

4-10

Invigilators Signature

ENTRANCE EXAMINATION – 2012
M. Sc. Chemistry

TIME: 2 HOURS

MAXIMUM MARKS: 100

HALL TICKET NUMBER:

INSTRUCTIONS

1. Write your **HALL TICKET NUMBER** in the space provided above and also in the **OMR ANSWER SHEET** given to you.
2. Make sure that pages numbered from 1 – 21 are present (excluding pages assigned for rough work).
3. There are 100 questions in this paper. All questions carry equal marks.
4. **There is negative marking. Each wrong answer carries -0.33 mark.**
5. Answers are to be marked on the OMR answer sheet following the instructions provided there upon.
6. Hand over both the question paper booklet and OMR answer sheet at the end of the examination.
7. In case of a tie, the marks obtained in the first 25 questions (**PART A**) will be used to determine the order of merit.
8. No additional sheets will be provided. Rough work can be done in the space provided at the end of the booklet.
9. Calculators are allowed.
10. Useful constants are provided on top of **PART A** in the question paper.

Useful Constants:

Rydberg constant = 109737 cm^{-1} ; Faraday constant = 96500 C ; Planck constant = $6.625 \times 10^{-34} \text{ J s}$;
Speed of light = $2.998 \times 10^8 \text{ m s}^{-1}$; Boltzmann constant = $1.380 \times 10^{-23} \text{ J K}^{-1}$; Gas constant = $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$;
Mass of electron = $9.109 \times 10^{-31} \text{ kg}$; Mass of proton = $1.672 \times 10^{-27} \text{ kg}$; Charge of electron = $1.6 \times 10^{-19} \text{ C}$;
 $1 \text{ D} = 3.336 \times 10^{-30} \text{ Cm}$; $1 \text{ bar} = 10^5 \text{ Nm}^{-2}$; $RT/F = 0.059 \text{ V}$.

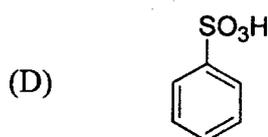
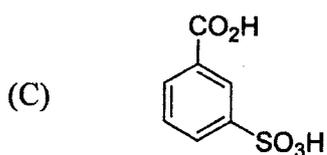
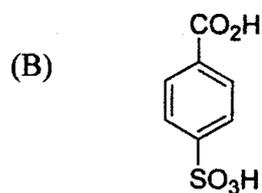
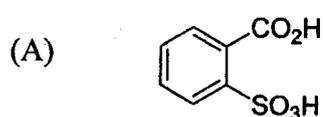
PART – A

- Cell membranes are made up of
 - proteins and carbohydrates
 - proteins and nucleic acids
 - lipids and proteins
 - lipids and nucleic acids
- The radiation with the highest energy among the following is
 - X-rays
 - microwave
 - ultraviolet
 - gamma rays
- Which of the following compounds is used in tear gas?
 - Benzene hexachloride
 - DDT
 - Chloropicrine
 - Chloretone
- Which among the following is not a colloid?
 - Blood
 - Latex
 - Ghee
 - Butter
- An octahedron has
 - 8 faces, 12 edges and 6 vertices
 - 6 faces, 8 edges and 12 vertices
 - 6 faces, 8 edges and 12 vertices
 - 8 faces, 12 edges and 8 vertices

6. The number of common points on the two curves $x^2 + 4y^2 = 5$ and $4x^2 + y^2 = 5$ are

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

7. Saccharin is an imide of



8. Which of the following polymer is used to make bullet proof fiber?

- (A) PMMA (B) Lexan (C) Nomex (D) Kevlar

9. When one adds dilute AgNO_3 solution to another solution containing equal concentration of Cl^- , Br^- , and I^- , which is precipitated most?

- (A) AgCl (B) AgBr (C) AgI (D) All together

10. The enzyme nitrogenase is associated with

- (A) manganese (B) magnesium
(C) molybdenum (D) mercury

11. For the hydrogen atom, which electronic transition would result in the emission of a photon with the highest energy?

- (A) $4p \rightarrow 2s$ (B) $3p \rightarrow 6d$
(C) $5f \rightarrow 3d$ (D) $2s \rightarrow 3p$

12. Which of the following compounds, present in urine, is detected by Benedict's method?
- (A) Urea (B) Steroid
(C) Glucose (D) Amino acids
13. The angle of intersection (in radian) of the curves $2x^2 + y^2 = 20$ and $4y^2 - x^2 = 8$ is
- (A) 0 (B) $\pi/4$ (C) $\pi/2$ (D) π
14. The diagonally adjacent element to beryllium, that exhibits properties similar to beryllium is
- (A) Magnesium (B) Boron
(C) Aluminum (D) Lithium
15. When a coin is tossed 5 times, the probability of getting 3 heads and 2 tails in any order is
- (A) $5/16$ (B) $7/16$
(C) $1/2$ (D) $9/16$
16. The radiation responsible for heating in the "Green House Effect" is
- (A) Ultraviolet rays (B) Infrared rays
(C) Cosmic rays (D) Visible light
17. Which one of the following compounds will have the highest boiling point?
- (A) *n*-Butane (B) *n*-Butyraldehyde
(C) 2-Butanone (D) *n*-Butanol

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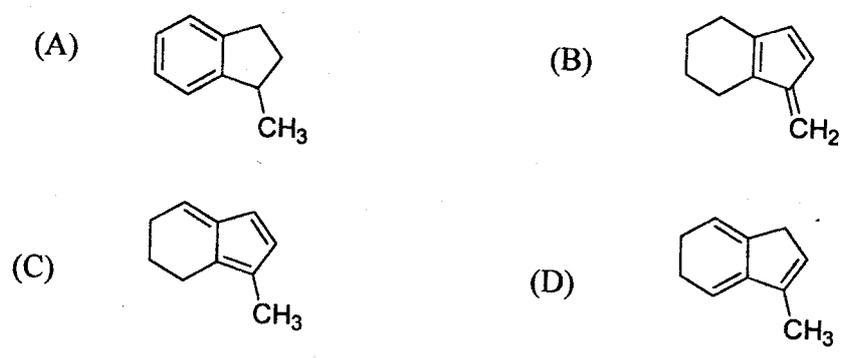
18. $\sin^4 \theta - \cos^4 \theta =$

- (A) $\sin 2\theta$ (B) $\cos 2\theta$ (C) $-\cos 2\theta$ (D) $\sin 2\theta + \cos 2\theta$

19. Arrhenius equation is given by:

- (A) $\ln k = \ln A + E_a/RT$ (B) $\ln k = \ln A - E_a/RT$
(C) $k = A \cdot E_a/RT$ (D) $k = A \cdot e^{E_a/RT}$

20. The most acidic isomer hydrocarbon among the following is



21. Which atom among the following has the highest number of unpaired electrons in its ground state?

- (A) C (B) N (C) O (D) F

22. The density of elemental silver having fcc lattice with unit cell length of 4.086 Å is (atomic weight of Ag = 108):

- (A) 1.05 g/cc (B) 10.5 g/cc
(C) 5.01 g/cc (D) 15.0 g/cc

23. For a particular orbital, as one goes away from the nucleus along the z-axis, the probability density decreases to zero, then increases, and finally decreases without increasing a second time. This is consistent with a

- (A) $3p_x$ orbital. (B) $2s$ orbital.
(C) $2p_z$ orbital. (D) $3s$ orbital.

24. Consider a crystal with a simple cubic lattice. If on heating, the unit cell volume increases by 5% isotropically (equally in all directions), the percentage increase in the (110) interplanar distance is:

- (A) 1.64 (B) 1.67
(C) 2.50 (D) 5.00

25. The carrier of genetic information in organisms is

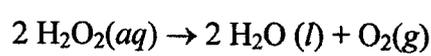
- (A) proteins (B) RNA
(C) nucleic acids (D) DNA

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PART - B

26. Among the following, the most unstable molecule is
 (A) Li_2 (B) Be_2 (C) B_2 (D) C_2

27. Hydrogen peroxide decomposes to water and oxygen according to the reaction below:

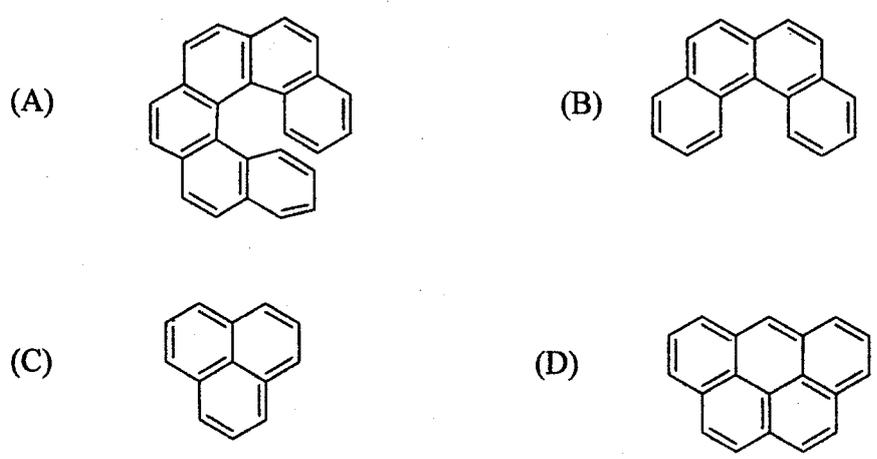


In the presence of large excess of I^- ion, the following set of data is obtained. What is the average rate of disappearance of $\text{H}_2\text{O}_2(aq)$ in M/s in the first 15.0 seconds of the reaction if 1.00L of H_2O_2 reacts at 25°C and 1 atm pressure?

Time, s	$\text{O}_2(g)$ collected, ml
0.0	0.0
45.0	2.00
90.0	4.00
135.0	6.00

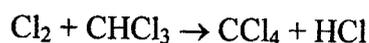
- (A) $9.09 \times 10^{-7} \text{M/s}$ (B) $1.64 \times 10^{-4} \text{M/s}$
 (C) $4.33 \times 10^{-5} \text{M/s}$ (D) $3.63 \times 10^{-6} \text{M/s}$

28. A chiral molecule among the following is



29. If the H - N - H angle in NH_3 is 107° , the angle between the direction of the lone pair of electron (pyramidal axis) and the N - H bond is
- (A) 107.0° (B) 109.3° (C) 110.0° (D) 111.8°
30. Identify the unicellular organism(s) among the following (i) earth worm (ii) bacteria (iii) hydra (iv) yeast:
- (A) i, iii (B) ii (C) ii, iii (D) ii, iv
31. Correct order of basicity is
- (A) $\text{NH}_3 < \text{NMe}_3 < \text{NF}_3$ (B) $\text{NF}_3 < \text{NMe}_3 < \text{NH}_3$
 (C) $\text{NH}_3 < \text{NF}_3 < \text{NMe}_3$ (D) $\text{NF}_3 < \text{NH}_3 < \text{NMe}_3$

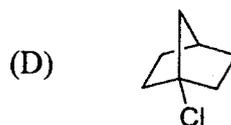
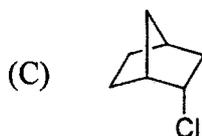
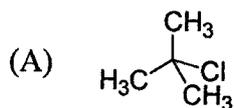
32. Chlorine reacts with chloroform according to the reaction given below:



When the initial concentration of Cl_2 is doubled the reaction rate increases by factor of 1.41.

What is the order of reaction with respect to Cl_2 ?

- (A) $-1/2$ (B) 2 (C) $1/2$ (D) -1
33. Which of the following compounds will not react through $\text{S}_{\text{N}}1$ mechanism?



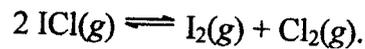
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34. If the function $f(\theta) = Ae^{i\theta}$ where A is a constant, $f'(\theta) = \frac{df(\theta)}{d\theta}$ and $f''(\theta) = \frac{d^2f(\theta)}{d\theta^2}$, then
- (A) $f(\theta) + f''(\theta) = 0$ (B) $f(\theta) + f'(\theta) = 0$
(B) $f'(\theta) - f''(\theta) = 0$ (D) $f(\theta) - f''(\theta) = 0$
35. Viruses are made up of: (i) proteins only (ii) protein and DNA (iii) protein and RNA (iv) DNA and RNA
- (A) i, ii (B) ii,iii (C) iii, iv (D) ii, iv
36. 10 ml of 0.10 M sodium carbonate is added to 20 ml 0.10 M sulphuric acid and the resultant solution is titrated against 0.10 M sodium hydroxide. What will be the titre value at the end point?
- (A) 5 ml (B) 10 ml (C) 20 ml (D) 30 ml
37. If K_c equals to 0.11 at 25 °C for the reaction: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, what is K_c for the reaction: $NO_2(g) \rightleftharpoons \frac{1}{2} N_2O_4(g)$?
- (A) 4.5 (B) 0.33 (C) 3.0 (D) 9.1
38. The vinyl chloride does not react with NaOH through S_N2 mechanism because
- (A) hydroxide is too weak as a nucleophile.
(B) the sp^2 C-Cl bond is stronger than a sp^3 C-Cl bond.
(C) the hydrogen atom trans to the chlorine atom sterically inhibits the substitution reaction.
(D) chlorine atom is not a good leaving group.

39. In the DNA double helix, the base complementarity is governed by
- (A) electrostatic forces (B) hydrophobic interaction
(C) hydrogen bonding (D) van der Waals' forces
40. The reagent that can be used to precipitate Ba^{2+} from an aqueous solution is

- (A) hydrochloric acid (B) sulfuric acid
(C) silver nitrate (D) ammonium chloride

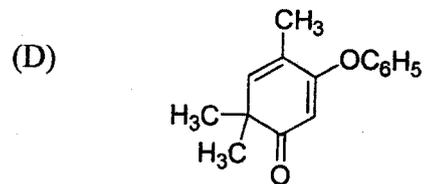
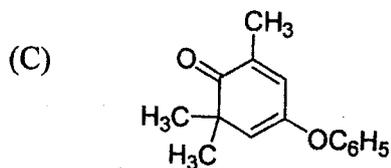
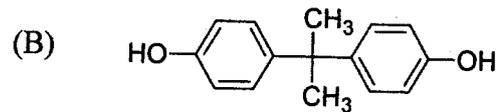
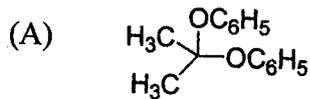
41. At a certain temperature, the equilibrium constant, K_c equals 0.11 for the reaction:



What is the equilibrium concentration of ICl if 0.75 mol of I_2 and 0.75 mol of Cl_2 are initially mixed in a 2.0 L flask?

- (A) 0.28 mol/L (B) 0.22 mol/L (C) 0.45 mol/L (D) 0.56 mol/L

42. Identify the product with molecular formula, $\text{C}_{15}\text{H}_{16}\text{O}_2$ formed when phenol reacts with acetone in the presence of conc. H_2SO_4 .



43. Consider the following vectors:

$\vec{X} = 2\hat{i} + 3\hat{j} + 4\hat{k}$; $\vec{Y} = -2\hat{i} + 2\hat{j} + 2\hat{k}$; $\vec{Z} = 2\hat{i} - 4\hat{j} + 2\hat{k}$. Which of the following vectors are orthogonal?

- (A) \vec{X} and \vec{Y} (B) \vec{X} and \vec{Z} (C) \vec{Y} and \vec{Z} (D) $(\vec{X} + \vec{Y})$ and \vec{Z}

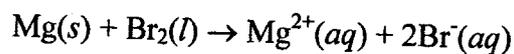
44. Equation to the tangent to the curve $y = x^3 - 2x^2 + 4$ at (2, 4) is

- (A) $x = 4y - 4$ (B) $y = 4x - 4$
 (C) $x + y = 4$ (D) $4y = 4x - 4$

45. Which compound among the following can act as Lewis acid as well as a Lewis base?

- (A) H_2O (B) $SnCl_2$ (C) NH_3 (D) BF_3

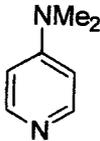
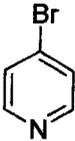
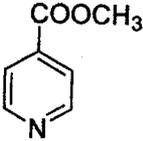
46. What is the standard cell potential for the reaction below?



The standard reduction potential is -2.37 V for the Mg^{2+}/Mg half-cell and +1.09V for the Br_2/Br^- half-cell.

- (A) +1.28V (B) -1.28V (C) +3.46V (D) -3.46V

47. Identify the strongest nucleophile from the following.

- (A)  (B) 
 (C)  (D) 

48. The arc length of the curve $y = x^{3/2}$ from $x = 0$ to 5 is

- (A) $27/335$ (B) $335/27$ (C) $533/27$ (D) $27/533$

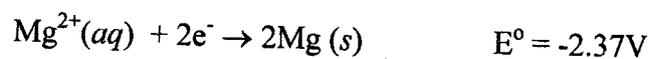
49. Which one among the following is an example of "sandwich" compound?

- (A) $\text{Cr}(\text{C}_6\text{H}_6)_2$ (B) $\text{Mn}_2(\text{CO})_{10}$
 (C) $\text{Cr}_2(\text{CH}_3\text{COO})_2$ (D) $[\text{Pt}(\text{NH}_3)_2][\text{PtCl}_4]$

50. $\lim_{x \rightarrow +\infty} \frac{(\ln x)^{n+1}}{x} =$

- (A) 1 (B) $\ln x$ (C) x (D) 0

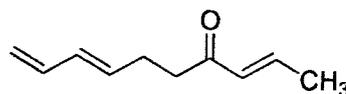
51. Based on the following information,



which of the following chemical species is the strongest reducing agent?

- (A) $\text{F}^-(\text{aq})$ (B) $\text{Mg}^{2+}(\text{aq})$ (C) $\text{F}_2(\text{g})$ (D) $\text{Mg}(\text{s})$

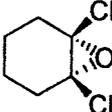
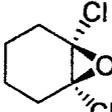
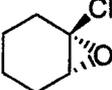
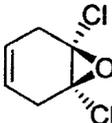
52. Heating the triene



promotes the intramolecular cycloaddition reaction to furnish:

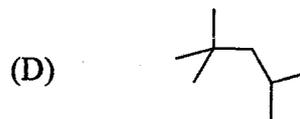
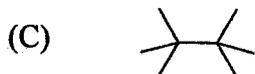
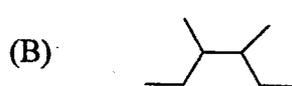
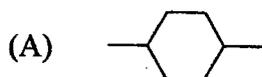
- (A) (B)
 (C) (D)

53. The hybridization of the metal centre in $[\text{Zn}(\text{CN})_4]^{2-}$ is
- (A) sp^2 (B) sp^2d
(C) dsp^2 (D) sp^3
54. The polar coordinates of the point $(1, \sqrt{3})$ is
- (A) $(2, \pi/3)$ (B) $(3, \pi/2)$ (C) $(2, \pi/4)$ (D) $(2, \pi/6)$
55. The absorption of light of frequency 1.16×10^{11} Hz is required for CO molecules to go from the lowest rotational energy level to the next higher rotational energy level. Determine the energy for this transition in kJ/mol. ($h = 6.626 \times 10^{-34}$ Js)
- (A) 949 kJ/mol (B) 0.0463 kJ/mol (C) 46.3 kJ/mol (D) 7.69×10^{-23} kJ/mol
56. A typical sample of (R) & (S)-lactic acid shows optical rotation $+12.1^\circ$. The optical rotation of pure (R)-lactic acid is -13.5° . The percentage of R & S lactic acid present in the sample is
- (A) R = 81, S = 19 (B) R = 90, S = 10
(C) R = 10, S = 90 (D) R = 95, S = 5
57. Identify the most appropriate reaction which involves one C-C and one C-O bond formation
- (A) Knoevenagel (B) Darzens condensation
(C) Michael reaction (D) Shapiro reaction
58. Magnitude of the area enclosed by the curve, $f(x) = x^2 - x$ and the x-axis is
- (A) 1 (B) $1/3$ (C) $1/6$ (D) 0

59. The organometallic compound that obeys the 18-electron rule among the following is
- (A) $[\text{V}(\text{CO})_6]$ (B) $[(\eta^5\text{-C}_5\text{H}_5)\text{Cr}(\text{CO})_3]$
 (C) $[\text{Mn}(\text{CO})_5(\text{CH}_3)]$ (D) $[\text{Co}(\eta^5\text{-C}_5\text{H}_5)_2]$
60. KCl crystallizes in a cubic unit cell with Cl^- ions at each vertex and face centre. How many K^+ ions and Cl^- ions are there in each unit cell of KCl?
- (A) 1 K^+ ion and 1 Cl^- ion (B) 8 K^+ ions and 8 Cl^- ions
 (C) 4 K^+ ions and 4 Cl^- ions (D) 2 K^+ ions and 2 Cl^- ions
61. Which of the following information will be necessary to calculate the change in entropy of a reversible process?
- (A) Pressure (B) Volume
 (C) Internal energy (D) Temperature
62. Identify the most appropriate chiral molecule which may be resolvable:
- (A)  (B) 
 (C)  (D) 
63. Consider an array of 1 mol of H atoms. If each atom could be in one of the two spin states (up/down), the number of possible spin distributions for the collection of H atoms is ($N =$ Avogadro number)
- (A) 2^N (B) N^2 (C) $2N$ (D) $N/2$

64. The crystal field stabilization energy of Ti(III) in octahedral field is more than the crystal field stabilization energy of Ti(III) in tetrahedral field. The difference is
- (A) $1.33 Dq_0$ (B) $2.67 Dq_0$ (C) $4 Dq_0$ (D) $6 Dq_0$
65. If the spin-only magnetic moment of the brown ring compound $[\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]\text{SO}_4$ is $3.90 \mu_B$, then the oxidation state of iron is
- (A) +1 (B) +2 (C) +3 (D) +4
66. Which of the following solvents is not suitable for a Grignard reaction?
- (A) Tetrahydrofuran (B) Diethyl ether
(C) Acetonitrile (D) Hexane
67. Given four different dyes P, Q, R and S, how many different dye combinations (containing at least two types) can be generated?
- (A) 4 (B) 6 (C) 11 (D) 16
68. In thermodynamics, a property is called extensive if its value is additive. Which of the following is not an extensive property?
- (A) Mass (B) Volume (C) Heat capacity (D) Specific heat
69. The radiation intensity of a sample of radioactive Na (half life = 15 h) will become one-tenth of its original intensity in
- (A) 15 h (B) 30 h (C) 50 h (D) 75 h

70. Which one of the following is the major constituent of petrol?



71. $\int_{-\pi}^{\pi} x \cos x dx =$

(A) -0.5π

(B) 0

(C) 0.5π

(D) 2π

72. For combustion of benzene in a sealed container having rigid thermally conducting walls that is immersed in a water bath at 25°C

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

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

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

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

73. The number of nodal planes present in $s - s$ antibonding orbital is

(A) 0

(B) 2

(C) 3

(D) 1

74. The preferred method to separate 2- and 4-nitrophenol is

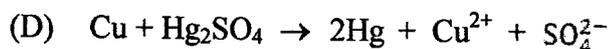
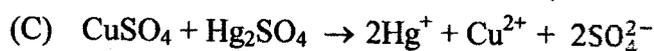
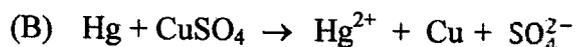
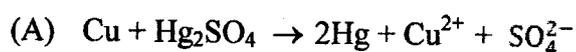
(A) sublimation

(B) fractional distillation

(C) steam distillation

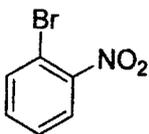
(D) filtration

75. For the cell, $\text{Cu} \mid \text{CuSO}_4 (0.1\text{mol/kg}) \parallel \text{Hg}_2\text{SO}_4 (\text{S}) \mid \text{Hg} \mid \text{Cu}$, the cell reaction among the following is:

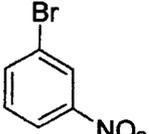


76. To what pressure must a sample of gas be subjected at constant temperature in order to compress it from 122 ml to 105 ml if its original pressure is 1.71 atm?
- (A) 1.99 atm (B) 2.2 atm (C) 3 atm (D) 0.99 atm
77. The number of double bonds in C_3O_2 , satisfying the normal valencies of the elements, is
- (A) 2 (B) 3 (C) 4 (D) 1
78. Which one of the following alcohols will give ketone with Fenton's reagent?
- (A) Methanol (B) Ethanol (C) Isobutanol (D) 2-Butanol
79. The function, y , that has both an upper bound and a lower bound over its complete domain among the following is
- (A) $x^2 - y^2 = 0$ (B) $x^2 + y^2 = 1$
(C) $x^2 - y^2 = 1$ (D) $x^2 - 4y = 1$
80. How many moles of NaCl are produced by the reaction of 0.750 mol Cl_2 (with Na)?
- (A) 1.50 mol (B) 0.375 mol (C) 0.750 mol (D) None
81. Among the following, the crystal lattice with the largest packing fraction is
- (A) simple cubic (B) body centred cubic
(C) face centred cubic (D) simple tetragonal
82. The isomer which has highest heat of combustion among the following isomers (molecular formula C_6H_{12}) is
- (A) 1,1,2-trimethylcyclopropane (B) cyclohexane
(C) methylcyclopentane (D) ethylcyclobutane

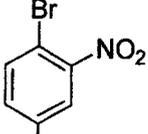
83. The periodicity of the function $\tan x$ is
- (A) π (B) 2π (C) 3π (D) 4π
84. On addition of a surfactant, the surface tension of water
- (A) increases (B) remains unchanged
(C) decreases (D) becomes temperature independent
85. 40.00 ml of 0.11 M HCl is diluted to 100 ml with water and then titrated with 0.1 M NaOH. The pH of the resulting solution after addition of 10 ml titrant is
- (A) 12.49 (B) 1.51
(C) 0.11 (D) 0.21
86. Among the four isomers of C_7H_7Cl , which one will have weakest carbon-halogen bond?
- (A) 2-Chlorotoluene (B) 3-Chlorotoluene
(C) 4-Chlorotoluene (D) Benzyl chloride
87. Given two sets A and B, each with four elements, the number of relations that are possible between A and B in which every element in A is uniquely mapped to B and vice-versa is
- (A) 24 (B) 16 (C) 8 (D) 4
88. Assuming that the volume of water does not change on dissolving NaCl, the density of a 0.1 M aqueous solution of NaCl at 25 °C (atomic weight of Na = 23.0 and Cl = 35.5) is
- (A) 0.93 g/ml (B) 1.00 g/ml (C) 1.01 g/ml (D) 1.10 g/ml

89. Which among the following is a "superoxide" ?
- (A) Na_2O_2 (B) K_2O
 (C) KO_2 (D) Fe_3O_4
90. Aqua regia is a powerful oxidizing agent because it contains
- (A) free O_2 and Cl_2O (B) free O_2 and N_2
 (C) free Cl_2 and ClNO (D) free N_2 and Cl_2O
91. Rank the following in order of decreasing rate of reaction with ethoxide ion in a nucleophilic aromatic substitution:
- 

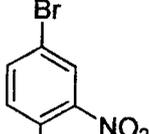
1



2

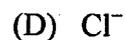


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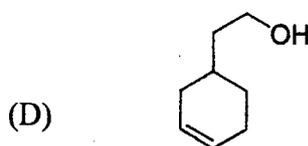
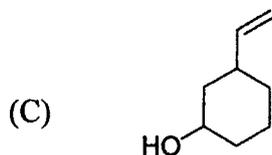
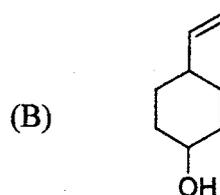
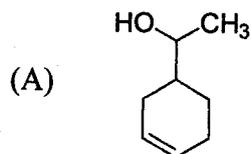
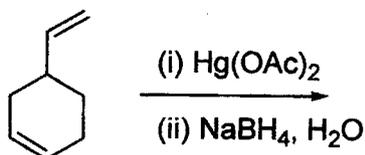


4
- (A) $3 > 4 > 1 > 2$ (B) $2 > 1 > 4 > 3$
 (C) $3 > 4 > 2 > 1$ (D) $4 > 3 > 2 > 1$
92. 4.5 g of PCl_5 on vaporization occupied a volume of 1700 cc at 1 atm and 227°C . The degree of dissociation of PCl_5 is
- (A) 100% (B) 92.1% (C) 89.2% (D) 50.5%
93. The function that is continuous over the complete real axis is
- (A) $\text{coth } x$ (B) $\text{cot } x$ (C) $\text{tanh } x$ (D) $\text{tan } x$

94. Which of the following cannot act as a ligand?



95. What is the major product obtained in the following reaction?



96. $\lim_{x \rightarrow 0} \frac{\tan x}{x}$ is

(A) ∞ (B) $\pi/2$

(C) 1

(D) $-\infty$

97. Choose the correct combination of true statements from the statements given below regarding H_3BNH_3 and H_3CCH_3

(i) the two molecules are isoelectronic, (ii) the two molecules are isostructural. (iii) both molecules have zero dipole moment, (iv) H_3BNH_3 is paramagnetic while H_3CCH_3 is diamagnetic, (v) both may be viewed as coordination compounds

(A) (i), (iii) and (iv)

(B) (i) and (ii)

(C) (ii) and (v)

(D) (i), (ii) and (v)

4-10

98. The IUPAC name of $\text{CH}_3\text{CONBr(Cl)}$ is
- (A) *N*-bromo-*N*-chloroacetamide (B) *N*-bromo-*N*-chloroethanamide
(C) 1-(dimethylamino)ethane (D) 1-(ethylamino)methane
99. Iodimetry involves
- (A) titration with standard iodine solution
(B) iodine as a reducing agent
(C) production of iodine from excess iodide by analyte
(D) precipitation of iodine for gravimetric estimation
100. Phenyl isocyanide is prepared by
- (A) Stephens reaction (B) carbylamine reaction
(C) Reimer-Tiemann reaction (D) Wurtz reaction
