

|                                |                                                                                                                                                                    |  |  |  |  |  |  |  |                    |                  |  |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--------------------|------------------|--|
| <h1 style="margin: 0;">A1</h1> | <b>ELIGIBILITY EXAMINATION-2025</b><br><b>PAPER-2</b><br>Total Number of Questions : 100<br>Maximum Marks : 200<br>Subject : CHEMICAL SCIENCE<br>Subject Code : 27 |  |  |  |  |  |  |  | Serial<br>Number : |                  |  |
|                                | <b>MENTION YOUR REGISTER NUMBER</b>                                                                                                                                |  |  |  |  |  |  |  | Paper<br>Code      |                  |  |
| <b>VERSION<br/>CODE</b>        |                                                                                                                                                                    |  |  |  |  |  |  |  |                    | <b>CHE21125A</b> |  |

### INSTRUCTIONS FOR CANDIDATES

#### DOs:

1. This question booklet is issued to you at **9.55 AM** by the room invigilator.
2. Check whether the Register Number has been entered and shaded in the respective circles on the OMR answer sheet.
3. The version code of this question booklet should be entered on the OMR answer sheet and the respective circles should also be shaded completely.
4. The Version Code and Serial Number of this question booklet should also be entered on the Nominal Roll without any mistakes.
5. Compulsorily sign at the bottom portion of the OMR answer sheet in the space provided.

#### DON'Ts:

- **THE TIMING AND MARKS PRINTED ON THE OMR ANSWER SHEET SHOULD NOT BE DAMAGED / MUTILATED / SPOILED.**

### IMPORTANT INSTRUCTIONS TO CANDIDATES

1. In case of usage of **signs and symbols** in the questions, the regular textbook connotation should be considered unless stated otherwise.
2. This question booklet contains **100** questions and each question will have one statement and four different options / responses & out of which you have to choose one correct answer.
3. **After 10.00 AM**, remove the paper seal of this question booklet and check that this booklet does not have any unprinted or torn or missing pages or items etc., if so, get it replaced by a complete test booklet within 5 minutes of the commencement of exam. Read each item and start answering on the OMR answer sheet.
4. Completely **darken / shade** the relevant circle with a **blue or black ink ballpoint pen against the question number on the OMR answer sheet.**

| ಸರಿಯಾದ ಕ್ರಮ<br>CORRECT METHOD    |                                  |                       |                       | ತಪ್ಪು ಕ್ರಮಗಳು<br>WRONG METHODS   |                                  |                       |                       |                       |                                  |                                  |                       |                       |                       |                       |                       |
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5. Please note that even a minute unintended ink dot on the OMR answer sheet will also be recognized and recorded by the scanner. Therefore, avoid multiple markings of any kind on the OMR answer sheet.
6. Use the space provided on each page of the question booklet for rough work. Do not use the OMR answer sheet for the same.
7. **Once the last Bell rings at 1.00 PM**, stop writing on the OMR answer sheet and hand over the **OMR answer sheet** to the room invigilator as it is.
8. After separating the top sheet (Office copy), the invigilator will return the bottom sheet replica (Candidate's copy) to you.
9. All questions carry equal marks.
10. **There will be no negative marking.**
11. Use of Mobile Phones, Calculators and other Electronic/Communication gadgets of any kind is prohibited inside the Examination venue.

**DO NOT WRITE HERE**

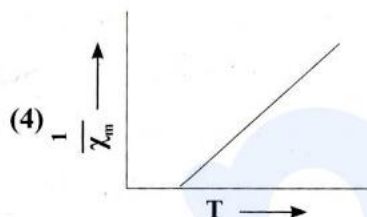
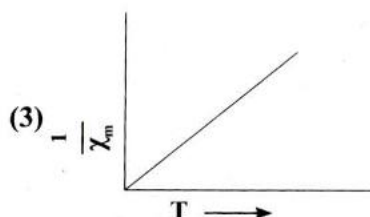
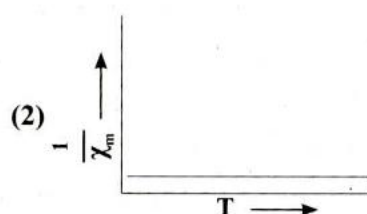
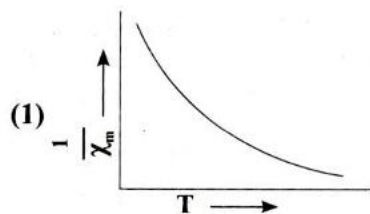


- The correct order of 1<sup>st</sup> ionization enthalpies of P, Si, Mg and Al is
  - $\text{Mg} < \text{Al} < \text{Si} < \text{P}$
  - $\text{P} < \text{Si} < \text{Al} < \text{Mg}$
  - $\text{Al} < \text{Mg} < \text{Si} < \text{P}$
  - $\text{Al} < \text{Si} < \text{P} < \text{Mg}$
- Which of the following is the correct order for the melting points of compounds, NaBr, AlBr<sub>3</sub> and MgBr<sub>2</sub>, as a result of polarization?
  - $\text{NaBr} < \text{MgBr}_2 < \text{AlBr}_3$
  - $\text{NaBr} > \text{MgBr}_2 > \text{AlBr}_3$
  - $\text{NaBr} < \text{AlBr}_3 < \text{MgBr}_2$
  - $\text{MgBr}_2 > \text{AlBr}_3 > \text{NaBr}$
- The number of faces in the trigonal bipyramidal and trigonal prismatic geometry are \_\_\_\_ respectively.
  - 5 and 6
  - 6 and 5
  - 6 and 4
  - 4 and 5
- Identify the correct statement with respect to the binding of Me<sub>3</sub>N and Me<sub>3</sub>P with Be<sup>2+</sup> and Pd<sup>2+</sup> in the following.
  - The binding is stronger for Me<sub>3</sub>N with Pd<sup>2+</sup> and Me<sub>3</sub>P with Be<sup>2+</sup>
  - Me<sub>3</sub>N and Me<sub>3</sub>P bind equally strong with both metal ions
  - Me<sub>3</sub>N and Me<sub>3</sub>P form adducts with Pd<sup>2+</sup> and complexes with Be<sup>2+</sup>
  - Me<sub>3</sub>N binds strongly with Be<sup>2+</sup> while Me<sub>3</sub>P binds strongly with Pd<sup>2+</sup>
- The molecular shapes of [XeF<sub>5</sub>]<sup>-</sup> and [XeF<sub>5</sub>]<sup>+</sup> are \_\_\_\_ respectively.
  - Square pyramidal and TBP
  - TBP and square pyramidal
  - Pentagonal planar and square pyramidal
  - Pentagonal bipyramidal and TBP
- Arrange the following molecules in the increasing order of bond polarity:
 

|                       |                       |
|-----------------------|-----------------------|
| (i) H <sub>2</sub> O  | (ii) NH <sub>3</sub>  |
| (iii) PH <sub>3</sub> | (iv) H <sub>2</sub> S |
| (1) iii < iv < ii < i | (2) i < ii < iv < iii |
| (3) iii < ii < iv < i | (4) iv < iii < ii < i |

7. Based on the equation,  $pK_a = 15.1 - (88.2 \frac{Z^2}{r})$  {where  $Z$  = charge on the cation}, the relative acidities of  $Eu^{2+}$ ,  $Ti^{4+}$  and  $Mg^{2+}$  are expected to be in the order \_\_\_\_ (Given:  $\frac{Z^2}{r}$  for  $Eu^{2+}$ ,  $Ti^{4+}$  and  $Mg^{2+}$  are 0.03, 0.2 and 0.05, respectively)
- (1)  $Eu^{2+} < Mg^{2+} < Ti^{4+}$  (2)  $Eu^{2+} > Mg^{2+} > Ti^{4+}$   
 (3)  $Mg^{2+} < Eu^{2+} < Ti^{4+}$  (4)  $Mg^{2+} > Eu^{2+} > Ti^{4+}$
8. According to Wade's rules, white phosphorus( $P_4$ ) and  $B_{10}C_2H_{12}$  belong to
- (1) Nido and closo systems, respectively  
 (2) Arachno and hypho systems, respectively  
 (3) Closo and nido systems, respectively  
 (4) Arachno and closo systems, respectively
9. Aqueous solutions of pseudohalogens, A, B and C are colourless. Solution of 'A' gives a white precipitate with  $Cu(I)$  solution. Solution of 'B' gives orange-red colour with  $Mo(V)$  solution and solution 'C' gives an intense blue colour on reaction with a solution containing  $Fe^{2+}$  and  $Fe^{3+}$  ions. The pseudohalogens, A, B and C are \_\_\_\_ respectively.
- (1)  $CN^-$ ,  $SCN^-$  and  $N_3^-$  (2)  $N_3^-$ ,  $CN^-$  and  $SCN^-$   
 (3)  $CN^-$ ,  $N_3^-$  and  $SCN^-$  (4)  $N_3^-$ ,  $SCN^-$  and  $CN^-$
10. Identify the number of OH groups in phosphinic acid ( $H_3PO_2$ ) and phosphorus acid ( $H_3PO_3$ ).
- (1) 1 and 2 respectively (2) 1 and 3 respectively  
 (3) 2 and 3 respectively (4) 2 and 1 respectively
11. Consider the following reactions:
- (i)  $[Ru(NH_3)_6]^{2+} + [Co(phen)_3]^{3+} \longrightarrow [Ru(NH_3)_6]^{3+} + [Co(phen)_3]^{2+}$   
 (ii)  $[Co(NH_3)_5Cl]^{2+} + [Cr(OH_2)_6]^{2+} + 5 [H_3O]^+ \longrightarrow [Co(OH_2)_6]^{2+} + [Cr(OH_2)_5Cl]^{2+} + 5[NH_4]^+$
- (1) Reaction (i) follows the outer-sphere while reaction (ii) follows the inner-sphere mechanism  
 (2) Reaction (i) follows the inner-sphere while reaction (ii) follows the outer-sphere mechanism  
 (3) Both reactions follow an inner-sphere mechanism  
 (4) Both reactions follow an outer-sphere mechanism
12. The total number of isomers of  $[Co(en)_2Cl_2]^+$  ( $en$  = ethylenediamine) is
- (1) 4 (2) 5  
 (3) 6 (4) 3

13. The correct plot of inverse molar magnetic susceptibility  $\left[\frac{1}{\chi_m}\right]$  versus temperature  $[T]$  for a paramagnetic compound is



14. The electronic transitions of the type  ${}^3A_{2g} \rightarrow {}^3T_{1g}(P)$ ,  ${}^3A_{2g} \rightarrow {}^3T_{2g}$  and  ${}^3A_{2g} \rightarrow {}^3T_{1g}(F)$  for  $[\text{Ni}(\text{en})_3]^{2+}$  complex.

These transitions occur respectively at

- (1) 550 nm, 900 nm and 325 nm  
(2) 325 nm, 900 nm and 550 nm  
(3) 900 nm, 325 nm and 550 nm  
(4) 900 nm, 550 nm and 325 nm
15. The effective magnetic moment for  $\text{H}_o^{3+} (f^{10})$  with a 'g' value of 1.25 is close to
- (1)  $10.6 \mu_B$   
(2)  $2.54 \mu_B$   
(3)  $9.58 \mu_B$   
(4)  $9.72 \mu_B$

16. The correct statements about actinoids are

- (i) Uranium exhibits oxidation states from + 3 to + 6 although U(IV) and U(VI) are the more common  
(ii) The 5f electrons are bound strongly than the 4f electrons  
(iii) All the actinoids are radioactive  
(iv) Actinoids exhibit actinoid contraction

- (1) i, ii and iii only  
(2) i, iii and iv only  
(3) ii, iii and iv only  
(4) i and iii only

17.  $\text{Co}(\text{CO})_3$  and  $\text{Fe}(\text{CO})_4$  are respectively isolobal with

- (1) CH and  $\text{CH}_2$   
(2)  $\text{CH}_2$  and  $\text{CH}_4$   
(3)  $\text{CH}_2$  and  $\text{CH}_3$   
(4) CH and  $\text{CH}_3$

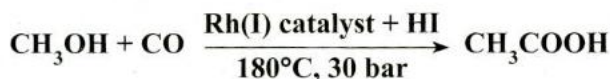


18. The number of bridging ligand(s) and metal-metal bonds present in

$[\text{Ru}_2(\eta^5\text{-C}_5\text{H}_5)_2(\text{ph}_2\text{PCH}_2\text{Pph}_2)(\text{CO})_2]$  (obeys 18-electron rule) are \_\_\_\_\_ respectively.

- (1) 0 and 1 (2) 2 and 1  
(3) 3 and 1 (4) 1 and 2

19. In Monsanto acetic acid process indicated below, the role of HI is to



- (1) Reduce Rh(I) catalyst to Rh(0) species  
(2) Reduce Rh(III) species to Rh(I) species in the catalyst cycle  
(3) Convert  $\text{CH}_3\text{OH}$  to a stronger nucleophile ( $\text{CH}_3\text{O}^-$ )  
(4) Convert  $\text{CH}_3\text{OH}$  to  $\text{CH}_3\text{I}$

20. In cyclophosphazenes  $(\text{NPX}_2)_3$  ( $\text{X} = \text{F, Cl, Br}$  and  $\text{Me}$ ), the strength of  $\text{P-N}$   $\pi$  bond varies with  $\text{X}$  in the order

- (1)  $\text{Me} > \text{Br} > \text{Cl} > \text{F}$  (2)  $\text{F} > \text{Cl} > \text{Br} > \text{Me}$   
(3)  $\text{Me} > \text{F} > \text{Cl} > \text{Br}$  (4)  $\text{Br} > \text{Cl} > \text{F} > \text{Me}$

21. A thermogram of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  (Mol. weight = 249.5 amu) weighing 48.02 mg loses 6.915 mg in the temperature range of  $74^\circ - 150^\circ\text{C}$ . The residue product corresponds to

- (1)  $\text{CuSO}_4 \cdot 2\text{H}_2\text{O}$  (2)  $\text{CuSO}_4 \cdot 3\text{H}_2\text{O}$   
(3)  $\text{CuSO}_4 \cdot \text{H}_2\text{O}$  (4)  $\text{CuSO}_4$

22. Spectrophotometric monitoring is not suitable to determine the end point in the titration of

- (1)  $\text{C}_2\text{O}_4^{2-}$  versus  $\text{MnO}_4^-$   
(2)  $\text{Fe}^{2+}$  versus 1, 10 - phenanthroline  
(3)  $\text{Co}^{2+}$  versus eriochrome Black T  
(4)  $\text{Zr}^{4+}$  versus alizarin Red S

23. If free heme in aqueous solution is exposed to dioxygen, it will be converted immediately to

- (1)  $\text{PFe}^{\text{II}}\text{O}_2$  (2)  $\text{PFe}^{\text{III}} - \text{O} - \text{O} - \text{Fe}^{\text{III}}\text{P}$   
(3)  $\text{PFe}^{\text{III}} - \text{O}$  (4)  $\text{PFe}^{\text{III}} - \text{O} - \text{Fe}^{\text{III}}\text{P}$

24. The active sites present in Vitamin B<sub>12</sub>, Chlorophyll, Rubredoxin and Myoglobin are \_\_\_\_\_ respectively

- (1) Chlorin, Corrin, 1Fe-OS and heme
- (2) Corrin, 1Fe-OS, Chlorin and heme
- (3) Corrin, Chlorin, 1Fe-OS and heme
- (4) Corrin, Chlorin, heme and 1Fe-OS

25. Match the items in Column A with items in Column B

| Column A                        | Column B                                                            |
|---------------------------------|---------------------------------------------------------------------|
| a) Vit B <sub>12</sub> coenzyme | (i) dioxygen transportation                                         |
| b) Cytochrome P450              | (ii) decomposes H <sub>2</sub> O <sub>2</sub>                       |
| c) Valinomycin                  | (iii) detoxification of xenobiotics                                 |
| d) Catalase                     | (iv) transports K <sup>+</sup> ions across cell membranes/ionophore |
|                                 | (v) contains cobalt and catalyzes the 1, 2-shifts reaction          |

Codes

- (1) a – v, b – iii, c – iv, d – ii
- (2) a – v, b – ii, c – iii, d – iv
- (3) a – v, b – iii, c – iv, d – i
- (4) a – iii, b – iv, c – v, d – ii

26. Identify the correct statements for the EPR spectrum of VO(ac ac)<sub>2</sub> (with square pyramidal geometry at vanadium) at 76K  $\left[ I(^{51}\text{V}) = \frac{7}{2} \right]$ :

- i) It has one g value
- ii) It has two g values
- iii) It has two sets of 8 lines each
- iv) It has two sets of 4 lines each

- |                     |                    |
|---------------------|--------------------|
| (1) ii and iii only | (2) i and iii only |
| (3) ii and iv only  | (4) i and iv only  |

27. In <sup>57</sup>Fe Mössbauer experiment, the source of 14.4 keV (equivalent to 3.48 × 10<sup>12</sup> MHz) is moved towards absorber at a velocity of 2.2 mms<sup>-1</sup>. Then the shift in frequency of the source for the sample is

- |              |              |
|--------------|--------------|
| (1) 20.2 MHz | (2) 10.5 MHz |
| (3) 35.5 MHz | (4) 25.5 MHz |

28. The compound that shows two signals in  $^{19}\text{F}$  NMR spectra is

- a)  $\text{SF}_6$
- b)  $\text{SF}_4$
- c)  $\text{ClF}_5$
- d)  $\text{XeOF}_4$

(1) a and b only

(2) a and c only

(3) c and d only

(4) b and c only

29.  $^{235}_{92}\text{U}$  absorbs one neutron and gives two products with the emission of two neutrons. If one product formed is  $^{141}_{55}\text{Cs}$ , then identify the second nuclide.

(1)  $^{235}_{37}\text{Rb}$

(2)  $^{94}_{37}\text{Rb}$

(3)  $^{92}_{37}\text{Rb}$

(4)  $^{93}_{37}\text{Rb}$

30. In neutron activation analysis (NAA), the radiation generally detected is

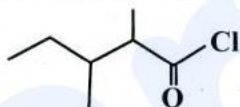
(1) X-rays

(2)  $\alpha$ -rays

(3)  $\gamma$ -rays

(4)  $\beta$ -rays

31. Give the systematic name for the following



(1) 2-Ethyl-3-methylbutanoyl chloride

(2) 2, 3-Dimethylpentanoyl chloride

(3) 3, 4-Dimethylpentanoyl chloride

(4) 1-Chloro-1-oxo-2, 3-dimethylpentane

32. The IUPAC name of the following compound is



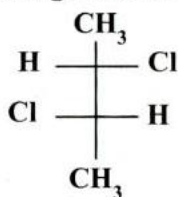
(1) Spiro [4,5] deca-1, 6-diene

(2) Spiro [5,4] deca-1, 6-diene

(3) Spiro [4,5] deca-3, 6-diene

(4) Spiro [5,4] deca-3, 6-diene

33. The configuration at C-2 and C-3 of the compound given below is



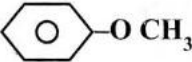
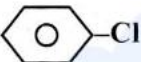
(1) 2R, 3S

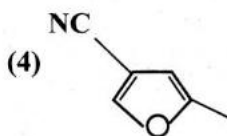
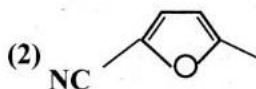
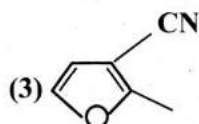
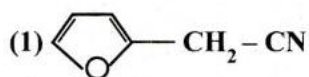
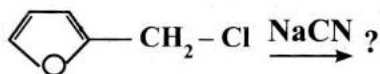
(2) 2S, 3R

(3) 2S, 3S

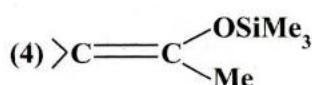
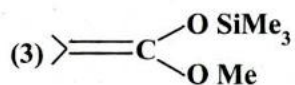
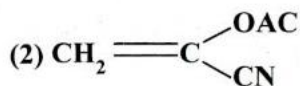
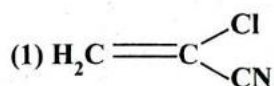
(4) 2R, 3R



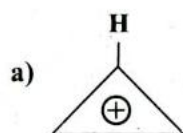
34. Which of the following compounds contains diastereotopic protons?  
 (1) Ethyl chloride (2) 2-Methylpropane  
 (3) 1, 2-Dichloroethane (4) 1, 2-Dichloropropane
35. Cyclobutadiene is said to be  
 (1) Aromatic (2) Anti aromatic  
 (3) Homo aromatic (4) Cyclic aliphatic
36. In the following compounds, the relative reactivity towards nitronium ion is in the order \_\_\_\_\_
- a)  b)  c) 
- (1)  $c < a < b$  (2)  $b < a < c$   
 (3)  $a < c < b$  (4)  $c < b < a$
37. When acid azides are converted to isocyanates, the intermediate involved is  
 (1) Carbene (2) Carbanion  
 (3) Carbocation (4) Nitrene
38. Cyclohexene can be used as trapping agent for which of the following reactive intermediates?  
 (1) Nitrene and carbocations (2) Carbene and carbocation  
 (3) Carbene and nitrene (4) Benzyne and carbanion
39. The  $S_Ni$  mechanism proceeds with  
 (1) Retention of configuration (2) Inversion of configuration  
 (3) Formation of racemic product (4) Loss of configuration
40. Predict the product in the following reaction



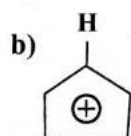
41. The compound which cannot be used as ketene equivalent in synthesis is



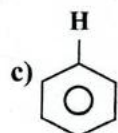
42. Match the chemical shift values( $\delta$ ) for the indicated protons and choose the correct option:



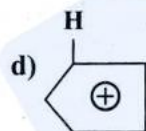
i) 7.27



ii) 9.17



iii) 10.3



iv) 5.37

(1) a - iii, b - iv, c - i, d - ii

(2) a - iv, b - iii, c - i, d - ii

(3) a - iv, b - iii, c - ii, d - i

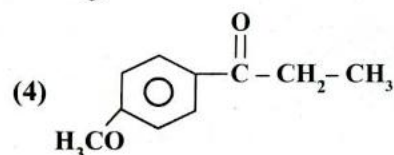
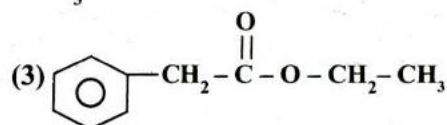
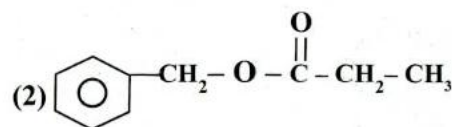
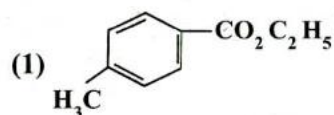
(4) a - i, b - ii, c - iii, d - iv

43. An organic compound with M.F.,  $\text{C}_{10}\text{H}_{12}\text{O}_2$  exhibits the following spectral data

IR :  $1750\text{ cm}^{-1}$

PMR  $\delta$  ppm, 7.30 (m, 5H), 4.15 (q, 2H), 3.58 (s, 2H) and 1.22 (t, 3H).

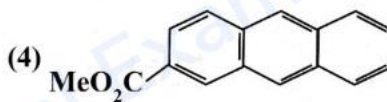
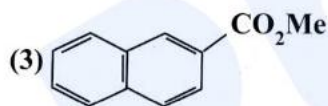
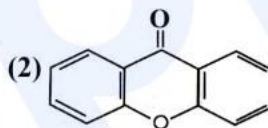
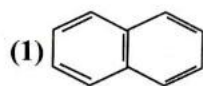
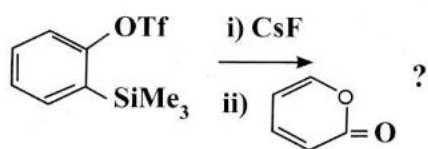
The structure of the compound is



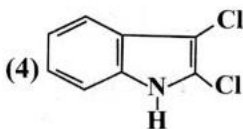
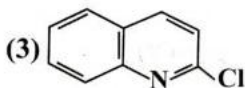
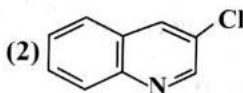
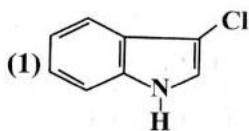
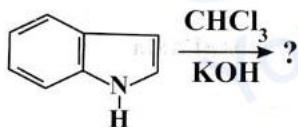
44. The sequence of amino acids in a pentapeptide that gives the dipeptide Val-Asp, Glu-His, Phe-Val and Asp-Glu upon partial hydrolysis is

- (1) Asp-Glu-His-Phe-Val
- (2) Asp-Val-His-Phe-Glu
- (3) Glu-Phe-His-Asp-Val
- (4) Phe-Val-Asp-Glu-His

45. Identify the product of the following reaction:

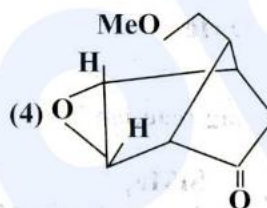
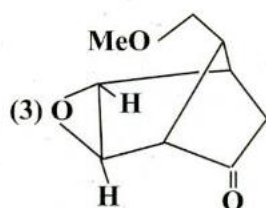
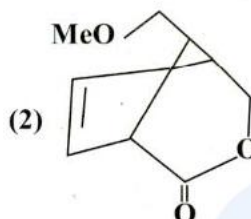
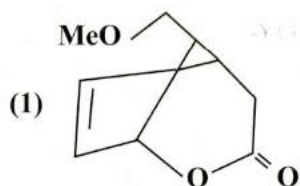
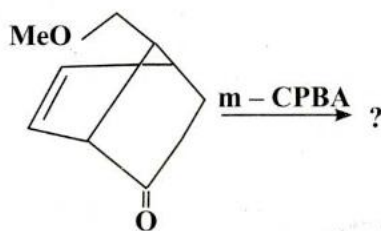


46. Predict the product in the following





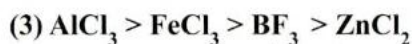
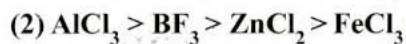
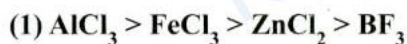
47. The product of the following reaction is



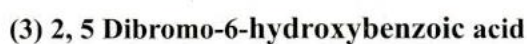
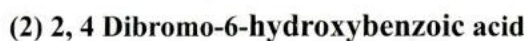
48. The reaction of 1-bromo-3-chlorocyclobutane with metallic sodium in dioxane under reflux condition gives



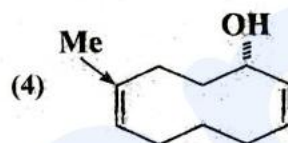
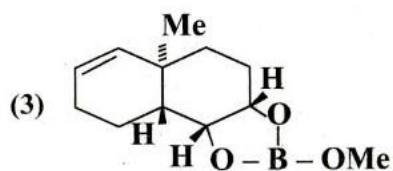
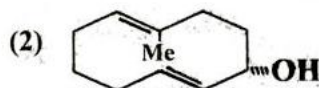
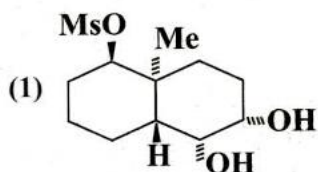
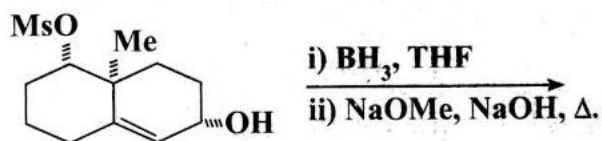
49. Select the correct order of effectiveness of Lewis acid catalyst in Friedel-Crafts reaction.



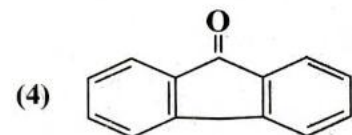
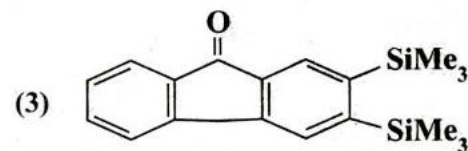
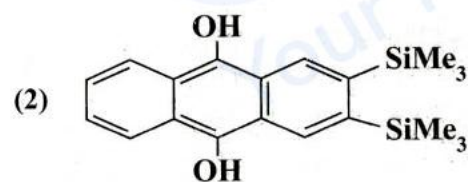
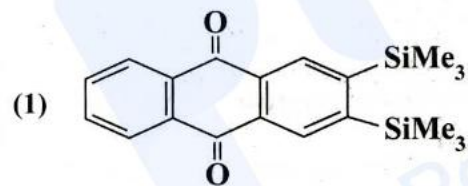
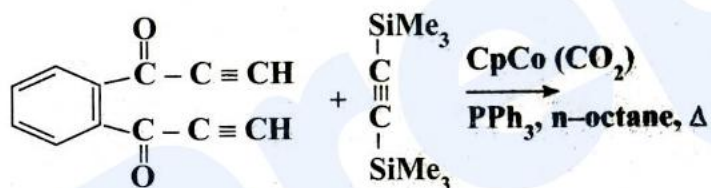
50. The product formed by the reaction of salicylic acid with excess of bromine is



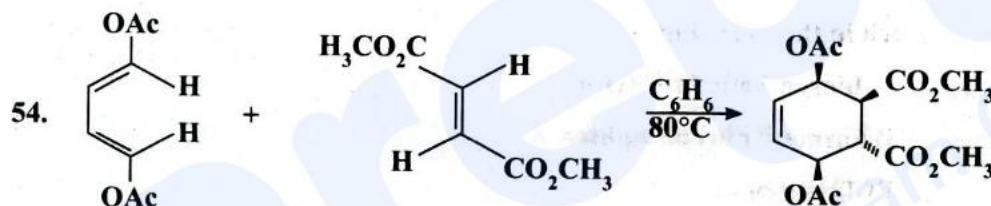
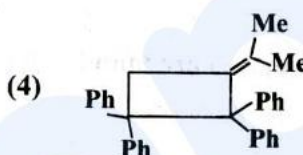
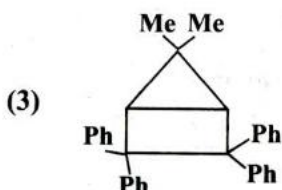
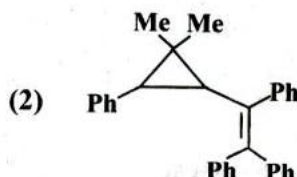
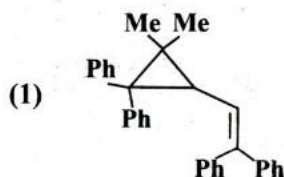
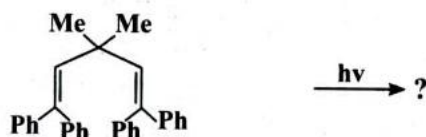
51. Identify the correct product in the following reaction:



52. The product of the following reaction is



53. The product of the following photochemical reaction is



The above reaction is an example for

- (1) [2 + 2] cycloaddition reaction      (2) Electrocyclic reaction  
(3) Sigmatropic reaction      (4) Diels-Alder reaction

55. Oxidation of quinoline with alkaline potassium permanganate gives

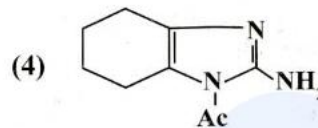
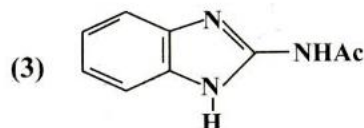
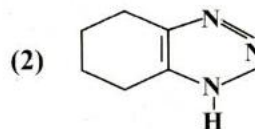
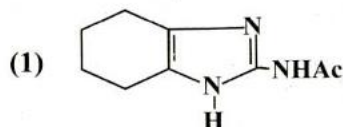
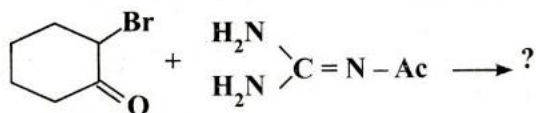
- (1) Nicotinic acid  
(2) Pyridine-3, 4-dicarboxylic acid  
(3) Pyridine-2, 3-dicarboxylic acid  
(4) Phthalic acid

56. Citral is \_\_\_\_\_

- (1) Monoterpene      (2) Sesquiterpene  
(3) Diterpene      (4) Triterpene



57. The heterocycle formed in the following reaction is



58. How many PMR signals are found in trans and cis-dimethylcyclopropanes?

(1) 2 and 3

(2) 3 and 4

(3) 1 and 2

(4) 6 and 8

59. Find out the correct match in the following:

Natural product

Biosynthetic Precursor

a) Cholesterol

i) Farnesyl pyrophosphate

b) Morphine

ii) Tryptophan

c)  $\beta$ -Caryophyllene

iii) Squalene

d) Reserpine

iv) L-Tyrosine

(1) a - iii, b - iv, c - i, d - ii

(2) a - ii, b - iv, c - iii, d - i

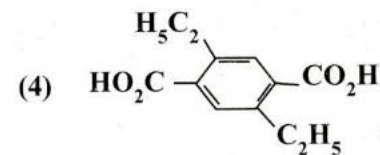
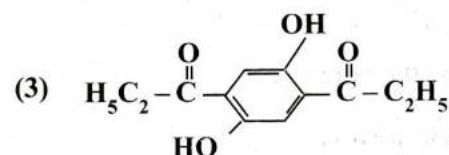
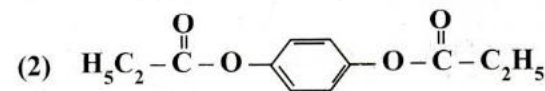
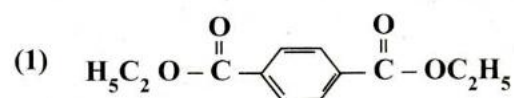
(3) a - iv, b - iii, c - ii, d - i

(4) a - ii, b - iii, c - iv, d - i

60. A compound showed the molecular ion peak at  $m/z$ , 222.

In the PMR spectrum, it showed signals at  $\delta$  (PPM) 1.41 (t, 6H), 4.4 (Q, 4H), 8.10 (s, 4H)

The IR spectrum of the compound showed a sharp peak at  $1724\text{ cm}^{-1}$ . Predict the structure.



61. The thermodynamic property that may be utilised for specifying the direction of time is
- (1) E – Internal Energy (2) H – Enthalpy  
(3) S – Entropy (4) G – Free Energy
62. The quantities which are held fixed in a canonical ensemble are
- (1) N T and P (2) V T and N  
(3) N V and E (4) N V and P
63. Which of the following are the correct statements about phase equilibria?
- a) At the triple point, three phases coexist in equilibrium  
b) Below the eutectic temperature, the system exists in a single phase region  
c) The Clapeyron equation relates the slope of the phase boundary to enthalpy and entropy change  
d) The critical point marks the end of the liquid-vapour equilibrium line
- (1) a, c and d (2) a, b and c  
(3) a, d and b (4) b, c and d
64. Polymers in which *d* and *l* configurations of the asymmetric carbon atoms are present in a random manner are called
- (1) Isotactic polymers (2) Syndiotactic polymers  
(3) Atactic polymers (4) Stereoregular polymers
65. An example of a hydrophobic sol is
- (1) Glue Sol (2) Gelatine Sol  
(3) Albumin Sol (4) Sulphur Sol
66. Only those radiations which are absorbed by the system can bring about chemical change. This is related to
- (1) Lambert's Law (2) Grothus-Draper Law  
(3) Beer's Law (4) Einstein's Law
67. Which of the following molecules has the lowest vibrational stretching frequency?
- (1) HF (2) DF  
(3) HCl (4) DCl

68. The number of nodal plane in HOMO of butadiene in ground state is  
 (1) 0 (2) 1  
 (3) 2 (4) 3
69. Calculate the coefficient of variation in percentage. Given the Standard deviation  $\sigma = 0.1$  and mean  $\mu = 5$ .  
 (1) 0.1% (2) 0.2%  
 (3) 2% (4) 0.5%
70.  $\text{CO}_2$  has a centre of symmetry. Which of the following statements is correct about its vibrations?  
 (1) Both symmetric and asymmetric stretches are IR active  
 (2) Symmetric stretch is Raman active but IR inactive  
 (3) Asymmetric stretch is Raman active but IR inactive  
 (4) Both symmetric and asymmetric stretches are Raman active
71. In near IR region, the transitions observed in organic molecules are  
 (1) Electronic  
 (2) Fundamental vibrational  
 (3) Overtones and combinations  
 (4) Functional group vibrations
72. The number of lines in the EPR spectrum of  $\text{ND}_3$  radical is  
 (1) 4 (2) 7  
 (3) 12 (4) 21
73. HCl shows fundamental absorption and first overtone at 2886 and 5668  $\text{cm}^{-1}$ , respectively. The equilibrium vibration frequency of HCl is \_\_\_\_\_  $\text{cm}^{-1}$ .  
 (1) 2886 (2) 2990  
 (3) 2995 (4) 3000
74. If  $\Delta G$  for a reaction is negative, then you infer that the change is  
 (1) reversible (2) irreversible  
 (3) spontaneous (4) non-spontaneous
75. The first thermodynamic equation of state says that  
 (1)  $\left(\frac{\partial U}{\partial V}\right)_T = T \left(\frac{\partial P}{\partial T}\right)_V - P$  (2)  $\left(\frac{\partial U}{\partial V}\right)_T = T \left(\frac{\partial P}{\partial T}\right)_V + P$   
 (3)  $\left(\frac{\partial H}{\partial P}\right)_T = U - T \left(\frac{\partial V}{\partial T}\right)_P$  (4)  $\left(\frac{\partial H}{\partial P}\right)_T = U + T \left(\frac{\partial V}{\partial T}\right)_P$



76. Which of the following statements is true for heat and work which are equivalent?
- (1) Heat can't be converted to work with 100% efficiency
  - (2) Heat can be converted to work with 100% efficiency
  - (3) Work can be converted to heat with 100% efficiency
  - (4)  $W_{\text{rev}}$  and  $q_{\text{rev}}$  are path functions
77. Choose the correct statement
- (1) Solvent obeys Raoult's law over the entire concentration range in solution
  - (2) Solute obeys Henry's law over the entire concentrations range in solution
  - (3) Solvent obeys Raoult's law in the limit of solute obeying Henry's law in solution
  - (4) Solvent and solute obey Raoult's law over the entire concentration range in solution
78. Which of the following partition functions has highest magnitude?
- (1) Translational
  - (2) Rotational
  - (3) Vibrational
  - (4) Electronic
79. The residual entropy of 1, 3-dichlorobenzene is
- (1)  $R$
  - (2)  $R \ln 2$
  - (3)  $R \ln 3$
  - (4)  $R \ln 4$
80. The cell below is a  $\text{Zn}_{(s)} | \text{Zn}^{2+}_{(aq)} || \text{Cu}^{2+}_{(aq)} | \text{Cu}_{(s)}$  is
- (1) Weston Cell
  - (2) Daniell Cell
  - (3) Faraday Cell
  - (4) Calomel Cell
81. A molecule goes from the excited singlet state to the excited triplet state without emitting light. The process is known as
- (1) Phosphorescence
  - (2) Fluorescence
  - (3) Internal conversion
  - (4) Intersystem crossing
82. The energy levels of propenyl radical are  $\alpha + \sqrt{2} \beta$ ,  $\alpha$  and  $\alpha - \sqrt{2} \beta$  for  $\pi_1$ ,  $\pi_2$  and  $\pi_3$  molecular orbitals, respectively. The electronic transition energy from  $\pi_1 \rightarrow \pi_2$  is 4.8 eV, the transition energy from  $\pi_1 \rightarrow \pi_3$  would be
- (1) 2.4 eV
  - (2) 4.8 eV
  - (3) 9.6 eV
  - (4) 14.4 eV

83. The proposed hydrogen wave function

$$\psi = N r(6 - r) e^{-r/3} \cos\theta$$

where  $r$  is the radial distance from the nucleus,  $\theta$  is the azimuthal angle and  $N$  is the normalization constant. The INCORRECT statement about  $\psi$  is

- (1)  $\psi = 0$  in the  $xy$ -plane
- (2) Two radial nodes are present in  $\psi$
- (3) One angular node is present in  $\psi$
- (4) The size of the orbital decreases with increase in atomic number

84. The character table of the  $C_{2v}$  point group is given below for water molecule. The IR active modes are

| $C_{2v}$ | E | $C_2$ | $\sigma_v(xz)$ | $\sigma_v'(yz)$ |          |                 |
|----------|---|-------|----------------|-----------------|----------|-----------------|
| $A_1$    | 1 | 1     | 1              | 1               | Z        | $x^2, y^2, z^2$ |
| $A_2$    | 1 | 1     | -1             | -1              | $R_z$    | xy              |
| $B_1$    | 1 | -1    | 1              | -1              | x, $R_y$ | xz              |
| $B_2$    | 1 | -1    | -1             | 1               | y, $R_x$ | yz              |

- (1)  $2A_1 + B_1$
- (2)  $2A_1 + A_2 + B_1 + B_2$
- (3)  $3A_1 + A_2 + 3B_1 + 2B_2$
- (4)  $2A_1 + B_2$

85. The Vibrational frequency and Anharmonicity constant of an alkali halide are  $400 \text{ cm}^{-1}$  and 0.0050, respectively. The position (in  $\text{cm}^{-1}$ ) of its fundamental mode and second overtone are \_\_\_\_\_, respectively.

- (1) 396, 1176
- (2) 396, 788
- (3) 404, 1176
- (4) 404, 788

86. The Nernst equation for the reaction,  $A^{2+} + 2e^- \rightleftharpoons B$  in terms of the free energy change is \_\_\_\_\_

- (1)  $\Delta G = \Delta G^\circ + 2.303 RT \ln \frac{[B]}{[A]}$
- (2)  $\Delta G = \Delta G^\circ - 2.303 RT \ln \frac{[B]}{[A]}$
- (3)  $-\Delta G = -\Delta G^\circ + 2.303 RT \ln \frac{[B]}{[A]}$
- (4)  $\Delta G = -\Delta G^\circ + 2.303 RT \ln \frac{[B]}{[A]}$

87. Which of the following plot would give the value of activation energy?

(1)  $K$  Vs  $T$

(2)  $\ln k$  Vs  $\frac{1}{T}$

(3)  $C$  Vs  $T$

(4)  $\frac{1}{C}$  Vs  $T$

88. A polymer sample has the following composition:

| Number of molecules | Molecular weight |
|---------------------|------------------|
| 10                  | 1000             |
| 50                  | 2000             |
| 40                  | 4000             |

The Poly Dispersity Index (PDI) of the polymer is \_\_\_\_\_

(1)  $\frac{85000}{27}$

(2)  $\frac{85}{81}$

(3)  $\frac{850}{729}$

(4)  $\frac{729}{850}$

89. Two particles are said to be distinguishable when

(1) The average distance between them is large compared to their de-Broglie wavelengths

(2) The average distance between them is small compared to their de-Broglie wavelengths

(3) They have overlapping wave packets

(4) Their total wave function is symmetric under particle exchange

90. A crystal plane has intercepts on the three axes of a crystal in the ratio of  $\frac{3}{2} : 2 : 1$ . The Miller indices of the plane is

(1) 436

(2) 346

(3) 323

(4) 643

91. Supercritical  $\text{CO}_2$  is considered 'green' because

(1) It is flammable

(2) It replaces toxic solvents

(3) It reacts with  $\text{O}_2$

(4) It is weakly acidic

92. Lipinski's 'rule of five' is used to evaluate

(1) Drug solubility in water

(2) Drug toxicity

(3) Oral bioavailability

(4) Drug-protein binding



93. Choose the drug that inactivates the COX enzyme from the following:

- |                    |               |
|--------------------|---------------|
| (1) Ceterizine HCl | (2) Metformin |
| (3) Penicillin     | (4) Aspirin   |

94. The main source of photochemical smog in cities is

- |                                      |                            |
|--------------------------------------|----------------------------|
| (1) Particulate matter               | (2) Lead compounds         |
| (3) Hydrocarbons and nitrogen oxides | (4) CO and CO <sub>2</sub> |

95. Eutrophication is primarily caused by

- (1) Heavy metals
- (2) Excess nitrate and phosphate
- (3) Organic waste
- (4) Pesticides and insecticides

96. Choose the correct statements about quantum dots:

- i) They have size which is less than 10 nm
- ii) Their emission colour depends on the size
- iii) They are used in solar cells and displays
- iv) They always exhibit phosphorescence

- |                        |                         |
|------------------------|-------------------------|
| (1) i and ii only      | (2) i, ii and iv only   |
| (3) i, ii and iii only | (4) ii, iii and iv only |

97. The role of surfactants in nanoparticle synthesis is to

- (1) Initiate the reaction
- (2) Reduce particle size
- (3) Act as a medium
- (4) Control particle shape and prevent agglomeration

98. Identify the mechanically interlocked molecules among the following.

- |               |                 |
|---------------|-----------------|
| (1) Catenanes | (2) Calixarenes |
| (3) Cavitands | (4) Cryptands   |

99. The method that cannot be used for the determination of binding constants of host-guest complexes is
- (1) Proton NMR spectroscopy
  - (2) Spectrophotometry
  - (3) Isothermal calorimetry
  - (4) Scanning electron microscopy
100. The E-factor of a chemical process is defined as
- (1) Total mass of waste from process / Total mass of product
  - (2) Total mass of product / Total mass of raw materials
  - (3) Total mass of waste from process / Total mass of raw materials
  - (4) Total mass of products / Total mass of waste from process

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