

Seat No. : _____

AG-129

April-2025

M.Sc., Sem.-IV

CHE(A)-510 : Chemistry (Professional Chemistry Test)

Time : 2:30 Hours]

[Max. Marks : 70

- Instructions :** (1) **Part – A** (Q : 1 to 15) maximum 10 out of 15 questions.
(2) **Part – B** (Q : 16 to 35) maximum 13 out of 20 questions.
(3) **Part – C** (Q : 36 to 51) maximum 6 out of 16 questions.

If more than the specified number of questions are answered then the first 10, 13 and 6 respectively will be considered for assessment.

Part – A

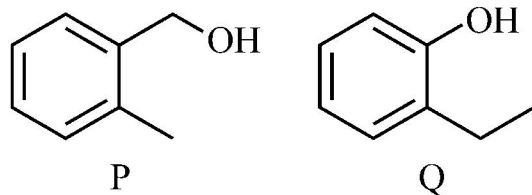
- Four identical cones with base diameter of 10 cm are compactly placed inside a box in upright position. What will be the area of square (in cm^2) formed by connecting tips of the cones ?
(A) 25 (B) 100
(C) 144 (D) 400
- The sides a, b and c of a ΔABC satisfy the equation
 $(a - 8)^2 + (b - 15)^2 + (c - 17)^2 = 0$.
Then ΔABC is
(A) Equilateral (B) Obtuse Angled Triangle
(C) Isosceles (D) Right-angled
- Three apartments, which are in a row, are occupied by Umar, Ramesh and John. Only one of them is the landlord, whose apartment is at one end. Ramesh's apartment is not next to John's apartment. The apartment on the left is not the landlord's, the one in the middle is not Ramesh's and the one on the right is not John's. Who is the landlord ?
(A) John
(B) Umar
(C) Ramesh
(D) All the above information is insufficient to identify the landlord.

4. What will be the difference in mass (in g) between two packets each containing 500 sheets of 80 GSM and 70 GSM papers of size 20 cm × 30 cm ? (GSM = g/m²)
- (A) 3000 (B) 300
(C) 2000 (D) 200
5. Suppose there are 6 non-stop flights from Chennai to Mumbai in the morning and 4 non-stop flights from Mumbai to Goa in the evening. In how many ways can one fly from Chennai to Goa via Mumbai using these flights in a day ?
- (A) 24 (B) 10
(C) 4⁶ (D) 6⁴
6. A worker is asked to arrange 1000 identical square tiles into a rectangular pattern and paint only the tiles forming the border. What should be the dimension of the rectangular pattern he arranges, in order to use the minimum amount of paint ?
- (A) 8 tiles × 125 tiles (B) 50 tiles × 20 tiles
(C) 40 tiles × 25 tiles (D) 200 tiles × 5 tiles
7. A substance decays at a rate proportional to the amount of the substance itself. If half of the substance decays in one year, then what is the proportionality constant ?
- (A) $\log_{10}2$ (B) \log_e2
(C) $(\log_e2)/2$ (D) $(\log_{10}2)/2$
8. In a hall, the fraction of people seated is 9/13 and the fraction of chairs occupied is 7/9. If the number of empty chairs is 36, how many more chairs are needed to seat everyone in the hall ?
- (A) 6 (B) 20
(C) 26 (D) 32
9. A tropical location B is 20 km N15° E of A. Another location C is N45° W of A and S75° W of B. How far (in km) is C from A ? (N15° E denotes a direction 15° East of North.)
- (A) $10\sqrt{3}$ (B) $20\sqrt{2}$
(C) 20 (D) 10

10. Which of the options will make the following sentence a TRUE statement ?
THE LETTER "S" OF THE ENGLISH ALPHABET OCCURS IN THIS SENTENCE
TIMES.
- (A) EIGHT (B) FIVE
(C) SIX (D) SEVEN
11. Percentage marks scored by a student in six different papers are in the ratio
9 : 10 : 11 : 13 : 14 : 15. If the average percentage marks is 60 then in how many papers
did the student score more than 60% ?
- (A) 2 (B) 1
(C) 3 (D) 4
12. Dividing sixty by half and adding half of forty yields
- (A) 50 (B) 70
(C) 100 (D) 140
13. Two varieties of sugar A and B, costing ₹ 40 per kg and ₹ 50 per kg, respectively were
mixed before selling. The mixture containing 500 kg of A, was sold with a gain of 10%
for ₹ 88,000. How many kilograms of B did the sold mixture contain ?
- (A) 1200 (B) 1300
(C) 1400 (D) 1500
14. The product $1 \times 2 \times 3 \times 4 \times \dots \times 51$ ends with
- (A) 10 zeros (B) 11 zeros
(C) 12 zeros (D) 14 zeros
15. Chairs in 3 colours are placed around a round table such that no two neighbouring
chairs have the same colour, and no two pairs of consecutive chairs (in the same
direction) have colours in the same order. The maximum number of chairs that can be
so placed is
- (A) 8 (B) 7
(C) 6 (D) 9

Part – B

16. The base peaks (m/z) in the EI mass spectra of compounds P and Q appear, respectively, at

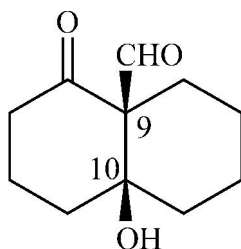


- (A) 91 and 107
(B) 104 and 107
(C) 107 and 104
(D) 107 and 93
17. Out of the following, the correct statements about carboxypeptidase-A are
- A. Zn^{+2} ion acts as a Lewis acid.
B. The substitution of Zn^{+2} ion by Co^{+2} ion renders the enzyme inactive.
C. Two histidine nitrogen atoms, glutamate oxygen atom(s) and a water molecule coordinate to a Zn^{+2} ion.
D. Three histidine nitrogen atoms and a water molecule coordinate to a Zn^{+2} ion.
- (A) A and C only
(B) A, C and D only
(C) B and D only
(D) A and B only
18. In the upper atmosphere, SF_6 undergoes photolysis to form species A. Species A combines with O_2 giving a radical B. The correct statement is
- (A) Unpaired electrons in A and B are located on sulfur and oxygen atoms, respectively.
(B) Unpaired electrons in A and B are on sulfur atom only.
(C) Species A is diamagnetic.
(D) The hybridization of central atoms in A and B are different.

19. In the solid state, methyl lithium is tetrameric and has a Li_4 core. The correct statement about the structure and bonding in methyl lithium is :

- (A) Each methyl anion is bridging between two Li-centres, via 3-center-2-electron bonding.
- (B) Each methyl anion binds to three Li-centres via 4-center-2-electron bonding.
- (C) It possesses a 2-center-2-electron bond.
- (D) Each methyl anion is terminally bound to each Li-centre.

20. The absolute configuration of the stereogenic centres present in the following present in the following molecule :



- (A) 9R, 10S
- (B) 9R, 10R
- (C) 9S, 10S
- (D) 9S, 10R

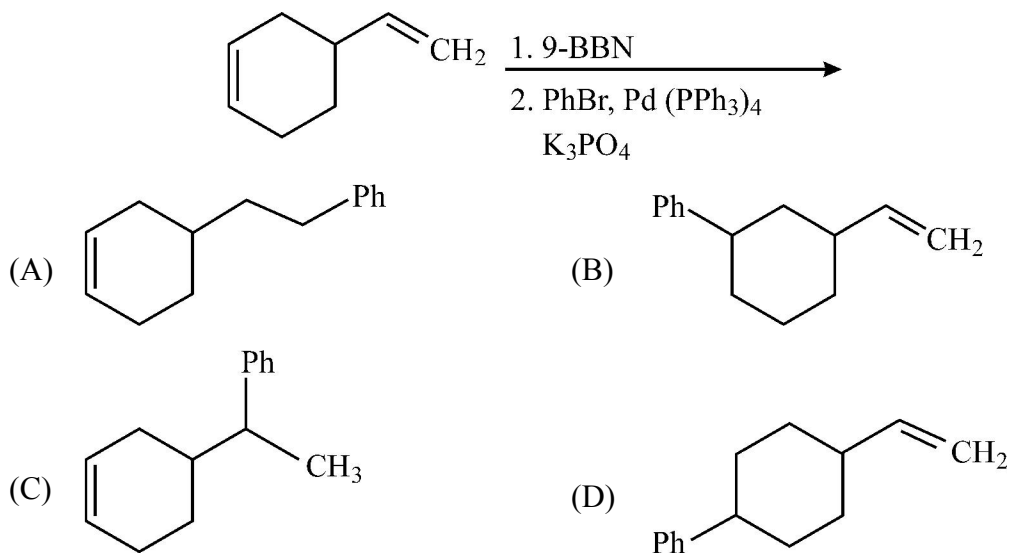
21. Consider the following molecules/ions :

- A. $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$
- B. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
- C. VCl_4

The John-Teller effect is expected for

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

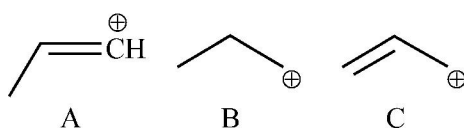
22. The major product formed in the following reaction is



23. An octahedral d^6 complex has a single spin-allowed absorption band. The spin-only magnetic moment (B.M) and then electronic transition for this complex, respectively, are

- (A) 0 and ${}^1T_{1g} \longrightarrow {}^1A_{1g}$ (B) 4.9 and ${}^5T_{2g} \longrightarrow {}^5E_g$
 (C) 4.9 and ${}^5E_g \longrightarrow {}^5T_{2g}$ (D) 0 and ${}^1T_{2g} \longrightarrow {}^1A_{1g}$

24. The correct order of stability of the carbocations A-C is



- (A) $C > A > B$ (B) $A > C > B$
 (C) $B > C > A$ (D) $C > B > A$

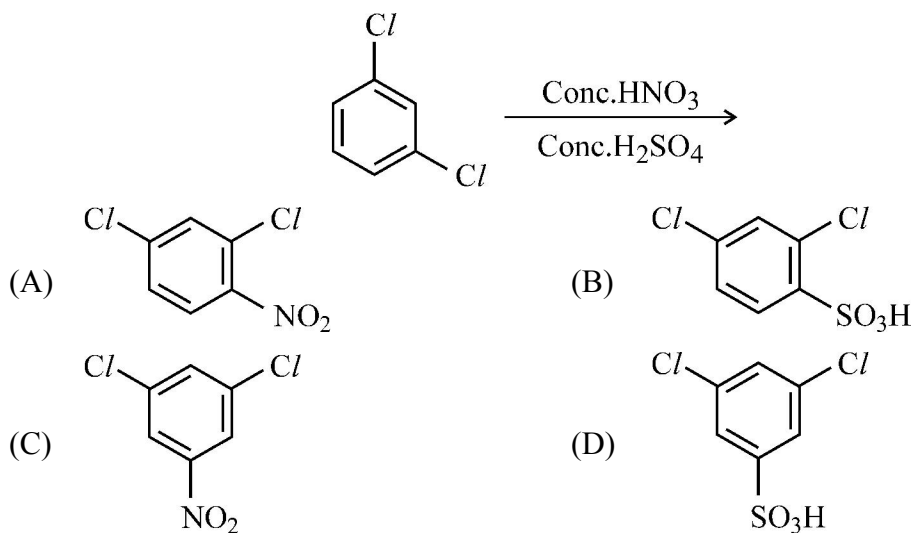
25. The ground state term and the calculated magnetic moment in (BM) for Dy^{3+} ion respectively, are

- (A) ${}^6H_{15/2}$ and 5.91 (B) ${}^6H_{15/2}$ and 10.65
 (C) ${}^6H_{5/2}$ and 6.23 (D) ${}^6H_{5/2}$ and 5.91

26. Among the following, the NMR inactive nucleus is
- (A) $^{24}\text{Mg}_{12}$ (B) $^{14}\text{N}_7$
(C) $^{31}\text{P}_{15}$ (D) $^{29}\text{Si}_{14}$
27. A compound shows $[\text{M}]^+$ at m/z 84 and has a base peak at 56. It exhibits only one signal in ^1H NMR at δ 35 ppm. The compound is
- (A) Cyclobutene-1, 3-dione (B) dichloromethane
(C) 1, 2, 3-trimethylcyclopropane (D) cyclohexane
28. The silver salt with the highest solubility product (K_{sp}) in water is
- (A) AgI (B) AgF
(C) AgBr (D) AgCl
29. For every atom that is not shifted under C_4 and σ symmetry operations, the character are respectively
- (A) -1, -1 (B) 0, 0
(C) 1, 1 (D) -1, 1
30. Transition state theory was developed to explain the empirical Arrhenius expression for rate constants. For a non-linear transition state with N atoms, the effective number of vibrational degree of freedom used in calculating its vibrational partition function
- (A) $3N-7$ (B) $3N-6$
(C) $3N-5$ (D) $3N-8$
31. If A_xB_y crystallizes in an FCC lattice, with atom A occupying every corner and atom B occupying the center of each face of the unit cell, the correct stoichiometry is
- (A) A_2B (B) AB_2
(C) AB_3 (D) A_3B

32. A sample of polystyrene is composed of three weight fractions : 0.20, 0.50 and 0.30. The molecular weight of these fractions are 10,000; 40,000 and 60,000; respectively. The weight average molecular weight of this sample is
- (A) 55000 (B) 40000
(C) 50000 (D) 60000
33. Six distinguishable particles are distributed over 3 non-degenerate levels of energies 0, ϵ and 2ϵ . The most probable value for the total energy is
- (A) 5ϵ (B) 7ϵ
(C) 8ϵ (D) 6ϵ
34. In the ccp packing, the number of lattice points per unit area in the planes is in the order
- (A) $(100) > (110) > (111)$
(B) $(100) > (111) > (110)$
(C) $(111) > (100) > (110)$
(D) $(111) > (110) > (100)$
35. Consider the following statements about the Oxo-process :
- A. The reaction is first order with respect to olefin.
B. The rate is faster for terminal olefins compared to internal olefins.
C. The rate is faster for internal olefins compared to terminal olefins.
D. Excess of CO inhibits the reaction.
- The correct statements are :
- (A) A, B and D only
(B) C and D only
(C) A and B only
(D) A and D only

40. The major product formed in the following reaction is



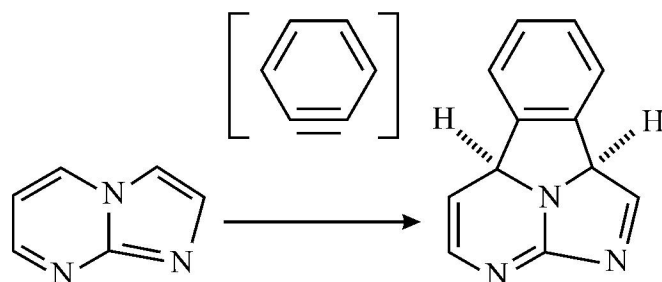
41. Consider the following statements regarding EPR spectra :

- A. For allowed transitions, $\Delta m_s = \pm 1$ and $\Delta m_l = 0$
- B. For allowed transitions, $\Delta m_s = 0$ and $\Delta m_l = \pm 1$
- C. Tetragonally elongated Cu(II) complexes have $g_{\parallel} > g_{\perp}$.
- D. The orbital considered as ground state for tetragonally compressed Cu(II), complexes, dx^2-y^2

The correct statements are

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

42. The following transformation :



- (A) $[3\pi + 2\pi]$ cycloaddition
- (B) $[6\pi + 2\pi]$ cycloaddition
- (C) $[8\pi + 2\pi]$ cycloaddition
- (D) $[8\pi + 4\pi]$ cycloaddition

43. The vibrational transition energies of a diatomic molecule corresponding to $v = 1 \leftarrow v = 0$ and $v = 2 \leftarrow v = 1$ are 2143.1 cm^{-1} and 21161.1 cm^{-1} , respectively. The anharmonic constant ($w_e x_e$) of the molecule in cm^{-1} is
- (A) 28 (B) 13.5
(C) 10 (D) 54
44. Given that pK_{a1} and pK_{a2} values for alanine are 2.34 and 7.68 respectively, its isoelectric point (PI) is
- (A) 6.01 (B) 12.02
(C) 7.34 (D) 4.14
45. The reasons for significantly high solubility of AgClO_4 in benzene than in alkane solvent is
- (A) Alkane solvents are non-polar.
(B) Benzene is an aprotic solvent.
(C) PhAg is formed.
(D) Benzene acts as a soft base.
46. The pair of complexes/ions that does not obey the 18-electron rule, is
- (A) $[\text{V}(\text{CO})_6]$ and $[\text{Ti}(\text{Cp})_2\text{Cl}_2]$
(B) $[\text{Mn}(\text{Br})(\text{CO})_5]$ and $[\text{Mn}(\text{CO})_5]^-$
(C) $[\text{Co}(\text{CO})_3\text{PPh}_3]$ and $[\text{Co}_4(\text{CO})_{12}]^-$
(D) $[\text{Fe}(\text{CO})_5]$ and $[\text{Fe}_2(\text{CO})_9]$
47. For a reaction, raising the temperature from 200 K to 300 K results in the increase of rate constant by a factor of 2. The activation energy for this reaction in kJ mol^{-1} is closest to ($\ln 2 = 0.69$)
- (A) 7.0 (B) 3.5
(C) 14.0 (D) 0.83

48. The EI (electron-impact) mass spectrum of $\text{CH}_3(\text{CH}_2)_2\text{CN}$ will show a base peak at m/z value of
- (A) 54 (B) 26
(C) 41 (D) 70
49. The correct order of second ionization enthalpies, is
- (A) $\text{B} > \text{C} > \text{N} > \text{Be}$ (B) $\text{N} > \text{C} > \text{Be} > \text{B}$
(C) $\text{B} > \text{N} > \text{C} > \text{Be}$ (D) $\text{N} > \text{B} > \text{C} > \text{Be}$
50. X, Y and Z are three p-block elements in the second row of the periodic table, with electron affinities (in kJ/mol) of -15 , -142 and -333 , respectively. The correct statement among the following, is
- (A) Y has the highest first ionization energy.
(B) X has the greatest number of p-electrons.
(C) X has the highest proton affinity.
(D) Z has the highest electronegativity.
51. The excess molar entropy of mixing of liquid A with liquid B is $-R \ln 2$. The experimentally observed change in entropy upon mixing 1.0 mol of liquid A with 1.0 mol of liquid B is
- (A) $-2R \ln 2$ (B) $+4R \ln 2$
(C) 0 (D) $+R \ln 2$
-