DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

23-0009-AG TEST BOOKLET

CHEMISTRY

PAPER – II

Time Allowed: 3 hours | **Maximum Marks: 300**

INSTRUCTIONS TO CANDIDATES

Read the instructions carefully before answering the questions: -

1. This Test Booklet consists of **20 (twenty) pages** and has **75 (seventy-five) items (questions)**.
2. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD 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.
3. **Please note that it is the candidate's responsibility to fill in the Roll Number and other required details carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet and the Separate Answer Booklet. Any omission/discrepancy will render the OMR Answer Sheet and the Separate Answer Booklet liable for rejection.**
4. Do not write anything else on the OMR Answer Sheet except the required information. Before you proceed to mark in the OMR Answer Sheet, please ensure that you have filled in the required particulars as per given instructions.
5. Use **only Black Ball Point Pen** to fill the OMR Answer Sheet.
6. This Test Booklet is divided into 4 (four) parts – **Part – I, Part – II, Part - III** and **Part – IV**.
7. All three parts are **Compulsory**.
8. **Part-I consists of Multiple Choice-based Questions.** The answers to these questions have to be marked in the **OMR Answer Sheet** provided to you.
9. **Part-II, Part-III and Part-IV consist of Conventional Essay-type Questions.** The answers to these questions have to be written in the separate **Answer Booklet** provided to you.
10. In Part-I, each item (question) comprises of 04 (four) responses (answers). You are required to select the response which you want to mark on the OMR Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose *ONLY ONE* response for each item.
11. After you have completed filling in all your responses on the OMR Answer Sheet and the Answer Booklet(s) and the examination has concluded, you should hand over to the Invigilator *only the OMR Answer Sheet and the Answer Booklet(s)*. You are permitted to take the Test Booklet with you.
12. **Penalty for wrong answers in Multiple Choice-based Questions:**

THERE WIL BE **PENALTY** FOR WRONG ANSWERS MARKED BY A CANDIDATE.

(i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to the question will be deducted as penalty.

(ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to the question.

(iii) If a question is left blank. i.e., no answer is given by the candidate, there will be **no penalty** for that question.

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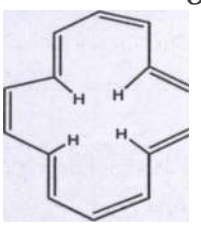
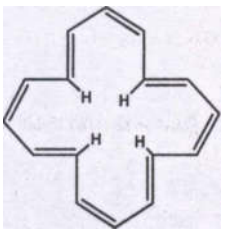
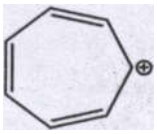
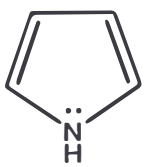
PART-I
(Multiple Choice-based Questions)

Instructions for Questions 1 to 50:

- *Attempt all questions. Each question carries 3 marks.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[3 x 50 = 150]

1. According to Huckel's rule, an aromatic compound must possess _____
   (a) $(4n + 2)\pi$ electrons
   (b) $(4n + 1)\pi$ electrons
   (c) $(2n + 2)\pi$ electrons
   (d) None of the above.

2. Which of the following is an anti – aromatic system?
   (a) 
   (b) 
   (c) 
   (d) 

3. *Cyclopropenyl* cation is _____
   (a) *benzenoid* aromatic
   (b) *non – benzenoid* aromatic
   (c) anti-aromatic
   (d) None of the above

4. Pyrene has **16 π** electrons. However, it is considered to be aromatic compounds due to -
   (a) the 10 peripheral π electrons
   (b) the 2 internal π electrons
   (c) the 14 peripheral π electrons
   (d) None of these

5. If value of $k_H/k_D < 1$, it is referred to as -
   (a) Primary isotope effect
   (b) Secondary isotope effect
   (c) Inverse isotope effect
   (d) None of these

6. Any ring opening reaction would involve _____
   (a) a gain in entropy
   (b) a loss in entropy
   (c) no change in entropy
   (d) an increase at first and then a decrease in entropy

7. A singlet *carbene* has _____ in its ground state.
   (a) a pair of electrons in a single orbital
   (b) two electrons in two different orbitals
   (c) one electron in an unhybrid orbital
   (d) None of the above.

8. What is the hybridisation of *carbon* atom in a *carbanion*?
   (a) sp^3 hybridisation.
   (b) sp^2 hybridisation.
   (c) sp hybridisation.
   (d) None of the above.

9. Reimer-Tiemann reaction involves formation of an intermediate _____
   (a) *Carbocation*
   (b) *Nitrane*
   (c) *Aryne*
   (d) *Carbene*

10. Pinacol - pinacolone rearrangement take place through the _____ intermediate.
   (a) *carbanion*
   (b) *carbocation*
   (c) free- radical
   (d) *carbene*

11. What is the IUPAC designation of $S_N{}^2$ mechanism?
    (a) $A_N D_N$
    (b) $D_N + A_N$
    (c) $A_N + D_N$
    (d) None of the above.

12. In which of the following are radical ion species involved in the substitution mechanism?
    (a) $S_N 1$
    (b) $S_N 2$
    (c) SET
    (d) Both $S_N 1$ and $S_N 2$

13. Which type of mechanism is Cine substitution?
    (a) $S_N Ar$ Mechanism
    (b) The Benzym Mechanism
    (c) $S_N 1$ Mechanism
    (d) $S_{RN} 1$ Mechanism

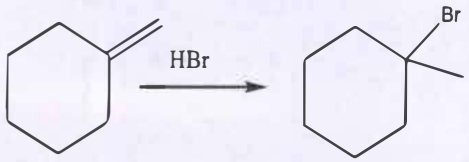
14. Which of the following statement is TRUE?
    (a) Nucleophiles that are weak bases favour elimination over substitution.
    (b) Nucleophiles that are very strong bases favour elimination over substitution.
    (c) Low temperature favours elimination over substitution.
    (d) None of the above is true.

15. Which of the following conditions must be satisfied for E2 elimination in *cyclohexanes*?
    (a) $C - H$ must equatorial and $C - X$ must be axial.
    (b) Both $C - H$ and $C - X$ must be equatorial.
    (c) $C - H$ must be axial and $C - X$ must be equatorial.
    (d) Both $C - H$ and $C - X$ must be axial.

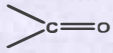
16. Which of the following is TRUE with respect to nucleophilic addition to carbonyl groups?
    (a) Acid catalysts work by making the carbonyl group more electrophilic.
    (b) Base catalysts work by making the nucleophile less nucleophilic.
    (c) Acid catalysts work by making the carbonyl group less electrophilic.
    (d) None of the above is true.

17. Compounds with carbon-hetero multiple bonds (e.g., C=O) are more susceptible to _____
    (a) Nucleophilic addition reaction
    (b) Electrophilic addition reaction
    (c) both Nucleophilic and Electrophilic addition reactions
    (d) None of the above

18. The reaction depicted in the figure below is an example of:



(a) Electrophilic addition
(b) Nucleophilic addition
(c) Free radical addition
(d) None of these

19. Which of the following statements is FALSE?
(a) The more electron-withdrawing the substituent, the higher the frequency of the carbonyl bond.
(b) Conjugation decreases the frequency of the carbonyl bond markedly.
(c) The more electron-releasing the substituent, the lower the frequency of the carbonyl bond.
(d)  absorption frequency of aryl ketones is higher than alkyl ketones.

20. How many NMR signals would one expect from *vinyl chloride*?
(a) Two signals.
(b) Three signals.
(c) Four signals.
(d) None of the above.

21. The **fingerprint region** of IR spectrum is between _____.
(a) $1300 - 900\ cm^{-1}$
(b) $1000 - 600\ cm^{-1}$
(c) $1500 - 800\ cm^{-1}$
(d) $900 - 500\ cm^{-1}$

22. What is the λ_{max} of compound $(CH_3)_2C = CHCOCH_3$?
(a) 253
(b) 249
(c) 239
(d) 268

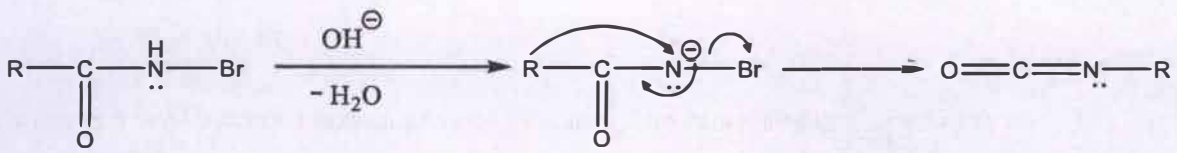
23. Which of the following spectroscopies is based on magnetic properties of the nucleus of an atom?
(a) IR
(b) UV
(c) NMR
(d) MS

24. Which of the following spectroscopy does not involves absorption or emission of light.
    (a) NMR
    (b) IR
    (c) UV
    (d) MS

25. The *Pinacol – pinacolone* rearrangement is an example of _____ .
    (a) Nucleophilic Rearrangement
    (b) Electrophilic Rearrangement
    (c) Free radical Rearrangement
    (d) None of the above.

26. In a *Wagner – Meerwein* rearrangement reaction, the intermediate species is a -
    (a) Carbanion
    (b) Free radical
    (c) Carbene
    (d) Carbocation

27. The following rearrangement is known as,



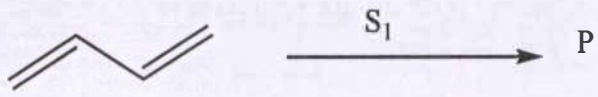
    (a) Schmidt Reaction
    (b) Beckmann Rearrangement
    (c) Curtius Rearrangement
    (d) Hofmann Rearrangement

28. What is the approximate order of migration for unsymmetrical ketones in a Baeyer-Villiger rearrangement?
    (a) Tertiary alkyl > secondary alkyl, aryl >primary alkyl > methyl.
    (b) Secondary alkyl, aryl > Tertiary alkyl > primary alkyl > methyl
    (c) Methyl > primary alkyl > tertiary alkyl > secondary alkyl, aryl
    (d) Secondary alkyl, aryl > methyl > primary alkyl > tertiary alkyl

29. Organozinc compound is formed as intermediate in which of the following reactions?
    (a) Sandmayer reaction
    (b) Reformatsky reaction
    (c) Acyloin condensation
    (d) Cannizzaro reaction

30. Which of the following statements is TRUE for a photo-chemical reaction?
    (a) Individual molecules are promoted to an excited state by light.
    (b) All molecules are affected by heat generated by light.
    (c) The chemistry of an excited molecule is the same as in its ground state.
    (d) None of the above.

31. An ISC process involves _____.
    (a) $S_0 \rightarrow S_1$ transition
    (b) $S_1 \rightarrow T_1$ transition
    (c) $S_1 \rightarrow S_2$ transition
    (d) $S_2 \rightarrow S_0$ transition

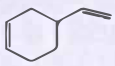
32. 

In the reaction depicted above, what could '***P***' be?

(a) 

(b) 

(c) 

(d) 

33. In which of the following reactions does the $\delta - H$ atom form a six-membered cyclic transition state?
    (a) Norrish type-I reaction
    (b) Norrish type-II reaction
    (c) Paterno-Buchi reaction
    (d) Barton reaction

34. Addition of oxygen to anthracene in presence of light is known as-
    (a) Photochemical oxidation
    (b) Photochemical addition
    (c) Photochemical reduction
    (d) None of the above

35. Which one of following is an elastomer?
    (a) Rubber
    (b) Bakelite
    (c) Nylon-6,6
    (d) Epoxy resin

36. What is Teflon made of?
    (a) Vinylchloride
    (b) 1, 3 - butadiene
    (c) Acrylonitrile
    (d) Tetrafluoroethylene

37. Gutta-percha is -
    (a) a mixture of *cis* and *trans* isomers.
    (b) the *trans* form of natural rubber.
    (c) the *as* form of natural rubber.
    (d) none of the above.

38. Buna-N is a copolymer of -
    (a) Styrene and 1, 3 butadiene.
    (b) 1, 3 – butadiene and acrylonitrile.
    (c) Isoprene and acrylonitrile.
    (d) none of the above.

39. Primary structure of protein shows:
    (a) orientation of amino acids.
    (b) a linear arrangement of peptide chain.
    (c) a linear sequence of amino acids.
    (d) α or β helix space structure.

40. Proteins have a characteristic _____
    (a) boiling point
    (b) melting point
    (c) iso-electric point
    (d) none of the above

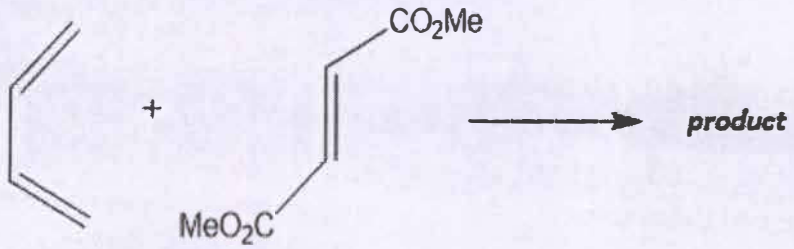
41. Which of the following is the complementary base of adenine in the opposite strand of a DNA?
    (a) Thymine
    (b) Uracil
    (c) Cytosine
    (d) Gwanine

42. Which position of the purine base is attached to the C-1 position of pentose sugar in a polynucleotide chain?
    (a) N-1
    (b) N-3
    (c) N-7
    (d) N-9

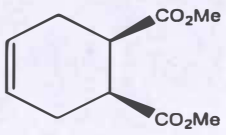
43. What is the reaction depicted below called as?

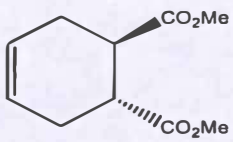
    (a) Diels – Alder's reaction.
    (b) Claisen rearrangement.
    (c) Electrocyclic reaction.
    (d) None of the above.

44. What is the product of the reaction depicted below?



Select the correct answer from the options given below.

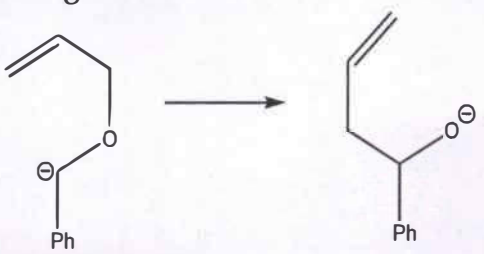
(a) 

(b) 

    (c) both (a) and (b)
    (d) None of the above.

45. Thermal electrocyclic reactions involving $(4n + 2)\pi$ electrons are _____.
    (a) conrotatory
    (b) disrotatory
    (c) both conrotatory and disrotatory
    (d) None of the above

46. The reaction depicted below is an example of which type of rearrangement? Select the correct answer from the options given.



(a) [3,3] - Sigmatropic rearrangement
(b) [2,2] - Sigmatropic rearrangement
(c) [2,3] - Sigmatropic rearrangement
(d) [3,4] - Sigmatropic rearrangement

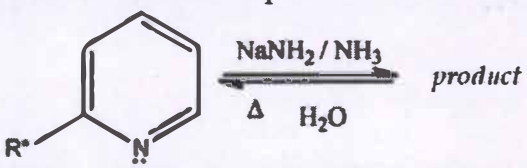
47. Which of the following reagents is used in oxidation, acetoxylation and methylation reactions?

(a) OsO_4
(b) SeO_2
(c) $Pb(OAc)_4$
(d) Al

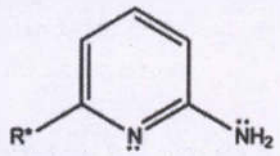
48. Which of the following reagents is used for *cis*-hydroxylation of double bonds?

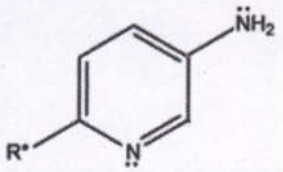
(a) OsO_4
(b) SeO_2
(c) *Sodamide*
(d) *Baker's yeast*

49. What would be the product of the reaction depicted below?



Select the correct answer from the options given below.

(a) 

(b) 

(c) Mixture of (a) and (b)

(d) None of these

50. Which of these reagents can be used in reducing carbonyl group at moderate temperature without affecting the other reducible group (eg -NO_2,-$COOH$ etc.)

(a) $LiAlH_4$
(b) NBS
(c) $Na/NH_3(liq.)$
(d) $NaBH_4$

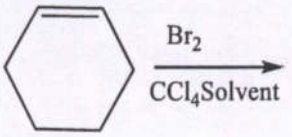
PART-II
(Short Answer-type Questions)

Instructions for Questions 51 to 63:

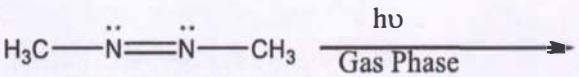
- *Write the answers in short for any 10 (TEN) out of the thirteen questions.*
- *Each question carries 5 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[5 x 10 = 50]

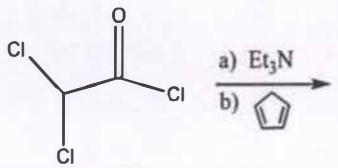
51. Why is Azulene termed as a *non-benzenoid aromatic* compound?
52. What is the *primary isotope effect*?
53. What do you understand by the term *energy of activation*?
54. Write a short note on S_N1 reaction mechanism.
55. Write a short note on S_NAr reaction mechanism.
56. What is the *ortho/para ratio*?
57. What is the *Bredt's rule*?
58. What would the product be for the reaction shown below?



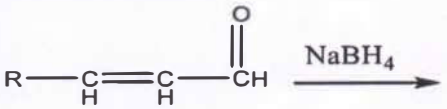
59. Write the correct order of migratory aptitude in the case of *Wittig Rearrangement*.
60. Complete the following reaction.



61. What is a *Ziegler-Natta catalyst*?
62. Complete the following reaction.



63. Predict the product of following reaction.



PART-III
(Long Answer-type Questions)

Instructions for Questions 64 to 71:

- ***Answer any 5 (FIVE) out of the eight questions.***
- ***Each question carries 10 marks.***
- ***Candidates are required to give their answers in their own words as far as practicable.***
- ***No Data Books/Tables are allowed; assume the data if required anywhere.***
- ***Unless otherwise mentioned, symbols and notations have their usual meaning.***

[10 x 5 = 50]

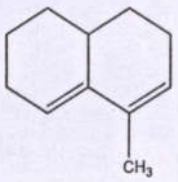
64. What is ***Double Labeling***? Explain ***Crossover*** experiments.

65. Explain in detail the ***Benzyne Mechanism***.

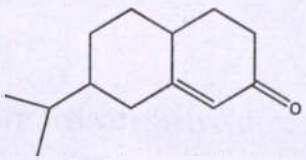
66. Write a short note on the ***anti − periplanar*** transition states of ***E2 elimination reaction***. Also comment if ***E2 elimination reactions*** can be stereo specific or not.

67. Calculate the λ_{max} for following compounds:

(a)



(b)



68. Explain how one can differentiate ethane, ethylene and acetylene by *NMR spectroscopy*.

69. Write a note on ***elimination reaction*** duly explaining ***Norrish type I*** and ***Norrish type II*** processes.

70. Discuss the ***Frontier molecular orbital theory of cycloaddition reactions***.

71. Write a short note on the applications of oxidating agents OsO_4 and SeO_2.

PART-IV
(Essay-type Questions)

Instructions for Questions 72 to 75:

- *Answer any 2 (TWO) out of the four questions.*
- *Each question carries 25 marks.*
- *Candidates are required to give their answers in their own words as far as practicable.*
- *No Data Books/Tables are allowed; assume the data if required anywhere.*
- *Unless otherwise mentioned, symbols and notations have their usual meaning.*

[25 x 2 = 50]

72.

(i) Explain the ***E1cB mechanism*** with suitable examples.

(ii) What is ***regioselectivity***? How does ***regioselectivity*** affect ***E2 elimination*** reaction.

(iii) What is the role of ***substrate*** structure in ***elimination*** reaction? Elaborate with acceptable examples.

73. Write explanatory notes on following:

(i) ***Oxidation of alkenes to form epoxides*** with examples of various reagents and the mechanism.

(ii) ***Electrophilic addition to dienes*** along with the mechanism.

74.

(i) What are ***nucleoside*** and ***nucleotides***?

(ii) Explain the process of ***DNA replication***.

(iii) Explain the ***transcription process***.

75.

(i) What are ***cycloaddition reactions***? Explain $\mathbf{1,3-}$***dipolar cycloaddition*** reactions with suitable examples.

(ii) Write a note on ***Claisen rearrangement***.

(iii) Explain the $[\mathbf{1,5}]$ ***Sigmatropic Hydrogen Shifts*** in ***pericyclic*** reactions.

(iv) What are ***conrotatory*** and ***disrotatory*** reactions? Explain with suitable examples.

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