaneous at the freezing point of water. However, the reaction is spontaneous at boiling point of water. Choose the correct option.

(A) Both ΔH and ΔS are (+ve)

(B) ΔH is $(-ve)$ but ΔS is $(+ve)$

(C) ΔH is $(+ve)$ but ΔS is $(-ve)$

(D) Both ΔH and ΔS are (-ve)

59. Given below are two statements I and II.

Statement I : Dumas method is used for estimation of "Nitrogen" in an organic compound.

Statement II : Dumas method involves the formation of ammonium sulphate by heating the organic compound with conc H_2SO_4.

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

(A) Both Statement I and Statement II are true

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

(C) Both Statement I and Statement II are false

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

60. Which of the following Statements are NOT true about the periodic table?

A. The properties of elements are function of atomic weights.

B. The properties of elements are function of atomic numbers.

C. Elements having similar outer electronic configuration are arranged in same period.

D. An element's location reflects the quantum numbers of the last filled orbital.

E. The number of elements in a period is same as the number of atomic orbitals available in energy level that is being filled.

Choose the correct answer from the options given below:

(A) A, C and E Only (B) D and E Only (C) A and E Only (D) B, C and E Only

61. The carbohydrates "Ribose" present in DNA, is

A. A pentose sugar

B. present in pyranose from
C. in "D" configuration
D. a reducing sugar, when free
E. in α-anomeric form
Choose the correct answer from the options given below :

(A) A, C and D Only
(B) A, B and E Only
(C) B, D and E Only
(D) A, D and E Only

62. Preparation of potassium permanganate from MnO_2 involves two step process in which the 1^{st} step is a reaction with KOH and KNO_3 to produce

(A) $K_4[Mn(OH)_6]$
(B) K_3MnO_4
(C) $KMnO_4$
(D) K_2MnO_4

63. The large difference between the melting and boiling points of oxygen and sulphur may be explained on the basis of

(A) Atomic size
(B) Atomicity
(C) Electronegativity
(D) Electron gain enthalpy

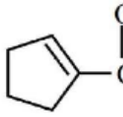
64. For a reaction, $N_2O_{5(g)} \rightarrow 2NO_{2(g)} + \frac{1}{2}O_{2(g)}$ in a constant volume container, no products were present initially. The final pressure of the system when 50% of reaction gets completed is

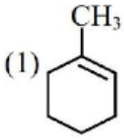
(A) $7/2$ times of initial pressure
(B) 5 times of initial pressure
(C) $5/2$ times of initial pressure
(D) $7/4$ times of initial pressure

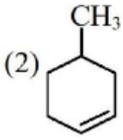
65. Which of the following arrangements with respect to their reactivity in nucleophilic addition reaction is correct?

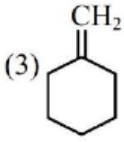
(A) benzaldehyde $<$ acetophenone $<$ p-nitrobenzaldehyde $<$ p-tolualdehyde
(B) acetophenone $<$ benzaldehyde $<$ p-tolualdehyde $<$ p-nitrobenzaldehyde
(C) acetophenone $<$ p-tolualdehyde < benzaldehyde < p-nitrobenzaldehyde
(D) p-nitrobenzaldehyde $<$ benzaldehyde $<$ p-tolualdehyde $<$ acetophenone

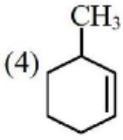
66.

Aman has been asked to synthesise the molecule  (x). He thought of preparing the molecule using an aldol condensation reaction. He found a few cyclic alkenes in his laboratory. He thought of performing ozonolysis reaction on alkene to produce a dicarbonyl compound followed by aldol reaction to prepare "x". Predict the suitable alkene that can lead to the formation of "x".

(1) 

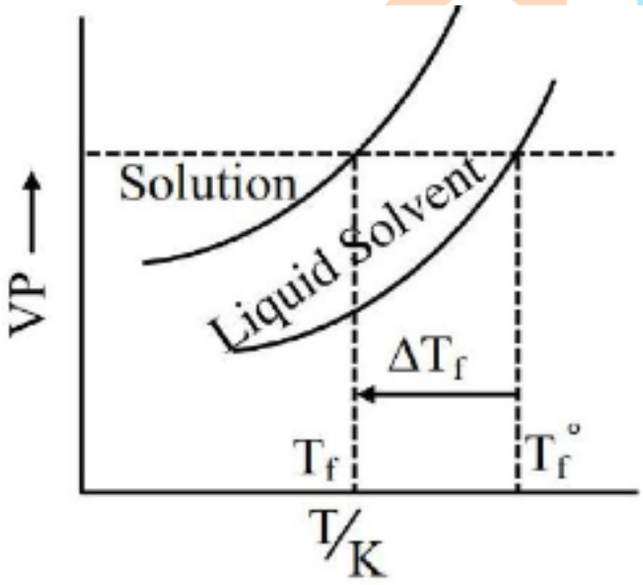
(2) 

(3) 

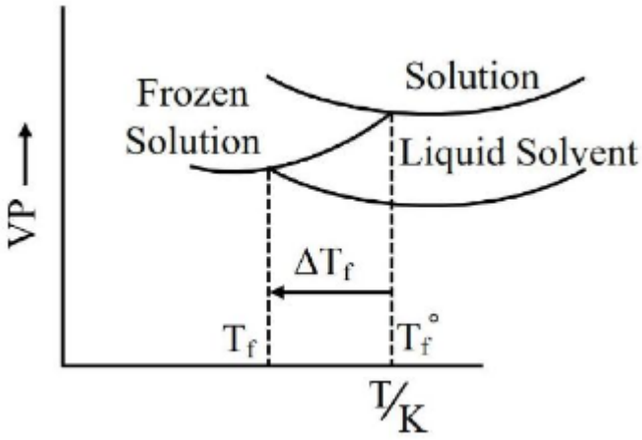
(4) 

67. Consider the given plots of vapour pressure (VP) vs temperature (T/K) Which amongst the following options is correct graphical representation showing ΔT_f, depression in the freezing point of solvent in a solution?

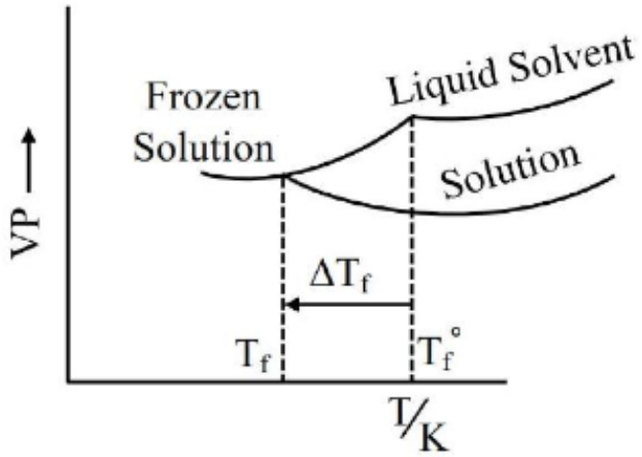
(A)



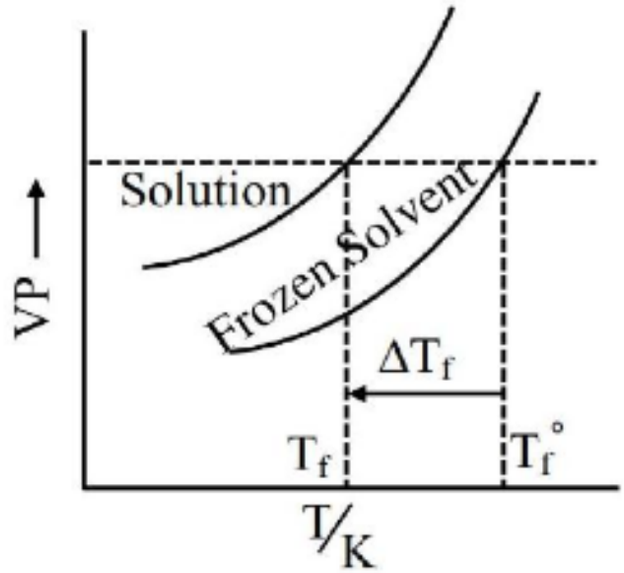
(B)



(C)



(D)



68. Which of the following statement is true with respect to H_2O, NH_3 and CH_4 ?

A. The central atoms of all the molecules are sp^3 hybridized.

B. The $H-O-H, H-N-H$ and $H-C-H$ angles in the above molecules are

$104.5°, 107.5°$ and $109.5°$ respectively.

C. The increasing order of dipole moment is $CH_4 < NH_3 < H_2O$.

D. Both H_2O and NH_3 are Lewis acids and CH_4 is a Lewis base

E. A solution of NH_3 in H_2O is basic. In this solution NH_3 and H_2O act as Lowry-Bronsted acid and base respectively.

Choose the correct answer from the options given below :

(A) A, B and C only

(B) C, D and E only

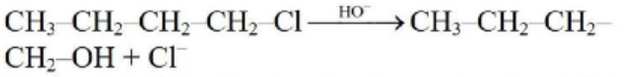
(C) A, D and E only

(D) A, B, C and E only

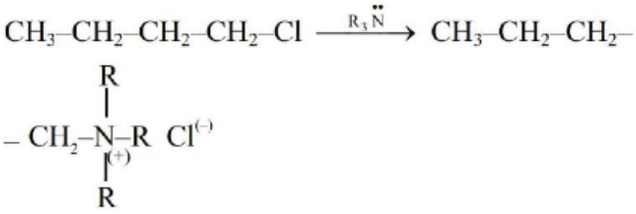
69.

Given below are two statements :

Statement-I : The conversion proceeds well in the less polar medium.



Statement-II : The conversion proceeds well in the more polar medium.



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

(A) Both statement I and statement II are true

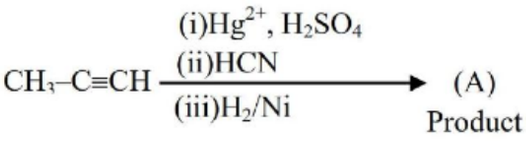
(B) Both statement I and statement II are false

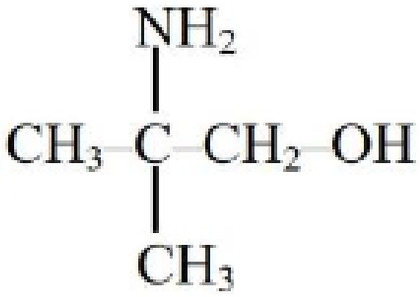
(C) Statement I is false but statement II is true

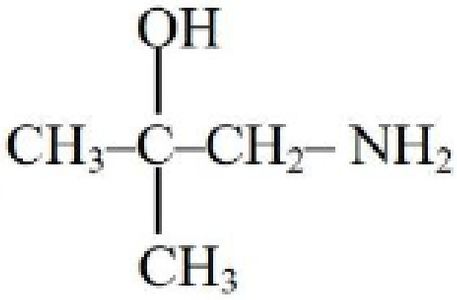
(D) Statement I is true but statement II is false

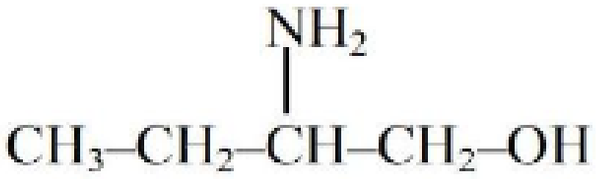
70.

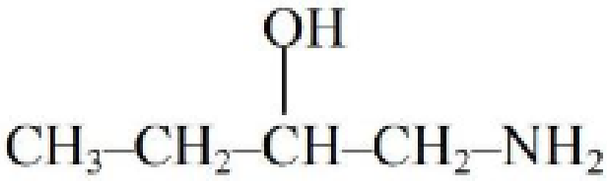
The product (A) formed in the following reaction sequence is :











*** SECTION - B** **[20]**

71. $37.8\ \mathrm{g}\ \mathrm{N_2O_5}$ was taken in a 1 L reaction vessel and allowed to undergo the following reaction at 500 K

$2\ \mathrm{N_2O_{5(g)}} \rightarrow 2\ \mathrm{N_2O_{4(g)}} + \mathrm{O_{2(g)}}$

The total pressure at equilibrium was found to be 18.65 bar.

Then, $\mathrm{Kp} =$ _____ $\times 10^{-2}$ [nearest integer]

Assume $\mathrm{N_2O_5}$ to behave ideally under these conditions

Given : $\mathrm{R} = 0.082$ bar $\mathrm{Lmol^{-1}\ K^{-1}}$

72. Standard entropies of X_2, Y_2 and XY_5 are 70,50 and $110\ \mathrm{J\ K^{-1}\ mol^{-1}}$ respectively. The temperature in Kelvin at which the reaction $\frac{1}{2}\mathrm{X_2} + \frac{5}{2}\mathrm{Y_2} \rightarrow \mathrm{XY_5}\ \Delta\mathrm{H}^{-} = -35\ \mathrm{kJ\ mol^{-1}}$ Will be at equilibrium is _____ (Nearest integer)

73. Xg of benzoic acid on reaction with aq. $NaHCO_3$ release CO_2 that occupied 11.2 L volume at STP. X is _____ g.

74. Among the following cations, the number of cations which will give characteristic precipitate in their identification tests with $K_4[Fe(CN)_6]$ is :
$Cu^{2+}, Fe^{3+}, Ba^{2+}, Ca^{2+}, NH_4^+, Mg^{2+}, Zn^{2+}$

75. Consider the following reaction occurring in the blast furnace.
$Fe_3O_{4(s)} + 4CO_{(g)} \rightarrow 3Fe_{(l)} + 4CO_{2(g)}$
' x ' kg of iron is produced when 2.32×10^3 kg Fe_3O_4 and 2.8×10^2 kgCO are brought together in the furnace. The value of ' x ' is
_____ .
(nearest integer)
{Given :
Molar mass of $Fe_3O_4 = 232$ g mol^{-1}
Molar mass of $CO = 28$ g mol^{-1}
Molar mass of $Fe = 56$ g mol^{-1}}

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JEE

Total Marks : 300

24 Jan 2025 Shift 2

Mathematics

* SECTION - A

[80]

1. The equation of the chord, of the ellipse $\frac{x^2}{25}+\frac{y^2}{16}=1$, whose mid-point is $(3,1)$ is :

(A) $48x+25y=169$ (B) $4x+122y=134$ (C) $25x+101y=176$ (D) $5x+16y=31$

2. The function $f:(-\infty,\infty)\to(-\infty,1)$, defined by $f(x)=\frac{2^x-2^{-x}}{2^x+2^{-x}}$ is :

(A) One-one but not onto (B) Onto but not one-one

(C) Both one-one and onto (D) Neither one-one nor onto

3. If $\alpha>\beta>\gamma>0$, then the expression

$\cot^{-1}\left\{\beta+\frac{(1+\beta^2)}{(\alpha-\beta)}\right\}+\cot^{-1}\left\{\gamma+\frac{(1+\gamma^2)}{(\beta-\gamma)}\right\}+\cot^{-1}\left\{\alpha+\frac{(1+\alpha^2)}{(\gamma-\alpha)}\right\}$ is equal to:

(A) $\frac{\pi}{2}-(\alpha+\beta+\gamma)$ (B) 3π (C) 0 (D) π

4. Let $\mathrm{f}:(0,\infty)\to\mathbf{R}$ be a function which is differentiable at all points of its domain and satisfies the condition $x^2f'(x)=2xf(x)+3$, with $f(1)=4$. Then $2f(2)$ is equal to:

(A) 29 (B) 19 (C) 39 (D) 23

5. Let

$A=\left\{x\in(0,\pi)-\left\{\frac{\pi}{2}\right\}:\log_{(2/\pi)}|\sin x|+\log_{(2/\pi)}|\cos x|=2\right\}$

and

$B=\{x\geq 0:\sqrt{x}(\sqrt{x}-4)-3|\sqrt{x}-2|+6=0\}$. Then $\mathrm{n(A\cup B)}$ is equal to:

(A) 4 (B) 2 (C) 8 (D) 6

6. Let the position vectors of three vertices of a triangle be $4\vec{\mathrm{p}}+\vec{\mathrm{q}}-3\vec{\mathrm{r}},-5\vec{\mathrm{p}}+\vec{\mathrm{q}}+2\vec{\mathrm{r}}$ and $2\vec{p}-\vec{q}+2\vec{r}$. If the position vectors of the orthocenter and the circumcenter of the triangle are $\frac{\vec{\mathrm{p}}+\vec{\mathrm{q}}+\vec{\mathrm{r}}}{4}$ and $\alpha\vec{\mathrm{p}}+\beta\vec{\mathrm{q}}+\gamma\vec{\mathrm{r}}$ respectively, then $\alpha+2\beta+5\gamma$ is equal to:

(A) 3 (B) 1 (C) 6 (D) 4

7. Let $[\mathrm{x}]$ denote the gereatest integer function, and let m and n respectively be the numbers of the points, where the function $f(x)=[x]+|x-2|$, $-2<x<3$, is not

continuous and not differentiable.

(A) 6 (B) 9 (C) 8 (D) 7

8. Let the points $\left(\frac{11}{2}, \alpha\right)$ lie on or inside the triangle with sides $\mathrm{x}+\mathrm{y}=11, \mathrm{x}+2\mathrm{y}=16$ and $2\mathrm{x}+3\mathrm{y}=29$. Then the product of the smallest and the largest values of α is equal to :

(A) 22 (B) 44 (C) 33 (D) 55

9. In an arithmetic progression, if $\mathrm{S}_{40}=1030$ and $\mathrm{S}_{12}=57$, then $\mathrm{S}_{30}-\mathrm{S}_{10}$ is equal to:

(A) 510 (B) 515 (C) 525 (D) 505

10. If $7=5+\frac{1}{7}(5+\alpha)+\frac{1}{7^2}(5+2\alpha)+\frac{1}{7^3}(5+3\alpha)+\quad \infty$, then the value of α is:

(A) 1 (B) $\frac{6}{7}$ (C) 6 (D) $\frac{1}{7}$

11. If the system of equations

$x+2y-3z=2$

$2x+\lambda y+5z=5$

$14x+3y+\mu z=33$

has infinitely many solutions, then $\lambda+\mu$ is equal to:

(A) 13 (B) 10 (C) 11 (D) 12

12. Let $(2,3)$ be the largest open interval in which the function $f(x)=2\log_c(x-2)-x^2+ax+1$ is strictly increasing and (b, c) be the largest open interval, in which the function $g(x)=(x-1)^3(x+2-a)^2$ is strictly decreasing. Then $100(a+b-c)$ is equal to:

(A) 280 (B) 360 (C) 420 (D) 160

13. Suppose A and B are the coefficients of 30^{th} and 12^{th} terms respectively in the binomial expansion of $(1+x)^{2n-1}$. If $2A=5B$, then n is equal to:

(A) 22 (B) 21 (C) 20 (D) 19

14. Let $\vec{a}=3\hat{i}-\hat{j}+2\hat{k}, \vec{b}=\vec{a}\times(\hat{i}-2\hat{k})$ and $\vec{c}=\vec{b}\times\hat{k}$.

Then the projection of $\overrightarrow{\mathbf{c}}-2\hat{\mathrm{j}}$ on $\overrightarrow{\mathrm{a}}$ is:

(A) $3\sqrt{7}$ (B) $\sqrt{14}$ (C) $2\sqrt{14}$ (D) $2\sqrt{7}$

15. For some a, b, let

$$f(x)=\begin{vmatrix} a+\frac{\sin x}{x} & 1 & b \\ a & 1+\frac{\sin x}{x} & b \\ a & 1 & b+\frac{\sin x}{x} \end{vmatrix}, \quad x \neq 0,$$

$\lim_{x\to 0} f(x)=\lambda+\mu a+vb$. Then $(\lambda+\mu+v)^2$ is equal to:

(A) 25 (B) 9 (C) 36 (D) 16

16. Group A consists of 7 boys and 3 girls, while group B consists of 6 boys and 5 girls. The number of ways, 4 boys and 4 girls can be invited for a picnic if 5 of

them must be from group A and the remaining 3 from group B, is equal to:

(A) 8575 (B) 9100 (C) 8925 (D) 8750

17. The area of the region enclosed by the curves $y = e^x, y = |e^x - 1|$ and y -axis is:

(A) $1 + \log_c 2$ (B) $\log_e 2$ (C) $2\log_c 2 - 1$ (D) $1 - \log_e 2$

18. The number of real solution(s) of the equation $x^2 + 3x + 2 = \min\{|x-3|, |x+2|\}$ is :

(A) 2 (B) 0 (C) 3 (D) 1

19. Let $A = [a_{ij}]$ be a square matrix of order 2 with entries either 0 or 1 . Let E be the event that A is an invertible matrix. Then the probability $P(E)$ is :

(A) $\frac{5}{8}$ (B) $\frac{3}{16}$ (C) $\frac{1}{8}$ (D) $\frac{3}{8}$

20. If the equation of the parabola with vertex $V\left(\frac{3}{2}, 3\right)$ and the directrix $x + 2y = 0$ is $\alpha x^2 + \beta y^2 - \gamma xy - 30x - 60y + 225 = 0$, then $\alpha + \beta + \gamma$ is equal to:

(A) 6 (B) 8 (C) 7 (D) 9

*** SECTION - B** **[20]**

21. Number of functions $f : \{1, 2, \ldots, 100\} \to \{0, 1\}$, that assign 1 to exactly one of the positive integers less than or equal to 98 , is equal to _____ .

22. Let P be the image of the point $Q(7, -2, 5)$ in the line $L : \frac{x-1}{2} = \frac{y+1}{3} = \frac{z}{4}$ and $R(5, p, q)$ be a point on L . Then the square of the area of $\triangle PQR$ is _____ .

23. Let $y = y(x)$ be the solution of the differential equation $2\cos x \frac{dy}{dx} = \sin 2x - 4y \sin x, x \in \left(0, \frac{\pi}{2}\right)$. If $y\left(\frac{\pi}{3}\right) = 0$, then $y'\left(\frac{\pi}{4}\right) + y\left(\frac{\pi}{4}\right)$ is equal to _____ .

24. Let $H_1 : \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ and $H_2 : -\frac{x^2}{A^2} + \frac{y^2}{B^2} = 1$ be two hyperbolas having length of latus rectums $15\sqrt{2}$ and $12\sqrt{5}$ respectively. Let their eccentricities be $e_1 = \sqrt{\frac{5}{2}}$ and e_2 respectively. If the product of the lengths of their transverse axes is $100\sqrt{10}$, then $25e_2^2$ is equal to _____ .

25. If $\int \frac{2x^2+5x+9}{\sqrt{x^2+x+1}} dx = x\sqrt{x^2+x+1} + \alpha\sqrt{x^2+x+1} + \beta \log_e \left|x + \frac{1}{2} + \sqrt{x^2+x+1}\right| + C$, where C is the constant of integration, then $\alpha + 2\beta$ is equal to _____ .

Physics

*** SECTION - A** **[80]**

26. Young's double slit interference apparatus is immersed in a liquid of refractive index 1.44. It has slit separation of 1.5 mm . The slits are illuminated by a parallel beam of light whose wavelength in air is 690 nm . The fringe-width on a screen placed behind the plane of slits at a distance of 0.72 m , will be :

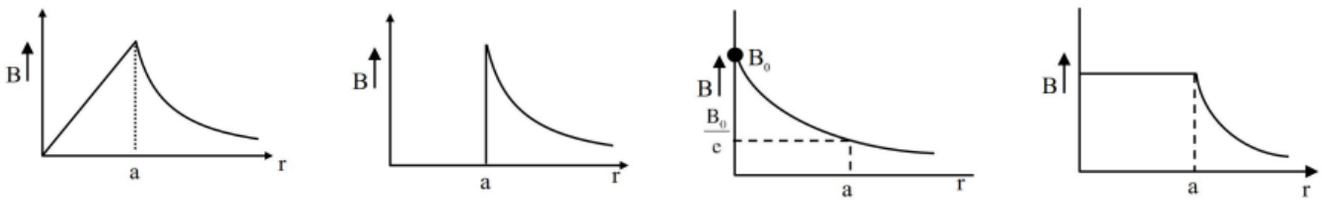
(A) 0.23 mm (B) 0.33 mm (C) 0.63 mm (D) 0.46 mm

27. Arrange the following in the ascending order of wavelength (λ) :
(A) Microwaves (λ_1)
(B) Ultraviolet rays (λ_2)
(C) Infrared rays (λ_3)
(D) X -rays (λ_4)
Choose the most appropriate answer from the options given below :-
(A) $\lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$ (B) $\lambda_3 < \lambda_4 < \lambda_2 < \lambda_1$
(C) $\lambda_4 < \lambda_2 < \lambda_3 < \lambda_1$ (D) $\lambda_4 < \lambda_3 < \lambda_1 < \lambda_2$

28. Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason(R).
Assertion (A) : A electron in a certain region of uniform magnetic field is moving with constant velocity in a straight line path.
Reason (A) : The magnetic field in that region is along the direction of velocity of the electron.
In the light of the above statements, choose the correct answer from the options given below :
(A) (A) is false but (R) is true
(B) Both (A) and (R) are true and (R) is the correct explanation of (A)
(C) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)
(D) (A) is true but (R) is false

29. A solid sphere is rolling without slipping on a horizontal plane. The ratio of the linear kinetic energy of the centre of mass of the sphere and rotational kinetic energy is :
(A) $\frac{2}{5}$ (B) $\frac{5}{2}$ (C) $\frac{3}{4}$ (D) $\frac{4}{3}$

30. A long straight wire of a circular cross-section with radius ' a ' carries a steady current I. The current I is a uniformly distributed across this cross-section. The plot of magnitude of magnetic field B with distance r from the centre of the wire is given by
(A) (B) (C) (D)



31. Given below are two statements. One is labelled as **Assertion (A)** and the other is labelled as **Reason(R).**
Assertion (A) : In an insulated container, a gas is adiabatically shrunk to half of

its initial volume. The temperature of the gas decreases.

Reason (R) : Free expansion of an ideal gas is an irreversible and an adiabatic process.

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

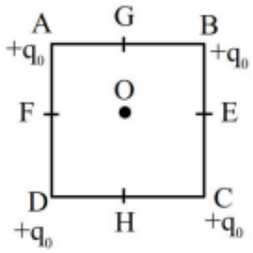
(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) (A) is true but (R) is false

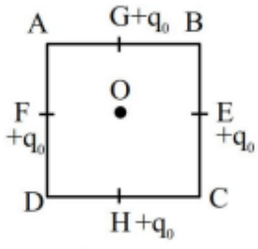
(C) (A) is false but (R) is true

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

32.



Configuration(1)



Configuration(2)

In the first configuration (1) as shown in the figure, four identical charges (q_0) are kept at the corners A, B, C and D of square of side length ' a '. In the second configuration (2), the same charges are shifted to mid points G, E, H and F, of the square, If $K = \frac{1}{4\pi\varepsilon_0}$, the difference between the potential energies of configuration (2) and (1) is given by :

(A) $\frac{Kq_0^2}{a}(4\sqrt{2}-2)$ (B) $\frac{Kq_0^2}{a}(3-\sqrt{2})$ (C) $\frac{Kq_0^2}{a}(4-2\sqrt{2})$ (D) $\frac{Kq_0^2}{a}(3\sqrt{2}-2)$

33. The position vector of a moving body at any instant of time is given as $\vec{r} = \left(5t^2\hat{i} - 5t\hat{j}\right)m$. The magnitude and direction of velocity at $t = 2s$ is,

(A) $5\sqrt{15}m/s$, making an angle of $\tan^{-1}4$ with -ve Y axis

(B) $5\sqrt{15}m/s$, making an angle of $\tan^{-1}4$ with +ve X axis

(C) $5\sqrt{17}m/s$, making an angle of $\tan^{-1}4$ with -ve Y axis

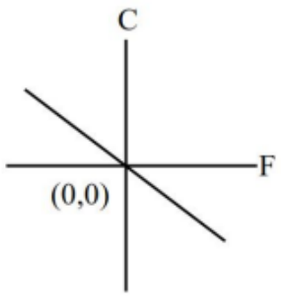
(D) $5\sqrt{17}m/s$, making an angle of $\tan^{-1}4$ with + ve X axis

34. A solid sphere and a hollow sphere of the same mass and of same radius are rolled on an inclined plane. Let the time taken to reach the bottom by the solid sphere and the hollow sphere be t_1 and t_2, respectively, then

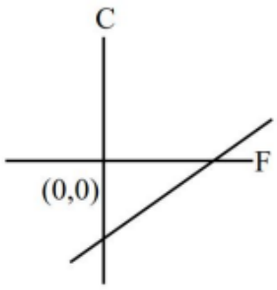
(A) $t_1 < t_2$ (B) $t_1 = t_2$ (C) $t_1 = 2t_2$ (D) $t_1 > t_2$

35. Which of the following figure represents the relation between Celsius and Fahrenheit temperatures?

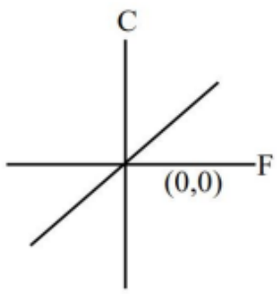
(A)



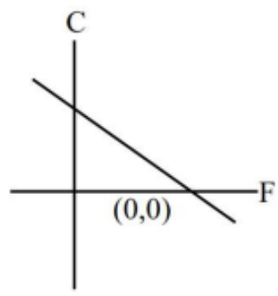
(B)



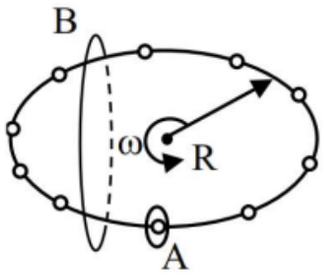
(C)



(D)



36.

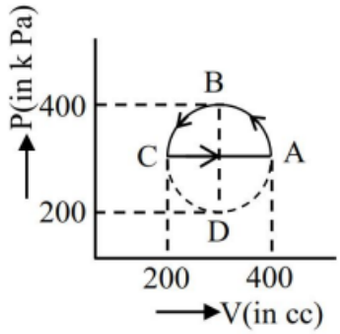


N equally spaced charges each of value q , are placed on a circle of radius R . The circle rotates about its axis with an angular velocity ω as shown in the figure. A bigger Amperian loop B encloses the whole circle where as a smaller Amperian loop A encloses a small segment. The difference between enclosed currents, $I_A - I_B$, for the given Amperian loops is

(A) $\frac{N^2}{2\pi}q\omega$ (B) $\frac{2\pi}{N}q\omega$ (C) $\frac{N}{2\pi}q\omega$ (D) $\frac{N}{\pi}q\omega$

37. In photoelectric effect, the stopping potential (V_0) v/s frequency (v) curve is plotted.
(h is the Planck's constant and ϕ_0 is work function of metal)
(A) $V_0 v/sv$ is linear
(B) The slope of $V_0 v/sv$ curve $= \frac{\phi_0}{h}$
(C) h constant is related to the slope of V_0 v/s v line
(D) The value of electric charge of electron is not required to determine h using the V_0 v/s v curve.
(E) The work function can be estimated without knowing the value of h.
Choose the **correct** answer from the options given below :
(A) (A), (B) and (C) only
(B) (C) and (D) only
(C) (A),(C) and (E) only
(D) (D) and (E) only

38. The magnitude of heat exchanged by a system for the given cyclic process ABCA (as shown in figure) is (in SI unit)

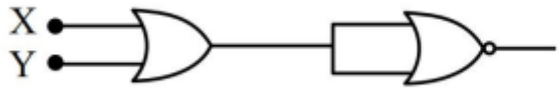


(A) 10π (B) 5π (C) zero (D) 40π

39. A photograph of a landscape is captured by a drone camera at a height of 18 km . The size of the camera film is $2cm \times 2cm$ and the area of the landscape photographed is $400km^2$. The focal length of the lens in the drone camera is :

(A) 1.8 cm (B) 2.8 cm (C) 2.5 cm (D) 0.9 cm

40. The output of the circuit is low (zero) for



(A) $X = 0, Y = 0$
(B) $X = 0, Y = 1$
(C) $X = 1, Y = 0$
(D) $X = 1, Y = 1$

Choose the correct answer from the options given below:

(A) (A), (C) and (D) only (B) (A), (B) and (C) only
(C) (B), (C) and (D) only (D) (A), (B) and (D) only

41. The temperature of a body in air falls from $40^\circ C$ to $24^\circ C$ in 4 minutes. The temperature of the air is $16^\circ C$. The temperature of the body in the next 4 minutes will be :

(A) $\frac{14}{3}^\circ C$ (B) $\frac{28}{3}^\circ C$ (C) $\frac{56}{3}^\circ C$ (D) $\frac{42}{3}^\circ C$

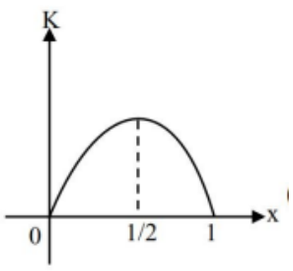
42. The energy E and momentum p of a moving body of mass m are related by some equation. Given that e represents the speed of light, identify the correct equation.

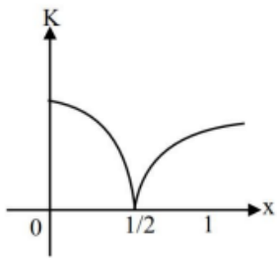
(A) $E^2 = pc^2 + m^2c^4$ (B) $E^2 = pc^2 + m^2c^2$ (C) $E^2 = p^2c^2 + m^2c^2$ (D) $E^2 = p^2c^2 + m^2c^4$

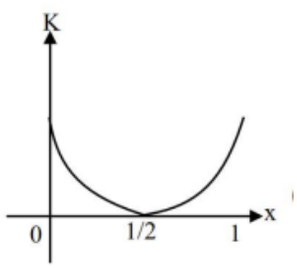
43. A small uncharged conducting sphere is placed in contact with an identical sphere but having 4×10^{-8} C charge and then removed to a distance such that the force of repulsion between them is $9 \times 10^{-3} N$. The distance between them is (Take $\frac{1}{4\pi\varepsilon_0}$ as $9 \times 10^\circ$ in SI units)

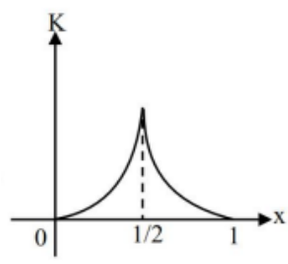
(A) 2cm (B) 3cm (C) 4cm (D) 1cm

44. A particle oscillates along the x-axis according to the law, $x(t) = x_0 \sin^2\left(\frac{t}{2}\right)$ where $x_0 = 1m$. The kinetic energy (K) of the particle as a function of x is correctly represented by the graph.

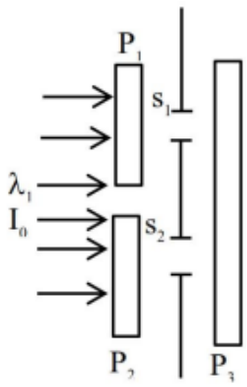
(A) 

(B) 

(C) 

(D) 

45. In a Young's double slit experiment, three polarizers are kept as shown in the figure. The transmission axes of P_1 and P_2 are orthogonal to each other. The polarizer P_3 covers both the slits with its transmission axis at 45° to those of P and P_2. An unpolarized light of wavelength λ and intensity I_0 is incident on P_1 and P_2. The intensity at a point after P_3 where the path difference between the light waves from s_1 and s_2 is $\frac{\lambda}{3}$, is



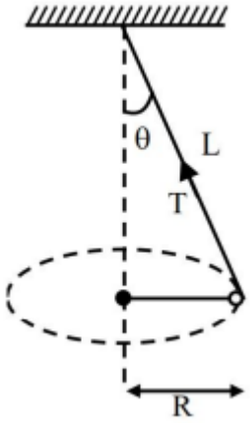
(A) $\frac{I_6}{2}$ (B) $\frac{I_0}{4}$ (C) I_0 (D) $\frac{I_0}{3}$

*** SECTION - B** **[20]**

46. A tightly wound long solenoid carries a current of 1.5 A. An electron is executing uniform circular motion inside the solenoid with a time period of 75 ns . The number of turns per metre in the solenoid is _____ .

[Take mass of electron $m_e = 9 \times 10^{31} kg$, charge of electron $|q_e| = 1.6 \times 10^{-19} C$, $\mu_o = 4\pi \times 10^{-7} \frac{N}{A^2}, 1ns = 10^{-9} s$]

47.



A string of length L is fixed at one end and carries a mass of M at the other end. The mass makes $\left(\frac{3}{\pi}\right)$ rotations per second about the vertical axis passing through end of the string as shown. The tension in the string is _____ ML.

48. The ratio of the power of a light source S_1 to that the light source S_2 is $2.S_1$ is emitting 2×10^{15} photons per second at 600 nm . If the wavelength of the source S_2 is 300 nm , then the number of photons per second emitted by S_2 is _____ $\times 10^{14}$. (5)

49. The increase in pressure required to decrease the volume of a water sample by 0.2% is $P \times 10^{\circ} Nm^{-2}$. Bulk modulus of water is $2.15 \times 10^{9} Nm^{-2}$. The value of P is _____

50. Acceleration due to gravity on the surface of earth is ' g '. If the diameter of earth is reduced to one third of its original value and mass remains unchanged, then the acceleration due to gravity on the surface of the earth is _____ g.

Chemistry

*** SECTION - A** **[80]**

51. Based on the data given below:

$E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33V \quad E^0_{C_2/Cr^{(-1}} = 1.36V$

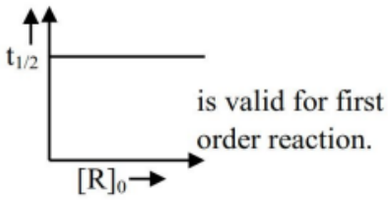
$E^0_{MnO_4^-/Mn^{2+}} = 1.51V \quad E^0_{Cr^{2+}/Cr} = -0.74V$

the strongest reducing agent is :

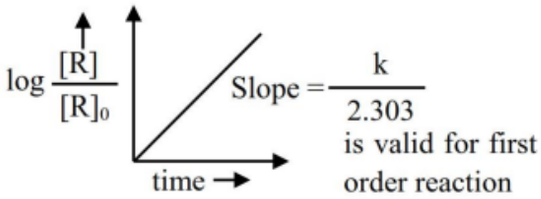
(A) Mn^{2+} (B) Cr (C) MnO_4^- (D) Cl^-

52. Given below are two statements :

Statement(I) :



Statement(II) :



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

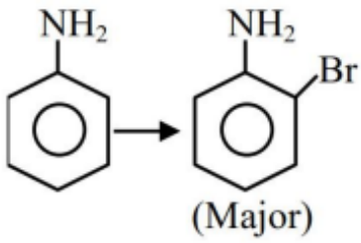
(A) Both Statement I and Statement II are false

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

(C) Both Statement I and Statement II are true

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

53. For reaction



The correct order of set of reagents for the above conversion is :

(A) $Br_2 \mid FeBr_3, H_2O(\Delta), NaOH$

(B) $H_2SO_4, Ac_2O, Br_2, H_2O(\Delta), NaOH$

(C) $Ac_2O, Br_2, H_2O(\Delta), NaOH$

(D) $Ac_2O, H_2SO_4, Br_2, NaOH$

54. For hydrogen atom, the orbital/s with lowest energy is/are :

(A) 4 s

(B) $3p_x$

(C) $3d_{x^2-y^2}$

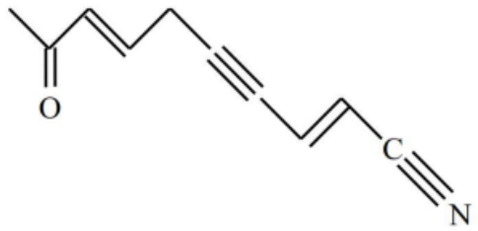
(D) $3d_{z^2}$

(E) $4p_2$

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

(A) (A) and (E) only
(B) (B) only
(C) (A) only
(D) (B), (C) and (D) only

55. In the given structure, number of sp and sp^2 hybridized carbon atoms present respectively are :



(A) 3 and 6
(B) 3 and 5
(C) 4 and 6
(D) 4 and 5

56. Which of the following mixing of 1 M base and 1 M acid leads to the largest increase in temperature?
(A) 30 mL HCl and 30 mL NaOH
(B) $30mL CH_3COOH$ and 30 mL NaOH
(C) 50 mL HCl and 20 mL NaOH
(D) $45mL CH_3COOH$ and 25 mL NaOH

57. Given below are two statements :
Statement(I) : Experimentally determined oxygen-oxygen bond lengths in the O_3 are found to be same and the bond length is greater than that of a $O=O$ (double bond) but less than that of a single ($O-O$) bond.
Statement (II) : The strong lone pair-lone pair repulsion between oxygen atoms is solely responsible for the fact that the bond length in ozone is smaller than that of a double bond $(O=O)$ but more than that of a single bond $(O-O)$.
In the light of the above statements, choose the correct answer from the options given below:
(A) Statement I is true but Statement II is false
(B) Both Statement I and Statement II are true
(C) Both Statement I and Statement II are false
(D) Statement I is false but Statement II is true

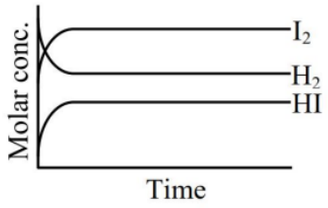
58. Find the compound ' A ' from the following reaction sequences.

$$\mathrm{A} \xrightarrow{\text{aqua-regia}} \mathrm{B} \xrightarrow[(2)\mathrm{AcOH}]{(1)\mathrm{KNO_2}|\mathrm{NH_4OH}} \text{yellow ppt}$$

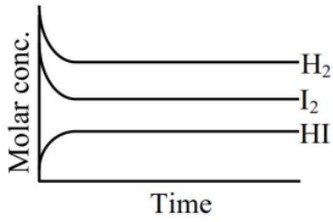
(A) ZnS
(B) CoS
(C) MnS
(D) Nis

59. For the reaction,
$H_2(g)+I_2(g) \rightleftharpoons 2HI(g)$
Attainment of equilibrium is predicted correctly by:

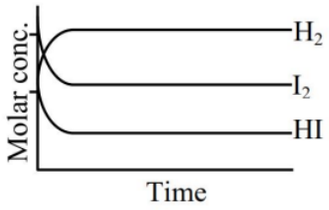
(A)



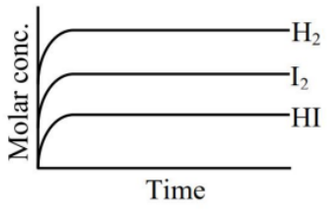
(B)



(C)



(D)



60. Match List-I with List-II.

List-I (Transition metal ion)	List-II (Spin only magnetic moment (B.M.))
(A) Ti^{3+}	(I) 3.87
(B) V^{2+}	(II) 0.00
(C) Ni^{2+}	(III) 1.73
(D) Sc^{3+}	(IV) 2.84

Choose the correct answer from the options given below :

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

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

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

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

61. The elemental composition of a compound is $54.2\%, C, 9.2\% H$ and $36.6\% O$. If the molar mass of the compound is $132 g mol^{-1}$, the molecular formula of the compound is :

[Given : The relative atomic mass of $C : H : O =$ 12:1:16]

(A) $C_4H_9O_3$ (B) $C_6H_{12}O_6$ (C) $C_6H_{12}O_3$ (D) $C_4H_8O_2$

62. When Ethane-1,2-diamine is added progressively to an aqueous solution of Nickel (II) chloride, the sequence of colour change observed will be :

(A) Pale Blue $\rightarrow$ Blue $\rightarrow$ Green $\rightarrow$ Violet

(B) Pale Blue $\rightarrow$ Blue $\rightarrow$ Violet $\rightarrow$ Green

(C) Green $\rightarrow$ Pale Blue $\rightarrow$ Blue $\rightarrow$ Violet

(D) Violet $\rightarrow$ Blue $\rightarrow$ Pale Blue $\rightarrow$ Green

63. The conditions and consequence that favours the ${t_{2g}}^3, {e_g}^1$ configuration in a metal complex are :

(A) weak field ligand, high spin complex

(B) strong field ligand, high spin complex

(C) strong field ligand, low spin complex

(D) weak field ligand, low spin complex

64. Identify correct statement/s :

(A) $-OCH_3$ and $-NHCOCH_3$ are activating group

(B) - CN and - OH are meta directing group

(C) - CN and $-SO_3H$ are meta directing group

(D) Activating groups act as ortho - and para directing groups

(E) Halides are activating groups

Choose the correct answer from the options given below :

(A) (A), (C) and (D) only

(B) (A), (B) and (E) only

(C) (A) only

(D) (A) and (C) only

65. Given below are two statements :

Statement (I) : The first ionization energy of Pb is greater than that of Sn

Statement(II) : The first ionization energy of Ge is greater than that of Si .

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

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

(B) Both Statement I and Statement II are false

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

(D) Both Statement I and Statement II are true

66. $S(g)+\frac{3}{2}O_2(g) \rightarrow SO_3(g)+2x$ kcal

$SO_2(g)+\frac{1}{2}O_2(g) \rightarrow SO_3(g)+ykcal$

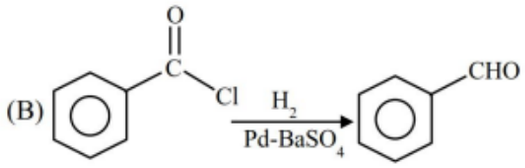
The heat of formation of $SO_2(g)$ is given by :

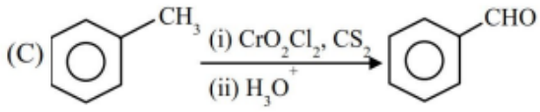
(A) $\frac{2x}{y}kcal$ (B) $y-2x$ kcal (C) $2x+y$ kcal (D) $x+y$ kcal

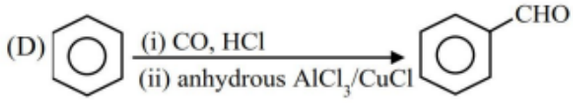
67. Match List-I with List-II

List-I

(A) $RCN \xrightarrow[(ii)H_3O^+]{(i)SnCl_2,HCl} RCHO$

(B) 

(C) 

(D) 

List-II

(I) Etard reaction

(II) Gatterman -Koch reaction

(III) Rosenmund reduction

(IV) Stephen reaction

Choose the correct answer from the options given below :

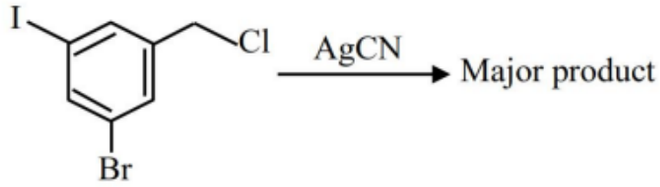
(A) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

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

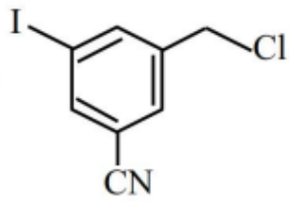
(C) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

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

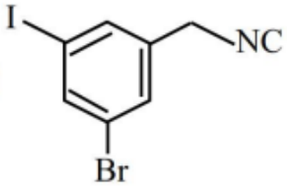
68. The structure of the major product formed in the following reaction is :



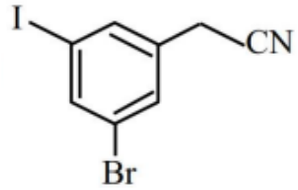
(A)



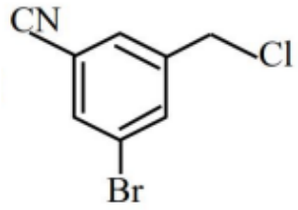
(B)



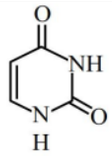
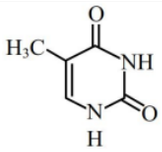
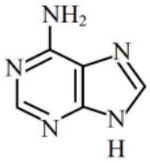
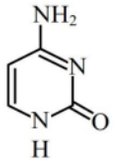
(C)



(D)



69. Match List-I with List-II.

	List - I		List - II
(A)	Adenine	(I)	
(B)	Cytosine	(II)	
(C)	Thymine	(III)	
(D)	Uracil	(IV)	

Choose the correct answer from the options given below :

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

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

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

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

70. The successive 5 ionisation energies of an element are $800, 2427, 3658, 25024$ and $32824 kJ/mol$, respectively. By using the above values predict the group in which the above element is present :

(A) Group 2 (B) Group 13 (C) Group 4 (D) Group 14

*** SECTION - B**

71. The observed and normal masses of compound MX_2 are 65.6 and 164 respectively. The percent degree of ionisation of MX_2 is _____%. (Nearest integer)

72. The possible number of stereoisomers for 5-phenylpent-4-en-2-ol is _____

73. Consider a complex reaction taking place in three steps with rate constants k_1, k_2 and k_3 respectively. The overall rate constant k is given by the expression $k = \sqrt{\frac{k_1 k_3}{k_2}}$. If the activation energies of the three steps are 60,30 and $10 kJ mol^{-1}$ respectively, then the overall energy of activation in $kJ mol^{-1}$ is _____ . (Nearest integer)

74. The hydrocarbon (X) with molar mass $80 g mol^{-1}$ and 90% carbon has _____ degree of unsaturation.

75. In Carius method of estimation of halogen, 0.25 g of an organic compound gave 0.15 g of silver bromide $(AgBr)$. The percentage of Bromine in the organic compound is _____ $\times 10^{-1}\%$ (Nearest integer).
(Given : Molar mass of Ag is 108 and Br is $80 g mol^{-1}$)

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JEE

Total Marks : 300

28 Jan 2025 Shift 1

Mathematics

* SECTION - A [80]

1. Find the total number of 9 digit numbers which have all the digits different

(A) 9×9 ! (B) 9 ! (C) 10 ! (D) None of these

2. The number of ways in which an arrangement of 4 letters of the word ' $PROPORTION$' can be made is

(A) 700 (B) 750 (C) 758 (D) 800

3. If ${}^{n}P_{5} = 20.\,{}^{n}P_{3}$, then $n =$

(A) 4 (B) 8 (C) 6 (D) 7

4. There are 5 roads leading to a town from a village. The number of different ways in which a villager can go to the town and return back, is

(A) 25 (B) 20 (C) 10 (D) 5

5. If ${}^{12}P_{r} = 1320$, then r is equal to

(A) 5 (B) 4 (C) 3 (D) 2

6. The number of arrangements of the letters of the word $CALCUTTA$

(A) 2520 (B) 5040 (C) 10080 (D) 40320

7. The number of ways in which 5 boys and 3 girls can be seated in a row so that each girl in between two boys

(A) 2880 (B) 1880 (C) 3800 (D) 2800

8. The number of words which can be made out of the letters of the word $MOBILE$when consonants always occupy odd places is

(A) 20 (B) 36 (C) 30 (D) 720

9. Let $\binom{n}{k}$ denotes ${}^{n}C_{k}$ and $\begin{bmatrix} n \\ k \end{bmatrix} = \begin{cases} \binom{n}{k}, & \text{if } 0 \le k \le n \\ 0, & \text{otherwise} \end{cases}$

If $A_{k} = \sum_{i=0}^{9} \binom{9}{i} \begin{bmatrix} 12 \\ 12-k+i \end{bmatrix} + \sum_{i=0}^{8} \binom{8}{i} \begin{bmatrix} 13 \\ 13-k+i \end{bmatrix}$

and $A_{4} - A_{3} = 190\mathrm{p}$, then p is equal to :

(A) 50 (B) 51 (C) 48 (D) 49

10. The number of words not starting and ending with vowels formed, using all the letters of the word $'UNIVERSITY'$ such that all vowels are in alphabetical order, is

(A) ${}^8C_4.6!$ (B) ${}^8C_4.8!$ (C) ${}^8C_6.6!$ (D) ${}^8C_4.7!$

11. A man has 7 friends. In how many ways he can invite one or more of them for a tea party

(A) 128 (B) 256 (C) 127 (D) 130

12. ${}^nC_r \div {}^nC_{r-1} =$

(A) $\frac{n-r}{r}$ (B) $\frac{n+r-1}{r}$ (C) $\frac{n-r+1}{r}$ (D) $\frac{n-r-1}{r}$

13. In how many ways a team of 11 players can be formed out of 25 players, if 6 out of them are always to be included and 5 are always to be excluded

(A) 2020 (B) 2002 (C) 2008 (D) 8002

14. Out of 6 books, in how many ways can a set of one or more books be chosen

(A) 64 (B) 63 (C) 62 (D) 65

15. 10 different letters of English alphabet are given. Out of these letters, words of 5 letters are formed. How many words are formed when at least one letter is repeated

(A) 99748 (B) 98748 (C) 96747 (D) 97147

16. In an examination,5 students have been allotted their seats as per their roll numbers. The number of ways, in which none of the students sits on the allotted seat, is ..... .

(A) 43 (B) 44 (C) 42 (D) 41

17. The number of non-congruent integer-sided triangles whose sides belong to the set $\{10,11,12,\ldots,22\}$ is

(A) 283 (B) 446 (C) 448 (D) 449

18. There are 16 points in a plane out of which 6 are collinear, then how many lines can be drawn by joining these points

(A) 106 (B) 105 (C) 60 (D) 55

19. The number of divisors of 9600 including 1 and 9600 are

(A) 60 (B) 58 (C) 48 (D) 46

20. The sum of all local minimum values of the function

$$f(x) = \begin{cases} 1-2x, & x < -1 \\ \frac{1}{3}(7+2|x|), & -1 \le x \le 2 \\ \frac{11}{18}(x-4)(x-5), & x > 2 \end{cases}$$

(A) $\frac{171}{72}$ (B) $\frac{131}{72}$ (C) $\frac{157}{72}$ (D) $\frac{167}{72}$

*** SECTION - B** **[20]**

21. Three children, each accompanied by a guardian, seek admission in a school. The principal wants to interview all the 6 persons one after the other subject to the condition that no child is interviewed before its guardian. In how many ways can this be done?

22. Some couples participated in a mixed doubles badminton tournament. If the number of matches played, so that no couple played in a match, is 840, then the total numbers of persons, who participated in the tournament, is ..... .

23. There are 5 apples, 4 mangoes, 3 oranges and 1 each of 2 other varieties of fruits. The number of ways of selecting at least one fruit of each kind is

24. Let $\binom{n}{k}$ denotes ${}^{n}C_{k}$ and $\begin{bmatrix} n \\ k \end{bmatrix} = \begin{cases} \binom{n}{k}, & \text{if } 0 \le k \le n \\ 0, & \text{otherwise} \end{cases}$

If $A_k = \sum_{i=0}^{9} \binom{9}{i} \begin{bmatrix} 12 \\ 12-k+i \end{bmatrix} + \sum_{i=0}^{8} \binom{8}{i} \begin{bmatrix} 13 \\ 13-k+i \end{bmatrix}$

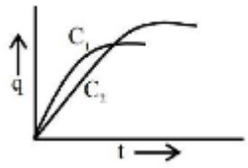
and $A_4 - A_3 = 190\text{p}$, then p is equal to :

25. The number of ways to distribute 30 identical candies among four children C_1, C_2, C_3 and C_4 so that C_2 receives atleast 4 and atmost 7 candies, C_3 receives atleast $2$and atmost 6 candies, is equal to

Physics

*** SECTION - A** **[80]**

26. Two capacitors C_1 and C_2 are connected in parallel to a battery. Charge-time graph is shown below for the two capacitors. The energy stored with them are U_1 and U_2, respectively. Which of the given statements is true?



(A) $\mathrm{C}_1 > \mathrm{C}_2, \mathrm{U}_1 > \mathrm{U}_2$ (B) $\mathrm{C}_2 > \mathrm{C}_1, \mathrm{U}_2 < \mathrm{U}_1$

(C) $\mathrm{C}_1 > \mathrm{C}_2, \mathrm{U}_1 < \mathrm{U}_2$ (D) $\mathrm{C}_2 > \mathrm{C}_1, \mathrm{U}_2 > \mathrm{U}_1$

27. In the experiment for measurement of viscosity ' η ' of given liquid with a ball having radius R, consider following statements.
A. Graph between terminal velocity V and R will be a parabola
B. The terminal velocities of different diameter balls are constant for a given liquid.

C. Measurement of terminal velocity is dependent on the temperature.
D. This experiment can be utilized to assess the density of a given liquid.
E. If balls are dropped with some initial speed, the value of η will change.
Choose the correct answer from the options given below:

(A) B, D and E only (B) A, C and D only (C) C, D and E only (D) A, B and E only

28. Consider following statements:
A. Surface tension arises due to extra energy of the molecules at the interior as compared to the molecules at the surface, of a liquid.
B. As the temperature of liquid rises, the coefficient of viscosity increases.
C. As the temperature of gas increases, the coefficient of viscosity increases.
D. The onset of turbulence is determined by Reynold's number.
E. In a steady flow two stream lines never intersect.
Choose the correct answer from the options given below :

(A) A, D, E only (B) C, D, E only (C) B, C, D only (D) A, B, C only

29. Three infinitely long wires with linear charge density λ are placed along the x -axis, y -axis and z axis respectively. Which of the following denotes an equipotential surface?

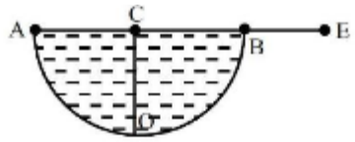
(A) $xy+yz+zx=$ constant

(B) $(x+y)(y+z)(z+x)=$ constant

(C) $\left(x^2+y^2\right)\left(y^2+z^2\right)\left(z^2+x^2\right)=$ constant

(D) $xyz=$ constant

30. A hemispherical vessel is completely filled with a liquid of refractive index μ. A small coin is kept at the lowest point (O) of the vessel as shown in figure. The minimum value of the refractive index of the liquid so that a person can see the coin from point E (at the level of the vessel) is _____ .



(A) $\sqrt{3}$ (B) $\frac{3}{2}$ (C) $\sqrt{2}$ (D) $\frac{\sqrt{3}}{2}$

31. Consider a long thin conducting wire carrying a uniform current I. A particle having mass " M " and charge " q " is released at a distance " a " from the wire with a speed v_0 along the direction of current in the wire. The particle gets attracted to the wire due to magnetic force. The particle turns round when it is at distance x from the wire. The value of x is [μ_0 is vacuum permeability]

(A) $a\left[1-\frac{mv_o}{2q\mu_o I}\right]$ (B) $\frac{a}{2}$ (C) $\mathrm{a}\left[1-\frac{mv_o}{q\mu_o I}\right]$ (D) $\mathrm{ae}^{\frac{-4\pi \mathrm{mv}_0}{\mathrm{qu}_0 \mathrm{I}}}$

32. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason $\mathbf{R}$

Assertion A: A sound wave has higher speed in solids than gases.
Reason R: Gases have higher value of Bulk modulus than solids.
In the light of the above statements, choose the correct answer from the options given below

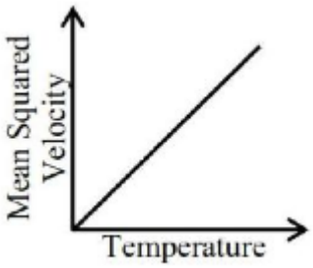
(A) Both $\mathbf{A}$ and $\mathbf{R}$ are true and $\mathbf{R}$ is the correct explanation of $\mathbf{A}$

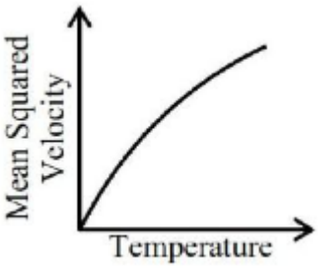
(B) $\mathbf{A}$ is false but $\mathbf{R}$ is true

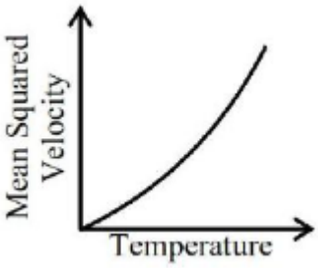
(C) Both $\mathbf{A}$ and $\mathbf{R}$ are true but $\mathbf{R}$ is NOT the correct explanation of $\mathbf{A}$

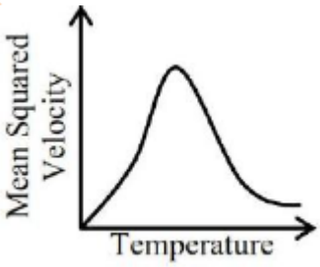
(D) $\mathbf{A}$ is true but $\mathbf{R}$ is false.

33. For a particular ideal gas which of the following graphs represents the variation of mean squared velocity of the gas molecules with temperature?

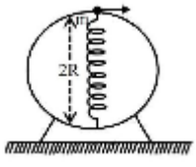
(A)


(B)


(C)


(D)


34. A bead of mass ' m ' slides without friction on the wall of a vertical circular hoop of radius ' R ' as shown in figure. The bead moves under the combined action of gravity and a massless spring (k) attached to the bottom of the hoop. The equilibrium length of the spring is ' R '. If the bead is released from top of the hoop with (negligible) zero initial speed, velocity of bead, when the length of spring becomes ' R ', would be (spring constant is ' k ', g is acceleration due to gravity)



(A) $2\sqrt{\mathrm{gR}+\frac{\mathrm{kR}^2}{\mathrm{m}}}$ (B) $\sqrt{2\mathrm{Rg}+\frac{4\mathrm{kR}^2}{\mathrm{m}}}$ (C) $\sqrt{2Rg+\frac{\mathrm{kR}^2}{\mathrm{m}}}$ (D) $\sqrt{3Rg+\frac{kR^2}{m}}$

35. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason $\mathbf{R}$
Assertion A: In a central force field, the work done is independent of the path chosen

Reason R: Every force encountered in mechanics does not have an associated potential energy.

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

(A) $\mathbf{A}$ is true but $\mathbf{R}$ is false

(B) Both $\mathbf{A}$ and $\mathbf{R}$ are true but $\mathbf{R}$ is NOT the correct explanation of $\mathbf{A}$

(C) Both $\mathbf{A}$ and $\mathbf{R}$ are true and $\mathbf{R}$ is the correct explanation of $\mathbf{A}$

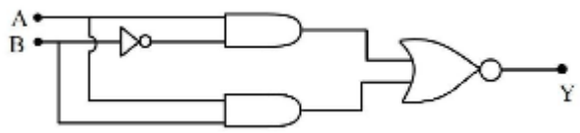
(D) $\mathbf{A}$ is false but $\mathbf{R}$ is true

36. Choose the correct nuclear process from the below options

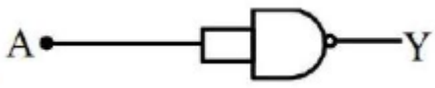
[p: proton, n : neutron, e^-: electron, e^+: positron, v : neutrino, $\bar{v}$: antineutrino]

(A) $n \rightarrow p + e^- + \bar{v}$ (B) $n \rightarrow p + e^- + v$ (C) $\mathrm{n} \rightarrow \mathrm{p} + \mathrm{e}^+ + \bar{v}$ (D) $n \rightarrow p + e^+ + v$

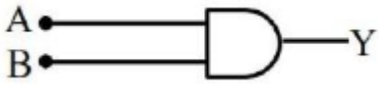
37. Which of the following circuits has the same output as that of the given circuit?



(A)

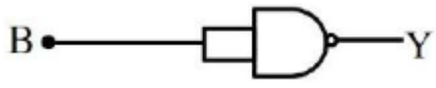


(B)

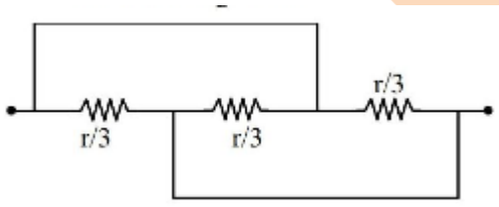


(C)

(D)



38. Find the equivalent resistance between two ends of the following circuit.



(A) r (B) $\frac{r}{6}$ (C) $\frac{r}{9}$ (D) $\frac{r}{3}$

39. A wire of resistance R is bent into an equilateral triangle and an identical wire is bent into a square. The ratio of resistance between the two end points of an edge of the triangle to that of the square is

(A) $9/8$ (B) $8/9$ (C) $27/32$ (D) $32/27$

40. Due to presence of an em-wave whose electric component is given by $\mathrm{E} = 100\sin(\omega \mathrm{t} - \mathrm{kx})\mathrm{NC}^{-1}$, a cylinder of length 200 cm holds certain amount of em-energy inside it. If another cylinder of same length but half diameter than previous one holds same amount of em-energy, the magnitude of the electric field of the corresponding em-wave should be modified as

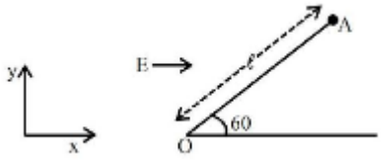
(A) $25\sin(\omega \mathrm{t} - \mathrm{kx})\mathrm{NC}^{-1}$

(B) $200\sin(\omega t - kx)\mathrm{NC}^{-1}$

(C) $400\sin(\omega t - kx)\mathrm{NC}^{-1}$

(D) $50\sin(\omega \mathrm{t} - \mathrm{kx})\mathrm{NC}^{-1}$

41. A particle of mass ' m ' and charge ' q ' is fastened to one end ' A ' of a massless string having equilibrium length ℓ, whose other end is fixed at point ' O '. The whole system is placed on a frictionless horizontal plane and is initially at rest. If uniform electric field is switched on along the direction as shown in figure, then the speed of the particle when it crosses the x -axis is



(A) $\sqrt{\frac{2qE\ell}{m}}$ (B) $\sqrt{\frac{qE\ell}{4m}}$ (C) $\sqrt{\frac{qE\ell}{m}}$ (D) $\sqrt{\frac{qE\ell}{2m}}$

42. A proton of mass ' m_p ' has same energy as that of a photon of wavelength ' λ '. If the proton is moving at non-relativistic speed, then ratio of its de Broglie wavelength to the wavelength of photon is.

(A) $\frac{1}{c}\sqrt{\frac{2E}{m_p}}$ (B) $\frac{1}{c}\sqrt{\frac{E}{m_p}}$ (C) $\frac{1}{c}\sqrt{\frac{E}{2m_p}}$ (D) $\frac{1}{2c}\sqrt{\frac{E}{m_p}}$

43. The centre of mass of a thin rectangular plate (fig x) with sides of length a and b , whose mass per unit area (σ) varies as $\sigma = \frac{\sigma_0 \mathrm{x}}{\mathrm{ab}}$ (where σ_0 is a constant), would be

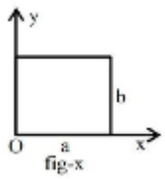


fig-x

(A) $\left(\frac{2}{3}a, \frac{b}{2}\right)$ (B) $\left(\frac{2}{3}a, \frac{2}{3}b\right)$ (C) $\left(\frac{\mathrm{a}}{2}, \frac{\mathrm{b}}{2}\right)$ (D) $\left(\frac{1}{3}a, \frac{b}{2}\right)$

44. A thin prism P_1 with angle 4° made of glass having refractive index 1.54 , is combined with another thin prism P_2 made of glass having refractive index 1.72 to get dispersion without deviation. The angle of the prism P_2 in degrees is

(A) 4 (B) 3 (C) $16/3$ (D) 1.5

45. A Carnot engine (E) is working between two temperatures 473 K and 273 K . In a new system two engines - engine E_1 works between 473 K to 373 K and engine E_2 works between 373 K to 273 K . If η_{12}, η_1 and η_2 are the efficiencies of the engines E, E_1 and E_2, respectively, then

(1) $\eta_{12} < \eta_1 + \eta_2$ (2) $\eta_{12} = \eta_1 \eta_2$

(3) $\eta_{12} = \eta_1 + \eta_2$ (4) $\eta_{12} \geq \eta_1 + \eta_2$

*** SECTION - B** **[20]**

46. A tiny metallic rectangular sheet has length and breadth of 5 mm and 2.5 mm , respectively. Using a specially designed screw gauge which has pitch of 0.75 mm and 15 divisions in the circular scale, you are asked to find the area of the sheet. In this measurement, the maximum fractional error will be $\frac{x}{100}$ where x is

47. The moment of inertia of a solid disc rotating along its diameter is 2.5 times higher than the moment of inertia of a ring rotating in similar way. The moment of inertia of a solid sphere which has same radius as the disc and rotating in similar way, is n times higher than the moment of inertia of the given ring. Here, $n =$_____ .
Consider all the bodies have equal masses.

48. In a measurement, it is asked to find modulus of elasticity per unit torque applied on the system. The measured quantity has dimension of $\left[M^a L^b T^c\right]$. If $b = 3$, the value of c is

49. Two iron solid discs of negligible thickness have radii R_1 and R_2 and moment of intertia I_1 and I_2, respectively. For $R_2 = 2R_1$, the ratio of I_1 and I_2 would be $1/x$, where $x =$

50. A double slit interference experiment performed with a light of wavelength 600 nm forms an interference fringe pattern on a screen with 10^{th} bright fringe having its centre at a distance of 10 mm from the central maximum. Distance of the centre of the same 10^{th} bright fringe from the central maximum when the source of light is replaced by another source of wavelength 660 nm would be _____ mm .

Chemistry

*** SECTION - A** **[80]**

51. The incorrect decreasing order of atomic radii is :
(A) $Mg > Al > C > O$
(B) $Al > B > N > F$
(C) $Be > Mg > Al > Si$
(D) $Si > P > Cl > F$

52. Given below are two statements :
Statement I : In the oxalic acid vs $KMnO_4$ (in the presence of dil H_2SO_4) titration the solution needs to be heated initially to $60^\circ C$, but no heating is required in Ferrous ammonium sulphate (FAS) vs $KMnO_4$ titration (in the presence of dil H_2SO_4)
Statement II : In oxalic acid vs $KMnO_4$ titration, the initial formation of $MnSO_4$ takes place at high temperature, which then acts as catalyst for further reaction. In the case of FAS vs $KMnO_4$, heating oxidizes Fe^{2+} into Fe^{3-} by oxygen of air and error may be introduced in the experiment.

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

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

(B) Both Statement I and Statement II are true

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

(D) Both Statement I and Statement II are false

53. Match the List-I with List-II

	List-I edox Reaction)		List-II(Type of RedoxReaction)
A	$CH_{4(g)} + 2O_{2(g)} \xrightarrow{\Delta} CO_{2(g)} + 2H_2O_{(l)}$	(I)	Disproportionation reaction
B	$2NaH_{(s)} \xrightarrow{\Delta} 2Na_{(s)} + H_{2(g)}$	(II)	Combination reaction
C	$V_2O_{5(s)} + 5Ca_{(s)} \xrightarrow{\Delta} 2V_{(s)} + 5CaO_{(s)}$	(III)	Decomposition reaction
D	$2H_2O_{2(aq)} \xrightarrow{\Delta} 2H_2O_{(l)} + O_{2(g)}$	(IV)	Displacement reaction

Choose the correct answer from the options given below :

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

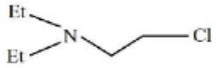
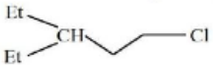
(B) A-II, B-III, C-I, D-IV

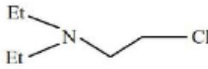
(C) A-III, B-IV, C-I, D-II

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

54.

Given below are two statements :

Statement I :  will undergo alkaline hydrolysis at a faster rate than 

Statement II :  , intramolecular substitution takes place first by involving lone pair of electrons on nitrogen.

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

(A) Both Statement I and Statement II are incorrect

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

(C) Both Statement I and Statement II are correct

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

55. A weak acid HA has degree of dissociation x. Which option gives the correct expression of $\mathrm{pH}=\mathrm{pK}_{\mathrm{a}}$) ?

(A) $\log(1+2x)$ (B) $\log\left(\frac{1-x}{x}\right)$ (D) $\log\left(\frac{x}{1-x}\right)$

56. Consider ' n ' is the number of lone pair of electrons present in the equatorial position of the most stable structure of ClF_3. The ions from the following with ' n ' number of unpaired electrons are :

A. V^{3+}

B. Ti^{3+}

C. Cu^{2+}

D. Ni^{2+}

E. Ti^{2+}

Choose the correct answer from the options given below :

(A) A and C only (B) A, D and E only (C) B and C only (D) B and D only

57.

$[A]_0$ $/molL^{-1}$	$t_{1/2}$ $/min$
0.100	200
0.025	100

For a given reaction $\mathrm{R}\rightarrow\mathrm{P}, \mathrm{t}_{1/2}$ is related to $[\mathrm{A}]_0$ as given in table :

Given : $\log 2=0.30$

Which of the following is true ?

A. The order of the reaction is $\frac{1}{2}$.

B. If $[A]_0$ is 1 M , then $\mathrm{t}_{1/2}$ is $200\sqrt{10}$ min

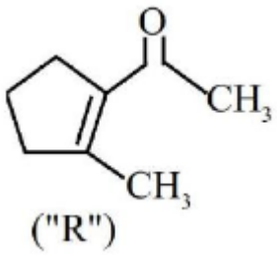
C. The order of the reaction changes to 1 if the concentration of reactant changes from 0.100 M to 0.500 M .

D. $\mathrm{t}_{1/2}$ is 800 min for $[\mathrm{A}]_0=1.6\mathrm{M}$

Choose the correct answer from the options given below :

(A) A and C only (B) A and B only (C) A, B and D only (D) C and D only

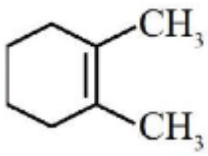
58. A molecule ("P") on treatment with acid undergoes rearrangement and gives ("Q") ("Q") on ozonolysis followed by reflux under alkaline condition gives ("R"). The structure of ("R") is given below :



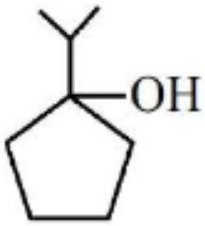
("R")

The structure of (" $\mathbf{P}''$) is

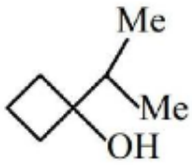
(A)



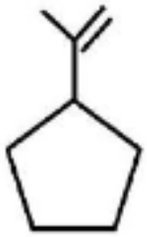
(B)



(C)



(D)



59. Ice and water are placed in a closed container at a pressure of 1 atm and temperature 273.15 K . If pressure of the system is increased 2 times, keeping temperature constant, then identify correct observation from following :

(A) Volume of system increases.

(B) Liquid phase disappears completely.

(C) The amount of ice decreases.

(D) The solid phase (ice) disappears completely.

60. The molecules having square pyramidal geometry are

(A) $BrF_5 \& XeOF_4$ (B) $SbF_5 \& XeOF_4$ (C) $SbF_5 \& PCl_5$ (D) $BrF_5 \& PCl_5$

61. The metal ion whose electronic configuration is not affected by the nature of the ligand and which gives a violet colour in non-luminous flame under hot condition in borax bead test is

(A) Ti^{3+} (B) Ni^{2+} (C) Mn^{2+} (D) Cr^{3+}

62. Both acetaldehyde and acetone (individually) undergo which of the following reactions?

A. Iodoform Reaction

B. Cannizaro Reaction

C. Aldol condensation

D. Tollen's Test

E. Clemmensen Reduction

Choose the correct answer from the options given below :

(A) A, B and D only (B) A, C and E only (C) C and E only (D) B, C and D only

63. In a multielectron atom, which of the following orbitals described by three quantum numbers with have same energy in absence of electric and magnetic

fields?

A. $n = 1, 1 = 0, m_1 = 0$

B. $n = 2, 1 = 0, m_1 = 0$

C. $n = 2, 1 = 1, m_1 = 1$

D. $n = 3, 1 = 2, m_1 = 1$

E. $n = 3, 1 = 2, m_1 = 0$

Choose the correct answer from the options given below :

(A) A and B only (B) B and C only (C) C and D only (D) D and E only

64. The products A and B in the following reactions, respectively are

$$A \xrightarrow{Ag_N - NO_2} CH_3 - CH_2 - CH_2 - Br \xrightarrow{AgCN} B$$

(A) $CH_3 - CH_2 - CH_2 - ONO, CH_3 - CH_2 - CH_2 - NC$

(B) $CH_3 - CH_2 - CH_2 - ONO, CH_3 - CH_2 - CH_2 - CN$

(C) $CH_3 - CH_2 - CH_2 - NO_2, CH_3 - CH_2 - CH_2 - CN$

(D) $CH_3 - CH_2 - CH_2 - NO_2, CH_3 - CH_2 - CH_2 - NC$

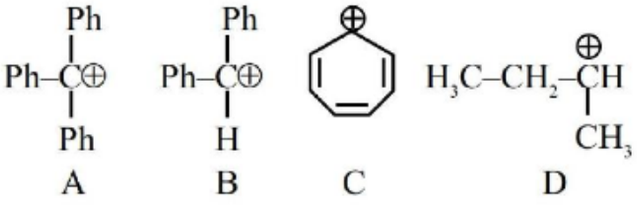
65. What is the freezing point depression constant of a solvent, 50 g of which contain 1 g non volatile solute (molar mass $256\ g\ mol^{-1}$) and the decrease in freezing point is 0.40 K ?

(A) $5.12\ K\ kg\ mol^{-1}$ (B) $4.43\ K\ kg\ mol^{-1}$ (C) $1.86\ K\ kg\ mol^{-1}$ (D) $3.72\ K\ kg\ mol^{-1}$

66. Consider the following elements In, Tl, Al, Pb, Sn and Ge. The most stable oxidation states of elements with highest and lowest first ionisation enthalpies, respectively, are

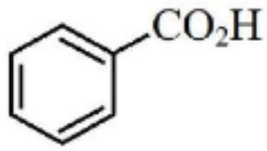
(A) +2 and +3 (B) +4 and +3 (C) +4 and +1 (D) +1 and +4

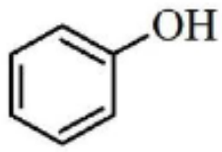
67. The correct order of stability of following carbocations is :

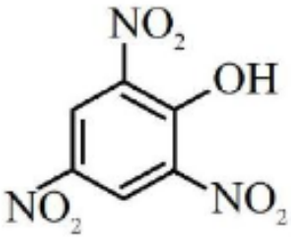


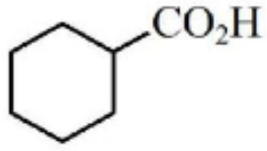
(A) A > B > C > D (B) B > C > A > D (C) C > B > A > D (D) C > A > B > D

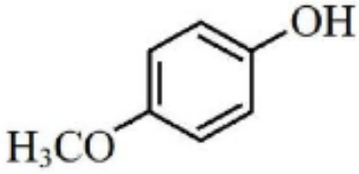
68. The compounds that produce CO_2 with aqueous $NaHCO_3$ solution are :

A. 

B. 

C. 

D. 

E. 

Choose the correct answer from the options given below :

(A) A and C only (B) A, B and E only (C) A, C and D only (D) A and B only

69. Which of the following oxidation reactions are carried out by both $K_2Cr_2O_7$ and $KMnO_4$ in acidic medium?

A. $I \rightarrow I_2$

B. $S^{2-} \rightarrow S$

C. $Fe^{2+} \rightarrow Fe^{3+}$

D. $I^- \rightarrow IO_3^-$

E. ${S_2O_3}^{2-} \rightarrow {SO_4}^{2-}$

Choose the correct answer from the options given below :

(A) B, C and D only (B) A, D and E only (C) A, B and C only (D) C, D and E only

70. Given below are two statements :

Statement I : D-glucose pentaacetate reacts with 2, 4-dinitrophenylhydrazine.

Statement II : Starch, on heating with concentrated sulfuric acid at $100^\circ C$ and $2-3$ atmosphere pressure produces glucose.

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

(A) Both Statement I and Statement II are false

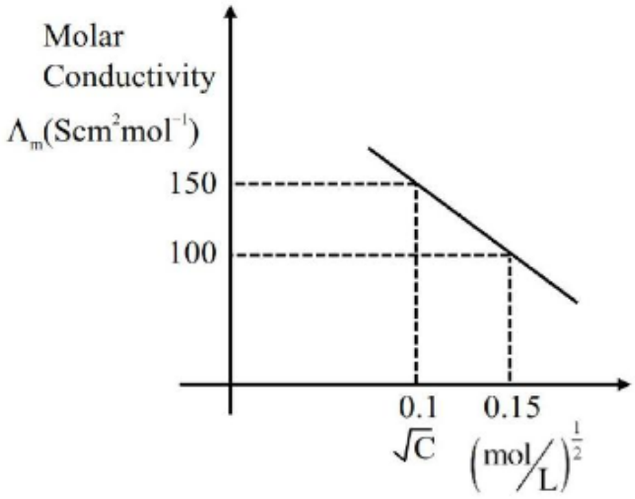
(B) Statement I is false but Statement II is true

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

(D) Both Statement I and Statement II are true

* SECTION - B [20]

71. Given below is the plot of the molar conductivity vs $\sqrt{\text{concentration}}$ for KCl in aqueous solution.



If, for the higher concentration of KCl solution, the resistance of the conductivity cell is 100Ω, then the resistance of the same cell with the dilute solution is ' x ' Ω. The value of x is _____ (Nearest integer)

72. Quantitative analysis of an organic compound (X) shows following % composition.

C : 14.5 %

$\mathrm{Cl}: 64.46$

H: 1.8 %

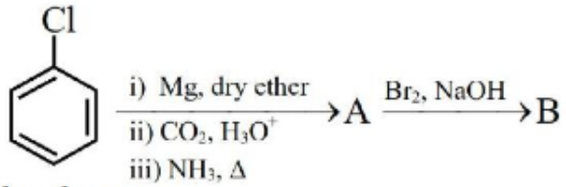
(Empirical formula mass of the compound (X) is

_____ $\times 10^{-1}$

(Given molar mass in gmol^{-1} of $\mathrm{C}: 12, \mathrm{H}: 1$, $\mathrm{O}: 16, \mathrm{Cl}: 35.5$)

73. The molarity of a 70% (mass/mass) aqueous solution of a monobasic acid (X) is _____ M(Nearest integer) [Given : Density of aqueous solution of (X) is $1.25\ \mathrm{g\ mL}^{-1}$ Molar mass of the acid is $70\ \mathrm{g\ mol}^{-1}$]

74. Consider the following sequence of reactions :



Chlorobenzene

11.25 mg of chlorobenzene will produce_____ $\times 10^{-1}$mg of product B .
(Consider the reactions result in complete conversion.)
[Given molar mass of C, H, O, N and Cl as 12,1 , 16,14 and $35.5\ g\ mol^{-1}$ respectively]

75. The formation enthalpies, $\Delta H_f^{\ominus}$ for $H_{(g)}$ and $O_{(g)}$ are 220.0 and $250.0\ kJ\ mol^{-1}$, respectively, at 298.15 K , and ΔH_f^{-} for $H_2O_{(g)}$ is $-242.0\ kJ\ mol^{-1}$ at the same temperature. The average bond enthalpy of the $O-H$ bond in water at 298.15 K is _____ $kJmol^{-1}$ (nearest integer).

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JEE

Total Marks : 300

28 Jan 2025 Shift 2

Mathematics

* SECTION - A [80]

1. Bag B_1 contains 6 white and 4 blue balls, Bag B_2 contains 4 white and 6 blue balls, and BagB_3 contains 5 white and 5 blue balls. One of the bags is selected at random and a ball is drawn from it. If the ball is white, then the probability, that the ball is drawn from Bag B_2, is :

(A) $\frac{1}{3}$ (B) $\frac{4}{15}$ (C) $\frac{2}{3}$ (D) $\frac{2}{5}$

2. Let A, B, C be three points in xy-plane, whose position vector are given by $\sqrt{3}\hat{i}+\hat{j}, \hat{i}+\sqrt{3}\hat{j}$ and $a\hat{i}+(1-a)\hat{j}$ respectively with respect to the origin O . If the distance of the point C from the line bisecting the angle between the vectors $\overrightarrow{\mathrm{OA}}$ and $\overrightarrow{\mathrm{OB}}$ is $\frac{9}{\sqrt{2}}$, then the sum of all the possible values of a is :

(A) 1 (B) $9/2$ (D) 2

3. If the components of $\vec{a}=\alpha\hat{i}+\beta\hat{j}+\gamma\hat{k}$ along and perpendiculer to $\vec{b}=3\hat{i}+\hat{j}-\hat{k}$ respectively, are $\frac{16}{11}(3\hat{i}+\hat{j}-\hat{k})$ and $\frac{1}{11}(-4\hat{i}-5\hat{j}-17\hat{k})$, then $\alpha^2+\beta^2+\gamma^2$ is equal to :

(A) 23 (B) 18 (C) 16 (D) 26

4. If $\alpha+i\beta$ and $\gamma+i\delta$ are the roots of $x^2-(3-2i)x-(2i-2)=0, i=\sqrt{-1}$, then $\alpha\gamma+\beta\delta$ is equal to :

(A) 6 (B) 2 (C) -2 (D) -6

5. If the midpoint of a chord of the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ is $(\sqrt{2}, 4/3)$, and the length of the chord is $\frac{2\sqrt{\alpha}}{3}$, then α is :

(A) 18 (B) 22 (C) 26 (D) 20

6. Let S be the set of all the words that can be formed by arranging all the letters of the word GARDEN. From the set S , one word is selected at random. The probability that the selected word will NOT have vowels in alphabetical order is :

(A) $\frac{1}{4}$ (B) $\frac{2}{3}$ (C) $\frac{1}{3}$ (D) $\frac{1}{2}$

7. Let f be a real valued continuous function defined on the positive real axis such that $g(x)=\int_0^x tf(t)dt$.
If $g\left(x^3\right)=x^6+x^7$, then value of $\sum_{r=1}^{15} f\left(r^3\right)$ is:
(A) 320 (B) 340 (C) 270 (D) 310

8. The square of the distance of the point $\left(\frac{15}{7},\frac{32}{7},7\right)$ from the line $\frac{x+1}{3}=\frac{y+3}{5}=\frac{z+5}{7}$ in the direction of the vector $\hat{i}+4\hat{j}+7\hat{k}$ is :
(A) 54 (B) 41 (C) 66 (D) 44

9. The area of the region bounded by the curves $x\left(1+y^2\right)=1$ and $y^2=2x$ is:
(A) $2\left(\frac{\pi}{2}-\frac{1}{3}\right)$ (B) $\frac{\pi}{4}-\frac{1}{3}$ (C) $\frac{\pi}{2}-\frac{1}{3}$ (D) $\frac{1}{2}\left(\frac{\pi}{2}-\frac{1}{3}\right)$

10. Let $A=\begin{bmatrix}\frac{1}{\sqrt{2}} & -2\\ 0 & 1\end{bmatrix}$ and $P=\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{bmatrix}, \theta>0$.
If $B=PAP^T, C=P^\top B^{10}P$ and the sum of the diagonal elements of C is $\frac{m}{n}$, where $\gcd(m,n)=1$, then $m+n$ is :
(A) 65 (B) 127 (C) 258 (D) 2049

11. If $f(x)=\int \frac{1}{x^{1/4}\left(1+x^{1/4}\right)}dx, f(0)=-6$, then $f(1)$ is equal to :
(A) $\log_e 2+2$ (B) $4\left(\log_e 2-2\right)$ (C) $2-\log_e 2$ (D) $4\left(\log_e 2+2\right)$

12. Let $f: R\to R$ be a twice differentiable function such that $f(2)=1$. If $F(x)=xf(x)$ for all $x\in R$, $\int_0^2 xF'(x)dx=6$ and $\int_0^2 x^2F''(x)dx=40$, then $F'(2)+\int_0^2 F(x)dx$ is equal to :
(A) 11 (B) 15 (C) 9 (D) 13

13. For positive integers n, if $4a_n=\left(n^2+5n+6\right)$ and$\mathrm{S_n}=\sum_{\mathrm{k}=1}^{\mathrm{n}}\left(\frac{1}{\mathrm{a_k}}\right)$, then the value of $507\ \mathrm{S}_{2025}$ is :
(A) 540 (B) 1350 (C) 675 (D) 135

14. Let $f:[0,3]\to \mathrm{A}$ be defined by$f(x)=2\mathrm{x}^3-15\mathrm{x}^2+36\mathrm{x}+7$ and $\mathrm{g}:[0,\infty)\to \mathrm{B}$ be defined by $g(x)=\frac{x^{2025}}{x^{2025}+1}$. If both the functions are onto and $S=\{x\in \mathbf{Z}: x\in A$ or $x\in B\}$, then $n(S)$ is equal to :
(A) 30 (B) 36 (C) 29 (D) 31

15. Let $[\mathrm{x}]$ denote the greatest integer less than or equal to x. Then domain of $f(x)=\sec^{-1}(2[x]+1)$ is :
(A) $(-\infty,-1]\cup[0,\infty)$ (B) $(-\infty,-\infty)$ (C) $(-\infty,-1]\cup[1,\infty)$ (D) $(-\infty,\infty]-\{0\}$

16. If $\sum_{r=1}^{13}\left\{\frac{1}{\sin\left(\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right)\sin\left(\frac{\pi}{4}+\frac{r\pi}{6}\right)}\right\}=a\sqrt{3}+b, a,b\in \mathbf{Z}$, then a^2+b^2 is equal to :
(A) 10 (B) 2 (C) 8 (D) 4

17. Two equal sides of an isosceles triangle are along $-x+2y=4$ and $x+y=4$. If m is the slope of its third side, then the sum, of all possible distinct values of m, is :

(A) -6 (B) 12 (C) 6 (D) $-2\sqrt{10}$

18. Let the coefficients of three consecutive terms T_r, T_{r+1} and T_{r+2} in the binomial expansion of $(a+b)^{12}$ be in a G.P. and let p be the number of all possible values of r. Let q be the sum of all rational terms in the binomial expansion of $(\sqrt[4]{3}+\sqrt[3]{4})^{12}$. Then $\mathrm{p}+\mathrm{q}$ is equal to :

(A) 283 (B) 295 (C) 287 (D) 299

19. If A and B are the points of intersection of the circle $x^2+y^2-8x=0$ and the hyperbola $\frac{x^2}{9}-\frac{y^2}{4}=1$ and a point P moves on the line $2x-3y+4=0$, then the centroid of $\triangle PAB$ lies on the line :

(A) $4x-9y=12$ (B) $x+9y=36$ (C) $9x-9y=32$ (D) $6x-9y=20$

20. Let $f:\mathbf{R}-\{0\}\to(-\infty,1)$ be a polynomial of degree 2, satisfying $f(\mathrm{x})f\left(\frac{1}{\mathrm{x}}\right)=f(\mathrm{x})+f\left(\frac{1}{\mathrm{x}}\right)$. If $f(\mathrm{K})=-2\,\mathrm{K}$, then the sum of squares of all possible values of K is :

(A) 1 (B) 6 (C) 7 (D) 9

*** SECTION - B** **[20]**

21. The number of natural numbers, between 212 and 999 , such that the sum of their digits is 15 , is _____ .

22. Let $f(\mathrm{x})=\lim_{\mathrm{n}\to\infty}\sum_{\mathrm{r}=0}^{\mathrm{n}}\left(\frac{\tan\left(\mathrm{x}/2^{\mathrm{r}+1}\right)+\tan^3\left(\mathrm{x}/2^{\mathrm{r}+1}\right)}{1-\tan^2\left(\mathrm{x}/2^{\mathrm{r}+1}\right)}\right)$. Then $\lim_{x\to0}\frac{\mathrm{e}^{\mathrm{x}}-\mathrm{e}^{f(\mathrm{x})}}{(\mathrm{x}-f(\mathrm{x}))}$ is equal to _____ .

23. The interior angles of a polygon with n sides, are in an A.P. with common difference 6°. If the largest interior angle of the polygon is 219°, then n is equal to _____ .

24. Let A and B be the two points of intersection of the line $y+5=0$ and the mirror image of the parabola $y^2=4x$ with respect to the line $x+y+4=0$. If d denotes the distance between A and B , and a denotes the area of $\triangle\mathrm{SAB}$, where S is the focus of the parabola $y^2=4x$, then the vlaue of $(a+d)$ is _____ .

25. If $y=y(x)$ is the solution of the differential equation, $\sqrt{4-x^2}\,\frac{dy}{dx}=\left(\left(\sin^{-1}\left(\frac{x}{2}\right)\right)^2-y\right)\sin^{-1}\left(\frac{x}{2}\right), -2\le x\le 2, y(2)=\left(\frac{\pi^2-8}{4}\right)$, then $\mathrm{y}^2(0)$ is equal to _____ .

Physics

*** SECTION - A** **[80]**

26. A uniform magnetic field of 0.4 T acts perpendicular to a circular copper disc 20 cm in radius. The disc is having a uniform angular velocity of $10\pi \text{rads}^{-1}$ about an axis through its centre and perpendicular to the disc. What is the protential difference developed between the axis of the disc and the rim ? $(\pi = 3.14)$

(A) 0.0628 V (B) 0.5024 V (C) 0.2512 V (D) 0.1256 V

27. A parallel plate capacitor of capacitance $1\mu\,\text{F}$ is charged to a potential difference of 20 V . The distance between plates is $1\mu\,\text{m}$. The energy density between plates of capacitor is :

(A) $1.8 \times 10^3\ \text{J/m}^3$ (B) $2 \times 10^{-4}\ \text{J/m}^3$ (C) $2 \times 10^2\ \text{J/m}^3$ (D) $1.8 \times 10^5\ \text{J/m}^3$

28. Match List-I with List-II

List-I	List-II
(A) Angular Impulse	(I) $\left[\text{M}^0\,\text{L}^2\,\text{T}^{-2}\right]$
(B) Latent Heat	(II) $\left[\text{ML}^2\,\text{T}^{-3}\,\text{A}^{-1}\right]$
(C) Electrical resistivity	(III) $\left[\text{ML}^2\,\text{T}^{-1}\right]$
(D) Electromotive force	(IV) $\left[\text{ML}^3\,\text{T}^{-3}\,\text{A}^{-2}\right]$

Choose the correct answer from the options given below:

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

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

29. The ratio of vapour densities of two gases at the same temperature is $\frac{4}{25}$, then the ratio of r.m.s. velocities will be :

(A) $\frac{25}{4}$ (B) $\frac{2}{5}$ (C) $\frac{5}{2}$ (D) $\frac{4}{25}$

30. The kinetic energy of translation of the molecules in 50 g of CO_2 gas at 17°C is :

(A) 3986.3 J (B) 4102.8 J (C) 4205.5 J (D) 3582.7 J

31. In a long glass tube, mixture of two liquids A and B with refractive indices 1.3 and 1.4 respectively, forms a convex refractive meniscus towards A . If an object placed at 13 cm from the vertex of the meniscus in A forms an image with a magnification of ' -2 ' then the radius of curvature of meniscus is :

(A) 1 cm (B) $\frac{1}{3}$ cm (C) $\frac{2}{3}$ cm (D) $\frac{4}{3}$ cm

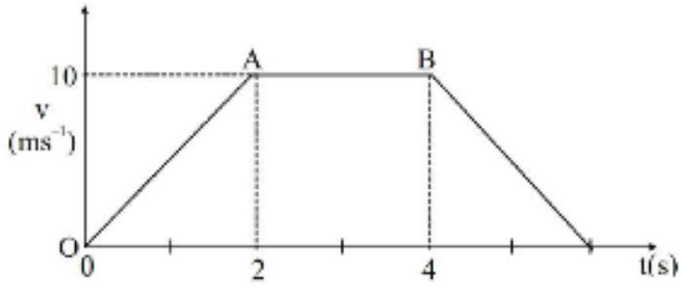
32. The frequency of revolution of the electron in Bohr's orbit varies with n, the principal quantum number as

(A) $\frac{1}{\text{n}}$ (B) $\frac{1}{n^3}$ (C) $\frac{1}{n^4}$ (D) $\frac{1}{n^2}$

33. Which of the following phenomena can not be explained by wave theory of light?

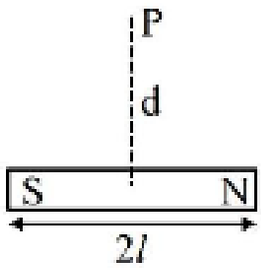
(A) Reflection of light
(B) Diffraction of light
(C) Refraction of light
(D) Compton effect

34. The velocity-time graph of an object moving along a straight line is shown in figure. What is the distance covered by the object between $t = 0$ to $\mathrm{t} = 4\ \mathrm{s}$?



(A) 30 m
(B) 10 m
(C) 13 m
(D) 11 m

35.



A bar magnet has total length $2l = 20$ units and the field point P is at a distance $\mathrm{d} = 10$ units from the centre of the magnet. If the relative uncertainty of length measurement is 1%, then uncertainty of the magnetic field at point P is :

(A) 10%
(B) 4%
(C) 3%
(D) 5%

36. Earth has mass 8 times and radius 2 times that of a planet. If the escape velocity from the earth is 11.2 $\mathrm{km/s}$, the escape velocity in $\mathrm{km/s}$ from the planet will be :

(A) 11.2
(B) 5.6
(C) 2.8
(D) 8.4

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

Assertion (A) : Knowing initial position $\mathrm{x_0}$ and initial momentum $\mathrm{p_0}$ is enough to determine the position and momentum at any time t for a simple harmonic motion with a given angular frequency ω.

Reason (R) : The amplitude and phase can be expressed in terms of $\mathrm{x_0}$ an $\mathrm{p_0}$.

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

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

(B) (A) is false but (R) is true.

(C) (A) is true but ($\mathbf{R}$) is false.

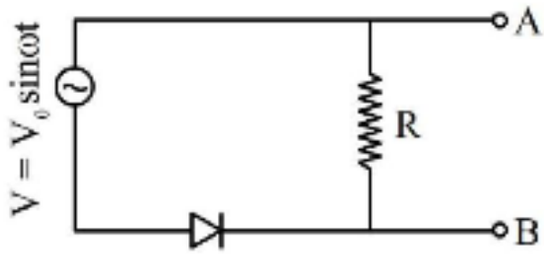
(D) Both (A) and (R) are true and (R) is the correct explanation of (A).

38. A concave mirror produces an image of an object such that the distance between the object and image is 20 cm . If the magnification of the image is ' -3 ', then the magnitude of the radius of curvature of the mirror is :

(A) 3.75 cm (B) 30 cm (C) 7.5 cm (D) 15 cm

39. A body of mass 4 kg is placed on a plane at a point P having coordinate $(3,4)\mathrm{m}$. Under the action of force $\vec{F}=(2\hat{i}+3\hat{j})N$, it moves to a new point Q having coordinates $(6,10)\mathrm{m}$ in 4 sec . The average power and instantaneous power at the end of 4 sec are in the ratio of :

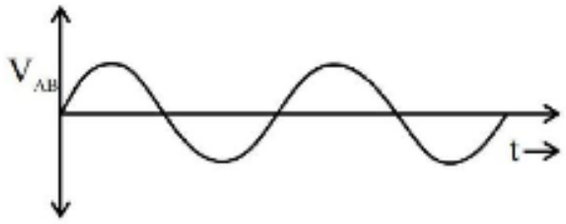
(A) $13:6$ (B) $6:13$ (C) $1:2$ (D) $4:3$

40. 

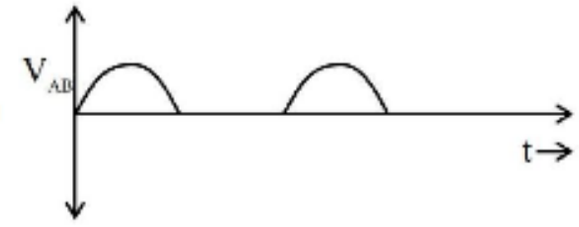
In the circuit shown here, assuming threshold voltage of diode is negligibly small, then voltage $\mathrm{V_{AB}}$ is correctly represented by :

(A) V_{AB} would be zero at all times

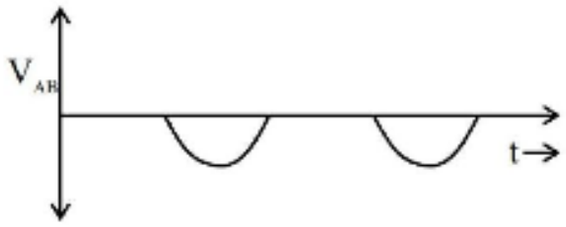
(B)



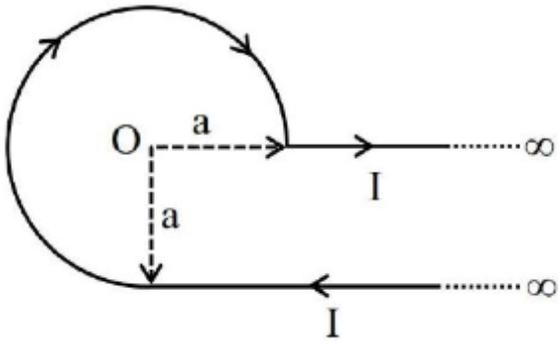
(C)



(D)



41.



An infinite wire has a circular bend of radius a, and carrying a current I as shown in figure. The magnitude of magnetic field at the origin O of the arc is given by :

(A) $\frac{\mu_0}{4\pi}\frac{I}{a}\left[\frac{\pi}{2}+1\right]$ (B) $\frac{\mu_0}{4\pi}\frac{I}{a}\left[\frac{3\pi}{2}+1\right]$ (C) $\frac{\mu_0}{2\pi}\frac{I}{a}\left[\frac{\pi}{2}+2\right]$ (D) $\frac{\mu_0}{4\pi}\frac{I}{\mathrm{a}}\left[\frac{3\pi}{2}+2\right]$

42. A uniform rod of mass 250 g having length 100 cm is balanced on a sharp edge at 40 cm mark. A mass of 400 g is suspended at 10 cm mark. To maintain the balance of the rod, the mass to be suspended at 90 cm mark, is

(A) 300 g (B) 190 g (C) 200 g (D) 290 g

43. a 400 g solid cube having an edge of length 10 cm floats in water. How much volume of the cube is outside the water?

(Given : density of water $= 1000\ \mathrm{kg\ m^{-3}}$)

(A) $1400\ \mathrm{cm^3}$ (B) $4000\ \mathrm{cm^3}$ (C) $400\ \mathrm{cm^3}$ (D) $600\ \mathrm{cm^3}$

44. The magnetic field of an E.M. wave is given by $\vec{B}=\left(\frac{\sqrt{3}}{2}\hat{i}+\frac{1}{2}\hat{j}\right)30\sin\left[\omega\left(t-\frac{z}{c}\right)\right]$ (S.I. Units) The corresponding electric field in S.I. units is :

(A) $\overrightarrow{\mathrm{E}}=\left(\frac{1}{2}\hat{\mathrm{i}}-\frac{\sqrt{3}}{2}\hat{\mathrm{j}}\right)30\,\mathrm{cosin}\left[\omega\left(\mathrm{t}-\frac{\mathrm{z}}{\mathrm{c}}\right)\right]$

(B) $\overrightarrow{\mathrm{E}}=\left(\frac{3}{4}\hat{\mathrm{i}}+\frac{1}{4}\hat{\mathrm{j}}\right)30\mathrm{c}\cos\left[\omega\left(\mathrm{t}-\frac{\mathrm{z}}{\mathrm{c}}\right)\right]$

(C) $\overrightarrow{\mathrm{E}}=\left(\frac{1}{2}\hat{\mathrm{i}}+\frac{\sqrt{3}}{2}\hat{\mathrm{j}}\right)30\mathrm{c}\sin\left[\omega\left(\mathrm{t}+\frac{\mathrm{z}}{\mathrm{c}}\right)\right]$

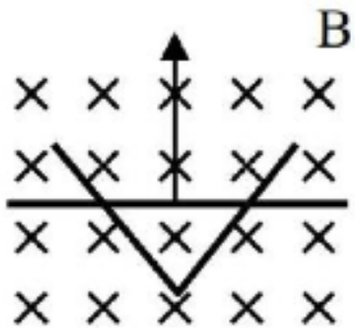
(D) $\overrightarrow{\mathrm{E}}=\left(\frac{\sqrt{3}}{2}\hat{\mathrm{i}}-\frac{1}{2}\hat{\mathrm{j}}\right)30\mathrm{c}\sin\left[\omega\left(\mathrm{t}+\frac{\mathrm{z}}{\mathrm{c}}\right)\right]$

45. A balloon and its content having mass M is moving up with an acceleration 'a'. The mass that must be released from the content so that the balloon starts moving up with an acceleration ' $3\mathrm{a}'$ will be : (Take ' g ' as acceleration due to gravity)

(A) $\frac{3Ma}{2a-g}$ (B) $\frac{3Ma}{2a+g}$ (C) $\frac{2Ma}{3a+g}$ (D) $\frac{2Ma}{3a-g}$

*** SECTION - B** **[20]**

46.

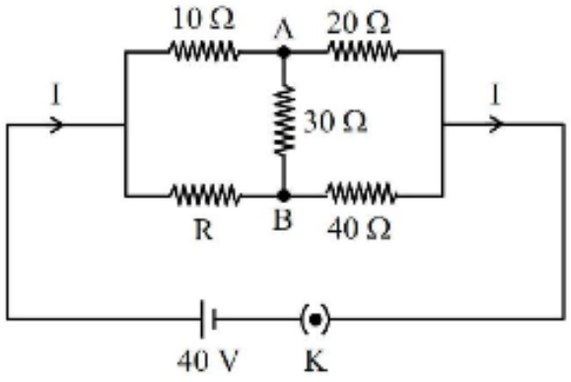


A conducting bar moves on two conducting rails as shown in the figure. A constant magnetic field B exists into the page. The bar starts to move from the vertex at time $t = 0$ with a constant velocity. If the induced EMF is $E \propto t^n$, then value of n is _____ .

47. An electric dipole of dipole moment $6 \times 10^{-6}\text{Cm}$ is placed in uniform electric field of magnitude $10^6\ \text{V/m}$. Initially, the dipole moment is parallel to electric field. The work that needs to be done on the dipole to make its dipole moment opposite to the field, will be _____ J.

48. The volume contraction of a solid copper cube of edge length 10 cm , when subjected to a hydraulic pressure of $7 \times 10^6\ \text{Pa}$, would be _____ mm^3. (Given bulk modulus of copper $= 1.4 \times 10^{11}\text{Nm}^{-2}$)

49. The value of current I in the electrical circuit as given below, when potential at A is equal to the potential at B, will be _____ A.



50. A thin transparent film with refractive index 1.4 , is held on circular ring of radius 1.8 cm . The fluid in the film evaporates such that transmission through the film at wavelength 560 nm goes to a minimum every 12 seconds. Assuming that the film is flat on its two sides, the rate of evaporation is _____ $\pi \times 10^{-13}\ \text{m}^3/\text{s}$.

Chemistry

*** SECTION - A** **[80]**

51. consider the elementary reaction $A(g)+B(g) \rightarrow C(g)+D(g)$ If the volume of reaction mixture is suddenly reduced to $\frac{1}{3}$ of its initial volume, the reaction rate will become ' x ' times of the original reaction rate. The value of x is :

(A) $\frac{1}{9}$ (B) 9 (C) $\frac{1}{3}$ (D) 3

52. The amphoteric oxide among V_2O_3, V_2O_4 and V_2O_5 upon reaction with alkali leads to formation of an oxide anion. The oxidation state of V in the oxide anion is :

(A) +3 (B) +7 (C) +5 (D) +4

53. Match List-I with List-II

List-I (Saccharides)	**List-II (Glycosidic-linkages found)**
(A) Sucrose	(I) α 1-4
(B) Maltose	(II) $\alpha 1-4$ and $\alpha 1-6$
(C) Lactose	(III) $\alpha 1-\beta 2$
(D) Amylopectin	(IV) $\beta 1-4$

Choose the correct answer from the options given below :

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

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

54. Identify product $[A], [B]$ and $[C]$ in the following reaction sequence :

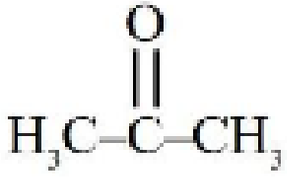
$$CH_3-C\equiv CH \xrightarrow[H_2]{Pd/C} [A] \xrightarrow[(ii)Zn,H_2O]{(i)O_3} [B]+[C]$$

(A)

$[A] : CH_3-CH-CH_2$, $[B] : CH_3CHO$,

$[C] : HCHO$

(B)

$[A] : CH_2=CH_2$, $[B] :$ 

$[C] : HCHO$

(C)

$[A] : CH_3–CH=CH_2$, $[B] : CH_3CHO$,

$[C] : CH_3CH_2OH$

(D)

$CH_3CH_2CH_3$, $[B] : CH_3CHO$, $[C] : HCHO$

55. Arrange the following in increasing order of solubility product :

$Ca(OH)_2, AgBr, PbS, HgS$

(A) $PbS < HgS < Ca(OH)_2 < AgBr$

(B) $HgS < PbS < AgBr < Ca(OH)_2$

(C) $Ca(OH)_2 < AgBr < HgS < PbS$

(D) $HgS < AgBr < PbS < Ca(OH)_2$

56. The purification method based on the following physical transformation is :

$$\underset{(X)}{\text{Solid}} \xrightarrow{\text{Heat}} \underset{(X)}{\text{Vapour}} \xrightarrow{\text{Cool}} \underset{(X)}{\text{Solid}}$$

(A) Sublimation (B) Distillation (C) Crystallization (D) Extraction

57. Identify correct conversion during acidic hydrolysis from the following :

(A) starch gives galactose.

(B) cane sugar gives equal amount of glucose and fructose.

(C) milk sugar gives glucose and galactose.

(D) amylopectin gives glucose and fructose.

(E) amylose gives only glucose.

(A) (C), (D) and (E) only

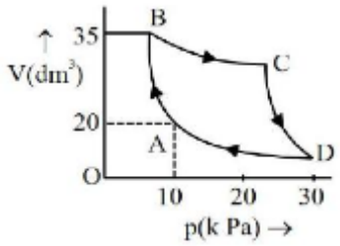
(B) (A), (B) and (C) only

(C) (B), (C) and (E) only

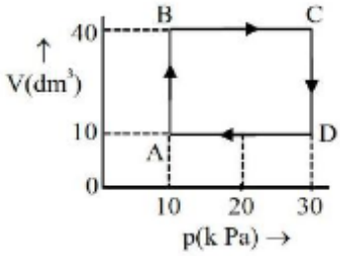
(D) (B), (C) and (D) only

58.

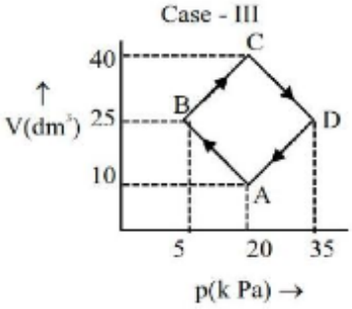
Case - I



Case - II



Case - III



An ideal gas undergoes a cyclic transformation starting from the point A and coming back to the same point by tracing the path $A \rightarrow B \rightarrow C \rightarrow D \rightarrow A$ as shown in the three cases above.

Choose the correct option regarding ΔU.

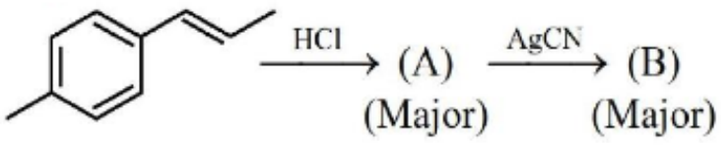
(A) ΔU(Case-III)$>\Delta U$(Case-II)$>\Delta U$(Case-I)

(B) ΔU(Case-I) $>\Delta U$(Case-II)$>\Delta U$ (Case-III)

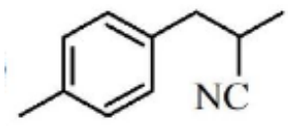
(C) ΔU(Case-I) $>\Delta U$(Case-III)$>\Delta U$(Case-II)

(D) ΔU(Case-I)$=\Delta U$(Case-II)$=\Delta U$(Case-III)

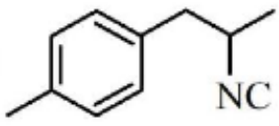
59. The product B formed in the following reaction sequence is :



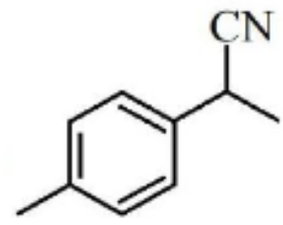
(A)



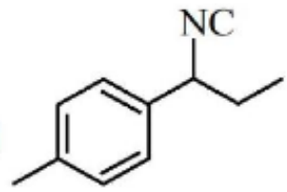
(B)



(C)



(D)



60. Concentrated nitric acid is labelled as 75% by mass. The volume in mL of the solution which contains 30 g of nitric acid is _____ .

Given : Density of nitric acid solution is $1.25\ \mathrm{g/mL}$

(A) 45 (B) 55 (C) 32 (D) 40

61. Match List-I with List-II.

List-I (Complex)}	List-II (Hybridisation of central metal ion)
(A) $[CoF_6]^{3-}$	(I) d^2sp^3
(B) $[NiCl_4]^{2}$	(II) sp^3
(C) $[Co(NH_3)_6]^{3+}$	(III) sp^3d^2
(D) $[Ni(CN)_4]^{2-}$	(IV) dsp^2

Choose the correct answer from the options given

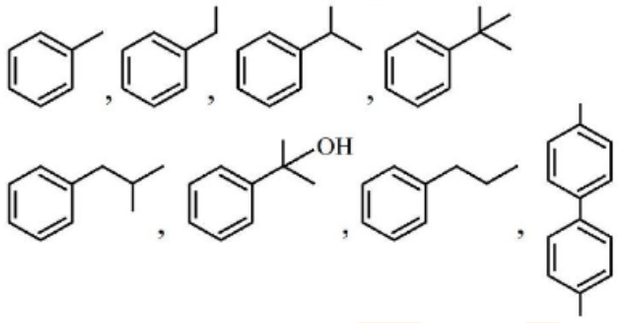
(A) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

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

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

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

62. The total number of compounds from below when treated with hot $KMnO_4$ giving benzoic acid is :



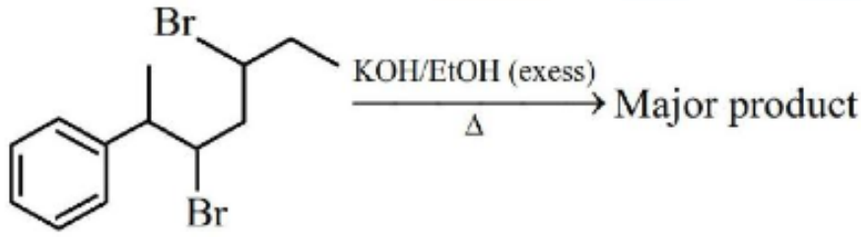
(A) 3

(B) 4

(C) 6

(D) 5

63. The major product of the following reaction is :



(A) 6-Phenylhepta-2,4-diene

(B) 2-Phenylhepta-2,5-diene

(C) 6-Phenylhepta-3,5-diene

(D) 2-Phenylhepta-2,4-diene

64. Given below are two statements :

Statement (I): According to the Law of Octaves, the elements were arranged in the increasing order of their atomic number.

Statement (II) : Meyer observed a periodically repeated pattern upon plotting physical properties of certain elements against their respective atomic numbers.

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

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

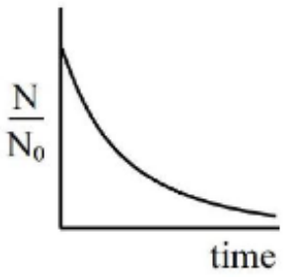
(B) Both Statement I and Statement II are true

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

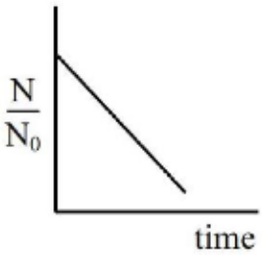
(D) Both Statement I and Statement II are false

65. For bacterial growth in a cell culture, growth law is very similar to the law of radioactive decay.
Which of the following graphs is most suitable to represent bacterial colony growth ?

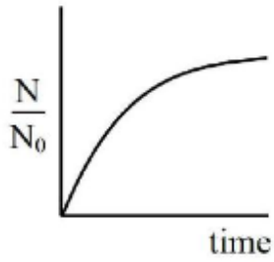
(A)



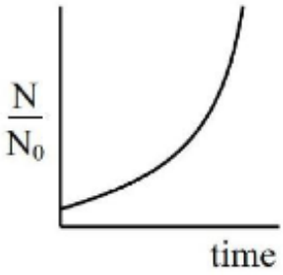
(B)



(C)



(D)



66. Which of the following is/are not correct with respect to energy of atomic orbitals of hydrogen atom?
(A) 1 s $<$ 2 p $<$ 3 d $<$ 4 s
(B) $1\,s < 2\,s = 2p < 3\,s = 3p$
(C) 1 s $<$ 2 s $<$ 2 p $<$ 3 s $<$ 3 p
(D) 1 s $<$ 2 s $<$ 4 s $<$ 3 d
Choose the correct answer from the options given below:
(A) (B) and (D) only (B) (A) and (C) only (C) (C) and (D) only (D) (A) and (B) only

67. Assume a living cell with $0.9\%(\omega/\omega)$ of glucose solution (aqueous). This cell is immersed in another solution having equal mole fraction of glucose and water.
(Consider the data upto first decimal place only)The cell will :
(A) shrink since soluton is $0.5\%(\omega/\omega)$
(B) shrink since solution is $0.45\%(\omega/\omega)$ as a result of association of glucose molecules (due to hydrogen bonding)
(C) swell up since solution is $1\%(\omega/\omega)$
(D) Show no change in volume since solution is $0.9\%(\omega/\omega)$

68. Identify correct statements :
(A) Primary amines do not give diazonium salts when treated with $NaNO_2$ in acidc condition.
(B) Aliphatic and aromatic primary amines on heating wth $CHCl_3$ and ethanolic KOH form carbylamines.
(C) Secondary and tertiary amines also give carbylamine test.
(D) Benzenesulfonyl chloride is known as Hinsberg's reagent.

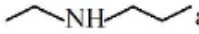
(E) Tertiary amines reacts with benzenesulfonyl chloride very easily.

Choose the correct answer from the options given below :

(A) (B) and (D) only (B) (A) and (B) only (C) (D) and (E) only (D) (B) and (C) only

69. Given below are two statements :

Statement (I) :  and  are isomeric compounds.

Statement (II) :  and  are functional group isomers.

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

(A) Both Statement I and Statement II are false

(B) Both Statement I and Statement II are true

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

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

70. Identify the inorganic sulphides that are yellow in colour :

(A) $(NH_4)_2\ S$

(B) PbS

(C) CuS

(D) $As_2\ S_3$

(E) $As_2\ S_5$

Choose the correct answer from the options given below:

(A) (A) and (C) only (B) (A), (D) and (E) only

(C) (A) and (B) only (D) (D) and (E) only

* SECTION - B [20]

71. The spin only magnetic moment (μ) value (B.M.) of the compound with strongest oxidising power among Mn_2O_3, TiO and VO is _____ B.M. (Nearest integer).

72. Consider the following data :

Heat of formation of $CO_2(g) = -393.5\ kJ\ mol^{-1}$

Heat of formation of $H_2O(l) = -286.0\ kJ\ mol^{-1}$

Heat of combustion of benzene $= -3267.0\ kJ\ mol^{-1}$

The heat of formation of benzene is _____ $kJmol^{-1}$.
(Nearest integer)

73. Electrolysis of 600 mL aqueous solution of NaCl for 5 min changes the pH of the solution to 12 .

The current in Amperes used for the given electrolysis is _____ .
(Nearest integer).

74. A group 15 element forms $d\pi - d\pi$ bond with transition metals. It also forms hydride, which is a strongest base among the hydrides of other group members that form $d\pi - d\pi$ bond. The atomic number of the element is _____ .

75. Total number of molecules/species from following which will be paramagnetic is _____ .

$O_2, O_2^+, O_2^-, NO, NO_2, CO, K_2[NiCl_4]$,
$[Co(NH_3)_6]Cl_3$, $K_2[Ni(CN)_4]$

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JEE

Total Marks : 300

29 Jan 2025 Shift 1

Mathematics

* SECTION - A [80]

1. Let the line $x+y=1$ meet the circle $x^2+y^2=4$ at the points A and B . If the line perpendicular to AB and passing through the mid point of the chord AB intersects the circle at C and D , then the area of the quadrilateral ADBC is equal to

(A) $3\sqrt{7}$ (B) $2\sqrt{14}$ (C) $5\sqrt{7}$ (D) $\sqrt{14}$

2. Let M and m respectively be the maximum and the minimum values of

$$f(x)=\begin{vmatrix} 1+\sin^2 x & \cos^2 x & 4\sin 4x \\ \sin^2 x & 1+\cos^2 x & 4\sin 4x \\ \sin^2 x & \cos^2 x & 1+4\sin 4x \end{vmatrix}, x \in R$$

Then M^4-m^4 is equal to :

(A) 1280 (B) 1295 (C) 1040 (D) 1215

3. Two parabolas have the same focus $(4,3)$ and their directrices are the x-axis and the y-axis, respectively. If these parabolas intersects at the points A and B, then $(AB)^2$ is equal to

(A) 192 (B) 384 (C) 96 (D) 392

4. Let ABC be a triangle formed by the lines $7x-6y+3=0, x+2y-31=0$ and $9x-2y-19=0$, Let the point (h,k) be the image of the centroid of ΔABC in the line $3x+6y-53=0$. Then h^2+k^2+hk is equal to

(A) 37 (B) 47 (C) 40 (D) 36

5. Let $\vec{a}=2\hat{i}-\hat{j}+3\hat{k}, \vec{b}=3\hat{i}-5\hat{j}+\hat{k}$ and $\vec{c}$ be a vector such that $\vec{a}\times\vec{c}=\vec{c}\times\vec{b}$ and $(\vec{a}+\vec{c})\cdot(\vec{b}+\vec{c})=168$. Then the maximum value of $|\vec{c}|^2$ is :

(A) 77 (B) 462 (C) 308 (D) 154

6. Let P be the set of seven digit numbers with sum of their digits equal to 11 . If the numbers in P are formed by using the digits 1,2 and 3 only, then the number of elements in the set P is :

(A) 158 (B) 178 (C) 164 (D) 161

7. Let the area of the region $\{(x,y): 2y \le x^2+3,\ y+|x| \le 3, y \ge |x-1|\}$ be A. Then $6A$ is equal to:

(A) 16 (B) 12 (C) 18 (D) 14

8. The least value of n for which the number of integral terms in the Binomial expansion of $(\sqrt[3]{7}+\sqrt[12]{11})^n$ is 183 , is :

(A) 2184 (B) 2148 (C) 2172 (D) 2196

9. The number of solutions of the equation $\left(\frac{9}{x}-\frac{9}{\sqrt{x}}+2\right)\left(\frac{2}{x}-\frac{7}{\sqrt{x}}+3\right)=0$ is :

(A) 2 (B) 4 (C) 1 (D) 3

10. Let $y=y(x)$ be the solution of the differential equation $\cos x(\log_e(\cos x))^2 dy+(\sin x-3y\sin x\log_e(\cos x))dx=0$, $x \in \left(0,\frac{\pi}{2}\right)$. If $y\left(\frac{\pi}{4}\right)=\frac{-1}{\log_e 2}$, then $y\left(\frac{\pi}{6}\right)$ is :

(A) $\frac{2}{\log_e(3)-\log_e(4)}$ (B) $\frac{1}{\log_e(4)-\log_e(3)}$ (C) $-\frac{1}{\log_e(4)}$ (D) $\frac{1}{\log_e(3)-\log_e(4)}$

11. Define a relation R on the interval $\left[0,\frac{\pi}{2}\right)$ by xRy if and only if $\sec^2 x-\tan^2 y=1$. Then R is :

(A) an equivalence relation

(B) both reflexive and transitive but not symmetric

(C) both reflexive and symmetric but not transitive

(D) reflexive but neither symmetric not transitive

12. Let the ellipse, $E_1: \frac{x^2}{a^2}+\frac{y^2}{b^2}=1, a>b$ and $E_2: \frac{x^2}{A^2}+\frac{y^2}{B^2}=1, A<B$ have same eccentricity $\frac{1}{\sqrt{3}}$. Let the product of their lengths of latus rectums be $\frac{32}{\sqrt{3}}$, and the distance between the foci of E_1 be 4. If E_1 and E_2 meet at A,B,C and D, then the area of the quadrilateral ABCD equals:

(A) $6\sqrt{6}$ (B) $\frac{18\sqrt{6}}{5}$ (C) $\frac{12\sqrt{6}}{5}$ (D) $\frac{24\sqrt{6}}{5}$

13. Consider an A.P. of positive integers, whose sum of the first three terms is 54 and the sum of the first twenty terms lies between 1600 and 1800 . Then its 11^{th} term is :

(A) 84 (B) 122 (C) 90 (D) 108

14. Let $\vec{a}=\hat{i}+2\hat{j}+\hat{k}$ and $\vec{b}=2\hat{i}+7\hat{j}+3\hat{k}$. Let $L_1: \vec{r}=(-\hat{i}+2\hat{j}+\hat{k})+\lambda\vec{a}, \lambda \in R$ and $L_2: \vec{r}=(\hat{j}+\hat{k})+\mu\vec{b}, \mu \in R$ be two lines. If the line L_3 passes through the point of intersection of L_1 and L_2, and is parallel to $\vec{a}+\vec{b}$, then L_3 passes through the point:

(A) $(8,26,12)$ (B) $(2,8,5)$ (C) $(-1,-1,1)$ (D) $(5,17,4)$

15. The value of $\lim_{n\to\infty}\left(\sum_{K=1}^{n}\frac{k^3+6k^2+11k+5}{(k+3)!}\right)$ is :

(A) $\frac{4}{3}$ (B) 2 (C) $\frac{7}{3}$ (D) $\frac{5}{3}$

16. The integral $80\int_0^{\frac{\pi}{4}}\left(\frac{\sin\theta+\cos\theta}{9+16\sin 2\theta}\right)d\theta$ is equal to :

(A) $3\log_e 4$ (B) $6\log_e 4$ (C) $4\log_e 3$ (D) $2\log_e 3$

17. Let $L_1:\frac{x-1}{1}=\frac{y-2}{-1}=\frac{z-1}{2}$ and $L_2:\frac{x+1}{-1}=\frac{y-2}{2}=\frac{z}{1}$ be two lines.
Let L_3 be a line passing through the point (α,β,γ) and be perpendicular to both L_1 and L_2. If L_3 intersects L_1, then $|5\alpha-11\beta-8\gamma|$ equals :

(A) 18 (B) 16 (C) 25 (D) 20

18. Let $x_1,x_2,.....x_{10}$ be ten observations such that $\sum_{i=1}^{10}(x_i-2)=30,\sum_{i=1}^{10}(x_i-\beta)^2=98,\beta>2$ and their variance is $\frac{4}{5}$. If μ and σ^2 are respectively the mean and the variance of $2(x_1-1)+4\beta,2(x_2-1)+4\beta,....,2(x_{10}-1)+4\beta$, then $\frac{\beta\mu}{\sigma^2}$ is equal to :

(A) 100 (B) 110 (C) 120 (D) 90

19. Let $|z_1-8-2i|\le 1$ and $|z_2-2+6i|\le 2$, $z_1,z_2\in C$. Then the minimum value of $|z_1-z_2|$ is :

(A) 3 (B) 7 (C) 13 (D) 10

20. Let $A=[a_{ij}]=\begin{bmatrix}\log_5 128 & \log_4 5\\ \log_5 8 & \log_4 25\end{bmatrix}$. If $\mathrm{A_{ij}}$ is the cofactor of $\mathrm{a_{ij}},\mathrm{C_{ij}}=\sum_{k=1}^{2}\mathrm{a_{ik}A_{jk}},1\le i,j\le 2$, and $\mathrm{C}=[\mathrm{C_{ij}}]$, then $8|\mathrm{C}|$ is equal to :

(A) 262 (B) 288 (C) 242 (D) 222

* SECTION - B [20]

21. Let $\mathrm{f}:(0,\infty)\to\mathrm{R}$ be a twice differentiable function. If for some $a\neq 0,\int_0^1\mathrm{f}(\lambda x)\mathrm{d}\lambda=\mathrm{af(x)}$, $f(1)=1$ and $f(16)=\frac{1}{8}$, then $16-f'\left(\frac{1}{16}\right)$ is equal to _____ .

22. Let $S=m\in Z:A^{m^2}+A^m=3I-A^{-6}$, where $A=\begin{bmatrix}2 & -1\\ 1 & 0\end{bmatrix}$. Then $n(S)$ is equal to _____ .

23. Let $[t]$ be the greatest integer less than or equal to t. Then the least value of $p\in N$ for which

$\lim_{x\to 0^+}\left(x\left(\left[\frac{1}{x}\right]+\left[\frac{2}{x}\right]+.....+\left[\frac{p}{x}\right]\right)-x^2\left(\left[\frac{1}{x^2}\right]+\left[\frac{2^2}{x^2}\right]+....+\left[\frac{9^2}{x^2}\right]\right)\right)$
≥ 1
is equal to _____ .

24. The number of 6 -letter words, with or without meaning, that can be formed using the letters of the word MATHS such that any letter that appears in the word must appear at least twice, is 4 _____.

25. Let $S = x : \cos^{-1} x = \pi + \sin^{-1} x + \sin^{-1} 2x + 1$

Then $\sum_{x \in S} (2x-1)^2$ is equal to -

Physics

*** SECTION - A** **[80]**

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

Assertion (A) : Choke coil is simply a coil having a large inductance but a small resistance. Choke coils are used with fluorescent mercury-tube fittings. If household electric power is directly connected to a mercury tube, the tube will be damaged.

Reason (R): By using the choke coil, the voltage across the tube is reduced by a factor $\left(R/\sqrt{R^2+\omega^2 L^2}\right)$, where ω is frequency of the supply across resistor R and inductor L . If the choke coil were not used, the voltage across the resistor would be the same as the applied voltage.

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

(A) Both (A) and ($\mathbf{R}$) are true but ($\mathbf{R}$) is not the correct explanation of $(\mathbf{A})$.

(B) (A) is false but (R) is true.

(C) Both (A) and (R) are true and $(\mathbf{R})$ is the correct explanation of (A).

(D) (A) is true but (R) is false.

27. Two projectiles are fired with same initial speed from same point on ground at angles of $(45^\circ - \alpha)$ and $(45^\circ + \alpha)$, respectively, with the horizontal direction. The ratio of their maximum heights attained is :

(A) $\frac{1-\tan\alpha}{1+\tan\alpha}$ (B) $\frac{1+\sin\alpha}{1-\sin\alpha}$ (C) $\frac{1-\sin 2\alpha}{1+\sin 2\alpha}$ (D) $\frac{1+\sin 2\alpha}{1-\sin 2\alpha}$

28. An electric dipole of mass m, charge q, and length l is placed in a uniform electric field $\vec{E} = E_0 \hat{i}$. When the dipole is rotated slightly from its equilibrium position and released, the time period of its oscillations will be :

(A) $\frac{1}{2\pi}\sqrt{\frac{2\,ml}{qE_0}}$ (B) $2\pi\sqrt{\frac{ml}{qE_0}}$ (C) $\frac{1}{2\pi}\sqrt{\frac{ml}{2qE_0}}$ (D) $2\pi\sqrt{\frac{ml}{2qE_0}}$

29. The pair of physical quantities not having same dimensions is :

(A) Torque and energy

(B) Surface tension and impulse

(C) Angular momentum and Planck's constant

(D) Pressure and Young's modulus

30. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R).**

Assertion (A) : Time period of a simple pendulum is longer at the top of a mountain than that at the base of the mountain.

Reason (R): Time period of a simple pendulum decreases with increasing value of acceleration due to gravity and vice-versa.

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

(A) Both **(A)** and ($\mathbf{R}$) are true but ($\mathbf{R}$) is not the correct explanation of $(\mathbf{A})$.

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

(C) **(A)** is true but **(R)** is false.

(D) **(A)** is false but **(R)** is true.

31. The expression given below shows the variation of velocity (v) with time (t), $v = \mathrm{At}^2 + \frac{\mathrm{Bt}}{\mathrm{C+t}}$. The dimension of ABC is :

(A) $\left[\mathrm{M}^0\ \mathrm{L}^2\ \mathrm{T}^{-3}\right]$ (B) $\left[\mathrm{M}^0\ \mathrm{L}^1\ \mathrm{T}^{-3}\right]$ (C) $\left[\mathrm{M}^0\ \mathrm{L}^1\ \mathrm{T}^{-2}\right]$ (D) $\left[\mathrm{M}^0\ \mathrm{L}^2\ \mathrm{T}^{-2}\right]$

32. Consider I_1 and I_2 are the currents flowing simultaneously in two nearby coils 1&2, respectively. If $L_1 =$ self inductance of coil 1 , $\mathrm{M}_{12} =$ mutual inductance of coil 1 with respect to coil 2 , then the value of induced emf in coil 1 will be

(A) $\varepsilon_1 = -L_1 \frac{dI_1}{dt} + M_{12} \frac{dI_2}{dt}$ (B) $\varepsilon_1 = -\mathrm{L}_1 \frac{\mathrm{dI}_1}{\mathrm{dt}} - \mathrm{M}_{12} \frac{\mathrm{dI}_1}{\mathrm{dt}}$

(C) $\varepsilon_1 = -\mathrm{L}_1 \frac{\mathrm{dI}_1}{\mathrm{dt}} - \mathrm{M}_{12} \frac{\mathrm{dI}_2}{\mathrm{dt}}$ (D) $\varepsilon_1 = -\mathrm{L}_1 \frac{\mathrm{dI}_2}{\mathrm{dt}} - \mathrm{M}_{12} \frac{\mathrm{dI}_1}{\mathrm{dt}}$

33. At the interface between two materials having refractive indices n_1 and n_2, the critical angle for reflection of an em wave is θ_{1C}. The n_2 material is replaced by another material having refractive index n_3, such that the critical angle at the interface between n_1 and n_3 materials is θ_{2C}. If $n_3 > n_2 > n_1$; $\frac{\mathrm{n}_2}{\mathrm{n}_3} = \frac{2}{5}$ and $\sin\theta_{2\mathrm{C}} - \sin\theta_{1\mathrm{C}} = \frac{1}{2}$, then $\theta_{1\mathrm{C}}$ is

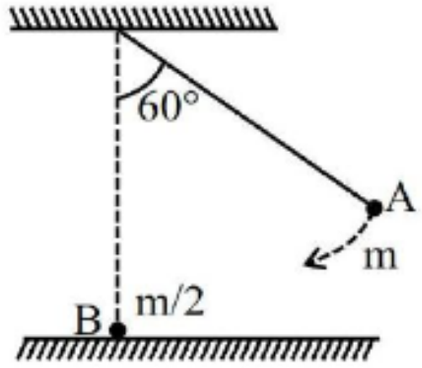
(A) $\sin^{-1}\left(\frac{1}{6n_1}\right)$ (B) $\sin^{-1}\left(\frac{2}{3n_1}\right)$ (C) $\sin^{-1}\left(\frac{5}{6n_1}\right)$ (D) $\sin^{-1}\left(\frac{1}{3\mathrm{n}_1}\right)$

34. Consider a long straight wire of a circular cross-section (radius a) carrying a steady current I. The current is uniformly distributed across this cross-section. The distances from the centre of the wire's cross-section at which the magnetic field [inside the wire, outside the wire] is half of the maximum possible magnetic field, any where due to the wire, will be

(A) $[a/4, 3a/2]$ (B) $[a/2, 2a]$ (C) $[a/2, 3a]$ (D) $[a/4, 2a]$

35. As shown below, bob A of a pendulum having massless string of length ' R ' is released from 60° to the vertical. It hits another bob B of half the mass that is at rest on a friction less table in the centre. Assuming elastic collision, the

magnitude of the velocity of bob A after the collision will be (take g as acceleration due to gravity)



(A) $\frac{1}{3}\sqrt{\mathrm{Rg}}$ (B) $\sqrt{\mathrm{Rg}}$ (C) $\frac{4}{3}\sqrt{Rg}$ (D) $\frac{2}{3}\sqrt{\mathrm{Rg}}$

36. Given below are two statements: one is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.

Assertion (A) : Emission of electrons in photoelectric effect can be suppressed by applying a sufficiently negative electron potential to the photoemissive substance.

Reason (R): A negative electric potential, which stops the emission of electrons from the surface of a photoemissive substance, varies linearly with frequency of incident radiation.

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

(A) **(A)** is false but **(R)** is true.

(B) **(A)** is true but **(R)** is false.

(C) Both **(A)** and **(R)** are true and ($\mathbf{R}$) is the correct explanation of $(\mathbf{A})$.

(D) Both **(A)** and **(R)** are true but ($\mathbf{R}$) is not the correct explanation of (A).

37. A coil of area A and N turns is rotating with angular velocity ω in a uniform magnetic field $\vec{B}$ about an axis perpendicular to $\vec{B}$. Magnetic flux φ and induced emf ε across it, at an instant when $\overrightarrow{\mathrm{B}}$ is parallel to the plane of coil, are :

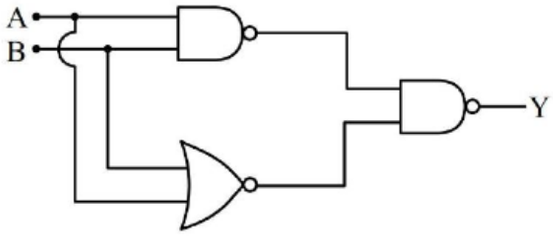
(A) $\varphi=\mathrm{AB}, \varepsilon=0$ (B) $\varphi=0, \varepsilon=\mathrm{NAB}\omega$

(C) $\varphi=0, \varepsilon=0$ (D) $\varphi=\mathrm{AB}, \varepsilon=\mathrm{NAB}\omega$

38. The fractional compression $\left(\frac{\Delta V}{V}\right)$ of water at the depth of 2.5 km below the sea level is_____ %. Given, the Bulk modulus of water $=2\times10^{9}\mathrm{Nm}^{-2}$, density of water $=10^{3}\ \mathrm{kg\ m}^{-3}$, acceleration due to gravity $=\mathrm{g}=10\ \mathrm{ms}^{-2}$.

(A) 1.75 (B) 1.0 (C) 1.5 (D) 1.25

39.



For the circuit shown above, equivalent GATE is :

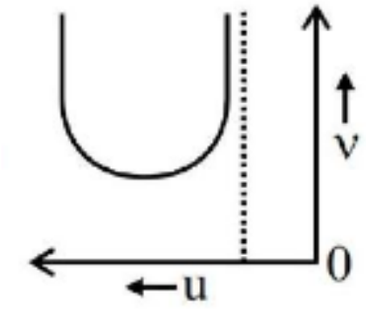
(A) OR gate (B) NOT gate (C) AND gate (D) NAND gate

40. A body of mass ' m ' connected to a massless and unstretchable string goes in verticle circle of radius ' R ' under gravity g . The other end of the string is fixed at the center of circle. If velocity at top of circular path is $n\sqrt{gR}$, where, $n \geq 1$, then ratio of kinetic energy of the body at bottom to that at top of the circle is

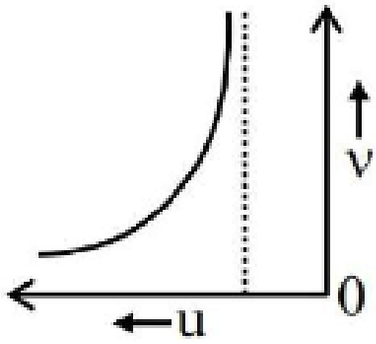
(A) $\frac{n}{n+4}$ (B) $\frac{n+4}{n}$ (C) $\frac{n^2}{n^2+4}$ (D) $\frac{n^2+4}{n^2}$

41. Let u and v be the distances of the object and the image from a lens of focal length f. The correct graphical representation of u and v for a convex lens when $|\mathbf{u}| > f$, is

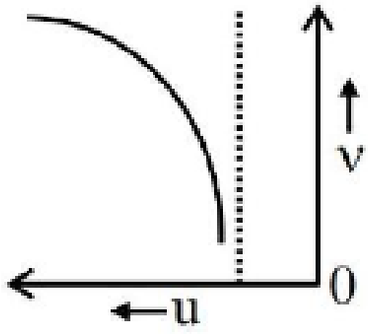
(A)



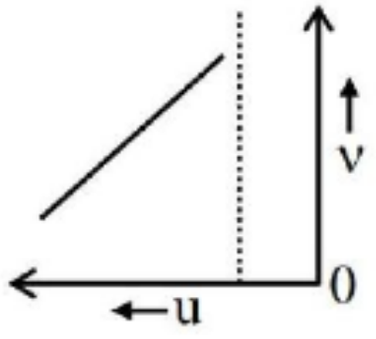
(B)



(C)



(D)



42. Match List-I with List-II.

	List-I		List-II

(A)	Electric field inside (distance r > 0 from center) of a uniformly charged spherical shell with surface charge density σ, and radius R.	**(I)**	σ/ε_0
(B)	Electric field at distance r > 0 from a uniformly charged infinite plane sheet with surface charge density σ.	**(II)**	$\sigma/2\varepsilon_0$
(C)	Electric field outside (distance r > 0 from center) of a uniformly charged spherical shell with surface charge density σ, and radius R	**(III)**	0
(D)	oppositely charged infinite plane parallel sheets with uniform surface charge density σ.	**(IV)**	$\frac{\sigma}{\varepsilon_0 r^2}$

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

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

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

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

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

43. The workdone in an adiabatic change in an ideal gas depends upon only :

(A) change in its pressure

(B) change in its specific heat

(C) change in its volume

(D) change in its temperature

44. Given below are two statements : one is labelled as **Assertion (A)** and other is labelled as **Reason (R)**.

Assertion (A) : Electromagnetic waves carry energy but not momentum.

Reason (R): Mass of a photon is zero.

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

(A) **(A)** is true but **(R)** is false.

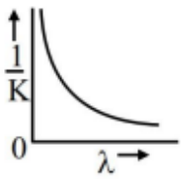
(B) **(A)** is false but **(R)** is true.

(C) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.

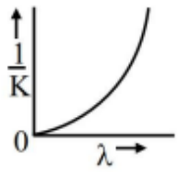
(D) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A).**

45. If λ and K are de Broglie Wavelength and kinetic energy, respectively, of a particle with constant mass. The correct graphical representation for the particle will be :-

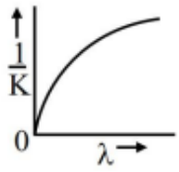
(A)



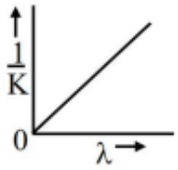
(B)



(C)



(D)



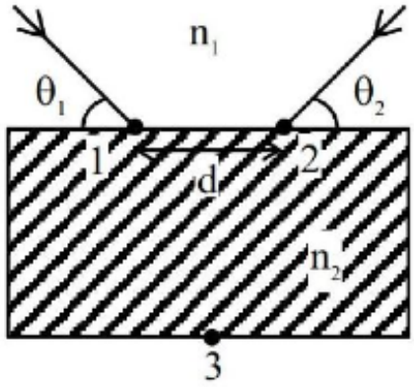
*** SECTION - B** **[20]**

46. The coordinates of a particle with respect to origin in a given reference frame is $(1,1,1)$ meters. If a force of $\vec{F}=\hat{i}-\hat{j}+\hat{k}$ acts on the particle, then the magnitude of torque (with respect to origin) in z-direction is _____ .

47. A container of fixed volume contains a gas at $27^{\circ}\mathrm{C}$. To double the pressure of the gas, the temperature of gas should be raised to _____ $^{\circ}\mathrm{C}$.

48. Two light beams fall on a transparent material block at point 1 and 2 with angle θ_1 and θ_2, respectively, as shown in figure. After refraction, the beams intersect at point 3 which is exactly on the interface at other end of the block. Given : the distance between 1 and $2, d=4\sqrt{3}\,\mathrm{cm}$ and $\theta_1=\theta_2=\cos^{-1}\left(\frac{n_2}{2n_1}\right)$, where refractive index of the block $\mathrm{n}_2>$ refractive index of the outside medium n_1, then the thickness of the block is

_____ cm .



49. In a hydraulic lift, the surface area of the input piston is $6\ \mathrm{cm}^2$ and that of the output piston is $1500\ \mathrm{cm}^2$. If 100 N force is applied to the input piston to raise the output piston by 20 cm , then the work done is_____ kJ.

50. The maximum speed of a boat in still water is $27\ \mathrm{km/h}$. Now this boat is moving downstream in a river flowing at $9\ \mathrm{km/h}$. A man in the boat throws a ball vertically upwards with speed of $10\ \mathrm{m/s}$. Range of the ball as observed by an observer at rest on the river bank, is _____ cm . (Take $\mathrm{g} = 10\ \mathrm{m/s^2}$)

Chemistry

*** SECTION - A** **[80]**

51. Total number of nucleophiles from the following is :

$NH_3,\quad PhSH,\quad (H_3C)_2S,\quad H_2C=CH_2,\quad \overset{\ominus}{O}H,\quad H_3O^{\oplus},$
$(CH_3)_2CO, \geqslant NCH_3$

(A) 5 (B) 4 (C) 7 (D) 6

52. The standard reduction potential values of some of the p-block ions are given below. Predict the one with the strongest oxidising capacity.

(A) $\mathrm{E}^{\ominus}_{\mathrm{Sn^4/Sn^{2+}}} = +1.15\ \mathrm{V}$

(B) $\mathrm{E}^{\ominus}_{\mathrm{T\beta^{3+}/Tl}} = +1.26\ \mathrm{V}$

(C) $\mathrm{E}^{\ominus}_{\mathrm{Al^{3+}/Al}} = -1.66\ \mathrm{V}$

(D) $\mathrm{E}^{\ominus}_{\mathrm{Pb^{4+}/Pb^{2+}}} = +1.67\ \mathrm{V}$

53. The molar conductivity of a weak electrolyte when plotted against the square root of its concentration, which of the following is expected to be observed?

(A) A small decrease in molar conductivity is observed at infinite dilution.

(B) A small increase in molar conductivity is observed at infinite dilution.

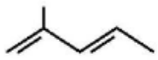
(C) Molar conductivity increases sharply with increase in concentration.

(D) Molar conductivity decreases sharply with increase in concentration.

54. At temperature T, compound $AB_{2(g)}$ dissociates as $AB_{2(g)} \rightleftharpoons AB_{(g)} + \frac{1}{2} B_{2(g)}$ having degree of dissociation x (small compared to unity). The correct expression for x in terms of K_p and p is

(A) $\sqrt[3]{\frac{2K_p}{p}}$ (B) $\sqrt[4]{\frac{2K_p}{p}}$ (C) $\sqrt[3]{\frac{2K_p^2}{p}}$ (D) $\sqrt{K_p}$

55. Match List-I with List-II.

List-I (Structure)		List-II (IUPAC Name)	
(A)	$H_3C–CH_2–\underset{\underset{C_2H_5}{|}}{CH}–CH_2–\underset{\underset{CH_3}{|}}{CH}–C_2H_5$	(I)	4-Methylpent-1-ene
(B)	$(CH_3)_2C(C_3H_7)_2$	(II)	3-Ethyl-5-methylheptane
(C)		(III)	4,4-Dimethylheptane
(D)		(IV)	2-Methyl-1,3-pentadiene

Choose the correct answer from the options given below :

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

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

56. Choose the correct statements.

(A) Weight of a substance is the amount of matter present in it.

(B) Mass is the force exerted by gravity on an object.

(C) Volume is the amount of space occupied by a substance.

(D) Temperatures below $0^\circ C$ are possible in Celsius scale, but in Kelvin scale negative temperature is not possible.

(E) Precision refers to the closeness of various measurements for the same quantity.

(A) (B), (C) and (D) Only (B) (A), (B) and (C) Only

(C) (A), (D) and (E) Only (D) (C), (D) and (E) Only

57. The correct increasing order of stability of the complexes based on Δ_0 value is :

(I) $[Mn(CN)_6]^{3-}$

(II) $[Co(CN)_6]^{4-}$

(III) $[Fe(CN)_6]^{4}$

(IV) $[Fe(CN)_6]^{3-}$

(A) II < III < I < IV (B) IV < III < II < I (C) I < II < IV < III (D) III < II < IV < I

58.

List-I (Complex)	List-II (Hybridisation & Magnetic characters)

(A)	$[MnBr_4]^{2-}$	(I)	d^2sp^3 & diamagnetic
(B)	$[FeF_6]^3$	(II)	sp^3d^2 & paramagnetic
(C)	$[Co(C_2O_4)_3]^3$	(III)	sp^3 & diamagnetic
(D)	$[Ni(CO)_4]$	(IV)	sp^3 & paramagnetic

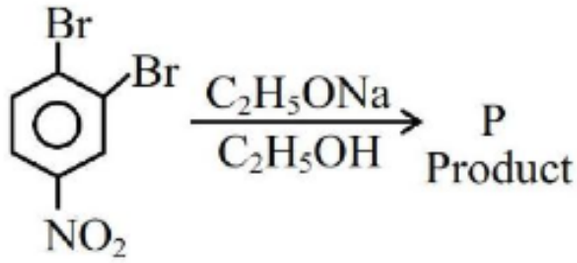
(A) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

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

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

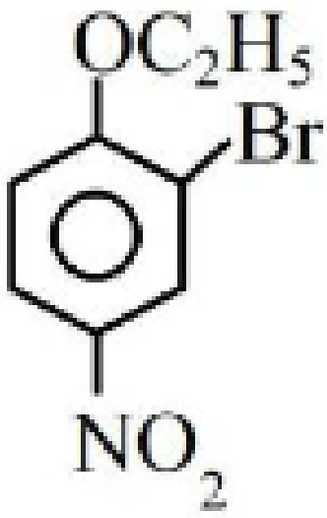
(D) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

59. In the following substitution reaction :

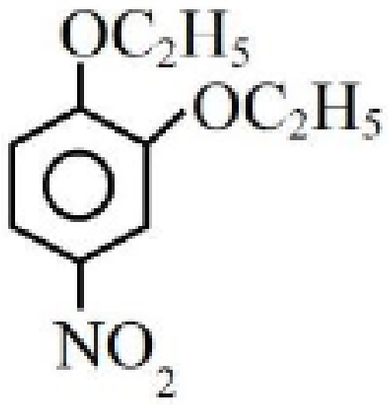


Product ' P ' formed is :

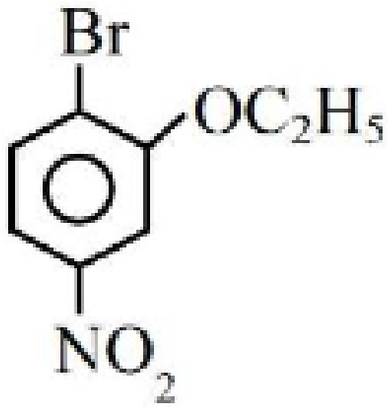
(A)



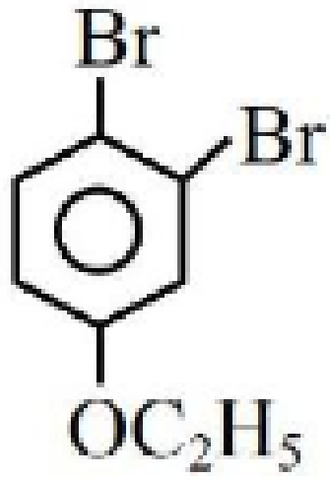
(B)



(C)



(D)



60. For a $Mg|Mg(aq)||Ag(aq)|Ag$ the correct Nernst Equation is :

(A) $E_{cell} = E^{o}_{cell} - \frac{RT}{2F}\ln\frac{[Ag^{+}]}{[Mg^{2+}]}$

(B) $E_{cell} = E^{o}_{cell} + \frac{RT}{2F}\ln\frac{[Ag^{+}]^{2}}{[Mg^{2+}]}$

(C) $E_{cell} = E^{o}_{cell} - \frac{RT}{2F}\ln\frac{[Mg^{2+}]}{[Ag^{+}]}$

(D) $E_{cell} = E^{o}_{cell} - \frac{RT}{2F} \ln \frac{[Ag^+]^2}{[Mg^{2+}]}$

61. The correct option with order of melting points of the pairs $(Mn, Fe), (Tc, Ru)$ and (Re, Os) is :

(A) $Fe < Mn, Ru < Tc$ and $Re < Os$

(B) $Mn < Fe, Tc < Ru$ and $Re < Os$

(C) $Mn < Fe, Tc < Ru$ and $Os < Re$

(D) $Fe < Mn, Ru < Tc$ and $Os < Re$

62. 1.24 g of AX_2 (molar mass $124\ g\ mol^{-1}$) is dissolved in 1 kg of water to form a solution with boiling point of $100.0156^{\circ}C$, while 25.4 g of AY_2 (molar mass $250\ g\ mol^{-1}$) in 2 kg of water constitutes a solution with a boiling point of $100.0260^{\circ}C$. $K_b\ (H_2O) = 0.52\ K\ kg\ mol^{-1}$ Which of the following is correct ?

(A) AX_2 and AY_2 (both) are completely unionised.

(B) AX_2 and AY_2 (both) are fully ionised.

(C) AX_2 is completely unionised while AY_2 is fully ionised.

(D) AX_2 is fully ionised while AY_2 is completely unionised.

63. 500 J of energy is transferred as heat to 0.5 mol of Argon gas at 298 K and 1.00 atm . The final temperature and the change in internal energy respectively are :Given : $R = 8.3\ J\ K^{-1}\ mol^{-1}$

(A) 348 K and 300 J (B) 378 K and 300 J (C) 368 K and 500 J (D) 378 K and 500 J

64. The reaction $A_2 + B_2 \rightarrow 2AB$ follows the mechanism

$A_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} A + A$ (fast)

$A + B_2 \xrightarrow{k_2} AB + B$ (slow)

$A + B \rightarrow AB$ (fast)

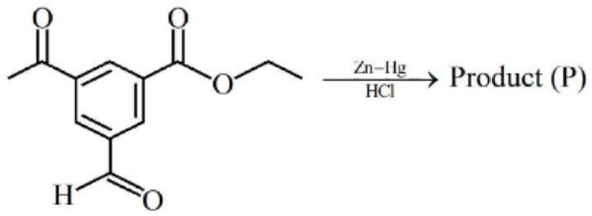
The overall order of the reaction is :

(A) 1.5 (B) 3 (C) 2.5 (D) 2

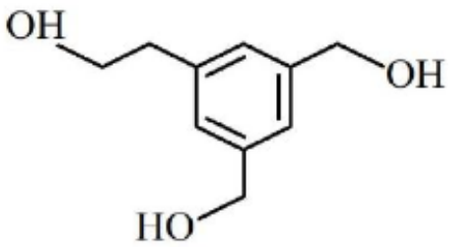
65. If a_0 is denoted as the Bohr radius of hydrogen atom, then what is the de-Broglie wavelength (λ) of the electron present in the second orbit of hydrogen atom? [n : any integer]

(A) $\frac{2a_0}{n\pi}$ (B) $\frac{8\pi a_0}{n}$ (C) $\frac{4\pi a_0}{n}$ (D) $\frac{4n}{\pi a_0}$

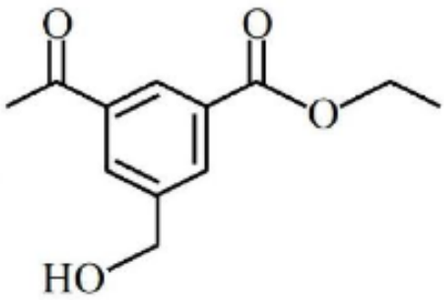
66. The product (P) formed in the following reaction is :



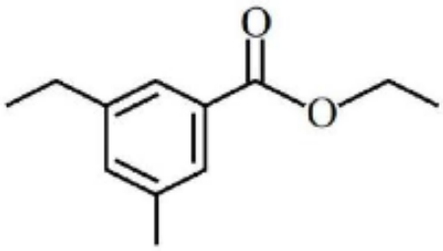
(A)



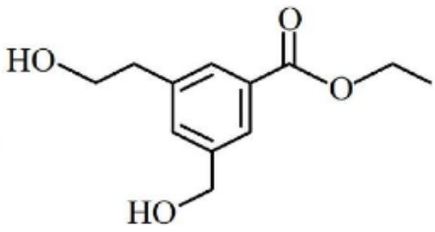
(B)



(C)



(D)



67. An element ' E ' has the ionisation enthalpy value of $374\ \mathrm{kJ\ mol^{-1}}$. 'E' reacts with elements A, B, C and D with electron gain enthalpy values of $-328, -349$, -325 and $-295\ \mathrm{kJ\ mol^{-1}}$, respectively.
The correct order of the products EA, EB, EC and ED in terms of ionic character is :

(A) $\mathrm{EB} > \mathrm{EA} > \mathrm{EC} > \mathrm{ED}$

(B) $\mathrm{ED} > \mathrm{EC} > \mathrm{EA} > \mathrm{EB}$

(C) $\mathrm{EA} > \mathrm{EB} > \mathrm{EC} > \mathrm{ED}$

(D) $\mathrm{ED} > \mathrm{EC} > \mathrm{EB} > \mathrm{EA}$

68.

List - I (Carbohydrate)	List - II (Linkage Source)
(A) Amylose	(I) $\beta - C_1 - C_4$, plant
(B) Cellulose	(II) $\alpha - C_1 - C_4$, animal
(C) Glycogen	(III) $\alpha - C_1 - C_4$, $\alpha - C_1 - C_6$, plant
(D) Amylopectin	(IV) $\alpha - C_1 - C_4$, plant

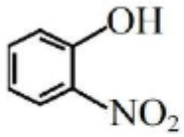
(A) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

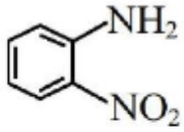
(B) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

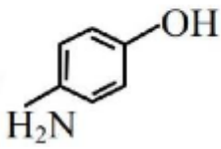
(C) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

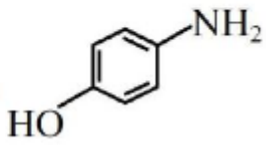
(D) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

69. The steam volatile compounds among the following are :

(A) 

(B) 

(C) 

(D) 

Choose the correct answer from the options given below :

(A) (B) and (D) only

(B) (A) and (C) only

(C) (A) and (B) only

(D) (A),(B) and (C) only

70. Given below are two statements :

Statement (I): The radii of isoelectronic species increases in the order.

$Mg^{2+} < Na^{+} < F^{-} < O^{2-}$

Statement (II) : The magnitude of electron gain enthalpy of halogen decreases in the order.

$Cl > F > Br > I$

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

(A) **Statement I** is incorrect but **Statement II** is correct

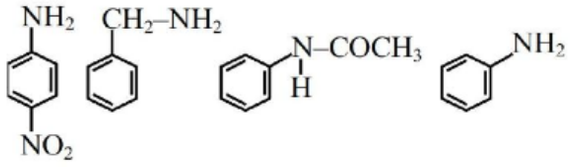
(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but Statement II is incorrect

(D) Both **Statement I** and **Statement II** are correct

* SECTION - B [20]

71. Given below are some nitrogen containing compounds.



Each of them is treated with HCl separately. 1.0 g of the most basic compound will consume _____ mg of HCl .

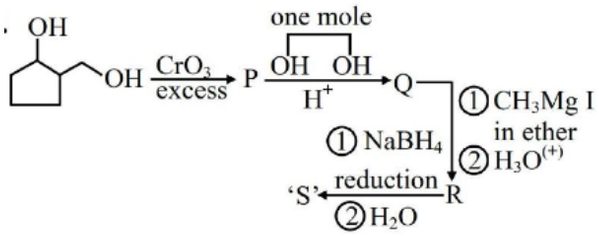
(Given molar mass in $gmol^{-1} C : 12, H : 1, O : 16$, $Cl : 35.5$)

72. The molar mass of the water insoluble product formed from the fusion of chromite ore $(FeCr_2O_4)$ with Na_2CO_3 in presence of O_2 is _____ $gmol^{-1}$.

73. The sum of sigma (σ) and pi(π) bonds in Hex-1,3-dien-5-yne is _____ .

74. If A_2B is 30% ionised in an aqueous solution, then the value of van't Hoff factor (i) is _____ $\times 10^{-1}$.

75.



0.1 mole of compound 'S' will weigh_____g.

(Given molar mass in g mol^{-1} C:12, H:1, O:16)

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JEE

Total Marks : 300

29 Jan 2025 Shift 2

Mathematics

* SECTION - A

[80]

1. If the set of all $a \in R$, for which the equation $2x^2+(a-5)x+15=3$ a has no real root, is the interval (α,β), and $X=\{x \in Z : \alpha < x < \beta\}$, then $\sum_{x\in X} x^2$ is equal to

(A) 2109 (B) 2129 (C) 2139 (D) 2119

2. If $\sin x+\sin^2 x=1, x \in \left(0,\frac{\pi}{2}\right)$, then $\left(\cos^{12} x+\tan^{12} x\right)+3\left(\cos^{10} x+\tan^{10} x+\cos^8 x+\tan^8 x\right) \quad +\left(\cos^6 x+\tan^6 x\right)$ is equal to

(A) 4 (B) 3 (C) 2 (D) 1

3. Let the area enclosed between the curves $|y|=1-\ x^2$ and $x^2+y^2=1$ be α. If $9\alpha=\beta\pi+\gamma;\beta,\gamma$ are integers, then the value of $|\beta-\gamma|$ equals

(A) 27 (B) 18 (C) 15 (D) 33

4. If the domain of the function $\log_5\left(18x-x^2-77\right)$ is (α,β) and the domain of the function $\log_{(x-1)}\left(\frac{2x^2+3x-2}{x^2-3x-4}\right)$ is (γ,δ), then $\alpha^2+\beta^2+\gamma^2$ is equal to :

(A) 195 (B) 174 (C) 186 (D) 179

5. Let the function $f(x)=\left(x^2-1\right)\left|x^2-ax+2\right|+\cos|x|$ be not differentiable at the two points $x=\alpha=2$ and $x=\beta$. Then the distance of the point (α,β) from the line $12x+5y+10=0$ is equal to :

(A) 3 (B) 4 (C) 2 (D) 5

6. Let a straight line L pass through the point $P(2,-1,3)$ and be perpendicular to the lines $\frac{x-1}{2}=\frac{y+1}{1}=\frac{z-3}{-2}$ and $\frac{x-3}{1}=\frac{y-2}{3}=\frac{z+2}{4}$. If the line L intersects the yz -plane at the point Q , then the distance between the points P and Q is :

(A) 2 (B) $\sqrt{10}$ (C) 3 (D) $2\sqrt{3}$

7. Let $S=N\cup\{0\}$. Define a relation R from S to R by : $R=\left\{(x,y) : \log_e y=x\log_e\left(\frac{2}{5}\right), x \in S, y \in R\right\}$
Then, the sum of all the elements in the range of R is equal to

(A) $\frac{3}{2}$ (B) $\frac{5}{3}$ (C) $\frac{10}{9}$ (D) $\frac{5}{2}$

8. Let the line $x+y=1$ meet the axes of x and y at A and B, respectively. A right angled triangle AMN is inscribed in the triangle OAB , where O is the origin and the points M and N lie on the lines OB and AB, respectively. If the area of the triangle AMN is $\frac{4}{9}$ of the area of the triangle OAB and $AN:NB=\lambda:1$, then the sum of all possible value(s) of is λ :

(A) $\frac{1}{2}$ (B) $\frac{13}{6}$ (C) $\frac{5}{2}$ (D) 2

9. If $\alpha x+\beta y=109$ is the equation of the chord of the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$, whose mid point is $\left(\frac{5}{2},\frac{1}{2}\right)$, then $\alpha+\beta$ is equal to

(A) 37 (B) 46 (C) 58 (D) 72

10. If all the words with or without meaning made using all the letters of the word "KANPUR" are arranged as in a dictionary, then the word at 440^{th} position in this arrangement, is :

(A) PRNAKU (B) PRKANU (C) PRKAUN (D) PRNAUK

11. Let $\alpha,\beta(\alpha\neq\beta)$ be the values of m, for which the equations $x+y+z=1; x+2y+4z=m$ and $x+4y+10z=m^2$ have infinitely many solutions. Then the value of $\sum_{n=1}^{10}\left(n^{\alpha}+n^{\beta}\right)$ is equal to :

(A) 440 (B) 3080 (C) 3410 (D) 560

12. Let $A=[a_i]$ be a matrix of order 3×3, with $a_{ij}=(\sqrt{2})^{i+j}$. If the sum of all the elements in the third row of A^2 is $\alpha+\beta\sqrt{2},\alpha,\beta\in Z$, then $\alpha+\beta$ is equal to

(A) 280 (B) 168 (C) 210 (D) 224

13. Let P be the foot of the perpendicular from the point $(1,2,2)$ on the line $L:\frac{x-1}{1}=\frac{y+1}{-1}=\frac{z-2}{2}$. Let the line $\overrightarrow{r}=(-\hat{i}+\hat{j}-2\hat{k})+\lambda(\hat{i}-\hat{j}+\hat{k}),\lambda\in R$, intersect the line L at Q . Then $2(PQ)^2$ is equal to:

(A) 27 (B) 25 (C) 29 (D) 19

14. Let a circle C pass through the points $(4,2)$ and $(0,\ 2\ )$, and its centre lie on $3x+2y+2=0$. Then the length of the chord, of the circle C , whose midpoint is $(1,2)$, is:

(A) $\sqrt{3}$ (B) $2\sqrt{3}$ (C) $4\sqrt{2}$ (D) $2\sqrt{2}$

15. Let $A=[a_{ij}]$ be a 2×2 matrix such that $a_{ij}\in\{0,1\}$ for all i and j . Let the random variable X denote the possible values of the determinant of the matrix A . Then, the variance of X is:

(A) $\frac{1}{4}$ (B) $\frac{3}{8}$ (C) $\frac{5}{8}$ (D) $\frac{3}{4}$

16. Bag 1 contains 4 white balls and 5 black balls, and Bag 2 contains n white balls and 3 black balls. One ball is drawn randomly from Bag 1 and transferred to Bag

2. A ball is then drawn randomly from Bag 2. If the probability, that the ball drawn is white, is $29/45$, then n is equal to:

(A) 3 (B) 4 (C) 5 (D) 6

17. The remainder, when 7^{103} is divided by 23 , is equal to:

(A) 14 (B) 9 (C) 17 (D) 6

18. Let $f(x)=\int_0^x t\left(t^2-9t+20\right)dt, \quad 1 \leq x \leq 5$. If the range of f is $[\alpha, \beta]$, then $4(\alpha+\beta)$ equals:

(A) 157 (B) 253 (C) 125 (D) 154

19. Let â be a unit vector perpendicular to the vectors $\vec{b}=\hat{i}-2\hat{j}+3\hat{k}$ and $\vec{c}=2\hat{i}+3\hat{j}-\hat{k}$, and makes an angle of $\cos^{-1}\left(-\frac{1}{3}\right)$ with the vector $\hat{i}+\hat{j}+\hat{k}$. If $\hat{a}$ makes an angle of $\frac{\pi}{3}$ with the vector $\hat{i}+\alpha\hat{j}+\hat{k}$, then the value of α is :

(A) $-\sqrt{3}$ (B) $\sqrt{6}$ (C) $-\sqrt{6}$ (D) $\sqrt{3}$

20. If for the solution curve $y=f(x)$ of the differential equation $\frac{dy}{dx}+(\tan x)y=\frac{2+\sec x}{(1+2\sec x)^2}$,

$x \in \left(\frac{-\pi}{2}, \frac{\pi}{2}\right), f\left(\frac{\pi}{3}\right)=\frac{\sqrt{3}}{10}$, then $f\left(\frac{\pi}{4}\right)$ is equal to:

(A) $\frac{9\sqrt{3}+3}{10(4+\sqrt{3})}$ (B) $\frac{\sqrt{3}+1}{10(4+\sqrt{3})}$ (C) $\frac{5-\sqrt{3}}{2\sqrt{2}}$ (D) $\frac{4-\sqrt{2}}{14}$

* SECTION - B [20]

21. If $24\int_0^{\frac{\pi}{4}}\left(\sin\left|4x-\frac{\pi}{12}\right|+[2\sin x]\right)dx=2\pi+\alpha$, where [.] denotes the greatest integer function, then α is equal to _____

22. If $\lim_{t\to 0}\left(\int_0^1(3x+5)^t dx\right)^{\frac{1}{t}}=\frac{\alpha}{5e}\left(\frac{8}{5}\right)^{\frac{2}{3}}$, then α is equal to _____ .

23. Let $a_1, a_2, \ldots, a_{204}$ be an Arithmetic Progression such that $a_1+(a_5+a_{10}+a_{19}+\ldots+a_{2000})+a_{2254}=$ 2233. Then $a_1+a_2+a_3+\ldots+a_{3034}$ is equal to _____

24. Let integers $a, b \in [-3,3]$ be such that $a+b \neq 0$. Then the number of all possible ordered pairs (a, b), for which $\left|\frac{z-a}{z+b}\right|=1$ and $\begin{vmatrix} z+1 & \omega & \omega^2 \\ \omega & z+\omega^2 & 1 \\ \omega^2 & 1 & z+\omega \end{vmatrix}=1, z \in C$, where ω and ω^2 are the roots of $x^2+x+1=0$, is equal to _____

25. Let $y^2=12x$ the parabola and S be its focus. Let PQ be a focal chord of the parabola such that (SP) $(SQ)=\frac{147}{4}$. Let C be the circle described taking PQ as a diameter. If the equation of a circle C is $64x^2+64y^2-\alpha x-64\sqrt{3}y=\beta$, then $\beta-\alpha$ is equal to _____

*** SECTION - A** **[80]**

26. The difference of temperature in a material can convert heat energy into electrical energy. To harvest the heat energy, the material should have

(A) low thermal conductivity and low electrical conductivity

(B) high thermal conductivity and high electrical conductivity

(C) low thermal conductivity and high electrical conductivity

(D) high thermal conductivity and low electrical conductivity

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

Assertion (A) : With the increase in the pressure of an ideal gas, the volume falls off more rapidly in an isothermal process in comparison to the adiabatic process.

Reason (R) : In isothermal process, $PV =$ constant, while in adiabatic process $PV^{\gamma} =$ constant. Here γ is the ratio of specific heats, P is the pressure and V is the volume of the ideal gas.

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

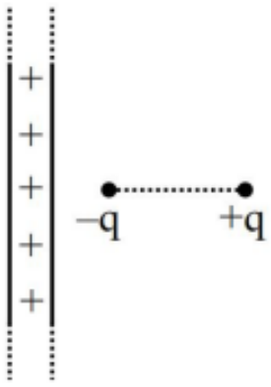
(A) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

(B) (A) is true but (R) is false

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

(D) (A) is false but (R) is true

28. An electric dipole is placed at a distance of 2 cm from an infinite plane sheet having positive charge density σ_0. Choose the correct option from the following.



(A) Torque on dipole is zero and net force is directed away from the sheet.

(B) Torque on dipole is zero and net force acts towards the sheet.

(C) Potential energy of dipole is minimum and torque is zero.

(D) Potential energy and torque both are maximum

29. In an experiment with photoelectric effect, the stopping potential.

(A) increases with increase in the wavelength of the incident light

(B) increases with increase in the intensity of the incident light

(C) is $\left(\frac{1}{e}\right)$ times the maximum kinetic energy of the emitted photoelectrons

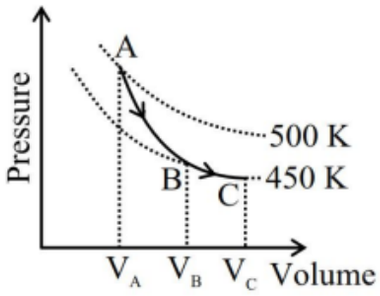
(D) decreases with increase in the intensity of the incident light

30. A point charge causes an electric flux of $-2 \times 10^4\ Nm^2C^{-1}$ to pass through a spherical Gaussian surface of 8.0 cm radius, centred on the charge. The value of the point charge is :

(Given $\epsilon_0 = 8.85 \times 10^{-12}C^2N^{-1}m^{-2}$)

(A) $-17.7 \times 10^3 C$ (B) $-15.7 \times 10^{-8} C$ (C) $17.7 \times 10^{-8} C$ (D) $15.7 \times 10^{-8} C$

31. **Sol.**

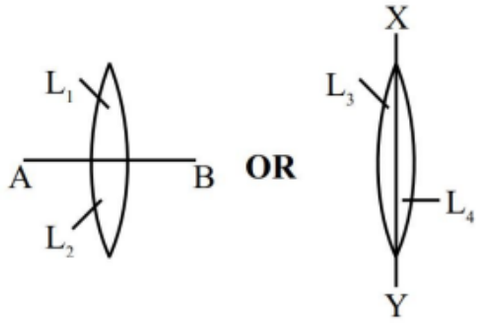


A poly-atomic molecule $(C_V = 3R, C_p = 4R$, where R is gas constant) goes from phase space point $A\left(P_A = 10^4 Pa, V_A = 4 \times 10^{-3} m^3\right)$ to point $B(P_B = 5 \times 10^4 Pa, V_B = 6 \times 10^{-6} m^3)$ to point $C\left(P_C = 10^4 Pa,\ V_c = 8 \times 10^{-6} m^3\right.$). A to B is an adiabatic path and B to C is an isothermal path.

The net heat absorbed per unit mole by the system is :

(A) $500R(\ln 3 + \ln 4)$ (B) $450R(\ln 4 - \ln 3)$ (C) $500R \ln 2$ (D) $400R \ln 4$

32. Two identical symmetric double convex lenses of focal length f are cut into two equal parts L_1, L_2 by AB plane and L_3, L_4 by XY plane as shown in figure respectively. The ratio of focal lengths of lenses L_1 and L_3 is



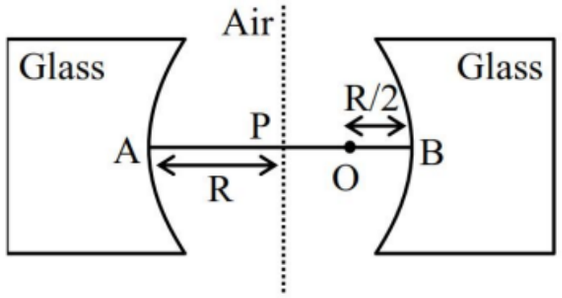
(A) $1:4$ (B) $1:1$ (C) $2:1$ (D) $1:2$

33. A plane electromagnetic wave propagates along the $+x$ direction in free space. The components of the electric field, $\vec{E}$ and magnetic field, $\vec{B}$ vectors associated

with the wave in Cartesian frame are :

(A) E_y, B_x (B) E_y, B_z (C) E_x, B_y (D) E_z, B_y

34.



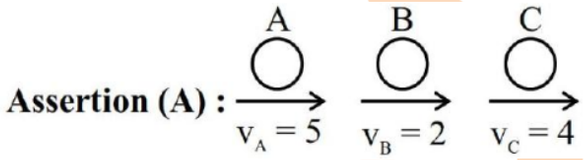
Two concave refracting surfaces of equal radii of curvature and refractive index 1.5 face each other in air as shown in figure. A point object O is placed midway, between P and B. The separation between the images of O , formed by each refracting surface is :

(A) 0.214 R (B) 0.114 R (C) 0.411 R (D) 0.124 R

35. Two bodies A and B of equal mass are suspended from two massless springs of spring constant k_1 and k_2, respectively. If the bodies oscillate vertically such that their amplitudes are equal, the ratio of the maximum velocity of A to the maximum velocity of B is

(A) $\sqrt{\frac{k_1}{k_2}}$ (B) $\frac{k_1}{k_2}$ (C) $\frac{k_2}{k_1}$ (D) $\sqrt{\frac{k_2}{k_1}}$

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



Three identical spheres of same mass undergo one dimensional motion as shown in figure with initial velocities $v_A = 5m/s, v_B = 2m/s, v_C = 4m/s$ If we wait sufficiently long for elastic collision to happen, then $v_A = 4m/s, v_s = 2m/s, v_c = 5m/s$ will be the final velocities.

Reason (R) : In an elastic collision between identical masses, two objects exchange their velocities.

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

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

(B) (A) is true but (R) is false

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

(D) (A) is false but (R) is true

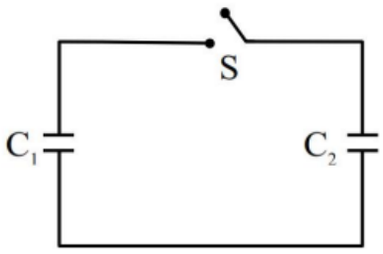
37. A sand dropper drops sand of mass $m(t)$ on a conveyer belt at a rate proportional to the square root of speed (v) of the belt, i.e. $\frac{dm}{dt} \propto \sqrt{v}$. If P is the power delivered to run the belt at constant speed then which of the following relationship is true?

(A) $P^2 \propto v^3$ (B) $P \propto \sqrt{v}$ (C) $P \propto V$ (D) $P^2 \propto v^s$

38. A convex lens mode of glass (refractive index $=$ 1.5) has focal length 24 cm in air. When it is totally immersed in water (refractive index $=1.33$), its focal length changes to

(A) 72 cm (B) 96 cm (C) 24 cm (D) 48 cm

39. A capacitor, $C_1 = 6F$ is charged to a potential difference of $V_0 = 5V$ using a 5 V battery. The battery is removed and another capacitor, $C_2 = 12\ \mu F$ is inserted in place of the battery. When the switch ' S ' is closed, the charge flows between the capacitors for some time until equilibrium condition is reached. What are the charges (q_1 and q_2) on the capacitors C_1 and C_2 when equilibrium condition is reached.



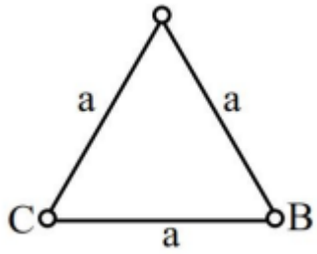
(A) $q_1 = 15\mu C, q_2 = 30\mu C$

(B) $q_1 = 30\mu C, q_2 = 15\mu C$

(C) $q_1 = 10\mu C, q_2 = 20\mu C$

(D) $q_1 = 20\mu C, q_2 = 10\mu C$

40. **Sol.**



Three equal masses m are kept at vertices (A, B, C) of an equilateral triangle of side a in free space. At $t = 0$, they are given an initial velocity $\vec{V}_A = V_0\overrightarrow{AC}$, $\vec{V}_B = V_0\overrightarrow{BA}$ and $\vec{V}_C = V_0\overrightarrow{CB}$.

Here, $\overrightarrow{AC}, \overrightarrow{CB}$ and $\overrightarrow{BA}$ are unit vectors along the edges of the triangle. If the

three masses interact gravitationally, then the magnitude of the net angular momentum of the system at the point of collision is :

(A) $\frac{1}{2}amV_0$ (B) $3amV_0$ (C) $\frac{\sqrt{3}}{2}amV_0$ (D) $\frac{3}{2}amV_0$

41. Match List-I with List-II

	List-I		List-II
(A)	Young's Modulus	(I)	$ML^{-1}T^{-1}$
(B)	Torque	(II)	$ML^{-1}T^{-2}$
(C)	Coefficient of Viscosity	(III)	$M^{-1}L^{3}T^{-2}$
(D)	Gravitational Constant	(IV)	$ML^{2}T^{-2}$

Choose the correct answer from the options given below :

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

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

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

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

42. Match List-I with List-II

	List-I		List-II
(A)	Magnetic induction	(I)	Ampere meter
(B)	Magnetic intensity	(II)	Weber
(C)	Magnetic flux	(III)	Gauss
(D)	Magnetic moment	(IV)	Ampere meter

Choose the correct answer from the options given below :

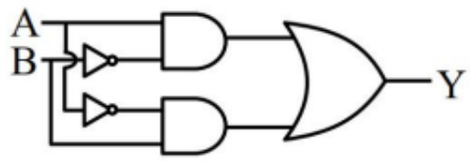
(A) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

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

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

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

43. The truth table for the circuit given below is :



(A)

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

(B)

A	B	C
0	0	0
1	0	0
1	1	0
0	1	1

(C)

A	B	C
0	0	0
1	0	1
0	1	0
1	1	0

(D)

A	B	C
0	0	0
1	1	1
1	0	1
0	1	1

44. A cup of coffee cools from $90^{\circ}C$ to $80^{\circ}C$ in t minutes when the room temperature is $20^{\circ}C$. The time taken by the similar cup of coffee to cool from $80^{\circ}C$ to $60^{\circ}C$ at the same room temperature is :

(A) $\frac{13}{5}t$ (B) $\frac{10}{13}t$ (C) $\frac{13}{10}t$ (D) $\frac{5}{13}t$

45. The number of spectral lines emitted by atomic hydrogen that is in the 4^{t} energy level, is

(A) 6 (B) 0 (C) 3 (D) 1

*** SECTION - B** **[20]**

46. The magnetic field inside a 200 turns solenoid of radius 10 cm is $2.9 \times 10^{-4} Tesla$. If the solenoid carries a current of 0.29 A , then the length of the solenoid is _____ πcm.

47. A parallel plate capacitor consisting of two circular plates of radius 10 cm is being charged by a constant current of 0.15 A . If the rate of change of potential difference between the plates is $7 \times 10^{8}\ V/s$ then the integer value of the distance between the parallel plates is -

(Take, $\epsilon_0 = 9 \times 10^{-12} \frac{F}{m}, \pi = \frac{22}{7}$) _____ μm.

48. A physical quantity Q is related to four observables a, b, c, d as follows : $Q = \frac{ab^4}{cd}$ where, $a = (60 \pm 3)Pa; b = (20 \pm 0.1)m$; $c = (40 \pm 0.2)Nsm^{-2}$ and $d = (50 \pm 0.1)m$, then the percentage error in Q is $\frac{x}{1000}$, where $x =$ _____ (77)

49. Two planets, A and B are orbiting a common star in circular orbits of radii R_A and R_B, respectively, with $R_B = 2R_A$. The planet B is $4\sqrt{2}$ times more massive than planet A. The ratio $\left(\frac{L_B}{L_A}\right)$ of angular momentum (L_B) of planet B to that of planet $A\,(L_A)$ is closest to integer _____

50. Two cars P and Q are moving on a road in the same direction. Acceleration of car P increases linearly with time whereas car Q moves with a constant acceleration. Both cars cross each other at time $t = 0$, for the first time. The maximum possible number of crossing(s) (including the crossing at $t = 0$) is _____

Chemistry

*** SECTION - A** **[80]**

51. The calculated spin-only magnetic moments of $K_3[Fe(OH)_6]$ and $K_4[Fe(OH)_6]$ respectively are :

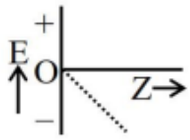
(A) 4.90 and 4.90 B.M.

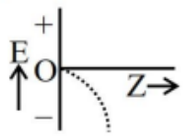
(B) 5.92 and 4.90 B.M.

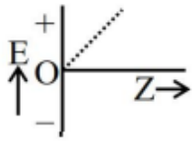
(C) 3.87 and 4.90 B.M.

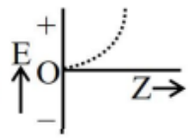
(D) 4.90 and 5.92 B.M.

52. For hydrogen like species, which of the following graphs provides the most appropriate representation of E vs Z plot for a constant n ?
[E : : Energy of the stationary state,
Z : atomic number, $n =$ principal quantum number]

(A) 

(B) 

(C) 

(D) 

53. Given below are two statements :Statement (I) : In partition chromatography, stationary phase is thin film of liquid present in the inert support.
Statement (II) : In paper chromatography, the material of paper acts as a stationary phase.
In the light of the above statements, choose the correct answer from the options given below :

(A) Both Statement I and Statement II are false

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

(C) Both Statement I and Statement II are true

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

54. Identify the essential amino acids from below :
(A) Valine
(B) Proline
(C) Lysine
(D) Threonine
(E) TyrosineChoose the correct answer from the options given below :

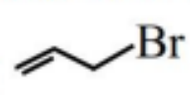
(A) (A), (C) and (D) only

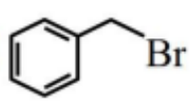
(B) (A), (C) and (E) only

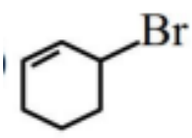
(C) (B),(C) and (E) only

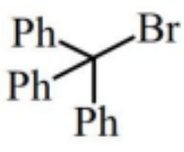
(D) (C),(D) and (E) only

55. Which among the following halides will generate the most stable carbocation in Nucleophillic substitution reaction?

(A) 

(B) 

(C) 

(D) 

56. Consider the equilibrium

$CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

If the pressure applied over the system increases by two fold at constant temperature then

(A) Concentration of reactants and products increases.

(B) Equilibrium will shift in forward direction.

(C) Equilibrium constant increases since concentration of products increases.

(D) Equilibrium constant remains unchanged as concentration of reactants and products remain same.

Choose the correct answer from the options given below :

(A) (A) and (B) only

(B) (A), (B) and (D) only

(C) (B) and (C) only

(D) (A), (B) and (C) only

57. Given below are two statements :

Statement (I) : NaCl is added to the ice at $0^\circ C$, present in the ice cream box to prevent the melting of ice cream.

Statement (II) : On addition of NaCl to ice at $0^\circ C$, there is a depression in freezing point.

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

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

(B) Both Statement I and Statement II are true

(C) Both Statement I and Statement II are false

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

58. Given below are two statements :

Statement (I) : On nitration of m-xylene with HNO_3, H_2SO_4 followed by oxidation, 4-nitrobenzene-1, 3-dicarboxylic acid is obtained as the major product.

Statement (II) : CH_3 group is o/p-directing while NO_2 group is m-directing group.

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

(A) Both Statement I and Statement II are false

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

(C) Both Statement I and Statement II are true

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

59. 0.1 M solution of KI reacts with excess of H_2SO_4 and KIO_3 solution. According to equation

$5I^- + IO_3^- + 6H^+ \rightarrow 3I_2 + 3H_2O$

Identify the correct statements :

(A) 200 mL of KI solution reacts with 0.004 mol of KIO_3

(B) 200 mL of KI solution reacts with 0.006 mol of H_2SO_4

(3) 0.5 L of KI solution produced 0.005 mol of I_2

(4) Equivalent weight of KIO_3 is equal to $\left(\frac{\text{Molecular weight}}{5}\right)$

Choose the correct answer from the options given below:

(A) (A) and (D) only (B) (B) and (C) only (C) (A) and (B) only (D) (C) and (D) only

60. Match List-I with List-II:

	List-1 Applications		**List-II Batteries/Cell**
(A)	Transistors	(I)	Anode - Zn/Hg; Cathode - HgO+C
(B)	Hearing aids	(II)	Hydrogen fuel cell
(C)	Invertors	(III)	Anode-Zn;Cathode Carbon
(D)	Apollo space ship	(IV)	Anode-Pb;Cathode Pb | PbO_2

Choose the correct answer from the options given below:

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

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

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

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

61. O_2 gas will be evolved as a product of electrolysis of :

(A) an aqueous solution of $AgNO_3$ using silver electrodes.

(B) an aqueous solution of $AgNO_3$ using platinum electrodes.

(C) a dilute solution of H_2SO_4 using platinum electrodes.

(D) a high concentration solution of H_2SO_4 using platinum electrodes.

Choose the correct answer from the options given below :

(A) (B) and (C) only (B) (A) and (D) only (C) (B) and (D) only (D) (A) and (C) only

62. Identify the homoleptic complexes with odd number of d electrons in the central metal.

(A) $[FeO_4]^{2-}$

(B) $[Fe(CN)_6]^{3-}$

(C) $[Fe(CN)_5NO]^{2-}$

(D) $[CoCl_4]^{2-}$

(E) $[Co(H_2O)_3F_3]$

Choose the correct answer from the options given below :

(A) (B) and (D) only (B) (C) and (E) only

(C) (A), (B) and (D) only (D) (A), (C) and (E) only

63. Total number of sigma (σ) _____ and $pi(\pi)$ _____ bonds respectively present in hex-1-en-4-yne are :

(A) 13 and 3 (B) 11 and 3 (C) 3 and 13 (D) 14 and 3

64. If C (diamond $)\rightarrow C$ (graphite $)+XkJmol^{-1}$

$$C(\text{ diamond }) + O_2(g) \rightarrow CO_2(g) + YkJmol^{-1}$$
$$C(\text{ graphite }) + O_2(g) \rightarrow CO_2(g) + ZkJmol^{-1}$$

At constant temperature. Then

(A) $X = Y + Z$ (B) $-X = Y + Z$ (C) $X = -Y + Z$ (D) $X = Y - Z$

65. Given below are two statements :

Statement (I): It is impossible to specify simultaneously with arbitrary precision, both the linear momentum and the position of a particle.

Statement (II) : If the uncertainty in the measurement of position and uncertainty in measurement of momentum are equal for an electron, then the uncertainty in the measurement of velocity is $\geq \sqrt{\frac{h}{\pi}} \times \frac{1}{2m}$.

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

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

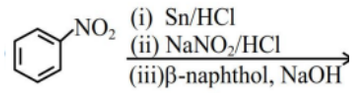
(B) Both Statement I and Statement II are true.

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

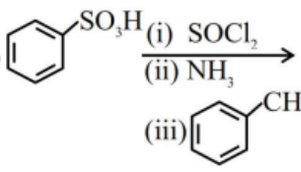
(D) Both Statement I and Statement II are false.

66. Which one of the following reaction sequences will give an azo dye ?

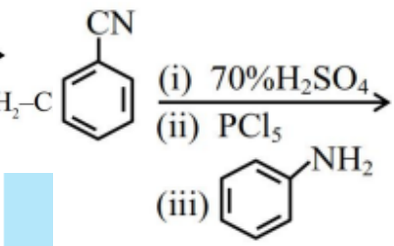
(A)



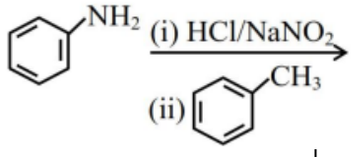
(B)



(C)



(D)



67. Drug X becomes ineffective after 50% decomposition. The original concentration of drug in a bottle was $16mg/mL$ which becomes 4 mg/mL in 12 months. The expiry time of the drug in months is _____.

Assume that the decomposition of the drug follows first order kinetics.

(A) 12 (B) 2 (C) 3 (D) 6

68. The type of oxide formed by the element among Li, Na, Be, Mg, B and Al that has the least atomic radius is :

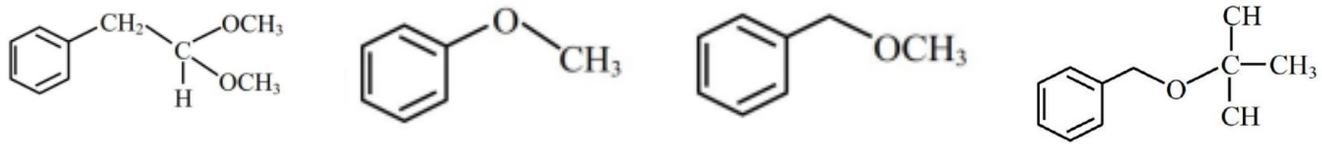
(A) A_2O_3 (B) AO_2 (C) AO (D) A_2O

69. First ionisation enthalpy values of first four group 15 elements are given below. Choose the correct value for the element that is a main component of apatite family :

(A) $1012kJmol^{-1}$ (B) $1402kJmol^{-1}$ (C) $834kJmol^{-1}$ (D) $947kJmol^{-1}$

70. Which one of the following, with HBr will give a phenol?

(A) (B) (C) (D)



*** SECTION - B** **[20]**

71. Consider the following low-spin complexes
$K_3[Co(NO_2)_6], K4[Fe(CN)_6], K_3[Fe(CN)_6]$
$Cu_2[Fe(CN)_6]$ and $Zn2[Fe(CN)_6]$.
The sum of the spin-only magnetic moment values of complexes having yellow colour is _____
B.M. (answer is nearest integer)

72. Isomeric hydrocarbons $\rightarrow$ negative Baeyer's test (Molecular formula C_9H_{12})
The total number of isomers from above with four different non-aliphatic substitution sites is -

73. In the Claisen-Schmidt reaction to prepare, dibenzalacetone from 5.3 g benzaldehyde, a total of 3.51 g of product was obtained. The percentage yield in this reaction was _____ \%.

74. In the sulphur estimation, 0.20 g of a pure organic compound gave 0.40 g of barium sulphate. The percentage of sulphur in the compound is _____ $\times 10^{-1}\%$.
(Molar mass : $O = 16, S = 32, Ba = 137$ in $gmol^{-1}$)

75. Total number of non bonded electrons present in NO_2^- ion based on Lewis theory is _____ .

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