EXEMPLAR PROBLEMS

CHEMISTRY

Class XII

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

FOREWORD

The National Curriculum Framework (NCF) 2005 initiated a new phase of development of syllabi and textbooks for all stages of school education. In this phase, a conscious effort has been made to discourage rote learning and to enhance comprehension. This is well in tune with the NPE-1986 and Learning Without Burden-1993 that recommend child centred system of education. The textbooks for Class XI were released in 2006 and for Class XII in 2007. Overall the books have been well received by students and teachers.

NCF-2005 notes that treating the prescribed textbooks as the sole basis of examination is one of the key reasons why other resources and sites of learning are ignored. It further reiterates that the methods used for teaching and evaluation will also determine how effective these textbooks prove for making children's life at school a happy experience, rather than source of stress or boredom. It calls for reforms in examination system currently prevailing in the country.

The position papers of the National Focus Groups on Teaching of Science, Teaching of Mathematics and Examination Reforms envisage that the question papers, set in annual examinations conducted by the various Boards do not really assess genuine understanding of the subjects. The quality of question papers is often not up to the mark. They usually seek mere information based on rote memorisation, and fail to test higher-order skills like reasoning and analysis, let alone lateral thinking, creativity, and judgment. Good unconventional questions, challenging problems and experiment-based problems rarely find a place in question papers. In order to address the issue, and also provide additional learning material, the Department of Education in Science and Mathematics (DESM) has made an attempt to develop resource book of exemplar problems in different subjects at secondary and higher secondary stages. Each resource book contains different types of questions of varying difficulty level. Some questions would require the students to apply simultaneously understanding of more than one concept. These problems are not meant to serve merely as question bank for examinations but are primarily meant to improve the quality of teaching/learning process in schools. It is expected that these problems would encourage teachers to design quality questions on their own. Students and teachers should always keep in mind that examination and assessment should test comprehension, information recall, analytical thinking and problem-solving ability, creativity and speculative ability.

A team of experts and teachers with an understanding of the subject and a proper role of examinations worked hard to accomplish this task. The material was discussed, edited, and finally included in this resource book.

NCERT would welcome suggestions from students, teachers and parents which would help us to further improve the quality of material in subsequent editions.

Professor Yash Pal
Chairperson
National Steering Committee
National Council of Educational
Research and Training

New Delhi
21 May 2008

PREFACE

The Department of Education in Science and Mathematics (DESM), National Council of Educational Research and Training (NCERT), initiated the programme for the development of 'Exemplar Problems' in science and mathematics for secondary and higher secondary stages based on the subject textbooks developed on the basis of the NCF-2005. The present book is based on the content of the Chemistry Textbook for Class XII published by the Council in 2007.

The main objective of the book on 'Exemplar Problems in Chemistry' is to provide the teachers and students a large number of quality problems in various forms and format with varying levels of difficulty to facilitate teaching-learning of concepts in Chemistry that are presented through the Textbook for Class XII. It is envisaged that the problems included in this book would help the teachers to design tasks to assess effectiveness of their preparation of balanced question papers for unit and terminal tests. The feedback based on the analysis of students' responses may help the teachers in further improving the quality of classroom instructions. In addition, the problems given in this book are also expected to help the teachers to perceive the basic characteristics of good quality questions and motivate them to frame similar problems on their own. Students can benefit themselves by attempting the problems given in the book for self assessment and also in mastering the basic techniques of problem solving. Some of the problems given in the book are expected to challenge the students' understanding of Chemistry concepts and to apply them in new situations. At a number of places elaboration of answers may be required.

The problems included in this book were developed in workshop mode organised by the DESM involving practising teachers, subject experts from universities and institutes of higher learning, and the members of the Chemistry group of the DESM whose names appear separately. I gratefully acknowledge their efforts and thank them for their valuable contribution in our endeavour to provide good quality instructional material for the school system. I, especially, thank Professor Brahm Parkash, Dr. Alka Mehrotra, and Dr. Anjni Koul of DESM for editing and refining the problems and for making the manuscript pressworthy. Thanks are also due to Professor Brahm Parkash and Dr. Alka Mehrotra of DESM for coordinating this programme.

I also thank Shri Ishwar Singh, Sr. DTP Operator for typing the manuscript and preparing a press-ready copy.

We look forward to feedback from students, teachers and parents for further improvement of the content of the book.

Hukum Singh
Professor and Head

THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a **SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity; and to promote among them all

FRATERNITY assuring the dignity of the individual and the unity and integrity of the Nation;

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949, do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

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The Council also thanks Seema Gupta, *Associate Professor*, Department of Chemistry, Acharya Narendra Dev College, New Delhi; C. Shriniwas, *PGT (Chemistry)*, Kendriya Vidyalaya, Pushp Vihar, Sector-3, New Delhi; Haritima Chopra, *Associate Professor*, Department of Chemistry Maitreyi College, New Delhi; A. Pramila, *PGT (Chemistry)*, Army Public School, Sector-37, Noida; K.C. Trikha, *Associate Professor (Retd.)*, Department of Chemistry, ARSD College, New Delhi.

The Council also acknowledges the contribution of team working for Hindi translation of the book specially Alok Chaturvedi, *Sr. Assistant Professor*, Department of Chemistry, Govt. College, Ajmer and K. K. Sharma, *Vice Principal (Retd.)*, College of Education, Govt. of Rajasthan, Ajmer for providing valuable suggestions to improve the English manuscript.

The help provided by Bal Yogeshwar, *Lab Assistant,* DESM, NCERT, during the workshop is also greatly acknowledged.

Special thanks are also due to Hukum Singh, *Professor and Head*, DESM, NCERT for his administrative support. The Council also acknowledges the support provided by the APC office of DESM; administraive staff of DESM; Deepak Kapoor, *Incharge*, Computer Station, DESM, Ishwar Singh, *DTP Operator* and K. T. Chitralekha, *Copy Editor*. The efforts of the Publication Department are also highly appreciated.

INTRODUCTION

Assessment of students is an important part of the teaching-learning process. It helps a teacher to evaluate (i) his/her own teaching and (ii) the achievement of students in a particular subject. In other words, assessment provides the present achievement and subsequent guidance to teaching-learning. It is also an instrument to assess the educational progress of learners.

According to Bloom's taxonomy, there are three domains of educational objectives (i) cognitive (ii) affective and (iii) psychomotor. Cognitive domain deals with the educational products and processes.

In the present book, the problems pertaining to cognitive domain have been included. These are categorised into different classes on the basis of the type of their construction.

(i) Multiple choice
(ii) Matching type
(iii) Short answer type
(iv) Long answer type
(v) Assertion and reason type

(i) **Multiple choice type :** Multiple choice questions are widely used in objective tests for different examinations. A multiple choice question consists of a stem followed by 4-5 responses.

(a) **Stem :** The stem is that part in which the task which the students have to undertake is set out. It may be a direct question or an incomplete statement.

(b) **Response :** Below the stem of the question, there are a number of options comprising of the correct answer(s) and distractors. These should appear to closely resemble with one another. The distractors distract students. The style of presentation i.e., length, precision etc. of any response should not provide any clue of its being a correct answer or a distractor. Correct responses should be arranged randomly. A good multiple choice question can induce higher order thinking among students. A number of multiple choice questions relating to various aspects of the same theme presented as material, picture or diagram, or a combination of more than one of these enables the learners to develop multiple abilities.

(ii) **Matching Type :** In this type, a premise is to be matched with single correct response out of a number of responses. It is known as simple matching. In compound matching, a premise has to be matched with more than one correct response.

(iii) **Short answer type :** These type of questions have a short answer either in the form of a word or a few sentences or diagram or numerical value or a combination of these. Good short answer questions involve the use of action oriented and precise verbs such as, deduce, conclude, classify, interpret, explain, extrapolate, translate etc. for precision. The words like, briefly, short notes on etc. are avoided.

(iv) **Long answer type :** These questions require long answers to be written with or without diagram(s). Long answer questions involve the following tasks to test higher order abilities.

(a) contrast, distinguish, discriminate and differentiate.

(b) compare, list similarities/dissimilarities.

(c) explain, show how and why and give explanatory reasons.

(d) discuss, defend, refute, prove, disprove, justify.

(e) judge, evaluate.

(v) **Assertion– Reason type :** These questions enhance the reasoning ability of the learner. In these questions there is a statement of assertion followed by a statement of reason. Learner selects the correct response through logical reasoning.

Some Problem Solving questions have also been included in the book. Such questions require the application of knowledge and procedures to a problem situation. It is a form of discovery learning, bridging the gap between the learner's existing knowledge and the solution to the problem. In problem solving the learner is required to construct some knowledge to find out the solution to the problem or investigate a fact or a result.

For closed-ended problems, there will only be one answer. For open-ended problems, there will be more than one answer.

CONTENTS

Unit

1

SOLID STATE

I. Multiple Choice Questions (Type-I)

1. Which of the following conditions favours the existence of a substance in the solid state?

(i) High temperature

(ii) Low temperature

(iii) High thermal energy

(iv) Weak cohesive forces

2. Which of the following is **not** a characteristic of a crystalline solid?

(i) Definite and characteristic heat of fusion.

(ii) Isotropic nature.

(iii) A regular periodically repeated pattern of arrangement of constituent particles in the entire crystal.

(iv) A true solid

3. Which of the following is an amorphous solid?

(i) Graphite (C)

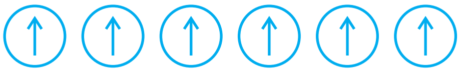
(ii) Quartz glass (SiO_2)

(iii) Chrome alum

(iv) Silicon carbide (SiC)

4. Which of the following arrangements shows schematic alignment of magnetic moments of antiferromagnetic substances?

(i)



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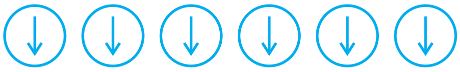
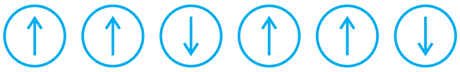
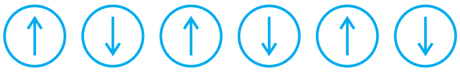


(iii) 

(iv) 

5. Which of the following is true about the value of refractive index of quartz glass?

(i) Same in all directions

(ii) Different in different directions

(iii) Cannot be measured

(iv) Always zero

6. Which of the following statement is **not** true about amorphous solids?

(i) On heating they may become crystalline at certain temperature.

(ii) They may become crystalline on keeping for long time.

(iii) Amorphous solids can be moulded by heating.

(iv) They are anisotropic in nature.

7. The sharp melting point of crystalline solids is due to ___________.

(i) a regular arrangement of constituent particles observed over a short distance in the crystal lattice.

(ii) a regular arrangement of constituent particles observed over a long distance in the crystal lattice.

(iii) same arrangement of constituent particles in different directions.

(iv) different arrangement of constituent particles in different directions.

8. Iodine molecules are held in the crystals lattice by ____________.

(i) london forces

(ii) dipole-dipole interactions

(iii) covalent bonds

(iv) coulombic forces

9. Which of the following is a network solid?

(i) SO_2 (Solid)

(ii) I_2

(iii) Diamond

(iv) H_2O (Ice)

10. Which of the following solids is **not** an electrical conductor?

(A) Mg (s) (B) TiO (s) (C) I_2 (s) (D) H_2O (s)

(i) (A) only

(ii) (B) Only

(iii) (C) and (D)

(iv) (B), (C) and (D)

11. Which of the following is **not** the characteristic of ionic solids?

(i) Very low value of electrical conductivity in the molten state.

(ii) Brittle nature.

(iii) Very strong forces of interactions.

(iv) Anisotropic nature.

12. Graphite is a good conductor of electricity due to the presence of __________.

(i) lone pair of electrons

(ii) free valence electrons

(iii) cations

(iv) anions

13. Which of the following oxides behaves as conductor or insulator depending upon temperature?

(i) TiO

(ii) SiO_2

(iii) TiO_3

(iv) MgO

14. Which of the following oxides shows electrical properties like metals?

(i) SiO_2

(ii) MgO

(iii) $SO_2(s)$

(iv) CrO_2

15. The lattice site in a pure crystal **cannot** be occupied by _________.

(i) molecule

(ii) ion

(iii) electron

(iv) atom

16. Graphite **cannot** be classified as __________.

(i) conducting solid

(ii) network solid

(iii) covalent solid

(iv) ionic solid

17. Cations are present in the interstitial sites in __________.

(i) Frenkel defect

(ii) Schottky defect

(iii) Vacancy defect

(iv) Metal deficiency defect

18. Schottky defect is observed in crystals when __________.

(i) some cations move from their lattice site to interstitial sites.
(ii) equal number of cations and anions are missing from the lattice.
(iii) some lattice sites are occupied by electrons.
(iv) some impurity is present in the lattice.

19. Which of the following is true about the charge acquired by *p*-type semiconductors?

(i) positive
(ii) neutral
(iii) negative
(iv) depends on concentration of *p* impurity

20. To get *a n*-type semiconductor from silicon, it should be doped with a substance with valence__________.

(i) 2
(ii) 1
(iii) 3
(iv) 5

21. The total number of tetrahedral voids in the face centred unit cell is __________.

(i) 6
(ii) 8
(iii) 10
(iv) 12

22. Which of the following point defects are shown by AgBr(s) crystals?

(A) Schottky defect (B) Frenkel defect
(C) Metal excess defect (D) Metal deficiency defect

(i) (A) and (B)
(ii) (C) and (D)
(iii) (A) and (C)
(iv) (B) and (D)

23. In which pair most efficient packing is present?

(i) *hcp* and *bcc*
(ii) *hcp* and *ccp*
(iii) *bcc* and *ccp*
(iv) *bcc* and simple cubic cell

24. The percentage of empty space in a body centred cubic arrangement is ________.

(i) 74

(ii) 68

(iii) 32

(iv) 26

25. Which of the following statement is **not** true about the hexagonal close packing?

(i) The coordination number is 12.

(ii) It has 74% packing efficiency.

(iii) Tetrahedral voids of the second layer are covered by the spheres of the third layer.

(iv) In this arrangement spheres of the fourth layer are exactly aligned with those of the first layer.

26. In which of the following structures coordination number for cations and anions in the packed structure will be same?

(i) Cl^- ion form *fcc* lattice and Na^+ ions occupy all octahedral voids of the unit cell.

(ii) Ca^{2+} ions form *fcc* lattice and F^- ions occupy all the eight tetrahedral voids of the unit cell.

(iii) O^{2-} ions form *fcc* lattice and Na^+ ions occupy all the eight tetrahedral voids of the unit cell.

(iv) S^{2-} ions form *fcc* lattice and Zn^{2+} ions go into alternate tetrahedral voids of the unit cell.

27. What is the coordination number in a square close packed structure in two dimensions?

(i) 2

(ii) 3

(iii) 4

(iv) 6

28. Which kind of defects are introduced by doping?

(i) Dislocation defect

(ii) Schottky defect

(iii) Frenkel defects

(iv) Electronic defects

29. Silicon doped with electron-rich impurity forms ________.

(i) *p*-type semiconductor

(ii) *n*-type semiconductor

(iii) intrinsic semiconductor

(iv) insulator

30. Which of the following statements is **not** true?

(i) Paramagnetic substances are weakly attracted by magnetic field.

(ii) Ferromagnetic substances cannot be magnetised permanently.

(iii) The domains in antiferromagnetic substances are oppositely oriented with respect to each other.

(iv) Pairing of electrons cancels their magnetic moment in the diamagnetic substances.

31. Which of the following is **not** true about the ionic solids?

(i) Bigger ions form the close packed structure.

(ii) Smaller ions occupy either the tetrahedral or the octahedral voids depending upon their size.

(iii) Occupation of all the voids is not necessary.

(iv) The fraction of octahedral or tetrahedral voids occupied depends upon the radii of the ions occupying the voids.

32. A ferromagnetic substance becomes a permanent magnet when it is placed in a magnetic field becuase ________.

(i) all the domains get oriented in the direction of magnetic field.

(ii) all the domains get oriented in the direction opposite to the direction of magnetic field.

(iii) domains get oriented randomly.

(iv) domains are not affected by magnetic field.

33. The correct order of the packing efficiency in different types of unit cells is ________.

(i) *fcc* < *bcc* < simple cubic

(ii) *fcc* > *bcc* > simple cubic

(iii) *fcc* < *bcc* > simple cubic

(iv) *bcc* < *fcc* > simple cubic

34. Which of the following defects is also known as dislocation defect?

(i) Frenkel defect

(ii) Schottky defect

(iii) Non-stoichiometric defect

(iv) Simple interstitial defect

35. In the cubic close packing, the unit cell has ________.

(i) 4 tetrahedral voids each of which is shared by four adjacent unit cells.

(ii) 4 tetrahedral voids within the unit cell.

(iii) 8 tetrahedral voids each of the which is shared by four adjacent unit cells.

(iv) 8 tetrahedral voids within the unit cells.

36. The edge lengths of the unit cells in terms of the radius of spheres constituting fcc, bcc and simple cubic unit cell are respectively________.

(i) $2\sqrt{2}r, \dfrac{4r}{\sqrt{3}}, 2r$

(ii) $\dfrac{4r}{\sqrt{3}}, 2\sqrt{2}r, 2r$

(iii) $2r, 2\sqrt{2}r, \dfrac{4r}{\sqrt{3}}$

(iv) $2r, \dfrac{4r}{\sqrt{3}}, 2\sqrt{2}r$

37. Which of the following represents correct order of conductivity in solids?

(i) $\kappa_{\text{metals}} >> \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

(ii) $\kappa_{\text{metals}} << \kappa_{\text{insulators}} < \kappa_{\text{semiconductors}}$

(iii) $\kappa_{\text{metals}} \square \kappa_{\text{semiconductors}} > \kappa_{\text{insulators}} = \text{zero}$

(iv) $\kappa_{\text{metals}} < \kappa_{\text{semiconductors}} > \kappa_{\text{insulators}} \neq \text{zero}$

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

38. Which of the following is **not** true about the voids formed in 3 dimensional hexagonal close packed structure?

(i) A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer.

(ii) All the triangular voids are not covered by the spheres of the second layer.

(iii) Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap.

(iv) Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.

39. The value of magnetic moment is zero in the case of antiferromagnetic substances because the domains ________.

(i) get oriented in the direction of the applied magnetic field.

(ii) get oriented opposite to the direction of the applied magnetic field.

(iii) are oppositely oriented with respect to each other without the application of magnetic field.

(iv) cancel out each other's magnetic moment.

40. Which of the following statements are **not** true?

(i) Vacancy defect results in a decrease in the density of the substance.

(ii) Interstitial defects results in an increase in the density of the substance.

(iii) Impurity defect has no effect on the density of the substance.

(iv) Frankel defect results in an increase in the density of the substance.

41. Which of the following statements are true about metals?

(i) Valence band overlaps with conduction band.

(ii) The gap between valence band and conduction band is negligible.

(iii) The gap between valence band and conduction band cannot be determined.

(iv) Valence band may remain partially filled.

42. Under the influence of electric field, which of the following statements is true about the movement of electrons and holes in a *p*-type semi conductor?

(i) Electron will move towards the positvely charged plate through electron holes.

(ii) Holes will appear to be moving towards the negatively charged plate.

(iii) Both electrons and holes appear to move towards the positively charged plate.

(iv) Movement of electrons is not related to the movement of holes.

43. Which of the following statements are true about semiconductors?

(i) Silicon doped with electron rich impurity is a *p*-type semiconductor.

(ii) Silicon doped with an electron rich impurity is an *n*-type semiconductor.

(iii) Delocalised electrons increase the conductivity of doped silicon.

(iv) An electron vacancy increases the conductivity of *n*-type semiconductor.

44. An excess of potassium ions makes KCl crystals appear violet or lilac in colour since ________.

(i) some of the anionic sites are occupied by an unpaired electron.

(ii) some of the anionic sites are occupied by a pair of electrons.

(iii) there are vacancies at some anionic sites.

(iv) F-centres are created which impart colour to the crystals.

45. The number of tetrahedral voids per unit cell in NaCl crystal is ________.

(i) 4

(ii) 8

(iii) twice the number of octahedral voids.

(iv) four times the number of octahedral voids.

46. Amorphous solid can also be called ________.

(i) pseudo solids

(ii) true solids

(iii) super cooled liquids

(iv) super cooled solids

47. A perfect crystal of silicon (Fig. 1.1) is doped with some elements as given in the options. Which of these options show *n*-type semiconductors?

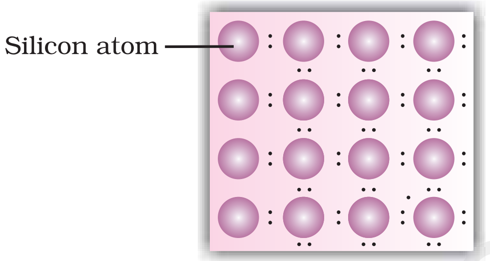
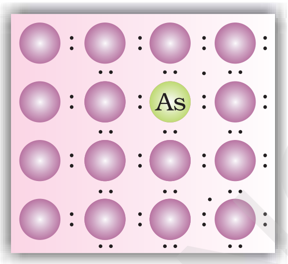
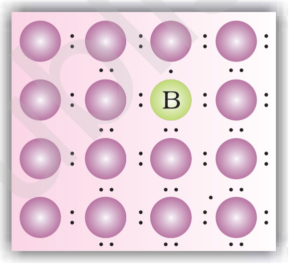
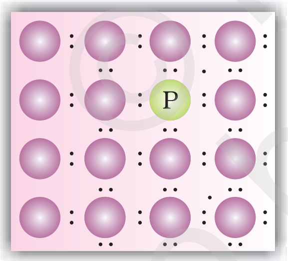
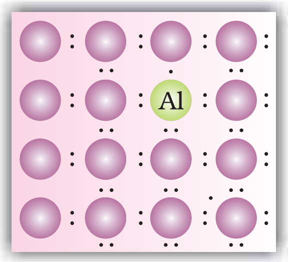


***Fig.* 1.1** Pure crystal

(i) 

(ii) 

(iii) 

(iv) 

48. Which of the following statements are correct?

(i) Ferrimagnetic substances lose ferrimagnetism on heating and become paramagnetic.

(ii) Ferrimagnetic substances do not lose ferrimagnetism on heating and remain ferrimagnetic.

(iii) Antiferromagnetic substances have domain structures similar to ferromagnetic substances and their magnetic moments are not cancelled by each other.

(iv) In ferromagnetic substances all the domains get oriented in the direction of magnetic field and remain as such even after removing magnetic field.

49. Which of the following features are **not** shown by quartz glass?

(i) This is a crystalline solid.

(ii) Refractive index is same in all the directions.

(iii) This has definite heat of fusion.

(iv) This is also called super cooled liquid.

50. Which of the following **cannot** be regarded as molecular solid?

(i) SiC (Silicon carbide)

(ii) AlN

(iii) Diamond

(iv) I_2

51. In which of the following arrangements octahedral voids are formed?

(i) *hcp*

(ii) *bcc*

(iii) simple cubic

(iv) *fcc*

52. Frenkel defect is also known as _______.

(i) stoichiometric defect

(ii) dislocation defect

(iii) impurity defect

(iv) non-stoichometric defect

53. Which of the following defects decrease the density?

(i) Interstitial defect

(ii) Vacancy defect

(iii) Frankel defect

(iv) Schottky defect

III. Short Answer Type

54. Why are liquids and gases categorised as fluids?

55. Why are solids incompressible?

56. Inspite of long range order in the arrangement of particles why are the crystals usually not perfect?

57. Why does table salt, NaCl, some times appear yellow in colour?

58. Why is FeO (s) not formed in stoichiometric composition?

59. Why does white ZnO (s) becomes yellow upon heating?

60. Why does the electrical conductivity of semiconductors increase with rise in temperature?

61. Explain why does conductivity of germanium crystals increase on doping with galium.

62. In a compound, nitrogen atoms (N) make cubic close packed lattice and metal atoms (M) occupy one-third of the tetrahedral voids present. Determine the formula of the compound formed by M and N?

63. Under which situations can an amorphous substance change to crystalline form?

IV. Matching Type

Note : In the following questions match the items given in Column I with the items given in Column II. In some questions more than one item of Column I and Column II may match.

64. Match the defects given in Column I with the statements in given Column II.

Column I	**Column II**
(i) Simple vacancy defect	(a) shown by non-ionic solids and increases density of the solid.
(ii) Simple interstitial defect	(b) shown by ionic solids and decreases density of the solid.
(iii) Frenkel defect	(c) shown by non ionic solids and density of the solid decreases
(iv) Schottky defect	(d) shown by ionic solids and density of the solid remains the same.

65. Match the type of unit cell given in Column I with the features given in Column II.

Column I	**Column II**
(i) Primitive cubic unit cell	(a) Each of the three perpendicular edges compulsorily have the different edge length i.e; $a \neq b \neq c$.
(ii) Body centred cubic unit cell	(b) Number of atoms per unit cell is one.
(iii) Face centred cubic unit cell	(c) Each of the three perpendicular edges compulsorily have the same edge length i.e; $a = b = c$
(iv) End centred orthorhombic unit cell	(d) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is one.
	(e) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is three.

66. Match the types of defect given in Column I with the statement given in Column II.

	Column I		**Column II**
(i)	Impurity defect	(a)	NaCl with anionic sites called F-centres
(ii)	Metal excess defect	(b)	FeO with Fe^{3+}
(iii)	Metal deficiency defect	(c)	NaCl with Sr^{2+} and some cationic sites vacant

67. Match the items given in Column I with the items given in Column II.

	Column I		**Column II**
(i)	Mg in solid state	(a)	*p*-Type semiconductor
(ii)	$MgCl_2$ in molten state	(b)	*n*-Type semiconductor
(iii)	Silicon with phosphorus	(c)	Electrolytic conductors
(iv)	Germanium with boron	(d)	Electronic conductors

68. Match the type of packing given in Column I with the items given in Column II.

	Column I		**Column II**
(i)	Square close packing in two dimensions	(a)	Triangular voids
(ii)	Hexagonal close packing in two dimensions	(b)	Pattern of spheres is repeated in every fourth layer
(iii)	Hexagonal close packing in three dimensions	(c)	Coordination number 4
(iv)	Cubic close packing in three dimensions	(d)	Pattern of sphere is repeated in alternate layers

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Assertion is wrong statement but reason is correct statement.

69. **Assertion** : The total number of atoms present in a simple cubic unit cell is one.

Reason : Simple cubic unit cell has atoms at its corners, each of which is shared between eight adjacent unit cells.

70. **Assertion** : Graphite is a good conductor of electricity however diamond belongs to the category of insulators.

Reason : Graphite is soft in nature on the other hand diamond is very hard and brittle.

71. **Assertion** : Total number of octahedral voids present in unit cell of cubic close packing including the one that is present at the body centre, is four.

Reason : Besides the body centre there is one octahedral void present at the centre of each of the six faces of the unit cell and each of which is shared between two adjacent unit cells.

72. **Assertion** : The packing efficiency is maximum for the *fcc* structure.

Reason : The cordination number is 12 in *fcc* structures.

73. **Assertion** : Semiconductors are solids with conductivities in the intermediate range from $10^{-6} – 10^{4}$ ohm^{-1}m^{-1}.

Reason : Intermediate conductivity in semiconductor is due to partially filled valence band.

VI. Long Answer Type

74. With the help of a labelled diagram show that there are four octahedral voids per unit cell in a cubic close packed structure.

75. Show that in a cubic close packed structure, eight tetrahedral voids are present per unit cell.

76. How does the doping increase the conductivity of semiconductors?

77. A sample of ferrous oxide has actual formula $Fe_{0.93}O_{1.00}$. In this sample what fraction of metal ions are Fe^{2+} ions? What type of nonstoichiometric defect is present in this sample?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii) 2. (ii) 3. (ii) 4. (iv) 5. (i) 6. (iv)
7. (ii) 8. (i) 9. (iii) 10. (iii) 11. (i) 12. (ii)
13. (iii) 14. (iv) 15. (iii) 16. (iv) 17. (i) 18. (ii)
19. (ii) 20. (iv) 21. (ii) 22. (i) 23. (ii) 24. (iii)
25. (iv) 26. (i) 27. (iii) 28. (iv) 29. (ii) 30. (ii)
31. (iv) 32. (i) 33. (ii) 34. (i) 35. (iv) 36. (i)
37. (i)

II. Multiple Choice Questions (Type-II)

38. (iii), (iv) 39. (iii), (iv) 40. (iii), (iv) 41. (i), (ii), (iv)

42. (i), (ii) 43. (ii), (iii) 44. (i), (iv) 45. (ii), (iii)

46. (i), (iii) 47. (i), (iii) 48. (i), (iv) 49. (i), (iii)

50. (i), (ii), (iii) 51. (i), (iv) 52. (i), (ii) 53. (ii), (iv)

III. Short Answer Type

54. The liquids and gases have a property to flow i.e. the molecules can move past and tumble over one another freely. Hence, they have been categorised as fluids.

55. The distance between the constituent particles (atoms, ions, molecules etc.) is very less in solids. On bringing them still closer repulsion will start between electron clouds of these particles. Hence, they cannot be brought further close to each other.

56. Crystals have long range repeated pattern of arrangement of constitutent particles but in the process of crystallisation some deviations from the ideal arrangement (i.e. defects) may be introduced, therefore, crystals are usually not perfect.

57. Yellow colour in sodium chloride is due to metal excess defect due to which unpaired electrons occupy anionic sites. These sites are called F-centres. These electrons absorb energy from the visible region for the excitation which makes crystal appear yellow.

58. In the crystals of FeO, some of the Fe^{2+} cations are replaced by Fe^{3+} ions. Three Fe^{2+} ions are replaced by two Fe^{3+} ions to make up for the loss of positive charge. Eventually there would be less amount of metal as compared to stoichiometric proportion.

59. On heating ZnO loses oxygen according to the following reaction.

$$ZnO \xrightarrow{heating} Zn^{2+} + \frac{1}{2}O_2 + 2e^-$$

Zn^{2+} ions and electrons move to interstitial sites and F-centres are created which impart yellow colour to ZnO(s).

60. The gap between conduction band and valence band is small in semiconductors (Fig. 1.1), therefore, electrons from the valence band can jump to the conduction band on increasing temperature. Thus they become more conducting as the temperature increases.

61. On doping germanium with galium some of the positions of lattice of germanium are occupied by galium. Galium atom has only three valence electrons. Therefore, fourth valency of nearby germanium atom is not satisfied. The place remains vacant. This place is deficient of electrons and is therefore called electron hole or electron vacancy. Electron from neighbouring atom comes and fills the gap, thereby creating a hole in its original position. Under the influence of electric field electrons move towards positively charged plates through these holes and conduct electricity. The holes appear to move towards negatively charged plates.

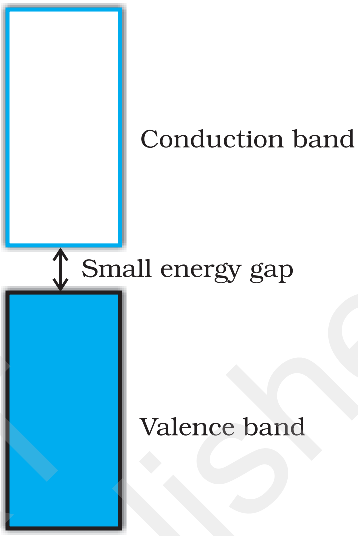


Fig. 1.2 : Semi conductor

62. M_2N_3

63. See page no. 3 of NCERT textbook for Class XII.

IV. Matching Type

64. (i) → (c) (ii) → (a) (iii) → (d) (iv) → (b)

65. (i) → (b), (c) (ii) → (c), (d) (iii) → (c), (e) (iv) → (a), (d)

66. (i) → (c) (ii) → (a) (iii) → (b)

67. (i) → (d) (ii) → (c) (iii) → (b) (iv) → (a)

68. (i) → (c) (ii) → (a) (iii) → (d) (iv) → (b)

V. Assertion and Reason Type

69. (i) 70. (ii) 71. (iii) 72. (ii) 73. (iii)

VI. Long Answer Type

74. **[Hint :** Draw structure and discuss]

75. **[Hint :**Draw structure and discuss]

76. See page no. 26 of NCERT textbook for Class XII.

77. Let the formula of sample be

$(Fe^{2+})_x(Fe^{3+})_yO.$

On looking at the given formula of the compound

$$x + y = 0.93 \qquad \ldots (1)$$

Total positive charge on ferrous and ferric ions should balance the two units of negative charge on oxygen. Therefore,

$$2x + 3y = 2 \qquad \ldots (2)$$

$$\Rightarrow \quad x + \frac{3}{2}y = 1 \qquad \ldots (3)$$

On subtracting equation (1) from equation (3) we have

$$\frac{3}{2}y - y = 1 - 0.93$$

$$\Rightarrow \quad \frac{1}{2}y = 0.07$$

$$\Rightarrow \quad y = 0.14$$

On putting the value of y in equation (1) we get,

$$x + 0.14 = 0.93$$

$$\Rightarrow \quad x = 0.93 - 0.14$$

$$x = 0.79$$

Fraction of Fe^{2+} ions present in the sample = $\frac{0.79}{0.93} = 0.81$

Metal deficiency defect is present in the sample because iron is less in amount than that required for stoichiometric composition.

Unit 2

SOLUTIONS

I. Multiple Choice Questions (Type-I)

1. Which of the following units is useful in relating concentration of solution with its vapour pressure?

(i) mole fraction

(ii) parts per million

(iii) mass percentage

(iv) molality

2. On dissolving sugar in water at room temperature solution feels cool to touch. Under which of the following cases dissolution of sugar will be most rapid?

(i) Sugar crystals in cold water.

(ii) Sugar crystals in hot water.

(iii) Powdered sugar in cold water.

(iv) Powdered sugar in hot water.

3. At equilibrium the rate of dissolution of a solid solute in a volatile liquid solvent is __________.

(i) less than the rate of crystallisation

(ii) greater than the rate of crystallisation

(iii) equal to the rate of crystallisation

(iv) zero

4. A beaker contains a solution of substance 'A'. Precipitation of substance 'A' takes place when small amount of 'A' is added to the solution. The solution is _________.

(i) saturated

(ii) supersaturated
(iii) unsaturated
(iv) concentrated

5. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does **not** depend upon ____________.

(i) Temperature
(ii) Nature of solute
(iii) Pressure
(iv) Nature of solvent

6. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to ____________.

(i) low temperature
(ii) low atmospheric pressure
(iii) high atmospheric pressure
(iv) both low temperature and high atmospheric pressure

7. Considering the formation, breaking and strength of hydrogen bond, predict which of the following mixtures will show a positive deviation from Raoult's law?

(i) Methanol and acetone.
(ii) Chloroform and acetone.
(iii) Nitric acid and water.
(iv) Phenol and aniline.

8. Colligative properties depend on ____________.

(i) the nature of the solute particles dissolved in solution.
(ii) the number of solute particles in solution.
(iii) the physical properties of the solute particles dissolved in solution.
(iv) the nature of solvent particles.

9. Which of the following aqueous solutions should have the highest boiling point?

(i) 1.0 M $NaOH$
(ii) 1.0 M Na_2SO_4
(iii) 1.0 M NH_4NO_3
(iv) 1.0 M KNO_3

10. The unit of ebulioscopic constant is _______________.

(i) $K\ kg\ mol^{-1}$ or $K\ (molality)^{-1}$
(ii) $mol\ kg\ K^{-1}$ or $K^{-1}(molality)$

(iii) kg mol^{-1} K^{-1} or K^{-1}(molality)$^{-1}$

(iv) K mol kg^{-1} or K (molality)

11. In comparison to a 0.01 M solution of glucose, the depression in freezing point of a 0.01 M $MgCl_2$ solution is _____________.

(i) the same

(ii) about twice

(iii) about three times

(iv) about six times

12. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _____________.

(i) it gains water due to osmosis.

(ii) it loses water due to reverse osmosis.

(iii) it gains water due to reverse osmosis.

(iv) it loses water due to osmosis.

13. At a given temperature, osmotic pressure of a concentrated solution of a substance _____________.

(i) is higher than that at a dilute solution.

(ii) is lower than that of a dilute solution.

(iii) is same as that of a dilute solution.

(iv) cannot be compared with osmotic pressure of dilute solution.

14. Which of the following statements is false?

(i) Two different solutions of sucrose of same molality prepared in different solvents will have the same depression in freezing point.

(ii) The osmotic pressure of a solution is given by the equation $\Pi = CRT$ (where C is the molarity of the solution).

(iii) Decreasing order of osmotic pressure for 0.01 M aqueous solutions of barium chloride, potassium chloride, acetic acid and sucrose is

$BaCl_2 > KCl > CH_3COOH >$ sucrose.

(iv) According to Raoult's law, the vapour pressure exerted by a volatile component of a solution is directly proportional to its mole fraction in the solution.

15. The values of Van't Hoff factors for KCl, NaCl and K_2SO_4, respectively, are _____________.

(i) 2, 2 and 2

(ii) 2, 2 and 3

(iii) 1, 1 and 2

(iv) 1, 1 and 1

16. Which of the following statements is **false**?

(i) Units of atmospheric pressure and osmotic pressure are the same.

(ii) In reverse osmosis, solvent molecules move through a semipermeable membrane from a region of lower concentration of solute to a region of higher concentration.

(iii) The value of molal depression constant depends on nature of solvent.

(iv) Relative lowering of vapour pressure, is a dimensionless quantity.

17. Value of Henry's constant K_H ____________.

(i) increases with increase in temperature.

(ii) decreases with increase in temperature.

(iii) remains constant.

(iv) first increases then decreases.

18. The value of Henry's constant K_H is ____________.

(i) greater for gases with higher solubility.

(ii) greater for gases with lower solubility.

(iii) constant for all gases.

(iv) not related to the solubility of gases.

19. Consider the Fig. 2.1 and mark the correct option.

(i) water will move from side (A) to side (B) if a pressure lower than osmotic pressure is applied on piston (B).

(ii) water will move from side (B) to side (A) if a pressure greater than osmotic pressure is applied on piston (B).

(iii) water will move from side (B) to side (A) if a pressure equal to osmotic pressure is applied on piston (B).

(iv) water will move from side (A) to side (B) if pressure equal to osmotic pressure is applied on piston (A).

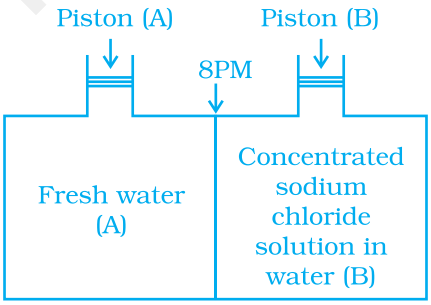


Fig. *2.1*

20. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in the order______.

(i) $i_A < i_B < i_C$

(ii) $i_A > i_B > i_C$

(iii) $i_A = i_B = i_C$

(iv) $i_A < i_B > i_C$

21. On the basis of information given below mark the correct option.

Information:

(A) In bromoethane and chloroethane mixture intermolecular interactions of A–A and B–B type are nearly same as A–B type interactions.

(B) In ethanol and acetone mixture A–A or B–B type intermolecular interactions are stronger than A–B type interactions.

(C) In chloroform and acetone mixture A–A or B–B type intermolecular interactions are weaker than A–B type interactions.

(i) Solution (B) and (C) will follow Raoult's law.

(ii) Solution (A) will follow Raoult's law.

(iii) Solution (B) will show negative deviation from Raoult's law.

(iv) Solution (C) will show positive deviation from Raoult's law.

22. Two beakers of capacity 500 mL were taken. One of these beakers, labelled as "A", was filled with 400 mL water whereas the beaker labelled "B" was filled with 400 mL of 2 M solution of NaCl. At the same temperature both the beakers were placed in closed containers of same material and same capacity as shown in Fig. 2.2.

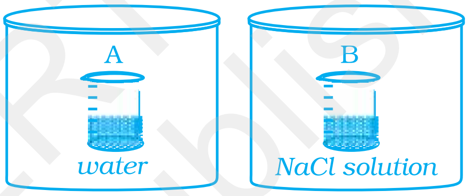


Fig. *2.2*

At a given temperature, which of the following statement is correct about the vapour pressure of pure water and that of NaCl solution.

(i) vapour pressure in container (A) is more than that in container (B).

(ii) vapour pressure in container (A) is less than that in container (B).

(iii) vapour pressure is equal in both the containers.

(iv) vapour pressure in container (B) is twice the vapour pressure in container (A).

23. If two liquids A and B form minimum boiling azeotrope at some specific composition then _____________.

(i) A–B interactions are stronger than those between A–A or B–B.

(ii) vapour pressure of solution increases because more number of molecules of liquids A and B can escape from the solution.

(iii) vapour pressure of solution decreases because less number of molecules of only one of the liquids escape from the solution.

(iv) A–B interactions are weaker than those between A–A or B–B.

24. 4L of 0.02 M aqueous solution of NaCl was diluted by adding one litre of water. The molality of the resultant solution is ___________.

(i) 0.004

(ii) 0.008

(iii) 0.012

(iv) 0.016

25. On the basis of information given below mark the correct option.

Information : On adding acetone to methanol some of the hydrogen bonds between methanol molecules break.

(i) At specific composition methanol-acetone mixture will form minimum boiling azeotrope and will show positive deviation from Raoult's law.

(ii) At specific composition methanol-acetone mixture forms maximum boiling azeotrope and will show positive deviation from Raoult's law.

(iii) At specific composition methanol-acetone mixture will form minimum boiling azeotrope and will show negative deviation from Raoult's law.

(iv) At specific composition methanol-acetone mixture will form maximum boiling azeotrope and will show negative deviation from Raoult's law.

26. K_H value for Ar(g), CO_2(g), HCHO (g) and CH_4(g) are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively.

Arrange these gases in the order of their increasing solubility.

(i) $HCHO < CH_4 < CO_2 < Ar$

(ii) $HCHO < CO_2 < CH_4 < Ar$

(iii) $Ar < CO_2 < CH_4 < HCHO$

(iv) $Ar < CH_4 < CO_2 < HCHO$

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

27. Which of the following factor (s) affect the solubility of a gaseous solute in the fixed volume of liquid solvent?

(a) nature of solute (b) temperature (c) pressure

(i) (a) and (c) at constant T

(ii) (a) and (b) at constant P

(iii) (b) and (c) only

(iv) (c) only

28. Intermolecular forces between two benzene molecules are nearly of same strength as those between two toluene molecules. For a mixture of benzene and toluene, which of the following are **not** true?

(i) $\Delta_{mix} H = \text{zero}$

(ii) $\Delta_{mix} V = \text{zero}$

(iii) These will form minimum boiling azeotrope.

(iv) These will not form ideal solution.

29. Relative lowering of vapour pressure is a colligative property because ____________.

(i) It depends on the concentration of a non electrolyte solute in solution and does not depend on the nature of the solute molecules.

(ii) It depends on number of particles of electrolyte solute in solution and does not depend on the nature of the solute particles.

(iii) It depends on the concentration of a non electrolyte solute in solution as well as on the nature of the solute molecules.

(iv) It depends on the concentration of an electrolyte or nonelectrolyte solute in solution as well as on the nature of solute molecules.

30. Van't Hoff factor i is given by the expression ____________.

(i) $i = \dfrac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$

(ii) $i = \dfrac{\text{Abnormal molar mass}}{\text{Normal molar mass}}$

(iii) $i = \dfrac{\text{Observed colligative property}}{\text{Calculated colligative property}}$

(iv) $i = \dfrac{\text{Calculated colligative property}}{\text{Observed colligative property}}$

31. Isotonic solutions must have the same ____________.

(i) solute

(ii) density

(iii) elevation in boiling point

(iv) depression in freezing point

32. Which of the following binary mixtures will have same composition in liquid and vapour phase?

(i) Benzene - Toluene

(ii) Water-Nitric acid

(iii) Water-Ethanol

(iv) *n*-Hexane - *n*-Heptane

33. In isotonic solutions ____________.

(i) solute and solvent both are same.

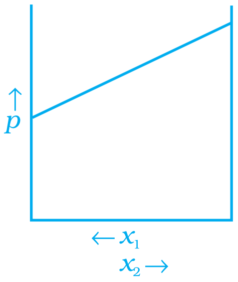
(ii) osmotic pressure is same.

(iii) solute and solvent may or may not be same.

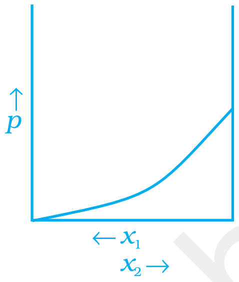
(iv) solute is always same solvent may be different.

34. For a binary ideal liquid solution, the variation in total vapour pressure versus composition of solution is given by which of the curves?

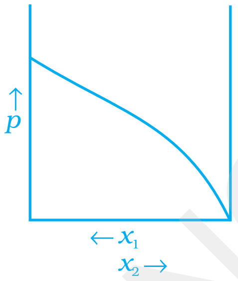
(i)



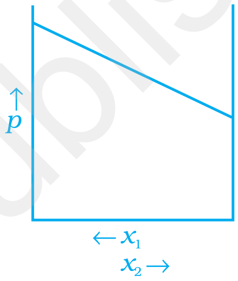
(ii)



(iii)



(iv)



35. Colligative properties are observed when _____________.

(i) a non volatile solid is dissolved in a volatile liquid.

(ii) a non volatile liquid is dissolved in another volatile liquid.

(iii) a gas is dissolved in non volatile liquid.

(iv) a volatile liquid is dissolved in another volatile liquid.

III. Short Answer Type

36. Components of a binary mixture of two liquids A and B were being separated by distillation. After some time separation of components stopped and composition of vapour phase became same as that of liquid phase. Both the components started coming in the distillate. Explain why this happened.

37. Explain why on addition of 1 mol of NaCl to 1 litre of water, the boiling point of water increases, while addition of 1 mol of methyl alcohol to one litre of water decreases its boiling point.

38. Explain the solubility rule "like dissolves like" in terms of intermolecular forces that exist in solutions.

39. Concentration terms such as mass percentage, ppm, mole fraction and molality are independent of temperature, however molarity is a function of temperature. Explain.

40. What is the significance of Henry's Law constant K_H?

41. Why are aquatic species more comfortable in cold water in comparison to warm water?

42. (a) Explain the following phenomena with the help of Henry's law.

- (i) Painful condition known as bends.
- (ii) Feeling of weakness and discomfort in breathing at high altitude.

(b) Why soda water bottle kept at room temperature fizzes on opening?

43. Why is the vapour pressure of an aqueous solution of glucose lower than that of water?

44. How does sprinkling of salt help in clearing the snow covered roads in hilly areas? Explain the phenomenon involved in the process.

45. What is "semi permeable membrane"?

46. Give an example of a material used for making semipermeable membrane for carrying out reverse osmosis.

IV. Matching Type

Note : In the following questions match the items given in Column I and Column II.

47. Match the items given in Column I and Column II.

	Column I		**Column II**
(i)	Saturated solution	(a)	Solution having same osmotic pressure at a given temperature as that of given solution.
(ii)	Binary solution	(b)	A solution whose osmotic pressure is less than that of another.
(iii)	Isotonic solution	(c)	Solution with two components.
(iv)	Hypotonic solution	(d)	A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.
(v)	Solid solution	(e)	A solution whose osmotic pressure is more than that of another.
(vi)	Hypertonic solution	(f)	A solution in solid phase.

48. Match the items given in Column I with the type of solutions given in Column II.

	Column I		Column II
(i)	Soda water	(a)	A solution of gas in solid
(ii)	Sugar solution	(b)	A solution of gas in gas
(iii)	German silver	(c)	A solution of solid in liquid
(iv)	Air	(d)	A solution of solid in solid
(v)	Hydrogen gas in palladium	(e)	A solution of gas in liquid
		(f)	A solution of liquid in solid

49. Match the laws given in Column I with expresions given in Column II.

	Column I		Column II
(i)	Raoult's law	(a)	$\Delta T_f = \mathrm{K}_f \mathrm{m}$
(ii)	Henry's law	(b)	$\Pi = CRT$
(iii)	Elevation of boiling point	(c)	$p = x_1 p_1^{\circ} + x_2 p_2^{\circ}$
(iv)	Depression in freezing point	(d)	$\Delta T_b = K_b \mathrm{m}$
(v)	Osmotic pressure	(e)	$p = K_{\mathrm{H}}.x$

50. Match the terms given in Column I with expressions given in Column II.

	Column I		Column II
(i)	Mass percentage	(a)	$\dfrac{\text{Number of moles of the solute component}}{\text{Volume of solution in litres}}$
(ii)	Volume percentage	(b)	$\dfrac{\text{Number of moles of a component}}{\text{Total number of moles of all the components}}$
(iii)	Mole fraction	(c)	$\dfrac{\text{Volume of the solute component in solution}}{\text{Total volume of solution}} \times 100$
(iv)	Molality	(d)	$\dfrac{\text{Mass of the solute component in solution}}{\text{Total mass of the solution}} \times 100$
(v)	Molarity	(e)	$\dfrac{\text{Number of moles of the solute components}}{\text{Mass of solvent in kilograms}}$

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(iii) Assertion is correct statement but reason is wrong statement.
(iv) Assertion and reason both are incorrect statements.
(v) Assertion is wrong statement but reason is correct statement.

51. Assertion : Molarity of a solution in liquid state changes with temperature.
Reason : The volume of a solution changes with change in temperature.

52. Assertion : When methyl alcohol is added to water, boiling point of water increases.
Reason : When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

53. Assertion : When NaCl is added to water a depression in freezing point is observed.
Reason : The lowering of vapour pressure of a solution causes depression in the freezing point.

54. Assertion : When a solution is separated from the pure solvent by a semi-permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side.
Reason : Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

VI. Long Answer Type

55. Define the following modes of expressing the concentration of a solution. Which of these modes are independent of temperature and why?

(i) w/w (mass percentage)
(ii) V/V (volume percentage)
(iii) w/V (mass by volume percentage)
(iv) ppm. (parts per million)
(v) x (mole fraction)
(vi) M (Molarity)
(vii) m (Molality)

56. Using Raoult's law explain how the total vapour pressure over the solution is related to mole fraction of components in the following solutions.

(i) $CHCl_3$ (*l*) and CH_2Cl_2(*l*)
(ii) NaCl(s) and H_2O (*l*)

57. Explain the terms ideal and non-ideal solutions in the light of forces of interactions operating between molecules in liquid solutions.

58. Why is it not possible to obtain pure ethanol by fractional distillation? What general name is given to binary mixtures which show deviation from Raoult's law and whose components cannot be separated by fractional distillation. How many types of such mixtures are there?

59. When kept in water, raisin swells in size. Name and explain the phenomenon involved with the help of a diagram. Give three applications of the phenomenon.

60. Discuss biological and industrial importance of osmosis.

61. How can you remove the hard calcium carbonate layer of the egg without damaging its semiprermiable membrane? Can this egg be inserted into a bottle with a narrow neck without distorting its shape? Explain the process involved.

62. Why is the mass determined by measuring a colligative property in case of some solutes abnormal ? Discuss it with the help of Van't Hoff factor.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (i) 2. (iv) 3. (iii)

4. (ii), [**Hint :** If added substance dissolves, the solution is unsaturated. If it does not dissolve solution is saturated. If precipitation occurs solution is supersaturated.]

5. (iii)

6. (ii), [**Hint :** Body temperature of human beings remains constant.]

7. (i) 8. (ii) 9. (ii) 10. (i) 11. (iii) 12. (iv)
13. (i) 14. (i) 15. (ii) 16. (ii) 17. (i) 18. (ii)
19. (ii) 20. (iii) 21. (ii) 22. (i) 23. (i) 24. (iv)
25. (ii) 26. (iii)

II. Multiple Choice Questions (Type-II)

27. (i), (ii) 28. (iii), (iv) 29. (i), (ii) 30. (i), (iii) 31. (ii), (iii)
32. (ii), (iii) 33. (ii), (iii) 34. (i), (iv) 35. (i), (ii)

III. Short Answer Type

36. Since both the components are appearing in the distillate and composition of liquid and vapour is same, this shows that liquids have formed azeotropic mixture and hence cannot be separated at this stage by distillation.

37. NaCl is a non volatile solute, therefore, addition of NaCl to water lowers the vapour pressure of water. As a result boiling point of water increases. Methyl alcohol on the other hand is more volatile than water, therefore its addition increases, the total vapour pressure over the solution and a decrease in boiling point of water results.

38. A substance (solute) dissolves in a solvent if the intermolecular interactions are similar in both the components; for example, polar solutes dissolve in polar solvents and non polar solutes in non polar solvents thus we can say “like dissolves like”.

39. Molarity of a solution is defined as the number of moles of solute dissolved in one litre of solution. Since volume depends on temperature and undergoes a change with change in temperature, the molarity will also change with change in temperature. On the other hand, mass does not change with change in temperature, as a result other concentration terms given in the question remain unchanged by changing temperature. According to the definition of all these terms, mass of the solvent used for making the solution is related to the mass of solute.

40. Higher the value of Henry’s law constant K_H, the lower is the solubility of the gas in the liquid.

41. At a given pressure the solubility of oxygen in water increases with decrease in temperature. Presence of more oxygen at lower temperature makes the aquatic species more comfortable in cold water.

42. Refer to the NCERT textbook for Class XII.

43. In pure liquid water the entire surface of liquid is occupied by the molecules of water. When a non volatile solute, for example glucose is dissolved in water, the fraction of surface covered by the solvent molecules gets reduced because some positions are occupied by glucose molecules. As a result number of solvent molecules escaping from the surface also gets reduced, consequently the vapour pressure of aqueous solution of glucose is reduced.

44. When salt is spread over snow covered roads, snow starts melting from the surface because of the depression in freezing point of water and it helps in clearing the roads.

45. Continuous sheets or films (natural or synthetic) which contain a network of submicroscopic holes or pores through which small solvent molecules like water can pass; but the passage of bigger molecules of solute is hindered, are known as semi permeable membrane.

46. Cellulose acetate.

IV. Matching Type

47. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b) (v) → (f) (vi) → (e)
48. (i) → (e) (ii) → (c) (iii) → (d) (iv) → (b) (v) → (a)
49. (i) → (c) (ii) → (e) (iii) → (d) (iv) → (a) (v) → (b)
50. (i) → (d) (ii) → (c) (iii) → (b) (iv) → (e) (v) → (a)

V. Assertion and Reason Type

51. (i) 52. (iv) 53. (i) 54. (ii)

VI. Long Answer Type

55. Refer to NCERT textbook for Class XII.

56. **Hint :** Discuss the following formulas

(i) for a binary solution having both components as volatile liquids, the total pressure will be

$$p = p_1 = x_1 p_1^0 + x_2 p_2^0$$
$$= x_1 p_1^0 + (1 - x_1) p_2^0$$
$$= (p_1^0 - p_2^0)\, x_1 + p_2^0$$

p = total vapour pressure

p_1 = partial vapour pressure of component 1

p_2 = partial vapour pressure of component 2.

(ii) For a solution containing non-volatile solute, the Raoult's law is applicable only to vaporisable component (1) and total vapour pressure is written as

$$p = p_1 = x_1 p_1^0$$

57. Refer to page 45 of NCERT textbook for Class XII.

58. See page 46 of NCERT textbook for Class XII.

59. [**Hint :** Explain it with the help of a diagram (Fig. 2.3) illustrating the osmosis of water into raisin.]

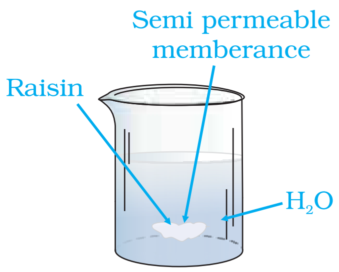


Fig. 2.3

60. **Hint :** The process of osmosis is of immense biological and industrial importance as is evident from the following examples :

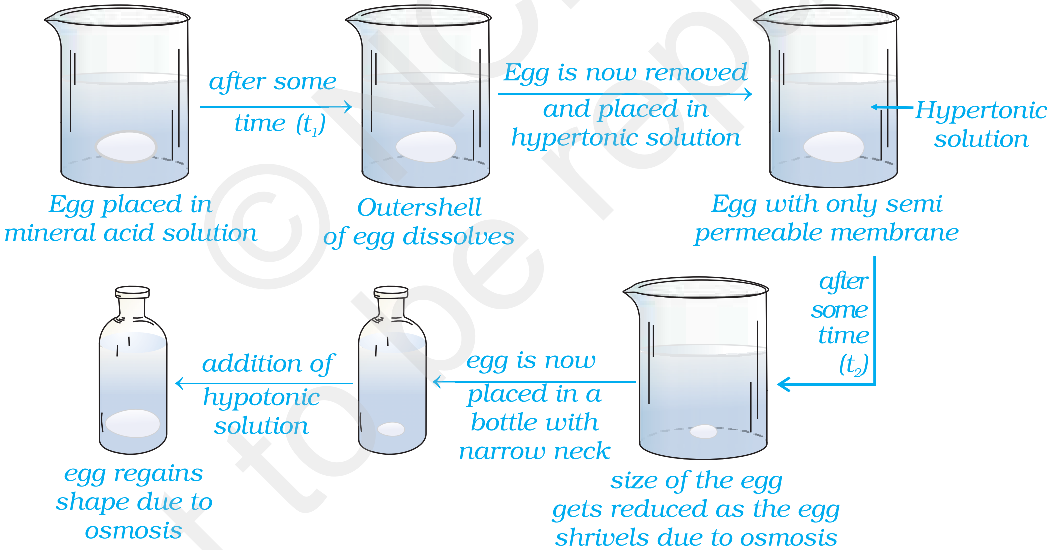
(i) Movement of water from soil into plant roots and subsequently into upper portion of the plant is partly due to osmosis.

(ii) Preservation of meat against bacterial action by adding salt.

(iii) Preservation of fruits against bacterial action by adding sugar. Bacterium in canned fruit loses water through the process of osmosis, shrivels and dies.

(iv) Reverse osmosis is used for desalination of water.

61. **Hint :**



62. Certain compounds when dissolved in suitable solvents either dissociate or associate.

For example ethanoic acid dimerises in benzene due to hydrogen bonding, while in water, it dissociates and forms ions. As a result the number of chemical species in solution increases or decreases as compared to the number of chemical species of solute added to form the solution. Since the magnitude of colligative property depends on the number of solute particles, it is expected that the molar mass determined on the basis of colligative properties will be either higher or lower than the expected value or the normal value and is called abnormal molar mass.

In order to account for the extent of dissociation or association of molecules in solution, Van't Hoff introduced a factor, *i*, known as the Van't Hoff factor. It can be defined as follows.

$$i = \frac{\text{Expected molar mass}}{\text{Abnormal molar mass}}$$

$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$= \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$$

Unit
3

ELECTROCHEMISTRY

I. Multiple Choice Questions (Type-I)

1. Which cell will measure standard electrode potential of copper electrode?

(i) Pt (s) | H_2 (g,0.1 bar) | H^+(aq.,1 M) || Cu^{2+}(aq.,1M) | Cu

(ii) Pt(s) | H_2 (g, 1 bar) | H^+(aq.,1 M) || Cu^{2+}(aq.,2 M) | Cu

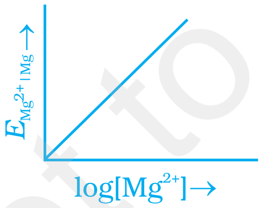
(iii) Pt(s) | H_2 (g, 1 bar) | H^+(aq.,1 M) || Cu^{2+} (aq.,1 M) | Cu

(iv) Pt(s) | H_2 (g, 1 bar) | H^+ (aq.,0.1 M) || Cu^{2+} (aq.,1 M) | Cu

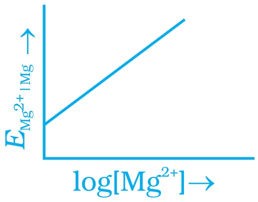
2. Electrode potential for Mg electrode varies according to the equation

$E_{Mg^{2+}|Mg} = E^{\ominus}_{Mg^{2+}|Mg} - \dfrac{0.059}{2}\log\dfrac{1}{[Mg^{2+}]}$. The graph of $E_{Mg^{2+}|Mg}$ vs log $[Mg^{2+}]$ is

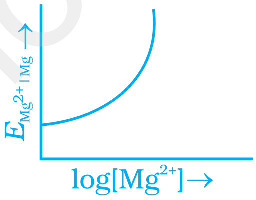
(i)



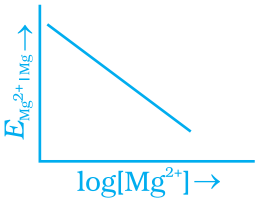
(ii)



(iii)



(iv)



3. Which of the following statement is correct?

(i) E_{Cell} and $\Delta_r G$ of cell reaction both are extensive properties.

(ii) E_{Cell} and $\Delta_r G$ of cell reaction both are intensive properties.

(iii) E_{Cell} is an intensive property while $\Delta_r G$ of cell reaction is an extensive property.

(iv) E_{Cell} is an extensive property while $\Delta_r G$ of cell reaction is an intensive property.

4. The difference between the electrode potentials of two electrodes when no current is drawn through the cell is called ___________.

(i) Cell potential

(ii) Cell emf

(iii) Potential difference

(iv) Cell voltage

5. Which of the following statement is **not** correct about an inert electrode in a cell?

(i) It does not participate in the cell reaction.

(ii) It provides surface either for oxidation or for reduction reaction.

(iii) It provides surface for conduction of electrons.

(iv) It provides surface for redox reaction.

6. An electrochemical cell can behave like an electrolytic cell when ___________.

(i) $E_{\text{cell}} = 0$

(ii) $E_{\text{cell}} > E_{\text{ext}}$

(iii) $E_{\text{ext}} > E_{\text{cell}}$

(iv) $E_{\text{cell}} = E_{\text{ext}}$

7. Which of the statements about solutions of electrolytes is **not** correct?

(i) Conductivity of solution depends upon size of ions.

(ii) Conductivity depends upon viscosiy of solution.

(iii) Conductivity does not depend upon solvation of ions present in solution.

(iv) Conductivity of solution increases with temperature.

8. Using the data given below find out the strongest reducing agent.

$$E^{\ominus}_{\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}} = 1.33V \qquad E^{\ominus}_{\text{Cl}_2/\text{Cl}^-} = 1.36V$$

$$E^{\ominus}_{\text{MnO}_4^-/\text{Mn}^{2+}} = 1.51V \qquad E^{\ominus}_{\text{Cr}^{3+}/\text{Cr}} = -0.74V$$

(i) Cl^-

(ii) Cr

(iii) Cr^{3+}

(iv) Mn^{2+}

9. Use the data given in Q.8 and find out which of the following is the strongest oxidising agent.

- (i) Cl^-
- (ii) Mn^{2+}
- (iii) MnO_4^-
- (iv) Cr^{3+}

10. Using the data given in Q.8 find out in which option the order of reducing power is correct.

- (i) $Cr^{3+} < Cl^- < Mn^{2+} < Cr$
- (ii) $Mn^{2+} < Cl^- < Cr^{3+} < Cr$
- (iii) $Cr^{3+} < Cl^- < Cr_2O_7^{2-} < MnO_4^-$
- (iv) $Mn^{2+} < Cr^{3+} < Cl^- < Cr$

11. Use the data given in Q.8 and find out the most stable ion in its reduced form.

- (i) Cl^-
- (ii) Cr^{3+}
- (iii) Cr
- (iv) Mn^{2+}

12. Use the data of Q.8 and find out the most stable oxidised species.

- (i) Cr^{3+}
- (ii) MnO_4^-
- (iii) $Cr_2O_7^{2-}$
- (iv) Mn^{2+}

13. The quantity of charge required to obtain one mole of aluminium from Al_2O_3 is ___________.

- (i) 1F
- (ii) 6F
- (iii) 3F
- (iv) 2F

14. The cell constant of a conductivity cell _____________.

- (i) changes with change of electrolyte.
- (ii) changes with change of concentration of electrolyte.
- (iii) changes with temperature of electrolyte.
- (iv) remains constant for a cell.

15. While charging the lead storage battery _____________.

- (i) $PbSO_4$ anode is reduced to Pb.
- (ii) $PbSO_4$ cathode is reduced to Pb.

(iii) $PbSO_4$ cathode is oxidised to Pb.

(iv) $PbSO_4$ anode is oxidised to PbO_2.

16. $\Lambda^0_{m\ (NH_4OH)}$ is equal to ______________.

(i) $\Lambda^0_{m\ (NH_4OH)} + \Lambda^0_{m\ (NH_4Cl)} - \Lambda^0_{(HCl)}$

(ii) $\Lambda^0_{m\ (NH_4Cl)} + \Lambda^0_{m\,(NaOH)} - \Lambda^0_{(NaCl)}$

(iii) $\Lambda^0_{m\ (NH_4Cl)} + \Lambda^0_{m\,(NaCl)} - \Lambda^0_{(NaOH)}$

(iv) $\Lambda^0_{m\ (NaOH)} + \Lambda^0_{m\,(NaCl)} - \Lambda^0_{(NH_4Cl)}$

17. In the electrolysis of aqueous sodium chloride solution which of the half cell reaction will occur at anode?

(i) $Na^+\,(aq) + e^- \longrightarrow Na\,(s)$; $E^{\ominus}_{Cell} = -2.71V$

(ii) $2H_2O\,(l) \longrightarrow O_2\,(g) + 4H^+\,(aq) + 4e^-$; $E^{\ominus}_{Cell} = 1.23V$

(iii) $H^+\,(aq) + e^- \longrightarrow \frac{1}{2}H_2\,(g)$; $E^{\ominus}_{Cell} = 0.00\ V$

(iv) $Cl^-\,(aq) \longrightarrow \frac{1}{2}Cl_2\,(g) + e^-$; $E^{\ominus}_{Cell} = 1.36\ V$

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more than two options may be correct.

18. The positive value of the standard electrode potential of Cu^{2+}/Cu indicates that ____________.

(i) this redox couple is a stronger reducing agent than the H^+/H_2 couple.

(ii) this redox couple is a stronger oxidising agent than H^+/H_2.

(iii) Cu can displace H_2 from acid.

(iv) Cu cannot displace H_2 from acid.

19. $E^{\ominus}_{Cell}$ for some half cell reactions are given below. On the basis of these mark the correct answer.

(a) $H^+\,(aq) + e^- \longrightarrow \frac{1}{2}H_2\,(g)$; $E^{\ominus}_{Cell} = 0.00V$

(b) $2H_2O\,(l) \longrightarrow O_2\,(g) + 4H^+\,(aq) + 4e^-\,;$ $\quad E^{\ominus}_{Cell} = 1.23V$

(c) $2SO_4^{2-}\,(aq) \longrightarrow S_2O_8^{2-}\,(aq) + 2e^-\,;$ $\quad E^{\ominus}_{Cell} = 1.96\,V$

(i) In dilute sulphuric acid solution, hydrogen will be reduced at cathode.

(ii) In concentrated sulphuric acid solution, water will be oxidised at anode.

(iii) In dilute sulphuric acid solution, water will be oxidised at anode.

(iv) In dilute sulphuric acid solution, SO_4^{2-} ion will be oxidised to tetrathionate ion at anode.

20. $E^{\ominus}_{Cell} = 1.1V$ for Daniel cell. Which of the following expressions are correct description of state of equilibrium in this cell?

(i) $1.1 = K_c$

(ii) $\dfrac{2.303RT}{2F}\log K_c = 1.1$

(iii) $\log K_c = \dfrac{2.2}{0.059}$

(iv) $\log K_c = 1.1$

21. Conductivity of an electrolytic solution depends on ____________.

(i) nature of electrolyte.

(ii) concentration of electrolyte.

(iii) power of AC source.

(iv) distance between the electrodes.

22. $\Lambda^0_m H_2O$ is equal to ______________.

(i) $\Lambda^0_{m\,(HCl)} + \Lambda^0_{m\,(NaOH)} - \Lambda^0_{m\,(NaCl)}$

(ii) $\Lambda^0_{m\,(HNO_3)} + \Lambda^0_{m\,(NaNO_3)} - \Lambda^0_{m\,(NaOH)}$

(iii) $\Lambda^0_{(HNO_3)} + \Lambda^0_{m\,(NaOH)} - \Lambda^0_{m\,(NaNO_3)}$

(iv) $\Lambda^0_{m\,(NH_4OH)} + \Lambda^0_{m\,(HCl)} - \Lambda^0_{m\,(NH_4Cl)}$

23. What will happen during the electrolysis of aqueous solution of $CuSO_4$ by using platinum electrodes?

(i) Copper will deposit at cathode.

(ii) Copper will deposit at anode.

(iii) Oxygen will be released at anode.

(iv) Copper will dissolve at anode.

24. What will happen during the electrolysis of aqueous solution of $CuSO_4$ in the presence of Cu electrodes?

(i) Copper will deposit at cathode.

(ii) Copper will dissolve at anode.

(iii) Oxygen will be released at anode.

(iv) Copper will deposit at anode.

25. Conductivity κ, is equal to ____________.

(i) $\frac{1}{R}\frac{l}{A}$

(ii) $\frac{G^{*}}{R}$

(iii) Λ_m

(iv) $\frac{l}{A}$

26. Molar conductivity of ionic solution depends on ___________.

(i) temperature.

(ii) distance between electrodes.

(iii) concentration of electrolytes in solution.

(iv) surface area of electrodes.

27. For the given cell, $Mg|Mg^{2+}||Cu^{2+}|Cu$

(i) Mg is cathode

(ii) Cu is cathode

(iii) The cell reaction is $Mg + Cu^{2+} \longrightarrow Mg^{2+} + Cu$

(iv) Cu is the oxidising agent

III. Short Answer Type

28. Can absolute electrode potential of an electrode be measured?

29. Can $E^{\ominus}_{Cell}$ or $\Delta_r G^{\ominus}$ for cell reaction ever be equal to zero?

30. Under what condition is $E_{Cell} = 0$ or $\Delta_r G = 0$?

31. What does the negative sign in the expression $E^{\ominus}_{Zn^{2+}/Zn} = -\ 0.76\ V$ mean?

32. Aqueous copper sulphate solution and aqueous silver nitrate solution are electrolysed by 1 ampere current for 10 minutes in separate electrolytic cells. Will the mass of copper and silver deposited on the cathode be same or different? Explain your answer.

33. Depict the galvanic cell in which the cell reaction is $Cu + 2Ag^+ \longrightarrow 2Ag + Cu^{2+}$

34. Value of standard electrode potential for the oxidation of Cl^- ions is more positive than that of water, even then in the electrolysis of aqueous sodium chloride, why is Cl^- oxidised at anode instead of water?

35. What is electrode potential?

36. Consider the following diagram in which an electrochemical cell is coupled to an electrolytic cell. What will be the polarity of electrodes 'A' and 'B' in the electrolytic cell?

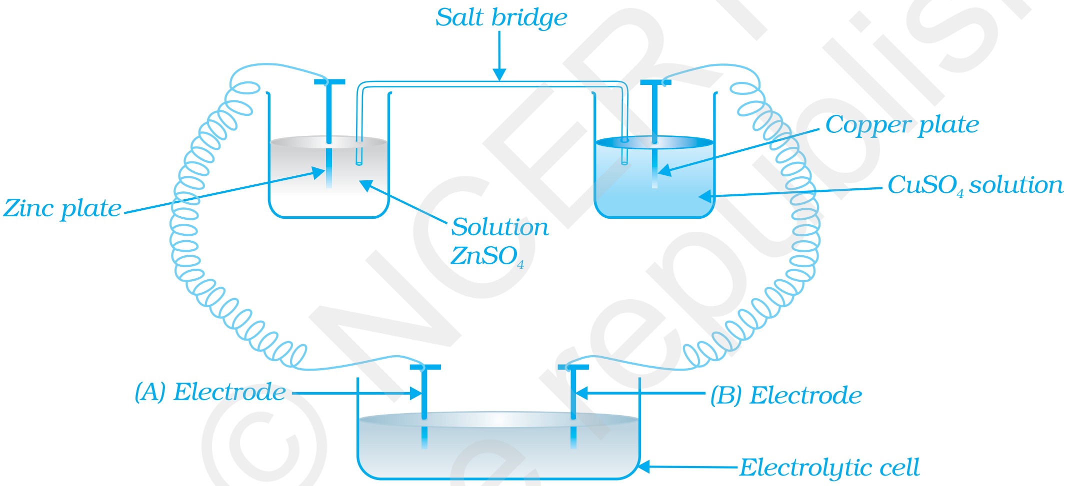


Fig. *3.1*

37. Why is alternating current used for measuring resistance of an electrolytic solution?

38. A galvanic cell has electrical potential of 1.1V. If an opposing potential of 1.1V is applied to this cell, what will happen to the cell reaction and current flowing through the cell?

39. How will the pH of brine (aq. NaCl solution) be affected when it is electrolysed?

40. Unlike dry cell, the mercury cell has a constant cell potential throughout its useful life. Why?

41. Solutions of two electrolytes 'A' and 'B' are diluted. The Λ_m of 'B' increases 1.5 times while that of A increases 25 times. Which of the two is a strong electrolyte? Justify your answer.

42. When acidulated water (dil.H_2SO_4 solution) is electrolysed, will the pH of the solution be affected? Justify your answer.

43. In an aqueous solution how does specific conductivity of electrolytes change with addition of water?

44. Which reference electrode is used to measure the electrode potential of other electrodes?

45. Consider a cell given below

$Cu|Cu^{2+}||Cl^{-}|Cl_2,Pt$

Write the reactions that occur at anode and cathode

46. Write the Nernst equation for the cell reaction in the Daniel cell. How will the E_{Cell} be affected when concentration of Zn^{2+} ions is increased?

47. What advantage do the fuel cells have over primary and secondary batteries?

48. Write the cell reaction of a lead storage battery when it is discharged. How does the density of the electrolyte change when the battery is discharged?

49. Why on dilution the Λ_m of CH_3COOH increases drastically, while that of CH_3COONa increases gradually?

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

50. Match the terms given in Column I with the units given in Column II.

Column I		**Column II**	
(i)	$\wedge_{\mathrm{m}}$	(a)	$S\ cm^{-1}$
(ii)	E_{Cell}	(b)	m^{-1}
(iii)	κ	(c)	$S\ cm^2\ mol^{-1}$
(iv)	G^*	(d)	V

51. Match the terms given in Column I with the items given in Column II.

Column I		**Column II**	
(i)	Λ_m	(a)	intensive property
(ii)	$E^{\ominus}_{\mathrm{Cell}}$	(b)	depends on number of ions/volume
(iii)	κ	(c)	extensive property
(iv)	$\Delta_r G_{\mathrm{Cell}}$	(d)	increases with dilution

52. Match the items of Column I and Column II.

Column I		**Column II**	
(i)	Lead storage battery	(a)	maximum efficiency

(ii)	Mercury cell	(b)	prevented by galvanisation
(iii)	Fuel cell	(c)	gives steady potential
(iv)	Rusting	(d)	Pb is anode, PbO_2 is cathode

53. Match the items of Column I and Column II.

	Column I		**Column II**
(i)	κ	(a)	$I \times t$
(ii)	Λ_m	(b)	Λ_m / Λ_m^0
(iii)	α	(c)	$\dfrac{\kappa}{c}$
(iv)	Q	(d)	$\dfrac{G^*}{R}$

54. Match the items of Column I and Column II.

	Column I		**Column II**
(i)	Lechlanche cell	(a)	cell reaction $2H_2 + O_2 \longrightarrow 2H_2O$
(ii)	Ni–Cd cell	(b)	does not involve any ion in solution and is used in hearing aids.
(iii)	Fuel cell	(c)	rechargeable
(iv)	Mercury cell	(d)	reaction at anode, $Zn \longrightarrow Zn^{2+} + 2e^-$
		(e)	converts energy of combustion into electrical energy

55. Match the items of Column I and Column II on the basis of data given below:

$$E^{\ominus}_{F_2/F^-} = 2.87V\ ,\ E^{\ominus}_{Li^+/Li} = -3.5V\ ,\ E^{\ominus}_{Au^{3+}/Au} = 1.4V\ ,\ E^{\ominus}_{Br_2/Br^-} = 1.09V$$

	Column I		**Column II**
(i)	F_2	(a)	metal is the strongest reducing agent
(ii)	Li	(b)	metal ion which is the weakest oxidising agent
(iii)	Au^{3+}	(c)	non metal which is the best oxidising agent
(iv)	Br^-	(d)	unreactive metal
(v)	Au	(e)	anion that can be oxidised by Au^{3+}
(vi)	Li^+	(f)	anion which is the weakest reducing agent
(vii)	F^-	(g)	metal ion which is an oxidising agent

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (i) Both assertion and reason are true and the reason is the correct explanation of assertion.
- (ii) Both assertion and reason are true and the reason is not the correct explanation of assertion.
- (iii) Assertion is true but the reason is false.
- (iv) Both assertion and reason are false.
- (v) Assertion is false but reason is true.

56. **Assertion** : Cu is less reactive than hydrogen.

Reason : $E^{\ominus}_{Cu^{2+}/Cu}$ is negative.

57. **Assertion** : E_{Cell} should have a positive value for the cell to function.

Reason : $E_{cathode} < E_{anode}$

58. **Assertion** : Conductivity of all electrolytes decreases on dilution.

Reason : On dilution number of ions per unit volume decreases.

59. **Assertion** : Λ_m for weak electrolytes shows a sharp increase when the electrolytic solution is diluted.

Reason : For weak electrolytes degree of dissociation increases with dilution of solution.

60. **Assertion** : Mercury cell does not give steady potential.

Reason : In the cell reaction, ions are not involved in solution.

61. **Assertion** : Electrolysis of NaCl solution gives chlorine at anode instead of O_2.

Reason : Formation of oxygen at anode requires overvoltage.

62. **Assertion** : For measuring resistance of an ionic solution an AC source is used.

Reason : Concentration of ionic solution will change if DC source is used.

63. **Assertion** : Current stops flowing when $E_{Cell} = 0$.

Reason : Equilibrium of the cell reaction is attained.

64. **Assertion** : $E_{Ag^+/Ag}$ increases with increase in concentration of Ag^+ ions.

Reason : $E_{Ag^+/Ag}$ has a positive value.

65. **Assertion** : Copper sulphate can be stored in zinc vessel.

Reason : Zinc is less reactive than copper.

VI. Long Answer Type

66. Consider the Fig. 3.2 and answer the following questions.

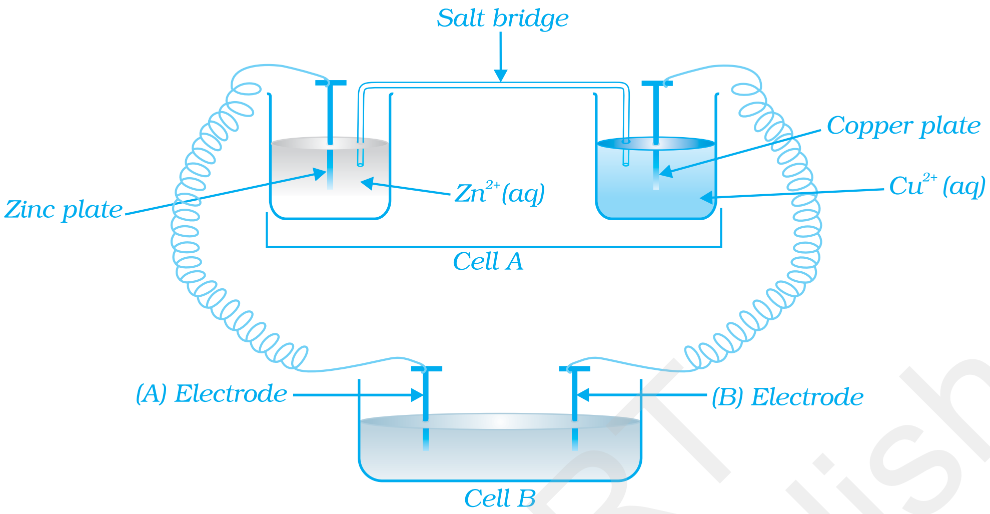


Fig. *3.2*

(i) Cell 'A' has $E_{Cell} = 2V$ and Cell 'B' has $E_{Cell} = 1.1V$ which of the two cells 'A' or 'B' will act as an electrolytic cell. Which electrode reactions will occur in this cell?

(ii) If cell 'A' has $E_{Cell} = 0.5V$ and cell 'B' has $E_{Cell} = 1.1V$ then what will be the reactions at anode and cathode?

67. Consider Fig. 3.2 and answer the questions (i) to (vi) given below.

(i) Redraw the diagram to show the direction of electron flow.

(ii) Is silver plate the anode or cathode?

(iii) What will happen if salt bridge is removed?

(iv) When will the cell stop functioning?

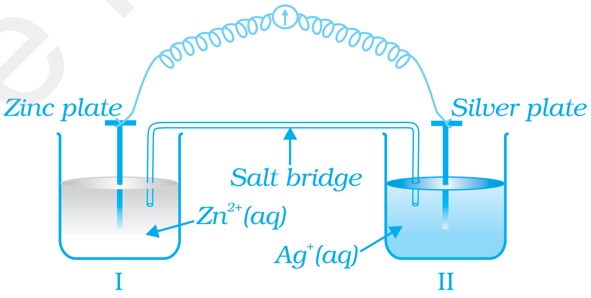


Fig. *3.3*

(v) How will concentration of Zn^{2+} ions and Ag^{+} ions be affected when the cell functions?

(vi) How will the concentration of Zn^{2+} ions and Ag^{+} ions be affected after the cell becomes 'dead'?

68. What is the relationship between Gibbs free energy of the cell reaction in a galvanic cell and the emf of the cell? When will the maximum work be obtained from a galvanic cell?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii) 2. (ii) 3. (iii) 4. (ii) 5. (iv) 6. (iii)
7. (iii) 8. (ii) 9. (iii) 10. (ii) 11. (iv) 12. (i)
13. (iii) 14. (iv) 15. (i) 16. (ii) 17. (ii)

II. Multiple Choice Questions (Type-II)

18. (ii), (iv) 19. (i), (iii) 20. (ii), (iii) 21. (i), (ii)
22. (i), (iv) 23. (i), (iii) 24. (i), (ii) 25. (i), (ii)
26. (i), (iii) 27. (ii), (iii)

III. Short Answer Type

28. No

29. No

30. When the cell reaction reaches equilibrium.

31. It means that Zn is more reactive than hydrogen. When zinc electrode will be connected to SHE, Zn will get oxidised and H^+ will get reduced.

32. Different, see the NCERT textbook, page no. 84.

33. $Cu|Cu^{2+}||Ag^+|Ag$

34. Under the conditions of electrolysis of aqueous sodium chloride, oxidation of water at anode requires overpotential hence Cl^- is oxidised instead of water.

35. See NCERT textbook, page no. 65

36. 'A' will have negative polarity

    'B' will have positive polarity

37. Alternating current is used to prevent electrolysis so that concentration of ions in the solution remains constant.

38. See NCERT textbook, page no. 64

39. The pH of the solution will rise as NaOH is formed in the electrolytic cell.

40. Ions are not involved in the overall cell reaction of mercury cells.

41. Electrolyte 'B' is strong as on dilution the number of ions remains the same, only interionic attraction decreases therefore increase in $\wedge_m$ is small.

42. pH of the solution will not be affected as $[H^+]$ remains constant.

At anode : $2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$

At cathode $4H^+ + 4e^- \longrightarrow 2H_2$

43. Conductivity decreases because number of ions per unit volume decreases.

44. Standard hydrogen electrode is the reference electrode whose electrode potential is taken to be zero. The electrode potential of other electrodes is measured with respect to it.

45. Anode : $Cu \longrightarrow Cu^{2+} + 2e^-$

Cathode : $Cl_2 + 2e^- \longrightarrow 2Cl^-$

Cu is anode as it is getting oxidised.

Cl_2 is cathode as it is getting reduced.

46. $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$

$$E_{Cell} = E^{\ominus}_{Cell} - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$$

E_{Cell} decreases when concentration of Zn^{2+} ions, $[Zn^{2+}]$ increases.

47. Primary batteries contain a limited amount of reactants and are discharged when the reactants have been consumed. Secondary batteries can be recharged but take a long time to recharge. Fuel cell runs continuously as long as the reactants are supplied to it and products are removed continuously.

48. $Pb + PbO_2 + 2H_2SO_4 \longrightarrow 2PbSO_4 + 2H_2O$

Density of electrolyte decreases as water is formed and sulphuric acid is consumed as the product during discharge of the battery.

49. In the case of CH_3COOH, which is a weak electrolyte, the number of ions increase on dilution due to an increase in degree of dissociation.

$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

In the case of strong electrolyte the number of ions remains the same but the interionic attraction decreases.

IV. Matching Type

50. (i) → (c) (ii) → (d) (iii) → (a) (iv) → (b)

51. (i) → (d) (ii) → (a) (iii) → (b) (iv) → (c)

52. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b)

53. (i) → (d) (ii) → (c) (iii) → (b) (iv) → (a)

54. (i) → (d) (ii) → (c) (iii) → (a), (e) (iv) → (b)

55. (i) → (c) (ii) → (a) (iii) → (g) (iv) → (e)
(v) → (d) (vi) → (b) (vii) → (g) (f)

V. Assertion and Reason Type

56. (iii) 57. (iii) 58. (i) 59. (i) 60. (v)
61. (i) 62. (i) 63. (i) 64. (ii) 65. (iv)

VI. Long Answer Type

66. (i) Cell 'B' will act as electrolytic cell as it has lower emf

∴ The electrode reactions will be:

$Zn^{2+} + 2e^- \longrightarrow Zn$ at cathode

$Cu \longrightarrow Cu^{2+} + 2e^-$ at anode

(ii) Now cell 'B' acts as galvanic cell as it has higher emf and will push electrons into cell 'A'.

The electrode reaction will be:

At anode : $Zn \longrightarrow Zn^{2+} + 2e^-$

At cathode : $Cu^{2+} + 2e^- \longrightarrow Cu$

67. **Hint :** (i) Electrons move from Zn to Ag.

(ii) Ag is the cathode.

(iii) Cell will stop functioning.

(iv) When $E_{Cell} = 0$.

(v) Concentration of Zn^{2+} ions will increase and concentration of Ag^+ ions will decrease

(vi) When $E_{cell} = 0$ equilibrium is reached and concentration of Zn^{2+} ions and Ag^+ ions will not change.

Unit 4

CHEMICAL KINETICS

I. Multiple Choice Questions (Type-I)

1. The role of a catalyst is to change ____________.

(i) gibbs energy of reaction.

(ii) enthalpy of reaction.

(iii) activation energy of reaction.

(iv) equilibrium constant.

2. In the presence of a catalyst, the heat evolved or absorbed during the reaction ___________.

(i) increases.

(ii) decreases.

(iii) remains unchanged.

(iv) may increase or decrease.

3. Activation energy of a chemical reaction can be determined by ____________.

(i) determining the rate constant at standard temperature.

(ii) determining the rate constants at two temperatures.

(iii) determining probability of collision.

(iv) using catalyst.

4. Consider Fig. 4.1 and mark the correct option.

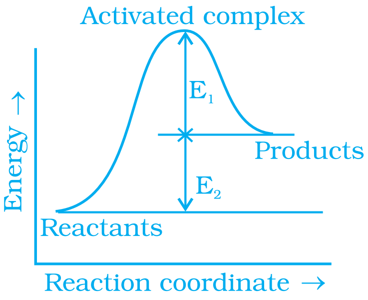


Fig. *4.1*

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

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

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

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

5. Consider a first order gas phase decomposition reaction given below :

$$A(g) \longrightarrow B(g) + C(g)$$

The initial pressure of the system before decomposition of A was p_i. After lapse of time 't', total pressure of the system increased by x units and became 'p_t' The rate constant k for the reaction is given as _________.

(i) $k = \dfrac{2.303}{t} \log \dfrac{p_i}{p_i - x}$

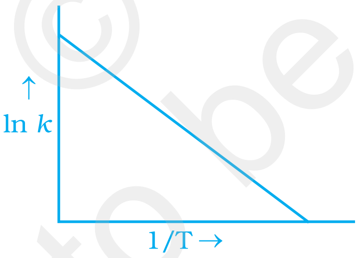
(ii) $k = \dfrac{2.303}{t} \log \dfrac{p_i}{2p_i - p_t}$

(iii) $k = \dfrac{2.303}{t} \log \dfrac{p_i}{2p_i + p_t}$

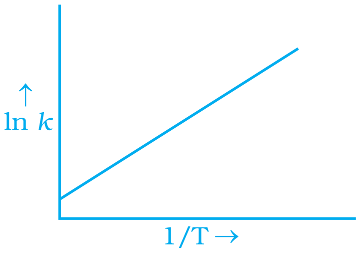
(iv) $k = \dfrac{2.303}{t} \log \dfrac{p_i}{p_i + x}$

6. According to Arrhenius equation rate constant k is equal to $A\,e^{-E_a/RT}$. Which of the following options represents the graph of ln k vs $\dfrac{1}{T}$?

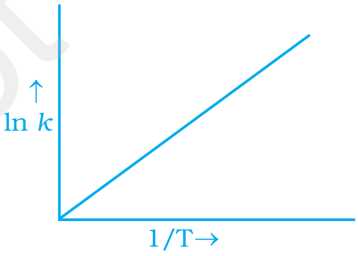
(i)



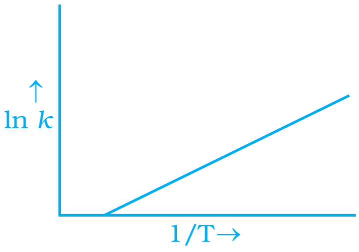
(ii)



(iii)



(iv)



7. Consider the Arrhenius equation given below and mark the correct option.

$$k = A\, e^{-E_a/RT}$$

(i) Rate constant increases exponentially with increasing activation energy and decreasing temperature.

(ii) Rate constant decreases exponentially with increasing activation energy and decreasing temperature.

(iii) Rate constant increases exponentially with decreasing activation energy and decreasing temperature.

(iv) Rate constant increases exponentially with decreasing activation energy and increasing temperature.

8. A graph of volume of hydrogen released vs time for the reaction between zinc and dil.HCl is given in Fig. 4.2. On the basis of this mark the correct option.

(i) Average rate upto 40s is $\dfrac{V_3 - V_2}{40}$

(ii) Average rate upto 40 seconds is $\dfrac{V_3 - V_2}{40 - 30}$

(iii) Average rate upto 40 seconds is $\dfrac{V_3}{40}$

(iv) Average rate upto 40 seconds is $\dfrac{V_3 - V_1}{40 - 20}$

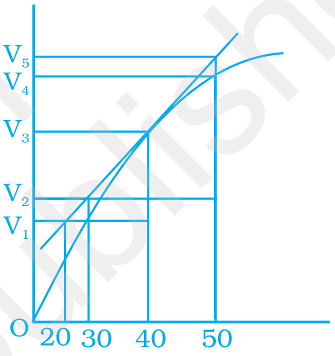


Fig. *4.2*

9. Which of the following statements is **not** correct about order of a reaction.

(i) The order of a reaction can be a fractional number.

(ii) Order of a reaction is experimentally determined quantity.

(iii) The order of a reaction is always equal to the sum of the stoichiometric coefficients of reactants in the balanced chemical equation for a reaction.

(iv) The order of a reaction is the sum of the powers of molar concentration of the reactants in the rate law expression.

10. Consider the graph given in Fig. 4.2. Which of the following options does **not** show instantaneous rate of reaction at 40th second?

(i) $\dfrac{V_5 - V_2}{50 - 30}$

(ii) $\dfrac{V_4 - V_2}{50 - 30}$

(iii) $\dfrac{V_3 - V_2}{40 - 30}$

(iv) $\dfrac{V_3 - V_1}{40 - 20}$

11. Which of the following statements is correct?

(i) The rate of a reaction decreases with passage of time as the concentration of reactants dereases.

(ii) The rate of a reaction is same at any time during the reaction.

(iii) The rate of a reaction is independent of temperature change.

(iv) The rate of a reaction decreases with increase in concentration of reactant(s).

12. Which of the following expressions is correct for the rate of reaction given below?

$$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \longrightarrow 3Br_2(aq) + 3H_2O(l)$$

(i) $\frac{\Delta[Br^-]}{\Delta t} = 5\frac{\Delta[H^+]}{\Delta t}$

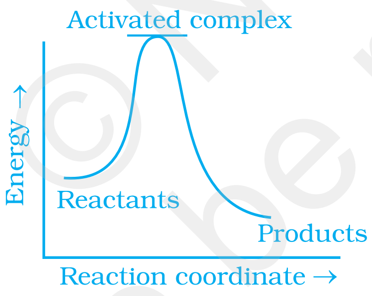
(ii) $\frac{\Delta[Br^-]}{\Delta t} = \frac{6}{5}\frac{\Delta[H^+]}{\Delta t}$

(iii) $\frac{\Delta[Br^-]}{\Delta t} = \frac{5}{6}\frac{\Delta[H^+]}{\Delta t}$

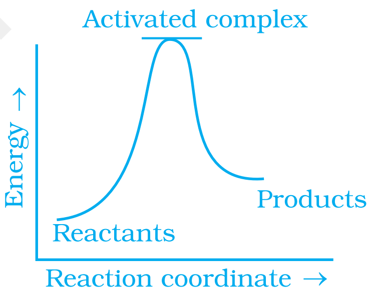
(iv) $\frac{\Delta[Br^-]}{\Delta t} = 6\frac{\Delta[H^+]}{\Delta t}$

13. Which of the following graphs represents exothermic reaction?

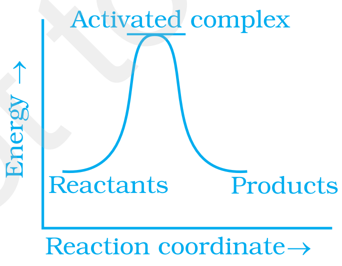
(a)



(b)



(c)



(i) (a) only

(ii) (b) only

(iii) (c) only

(iv) (a) and (b)

14. Rate law for the reaction $A + 2B \longrightarrow C$ is found to be

$$\text{Rate} = k\,[A][B]$$

Concentration of reactant 'B' is doubled, keeping the concentration of 'A' constant, the value of rate constant will be______.

(i) the same

(ii) doubled

(iii) quadrupled

(iv) halved

15. Which of the following statements is **incorrect** about the collison theory of chemical reaction?

(i) It considers reacting molecules or atoms to be hard spheres and ignores their structural features.

(ii) Number of effective collisions determines the rate of reaction.

(iii) Collision of atoms or molecules possessing sufficient threshold energy results into the product formation.

(iv) Molecules should collide with sufficient threshold energy and proper orientation for the collision to be effective.

16. A first order reaction is 50% completed in 1.26×10^{14} s. How much time would it take for 100% completion?

(i) 1.26×10^{15} s

(ii) 2.52×10^{14} s

(iii) 2.52×10^{28} s

(iv) infinite

17. Compounds 'A' and 'B' react according to the following chemical equation.

$$A\,(g) + 2\,B\,(g) \longrightarrow 2C\,(g)$$

Concentration of either 'A' or 'B' were changed keeping the concentrations of one of the reactants constant and rates were measured as a function of initial concentration. Following results were obtained. Choose the correct option for the rate equations for this reaction.

Experiment	**Initial concentration of [A]/ mol L^{-1}**	**Initial concentration of [B]/ mol L^{-1}**	**Initial rate of formation of [C]/ mol L^{-1} s^{-1}**
1.	0.30	0.30	0.10
2.	0.30	0.60	0.40
3.	0.60	0.30	0.20

(i) Rate = $k\,[A]^2\,[B]$

(ii) Rate = $k\,[A]\,[B]^2$

(iii) Rate = $k\,[A]\,[B]$

(iv) Rate = $k\,[A]^2\,[B]^0$

18. Which of the following statement is **not** correct for the catalyst?

(i) It catalyses the forward and backward reaction to the same extent.

(ii) It alters ΔG of the reaction.

(iii) It is a substance that does not change the equilibrium constant of a reaction.

(iv) It provides an alternate mechanism by reducing activation energy between reactants and products.

19. The value of rate constant of a pseudo first order reaction ____________.

(i) depends on the concentration of reactants present in small amount.

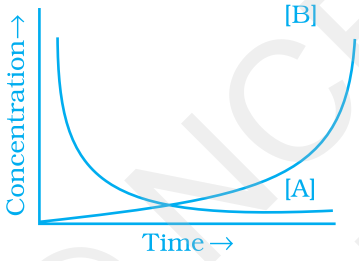
(ii) depends on the concentration of reactants present in excess.

(iii) is independent of the concentration of reactants.

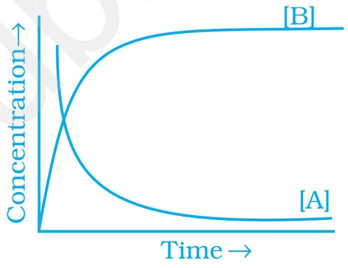
(iv) depends only on temperature.

20. Consider the reaction $A \rightleftharpoons B$. The concentration of both the reactants and the products varies exponentially with time. Which of the following figures correctly describes the change in concentration of reactants and products with time?

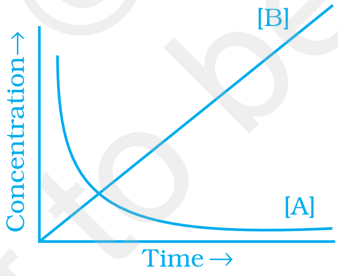
(i)



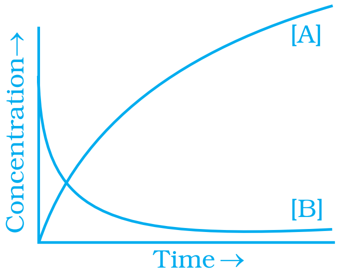
(ii)



(iii)



(iv)



II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

21. Rate law cannot be determined from balanced chemical equation if _______.

(i) reverse reaction is involved.

(ii) it is an elementary reaction.

(iii) it is a sequence of elementary reactions.

(iv) any of the reactants is in excess.

22. Which of the following statements are applicable to a balanced chemical equation of an elementary reaction?

(i) Order is same as molecularity.

(ii) Order is less than the molecularity.

(iii) Order is greater than the molecularity.

(iv) Molecularity can never be zero.

23. In any unimolecular reaction _____________.

(i) only one reacting species is involved in the rate determining step.

(ii) the order and the molecularity of slowest step are equal to one.

(iii) the molecularity of the reaction is one and order is zero.

(iv) both molecularity and order of the reaction are one.

24. For a complex reaction _____________.

(i) order of overall reaction is same as molecularity of the slowest step.

(ii) order of overall reaction is less than the molecularity of the slowest step.

(iii) order of overall reaction is greater than molecularity of the slowest step.

(iv) molecularity of the slowest step is never zero or non interger.

25. At high pressure the following reaction is zero order.

$$2NH_3(g) \xrightarrow[\text{Platinum catalyst}]{1130\text{ K}} N_2(g) + 3H_2(g)$$

Which of the following options are correct for this reaction?

(i) Rate of reaction = Rate constant

(ii) Rate of the reaction depends on concentration of ammonia.

(iii) Rate of decomposition of ammonia will remain constant until ammonia disappears completely.

(iv) Further increase in pressure will change the rate of reaction.

26. During decomposition of an activated complex

(i) energy is always released

(ii) energy is always absorbed

(iii) energy does not change

(iv) reactants may be formed

28. According to Maxwell Boltzmann distributon of energy, __________.

(i) the fraction of molecules with most probable kinetic energy decreases at higher temperatures.

(ii) the fraction of molecules with most probable kinetic energy increases at higher temperatures.

(iii) most probable kinetic energy increases at higher temperatures.

(iv) most probable kinetic energy decreases at higher temperatures.

28. In the graph showing Maxwell Boltzman distribution of energy, ____________.

(i) area under the curve must not change with increase in temperature.

(ii) area under the curve increases with increase in temperature.

(iii) area under the curve decreases with increase in temperature.

(iv) with increase in temperature curve broadens and shifts to the right hand side.

29. Which of the following statements are in accordance with the Arrhenius equation?

(i) Rate of a reaction increases with increase in temperature.

(ii) Rate of a reaction increases with decrease in activation energy.

(iii) Rate constant decreases exponentially with increase in temperature.

(iv) Rate of reaction decreases with decrease in activation energy.

30. Mark the **incorrect** statements.

(i) Catalyst provides an alternative pathway to reaction mechanism.

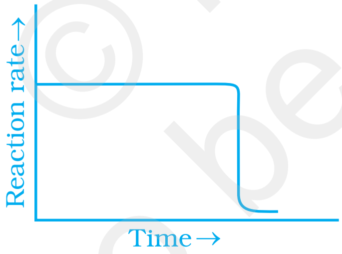
(ii) Catalyst raises the activation energy.

(iii) Catalyst lowers the activation energy.

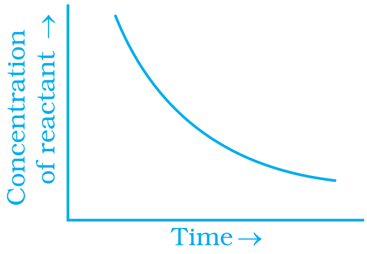
(iv) Catalyst alters enthalpy change of the reaction.

31. Which of the following graphs is correct for a zero order reaction?

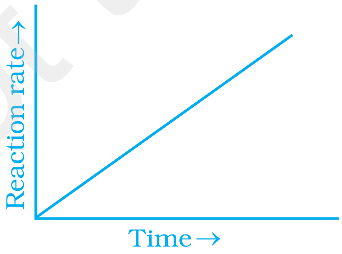
(i)



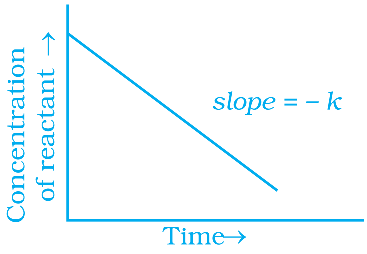
(ii)



(iii)

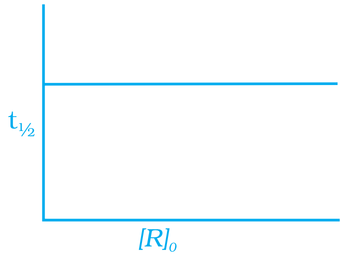


(iv)

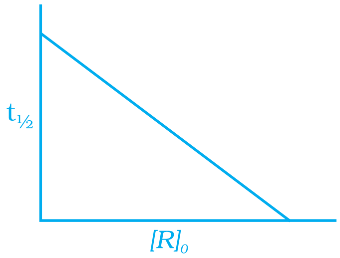


32. Which of the following graphs is correct for a first order reaction?

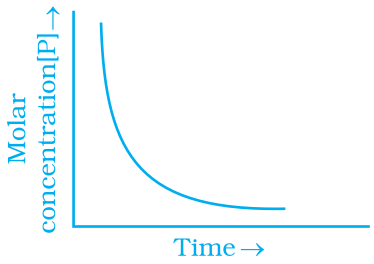
(i)



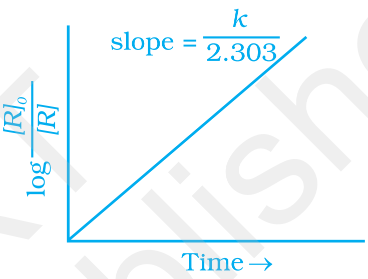
(ii)



(iii)



(iv)



III. Short Answer Type

33. State a condition under which a bimolecular reaction is kinetically first order reaction.

34. Write the rate equation for the reaction $2A + B \longrightarrow C$ if the order of the reaction is zero.

35. How can you determine the rate law of the following reaction?

$$2NO\ (g) + O_2\ (g) \longrightarrow 2NO_2\ (g)$$

36. For which type of reactions, order and molecularity have the same value?

37. In a reaction if the concentration of reactant A is tripled, the rate of reaction becomes twenty seven times. What is the order of the reaction?

38. Derive an expression to calculate time required for completion of zero order reaction.

39. For a reaction $A + B \longrightarrow$ Products, the rate law is — Rate = $k\,[A][B]^{3/2}$

Can the reaction be an elementary reaction? Explain.

40. For a certain reaction large fraction of molecules has energy more than the threshold energy, yet the rate of reaction is very slow. Why?

41. For a zero order reaction will the molecularity be equal to zero? Explain.

42. For a general reaction A $\longrightarrow$ B, plot of concentration of A vs time is given in Fig. 4.3. Answer the following question on the basis of this graph.

(i) What is the order of the reaction?

(ii) What is the slope of the curve?

(iii) What are the units of rate constant?

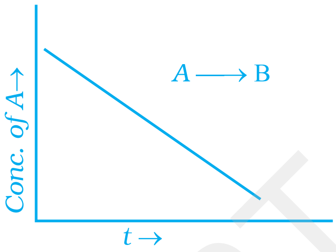


Fig. *4.3*

43. The reaction between H_2(g) and O_2(g) is highly feasible yet allowing the gases to stand at room temperature in the same vessel does not lead to the formation of water. Explain.

44. Why does the rate of a reaction increase with rise in temperature?

45. Oxygen is available in plenty in air yet fuels do not burn by themselves at room temperature. Explain.

46. Why is the probability of reaction with molecularity higher than three very rare?

47. Why does the rate of any reaction generally decreases during the course of the reaction?

48. Thermodynamic feasibility of the reaction alone cannot decide the rate of the reaction. Explain with the help of one example.

49. Why in the redox titration of $KMnO_4$ vs oxalic acid, we heat oxalic acid solution before starting the titration?

50. Why can't molecularity of any reaction be equal to zero?

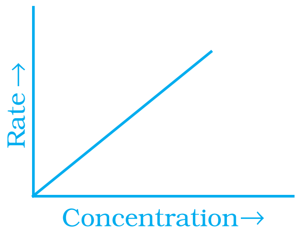
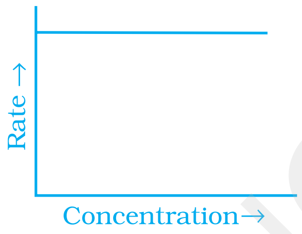
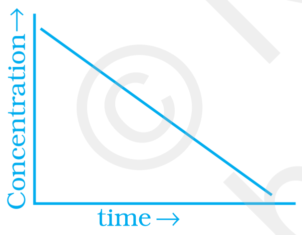
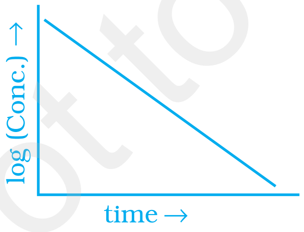
51. Why molecularity is applicable only for elementary reactions and order is applicable for elementary as well as complex reactions?

52. Why can we not determine the order of a reaction by taking into consideration the balanced chemical equation?

IV. Matching Type

Note : In the following questions match the items of Column I with appropriate item given in Column II.

53. Match the graph given in Column I with the order of reaction given in Column II. More than one item in Column I may link to the same item of Column II.

	Column I		**Column II**
(i)			
(ii)		(a)	Ist order
(iii)		(b)	Zero order
(iv)			

54. Match the statements given in Column I and Column II

	Column I		**Column II**
(i)	Catalyst alters the rate of reaction	(a)	cannot be fraction or zero
(ii)	Molecularity	(b)	proper orientation is not there always

(iii)	Second half life of first order reaction	(c)	by lowering the activation energy
(iv)	$e^{-E_a/RT}$	(d)	is same as the first
(v)	Energetically favourable reactions are sometimes slow	(e)	total probability is one
(vi)	Area under the Maxwell Boltzman curve is constant	(f)	refers to the fraction of molecules with energy equal to or greater than activation energy

55. Match the items of Column I and Column II.

	Column I		**Column II**
(i)	Diamond	(a)	short interval of time
(ii)	Instantaneous rate	(b)	ordinarily rate of conversion is imperceptible
(iii)	Average rate	(c)	long duration of time

56. Match the items of Column I and Column II.

	Column I		**Column II**
(i)	Mathematical expression for rate of reaction	(a)	rate constant
(ii)	Rate of reaction for zero order reaction is equal to	(b)	rate law
(iii)	Units of rate constant for zero order reaction is same as that of	(c)	order of slowest step
(iv)	Order of a complex reaction is determined by	(d)	rate of a reaction

V. Assertion and Reason Type

Note: In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are correct and the reason is correct explanation of assertion.

(ii) Both assertion and reason are correct but reason does not explain assertion.

(iii) Assertion is correct but reason is incorrect.

(iv) Both assertion and reason are incorrect.

(v) Assertion is incorrect but reason is correct.

57. **Assertion** : Order of the reaction can be zero or fractional.

Reason : We cannot determine order from balanced chemical equation.

58. **Assertion** : Order and molecularity are same.

Reason : Order is determined experimentally and molecularity is the sum of the stoichiometric coefficient of rate determining elementary step.

59. **Assertion** : The enthalpy of reaction remains constant in the presence of a catalyst.

Reason : A catalyst participating in the reaction, forms different activated complex and lowers down the activation energy but the difference in energy of reactant and product remains the same.

60. **Assertion** : All collision of reactant molecules lead to product formation.

Reason : Only those collisions in which molecules have correct orientation and sufficient kinetic energy lead to compound formation.

61. **Assertion** : Rate constants determined from Arrhenius equation are fairly accurate for simple as well as complex molecules.

Reason : Reactant molecules undergo chemical change irrespective of their orientation during collision.

VI. Long Answer Type

62. All energetically effective collisions do not result in a chemical change. Explain with the help of an example.

63. What happens to most probable kinetic energy and the energy of activation with increase in temperature?

64. Describe how does the enthalpy of reaction remain unchanged when a catalyst is used in the reaction.

65. Explain the difference between instantaneous rate of a reaction and average rate of a reaction.

66. With the help of an example explain what is meant by pseudo first order reaction.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii) 2. (iii) 3. (ii) 4. (i) 5. (ii) 6. (i)
7. (iv) 8. (iii) 9. (iii) 10. (ii) 11. (i) 12. (iii)
13. (i) 14. (ii) 15. (iii) 16. (iv) 17. (ii) 18. (ii)
19. (ii) 20. (ii)

II. Multiple Choice Questions (Type-II)

21. (i), (iii), (iv) 22. (i), (iv) 23. (i), (ii) 24. (i), (iv)
25. (i), (iii), (iv) 26. (i), (iv) 27. (i), (iii) 28. (i), (iv)
29. (i), (ii) 30. (ii), (iv) 31. (i), (iv) 32. (i), (iv)

III. Short Answer Type

33. Bimolecular reaction becomes kinetically first order when one of the reactants is in excess.

34. Rate = $k\,[A]^0[B]^0$ or Rate = k

35. See page no. 99 of NCERT textbook for Class XII.

36. If the reaction is an elementary reaction, order is same as molecularity.

37. Three, because rate = $k\,[A]^3$

38. $[R] = [R]_0 - kt$

for completion $[R] = 0$

$$\therefore\ t = \frac{[R]_0}{k}$$

39. During an elementary reaction, the number of atoms or ions colliding to react is referred to as molecularity. Had this been an elementary reaction the order of reaction with respect to B would have been 1, but in the given rate law it is $\frac{3}{2}$. This indicates that the reaction is not an elementary reaction.

40. Apart from the energy considerations, the colliding molecules should also have proper orientation for effective collision. This condition might not be getting fulfilled in the reaction.

41. No, the molecularity can never be zero or a fractional number.

42. (i) Zero (ii) $-k$ (iii) mol L^{-1} s^{-1}

43. This is because activation energy for the reaction is very high at room temperature.

44. At higher temperatures, larger fraction of colliding particles can cross the energy barrier (i.e. the activation energy), which leads to faster rate.

45. The activation energy for combustion reactions of fuels is very high at room temperature therefore they do not burn by themselves.

46. The probability of more than three molecules colliding simultaneously is very small. Hence possibility of molecularity being three is very low.

47. The rate of a reaction depends on the concentration of reactants. As the reaction progresses, reactants start getting converted to products so the concentration of reactants decreases hence the rate decreases.

48. Thermodynamically the conversion of diamond to graphite is highly feasible but this reaction is very slow because its activation energy is high.

49. The reaction between $KMnO_4$ and oxalic acid is very slow. By raising the temperature we can enhance the rate of reaction.

50. Molecularity is the number of molecules taking part in an elementary step. For this we require at least a single molecule leading to the value of minimum molecularity of one.

51. A complex reaction proceeds through several elementary reactions. Numbers of molecules involved in each elementary reaction may be different i.e., the molecularity of each step may be different. Therefore, discussion of molecularity of overall complex reaction is meaningless. On the other hand, order of a complex reaction is determined by the slowest step in its mechanism and is not meaningless even in the case of complex reactions.

52. Balanced chemical equation often leads to incorrect order or rate law. For example the following reaction seems to be a tenth order reaction.

$$KClO_3 + 6FeSO_4 + 3H_2SO_4 \longrightarrow KCl + 3H_2O + 3Fe_2(SO_4)_3$$

This is actually a second order reaction. Actually the reaction is complex and occurs in several steps. The order of such reaction is determined by the slowest step in the reaction mechanism. Order is determined experimentally and is confined to the dependence of observed rate of reaction on the concentration of reactants.

IV. Matching Type

53. (i) → (a) (ii) → (b) (iii) → (b) (iv) → (a)

54. (i) → (c) (ii) → (a) (iii) → (d) (iv) → (f)
(v) → (b) (vi) → (e)

55. (i) → (b) (ii) → (a) (iii) → (c)

56. (i) → (b) (ii) → (a) (iii) → (d) (iv) → (d)

V. Assertion and Reason Type

57. (ii) 58. (v) 59. (i) 60. (v) 61. (iii)

VI. Long Answer Type

62. **Hint:** Proper orientation of molecule should be explained in detail.

63. **Hint :**
- Flattening of curve and shifting of maxima towards high energy value.
- Area under the curve beyond the activation energy increases.

64. **Hint :**
- Enthalpy is a state function.
- Difference in energy between reactants and product is constant.

65. See NCERT textbook for Class XII.

66. See NCERT textbook for Class XII.

Unit 5

SURFACE CHEMISTRY

I. Multiple Choice Questions (Type-I)

1. Which of the following process does **not** occur at the interface of phases?
   (i) crystallisation
   (ii) heterogenous catalysis
   (iii) homogeneous catalysis
   (iv) corrosion

2. At the equilibrium position in the process of adsorption ___________.
   (i) $\Delta H > 0$
   (ii) $\Delta H = T\Delta S$
   (iii) $\Delta H > T\Delta S$
   (iv) $\Delta H < T\Delta S$

3. Which of the following interface **cannot** be obtained?
   (i) liquid-liquid
   (ii) solid-liquid
   (iii) liquid-gas
   (iv) gas-gas

4. The term 'sorption' stands for ____________.
   (i) absorption
   (ii) adsorption
   (iii) both absorption and adsorption
   (iv) desorption

5. Extent of physisorption of a gas increases with ___________.

(i) increase in temperature.

(ii) decrease in temperature.

(iii) decrease in surface area of adsorbent.

(iv) decrease in strength of van der Waals forces.

6. Extent of adsorption of adsorbate from solution phase increases with ________.

(i) increase in amount of adsorbate in solution.

(ii) decrease in surface area of adsorbent.

(iii) increase in temperature of solution.

(iv) decrease in amount of adsorbate in solution.

7. Which one of the following is **not** applicable to the phenomenon of adsorption?

(i) $\Delta H > 0$

(ii) $\Delta G < 0$

(iii) $\Delta S < 0$

(iv) $\Delta H < 0$

8. Which of the following is **not** a favourable condition for physical adsorption?

(i) high pressure

(ii) negative ΔH

(iii) higher critical temperature of adsorbate

(iv) high temperature

9. Physical adsorption of a gaseous species may change to chemical adsorption with ____________.

(i) decrease in temperature

(ii) increase in temperature

(iii) increase in surface area of adsorbent

(iv) decrease in surface area of adsorbent

10. In physisorption adsorbent does not show specificity for any particular gas because ____________.

(i) involved van der Waals forces are universal.

(ii) gases involved behave like ideal gases.

(iii) enthalpy of adsorption is low.

(iv) it is a reversible process.

11. Which of the following is an example of absorption?

(i) Water on silica gel

(ii) Water on calcium chloride

(iii) Hydrogen on finely divided nickel

(iv) Oxygen on metal surface

12. On the basis of data given below predict which of the following gases shows least adsorption on a definite amount of charcoal?

Gas	CO_2	SO_2	CH_4	H_2
Critical temp./K	304	630	190	33

(i) CO_2
(ii) SO_2
(iii) CH_4
(iv) H_2

13. In which of the following reactions heterogenous catalysis is involved?

(a) $2SO_2\,(g) + O_2\,(g) \xrightarrow{NO(g)} 2SO_3\,(g)$

(b) $2SO_2\,(g) \xrightarrow{Pt(s)} 2SO_3\,(g)$

(c) $N_2\,(g) + 3H_2\,(g) \xrightarrow{Fe(s)} 2NH_3\,(g)$

(d) $CH_3COOCH_3\,(l) + H_2O\,(l) \xrightarrow{HCl(l)} CH_3COOH\,(aq) + CH_3OH\,(aq)$

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

14. At high concentration of soap in water, soap behaves as ____________.

(i) molecular colloid
(ii) associated colloid
(iii) macromolecular colloid
(iv) lyophilic colloid

15. Which of the following will show Tyndall effect?

(i) Aqueous solution of soap below critical micelle concentration.
(ii) Aqueous solution of soap above critical micelle concentration.
(iii) Aqueous solution of sodium chloride.
(iv) Aqueous solution of sugar.

16. Method by which lyophobic sol can be protected.

(i) By addition of oppositely charged sol.
(ii) By addition of an electrolyte.
(iii) By addition of lyophilic sol.
(iv) By boiling.

17. Freshly prepared precipitate sometimes gets converted to colloidal solution by ____________.

(i) coagulation
(ii) electrolysis

(iii) diffusion

(iv) peptisation

18. Which of the following electrolytes will have maximum coagulating value for AgI/Ag^+ sol?

(i) Na_2S

(ii) Na_3PO_4

(iii) Na_2SO_4

(iv) $NaCl$

19. A colloidal system having a solid substance as a dispersed phase and a liquid as a dispersion medium is classified as ____________.

(i) solid sol

(ii) gel

(iii) emulsion

(iv) sol

20. The values of colligative properties of colloidal solution are of small order in comparison to those shown by true solutions of same concentration because of colloidal particles _________________.

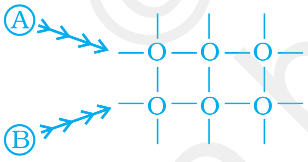
(i) exhibit enormous surface area.

(ii) remain suspended in the dispersion medium.

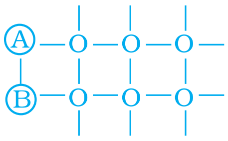
(iii) form lyophilic colloids.

(iv) are comparatively less in number.

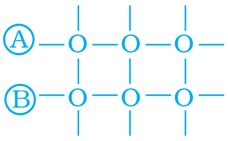
21. Arrange the following diagrams in correct sequence of steps involved in the mechanism of catalysis, in accordance with modern adsorption theory.



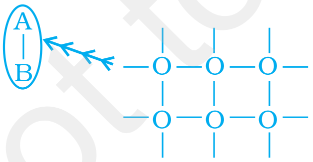
(a)



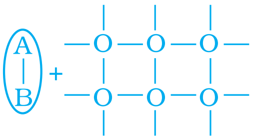
(b)



(c)



(d)



(e)

(i) a ⟶ b ⟶ c ⟶ d ⟶ e

(ii) a ⟶ c ⟶ b ⟶ d ⟶ e

(iii) a ⟶ c ⟶ b ⟶ e ⟶ d

(iv) a ⟶ b ⟶ c ⟶ e ⟶ d

22. Which of the following process is responsible for the formation of delta at a place where rivers meet the sea?

(i) Emulsification

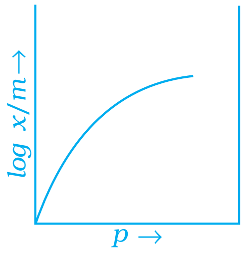
(ii) Colloid formation

(iii) Coagulation

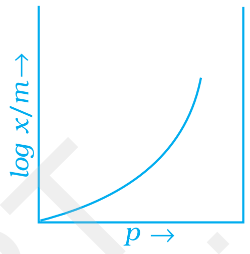
(iv) Peptisation

23. Which of the following curves is in accordance with Freundlich adsorption isotherm?

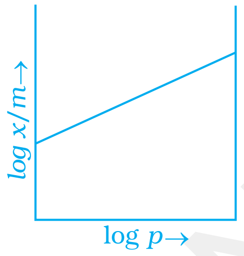
(i)



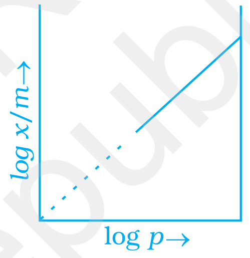
(ii)



(iii)



(iv)



24. Which of the following process is **not** responsible for the presence of electric charge on the sol particles?

(i) Electron capture by sol particles.

(ii) Adsorption of ionic species from solution.

(iii) Formation of Helmholtz electrical double layer.

(iv) Absorption of ionic species from solution.

25. Which of the following phenomenon is applicable to the process shown in the Fig. 5.1?

(i) Absorption

(ii) Adsorption

(iii) Coagulation

(iv) Emulsification

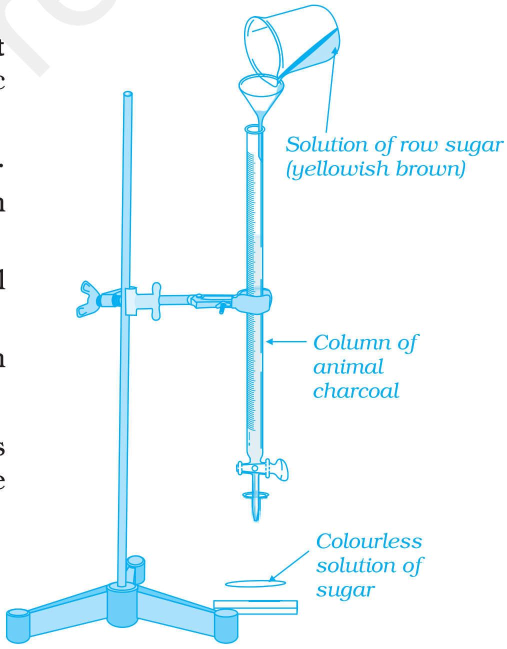


Fig. *5.1*

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

26. Which of the following options are correct?

(i) Micelle formation by soap in aqueous solution is possible at all temperatures.

(ii) Micelle formation by soap in aqueous solution occurs above a particular concentration.

(iii) On dilution of soap solution micelles may revert to individual ions.

(iv) Soap solution behaves as a normal strong electrolyte at all concentrations.

27. Which of the following statements are correct about solid catalyst?

(i) Same reactants may give different product by using different catalysts.

(ii) Catalyst does not change ΔH of reaction.

(iii) Catalyst is required in large quantities to catalyse reactions.

(iv) Catalytic activity of a solid catalyst does not depend upon the strength of chemisorption.

28. Freundlich adsorption isotherm is given by the expression $\frac{x}{m} = k\ p^{\frac{1}{n}}$ which of the following conclusions can be drawn from this expression.

(i) When $\frac{1}{n} = 0$, the adsorption is independent of pressure.

(ii) When $\frac{1}{n} = 0$, the adsorption is directly proportional to pressure.

(iii) When $n = 0$, $\frac{x}{m}$ vs p graph is a line parallel to x-axis.

(iv) When $n = 0$, plot of $\frac{x}{m}$ vs p is a curve.

29. H_2 gas is adsorbed on activated charcoal to a very little extent in comparison to easily liquefiable gases due to ____________.

(i) very strong van der Waal's interaction.

(ii) very weak van der Waals forces.

(iii) very low critical temperature.

(iv) very high critical temperature.

30. Which of the following statements are correct?

(i) Mixing two oppositely charged sols neutralises their charges and stabilises the colloid.

(ii) Presence of equal and similar charges on colloidal particles provides stability to the colloids.

(iii) Any amount of dispersed liquid can be added to emulsion without destabilising it.

(iv) Brownian movement stabilises sols.

31. An emulsion cannot be broken by __________ and ___________.

(i) heating

(ii) adding more amount of dispersion medium

(iii) freezing

(iv) adding emulsifying agent

32. Which of the following substances will precipitate the negatively charged emulsions?

(i) KCl

(ii) glucose

(iii) urea

(iv) NaCl

33. Which of the following colloids **cannot** be coagulated easily?

(i) Lyophobic colloids.

(ii) Irreversible colloids.

(iii) Reversible colloids.

(iv) Lyophilic colloids.

34. What happens when a lyophilic sol is added to a lyophobic sol?

(i) Lyophobic sol is protected.

(ii) Lyophilic sol is protected.

(iii) Film of lyophilic sol is formed over lyophobic sol.

(iv) Film of lyophobic sol is formed over lyophilic sol.

35. Which phenomenon occurs when an electric field is applied to a colloidal solution and electrophoresis is prevented?

(i) Reverse osmosis takes place.

(ii) Electroosmosis takes place.

(iii) Dispersion medium begins to move.

(iv) Dispersion medium becomes stationary.

36. In a reaction, catalyst changes ____________.

(i) physically

(ii) qualitatively

(iii) chemically

(iv) quantitatively

37. Which of the following phenomenon occurs when a chalk stick is dipped in ink?

(i) adsorption of coloured substance

(ii) adsorption of solvent

(iii) absorption and adsorption both of solvent

(iv) absoprtion of solvent

III. Short Answer Type

38. Why is it important to have clean surface in surface studies?

39. Why is chemisorption referred to as activated adsorption?

40. What type of solutions are formed on dissolving different concentrations of soap in water?

41. What happens when gelatin is mixed with gold sol?

42. How does it become possible to cause artificial rain by spraying silver iodide on the clouds?

43. Gelatin which is a peptide is added in icecreams. What can be its role?

44. What is collodion?

45. Why do we add alum to purify water?

46. What happens when electric field is applied to colloidal solution?

47. What causes brownian motion in colloidal dispersion?

48. A colloid is formed by adding $FeCl_3$ in excess of hot water. What will happen if excess sodium chloride is added to this colloid?

49. How do emulsifying agents stabilise the emulsion?

50. Why are some medicines more effective in the colloidal form?

51. Why does leather get hardened after tanning?

52. How does the precipitation of colloidal smoke take place in Cottrell precipitator?

53. How will you distinguish between dispersed phase and dispersion medium in an emulsion?

54. On the basis of Hardy-Schulze rule explain why the coagulating power of phosphate is higher than chloride.

55. Why does bleeding stop by rubbing moist alum?

56. Why is $Fe(OH)_3$ colloid positively charged, when prepared by adding $FeCl_3$ to hot water?

57. Why do physisorption and chemisorption behave differently with rise in temperature?

58. What happens when dialysis is prolonged?

59. Why does the white precipitate of silver halide become coloured in the presence of dye eosin.

60. What is the role of activated charcoal in gas mask used in coal mines?

61. How does a delta form at the meeting place of sea and river water?

62. Give an example where physisorption changes to chemisorption with rise in temperature. Explain the reason for change.

63. Why is desorption important for a substance to act as good catalyst?

64. What is the role of diffusion in heterogenous catalysis?

65. How does a solid catalyst enhance the rate of combination of gaseous molecules?

66. Do the vital functions of the body such as digestion get affected during fever? Explain your answer.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

67. Method of formation of solution is given in Column I. Match it with the type of solution given in Column II.

	Column I		Column II
(i)	Sulphur vapours passed through cold water	(a)	Normal electrolyte solution
(ii)	Soap mixed with water above critical micelle concentration	(b)	Molecular colloids
(iii)	White of egg whipped with water	(c)	Associated colloid
(iv)	Soap mixed with water below critical micelle concentration	(d)	Macro molecular colloids

68. Match the statement given in Column I with the phenomenon given in Column II.

	Column I		Column II
(i)	Dispersion medium moves in an electric field	(a)	Osmosis
(ii)	Solvent molecules pass through semi permeable membrane towards solvent side	(b)	Electrophoresis
(iii)	Movement of charged colloidal particles under the influence of applied electric potential towards oppositely charged electrodes	(c)	Electroosmosis
(iv)	Solvent molecules pass through semi permeable membranes towards solution side	(d)	Reverse osmosis

69. Match the items given in Column I and Column II.

Column I	Column II
(i) Protective colloid	(a) $FeCl_3$ + NaOH
(ii) Liquid - liquid colloid	(b) Lyophilic colloids
(iii) Positively charged colloid	(c) Emulsion
(iv) Negatively charged colloid	(d) $FeCl_3$ + hot water

70. Match the types of colloidal systems given in Column I with the name given in Column II.

Column I	Column II
(i) Solid in liquid	(a) Foam
(ii) Liquid in solid	(b) Sol
(iii) Liquid in liquid	(c) Gel
(iv) Gas in liquid	(d) Emulsion

71. Match the items of Column I and Column II.

Column I	Column II
(i) Dialysis	(a) Cleansing action of soap
(ii) Peptisation	(b) Coagulation
(iii) Emulsification	(c) Colloidal sol formation
(iv) Electrophoresis	(d) Purification

72. Match the items of Column I and Column II.

Column I	Column II
(i) Butter	(a) dispersion of liquid in liquid
(ii) Pumice stone	(b) dispersion of solid in liquid
(iii) Milk	(c) dispersion of gas in solid
(iv) Paints	(d) dispersion of liquid in solid

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct and the reason is correct explanation of assertion.

(ii) Assertion and reason both are correct but reason does not explain assertion.

(iii) Assertion is correct but reason is incorrect.

(iv) Both assertion and reason are incorrect.

(v) Assertion is incorrect but reason is correct.

73. **Assertion** : An ordinary filter paper impregnated with collodion solution stops the flow of colloidal particles.

Reason : Pore size of the filter paper becomes more than the size of colloidal particle.

74. **Assertion** : Colloidal solutions show colligative properties.

Reason : Colloidal particles are large in size.

75. **Assertion** : Colloidal solutions do not show brownian motion.

Reason : Brownian motion is responsible for stability of sols.

76. **Assertion** : Coagulation power of Al^{3+} is more than Na^{+}.

Reason : Greater the valency of the flocculating ion added, greater is its power to cause precipitation (Hardy Schulze rule).

77. **Assertion** : Detergents with low CMC are more economical to use.

Reason : Cleansing action of detergents involves the formation of micelles. These are formed when the concentration of detergents becomes equal to CMC.

VI. Long Answer Type

78. What is the role of adsorption in heterogenous catalysis?

79. What are the applications of adsorption in chemical analysis?

80. What is the role of adsorption in froth floatation process used especially for concentration of sulphide ores?

81. What do you understand by shape selective catalysis? Why are zeolites good shape selective catalysts?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii) 2. (ii) 3. (iv) 4. (iii) 5. (ii) 6. (i)
7. (i) 8. (iv) 9. (ii) 10. (i) 11. (ii) 12. (iv)
13. (i) 14. (ii) 15. (ii) 16. (iii) 17. (iv) 18. (ii)
19. (iv) 20. (iv) 21. (ii) 22. (iii) 23. (iii) 24. (iv)
25. (ii)

II. Multiple Choice Questions (Type-II)

26. (ii), (iii) 27. (i), (ii) 28. (i), (iii) 29. (ii), (iii)
30. (ii), (iv) 31. (ii), (iv) 32. (i), (iv) 33. (iii), (iv)
34. (i), (iii) 35. (ii), (iii) 36. (i), (ii) 37. (i), (iv)

III. Short Answer Type

38. It is important to have clean surface as it facilitates the adsorption of desired species.

39. Chemisorption involves formation of bond between gaseous molecules/ atoms and the solid surface for which high activation energy is required. Thus it is referred to as activated adsorption.

40. At lower concentration soap forms a normal electrolytic solution with water. After a certain concentration called critical micelle concentration, colloidal solution is formed.

41. Gold sol is a lyophobic sol. Addition of gelatin stabilises the sol.

42. Clouds are colloidal in nature and carry charge. Spray of silver iodide, an electrolyte, results in coagulation leading to rain.

43. Icecreams are emulsions which get stabilised by emulsifying agents like gelatin.

44. It is a 4% solution of nitrocellulose in a mixture of alcohol and ether.

45. The colloidal impurities present in water get coagulated by added alum, thus making water potable.

46. The charged colloidal particles start moving towards oppositely charged electrodes.

47. Unbalanced bombardment of the particles of dispersed phase by molecules of dispersion medium causes brownian motion. This stabilises the sol.

48. Positively charged sol of hydrated ferric oxide is formed and on adding excess of NaCl, negatively charged chloride ions coagulate the positively charged sol of hydrated ferric oxide.

49. The emulsifying agent forms an interfacial layer between suspended particles and the dispersion medium thereby stabilising the emulsion.

50. Medicines are more effective in the colloidal form because of large surface area and are easily assimilated in this form.

51. Animal hide is colloidal in nature and has positively charged particles. When it is soaked in tanin which has negatively charged colloidal particles, it results in mutual coagulation taking place.

52. In Cottrell precipitator, charged smoke particles are passed through a chamber containing plates with charge opposite to the smoke particles. Smoke particles lose their charge on the plates and get precipitated.

53. On adding dispersion medium, emulsions can be diluted to any extent. The dispersed phase forms a separate layer if added in excess.

54. Minimum quantity of an electrolyte required to cause precipitation of a sol is called its coagulating value. Greater the charge on flocculating ion and smaller is the amount of electrolyte required for precipitation, higher is the coagulating power of coagulating ion (Hardy-Schulze rule).

55. Moist alum coagulates the blood and so formed blood clot stops bleeding.

56. The adsorption of positively charged Fe^{3+} ions by the sol of hydrated ferric oxide results in positively charged colloid.

57. Physisorption involves weak van der Waals forces which weaken with rise in temperature. The chemisorption involves formation of chemical bond involving activation energy and like any other chemical reaction is favoured by rise in temperature.

58. Due to excessive dialysis, traces of electrolyte which stabilises the colloids is removed completely, making the colloid unstable. As a result coagulation takes place.

59. Eosin is adsorbed on the surface of silver halide precipitate making it coloured.

60. Activated charcoal acts as an adsorbent for various poisonous gases present in the coal mines.

61. River water is a colloidal solution of clay and sea water contains lot of electrolytes. The point at which river and sea meet is the site for coagulation. Deposition of coagulated clay results in delta formation.

62. The process of physisorption for example that of H_2 on finely divided nickel, involves weak van der Waals' forces. With increase in temperature, hydrogen molecules dissociate into hydrogen atoms which are held on the surface by chemisorption.

63. After the reaction is over between adsorbed reactants, the process of desorption is important to remove products and further create space for the other reactant molecules to approach the surface and react.

64. The gaseous molecules diffuse on to the surface of the solid catalyst and get adsorbed. After the required chemical changes the products diffuse away from the surface of the catalyst leaving the surface free for more reactant molecules to get adsorbed and undergo reaction.

65. When gaseous molecules come in contact with the surface of a solid catalyst, a weak chemical combination takes place between the surface of the catalyst and the gaseous molecules, which increases the concentration of reactants on the surface. Different moelcules adsorbed side by side have better chance to react and form new molecules. This enhances the rate of reaction. Also, adsorption is an exothermic process. The heat released in the process of adsorption is utilised in enhancing the reaction rate.

66. **Hint :** The optimum temperature range for enzymatic activity is 298-310 K. On either side of this temperature range, enzymatic activity gets affected. Thus, during fever, when temperature rises above 310 K, the activity of enzymes may be affected.

IV. Matching Type

67. (i) → (b) (ii) → (c) (iii) → (d) (iv) → (a)
68. (i) → (c) (ii) → (d) (iii) → (b) (iv) → (a)
69. (i) → (b) (ii) → (c) (iii) → (d) (iv) → (a)
70. (i) → (b) (ii) → (c) (iii) → (d) (iv) → (a)
71. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b)
72. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b)

V. Assertion and Reason Type

73. (iii) 74. (ii) 75. (v) 76. (i) 77. (i)

VI. Long Answer Type

78. **Hint**
- reactants are adsorbed on the surface of the catalyst
- occurrence of chemical reaction on the surface of catalyst
- desorption.

79. **Hint:**
- In TLC
- Adsorption indicators.
- In qualitative analysis.

80. **Hint:**
- Adsorption of pine oil on sulphide ore particles.
- Formation of emulsion.
- Hence ore comes out with froth.
- Explanation for shape selective catalysis.

81. **Hint:**
- Honey comb like structure of zeolites.
- Pores provide sites for reactants to react.

Unit

6

GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

I. Multiple Choice Questions (Type-I)

1. In the extraction of chlorine by electrolysis of brine ____________.

(i) oxidation of Cl^- ion to chlorine gas occurs.

(ii) reduction of Cl^- ion to chlorine gas occurs.

(iii) For overall reaction $\Delta G^\ominus$ has negative value.

(iv) a displacement reaction takes place.

2. When copper ore is mixed with silica, in a reverberatory furnace copper matte is produced. The copper matte contains ____________.

(i) sulphides of copper (II) and iron (II)

(ii) sulphides of copper (II) and iron (III)

(iii) sulphides of copper (I) and iron (II)

(iv) sulphides of copper (I) and iron (III)

3. Which of the following reactions is an example of autoreduction?

(i) $Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$

(ii) $Cu_2O + C \longrightarrow 2Cu + CO$

(iii) $Cu^{2+}\,(aq) + Fe\,(s) \longrightarrow Cu\,(s) + Fe^{2+}\,(aq)$

(iv) $Cu_2O + \frac{1}{2}Cu_2S \longrightarrow 3Cu + \frac{1}{2}SO_2$

4. A number of elements are available in earth's crust but most abundant elements are ___________.

(i) Al and Fe
(ii) Al and Cu
(iii) Fe and Cu
(iv) Cu and Ag

5. Zone refining is based on the principle that ___________.

(i) impurities of low boiling metals can be separated by distillation.
(ii) impurities are more soluble in molten metal than in solid metal.
(iii) different components of a mixture are differently adsorbed on an adosrbent.
(iv) vapours of volatile compound can be decomposed in pure metal.

6. In the extraction of copper from its sulphide ore, the metal is formed by the reduction of Cu_2O with

(i) FeS
(ii) CO
(iii) Cu_2S
(iv) SO_2

7. Brine is electrolysed by using inert electrodes. The reaction at anode is ________.

(i) $Cl^- (aq.) \longrightarrow \frac{1}{2} Cl_2 (g) + e^- ; \quad E^\ominus_{Cell} = 1.36V$

(ii) $2H_2O (l) \longrightarrow O_2 (g) + 4H^+ + 4e^- ; \quad E^\ominus_{Cell} = 1.23V$

(iii) $Na^+ (aq.) + e^- \longrightarrow Na(s) ; \quad E^\ominus_{Cell} = 2.71V$

(iv) $H^+ (aq.) + e^- \longrightarrow \frac{1}{2} H_2 (g) ; \quad E^\ominus_{Cell} = 0.00V$

8. In the metallurgy of aluminium _______________.

(i) Al^{3+} is oxidised to Al (s).
(ii) graphide anode is oxidised to carbon monoxide and carbon dioxide.
(iii) oxidation state of oxygen changes in the reaction at anode.
(iv) oxidation state of oxygen changes in the overall reaction involved in the process.

9. Electrolytic refining is used to purify which of the following metals?

(i) Cu and Zn
(ii) Ge and Si
(iii) Zr and Ti
(iv) Zn and Hg

10. Extraction of gold and silver involves leaching the metal with CN^- ion. The metal is recovered by ________________.

(i) displacement of metal by some other metal from the complex ion.

(ii) roasting of metal complex.

(iii) calcination followed by roasting.

(iv) thermal decomposition of metal complex.

Note : Answer the questions 11-13 on the basis of Fig. 6.1.

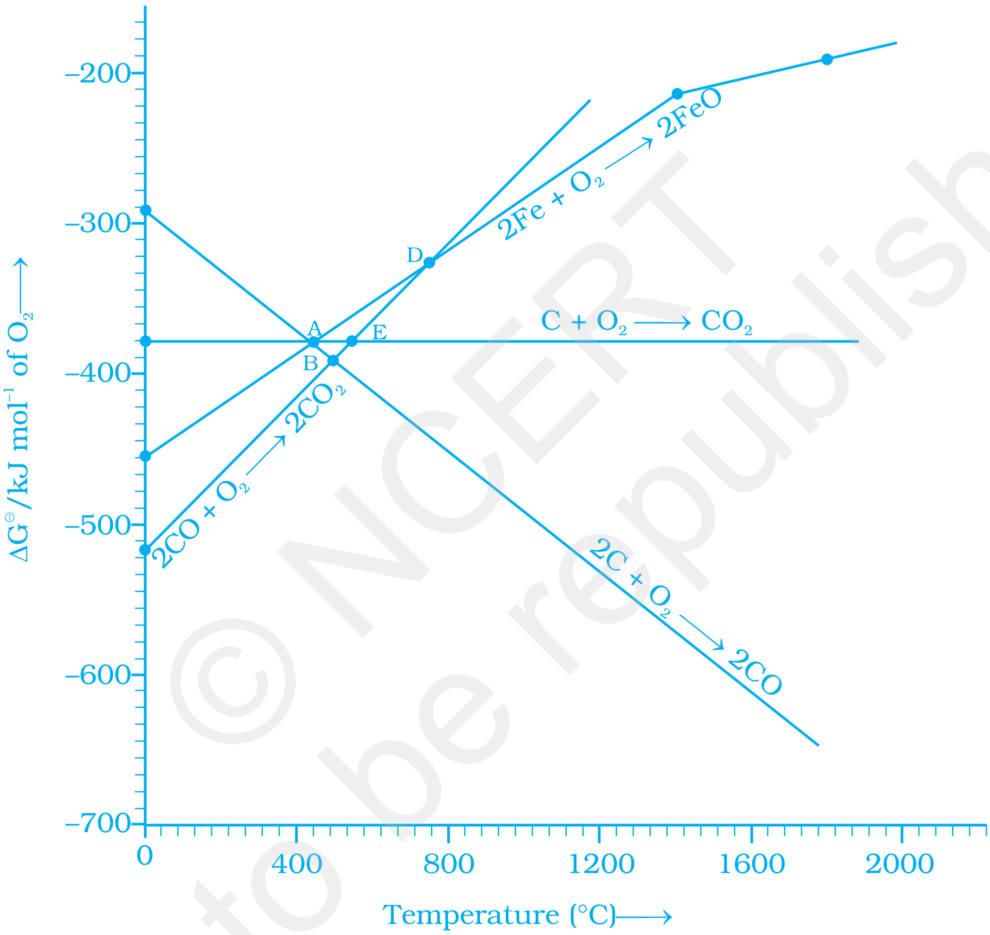


Fig. 6.1

11. Choose the correct option of temperature at which carbon reduces FeO to iron and produces CO.

(i) Below temperature at point A.

(ii) Approximately at the temperature corresponding to point A.

(iii) Above temperature at point A but below temperature at point D.

(iv) Above temperature at point A.

12. Below point 'A' FeO can _____________.

(i) be reduced by carbon monoxide only.

(ii) be reduced by both carbon monoxide and carbon.

(iii) be reduced by carbon only.

(iv) not be reduced by both carbon and carbon monoxide.

13. For the reduction of FeO at the temperature corresponding to point D, which of the following statements is correct?

(i) ΔG value for the overall reduction reaction with carbon monoxide is zero.

(ii) ΔG value for the overall reduction reaction with a mixture of 1 mol carbon and 1 mol oxygen is positive.

(iii) ΔG value for the overall reduction reaction with a mixture of 2 mol carbon and 1 mol oxygen will be positive.

(iv) ΔG value for the overall reduction reaction with carbon monoxide is negative.

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

14. At the temperature corresponding to which of the points in Fig.6.1, FeO will be reduced to Fe by coupling the reaction $2FeO \longrightarrow 2Fe + O_2$ with all of the following reactions?

(a) $C + O_2 \longrightarrow CO_2$ (b) $2C + O_2 \longrightarrow 2CO$ and (c) $2CO + O_2 \longrightarrow 2\,CO_2$

(i) Point A

(ii) Point B

(iii) Point D

(iv) Point E

15. Which of the following options are correct?

(i) Cast iron is obtained by remelting pig iron with scrap iron and coke using hot air blast.

(ii) In extraction of silver, silver is extracted as cationic complex.

(iii) Nickel is purified by zone refining.

(iv) Zr and Ti are purified by van Arkel method.

16. In the extraction of aluminium by Hall-Heroult process, purified Al_2O_3 is mixed with CaF_2 to

(i) lower the melting point of Al_2O_3.

(ii) increase the conductivity of molten mixture.

(iii) reduce Al^{3+} into Al(s).

(iv) acts as catalyst.

17. Which of the following statements is correct about the role of substances added in the froth floation process?

(i) Collectors enhance the non-wettability of the mineral particles.
(ii) Collectors enhance the wettability of gangue particles.
(iii) By using depressants in the process two sulphide ores can be separated.
(iv) Froth stabilisers decrease wettability of gangue.

18. In the Froth Floatation process, zinc sulphide and lead sulphide can be separated by ______________.

(i) using collectors.
(ii) adjusting the proportion of oil to water.
(iii) using depressant.
(iv) using froth stabilisers.

19. Common impurities present in bauxite are ____________.

(i) CuO
(ii) ZnO
(iii) Fe_2O_3
(iv) SiO_2

20. Which of the following ores are concentrated by froth floation?

(i) Haematite
(ii) Galena
(iii) Copper pyrites
(iv) Magnetite

21. Which of the following reactions occur during calcination?

(i) $CaCO_3 \longrightarrow CaO + CO_2$

(ii) $2FeS_2 + \frac{11}{2}O_2 \longrightarrow Fe_2O_3 + 4SO_2$

(iii) $Al_2O_3.x\,H_2O \longrightarrow Al_2O_3 + x\,H_2O$

(iv) $ZnS + \frac{3}{2}O_2 \longrightarrow ZnO + SO_2$

22. For the metallurgical process of which of the ores calcined ore can be reduced by carbon?

(i) haematite
(ii) calamine
(iii) iron pyrites
(iv) sphalerite

23. The main reactions occurring in blast furnace during extraction of iron from haematite are ________.

(i) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

(ii) $FeO + SiO_2 \longrightarrow FeSiO_3$

(iii) $Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

(iv) $CaO + SiO_2 \longrightarrow CaSiO_3$

24. In which of the following method of purification, metal is converted to its volatile compound which is decomposed to give pure metal?

(i) heating with stream of carbon monoxide.

(ii) heating with iodine.

(iii) liquation.

(iv) distillation.

25. Which of the following statements are correct?

(i) A depressant prevents certain type of particle to come to the froth.

(ii) Copper matte contains Cu_2S and ZnS.

(iii) The solidified copper obtained from reverberatory furnace has blistered appearance due to evolution of SO_2 during the extraction.

(iv) Zinc can be extracted by self-reduction.

26. In the extraction of chlorine from brine ____________.

(i) $\Delta G^{\ominus}$ for the overall reaction is negative.

(ii) $\Delta G^{\ominus}$ for the overall reaction is positive.

(iii) $E^{\ominus}$ for overall reaction has negative value.

(iv) $E^{\ominus}$ for overall reaction has positive value.

III. Short Answer Type

27. Why is an external emf of more than 2.2V required for the extraction of Cl_2 from brine?

28. At temperatures above 1073K coke can be used to reduce FeO to Fe. How can you justify this reduction with Ellingham diagram?

29. Wrought iron is the purest form of iron. Write a reaction used for the preparation of wrought iron from cast iron. How can the impurities of sulphur, silicon and phosphorus be removed from cast iron?

30. How is copper extracted from low grade copper ores?

31. Write two basic requirements for refining of a metal by Mond process and by Van Arkel Method.

32. Although carbon and hydrogen are better reducing agents but they are not used to reduce metallic oxides at high temperatures. Why?

33. How do we separate two sulphide ores by Froth Floatation Method? Explain with an example.

34. The purest form of iron is prepared by oxidising impurities from cast iron in a reverberatory furnace. Which iron ore is used to line the furnace? Explain by giving reaction.

35. The mixture of compounds A and B is passed through a column of Al_2O_3 by using alcohol as eluant. Compound A is eluted in preference to compound B. Which of the compounds A or B, is more readily adsorbed on the column?

36. Why is sulphide ore of copper heated in a furnace after mixing with silica?

37. Why are sulphide ores converted to oxide before reduction?

38. Which method is used for refining Zr and Ti? Explain with equation.

39. What should be the considerations during the extraction of metals by electrochemical method?

40. What is the role of flux in metallurgical processes?

41. How are metals used as semiconductors refined? What is the principle of the method used?

42. Write down the reactions taking place in Blast furnace related to the metallurgy of iron in the temperature range 500-800 K.

43. Give two requirements for vapour phase refining.

44. Write the chemical reactions involved in the extraction of gold by cyanide process. Also give the role of zinc in the extraction.

IV. Matching Type

Note : Match the items given in Column I and Column II in the following questions.

45. Match the items of Column I with items of Column II and assign the correct code:

Column I	Column II
(A) Pendulum	(1) Chrome steel
(B) Malachite	(2) Nickel steel
(C) Calamine	(3) Na_3AlF_6
(D) Cryolite	(4) $CuCO_3.Cu(OH)_2$
	(5) $ZnCO_3$

Code :

(i)	A (1)	B (2)	C (3)	D (4)
(ii)	A (2)	B (4)	C (5)	D (3)
(iii)	A (2)	B (3)	C (4)	D (5)
(iv)	A (4)	B (5)	C (3)	D (2)

46. Match the items of Column I with the items of Column II and assign the correct code :

Column I	Column II
(A) Coloured bands	(1) Zone refining
(B) Impure metal to volatile complex	(2) Fractional distillation
(C) Purification of Ge and Si	(3) Mond Process
(D) Purification of mercury	(4) Chromatography
	(5) Liquation

Code :

(i)	A (1)	B (2)	C (4)	D (5)
(ii)	A (4)	B (3)	C (1)	D (2)
(iii)	A (3)	B (4)	C (2)	D (1)
(iv)	A (5)	B (4)	C (3)	D (2)

47. Match items of Column I with the items of Column II and assign the correct code :

Column I	Column II
(A) Cyanide process	(1) Ultrapure Ge
(B) Froth Floatation Process	(2) Dressing of ZnS
(C) Electrolytic reduction	(3) Extraction of Al
(D) Zone refining	(4) Extraction of Au
	(5) Purification of Ni

Code :

(i)	A (4)	B (2)	C (3)	D (1)
(ii)	A (2)	B (3)	C (1)	D (5)
(iii)	A (1)	B (2)	C (3)	D (4)
(iv)	A (3)	B (4)	C (5)	D (1)

48. Match the items of Column I with the items of Column II and assign the correct code :

Column I	Column II
(A) Sapphire	(1) Al_2O_3
(B) Sphalerite	(2) NaCN
(C) Depressant	(3) Co
(D) Corundum	(4) ZnS
	(5) Fe_2O_3

Code :

(i) A (3) B (4) C (2) D (1)
(ii) A (5) B (4) C (3) D (2)
(iii) A (2) B (3) C (4) D (5)
(iv) A (1) B (2) C (3) D (4)

49. Match the items of Column I with items of Column II and assign the correct code :

Column I	Column II
(A) Blisterred Cu	(1) Aluminium
(B) Blast furnace	(2) $2Cu_2O + Cu_2S \longrightarrow 6Cu + SO_2$
(C) Reverberatory furnace	(3) Iron
(D) Hall-Heroult process	(4) $FeO + SiO_2 \longrightarrow FeSiO_3$
	(5) $2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$

Code :

(i) A (2) B (3) C (4) D (1)
(ii) A (1) B (2) C (3) D (5)
(iii) A (5) B (4) C (3) D (2)
(iv) A (4) B (5) C (3) D (2)

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are true and reason is the correct explanation of assertion.
(ii) Both assertion and reason are true but reason is not the correct explanation of assertion.
(iii) Assertion is true but reason is false.
(iv) Assertion is false but reason is true.
(v) Assertion and reason both are wrong.

50. **Assertion** : Nickel can be purified by Mond process.
Reason : Ni $(CO)_4$ is a volatile compound which decomposes at 460K to give pure Ni.

51. **Assertion** : Zirconium can be purified by Van Arkel method.
Reason : ZrI_4 is volatile and decomposes at 1800K.

52. **Assertion** : Sulphide ores are concentrated by Froth Flotation method.

Reason : Cresols stabilise the froth in Froth Flotation method.

53. **Assertion** : Zone refining method is very useful for producing semiconductors.

Reason : Semiconductors are of high purity.

54. **Assertion** : Hydrometallurgy involves dissolving the ore in a suitable reagent followed by precipitation by a more electropositive metal.

Reason : Copper is extracted by hydrometallurgy.

VI. Long Answer Type

55. Explain the following :

(a) CO_2 is a better reducing agent below 710K whereas CO is a better reducing agent above 710K.

(b) Generally sulphide ores are converted into oxides before reduction.

(c) Silica is added to the sulphide ore of copper in the reverberatory furnace.

(d) Carbon and hydrogen are not used as reducing agents at high temperatures.

(e) Vapour phase refining method is used for the purification of Ti.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii)
2. (iii)
3. (iv)
4. (i)
5. (ii)
6. (iii)
7. (i)
8. (ii)
9. (i)
10. (i)
11. (iv)
12. (i)
13. (i)

II. Multiple Choice Questions (Type-II)

14. (ii), (iv)
15. (i), (iv)
16. (i), (ii)
17. (i), (iii)
18. (ii), (iii)
19. (iii), (iv)
20. (ii), (iii)
21. (i), (iii)
22. (i), (ii)
23. (i), (iv)
24. (i), (ii)
25. (i), (iii)
26. (ii), (iii)

III. Short Answer Type

27. For the reaction

$$2Cl^-(aq) + 2H_2O\ (l) \longrightarrow 2OH^-(aq) + H_2(g) + Cl_2\ (g)$$

Value of $\Delta G^\ominus$ is + 422kJ. Using the equation $\Delta G^\ominus = -nFE^\ominus$ the value of $E^\ominus$ comes out to be –2.2V. Therefore extraction of Cl_2 from brine will require an external emf of greater than 2.2*V*.

28. As per Ellingham diagram at temperatures greater than 1073 K

ΔG (C, CO) < ΔG (Fe, FeO). Hence coke can reduce FeO to Fe.

29. $Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

Limestone is added as flux and sulphur, silicon and phosphorus change to their oxides and pass into the slag.

30. Copper is extracted by hydrometallurgy from low grade copper ores. It is leached out using acid or bacteria. The solution containing Cu^{2+} is treated with scrap iron, Zn or H_2.

$$Cu^{2+}(aq) + H_2(g) \longrightarrow Cu(s) + 2H^+(aq)$$

$$Cu^{2+} + Fe(s) \longrightarrow Fe^{2+}(aq) + Cu(s)$$

31. Basic requirements for both processes are :

(i) The metal should form a volatile compound with an available reagent.

(ii) The volatile compound should be easily decomposable, so that recovery of metal is easy.

32. It is because at high temperature carbon and hydrogen react with metals to form carbides and hydrides respectively.

33. Two sulphide ores can be separated by adjusting proportion of oil to water or by using depressants. For example, in the case of an ore containing ZnS and PbS, the depressant NaCN is used. It forms complex with ZnS and prevents it from coming with froth but PbS remains with froth.

34. Haematite

$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO$

35. Since compound 'A' comes out before compound 'B', the compound 'B' is more readily adsorbed on column.

36. Iron oxide present as impurity in sulphide ore of copper forms slag which is iron silicate and copper is produced in the form of copper matte.

$FeO + SiO_2 \longrightarrow FeSiO_3$

37. Sulphides are not reduced easily but oxides are easily reduced.

38. van Arkel method is used for refining Zr and Ti. In this method crude metal is heated with iodine.

$Zr + 2I_2 \longrightarrow ZrI_4$

$ZrI_4 \xrightarrow{1800K} Zr + 2I_2$

39. Generally two things are considered so that proper precautions can be taken.

(i) reactivity of metal produced.

(ii) suitability of electrodes.

40. Flux is used for making the molten mass more conducting.

41. Semiconducting metal is produced by zone refining method which is based on the principle that the impurities are more soluble in melt than in the solid state of metals.

42. $3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$

$Fe_3O_4 + 4CO \longrightarrow 3Fe + 4CO_2$

$Fe_2O_3 + CO \longrightarrow 2FeO + CO_2$

43. (i) The metal should form a volatile compound with available reagent.

(ii) The volatile compound should be easily decomposable so that the recovery is easy.

44. $4Au\ (s) + 8CN^-(aq) + 2H_2O\ (aq) + O_2\ (g) \longrightarrow 4\ [Au\ (CN)_2]^-\ (aq) + 4OH^-\ (aq)$

$2[Au(CN)_2]^-\ (aq) + Zn(s) \longrightarrow 2Au(s) + [Zn\ (CN)_4]^{2-}\ (aq)$

In this reaction zinc acts as a reducing agent.

IV. Matching Type

45. (ii) 46. (ii) 47. (i) 48. (i) 49. (i)

V. Assertion and Reason Type

50. (i) 51. (i) 52. (ii) 53. (ii) 54. (ii)

VI. Long Answer Type

55. (a) **Hint :** Use Ellingham diagram

(b) **Hint :** Oxides are easier to reduce. See Ellingham diagram.

(c) **Hint :** Sulphide ore of copper contains iron as impurity which is removed as iron silicate (slag)

$$FeO + SiO_2 \longrightarrow \underset{\text{(Slag)}}{FeSiO_3}$$

(d) **Hint :** Carbon and hydrogen react with metals at high temperature to form carbides and hydrides respectively.

(e) **Hint :** Ti reacts with iodine to form volatile TiI_4 which decomposes at high temperature to give extra pure titanium.

Unit 7

The p-Block Elements

I. Multiple Choice Questions (Type-I)

1. On addition of conc. H_2SO_4 to a chloride salt, colourless fumes are evolved but in case of iodide salt, violet fumes come out. This is because

(i) H_2SO_4 reduces HI to I_2

(ii) HI is of violet colour

(iii) HI gets oxidised to I_2

(iv) HI changes to HIO_3

2. In qualitative analysis when H_2S is passed through an aqueous solution of salt acidified with dil. HCl, a black precipitate is obtained. On boiling the precipitate with dil. HNO_3, it forms a solution of blue colour. Addition of excess of aqueous solution of ammonia to this solution gives _________.

(i) deep blue precipitate of Cu $(OH)_2$

(ii) deep blue solution of $[Cu(NH_3)_4]^{2+}$

(iii) deep blue solution of $Cu(NO_3)_2$

(iv) deep blue solution of $Cu(OH)_2.Cu(NO_3)_2$

3. In a cyclotrimetaphosphoric acid molecule, how many single and double bonds are present?

(i) 3 double bonds; 9 single bonds

(ii) 6 double bonds; 6 single bonds

(iii) 3 double bonds; 12 single bonds

(iv) Zero double bonds; 12 single bonds

4. Which of the following elements can be involved in $p\pi–d\pi$ bonding?

(i) Carbon

(ii) Nitrogen

(iii) Phosphorus
(iv) Boron

5. Which of the following pairs of ions are isoelectronic and isostructural?

(i) CO_3^{2-}, NO_3^-
(ii) ClO_3^-, CO_3^{2-}
(iii) SO_3^{2-}, NO_3^-
(iv) ClO_3^-, SO_3^{2-}

6. Affinity for hydrogen decreases in the group from fluorine to iodine. Which of the halogen acids should have highest bond dissociation enthalpy?

(i) HF
(ii) HCl
(iii) HBr
(iv) HI

7. Bond dissociation enthalpy of E—H (E = element) bonds is given below. Which of the compounds will act as strongest reducing agent?

Compound	NH_3	PH_3	AsH_3	SbH_3
Δ_{diss} (E—H)/kJ mol^{-1}	389	322	297	255

(i) NH_3
(ii) PH_3
(iii) AsH_3
(iv) SbH_3

8. On heating with concentrated NaOH solution in an inert atmosphere of CO_2, white phosphorus gives a gas. Which of the following statement is **incorrect** about the gas?

(i) It is highly poisonous and has smell like rotten fish.
(ii) It's solution in water decomposes in the presence of light.
(iii) It is more basic than NH_3.
(iv) It is less basic than NH_3.

9. Which of the following acids forms three series of salts?

(i) H_3PO_2
(ii) H_3BO_3
(iii) H_3PO_4
(iv) H_3PO_3

10. Strong reducing behaviour of H_3PO_2 is due to

(i) Low oxidation state of phosphorus
(ii) Presence of two –OH groups and one P–H bond

(iii) Presence of one –OH group and two P–H bonds

(iv) High electron gain enthalpy of phosphorus

11. On heating lead nitrate forms oxides of nitrogen and lead. The oxides formed are ______.

(i) N_2O, PbO

(ii) NO_2, PbO

(iii) NO, PbO

(iv) NO, PbO_2

12. Which of the following elements does not show allotropy?

(i) Nitrogen

(ii) Bismuth

(iii) Antimony

(iv) Arsenic

13. Maximum covalency of nitrogen is ____________.

(i) 3

(ii) 5

(iii) 4

(iv) 6

14. Which of the following statements is wrong?

(i) Single N–N bond is stronger than the single P–P bond.

(ii) PH_3 can act as a ligand in the formation of coordination compound with transition elements.

(iii) NO_2 is paramagnetic in nature.

(iv) Covalency of nitrogen in N_2O_5 is four.

15. A brown ring is formed in the ring test for NO_3^- ion. It is due to the formation of

(i) $[Fe(H_2O)_5 (NO)]^{2+}$

(ii) $FeSO_4.NO_2$

(iii) $[Fe(H_2O)_4(NO)_2]^{2+}$

(iv) $FeSO_4.HNO_3$

16. Elements of group-15 form compounds in +5 oxidation state. However, bismuth forms only one well characterised compound in +5 oxidation state. The compound is

(i) Bi_2O_5

(ii) BiF_5

(iii) $BiCl_5$

(iv) Bi_2S_5

17. On heating ammonium dichromate and barium azide separately we get

(i) N_2 in both cases
(ii) N_2 with ammonium dichromate and NO with barium azide
(iii) N_2O with ammonium dichromate and N_2 with barium azide
(iv) N_2O with ammonium dichromate and NO_2 with barium azide

18. In the preparation of HNO_3, we get NO gas by catalytic oxidation of ammonia. The moles of NO produced by the oxidation of two moles of NH_3 will be ______.

(i) 2
(ii) 3
(iii) 4
(iv) 6

19. The oxidation state of central atom in the anion of compound NaH_2PO_2 will be ______.

(i) +3
(ii) +5
(iii) +1
(iv) –3

20. Which of the following is **not** tetrahedral in shape?

(i) NH_4^+
(ii) $SiCl_4$
(iii) SF_4
(iv) SO_4^{2-}

21. Which of the following are peroxoacids of sulphur?

(i) H_2SO_5 and $H_2S_2O_8$
(ii) H_2SO_5 and $H_2S_2O_7$
(iii) $H_2S_2O_7$ and $H_2S_2O_8$
(iv) $H_2S_2O_6$ and $H_2S_2O_7$

22. Hot conc. H_2SO_4 acts as moderately strong oxidising agent. It oxidises both metals and nonmetals. Which of the following element is oxidised by conc. H_2SO_4 into two gaseous products?

(i) Cu
(ii) S
(iii) C
(iv) Zn

23. A black compound of manganese reacts with a halogen acid to give greenish yellow gas. When excess of this gas reacts with NH_3 an unstable trihalide is formed. In this process the oxidation state of nitrogen changes from ________.

(i) – 3 to +3
(ii) – 3 to 0
(iii) – 3 to +5
(iv) 0 to – 3

24. In the preparation of compounds of Xe, Bartlett had taken $O_2^+ \, Pt \, F_6^-$ as a base compound. This is because

(i) both O_2 and Xe have same size.

(ii) both O_2 and Xe have same electron gain enthalpy.

(iii) both O_2 and Xe have almost same ionisation enthalpy.

(iv) both Xe and O_2 are gases.

25. In solid state PCl_5 is a _________.

(i) covalent solid

(ii) octahedral structure

(iii) ionic solid with $[PCl_6]^+$ octahedral and $[PCl_4]^-$ tetrahedra

(iv) ionic solid with $[PCl_4]^+$ tetrahedral and $[PCl_6]^-$ octahedra

26. Reduction potentials of some ions are given below. Arrange them in decreasing order of oxidising power.

Ion	ClO_4^-	IO_4^-	BrO_4^-
Reduction potential $E^{\ominus}/V$	$E^{\ominus}=1.19V$	$E^{\ominus}=1.65V$	$E^{\ominus}=1.74V$

(i) $ClO_4^- > IO_4^- > BrO_4^-$

(ii) $IO_4^- > BrO_4^- > ClO_4^-$

(iii) $BrO_4^- > IO_4^- > ClO_4^-$

(iv) $BrO_4^- > ClO_4^- > IO_4^-$

27. Which of the following is isoelectronic pair?

(i) ICl_2, ClO_2

(ii) BrO_2^-, BrF_2^+

(iii) ClO_2, BrF

(iv) CN^-, O_3

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

28. If chlorine gas is passed through hot NaOH solution, two changes are observed in the oxidation number of chlorine during the reaction. These are ________ and _________.

(i) 0 to +5

(ii) 0 to +3

(iii) 0 to –1

(iv) 0 to +1

29. Which of the following options are **not** in accordance with the property mentioned against them?

(i)	$F_2 > Cl_2 > Br_2 > I_2$	Oxidising power.
(ii)	$MI > MBr > MCl > MF$	Ionic character of metal halide.
(iii)	$F_2 > Cl_2 > Br_2 > I_2$	Bond dissociation enthalpy.
(iv)	$HI < HBr < HCl < HF$	Hydrogen-halogen bond strength.

30. Which of the following is correct for P_4 molecule of white phosphorus?

(i) It has 6 lone pairs of electrons.
(ii) It has six P–P single bonds.
(iii) It has three P–P single bonds.
(iv) It has four lone pairs of electrons.

31. Which of the following statements are correct?

(i) Among halogens, radius ratio between iodine and fluorine is maximum.
(ii) Leaving F—F bond, all halogens have weaker X—X bond than X—X′ bond in interhalogens.
(iii) Among interhalogen compounds maximum number of atoms are present in iodine fluoride.
(iv) Interhalogen compounds are more reactive than halogen compounds.

32. Which of the following statements are correct for SO_2 gas?

(i) It acts as bleaching agent in moist conditions.
(ii) It's molecule has linear geometry.
(iii) It's dilute solution is used as disinfectant.
(iv) It can be prepared by the reaction of dilute H_2SO_4 with metal sulphide.

33. Which of the following statements are correct?

(i) All the three N—O bond lengths in HNO_3 are equal.
(ii) All P—Cl bond lengths in PCl_5 molecule in gaseous state are equal.
(iii) P_4 molecule in white phohsphorus have angular strain therefore white phosphorus is very reactive.
(iv) PCl is ionic in solid state in which cation is tetrahedral and anion is octahedral.

34. Which of the following orders are correct as per the properties mentioned against each?

(i)	$As_2O_3 < SiO_2 < P_2O_3 < SO_2$	Acid strength.
(ii)	$AsH_3 < PH_3 < NH_3$	Enthalpy of vapourisation.
(iii)	$S < O < Cl < F$	More negative electron gain enthalpy.
(iv)	$H_2O > H_2S > H_2Se > H_2Te$	Thermal stability.

35. Which of the following statements are correct?

(i) S–S bond is present in $H_2S_2O_6$.

(ii) In peroxosulphuric acid (H_2SO_5) sulphur is in +6 oxidation state.

(iii) Iron powder along with Al_2O_3 and K_2O is used as a catalyst in the preparation of NH_3 by Haber's process.

(iv) Change in enthalpy is positive for the preparation of SO_3 by catalytic oxidation of SO_2.

36. In which of the following reactions conc. H_2SO_4 is used as an oxidising reagent?

(i) $CaF_2 + H_2SO_4 \longrightarrow CaSO_4 + 2HF$

(ii) $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$

(iii) $Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$

(iv) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$

37. Which of the following statements are true?

(i) Only type of interactions between particles of noble gases are due to weak dispersion forces.

(ii) Ionisation enthalpy of molecular oxygen is very close to that of xenon.

(iii) Hydrolysis of XeF_6 is a redox reaction.

(iv) Xenon fluorides are not reactive.

III. Short Answer Type

38. In the preparation of H_2SO_4 by Contact Process, why is SO_3 not absorbed directly in water to form H_2SO_4?

39. Write a balanced chemical equation for the reaction showing catalytic oxidation of NH_3 by atmospheric oxygen.

40. Write the structure of pyrophosphoric acid.

41. PH_3 forms bubbles when passed slowly in water but NH_3 dissolves. Explain why?

42. In PCl_5, phosphorus is in sp^3d hybridised state but all its five bonds are not equivalent. Justify your answer with reason.

43. Why is nitric oxide paramagnetic in gaseous state but the solid obtained on cooling it is diamagnetic?

44. Give reason to explain why ClF_3 exists but FCl_3 does not exist.

45. Out of H_2O and H_2S, which one has higher bond angle and why?

46. SF_6 is known but SCl_6 is not. Why?

47. On reaction with Cl_2, phosphorus forms two types of halides 'A' and 'B'. Halide A is yellowish-white powder but halide 'B' is colourless oily liquid. Identify A and B and write the formulas of their hydrolysis products.

48. In the ring test of NO_3^- ion, Fe^{2+} ion reduces nitrate ion to nitric oxide, which combines with Fe^{2+} (aq) ion to form brown complex. Write the reactions involved in the formation of brown ring.

49. Explain why the stability of oxoacids of chlorine increases in the order given below:

$HClO < HClO_2 < HClO_3 < HClO_4$

50. Explain why ozone is thermodynamically less stable than oxygen.

51. P_4O_6 reacts with water according to equation $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$. Calculate the volume of 0.1 M NaOH solution required to neutralise the acid formed by dissolving 1.1 g of P_4O_6 in H_2O.

52. White phosphorus reacts with chlorine and the product hydrolyses in the presence of water. Calculate the mass of HCl obtained by the hydrolysis of the product formed by the reaction of 62 g of white phosphorus with chlorine in the presence of water.

53. Name three oxoacids of nitrogen. Write the disproportionation reaction of that oxoacid of nitrogen in which nitrogen is in +3 oxidation state.

54. Nitric acid forms an oxide of nitrogen on reaction with P_4O_{10}. Write the reaction involved. Also write the resonating structures of the oxide of nitrogen formed.

55. Phosphorus has three allotropic forms — (i) white phosphorus (ii) red phosphorus and (iii) black phosphorus. Write the difference between white and red phosphorus on the basis of their structure and reactivity.

56. Give an example to show the effect of concentration of nitric acid on the formation of oxidation product.

57. PCl_5 reacts with finely divided silver on heating and a white silver salt is obtained, which dissolves on adding excess aqueous NH_3 solution. Write the reactions involved to explain what happens.

58. Phosphorus forms a number of oxoacids. Out of these oxoacids phosphinic acid has strong reducing property. Write its structure and also write a reaction showing its reducing behaviour.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

59. Match the compounds given in Column I with the hybridisation and shape given in Column II and mark the correct option.

Column I	Column II
(A) XeF_6	(1) sp^3d^3 – distorted octahedral
(B) XeO_3	(2) sp^3d^2 - square planar
(C) $XeOF_4$	(3) sp^3 - pyramidal
(D) XeF_4	(4) sp^3d^2 - square pyramidal

Code :

(i) A (1) B (3) C (4) D (2)
(ii) A (1) B (2) C (4) D (3)
(iii) A (4) B (3) C (1) D (2)
(iv) A (4) B (1) C (2) D (3)

60. Match the formulas of oxides given in Column I with the type of oxide given in Column II and mark the correct option.

Column I	**Column II**
(A) Pb_3O_4	(1) Neutral oxide
(B) N_2O	(2) Acidic oxide
(C) Mn_2O_7	(3) Basic oxide
(D) Bi_2O_3	(4) Mixed oxide

Code :

(i) A (1) B (2) C (3) D (4)
(ii) A (4) B (1) C (2) D (3)
(iii) A (3) B (2) C (4) D (1)
(iv) A (4) B (3) C (1) D (2)

61. Match the items of Columns I and II and mark the correct option.

Column I	**Column II**
(A) H_2SO_4	(1) Highest electron gain enthalpy
(B) CCl_3NO_2	(2) Chalcogen
(C) Cl_2	(3) Tear gas
(D) Sulphur	(4) Storage batteries

Code :

(i) A (4) B (3) C (1) D (2)
(ii) A (3) B (4) C (1) D (2)
(iii) A (4) B (1) C (2) D (3)
(iv) A (2) B (1) C (3) D (4)

62. Match the species given in Column I with the shape given in Column II and mark the correct option.

Column I	**Column II**
(A) SF_4	(1) Tetrahedral
(B) BrF_3	(2) Pyramidal
(C) BrO_3^-	(3) Sea-saw shaped
(D) NH_4^+	(4) Bent T-shaped

Code :

(i) A (3) B (2) C (1) D (4)
(ii) A (3) B (4) C (2) D (1)
(iii) A (1) B (2) C (3) D (4)
(iv) A (1) B (4) C (3) D (2)

63. Match the items of Columns I and II and mark the correct option.

	Column I		**Column II**
(A)	Its partial hydrolysis does not change oxidation state of central atom	(1)	He
(B)	It is used in modern diving apparatus	(2)	XeF_6
(C)	It is used to provide inert atmosphere for filling electrical bulbs	(3)	XeF_4
(D)	Its central atom is in sp^3d^2 hybridisation	(4)	Ar

Code :

(i) A (1) B (4) C (2) D (3)
(ii) A (1) B (2) C (3) D (4)
(iii) A (2) B (1) C (4) D (3)
(iv) A (1) B (3) C (2) D (4)

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.

(ii) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.

(iii) Assertion is correct, but reason is wrong statement.

(iv) Assertion is wrong but reason is correct statement.

(v) Both assertion and reason are wrong statements.

64. **Assertion** : N_2 is less reactive than P_4.
Reason : Nitrogen has more electron gain enthalpy than phosphorus.

65. **Assertion** : HNO_3 makes iron passive.
Reason : HNO_3 forms a protective layer of ferric nitrate on the surface of iron.

66. **Assertion** : HI cannot be prepared by the reaction of KI with concentrated H_2SO_4

Reason : HI has lowest H–X bond strength among halogen acids.

67. **Assertion** : Both rhombic and monoclinic sulphur exist as S_8 but oxygen exists as O_2.

Reason : Oxygen forms $p\pi - p\pi$ multiple bond due to small size and small bond length but $p\pi - p\pi$ bonding is not possible in sulphur.

68. **Assertion** : NaCl reacts with concentrated H_2SO_4 to give colourless fumes with pungent smell. But on adding MnO_2 the fumes become greenish yellow.

Reason : MnO_2 oxidises HCl to chlorine gas which is greenish yellow.

69. **Assertion** : SF_6 cannot be hydrolysed but SF_4 can be.

Reason : Six F atoms in SF_6 prevent the attack of H_2O on sulphur atom of SF_6.

VI. Long Answer Type

70. An amorphous solid "A" burns in air to form a gas "B" which turns lime water milky. The gas is also produced as a by-product during roasting of sulphide ore. This gas decolourises acidified aqueous $KMnO_4$ solution and reduces Fe^{3+} to Fe^{2+}. Identify the solid "A" and the gas "B" and write the reactions involved.

71. On heating lead (II) nitrate gives a brown gas "A". The gas "A" on cooling changes to colourless solid "B". Solid "B" on heating with NO changes to a blue solid 'C'. Identify 'A', 'B' and 'C' and also write reactions involved and draw the structures of 'B' and 'C'.

72. On heating compound (A) gives a gas (B) which is a constituent of air. This gas when treated with 3 mol of hydrogen (H_2) in the presence of a catalyst gives another gas (C) which is basic in nature. Gas C on further oxidation in moist condition gives a compound (D) which is a part of acid rain. Identify compounds (A) to (D) and also give necessary equations of all the steps involved.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iii) 2. (ii) 3. (i) 4. (iii) 5. (i) 6. (i)
7. (iv) 8. (iii) 9. (iii) 10. (iii) 11. (ii) 12. (i)
13. (iii) 14. (i) 15. (i) 16. (ii) 17. (i) 18. (i)
19. (iii) 20. (iii) 21. (i) 22. (iii) 23. (i) 24. (iii)
25. (iv) 26. (iii) 27. (ii)

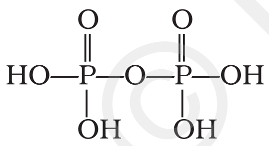
II. Multiple Choice Questions (Type-II)

28. (i), (iii) 29. (ii), (iii) 30. (ii), (iv) 31. (i), (iii), (iv)
32. (i), (iii) 33. (iii), (iv) 34. (i), (iv) 35. (i), (ii)
36. (ii), (iii) 37. (i), (ii)

III. Short Answer Type

38. Acid fog is formed, which is difficult to condense.

39. $4NH_3 + \underset{\text{(From air)}}{5O_2} \xrightarrow[\text{500K, 9 bar}]{\text{Pt/Rh gauge catalyst}} 4NO + 6H_2O$

40. 

$$HO-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle OH}{|}}{P}}-O-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle OH}{|}}{P}}-OH$$

Pyrophosphoric acid

41. NH_3 forms hydrogen bonds with water therefore it is soluble in it but PH_3 cannot form hydrogen bond with water so it escapes as gas.

42. [**Hint :** It has trigonal bipyramidal geometry]

43. In gaseous state NO_2 exists as monomer which has one unpaired electron but in solid state it dimerises to N_2O_4 so no unpaired electron is left hence solid form is diamagnetic.

44. Because fluorine is more electronegative as compared to chlorine.

45. Bond angle of H_2O is larger, because oxygen is more electronegative than sulphur therefore bond pair electron of O–H bond will be closer to oxygen and there will be more bond-pair bond-pair repulsion between bond pairs of two O–H bonds.

46. Due to small size of fluorine six F^- ion can be accomodated around sulphur whereas chloride ion is comparatively larger in size, therefore, there will be interionic repulsion.

47. A is PCl_5 (It is yellowish white powder)

$$P_4 + 10Cl_2 \longrightarrow 4PCl_5$$

B is PCl_3 (It is a colourless oily liquid)

$$P_4 + 6Cl_2 \longrightarrow 4PCl_3$$

Hydrolysis products are formed as follows :

$$PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl$$

$$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$$

48. $NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow NO + 3Fe^{3+} + 2H_2O$

$$[Fe(H_2O)_6]^{2+} + NO \longrightarrow [Fe(H_2O)_5(NO)]^{2+} + H_2O$$

(brown complex)

49. Oxygen is more electronegative than chlorine, therefore dispersal of negative charge present on chlorine increases from ClO^- to ClO_4^- ion because number of oxygen atoms attached to chlorine is increasing. Therefore, stability of ions will increase in the order given below :

$$ClO^- < ClO_2^- < ClO_3^- < ClO_4^-$$

Thus due to increase in stability of conjugate base, acidic strength of corresponding acid increases in the following order

$$HClO < HClO_2 < HClO_3 < HClO_4$$

50. See the NCERT textbook for Class XII, page 186.

51. $P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$

$H_3PO_3 + 2NaOH \longrightarrow Na_2\ HPO_3 + 2H_2O] \times 4$ (Neutralisation reaction)

$P_4O_6 + 8NaOH \longrightarrow 4Na_2\ HPO_4 + 2H_2O$

1 mol 8 mol

Product formed by 1 mol of P_4O_6 is neutralised by 8 mols of NaOH

$\therefore$ Product formed by $\dfrac{1.1}{220}$ mol of P_4O_6 will be neutralised by $\dfrac{1.1}{220} \times 8$ mol of NaOH

Molarity of NaOH solution is 0.1M

$\Rightarrow$ 0.1 mol NaOH is present in 1 L solution

$\therefore$ $\dfrac{1.1}{220} \times 8$ mol NaOH is present in $\dfrac{1.1 \times 8}{220 \times 0.1}L = \dfrac{88}{220}L = \dfrac{4}{10}L = 0.4\,L =$ 400 mL of NaOH solution.

52. $P_4 + 6Cl_2 \longrightarrow 4PCl_3$

$PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl] \times 4$

$P_4 + 6Cl_2 + 12H_2O \longrightarrow 4H_3PO_3 + 12HCl$

1 mol of white phosphorus produces 12 mol of HCl

62g of white phosphorus has been taken which is equivalent to $\frac{62}{124} = \frac{1}{2}$ mol.

Therefore 6 mol HCl will be formed.

$$\text{Mass of 6 mol HCl} = 6 \times 36.5 = 219.0 \text{ g HCl}$$

53. Three oxoacids of nitrogen are

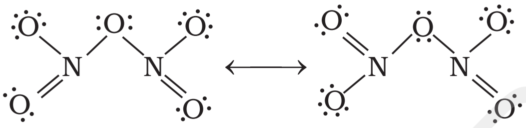
(i) HNO_2, Nitrous acid

(ii) HNO_3 , Nitric acid

(iii) Hyponitrous acid, $H_2N_2O_2$

$$3HNO_2 \xrightarrow{\text{Disproportionation}} HNO_3 + H_2O + 2NO$$

54. $4HNO_3 + P_4O_{10} \longrightarrow 4HPO_3 + 2N_2O_5$



55. (a)
- Structures (See NCERT textbook for Class XII)
- White phosphorus is discrete tetrahedral molecule. Thus it has tetrahedral structure with six P–P bonds.
- Red phosphorus has polymeric structure in which P_4 tetrahedra are linked together through P—P bonds to form chain.

(b) Reactivity

White phosphorus is much more reactive than red phosphorus. This is because in white phosphorus there is angular strain in P_4 molecules because the bond angles are only of 60°.

56. Dilute and concentrated nitric acid give different oxidation products on reaction with copper metal.

$$3Cu + 8HNO_3\,(\text{dil.}) \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$$

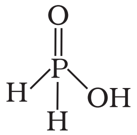
$$Cu + 4HNO_3\,(\text{Conc.}) \longrightarrow 3Cu(NO_3)_2 + 2NO + 2H_2O$$

57. $PCl_5 + 2Ag \longrightarrow 2AgCl + PCl_3$

$AgCl + 2NH_3(aq) \longrightarrow [Ag(NH_3)_2]^+Cl^-$

(soluble complex)

58. Structure of phosphinic acid (Hypophosphorous acid) is as follows :



Reducing behaviour of phosphinic acid is observable in the reaction with silver nitrate given below :

$4AgNO_3 + 2H_2O + H_3PO_2 \longrightarrow 4Ag + 4HNO_3 + H_3PO_4$

IV. Matching Type

59. (i) 60. (ii) 61. (i) 62. (ii) 63. (iii)

V. Assertion and Reason Type

64. (iii) 65. (iii) 66. (ii) 67. (i) 68. (i) 69. (i)

VI. Long Answer Type

70. 'A' is S_8 'B' is SO_2 gas

$$S_8 + 8O_2 \xrightarrow{\Delta} 8SO_2$$

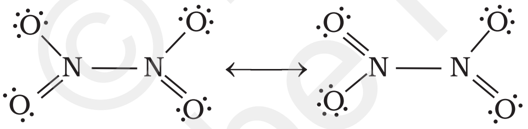
$$\underset{\text{(violet)}}{2MnO_4^-} + 5SO_2 + 2H_2O \longrightarrow 5\,SO_4^{2-} + 4H^+ + \underset{\text{(colourless)}}{2Mn^{2+}}$$

$$2Fe^{3+} + SO_2 + 2H_2O \longrightarrow 2Fe^{2+} + SO_4^{2-} + 4H^+$$

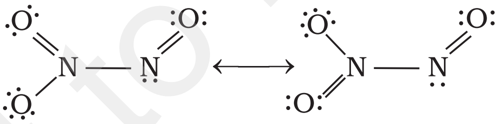
71. $$Pb(NO_3)_2 \xrightarrow[673K]{\Delta} 2PbO + \underset{\substack{\text{(A)} \\ \text{(Brown colour)}}}{4NO_2}$$

$$2NO_2 \underset{\text{Heating}}{\overset{\text{On cooling}}{\rightleftharpoons}} \underset{\substack{\text{(B)} \\ \text{(Colourless solid)}}}{N_2O_4}$$

$$2NO + N_2O_4 \xrightarrow{\Delta\ 250\ K} \underset{\substack{\text{(C)} \\ \text{(Blue solid)}}}{2\,N_2O_3}$$



(Structure of N_2O_4)



(Structure of N_2O_3)

72. A = NH_4NO_2 B = N_2 C = NH_3 D = HNO_3

(i) $NH_4NO_2 \rightarrow N_2 + 2H_2O$

(ii) $N_2 + 3H_2 \rightarrow 2NH_3$

(iii) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

$4NO + O_2 \rightarrow 2NO_2$

$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

Unit

8

The *d*- and *f*- Block Elements

I. Multiple Choice Questions (Type-I)

1. Electronic configuration of a transition element X in +3 oxidation state is [Ar]$3d^5$. What is its atomic number?

(i) 25

(ii) 26

(iii) 27

(iv) 24

2. The electronic configuration of Cu(II) is $3d^9$ whereas that of Cu(I) is $3d^{10}$. Which of the following is correct?

(i) Cu(II) is more stable

(ii) Cu(II) is less stable

(iii) Cu(I) and Cu(II) are equally stable

(iv) Stability of Cu(I) and Cu(II) depends on nature of copper salts

3. Metallic radii of some transition elements are given below. Which of these elements will have highest density?

Element	Fe	Co	Ni	Cu
Metallic radii/pm	126	125	125	128

(i) Fe

(ii) Ni

(iii) Co

(iv) Cu

4. Generally transition elements form coloured salts due to the presence of unpaired electrons. Which of the following compounds will be coloured in solid state?

(i) Ag_2SO_4
(ii) CuF_2
(iii) ZnF_2
(iv) Cu_2Cl_2

5. On addition of small amount of $KMnO_4$ to concentrated H_2SO_4, a green oily compound is obtained which is highly explosive in nature. Identify the compound from the following.

(i) Mn_2O_7
(ii) MnO_2
(iii) $MnSO_4$
(iv) Mn_2O_3

6. The magnetic nature of elements depends on the presence of unpaired electrons. Identify the configuration of transition element, which shows highest magnetic moment.

(i) $3d^7$
(ii) $3d^5$
(iii) $3d^8$
(iv) $3d^2$

7. Which of the following oxidation state is common for all lanthanoids?

(i) +2
(ii) +3
(iii) +4
(iv) +5

8. Which of the following reactions are disproportionation reactions?

(a) $Cu^+ \longrightarrow Cu^{2+} + Cu$
(b) $3MnO_4^- + 4H^+ \longrightarrow 2MnO_4^- + MnO_2 + 2H_2O$
(c) $2KMnO_4 \longrightarrow K_2MnO_4 + MnO_2 + O_2$
(d) $2MnO_4^- + 3Mn^{2+} + 2H_2O \longrightarrow 5MnO_2 + 4H^+$

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

9. When $KMnO_4$ solution is added to oxalic acid solution, the decolourisation is slow in the beginning but becomes instantaneous after some time because

(i) CO_2 is formed as the product.

(ii) Reaction is exothermic.

(iii) MnO_4^- catalyses the reaction.

(iv) Mn^{2+} acts as autocatalyst.

10. There are 14 elements in actinoid series. Which of the following elements does not belong to this series?

(i) U

(ii) Np

(iii) Tm

(iv) Fm

11. $KMnO_4$ acts as an oxidising agent in acidic medium. The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphide ions in acidic solution is

(i) $\frac{2}{5}$

(ii) $\frac{3}{5}$

(iii) $\frac{4}{5}$

(iv) $\frac{1}{5}$

12. Which of the following is amphoteric oxide?

Mn_2O_7, CrO_3, Cr_2O_3, CrO, V_2O_5, V_2O_4

(i) V_2O_5, Cr_2O_3

(ii) Mn_2O_7, CrO_3

(iii) CrO, V_2O_5

(iv) V_2O_5, V_2O_4

13. Gadolinium belongs to $4f$ series. It's atomic number is 64. Which of the following is the correct electronic configuration of gadolinium?

(i) $[Xe]\ 4f^7 5d^1 6s^2$

(ii) $[Xe]\ 4f^6 5d^2 6s^2$

(iii) $[Xe]\ 4f^8 6d^2$

(iv) $[Xe]\ 4f^9 5s^1$

14. Interstitial compounds are formed when small atoms are trapped inside the crystal lattice of metals. Which of the following is not the characteristic property of interstitial compounds?

(i) They have high melting points in comparison to pure metals.
(ii) They are very hard.
(iii) They retain metallic conductivity.
(iv) They are chemically very reactive.

15. The magnetic moment is associated with its spin angular momentum and orbital angular momentum. Spin only magnetic moment value of Cr^{3+} ion is __________.

(i) 2.87 B.M.
(ii) 3.87 B.M.
(iii) 3.47 B.M.
(iv) 3.57 B.M.

16. $KMnO_4$ acts as an oxidising agent in alkaline medium. When alkaline $KMnO_4$ is treated with KI, iodide ion is oxidised to ___________.

(i) I_2
(ii) IO^-
(iii) IO_3^-
(iv) IO_4^-

17. Which of the following statements is **not** correct?

(i) Copper liberates hydrogen from acids.
(ii) In its higher oxidation states, manganese forms stable compounds with oxygen and fluorine.
(iii) Mn^{3+} and Co^{3+} are oxidising agents in aqueous solution.
(iv) Ti^{2+} and Cr^{2+} are reducing agents in aqueous solution.

18. When acidified $K_2Cr_2O_7$ solution is added to Sn^{2+} salts then Sn^{2+} changes to

(i) Sn
(ii) Sn^{3+}
(iii) Sn^{4+}
(iv) Sn^{+}

19. Highest oxidation state of manganese in fluoride is +4 (MnF_4) but highest oxidation state in oxides is +7 (Mn_2O_7) because ____________.

(i) fluorine is more electronegative than oxygen.
(ii) fluorine does not possess *d*-orbitals.
(iii) fluorine stabilises lower oxidation state.
(iv) in covalent compounds fluorine can form single bond only while oxygen forms double bond.

20. Although Zirconium belongs to *4d* transition series and Hafnium to *5d* transition series even then they show similar physical and chemical properties because___________.

(i) both belong to *d*-block.

(ii) both have same number of electrons.

(iii) both have similar atomic radius.

(iv) both belong to the same group of the periodic table.

21. Why is HCl not used to make the medium acidic in oxidation reactions of $KMnO_4$ in acidic medium?

(i) Both HCl and $KMnO_4$ act as oxidising agents.

(ii) $KMnO_4$ oxidises HCl into Cl_2 which is also an oxidising agent.

(iii) $KMnO_4$ is a weaker oxidising agent than HCl.

(iv) $KMnO_4$ acts as a reducing agent in the presence of HCl.

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

22. Generally transition elements and their salts are coloured due to the presence of unpaired electrons in metal ions. Which of the following compounds are coloured?

(i) $KMnO_4$

(ii) $Ce\ (SO_4)_2$

(iii) $TiCl_4$

(iv) Cu_2Cl_2

23. Transition elements show magnetic moment due to spin and orbital motion of electrons. Which of the following metallic ions have almost same spin only magnetic moment?

(i) Co^{2+}

(ii) Cr^{2+}

(iii) Mn^{2+}

(iv) Cr^{3+}

24. In the form of dichromate, Cr (VI) is a strong oxidising agent in acidic medium but Mo (VI) in MoO_3 and W (VI) in WO_3 are not because ___________.

(i) Cr (VI) is more stable than Mo(VI) and W(VI).

(ii) Mo(VI) and W(VI) are more stable than Cr(VI).

(iii) Higher oxidation states of heavier members of group-6 of transition series are more stable.

(iv) Lower oxidation states of heavier members of group-6 of transition series are more stable.

25. Which of the following actinoids show oxidation states upto +7?

(i) Am

(ii) Pu

(iii) U

(iv) Np

26. General electronic configuration of actionoids is $(n–2)f^{1-14}(n-1)d^{0-2}ns^2$.Which of the following actinoids have one electron in 6*d* orbital?

(i) U (Atomic no. 92)

(ii) Np (Atomic no.93)

(iii) Pu (Atomic no. 94)

(iv) Am (Atomic no. 95)

27. Which of the following lanthanoids show +2 oxidation state besides the characteristic oxidation state +3 of lanthanoids?

(i) Ce

(ii) Eu

(iii) Yb

(iv) Ho

28. Which of the following ions show higher spin only magnetic moment value?

(i) Ti^{3+}

(ii) Mn^{2+}

(iii) Fe^{2+}

(iv) Co^{3+}

29. Transition elements form binary compounds with halogens. Which of the following elements will form MF_3 type compounds?

(i) Cr

(ii) Co

(iii) Cu

(iv) Ni

30. Which of the following will **not** act as oxidising agents?

(i) CrO_3

(ii) MoO_3

(iii) WO_3

(iv) CrO_4^{2-}

31. Although +3 is the characteristic oxidation state for lanthanoids but cerium also shows +4 oxidation state because ___________.

(i) it has variable ionisation enthalpy

(ii) it has a tendency to attain noble gas configuration

(iii) it has a tendency to attain f^0 configuration

(iv) it resembles Pb^{4+}

III. Short Answer Type

32. Why does copper not replace hydrogen from acids?

33. Why $E^{\ominus}$ values for Mn, Ni and Zn are more negative than expected?

34. Why first ionisation enthalpy of Cr is lower than that of Zn ?

35. Transition elements show high melting points. Why?

36. When Cu^{2+} ion is treated with KI, a white precipitate is formed. Explain the reaction with the help of chemical equation.

37. Out of Cu_2Cl_2 and $CuCl_2$, which is more stable and why?

38. When a brown compound of manganese (A) is treated with HCl it gives a gas (B). The gas taken in excess, reacts with NH_3 to give an explosive compound (C). Identify compounds A, B and C.

39. Although fluorine is more electronegative than oxygen, but the ability of oxygen to stabilise higher oxidation states exceeds that of fluorine. Why?

40. Although Cr^{3+} and Co^{2+} ions have same number of unpaired electrons but the magnetic moment of Cr^{3+} is 3.87 B.M. and that of Co^{2+} is 4.87 B.M. Why?

41. Ionisation enthalpies of Ce, Pr and Nd are higher than Th, Pa and U. Why?

42. Although Zr belongs to 4*d* and Hf belongs to 5*d* transition series but it is quite difficult to separate them. Why?

43. Although +3 oxidation states is the characteristic oxidation state of lanthanoids but cerium shows +4 oxidation state also. Why?

44. Explain why does colour of $KMnO_4$ disappear when oxalic acid is added to its solution in acidic medium.

45. When orange solution containing $Cr_2O_7^{2-}$ ion is treated with an alkali, a yellow solution is formed and when H^+ ions are added to yellow solution, an orange solution is obtained. Explain why does this happen?

46. A solution of $KMnO_4$ on reduction yields either a colourless solution or a brown precipitate or a green solution depending on pH of the solution. What different stages of the reduction do these represent and how are they carried out?

47. The second and third rows of transition elements resemble each other much more than they resemble the first row. Explain why?

48. $E^{\ominus}$ of Cu is + 0.34V while that of Zn is – 0.76V. Explain.

49. The halides of transition elements become more covalent with increasing oxidation state of the metal. Why?

50. While filling up of electrons in the atomic orbitals, the 4s orbital is filled before the 3*d* orbital but reverse happens during the ionisation of the atom. Explain why?

51. Reactivity of transition elements decreases almost regularly from Sc to Cu. Explain.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

52. Match the catalysts given in Column I with the processes given in Column II.

	Column I (Catalyst)		Column II (Process)
(i)	Ni in the presence of hydrogen	(a)	Zieglar Natta catalyst
(ii)	Cu_2Cl_2	(b)	Contact process
(iii)	V_2O_5	(c)	Vegetable oil to ghee
(iv)	Finely divided iron	(d)	Sandmeyer reaction
(v)	$TiCl_4 + Al(CH_3)_3$	(e)	Haber's Process
		(f)	Decomposition of $KClO_3$

53. Match the compounds/elements given in Column I with uses given in Column II.

	Column I (Compound/element)		Column II (Use)
(i)	Lanthanoid oxide	(a)	Production of iron alloy
(ii)	Lanthanoid	(b)	Television screen
(iii)	Misch metal	(c)	Petroleum cracking
(iv)	Magnesium based alloy is constituent of	(d)	Lanthanoid metal + iron
(v)	Mixed oxides of lanthanoids are employed	(e)	Bullets
		(f)	In X-ray screen

54. Match the properties given in Column I with the metals given in Column II.

	Column I (Property)		Column II (Metal)
(i)	An element which can show +8 oxidation state	(a)	Mn
(ii)	3*d* block element that can show upto +7 oxidation state	(b)	Cr
		(c)	Os
(iii)	3*d* block element with highest melting point	(d)	Fe

55. Match the statements given in Column I with the oxidation states given in Column II.

	Column I		Column II
(i)	Oxidation state of Mn in MnO_2 is	(a)	+ 2
(ii)	Most stable oxidation state of Mn is	(b)	+ 3
(iii)	Most stable oxidation state of Mn in oxides is	(c)	+ 4
		(d)	+ 5
(iv)	Characteristic oxidation state of lanthanoids is	(e)	+ 7

56. Match the solutions given in Column I and the colours given in Column II.

Column I **(Aqueous solution of salt)**		**Column II** **(Colour)**	
(i)	$FeSO_4.7H_2O$	(a)	Green
(ii)	$NiCl_2.4H_2O$	(b)	Light pink
(iii)	$MnCl_2.4H_2O$	(c)	Blue
(iv)	$CoCl_2.6H_2O$	(d)	Pale green
(v)	Cu_2Cl_2	(e)	Pink
		(f)	Colourless

57. Match the property given in Column I with the element given in Column II.

Column I (Property)		**Column II (Element)**	
(i)	Lanthanoid which shows +4 oxidation state	(a)	Pm
(ii)	Lanthanoid which can show +2 oxidation state	(b)	Ce
(iii)	Radioactive lanthanoid	(c)	Lu
(iv)	Lanthanoid which has $4f^{7}$ electronic configuration in +3 oxidation state	(d)	Eu
(v)	Lanthanoid which has $4f^{14}$ electronic configuration in +3 oxidation state	(e)	Gd
		(f)	Dy

58. Match the properties given in Column I with the metals given in Column II.

Column I (Property)		**Column II (Metal)**	
(i)	Element with highest second ionisation enthalpy	(a)	Co
(ii)	Element with highest third ionisation enthalpy	(b)	Cr
(iii)	M in $M(CO)_6$ is	(c)	Cu
(iv)	Element with highest heat of atomisation	(d)	Zn
		(e)	Ni

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are true, and reason is the correct explanation of the assertion.

(ii) Both assertion and reason are true but reason is not the correct explanation of assertion.

(iii) Assertion is not true but reason is true.

(iv) Both assertion and reason are false.

59. Assertion : Cu^{2+} iodide is not known.
Reason : Cu^{2+} oxidises I^- to iodine.

60. Assertion : Separation of Zr and Hf is difficult.
Reason : Because Zr and Hf lie in the same group of the periodic table.

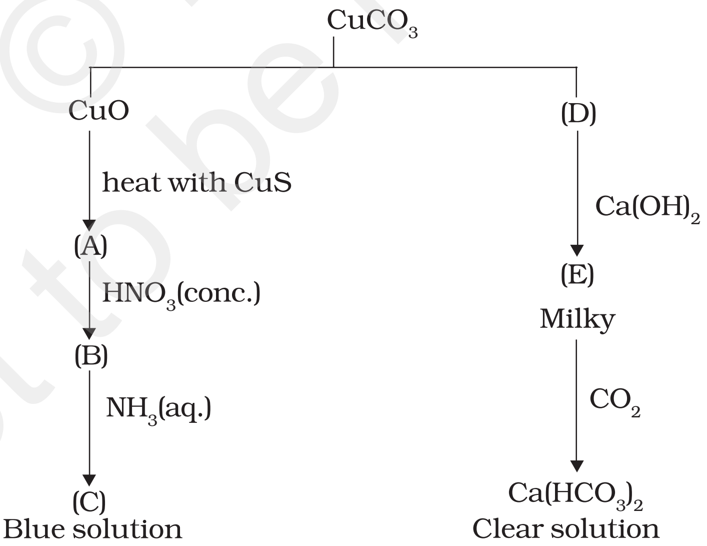
61. Assertion : Actinoids form relatively less stable complexes as compared to lanthanoids.
Reason : Actinoids can utilise their 5*f* orbitals along with 6*d* orbitals in bonding but lanthanoids do not use their 4*f* orbital for bonding.

62. Assertion : Cu cannot liberate hydrogen from acids.
Reason : Because it has positive electrode potential.

63. Assertion : The highest oxidation state of osmium is +8.
Reason : Osmium is a 5*d*-block element.

VI. Long Answer Type

64. Identify A to E and also explain the reactions involved.



65. When a chromite ore (A) is fused with sodium carbonate in free excess of air and the product is dissolved in water, a yellow solution of compound (B) is obtained. After treatment of this yellow solution with sulphuric acid, compound (C) can be crystallised from the solution. When compound (C) is treated with KCl, orange crystals of compound (D) crystallise out. Identify A to D and also explain the reactions.

66. When an oxide of manganese (A) is fused with KOH in the presence of an oxidising agent and dissolved in water, it gives a dark green solution of compound (B). Compound (B) disproportionates in neutral or acidic solution to give purple compound (C). An alkaline solution of compound (C) oxidises potassium iodide solution to a compound (D) and compound (A) is also formed. Identify compounds A to D and also explain the reactions involved.

67. On the basis of Lanthanoid contraction, explain the following :

(i) Nature of bonding in La_2O_3 and Lu_2O_3.

(ii) Trends in the stability of oxo salts of lanthanoids from La to Lu.

(iii) Stability of the complexes of lanthanoids.

(iv) Radii of 4*d* and 5*d* block elements.

(v) Trends in acidic character of lanthanoid oxides.

68. (a) Answer the following questions :

(i) Which element of the first transition series has highest second ionisation enthalpy?

(ii) Which element of the first transition series has highest third ionisation enthalpy?

(iii) Which element of the first transition series has lowest enthalpy of atomisation?

(b) Identify the metal and justify your answer.

(i) Carbonyl $M(CO)_5$

(ii) MO_3F

69. Mention the type of compounds formed when small atoms like H, C and N get trapped inside the crystal lattice of transition metals. Also give physical and chemical characteristics of these compounds.

70. (a) Transition metals can act as catalysts because these can change their oxidation state. How does Fe(III) catalyse the reaction between iodide and persulphate ions?

(b) Mention any three processes where transition metals act as catalysts.

71. A violet compound of manganese (A) decomposes on heating to liberate oxygen and compounds (B) and (C) of manganese are formed. Compound (C) reacts with KOH in the presence of potassium nitrate to give compound (B). On heating compound (C) with conc. H_2SO_4 and NaCl, chlorine gas is liberated and a compound (D) of manganese along with other products is formed. Identify compounds A to D and also explain the reactions involved.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii) 2. (i) 3. (iv) 4. (ii) 5. (i) 6. (ii)
7. (ii) 8. (i) 9. (iv) 10. (iii) 11. (i) 12. (i)
13. (i) 14. (iv) 15. (ii) 16. (iii) 17. (i) 18. (iii)
19. (iv) 20. (iii) 21. (ii)

II. Multiple Choice Questions (Type-II)

22. (i), (ii) 23. (i), (iv) 24. (ii), (iii) 25. (ii), (iv)
26. (i), (ii) 27. (ii), (iii) 28. (ii), (iii) 29. (i), (ii)
30. (ii), (iii) 31. (ii), (iii)

III. Short Answer Type

32. Cu shows positive $E^{\ominus}$ value.

33. **Hint :** Negative $E^{\ominus}$ values for Mn^{2+} and Zn^{2+} are related to stabilities of half filled and fully filled configuration respectively. But for Ni^{2+} , $E^{\ominus}$ value is related to the highest negative enthalpy of hydration.

34. Ionisation enthalpy of Cr is lower due to stability of d^5 and the value for Zn is higher because its electron comes out from 4*s* orbital.

35. The high melting points of transition metals are attributed to the involvement of greater number of electrons in the interatomic metallic bonding from (n-1) *d*-orbitals in addition to n*s* electrons

36. **Hint :** Cu^{2+} gets reduced to Cu^+

$$2Cu^{2+} + 4I^- \longrightarrow \underset{\text{(white precipitate)}}{Cu_2I_2} + I_2$$

37. **Hint :** $CuCl_2$ is more stable than Cu_2Cl_2. The stability of Cu^{2+} (aq.) rather than Cu^+(aq.) is due to the much more negative $\Delta_{hyd}H^{\ominus}$ of Cu^{2+} (aq.) than Cu^+(aq.).

38. A = MnO_2 B = Cl_2 C = NCl_3

$$\underset{\text{(A)}}{MnO_2} + 4HCl \longrightarrow MnCl_2 + \underset{\text{(B)}}{Cl_2} + 2H_2O$$

$$NH_3 + \underset{\text{(excess)}}{3Cl_2} \longrightarrow \underset{\text{(C)}}{NCl_3} + 3HCl$$

39. **Hint :** It is due to the ability of oxygen to form multiple bonds to metals.

40. **Hint :** Due to symmetrical electronic configuration there is no orbital contribution in Cr^{3+} ion. However appreciable orbital contribution takes place in Co^{2+} ion.

41. **Hint :** It is because in the beginning, when 5*f* orbitals begin to be occupied, they will penetrate less into the inner core of electrons. The 5*f* electrons will therefore, be more effectively shielded from the nuclear charge than 4*f* electrons of the corresponding lanthanoids. Therefore outer electrons are less firmly held and they are available for bonding in the actinoids.

42. **Hint :** Due to lanthanoid contraction, they have almost same size (Zr, 160 pm) and (Hf, 159 pm).

43. It is because after losing one more electron Ce acquires stable $4f^0$ electronic configuration.

44. $KMnO_4$ acts as oxidising agent. It oxidises oxalic acid to CO_2 and itself changes to Mn^{2+} ion which is colourless.

$$5C_2O_4^{2-} + \underset{\text{(Coloured)}}{2MnO_4^-} + 16H^+ \longrightarrow \underset{\text{(Colourless)}}{2Mn^{2+}} + 8H_2O + 10CO_2$$

45. $$\underset{\substack{\text{Dichromate}\\ \text{(Orange)}}}{Cr_2O_7^{2-}} \underset{H^+}{\overset{OH^-}{\rightleftharpoons}} \underset{\substack{\text{Chromate}\\ \text{(Yellow)}}}{CrO_4^{2-}}$$

46. Oxidising behaviour of $KMnO_4$ depends on pH of the solution.

In acidic medium (pH < 7)

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow \underset{\text{(Colourless)}}{Mn^{2+}} + 4H_2O$$

In alkaline medium (pH>7)

$$MnO_4^- + e^- \longrightarrow \underset{\text{(Green)}}{MnO_4^{2-}}$$

In neutral medium(pH=7)

$$MnO_4^- + 2H_2O + 3e^- \longrightarrow \underset{\text{(Brown precipitate)}}{MnO_2} + 4OH^-$$

47. Due to lanthanoid contraction, the atomic radii of the second and third row transition elements is almost same. So they resemble each other much more as compared to first row elements.

48. **Hint :** High ionisation enthalpy to transform Cu(s) to Cu^{2+} (aq) is not balanced by its hydration enthalpy. However, in case of Zn after removal of electrons from 4*s*-orbital, stable $3d^{10}$ configuration is acquired.

49. As the oxidation state increases, size of the ion of transition element decreases. As per Fajan's rule, as the size of metal ion decreases, covalent character of the bond formed increases.

50. $n + l$ rule : For $3d = n + l = 5$

$4s = n + l = 4$

So electron will enter in 4*s* orbital.

Ionisation enthalpy is responsible for the ionisation of atom. 4*s* electrons are loosely held by the nucleus. So electrons are removed from 4*s* orbital prior to 3*d*.

51. **Hint :** It is due to regular increase in ionisation enthalpy.

IV. Matching Type

52. (i) → (c) (ii) → (d) (iii) → (b) (iv) → (e) (v) → (a)
53. (i) → (b) (ii) → (a) (iii) → (d) (iv) → (e) (v) → (c)
54. (i) → (c) (ii) → (a) (iii) → (b)
55. (i) → (c) (ii) → (a) (iii) → (e) (iv) → (b)
56. (i) → (d) (ii) → (a) (iii) → (b) (iv) → (e) (v) → (f)
57. (i) → (b) (ii) → (d) (iii) → (a) (iv) → (e) (v) → (c)
58. (i) → (c) (ii) → (d) (iii) → (b) (iv) → (a)

V. Assertion and Reason Type

59. (i) 60. (ii) 61. (iii) 62. (i) 63. (ii)

VI. Long Answer Type

64. $A = Cu$ $B = Cu(NO_3)_2$ $C = [Cu(NH_3)_4]$ $D = CO_2$
$E = CaCO_3$ $F = Cu_2[Fe(CN)_6]$ $G = Ca\,(HCO_3)_2$

$$CuCO_3 \longrightarrow CuO + CO_2$$

$$CuO + CuS \longrightarrow \underset{(A)}{Cu} + SO_2$$

$$Cu + 4HNO_3\ (Conc) \longrightarrow \underset{(B)}{Cu\,(NO_3)_2} + 2NO + 2H_2O$$

$$\underset{(B)}{Cu^{2+}} + NH_3 \longrightarrow \underset{(C)}{[Cu(NH_3)_4]}$$

$$Ca(OH)_2 + \underset{(D)}{CO_2} \longrightarrow \underset{(E)}{CaCO_3} + H_2O$$

$$CaCO_3 + H_2O + CO_2 \longrightarrow Ca\,(HCO_3)_2$$

65. $A = FeCr_2O_4$ $B = Na_2CrO_4$ $C = Na_2Cr_2O_7.2H_2O$ $D = K_2Cr_2O_7$

$$\underset{(A)}{4FeCr_2O_4} + 8Na_2CO_3 + 7O_2 \longrightarrow \underset{(B)}{8Na_2CrO_4} + 2Fe_2O_3 + 8CO_2$$

$$2NaCrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$$

$$\underset{(C)}{Na_2Cr_2O_7} + 2KCl \longrightarrow \underset{(D)}{K_2Cr_2O_7} + 2NaCl$$

66. $A = MnO_2$ (B) K_2MnO_4 (C) $KMnO_4$ (D) KIO_3

$$\underset{(A)}{2\ MnO_2} + 4KOH + O_2 \longrightarrow \underset{(B)}{2K_2MnO_4} + 2H_2O$$

$$3MnO_4^{2-} + 4H^+ \longrightarrow \underset{(C)}{2MnO_4^-} + MnO_2 + 2H_2O$$

$$2MnO_4^- + H_2O + KI \longrightarrow \underset{(A)}{2MnO_2} + 2OH^- + \underset{(D)}{KIO_3}$$

67. **Hint :** (i) As the size decreases covalent character increases. Therefore La_2O_3 is more ionic and Lu_2O_3 is more covalent.

(ii) As the size decreases from La to Lu, stability of oxosalts also decreases.

(iii) Stability of complexes increases as the size of lanthanoids decreases.

(iv) Radii of 4*d* and 5*d* block elements will be almost same.

(v) Acidic character of oxides increases from La to Lu.

68. (a) (i) Cu, because the electronic configuration of Cu is $3d^{10}4s^1$. So second electron needs to be removed from completely filled *d*-orbital.

(ii) Zn [**Hint :** As above]

(iii) Zn [**Hint :** No unpaired electron for metallic bonding]

(b) (i) $Fe(CO)_5$ [**Hint :** EAN rule]

(ii) MnO_3F [**Hint :** Mn shows +7 oxidation state; *d*-electrons are not involved in bonding.]

69. Interstitial compounds.

Characteristic properties :

(i) High melting points, higher than those of pure metals.

(ii) Very hard.

(iii) Retain metallic conductivity.

(iv) Chemically inert.

70. (a) Reaction between iodide and persulphate ions is :

$$2I^- + S_2O_8^{2-} \xrightarrow{Fe(III)} I_2 + 2SO_4^{2-}$$

Role of Fe (III) ions :

$$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$$

$$2Fe^{2+} + S_2O_8^{2-} \longrightarrow 2Fe^{3+} + 2SO_4^{2-}$$

(b) (i) Vanadium (V) oxide in contact process for oxidation of SO_2 to SO_3.

(ii) Finely divided iron in Haber's process in conversion of N_2 and H_2 to NH_3.

(iii) MnO_2 in preparation of oxygen from $KClO_3$.

71. A = $KMnO_4$ B = K_2MnO_4 C = MnO_2 D = $MnCl_2$

$$\underset{(A)}{KMnO_4} \xrightarrow{\Delta} \underset{(B)}{K_2MnO_4} + \underset{(C)}{MnO_2} + O_2$$

$$MnO_2 + KOH + O_2 \longrightarrow 2K_2MnO_4 + 2H_2O$$

$$MnO_2 + 4NaCl + 4H_2SO_4 \longrightarrow \underset{(D)}{MnCl_2} + 2NaHSO_4 + 2H_2O + Cl_2$$

Unit

9

COORDINATION COMPOUNDS

I. Multiple Choice Questions (Type-I)

1. Which of the following complexes formed by Cu^{2+} ions is most stable?

(i) $Cu^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+}$, $\log K = 11.6$

(ii) $Cu^{2+} + 4CN^- \rightleftharpoons [Cu(CN)_4]^{2-}$, $\log K = 27.3$

(iii) $Cu^{2+} + 2en \rightleftharpoons [Cu(en)_2]^{2+}$, $\log K = 15.4$

(iv) $Cu^{2+} + 4H_2O \rightleftharpoons [Cu(H_2O)_4]^{2+}$, $\log K = 8.9$

2. The colour of the coordination compounds depends on the crystal field splitting. What will be the correct order of absorption of wavelength of light in the visible region, for the complexes, $[Co(NH_3)_6]^{3+}$, $[Co(CN)_6]^{3-}$, $[Co(H_2O)_6]^{3+}$

(i) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$

(ii) $[Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(CN)_6]^{3-}$

(iii) $[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$

(iv) $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$

3. When 0.1 mol $CoCl_3(NH_3)_5$ is treated with excess of $AgNO_3$, 0.2 mol of AgCl are obtained. The conductivity of solution will correspond to

(i) 1:3 electrolyte

(ii) 1:2 electrolyte

(iii) 1:1 electrolyte

(iv) 3:1 electrolyte

4. When 1 mol $CrCl_3 \cdot 6H_2O$ is treated with excess of $AgNO_3$, 3 mol of AgCl are obtained. The formula of the complex is :

(i) $[CrCl_3(H_2O)_3] \cdot 3H_2O$

(ii) $[CrCl_2(H_2O)_4]Cl \cdot 2H_2O$

(iii) $[CrCl(H_2O)_5]Cl_2 \cdot H_2O$

(iv) $[Cr(H_2O)_6]Cl_3$

5. The correct IUPAC name of $[Pt(NH_3)_2Cl_2]$ is

(i) Diamminedichloridoplatinum (II)

(ii) Diamminedichloridoplatinum (IV)

(iii) Diamminedichloridoplatinum (0)

(iv) Dichloridodiammineplatinum (IV)

6. The stabilisation of coordination compounds due to chelation is called the chelate effect. Which of the following is the most stable complex species?

(i) $[Fe(CO)_5]$

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

(iii) $[Fe(C_2O_4)_3]^{3-}$

(iv) $[Fe(H_2O)_6]^{3+}$

7. Indicate the complex ion which shows geometrical isomerism.

(i) $[Cr(H_2O)_4Cl_2]^+$

(ii) $[Pt(NH_3)_3Cl]$

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

(iv) $[Co(CN)_5(NC)]^{3-}$

8. The CFSE for octahedral $[CoCl_6]^{4-}$ is 18,000 cm^{-1}. The CFSE for tetrahedral $[CoCl_4]^{2-}$ will be

(i) 18,000 cm^{-1}

(ii) 16,000 cm^{-1}

(iii) 8,000 cm^{-1}

(iv) 20,000 cm^{-1}

9. Due to the presence of ambidentate ligands coordination compounds show isomerism. Palladium complexes of the type $[Pd(C_6H_5)_2(SCN)_2]$ and $[Pd(C_6H_5)_2(NCS)_2]$ are

(i) linkage isomers

(ii) coordination isomers

(iii) ionisation isomers

(iv) geometrical isomers

10. The compounds $[Co(SO_4)(NH_3)_5]Br$ and $[Co(SO_4)(NH_3)_5]Cl$ represent

(i) linkage isomerism

(ii) ionisation isomerism

(iii) coordination isomerism
(iv) no isomerism

11. A chelating agent has two or more than two donor atoms to bind to a single metal ion. Which of the following is **not** a chelating agent?

(i) thiosulphato
(ii) oxalato
(iii) glycinato
(iv) ethane-1,2-diamine

12. Which of the following species is **not** expected to be a ligand?

(i) NO
(ii) NH_4^+
(iii) $NH_2CH_2CH_2NH_2$
(iv) CO

13. What kind of isomerism exists between $[Cr(H_2O)_6]Cl_3$ (violet) and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$ (greyish-green)?

(i) linkage isomerism
(ii) solvate isomerism
(iii) ionisation isomerism
(iv) coordination isomerism

14. IUPAC name of $[Pt(NH_3)_2Cl(NO_2)]$ is :

(i) Platinum diaminechloronitrite
(ii) Chloronitrito-N-ammineplatinum (II)
(iii) Diamminechloridonitrito-N-platinum (II)
(iv) Diamminechloronitrito-N-platinate (II)

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

15. Atomic number of Mn, Fe and Co are 25, 26 and 27 respectively. Which of the following inner orbital octahedral complex ions are diamagnetic?

(i) $[Co(NH_3)_6]^{3+}$
(ii) $[Mn(CN)_6]^{3-}$
(iii) $[Fe(CN)_6]^{4-}$
(iv) $[Fe(CN)_6]^{3-}$

16. Atomic number of Mn, Fe, Co and Ni are 25, 26 27 and 28 respectively. Which of the following outer orbital octahedral complexes have same number of unpaired electrons?

(i) $[MnCl_6]^{3-}$

(ii) $[FeF_6]^{3-}$

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

(iv) $[Ni(NH_3)_6]^{2+}$

17. Which of the following options are correct for $[Fe(CN)_6]^{3-}$ complex?

(i) d^2sp^3 hybridisation

(ii) sp^3d^2 hybridisation

(iii) paramagnetic

(iv) diamagnetic

18. An aqueous pink solution of cobalt(II) chloride changes to deep blue on addition of excess of HCl. This is because____________.

(i) $[Co(H_2O)_6]^{2+}$ is transformed into $[CoCl_6]^{4-}$

(ii) $[Co(H_2O)_6]^{2+}$ is transformed into $[CoCl_4]^{2-}$

(iii) tetrahedral complexes have smaller crystal field splitting than octahedral complexes.

(iv) tetrahedral complexes have larger crystal field splitting than octahedral complex.

19. Which of the following complexes are homoleptic?

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

(ii) $[Co(NH_3)_4 Cl_2]^+$

(iii) $[Ni(CN)_4]^{2-}$

(iv) $[Ni(NH_3)_4Cl_2]$

20. Which of the following complexes are heteroleptic?

(i) $[Cr(NH_3)_6]^{3+}$

(ii) $[Fe(NH_3)_4 Cl_2]^+$

(iii) $[Mn(CN)_6]^{4-}$

(iv) $[Co(NH_3)_4Cl_2]$

21. Identify the optically active compounds from the following :

(i) $[Co(en)_3]^{3+}$

(ii) *trans*– $[Co(en)_2 Cl_2]^+$

(iii) *cis*– $[Co(en)_2 Cl_2]^+$

(iv) $[Cr(NH_3)_5Cl]$

22. Identify the correct statements for the behaviour of ethane-1, 2-diamine as a ligand.

(i) It is a neutral ligand.

(ii) It is a didentate ligand.

(iii) It is a chelating ligand.

(iv) It is a unidentate ligand.

23. Which of the following complexes show linkage isomerism?

(i) $[Co(NH_3)_5(NO_2)]^{2+}$

(ii) $[Co(H_2O)_5CO]^{3+}$

(iii) $[Cr(NH_3)_5SCN]^{2+}$

(iv) $[Fe(en)_2Cl_2]^{+}$

III. Short Answer Type

24. Arrange the following complexes in the increasing order of conductivity of their solution: $[Co(NH_3)_3Cl_3]$, $[Co(NH_3)_4Cl_2]Cl$, $[Co(NH_3)_6]Cl_3$, $[Cr(NH_3)_5Cl]Cl_2$

25. A coordination compound $CrCl_3 \cdot 4H_2O$ precipitates silver chloride when treated with silver nitrate. The molar conductance of its solution corresponds to a total of two ions. Write structural formula of the compound and name it.

26. A complex of the type $[M(AA)_2X_2]^{n+}$ is known to be optically active. What does this indicate about the structure of the complex? Give one example of such complex.

27. Magnetic moment of $[MnCl_4]^{2-}$ is 5.92 BM. Explain giving reason.

28. On the basis of crystal field theory explain why Co(III) forms paramagnetic octahedral complex with weak field ligands whereas it forms diamagnetic octahedral complex with strong field ligands.

29. Why are low spin tetrahedral complexes not formed?

30. Give the electronic configuration of the following complexes on the basis of Crystal Field Splitting theory.

$[CoF_6]^{3-}$, $[Fe(CN)_6]^{4-}$ and $[Cu(NH_3)_6]^{2+}$.

31. Explain why $[Fe(H_2O)_6]^{3+}$ has magnetic moment value of 5.92 BM whereas $[Fe(CN)_6]^{3-}$ has a value of only 1.74 BM.

32. Arrange following complex ions in increasing order of crystal field splitting energy (Δ_O) :

$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$.

33. Why do compounds having similar geometry have different magnetic moment?

34. $CuSO_4 \cdot 5H_2O$ is blue in colour while $CuSO_4$ is colourless. Why?

35. Name the type of isomerism when ambidentate ligands are attached to central metal ion. Give two examples of ambidentate ligands.

IV. Matching Type

Note : In the following questions match the items given in Columns I and II.

36. Match the complex ions given in Column I with the colours given in Column II and assign the correct code :

Column I (Complex ion)	**Column II (Colour)**
A. $[Co(NH_3)_6]^{3+}$	1. Violet
B. $[Ti(H_2O)_6]^{3+}$	2. Green
C. $[Ni(H_2O)_6]^{2+}$	3. Pale blue
D. $[Ni(H_2O)_4(en)]^{2+}$ (aq)	4. Yellowish orange
	5. Blue

Code :

(i)	A (1)	B (2)	C (4)	D (5)
(ii)	A (4)	B (3)	C (2)	D (1)
(iii)	A (3)	B (2)	C (4)	D (1)
(iv)	A (4)	B (1)	C (2)	D (3)

37. Match the coordination compounds given in Column I with the central metal atoms given in Column II and assign the correct code :

Column I (Coordination Compound)	**Column II (Central metal atom)**
A. Chlorophyll	1. rhodium
B. Blood pigment	2. cobalt
C. Wilkinson catalyst	3. calcium
D. Vitamin B_{12}	4. iron
	5. magnesium

Code :

(i)	A (5)	B (4)	C (1)	D (2)
(ii)	A (3)	B (4)	C (5)	D (1)
(iii)	A (4)	B (3)	C (2)	D (1)
(iv)	A (3)	B (4)	C (1)	D (2)

38. Match the complex ions given in Column I with the hybridisation and number of unpaired electrons given in Column II and assign the correct code :

Column I (Complex ion)	**Column II (Hybridisation, number of unpaired electrons)**
A. $[Cr(H_2O)_6]^{3+}$	1. dsp^2, 1
B. $[Co(CN)_4]^{2-}$	2. sp^3d^2, 5
C. $[Ni(NH_3)_6]^{2+}$	3. d^2sp^3, 3
D. $[MnF_6]^{4-}$	4. sp^3, 4
	5. sp^3d^2, 2

Code :

(i)	A (3)	B (1)	C (5)	D (2)

(ii)	A (4)	B (3)	C (2)	D (1)
(iii)	A (3)	B (2)	C (4)	D (1)
(iv)	A (4)	B (1)	C (2)	D (3)

39. Match the complex species given in Column I with the possible isomerism given in Column II and assign the correct code :

Column I (Complex species)	**Column II (Isomerism)**
A. $[Co(NH_3)_4Cl_2]^+$	1. optical
B. *cis*-$[Co(en)_2Cl_2]^+$	2. ionisation
C. $[Co(NH_3)_5(NO_2)]Cl_2$	3. coordination
D. $[Co(NH_3)_6][Cr(CN)_6]$	4. geometrical
	5. linkage

Code :

(i)	A (1)	B (2)	C (4)	D (5)
(ii)	A (4)	B (3)	C (2)	D (1)
(iii)	A (4)	B (1)	C (5)	D (3)
(iv)	A (4)	B (1)	C (2)	D (3)

40. Match the compounds given in Column I with the oxidation state of cobalt present in it (given in Column II) and assign the correct code.

Column I (Compound)	**Column II (Oxidation state of Co)**
A. $[Co(NCS)(NH_3)_5](SO_3)$	1. + 4
B. $[Co(NH_3)_4Cl_2]SO_4$	2. 0
C. $Na_4[Co(S_2O_3)_3]$	3. + 1
D. $[Co_2(CO)_8]$	4. + 2
	5. + 3

Code :

(i)	A (1)	B (2)	C (4)	D (5)
(ii)	A (4)	B (3)	C (2)	D (1)
(iii)	A (5)	B (1)	C (4)	D (2)
(iv)	A (4)	B (1)	C (2)	D (3)

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are true, reason is correct explanation of assertion.

(ii) Assertion and reason both are true but reason is not the correct explanation of assertion.

(iii) Assertion is true, reason is false.

(iv) Assertion is false, reason is true.

41. Assertion : Toxic metal ions are removed by the chelating ligands.

Reason : Chelate complexes tend to be more stable.

42. Assertion : $[Cr(H_2O)_6]Cl_2$ and $[Fe(H_2O)_6]Cl_2$ are reducing in nature.

Reason : Unpaired electrons are present in their *d*-orbitals.

43. Assertion : Linkage isomerism arises in coordination compounds containing ambidentate ligand.

Reason : Ambidentate ligand has two different donor atoms.

44. Assertion : Complexes of MX_6 and MX_5L type (X and L are unidentate) do not show geometrical isomerism.

Reason : Geometrical isomerism is not shown by complexes of coordination number 6.

45. Assertion : ($[Fe(CN)_6]^{3-}$ ion shows magnetic moment corresponding to two unpaired electrons.

Reason : Because it has d^2sp^3 type hybridisation.

VI. Long Answer Type

46. Using crystal field theory, draw energy level diagram, write electronic configuration of the central metal atom/ion and determine the magnetic moment value in the following :

(i) $[CoF_6]^{3-}$, $[Co(H_2O)_6]^{2+}$, $[Co(CN)_6]^{3-}$

(ii) $[FeF_6]^{3-}$, $[Fe(H_2O)_6]^{2+}$, $[Fe(CN)_6]^{4-}$

47. Using valence bond theory, explain the following in relation to the complexes given below:

$[Mn(CN)_6]^{3-}$, $[Co(NH_3)_6]^{3+}$, $[Cr(H_2O)_6]^{3+}$, $[FeCl_6]^{4-}$

(i) Type of hybridisation.

(ii) Inner or outer orbital complex.

(iii) Magnetic behaviour.

(iv) Spin only magnetic moment value.

48. $CoSO_4Cl.5NH_3$ exists in two isomeric forms 'A' and 'B'. Isomer 'A' reacts with $AgNO_3$ to give white precipitate, but does not react with $BaCl_2$. Isomer 'B' gives white precipitate with $BaCl_2$ but does not react with $AgNO_3$. Answer the following questions.

(i) Identify 'A' and 'B' and write their structural formulas.

(ii) Name the type of isomerism involved.

(iii) Give the IUPAC name of 'A' and 'B'.

49. What is the relationship between observed colour of the complex and the wavelength of light absorbed by the complex?

50. Why are different colours observed in octahedral and tetrahedral complexes for the same metal and same ligands?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii) 2. (iii) 3. (ii) 4. (iv) 5. (i) 6. (iii)
7. (i) 8. (iii) 9. (i) 10. (iv) 11. (i) 12. (ii)
13. (ii) 14. (iii)

II. Multiple Choice Questions (Type-II)

15. (i), (iii) 16. (i), (iii) 17. (i), (iii) 18. (ii), (iii)
19. (i), (iii) 20. (ii), (iv) 21. (i), (iii) 22. (i), (ii), (iii)
23. (i), (iii)

III. Short Answer Type

24. $[Co(NH_3)_3Cl_3] < [Cr(NH_3)_5Cl]Cl < [Co(NH_3)_5Cl]Cl_2 < [Co(NH_3)_6]Cl_3$

25. $[Co(H_2O)_4Cl_2]Cl$ (tetraaquadichloridocobalt(III) chloride)

26. An optically active complex of the type $[M(AA)_2X_2]^{n+}$ indicates *cis*-octahedral structure, e.g. *cis*-$[Pt(en)_2Cl_2]^{2+}$ or *cis*-$[Cr(en)_2Cl_2]^+$

27. The magnetic moment of 5.92 BM corresponds to the presence of five unpaired electrons in the *d*-orbitals of Mn^{2+} ion. As a result the hybridisation involved is sp^3 rather than dsp^2. Thus tetrahedral structure of $[MnCl_4]^{2-}$ complex will show 5.92 BM magnetic moment value.

28. With weak field ligands; $\Delta_O < p$, the electronic configuration of Co (III) will be $t^4_{2g}\, e^2_g$ and it has 4 unpaired electrons and is paramagnetic. With strong field ligands, $\Delta_0 > p$, the electronic configuration will be $t^6_{2g}\, e^0_g$. It has no unpaired electrons and is diamagnetic.

29. Because for tetrahedral complexes, the crystal field stabilisation energy is lower than pairing energy.

30. $[CoF_6]^{3-}$, $Co^{3+}(d^6)\ t_{2g}^4\ e_g^2$,
$[Fe(CN)_6]^{4-}$, $Fe^{2+}(d^6)\ t_{2g}^6\ e_g^0$,
$[Cu(NH_3)_6]^{2+}$, $Cu^{2+}(d^9)\ t_{2g}^6\ e_g^3$,

31. $[Fe(CN)_6]^{3-}$ involves d^2sp^3 hybridisation with one unpaired electron and $[Fe(H_2O)_6]^{3+}$ involves sp^3d^2 hybridisation with five unpaired electrons. This difference is due to the presence of strong ligand CN^- and weak ligand H_2O in these complexes.

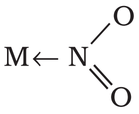
32. Crystal field splitting energy increases in the order $[Cr(Cl)_6]^{3-} < [Cr(NH_3)_6]^{3+} < [Cr(CN)_6]^{3-}$

33. It is due to the presence of weak and strong ligands in complexes, if CFSE is high, the complex will show low value of magnetic moment and vice versa, e.g. $[CoF_6]^{3-}$ and $[Co(NH_3)_6]^{3+}$, the former is paramagnetic and the latter is diamagnetic.

34. In $CuSO_4.5H_2O$, water acts as ligand as a result it causes crystal field splitting. Hence d—d transition is possible in $CuSO_4.5H_2O$ and shows colour. In the anhydrous $CuSO_4$ due to the absence of water (ligand), crystal field splitting is not possible and hence no colour.

35. Linkage isomerism

Examples : (i)



nitrito-N

$M \leftarrow O—N=O$

nitrito — O

(ii) $M \leftarrow SCN$ thiocyanato

$M \leftarrow NCS$ isothiocyanato

IV. Matching Type

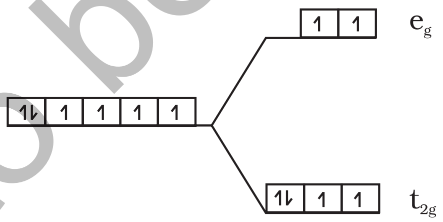
36. (ii) 37. (i) 38. (ii) 39. (iv) 40. (i)

V. Assertion and Reason Type

41. (i) 42. (ii) 43. (i) 44. (ii) 45. (iv)

VI. Long Answer Type

46. (i) $[CoF_6]^{3-}$



i.e. $t_{2g}^4 e_g^2$

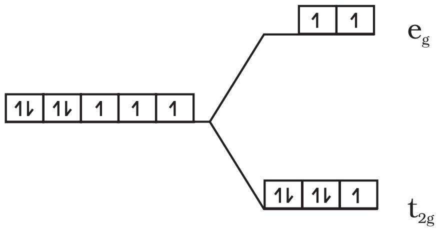
$Co^{3+} = 3d^6$

Number of unpaired electrons = 4

$$\sqrt{n(n+2)} = \sqrt{4(4+2)} = \sqrt{24} = 4.9 \text{ BM}$$

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

$Co^{2+} = 3d^7$



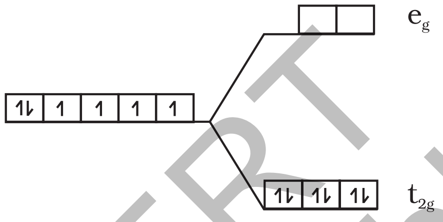
i.e. $t_{2g}^5 e_g^2$

Number of unpaired electrons = 3

$\sqrt{3(3+2)} = \sqrt{15} = 3.87$ BM

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

$Co^{3+} = 3d^6$

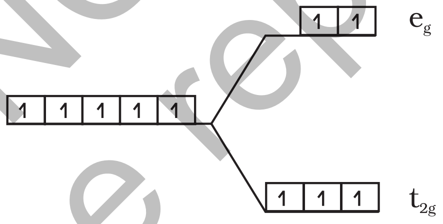


i.e. $t_{2g}^6 e_g^0$

No unpaired electrons so diamagnetic

(ii) FeF_6^{3-}

$Fe^{3+} = 3d^5$



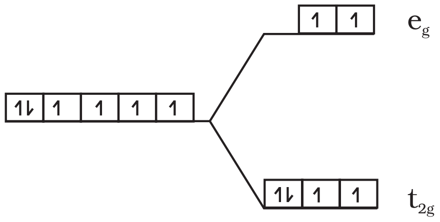
i.e. $t_{2g}^3 e_g^2$

Number of unpaired electrons = 5

$\sqrt{5(5+2)} = \sqrt{35} = 5.92$ BM

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

$Fe^{2+} = 3d^6$

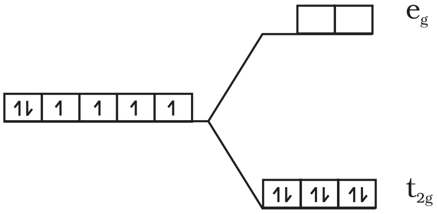


i.e. $t_{2g}^4 e_g^2$

Number of unpaired electrons = 4

$\sqrt{4(4+2)} = \sqrt{24} = 4.9$ BM

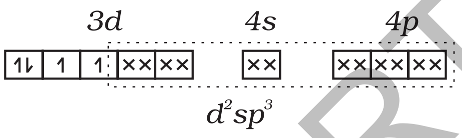
$[Fe(CN)_6]^{4-}$
$Fe^{2+} = 3d^6$
Since CN^- is strong field ligand all the electrons get paired.



i.e. $t_{2g}^6 e_g^0$

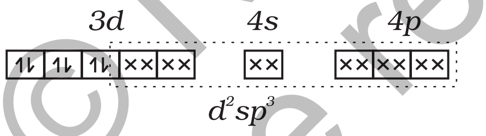
No unpaired electrons so diamagnetic

47. $[Mn(CN)_6]^{3-}$
$Mn^{3+} = 3d^4$



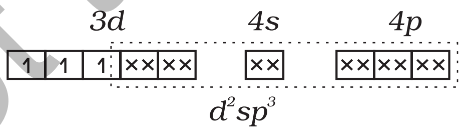
(i) d^2sp^3
(ii) Inner orbital complex
(iii) Paramagnetic
(iv) $\sqrt{2(2+2)} = \sqrt{8} = 2.87$ BM

$[Co(NH_3)_6]^{3+}$
$Co^{3+} = 3d^6$



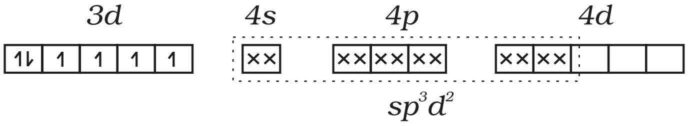
(i) d^2sp^3
(ii) Inner orbital complex
(iii) Diamagnetic
(iv) Zero

$[Cr(H_2O)_6]^{3+}$
$Cr^{3+} = 3d^3$



(i) d^2sp^3
(ii) Inner orbital complex
(iii) Paramagnetic
(iv) 3.87 BM

$[Fe(Cl)_6]^{4-}$
$Fe^{2+} = 3d^6$



(i) sp^3d^2
(ii) Outer orbital complex
(iii) Paramagnetic
(iv) 4.9 BM

48. (i) A - $[Co(NH_3)_5SO_4]Cl$
B - $[Co(NH_3)_5Cl]SO_4$
(ii) Ionisation isomerism
(iii) (A), Pentaamminesulphatocobalt (III) chloride
(B), Pentaamminechlorocobalt (III) sulphate.

49. When white light falls on the complex, some part of it is absorbed. Higher the crystal field splitting, lower will be the wavelength absorbed by the complex. The observed colour of complex is the colour generated from the wavelength left over.

50. $\Delta_t = \left(\frac{4}{9}\right)\Delta_0$. So higher wavelength is absorbed in octahedral complex than tetrahedral complex for same metal and ligands.

Unit

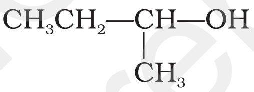
10

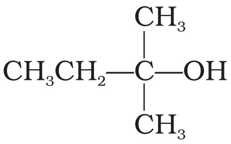
HALOALKANES AND HALOARENES

I. Multiple Choice Questions (Type-I)

1. The order of reactivity of following alcohols with halogen acids is __________.

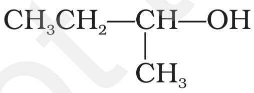
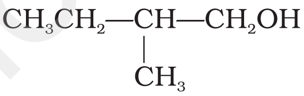
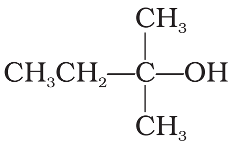
(A) $CH_3CH_2—CH_2—OH$

(B) 
$CH_3CH_2—\underset{\substack{|\\ CH_3}}{CH}—OH$

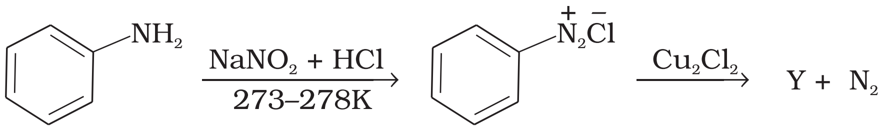
(C) 
$CH_3CH_2—\overset{\substack{CH_3\\ |}}{\underset{\substack{|\\ CH_3}}{C}}—OH$

- (i) (A) > (B) > (C)
- (ii) (C) > (B) > (A)
- (iii) (B) > (A) > (C)
- (iv) (A) > (C) > (B)

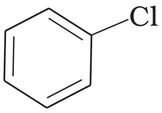
2. Which of the following alcohols will yield the corresponding alkyl chloride on reaction with concentrated HCl at room temperature?

- (i) $CH_3CH_2—CH_2—OH$
- (ii) 
$CH_3CH_2—\underset{\substack{|\\ CH_3}}{CH}—OH$
- (iii) 
$CH_3CH_2—\underset{\substack{|\\ CH_3}}{CH}—CH_2OH$
- (iv) 
$CH_3CH_2—\overset{\substack{CH_3\\ |}}{\underset{\substack{|\\ CH_3}}{C}}—OH$

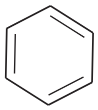
3. Identify the compound Y in the following reaction.



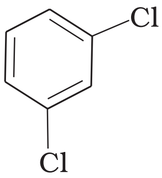
(i)



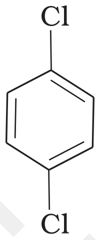
(ii)



(iii)



(iv)



4. Toluene reacts with a halogen in the presence of iron (III) chloride giving ortho and para halo compounds. The reaction is

(i) Electrophilic elimination reaction

(ii) Electrophilic substitution reaction

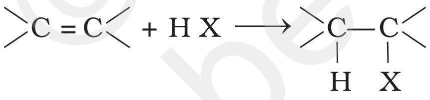
(iii) Free radical addition reaction

(iv) Nucleophilic substitution reaction

5. Which of the following is halogen exchange reaction?

(i) $RX + NaI \longrightarrow RI + NaX$

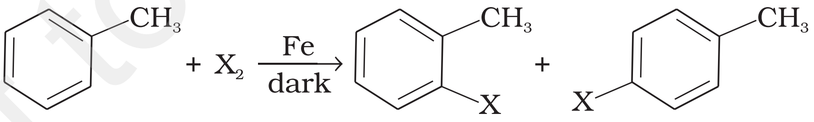
(ii)



$$>C=C< + HX \longrightarrow >\underset{H}{C}-\underset{X}{C}<$$

(iii) $R—OH + HX \xrightarrow{ZnCl_2} R—X + H_2O$

(iv)



6. Which reagent will you use for the following reaction?

$$CH_3CH_2CH_2CH_3 \longrightarrow CH_3CH_2CH_2CH_2Cl + CH_3CH_2CHClCH_3$$

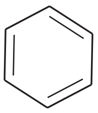
(i) Cl_2/UV light

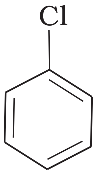
(ii) $NaCl + H_2SO_4$

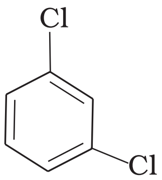
(iii) Cl_2 gas in dark

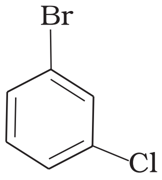
(iv) Cl_2 gas in the presence of iron in dark

7. Arrange the following compounds in the increasing order of their densities.

(a)


(b)


(c)


(d)


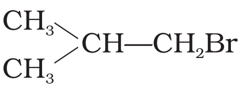
(i) (a) < (b) < (c) < (d)

(ii) (a) < (c) < (d) < (b)

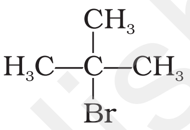
(iii) (d) < (c) < (b) < (a)

(iv) (b) < (d) < (c) < (a)

8. Arrange the following compounds in increasing order of their boiling points.

(a)

$\begin{array}{l}CH_3\diagdown \\ CH_3\diagup\end{array}CH-CH_2Br$

(b) $CH_3CH_2CH_2CH_2Br$

(c)

$H_3C-\underset{\underset{\displaystyle Br}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-CH_3$

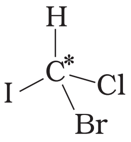
(i) (b) < (a) < (c)

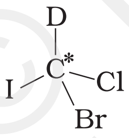
(ii) (a) < (b) < (c)

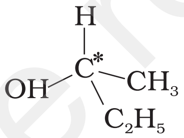
(iii) (c) < (a) < (b)

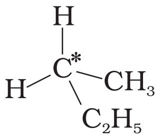
(iv) (c) < (b) < (a)

9. In which of the following molecules carbon atom marked with asterisk (*) is asymmetric?


(a)


(b)


(c)


(d)

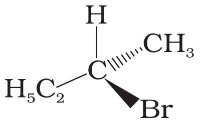
(i) (a), (b), (c), (d)

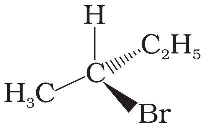
(ii) (a), (b), (c)

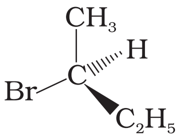
(iii) (b), (c), (d)

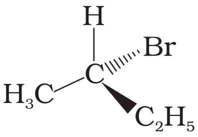
(iv) (a), (c), (d)

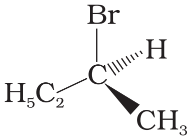
10. Which of the following structures is enantiomeric with the molecule (A) given below :


(A)

(i) 

(ii) 

(iii) 

(iv) 

11. Which of the following is an example of *vic*-dihalide?

(i) Dichloromethane
(ii) 1,2-dichloroethane
(iii) Ethylidene chloride
(iv) Allyl chloride

12. The position of –Br in the compound in $CH_3CH{=}CHC(Br)(CH_3)_2$ can be classified as ____________.

(i) Allyl
(ii) Aryl
(iii) Vinyl
(iv) Secondary

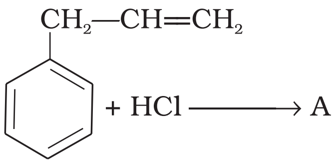
13. Chlorobenzene is formed by reaction of chlorine with benzene in the presence of $AlCl_3$. Which of the following species attacks the benzene ring in this reaction?

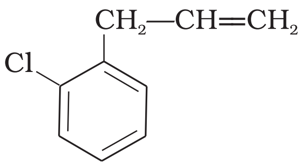
(i) Cl^-
(ii) Cl^+
(iii) $AlCl_3$
(iv) $[AlCl_4]^-$

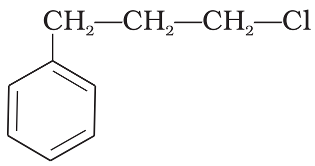
14. Ethylidene chloride is a/an ______________.

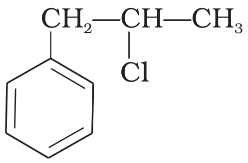
(i) *vic*-dihalide
(ii) *gem*-dihalide
(iii) allylic halide
(iv) vinylic halide

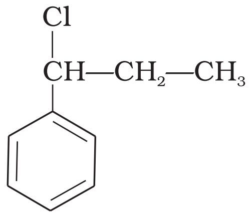
15. What is 'A' in the following reaction?



(i) 

(ii) 

(iii) 

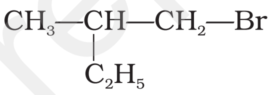
(iv) 

16. A primary alkyl halide would prefer to undergo _____________.

(i) S_N1 reaction
(ii) S_N2 reaction
(iii) α–Elimination
(iv) Racemisation

17. Which of the following alkyl halides will undergo S_N1 reaction most readily?

(i) $(CH_3)_3C—F$
(ii) $(CH_3)_3C—Cl$
(iii) $(CH_3)_3C—Br$
(iv) $(CH_3)_3C—I$

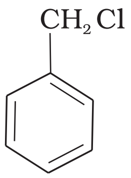
18. Which is the correct IUPAC name for  $CH_3—\underset{C_2H_5}{\underset{|}{CH}}—CH_2—Br$?

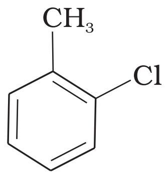
(i) 1-Bromo-2-ethylpropane
(ii) 1-Bromo-2-ethyl-2-methylethane
(iii) 1-Bromo-2-methylbutane
(iv) 2-Methyl-1-bromobutane

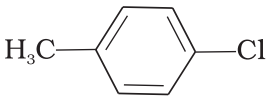
19. What should be the correct IUPAC name for diethylbromomethane?

(i) 1-Bromo-1,1-diethylmethane
(ii) 3-Bromopentane
(iii) 1-Bromo-1-ethylpropane
(iv) 1-Bromopentane

20. The reaction of toluene with chlorine in the presence of iron and in the absence of light yields _____________.

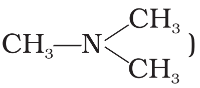
(i) 

(ii) 

(iii) 

(iv) Mixture of (ii) and (iii)

21. Chloromethane on treatment with excess of ammonia yields mainly

(i) N, N-Dimethylmethanamine ( $CH_3—N\begin{smallmatrix}CH_3\\ CH_3\end{smallmatrix}$)

(ii) N–methylmethanamine (CH_3—NH—CH_3)

(iii) Methanamine (CH_3NH_2)

(iv) Mixture containing all these in equal proportion

22. Molecules whose mirror image is non superimposable over them are known as chiral. Which of the following molecules is chiral in nature?

(i) 2-Bromobutane

(ii) 1-Bromobutane

(iii) 2-Bromopropane

(iv) 2-Bromopropan-2-ol

23. Reaction of $C_6H_5CH_2Br$ with aqueous sodium hydroxide follows ____________.

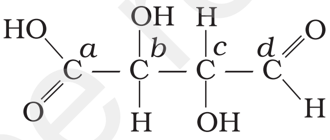
(i) S_N1 mechanism

(ii) S_N2 mechanism

(iii) Any of the above two depending upon the temperature of reaction

(iv) Saytzeff rule

24. Which of the carbon atoms present in the molecule given below are asymmetric?



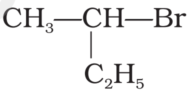
(i) a, b, c, d

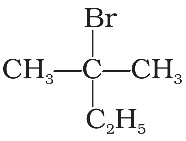
(ii) b, c

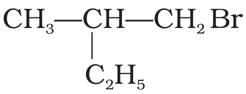
(iii) a, d

(iv) a, b, c

25. Which of the following compounds will give racemic mixture on nucleophilic substitution by OH^- ion?

(a)  $CH_3—\underset{C_2H_5}{\underset{|}{CH}}—Br$

(b)  $CH_3—\overset{Br}{\overset{|}{\underset{C_2H_5}{\underset{|}{C}}}}—CH_3$

(c)  $CH_3—\underset{C_2H_5}{\underset{|}{CH}}—CH_2Br$

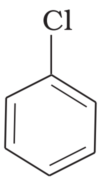
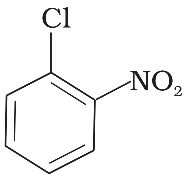
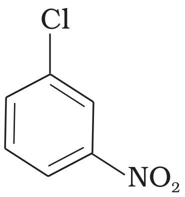
(i) (a)

(ii) (a), (b), (c)

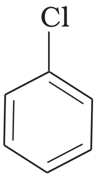
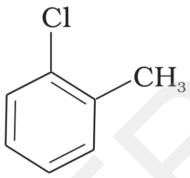
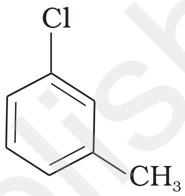
(iii) (b), (c)

(iv) (a), (c)

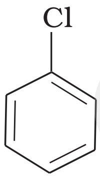
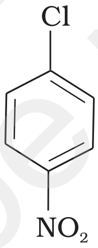
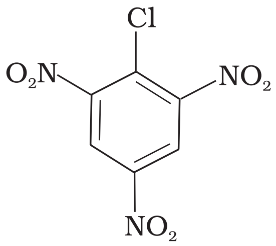
Note : In the questions 26 to 29 arrange the compounds in increasing order of rate of reaction towards nucleophilic substitution.

26. (a)  (b)  (c) 

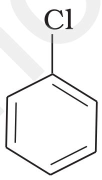
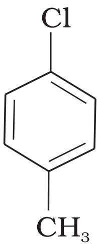
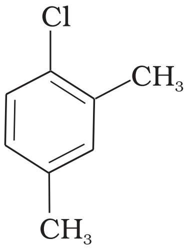
(i) (a) < (b) < (c)
(ii) (c) < (b) < (a)
(iii) (a) < (c) < (b)
(iv) (c) < (a) < (b)

27. (a)  (b)  (c) 

(i) (a) < (b) < (c)
(ii) (a) < (c) < (b)
(iii) (c) < (b) < (a)
(iv) (b) < (c) < (a)

28. (a)  (b)  (c) 

(i) (c) < (b) < (a)
(ii) (b) < (c) < (a)
(iii) (a) < (c) < (b)
(iv) (a) < (b) < (c)

29. (a)  (b)  (c) 

(i) (a) < (b) < (c)
(ii) (b) < (a) < (c)
(iii) (c) < (b) < (a)
(iv) (a) < (c) < (b)

30. Which is the correct increasing order of boiling points of the following compounds?

1-Iodobutane, 1-Bromobutane, 1-Chlorobutane, Butane

(i) Butane < 1-Chlorobutane < 1-Bromobutane < 1-Iodobutane
(ii) 1-Iodobutane < 1-Bromobutane < 1-Chlorobutane < Butane
(iii) Butane < 1-Iodobutane < 1-Bromobutane < 1-Chlorobutane
(iv) Butane < 1-Chlorobutane < 1-Iodobutane < 1-Bromobutane

31. Which is the correct increasing order of boiling points of the following compounds?

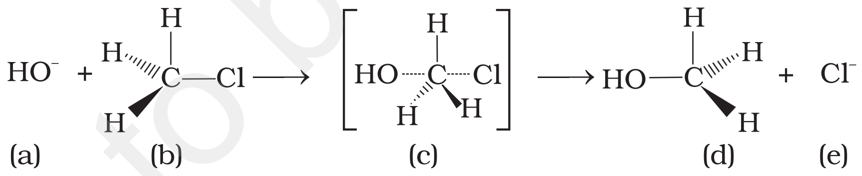
1-Bromoethane, 1-Bromopropane, 1-Bromobutane, Bromobenzene

(i) Bromobenzene < 1-Bromobutane < 1-Bromopropane < 1-Bromoethane
(ii) Bromobenzene < 1-Bromoethane < 1-Bromopropane < 1-Bromobutane
(iii) 1-Bromopropane < 1-Bromobutane < 1-Bromoethane < Bromobenzene
(iv) 1-Bromoethane < 1-Bromopropane < 1-Bromobutane < Bromobenzene

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

Consider the following reaction and answer the questions no. 32–34.



32. Which of the statements are correct about above reaction?

(i) (a) and (e) both are nucleophiles.
(ii) In (c) carbon atom is sp^3 hybridised.
(iii) In (c) carbon atom is sp^2 hybridised.
(iv) (a) and (e) both are electrophiles.

33. Which of the following statements are correct about this reaction?

(i) The given reaction follows S_N2 mechanism.
(ii) (b) and (d) have opposite configuration.

(iii) (b) and (d) have same configuration.

(iv) The given reaction follows S_N1 mechanism.

34. Which of the following statements are correct about the reaction intermediate?

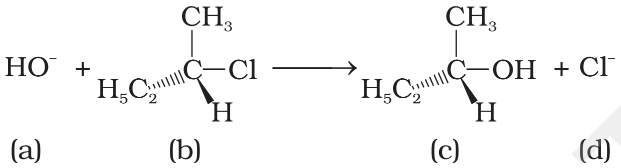
(i) Intermediate (c) is unstable because in this carbon is attached to 5 atoms.

(ii) Intermediate (c) is unstable because carbon atom is sp^2 hybridised.

(iii) Intermediate (c) is stable because carbon atom is sp^2 hybridised.

(iv) Intermediate (c) is less stable than the reactant (b).

Answer Q. No. 35 and 36 on the basis of the following reaction.



35. Which of the following statements are correct about the mechanism of this reaction?

(i) A carbocation will be formed as an intermediate in the reaction.

(ii) OH^- will attach the substrate (b) from one side and Cl^- will leave it simultaneously from other side.

(iii) An unstable intermediate will be formed in which OH^- and Cl^- will be attached by weak bonds.

(iv) Reaction proceeds through S_N1 mechanism.

36. Which of the following statements are correct about the kinetics of this reaction?

(i) The rate of reaction depends on the concentration of only (b).

(ii) The rate of reaction depends on concentration of both (a) and (b).

(iii) Molecularity of reaction is one.

(iv) Molecularity of reaction is two.

37. Haloalkanes contain halogen atom (s) attached to the sp^3 hybridised carbon atom of an alkyl group. Identify haloalkane from the following compounds.

(i) 2-Bromopentane

(ii) Vinyl chloride (chloroethene)

(iii) 2-chloroacetophenone

(iv) Trichloromethane

38. Ethylene chloride and ethylidene chloride are isomers. Identify the correct statements.

(i) Both the compounds form same product on treatment with alcoholic KOH.

(ii) Both the compounds form same product on treatment with aq.NaOH.

(iii) Both the compounds form same product on reduction.

(iv) Both the compounds are optically active.

39. Which of the following compounds are *gem*-dihalides?

(i) Ethylidene chloride

(ii) Ethylene dichloride

(iii) Methylene chloride

(iv) Benzyl chloride

40. Which of the following are secondary bromides?

(i) $(CH_3)_2\,CHBr$

(ii) $(CH_3)_3C\,CH_2Br$

(iii) $CH_3CH(Br)CH_2CH_3$

(iv) $(CH_3)_2CBrCH_2CH_3$

41. Which of the following compounds can be classified as aryl halides?

(i) *p*-$ClC_6H_4CH_2CH(CH_3)_2$

(ii) *p*-$CH_3CHCl(C_6H_4)CH_2CH_3$

(iii) *o*-BrH_2C-$C_6H_4CH(CH_3)CH_2CH_3$

(iv) C_6H_5-Cl

42. Alkyl halides are prepared from alcohols by treating with

(i) $HCl + ZnCl_2$

(ii) Red P + Br_2

(iii) H_2SO_4 + KI

(iv) All the above

43. Alkyl fluorides are synthesised by heating an alkyl chloride/bromide in presence of ___________ or ___________.

(i) $Ca\,F_2$

(ii) CoF_2

(iii) Hg_2F_2

(iv) NaF

III. Short Answer Type

44. Aryl chlorides and bromides can be easily prepared by electrophilic substitution of arenes with chlorine and bromine respectively in the presence of Lewis acid catalysts. But why does preparation of aryl iodides requires presence of an oxidising agent?

45. Out of *o*-and *p*-dibromobenzene which one has higher melting point and why?

46. Which of the compounds will react faster in S_N1 reaction with the ^-OH ion?

$CH_3—CH_2—Cl$ or $C_6H_5—CH_2—Cl$

47. Why iodoform has appreciable antiseptic property?

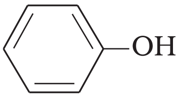
48. Haloarenes are less reactive than haloalkanes and haloalkenes. Explain.

49. Discuss the role of Lewis acids in the preparation of aryl bromides and chlorides in the dark.

50. Which of the following compounds (a) and (b) will not react with a mixture of NaBr and H_2SO_4. Explain why?

(a) $CH_3CH_2CH_2OH$

(b)

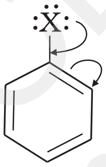


51. Which of the products will be major product in the reaction given below? Explain.

$$CH_3CH = CH_2 + HI \longrightarrow \underset{(A)}{CH_3CH_2CH_2I} + \underset{(B)}{CH_3CHICH_3}$$

52. Why is the solubility of haloalkanes in water very low?

53. Draw other resonance structures related to the following structure and find out whether the functional group present in the molecule is ortho, para directing or meta directing.



54. Classify the following compounds as primary, secondary and tertiary halides.

(i) 1-Bromobut-2-ene (ii) 4-Bromopent-2-ene

(iii) 2-Bromo-2-methylpropane

55. Compound 'A' with molecular formula C_4H_9Br is treated with aq. KOH solution. The rate of this reaction depends upon the concentration of the compound 'A' only. When another optically active isomer 'B' of this compound was treated with aq. KOH solution, the rate of reaction was found to be dependent on concentration of compound and KOH both.

(i) Write down the structural formula of both compounds 'A' and 'B'.

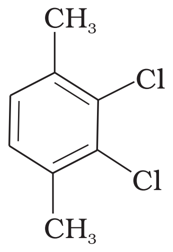
(ii) Out of these two compounds, which one will be converted to the product with inverted configuration.

56. Write the structures and names of the compounds formed when compound 'A' with molecular formula, C_7H_8 is treated with Cl_2 in the presence of $FeCl_3$.

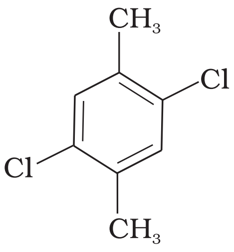
57. Identify the products A and B formed in the following reaction :

(a) $CH_3—CH_2—CH{=}CH—CH_3 + HCl \longrightarrow A + B$

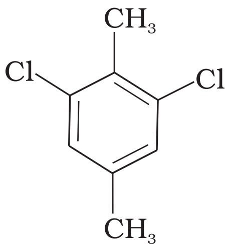
58. Which of the following compounds will have the highest melting point and why?



(I)



(II)



(III)

59. Write down the structure and IUPAC name for neo-pentylbromide.

60. A hydrocarbon of molecular mass 72 g mol^{-1} gives a single monochloro derivative and two dichloro derivatives on photo chlorination. Give the structure of the hydrocarbon.

61. Name the alkene which will yield 1-chloro-1-methylcyclohexane by its reaction with HCl. Write the reactions involved.

62. Which of the following haloalkanes reacts with aqueous KOH most easily? Explain giving reason.

(i) 1-Bromobutane

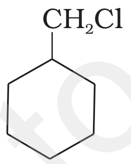
(ii) 2-Bromobutane

(iii) 2-Bromo-2-methylpropane

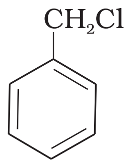
(iv) 2-Chlorobutane

63. Why can aryl halides not be prepared by reaction of phenol with HCl in the presence of $ZnCl_2$?

64. Which of the following compounds would undergo S_N1 reaction faster and why?



(A)



(B)

65. Allyl chloride is hydrolysed more readily than *n*-propyl chloride. Why?

66. Why is it necessary to avoid even traces of moisture during the use of a Grignard reagent?

67. How do polar solvents help in the first step in S_N1 mechanism?

68. Write a test to detect the presence of double bond in a molecule.

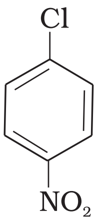
69. Diphenyls are potential threat to the environment. How are these produced from arylhalides?

70. What are the IUPAC names of the insecticide DDT and benzenehexachloride? Why is their use banned in India and other countries?

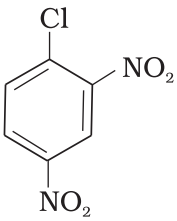
71. Elimination reactions (especially β-elimination) are as common as the nucleophilic substitution reaction in case of alkyl halides. Specify the reagents used in both cases.

72. How will you obtain monobromobenzene from aniline?

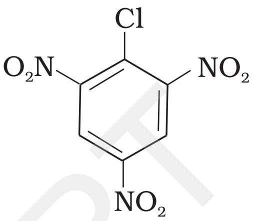
73. Aryl halides are extremely less reactive towards nucleophilic substitution. Predict and explain the order of reactivity of the following compounds towards nucleophilic substitution:



(I)



(II)



(III)

74. *tert*-Butylbromide reacts with aq. NaOH by S_N1 mechanism while n-butylbromide reacts by S_N2 mechanism. Why?

75. Predict the major product formed when HCl is added to isobutylene. Explain the mechanism involved.

76. Discuss the nature of C–X bond in the haloarenes.

77. How can you obtain iodoethane from ethanol when no other iodine containing reagent except NaI is available in the laboratory?

78. Cyanide ion acts as an ambident nucleophile. From which end it acts as a stronger nucleophile in aqueous medium? Give reason for your answer.

IV. Matching Type

Note : Match the items given in Column I and Column II in the following questions.

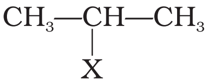
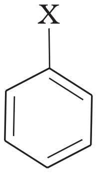
79. Match the the compounds given in Column I with the effects given in Column II.

	Column I		**Column II**
(i)	Chloramphenicol	(a)	Malaria
(ii)	Thyroxine	(b)	Anaesthetic
(iii)	Chloroquine	(c)	Typhoid fever
(iv)	Chloroform	(d)	Goiter
		(e)	Blood substituent

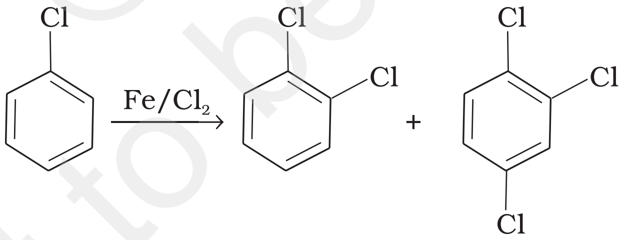
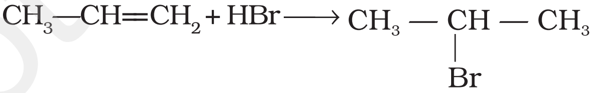
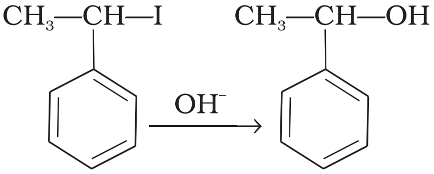
80. Match the items of Column I and Column II.

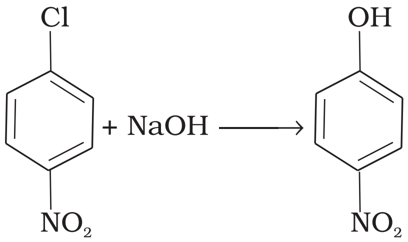
	Column I		**Column II**
(i)	S_N1 reaction	(a)	*vic*-dibromides
(ii)	Chemicals in fire extinguisher	(b)	*gem*-dihalides
(iii)	Bromination of alkenes	(c)	Racemisation
(iv)	Alkylidene halides	(d)	Saytzeff rule
(v)	Elimination of HX from alkylhalide	(e)	Chlorobromocarbons

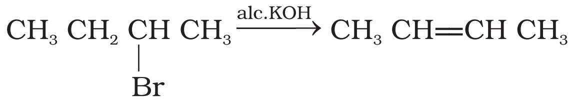
81. Match the structures of compounds given in Column I with the classes of compounds given in Column II.

	Column I		**Column II**
(i)	 $CH_3—\underset{\displaystyle X}{\underset{\vert}{C}H}—CH_3$	(a)	Aryl halide
(ii)	$CH_2{=}CH—CH_2—X$	(b)	Alkyl halide
(iii)		(c)	Vinyl halide
(iv)	$CH_2{=}CH—X$	(d)	Allyl halide

82. Match the reactions given in Column I with the types of reactions given in Column II.

	Column I		**Column II**
(i)		(a)	Nucleophilic aromatic substitution
(ii)	 $CH_3—CH{=}CH_2 + HBr \longrightarrow CH_3 — \underset{\displaystyle Br}{\underset{\vert}{C}H} — CH_3$	(b)	Electrophilic aromatic substitution
(iii)		(c)	Saytzeff elimination

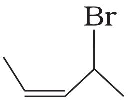
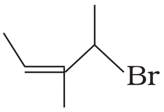
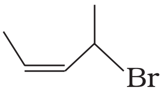
(iv)  (d) Electrophilic addition

(v) 

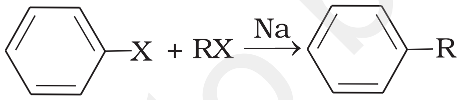
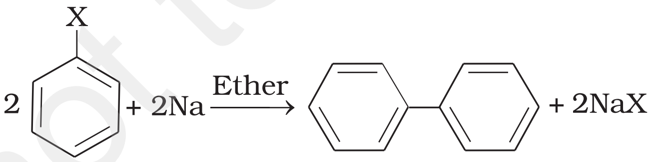
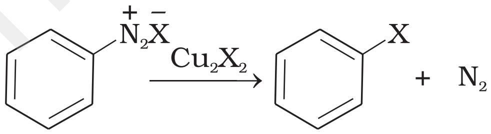
$\mathrm{CH_3\,CH_2\,\underset{\displaystyle Br}{CH}\,CH_3 \xrightarrow{alc.KOH} CH_3\,CH{=}CH\,CH_3}$

(f) Nucleophilic substitution (S_N1)

83. Match the structures given in Column I with the names in Column II.

Column I	**Column II**
(i) 	(a) 4-Bromopent-2-ene
(ii) 	(b) 4-Bromo-3-methylpent-2-ene
(iii) 	(c) 1-Bromo-2-methylbut-2-ene
(iv) 	(d) 1-Bromo-2-methylpent-2-ene

84. Match the reactions given in Column I with the names given in Column II.

Column I	**Column II**
(i) 	(a) Fittig reaction
(ii) 	(b) Wurtz Fittig reaction
(iii) 	(c) Finkelstein reaction
(iv) $\mathrm{C_2H_5Cl + NaI \xrightarrow{dry\ acetone} C_2H_5I + NaCl}$	(d) Sandmeyer reaction

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct and reason is correct explanation of assertion.

(ii) Assertion and reason both are wrong statements.

(iii) Assertion is correct but reason is wrong statement.

(iv) Assertion is wrong but reason is correct statement.

(v) Assertion and reason both are correct statements but reason is not correct explanation of assertion.

85. Assertion : Phosphorus chlorides (tri and penta) are preferred over thionyl chloride for the preparation of alkyl chlorides from alcohols.

Reason : Phosphorus chlorides give pure alkyl halides.

86. Assertion : The boiling points of alkyl halides decrease in the order :

RI > RBr > RCl > RF

Reason : The boiling points of alkyl chlorides, bromides and iodides are considerably higher than that of the hydrocarbon of comparable molecular mass.

87. Assertion : KCN reacts with methyl chloride to give methyl isocyanide

Reason : CN^- is an ambident nucleophile.

88. Assertion : *tert*-Butyl bromide undergoes Wurtz reaction to give 2, 2, 3, 3-tetramethylbutane.

Reason : In Wurtz reaction, alkyl halides react with sodium in dry ether to give hydrocarbon containing double the number of carbon atoms present in the halide.

89. Assertion : Presence of a nitro group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution.

Reason : Nitro group, being an electron withdrawing group decreases the electron density over the benzene ring.

90. Assertion : In monohaloarenes, further electrophilic substitution occurs at ortho and para positions.

Reason : Halogen atom is a ring deactivator.

91. Assertion : Aryl iodides can be prepared by reaction of arenes with iodine in the presence of an oxidising agent.

Reason : Oxidising agent oxidises I_2 into HI.

92. Assertion : It is difficult to replace chlorine by –OH in chlorobenzene in comparison to that in chloroethane.

Reason : Chlorine-carbon (C—Cl) bond in chlorobenzene has a partial double bond character due to resonance.

93.	**Assertion**	:	Hydrolysis of (–)-2-bromooctane proceeds with inversion of configuration.
	Reason	:	This reaction proceeds through the formation of a carbocation.
94.	**Assertion**	:	Nitration of chlorobenzene leads to the formation of *m*-nitrochlorobenzene
	Reason	:	—NO_2 group is a *m*-directing group.

VI. Long Answer Type

95. Some alkylhalides undergo substitution whereas some undergo elimination reaction on treatment with bases. Discuss the structural features of alkyl halides with the help of examples which are responsible for this difference.

96. Some halogen containing compounds are useful in daily life. Some compounds of this class are responsible for exposure of flora and fauna to more and more of UV light which causes destruction to a great extent. Name the class of these halocompounds. In your opinion, what should be done to minimise harmful effects of these compounds.

97. Why are aryl halides less reactive towards nucleophilic substitution reactions than alkyl halides? How can we enhance the reactivity of aryl halides?

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii)   2. (iv)   3. (i)   4. (ii)   5. (i)   6. (i)
7. (i)

8. (iii), boiling point of (a) 364 K. boiling point of (b) 375 K, boiling point of (c) 346 K

9. (ii)

10. (i), **Hint :** Make the models of all the molecules and superimpose (i) to (iv) molecules on molecule (A).

11. (ii)   12. (i)   13. (ii)   14. (ii)   15. (iii)   16. (ii)
17. (iv)   18. (iii)   19. (ii)   20. (iv)   21. (iii)   22. (i)

23. (i), **Hint :** $C_6H_5\overset{\oplus}{C}H_2$ is stable cation so favours the progress of reaction by S_N1 mechanism.

24. (ii)   25. (i)   26. (iii)   27. (iv)   28. (iv)   29. (iii)
30. (i)   31. (iv)

II. Multiple Choice Questions (Type-II)

32. (i), (iii)   33. (i), (ii)   34. (i), (iv)   35. (i), (iv)

36. (i), (iii)   37. (i), (iv)   38. (i), (iii)   39. (i), (iii)

40. (i), (iii)   41. (i), (iv)   42. (i), (ii)   43. (ii), (iii)

III. Short Answer Type

44. Iodination reactions are reversible in nature. To carry out the reaction in the forward direction, HI formed during iodination is removed by oxidation. HIO_4 is used as an oxidising agent.

45. *p*-Dibromobenzene has higher melting point than its *o*-isomer. It is due to symmetry of *p*-isomer which fits in crystal lattice better than the o-isomer.

46. $C_6H_5—CH_2—Cl$

47. Due to liberation of free iodine.

48. See NCERT textbook for Class XII.

49. See NCERT textbook for Class XII.

50. (b), C—O bond is more stable in (b) because of resonance.

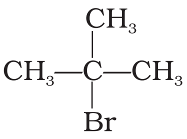
51. 'B' is major product of the reaction. For explanation, see Markownikov's rule. Consult chemistry textbook, Class XI, NCERT, Section 13.3.5.

52. See NCERT textbook for Class XII.

53. Ortho-para directing due to increase in the electron density at ortho and para positions. (For resonance structures consult NCERT textbook, Class XII)

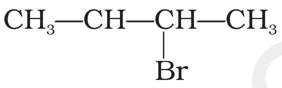
54. (i) Primary (ii) Secondary (iii) Tertiary

55. (i) Compound A :



$CH_3-\underset{Br}{\overset{CH_3}{C}}-CH_3$

Compound B :

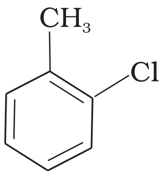


$CH_3-CH-\underset{Br}{CH}-CH_3$

(ii) Compound 'B'.

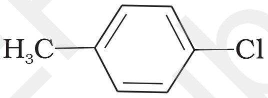
56.

(i)



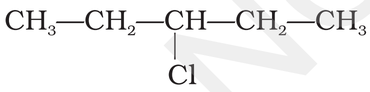
o–Chlorotoluene

(ii)



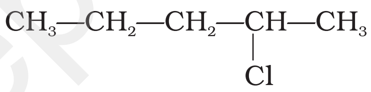
p-Chlorotoluene

57. (A)



$CH_3-CH_2-\underset{Cl}{CH}-CH_2-CH_3$

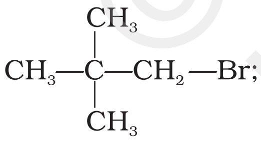
(B)



$CH_3-CH_2-CH_2-\underset{Cl}{CH}-CH_3$

58. II, due to symmetry of para-positions; it fits into crystal lattice better than other isomers.

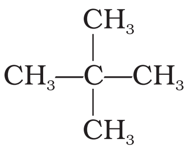
59.



$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-CH_2-Br$; 1-Bromo-2,2-dimethylpropane

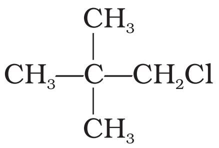
60. C_5H_{12}, pentane has molecular mass 72 g mol^{-1}, i.e. the isomer of pentane which yields single monochloro derivative should have all the 12 hydrogens equivalent.

The hydrocarbon is



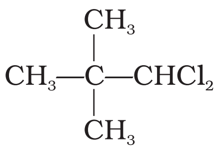
$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-CH_3$

Monochloro derivative



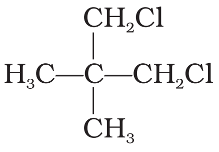
$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-CH_2Cl$

Dichloro derivatives



$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-CHCl_2$

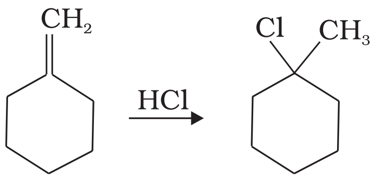
(i)



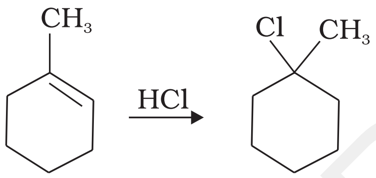
$H_3C-\underset{CH_3}{\overset{CH_2Cl}{C}}-CH_2Cl$

(ii)

61.



or



62. (iii); The tertiary carbocation formed in the reaction is stable.

63. C—O bond in phenols is more stable due to resonance effect and it has double bond character, hence breaking of this bond is difficult.

64. (B) Undergoes S_N1 reaction faster than (A) because in case of (B), the carbocation formed after the loss of Cl^- is stabilised by resonance, whereas, no such stabilisation is possible in the carbocation obtained from (A).

65. Allyl chloride shows high reactivity as the carbocation formed by hydrolysis is stabilised by resonance while no such stabilisation of carbocation exists in the case of *n*-propyl chloride.

66. Grignard reagents are highly reactive and react with water to give corresponding hydrocarbons.

$$RMgX + H_2O \longrightarrow RH + Mg(OH)X$$

67. [**Hint:** solvation of carbocation.]

68. [**Hint :** (1) Unsaturation test with Br_2 water (2) Bayer's test.]

69. Consult NCERT textbook for Class XII.

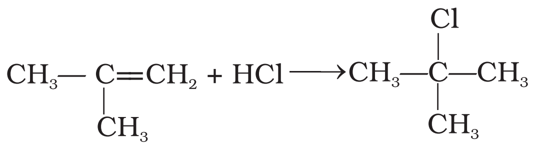
70. Consult NCERT textbook for Class XII.

71. Consult NCERT textbook for Class XII.

72. Consult NCERT textbook for Class XII.

73. III > II > I

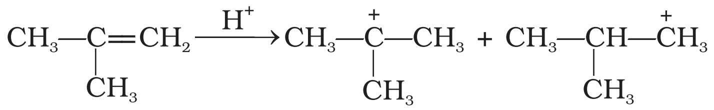
74. Consult Chemistry textbook (NCERT) Class XII, Part II.

75. 

$$CH_3-\underset{\substack{|\\ CH_3}}{C}=CH_2 + HCl \longrightarrow CH_3-\overset{\substack{Cl\\ |}}{\underset{\substack{|\\ CH_3}}{C}}-CH_3$$

(Isobutylene) (2-Chloro-2–methylpropane)

The mechanism involved in this reaction is:

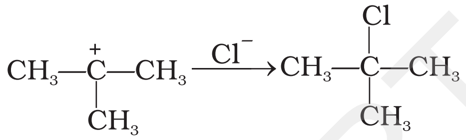
Step I 

$$CH_3-\underset{\substack{|\\ CH_3}}{C}=CH_2 \xrightarrow{H^+} CH_3-\underset{\substack{|\\ CH_3}}{\overset{+}{C}}-CH_3 + CH_3-\underset{\substack{|\\ CH_3}}{CH}-\overset{+}{CH_3}$$

Isobutylene

3° carbocation (more stable)

1° carbocation (less stable)

Step II 

$$CH_3-\underset{\substack{|\\ CH_3}}{\overset{+}{C}}-CH_3 \xrightarrow{Cl^-} CH_3-\overset{\substack{Cl\\ |}}{\underset{\substack{|\\ CH_3}}{C}}-CH_3$$

76. **Hint :** Discuss polar nature and stabilisation of C—X bond.

77. **Hint :** $C_2H_5OH + HCl \xrightarrow{ZnCl_2} C_2H_5Cl \xrightarrow{NaI} C_2H_5I$.

78. **Hint :** It acts as a stronger nucleophile from the carbon end because it will lead to the formation of C–C bond which is more stable than the C–N bond.

IV. Matching Type

79. (i) → (c) (ii) → (d) (iii) → (a) (iv) → (b)
80. (i) → (c) (ii) → (e) (iii) → (a) (iv) → (b) (v) → (d)
81. (i) → (b) (ii) → (d) (iii) → (a) (iv) → (c)
82. (i) → (b) (ii) → (d) (iii) → (e) (iv) → (a) (v) → (c)
83. (i) → (a) (ii) → (c) (iii) → (b) (iv) → (d)
84. (i) → (b) (ii) → (a) (iii) → (d) (iv) → (c)

V. Assertion and Reason Type

85. (ii) 86. (v) 87. (iv) 88. (i) 89. (i) 90. (v)
91. (iii) 92. (i) 93. (iii) 94. (iv)

VI. Long Answer Type

95. **Hint :** Primary alkyl halides prefer to undergo substitution reaction by S_N2 mechanism whereas tertiary halides undergo elimination reaction due to the formation of stable carbocation.

96. Consult Chemistry textbook of NCERT for Class XII.

97. Consult Chemistry textbook of NCERT for Class XII.

Unit

11

ALCOHOLS, PHENOLS AND ETHERS

I. Multiple Choice Questions (Type-I)

1. Monochlorination of toluene in sunlight followed by hydrolysis with aq. NaOH yields.

(i) *o*-Cresol
(ii) *m*-Cresol
(iii) 2, 4-Dihydroxytoluene
(iv) Benzyl alcohol

2. How many alcohols with molecular formula $C_4H_{10}O$ are chiral in nature?

(i) 1
(ii) 2
(iii) 3
(iv) 4

3. What is the correct order of reactivity of alcohols in the following reaction?

$$R—OH + HCl \xrightarrow{ZnCl_2} R—Cl + H_2O$$

(i) $1° > 2° > 3°$
(ii) $1° < 2° > 3°$
(iii) $3° > 2° > 1°$
(iv) $3° > 1° > 2°$

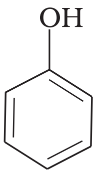
4. CH_3CH_2OH can be converted into CH_3CHO by ______________.

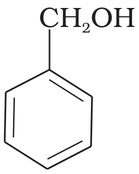
(i) catalytic hydrogenation
(ii) treatment with $LiAlH_4$

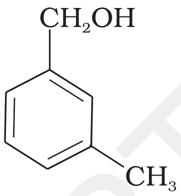
(iii) treatment with pyridinium chlorochromate
(iv) treatment with $KMnO_4$

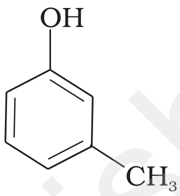
5. The process of converting alkyl halides into alcohols involves____________.
(i) addition reaction
(ii) substitution reaction
(iii) dehydrohalogenation reaction
(iv) rearrangement reaction

6. Which of the following compounds is aromatic alcohol?


(A)

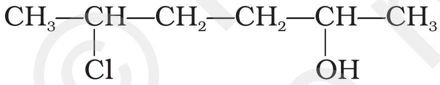

(B)


(C)


(D)

(i) A, B, C, D
(ii) A, D
(iii) B, C
(iv) A

7. Give IUPAC name of the compound given below.

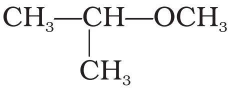


$$CH_3—\underset{\displaystyle Cl}{\underset{|}{CH}}—CH_2—CH_2—\underset{\displaystyle OH}{\underset{|}{CH}}—CH_3$$

(i) 2-Chloro-5-hydroxyhexane
(ii) 2-Hydroxy-5-chlorohexane
(iii) 5-Chlorohexan-2-ol
(iv) 2-Chlorohexan-5-ol

8. IUPAC name of *m*-cresol is ___________.
(i) 3-methylphenol
(ii) 3-chlorophenol
(iii) 3-methoxyphenol
(iv) benzene-1,3-diol

9. IUPAC name of the compound $CH_3—\underset{\displaystyle CH_3}{\underset{|}{CH}}—OCH_3$ is _____________.



(i) 1-methoxy-1-methylethane
(ii) 2-methoxy-2-methylethane

(iii) 2-methoxypropane

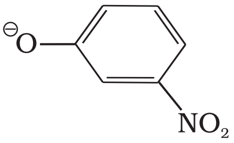
(iv) isopropylmethyl ether

10. Which of the following species can act as the strongest base?

(i) $^{\ominus}OH$

(ii) $^{\ominus}OR$

(iii) $^{\ominus}O\,C_6H_5$

(iv) 

11. Which of the following compounds will react with sodium hydroxide solution in water?

(i) C_6H_5OH

(ii) $C_6H_5CH_2OH$

(iii) $(CH_3)_3\,COH$

(iv) C_2H_5OH

12. Phenol is less acidic than ________________.

(i) ethanol

(ii) *o*-nitrophenol

(iii) *o*-methylphenol

(iv) *o*-methoxyphenol

13. Which of the following is most acidic?

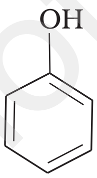
(i) Benzyl alcohol

(ii) Cyclohexanol

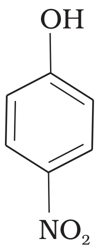
(iii) Phenol

(iv) *m*-Chlorophenol

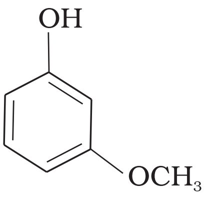
14. Mark the correct order of decreasing acid strength of the following compounds.



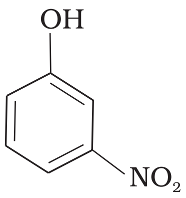
(a)



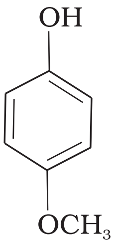
(b)



(c)



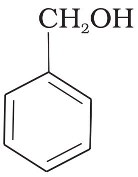
(d)

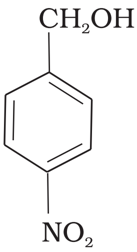


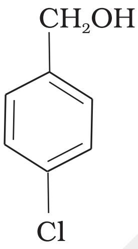
(e)

(i) e > d > b > a > c
(ii) b > d > a > c > e
(iii) d > e > c > b > a
(iv) e > d > c > b > a

15. Mark the correct increasing order of reactivity of the following compounds with HBr/HCl.


(a)


(b)


(c)

(i) a < b < c
(ii) b < a < c
(iii) b < c < a
(iv) c < b < a

16. Arrange the following compounds in increasing order of boiling point.
Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol

(i) Propan-1-ol, butan-2-ol, butan-1-ol, pentan-1-ol
(ii) Propan-1-ol, butan-1-ol, butan-2-ol, pentan-1-ol
(iii) Pentan-1-ol, butan-2-ol, butan-1-ol, propan-1-ol
(iv) Pentan-1-ol, butan-1-ol, butan-2-ol, propan-1-ol

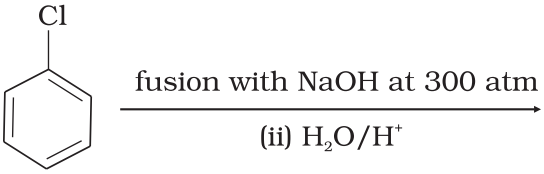
II. Multiple Choice Questions (Type-II)

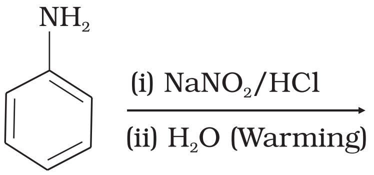
Note : In the following questions two or more options may be correct.

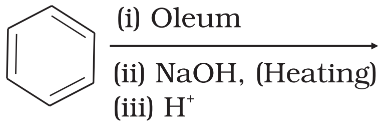
17. Which of the following are used to convert RCHO into RCH_2OH?

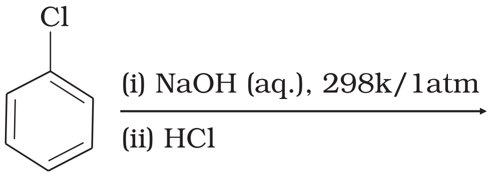
(i) H_2/Pd
(ii) $LiAlH_4$
(iii) $NaBH_4$
(iv) Reaction with RMgX followed by hydrolysis

18. Which of the following reactions will yield phenol?

(i)


(ii) 

(iii) 

(iv) 

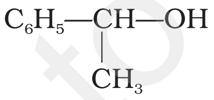
19. Which of the following reagents can be used to oxidise primary alcohols to aldehydes?

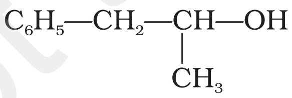
(i) CrO_3 in anhydrous medium.
(ii) $KMnO_4$ in acidic medium.
(iii) Pyridinium chlorochromate.
(iv) Heat in the presence of Cu at 573K.

20. Phenol can be distinguished from ethanol by the reactions with _________.

(i) Br_2/water
(ii) Na
(iii) Neutral $FeCl_3$
(iv) All the above

21. Which of the following are benzylic alcohols?

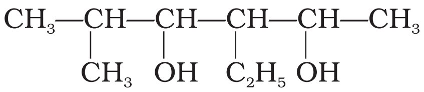
(i) $C_6H_5—CH_2—CH_2OH$
(ii) $C_6H_5—CH_2OH$
(iii) 
$C_6H_5—\underset{\displaystyle CH_3}{\underset{|}{CH}}—OH$

(iv) 
$C_6H_5—CH_2—\underset{\displaystyle CH_3}{\underset{|}{CH}}—OH$

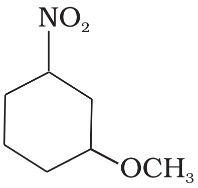
III. Short Answer Type

22. What is the structure and IUPAC name of glycerol?

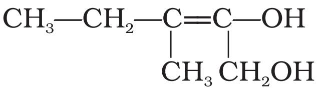
23. Write the IUPAC name of the following compounds.

(A) 

$CH_3-\underset{CH_3}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH}}-\underset{C_2H_5}{\underset{|}{CH}}-\underset{OH}{\underset{|}{CH}}-CH_3$

(B) 

24. Write the IUPAC name of the compound given below.

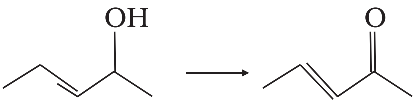


$CH_3-CH_2-\underset{CH_3}{\underset{|}{C}}=\underset{CH_2OH}{\underset{|}{C}}-OH$

25. Name the factors responsible for the solubility of alcohols in water.

26. What is denatured alcohol?

27. Suggest a reagent for the following conversion.



28. Out of 2-chloroethanol and ethanol which is more acidic and why?

29. Suggest a reagent for conversion of ethanol to ethanal.

30. Suggest a reagent for conversion of ethanol to ethanoic acid.

31. Out of *o*-nitrophenol and *p*-nitrophenol, which is more volatile? Explain.

32. Out of *o*-nitrophenol and o-cresol which is more acidic?

33. When phenol is treated with bromine water, white precipitate is obtained. Give the structure and the name of the compound formed.

34. Arrange the following compounds in increasing order of acidity and give a suitable explanation.

Phenol, *o*-nitrophenol, *o*-cresol

35. Alcohols react with active metals e.g. Na, K etc. to give corresponding alkoxides. Write down the decreasing order of reactivity of sodium metal towards primary, secondary and tertiary alcohols.

36. What happens when benzene diazonium chloride is heated with water?

37. Arrange the following compounds in decreasing order of acidity.

H_2O, ROH, $HC \equiv CH$

38. Name the enzymes and write the reactions involved in the preparation of ethanol from sucrose by fermentation.

39. How can propan-2-one be converted into *tert*- butyl alcohol?

40. Write the structures of the isomers of alcohols with molecular formula $C_4H_{10}O$. Which of these exhibits optical activity?

41. Explain why is OH group in phenols more strongly held as compared to OH group in alcohols.

42. Explain why nucleophilic substitution reactions are not very common in phenols.

43. Preparation of alcohols from alkenes involves the electrophilic attack on alkene carbon atom. Explain its mechanism.

44. Explain why is O═C═O nonpolar while R—O—R is polar.

45. Why is the reactivity of all the three classes of alcohols with conc. HCl and $ZnCl_2$ (Lucas reagent) different?

46. Write steps to carry out the conversion of phenol to aspirin.

47. Nitration is an example of aromatic electrophilic substitution and its rate depends upon the group already present in the benzene ring. Out of benzene and phenol, which one is more easily nitrated and why?

48. In Kolbe's reaction, instead of phenol, phenoxide ion is treated with carbon dioxide. Why?

49. Dipole moment of phenol is smaller than that of methanol. Why?

50. Ethers can be prepared by Williamson synthesis in which an alkyl halide is reacted with sodium alkoxide. Di-*tert*-butyl ether can't be prepared by this method. Explain.

51. Why is the C—O—H bond angle in alcohols slightly less than the tetrahedral angle whereas the C—O—C bond angle in ether is slightly greater?

52. Explain why low molecular mass alcohols are soluble in water.

53. Explain why *p*-nitrophenol is more acidic than phenol.

54. Explain why alcohols and ethers of comparable molecular mass have different boiling points?

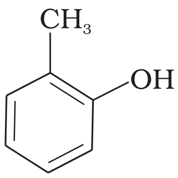
55. The carbon-oxygen bond in phenol is slightly stronger than that in methanol. Why?

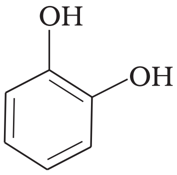
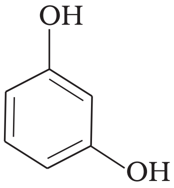
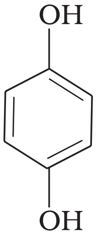
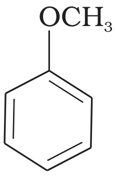
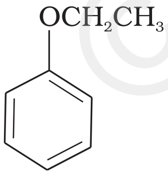
56. Arrange water, ethanol and phenol in increasing order of acidity and give reason for your answer.

IV. Matching Type

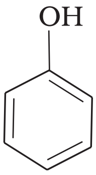
Note : Match the items of Column I and Column II in the following questions.

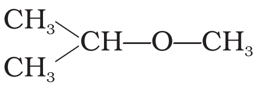
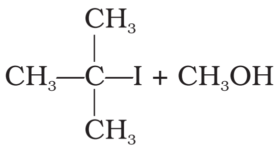
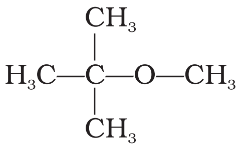
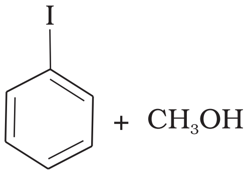
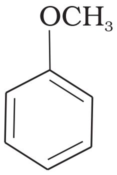
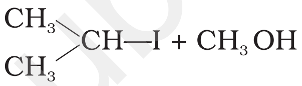
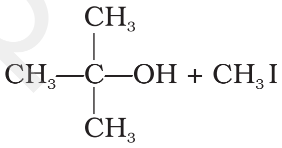
57. Match the structures of the compounds given in Column I with the name of the compounds given in Column II.

Column I	**Column II**
(i) 	(a) Hydroquinone

(ii)		(b) Phenetole
(iii)		(c) Catechol
(iv)		(d) *o*-Cresol
(v)		(e) Quinone
(vi)		(f) Resorcinol
		(g) Anisole

58. Match the starting materials given in Column I with the products formed by these (Column II) in the reaction with HI.

Column I	**Column II**
(i) $CH_3—O—CH_3$	(a)  + CH_3I

(ii) 	(b)  $CH_3—\overset{CH_3}{\underset{CH_3}{C}}—I + CH_3OH$
(iii)  $H_3C—\overset{CH_3}{\underset{CH_3}{C}}—O—CH_3$	(c) 
(iv) 	(d) $CH_3—OH + CH_3—I$
	(e) 
	(f) 
	(g)  $CH_3—\overset{CH_3}{\underset{CH_3}{C}}—OH + CH_3I$

59. Match the items of column I with items of column II.

Column I	**Column II**
(i) Antifreeze used in car engine	(a) Neutral ferric chloride
(ii) Solvent used in perfumes	(b) Glycerol
(iii) Starting material for picric acid	(c) Methanol
(iv) Wood spirit	(d) Phenol
(v) Reagent used for detection of phenolic group	(e) Ethleneglycol
(vi) By product of soap industry used in cosmetics	(f) Ethanol

60. Match the items of column I with items of column II.

Column I	**Column II**
(i) Methanol	(a) Conversion of phenol to *o*-hydroxysalicylic acid

(ii)	Kolbe’s reaction	(b)	Ethyl alcohol
(iii)	Williamson’s synthesis	(c)	Conversion of phenol to salicylaldehyde
(iv)	Conversion of 2° alcohol to ketone	(d)	Wood spirit
(v)	Reimer-Tiemann reaction	(e)	Heated copper at 573K
(vi)	Fermentation	(f)	Reaction of alkyl halide with sodium alkoxide

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct and reason is correct explanation of assertion.

(ii) Assertion and reason both are wrong statements.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Assertion is wrong statement but reason is correct statement.

(v) Both assertion and reason are correct statements but reason is not correct explanation of assertion.

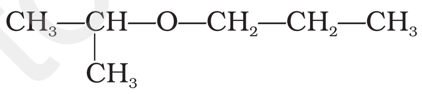
61. Assertion : Addition reaction of water to but-1-ene in acidic medium yields butan-1-ol

Reason : Addition of water in acidic medium proceeds through the formation of primary carbocation.

62. Assertion : *p*-nitrophenol is more acidic than phenol.

Reason : Nitro group helps in the stabilisation of the phenoxide ion by dispersal of negative charge due to resonance.

63. Assertion : IUPAC name of the compound



$CH_3—\underset{\displaystyle CH_3}{\underset{|}{CH}}—O—CH_2—CH_2—CH_3$ is 2-Ethoxy-2-methylethane.

Reason : In IUPAC nomenclature, ether is regarded as hydrocarbon derivative in which a hydrogen atom is replaced by —OR or —OAr group [where R = alkyl group and Ar = aryl group]

64. Assertion : Bond angle in ethers is slightly less than the tetrahedral angle.

Reason : There is a repulsion between the two bulky (—R) groups.

65. Assertion : Boiling points of alcohols and ethers are high.

Reason : They can form intermolecular hydrogen-bonding.

66.	**Assertion**	:	Like bromination of benzene, bromination of phenol is also carried out in the presence of Lewis acid.
	Reason	:	Lewis acid polarises the bromine molecule.
67.	**Assertion**	:	*o*-Nitrophenol is less soluble in water than the *m*- and *p*-isomers.
	Reason	:	*m*- and *p*- Nitrophenols exist as associated molecules.
68.	**Assertion**	:	Ethanol is a weaker acid than phenol.
	Reason	:	Sodium ethoxide may be prepared by the reaction of ethanol with aqueous NaOH.
69.	**Assertion**	:	Phenol forms 2, 4, 6 – tribromophenol on treatment with Br_2 in carbon disulphide at 273K.
	Reason	:	Bromine polarises in carbon disulphide.
70.	**Assertion**	:	Phenols give *o*- and *p*-nitrophenol on nitration with conc. HNO_3 and H_2SO_4 mixture.
	Reason	:	—OH group in phenol is *o*–, *p*– directing.

VI. Long Answer Type

71. Write the mechanism of the reaction of HI with methoxybenzene.

72. (a) Name the starting material used in the industrial preparation of phenol.

(b) Write complete reaction for the bromination of phenol in aqueous and non aqueous medium.

(c) Explain why Lewis acid is not required in bromination of phenol?

73. How can phenol be converted to aspirin?

74. Explain a process in which a biocatalyst is used in industrial preparation of a compound known to you.

ANSWERS

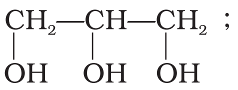
I. Multiple Choice Questions (Type-I)

1. (iv) 2. (i) 3. (iii) 4. (iii) 5. (ii) 6. (iii)
7. (iii) 8. (i) 9. (iii) 10. (ii) 11. (i) 12. (ii)
13. (iv) 14. (ii) 15. (iii) 16. (i)

II. Multiple Choice Questions (Type-II)

17. (i), (ii), (iii) 18. (i), (ii), (iii) 19. (i), (iii), (iv) 20. (i), (iii)
21. (ii), (iii)

III. Short Answer Type

22. 

$$\underset{OH}{CH_2}-\underset{OH}{CH}-\underset{OH}{CH_2}$$; Propane-1,2,3-triol

23. (A) 3-Ethyl-5-methylhexane-2,4-diol, (B) 1-Methoxy-3-nitrocyclohexane

24. 3-Methylpent-2-ene-1,2-diol

25. (i) Hydrogen bonding (ii) Size of alkyl/aryl group.

26. Alcohol is made unfit for drinking by mixing some copper sulphate and pyridine in it. This is called denatured alcohol.

27. CrO_3 , pyridine and HCl. (Pyridinium chlorochromate)

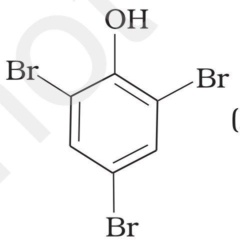
28. 2-Chloroethanol, due to –I effect of chlorine atom.

29. CrO_3, Pyridine and HCl (Pyridinium chlorochromate)

30. Any strong oxidising agent e.g., acidified $KMnO_4$ or $K_2Cr_2O_7$.

31. Ortho nitrophenol, [**Hint :** intramolecular hydrogen bonding in *o*-nitrophenol and intermolecular hydrogen bonding in *p*-nitrophenol.]

32. *o*-Nitrophenol, [**Hint :** CH_3 group is electron releasing]

33. 

(2, 4, 6- Tribromophenol)

34. Increasing order of acidity :

o-cresol < phenol < *o*-nitrophenol

[**Hint :** In substituted phenols, the presence of electron withdrawing groups, enhance the acidic strength of phenol whereas, electron releasing groups decrease the acidic strength of phenol.]

35. Decreasing order of reactivity of sodium metal is :

    1° > 2° > 3°

36. [**Hint :** It gives phenol]

37. [**Hint :** $H_2O > ROH > HC \equiv CH$]

38. See NCERT textbook for Class XII

39. [**Hint :** Using Grignard reagent]

40. See NCERT textbook for Class XII

41. See NCERT textbook for Class XII

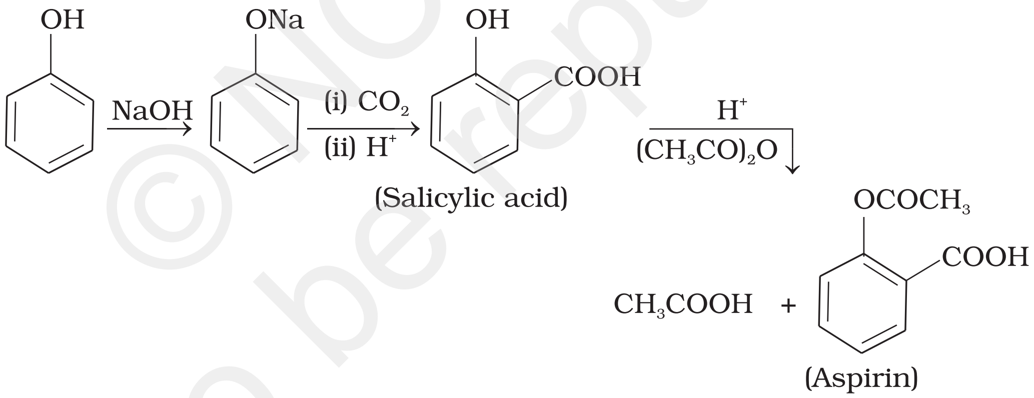
42. See NCERT textbook for Class XII

43. See NCERT textbook for Class XII

44. See NCERT textbook for Class XII

45. An alcohol reacts with conc. HCl and $ZnCl_2$ (Lucas reagent) to give carbocation. More stable is the carbocation, faster is the reaction.

46.

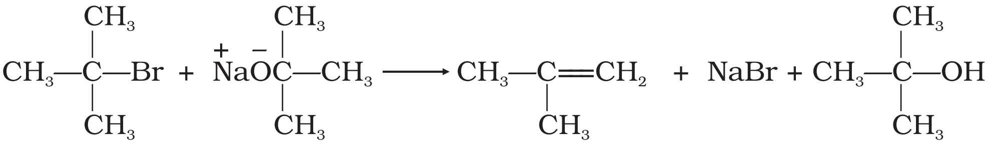


47. Phenol is more easily nitrated than benzene as the presence of —OH group in phenol increases the electron density at ortho and para positions in benzene ring by +R effect. The nitration, being an electrophilic substitution reaction is more facile where the electron density is more.

48. Phenoxide ion is more reactive than phenol towards electrophilic aromatic substitution and hence undergoes electrophilic substitution with carbondioxide which is a weak electrophile.

49. In phenol, C—O bond is less polar due to electron-withdrawing effect of benzene ring whereas in methanol, C—O bond is more polar due to electron-releasing effect of $—CH_3$ group.

50. In *tert*-butyl halides, elimination is favoured over substitution, so alkene is the only reaction product and ether is not formed.



$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Br + \overset{+}{Na}\overset{-}{O}\underset{CH_3}{\overset{CH_3}{C}}-CH_3 \longrightarrow CH_3-\underset{CH_3}{C}=CH_2 + NaBr + CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OH$$

(tert.butyl bromide) (2-methylprop-1-ene)

51. See NCERT textbook for Class XII.

52. See NCERT textbook for Class XII.

53. See NCERT textbook for Class XII.

54. See NCERT textbook for Class XII.

55. This is due to the fact that—

    (i) In phenol, conjugation of unshared electron pair over oxygen with aromatic ring results in partial double bond character in carbon-oxygen bond.

    (ii) In phenol, oxygen is attached to a sp^2 hybridised carbon atom while in methanol, it is attached to a sp^3 hyrbidised carbon atom. The bond formed between oxygen and sp^2 hybridised carbon is more stable than that formed between oxygen and sp^3 hybridised carbon.

56. Increasing order of acidity is ethanol < water < phenol. The phenoxide ion obtained after the removal of a proton is stabilised by resonance whereas the ethoxide ion obtained after the removal of a proton is destabilised by '+I' effect of $—C_2H_5$ group. Therefore phenol is stronger acid than ethanol. On the other hand ethanol is weaker acid than water because electron releasing $—C_2H_5$ group in ethanol inreases the electron density on oxygen and hence the polarity of O—H bond in ethanol decreases which results in the decreasing acidic strength. Hence acidic strength increases in the order given above.

IV. Matching Type

57. (i) — (d), (ii) — (c), (iii) — (f), (iv) — (a); (v) — (g), (vi) — (b)

58. (i) — (d), (ii) — (e), (iii) — (b), (iv) — (a)

59. (i)—(e), (ii)—(f), (iii)—(d), (iv)—(c), (v)—(a), (vi)—(b)

60. (i) —(d), (ii) — (a), (iii) — (f), (iv) — (e); (v) — (c), (vi) — (b)

V. Assertion and Reason Type

61. (ii) 62. (i) 63. (iv) 64. (iv) 65. (ii) 66. (iv)

67. (v) 68. (iii) 69. (ii) 70. (iv)

VI. Long Answer Type

71. Consult NCERT textbook for Class XII.

72. Consult NCERT textbook for Class XII.

73. Consult NCERT textbook for Class XII.

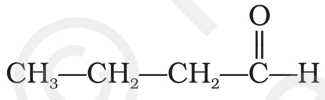
74. Consult NCERT textbook for Class XII.

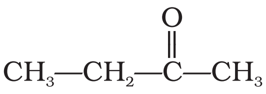
Unit 12

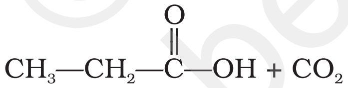
ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

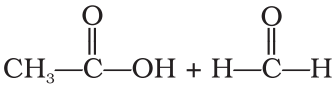
I. Multiple Choice Questions (Type-I)

1. Addition of water to alkynes occurs in acidic medium and in the presence of Hg^{2+} ions as a catalyst. Which of the following products will be formed on addition of water to but-1-yne under these conditions.

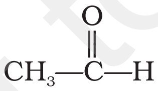
(i) 
$CH_3-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-H$

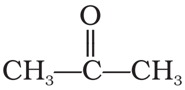
(ii) 
$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_3$

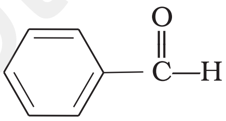
(iii) 
$CH_3-CH_2-\overset{\overset{O}{\|}}{C}-OH + CO_2$

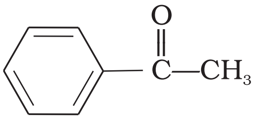
(iv) 
$CH_3-\overset{\overset{O}{\|}}{C}-OH + H-\overset{\overset{O}{\|}}{C}-H$

2. Which of the following compounds is most reactive towards nucleophilic addition reactions?

(i) 
$CH_3-\overset{\overset{O}{\|}}{C}-H$

(ii) 
$CH_3-\overset{\overset{O}{\|}}{C}-CH_3$

(iii) 

(iv) 

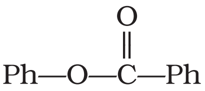
3. The correct order of increasing acidic strength is ____________.

(i) Phenol < Ethanol < Chloroacetic acid < Acetic acid

(ii) Ethanol < Phenol < Chloroacetic acid < Acetic acid

(iii) Ethanol < Phenol < Acetic acid < Chloroacetic acid

(iv) Chloroacetic acid < Acetic acid < Phenol < Ethanol

4. Compound  $Ph—O—\overset{\overset{O}{\|}}{C}—Ph$ can be prepared by the reaction of _____________.

(i) Phenol and benzoic acid in the presence of NaOH

(ii) Phenol and benzoyl chloride in the presence of pyridine

(iii) Phenol and benzoyl chloride in the presence of $ZnCl_2$

(iv) Phenol and benzaldehyde in the presence of palladium

5. The reagent which does not react with both, acetone and benzaldehyde.

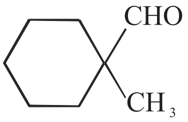
(i) Sodium hydrogensulphite

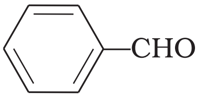
(ii) Phenyl hydrazine

(iii) Fehling's solution

(iv) Grignard reagent

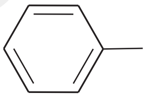
6. Cannizaro's reaction is **not** given by _____________.

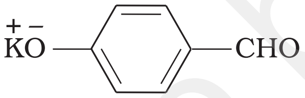
(i) 

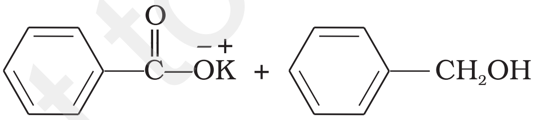
(ii) 

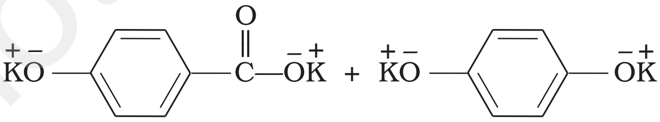
(iii) H CHO

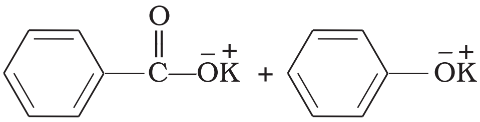
(iv) CH_3CHO

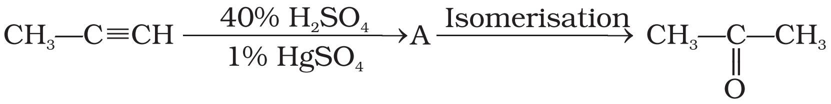
7. Which product is formed when the compound  CHO is treated with concentrated aqueous KOH solution?

(i) 

(ii) 

(iii) 

(iv) 

8. 

$$CH_3—C{\equiv}CH \xrightarrow[1\%\ HgSO_4]{40\%\ H_2SO_4} A \xrightarrow{\text{Isomerisation}} CH_3—\underset{\underset{O}{\|}}{C}—CH_3$$

Structure of 'A' and type of isomerism in the above reaction are respectively.

(i) Prop–1–en–2–ol, metamerism

(ii) Prop-1-en-1-ol, tautomerism

(iii) Prop-2-en-2-ol, geometrical isomerism

(iv) Prop-1-en-2-ol, tautomerism

9. Compounds A and C in the following reaction are __________.

$$CH_3\,CHO \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgBr} (A) \xrightarrow{H_2SO_4,\ \Delta} (B) \xrightarrow{\text{Hydroboration oxidation}} (C)$$

(i) identical

(ii) positional isomers

(iii) functional isomers

(iv) optical isomers

10. Which is the most suitable reagent for the following conversion?

$$CH_3—CH{=}CH—CH_2—\overset{\overset{O}{\|}}{C}—CH_3 \longrightarrow CH_3—CH{=}CH—CH_2—\overset{\overset{O}{\|}}{C}—OH$$

(i) Tollen's reagent

(ii) Benzoyl peroxide

(iii) I_2 and NaOH solution

(iv) Sn and NaOH solution

11. Which of the following compounds will give butanone on oxidation with alkaline $KMnO_4$ solution?

(i) Butan-1-ol

(ii) Butan-2-ol

(iii) Both of these

(iv) None of these

12. In Clemmensen Reduction carbonyl compound is treated with _____________.

(i) Zinc amalgam + HCl

(ii) Sodium amalgam + HCl

(iii) Zinc amalgam + nitric acid

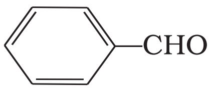
(iv) Sodium amalgam + HNO_3

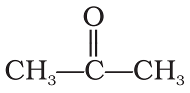
II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

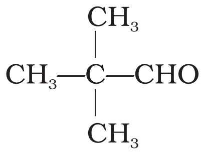
13. Which of the following compounds do not undergo aldol condensation?

(i) $CH_3—CHO$

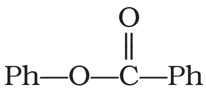
(ii) 

(iii) 

$CH_3—\overset{\overset{\displaystyle O}{||}}{C}—CH_3$

(iv) 

$CH_3—\underset{\underset{\displaystyle CH_3}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}—CHO$



14. Treatment of compound $Ph—O—\overset{\overset{\displaystyle O}{||}}{C}—Ph$ with NaOH solution yields

(i) Phenol

(ii) Sodium phenoxide

(iii) Sodium benzoate

(iv) Benzophenone

15. Which of the following conversions can be carried out by Clemmensen Reduction?

(i) Benzaldehyde into benzyl alcohol

(ii) Cyclohexanone into cyclohexane

(iii) Benzoyl chloride into benzaldehyde

(iv) Benzophenone into diphenyl methane

16. Through which of the following reactions number of carbon atoms can be increased in the chain?

(i) Grignard reaction

(ii) Cannizaro's reaction

(iii) Aldol condensation

(iv) HVZ reaction

17. Benzophenone can be obtained by ____________.

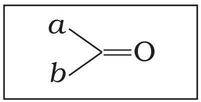
(i) Benzoyl chloride + Benzene + $AlCl_3$

(ii) Benzoyl chloride + Diphenyl cadmium

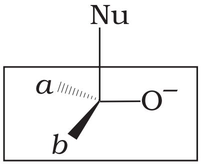
(iii) Benzoyl chloride + Phenyl magnesium chloride

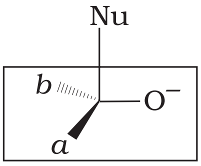
(iv) Benzene + Carbon monoxide + $ZnCl_2$

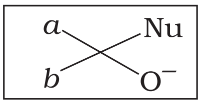
18. Which of the following is the correct representation for intermediate of nucleophilic addition reaction to the given carbonyl compound (A) :

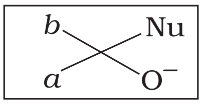


(A)

(i)


(ii)


(iii)


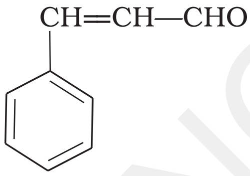
(iv)


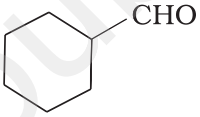
III. Short Answer Type

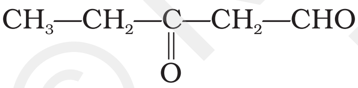
19. Why is there a large difference in the boiling points of butanal and butan-1-ol?

20. Write a test to differentiate between pentan-2-one and pentan-3-one.

21. Give the IUPAC names of the following compounds

(i)


(ii)


(iii)


$CH_3-CH_2-\underset{\underset{O}{\|}}{C}-CH_2-CHO$

(iv) $CH_3-CH=CH-CHO$

22. Give the structure of the following compounds.

(i) 4-Nitropropiophenone

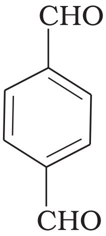
(ii) 2-Hydroxycyclopentanecarbaldehyde

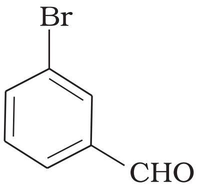
(iii) Phenyl acetaldehyde

23. Write IUPAC names of the following structures.

(i)


$\begin{array}{c}CHO\\|\\CHO\end{array}$

(ii)


(iii)


24. Benzaldehyde can be obtained from benzal chloride. Write reactions for obtaining benzalchloride and then benzaldehyde from it.

25. Name the electrophile produced in the reaction of benzene with benzoyl chloride in the presence of anhydrous $AlCl_3$. Name the reaction also.

26. Oxidation of ketones involves carbon-carbon bond cleavage. Name the products formed on oxidation of 2, 5-dimethylhexan-3-one.

27. Arrange the following in decreasing order of their acidic strength and give reason for your answer.

CH_3CH_2OH, CH_3COOH, $ClCH_2COOH$, FCH_2COOH, $C_6H_5CH_2COOH$

28. What product will be formed on reaction of propanal with 2-methylpropanal in the presence of NaOH? What products will be formed? Write the name of the reaction also.

29. Compound 'A' was prepared by oxidation of compound 'B' with alkaline $KMnO_4$. Compound 'A' on reduction with lithium aluminium hydride gets converted back to compound 'B'. When compound 'A' is heated with compound B in the presence of H_2SO_4 it produces fruity smell of compound C to which family the compounds 'A', 'B' and 'C' belong to?

30. Arrange the following in decreasing order of their acidic strength. Give explanation for the arrangement.

C_6H_5COOH, FCH_2COOH, NO_2CH_2COOH

31. Alkenes ($\rangle C{=}C\langle$) and carbonyl compounds ($\rangle C{=}O$), both contain a π bond but alkenes show electrophilic addition reactions whereas carbonyl compounds show nucleophilic addition reactions. Explain.

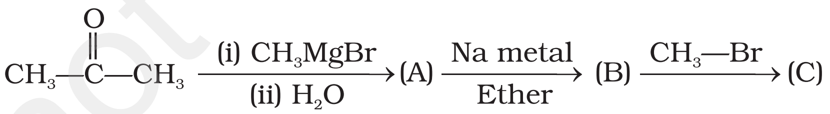
32. Carboxylic acids contain carbonyl group but do not show the nucleophilic addition reaction like aldehydes or ketones. Why?

33. Identify the compounds A, B and C in the following reaction.

$$CH_3{-}Br \xrightarrow{Mg/ether} (A) \xrightarrow[\text{(ii) Water}]{\text{(i) } CO_2} (B) \xrightarrow[\Delta]{CH_3OH/H^+} (C)$$

34. Why are carboxylic acids more acidic than alcohols or phenols although all of them have hydrogen atom attached to a oxygen atom (—O—H)?

35. Complete the following reaction sequence.



$$CH_3{-}\overset{\overset{O}{\|}}{C}{-}CH_3 \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgBr} (A) \xrightarrow[\text{Ether}]{\text{Na metal}} (B) \xrightarrow{CH_3{-}Br} (C)$$

36. Ethylbenzene is generally prepared by acetylation of benzene followed by reduction and not by direct alkylation. Think of a possible reason.

37. Can Gatterman-Koch reaction be considered similar to Friedel Craft's acylation? Discuss.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

38. Match the common names given in Column I with the IUPAC names given in Column II.

Column I **(Common names)**	**Column II** **(IUPAC names)**
(i) Cinnamaldehyde	(a) Pentanal
(ii) Acetophenone	(b) Prop-2-enal
(iii) Valeraldehyde	(c) 4-Methylpent-3-en-2-one
(iv) Acrolein	(d) 3-Phenylprop-2-enal
(v) Mesityl oxide	(e) 1-Phenylethanone

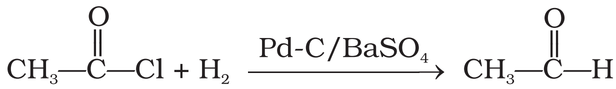
39. Match the acids given in Column I with their correct IUPAC names given in Column II.

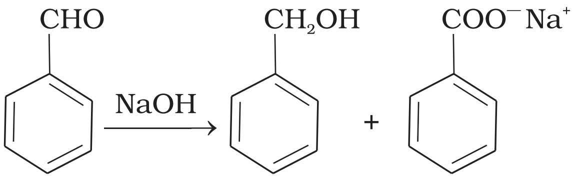
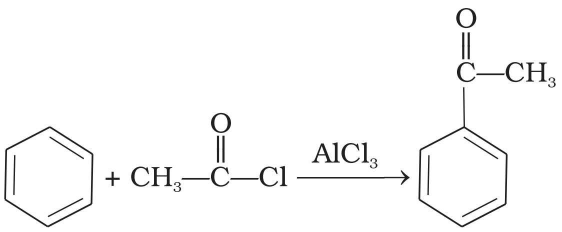
Column I **(Acids)**	**Column II** **(IUPAC names)**
(i) Phthalic acid	(a) Hexane-1,6-dioic acid
(ii) Oxalic acid	(b) Benzene-1,2-dicarboxylic acid
(iii) Succinic acid	(c) Pentane-1,5-dioic acid
(iv) Adipic acid	(d) Butane-1,4-dioic acid
(v) Glutaric acid	(e) Ethane-1,2-dioic acid

40. Match the reactions given in Column I with the suitable reagents given in Column II.

Column I **(Reactions)**	**Column II** **(Reagents)**
(i) Benzophenone → Diphenylmethane	(a) $LiAlH_4$
(ii) Benzaldehyde → 1-Phenylethanol	(b) DIBAL—H
(iii) Cyclohexanone → Cyclohexanol	(c) Zn(Hg)/Conc. HCl
(iv) Phenyl benzoate → Benzaldehyde	(d) CH_3MgBr

41. Match the example given in Column I with the name of the reaction in Column II.

Column I **(Example)**	**Column II** **(Reaction)**
(i)  $CH_3\text{—}\overset{\overset{\large O}{\|}}{C}\text{—}Cl + H_2 \xrightarrow{Pd\text{-}C/BaSO_4} CH_3\text{—}\overset{\overset{\large O}{\|}}{C}\text{—}H$	(a) Friedel Crafts acylation

(ii) 	(b) HVZ reaction
(iii) 	(c) Aldol condensation
(iv)  $R—CH_2—COOH \xrightarrow{Br_2/Red\ P} R—\underset{\underset{Br}{\vert}}{CH}—COOH$	(d) Cannizaro's reaction
(v) $CH_3—CN \xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } SnCl_2/HCl} CH_3CHO$	(e) Rosenmund's reduction
(vi) $2CH_3CHO \xrightarrow{NaOH} CH_3—CH{=}CHCHO$	(f) Stephen's reaction

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct and reason is correct explanation of assertion.

(ii) Assertion and reason both are wrong statements.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Assertion is wrong statement but reason is correct statement.

(v) Assertion and reason both are correct statements but reasson is not correct explanation of assertion.

42. Assertion : Formaldehyde is a planar molecule.

Reason : It contains sp^2 hybridised carbon atom.

43. Assertion : Compounds containing —CHO group are easily oxidised to corresponding carboxylic acids.

Reason : Carboxylic acids can be reduced to alcohols by treatment with $LiAlH_4$.

44. **Assertion** : The α-hydrogen atom in carbonyl compounds is less acidic.

Reason : The anion formed after the loss of α-hydrogen atom is resonance stabilised.

45. ***Assertion*** : Aromatic aldehydes and formaldehyde undergo Cannizaro reaction.

Reason : Aromatic aldehydes are almost as reactive as formaldehyde.

46. **Assertion** : Aldehydes and ketones, both react with Tollen's reagent to form silver mirror.

Reason : Both, aldehydes and ketones contain a carbonyl group.

VI. Long Answer Type

47. An alkene 'A' (Mol. formula C_5H_{10}) on ozonolysis gives a mixture of two compounds 'B' and 'C'. Compound 'B' gives positive Fehling's test and also forms iodoform on treatment with I_2 and NaOH. Compound 'C' does not give Fehling's test but forms iodoform. Identify the compounds A, B and C. Write the reaction for ozonolysis and formation of iodoform from B and C.

48. An aromatic compound 'A' (Molecular formula C_8H_8O) gives positive 2, 4-DNP test. It gives a yellow precipitate of compound 'B' on treatment with iodine and sodium hydroxide solution. Compound 'A' does not give Tollen's or Fehling's test. On drastic oxidation with potassium permanganate it forms a carboxylic acid 'C' (Molecular formula $C_7H_6O_2$), which is also formed along with the yellow compound in the above reaction. Identify A, B and C and write all the reactions involved.

49. Write down functional isomers of a carbonyl compound with molecular formula C_3H_6O. Which isomer will react faster with HCN and why? Explain the mechanism of the reaction also. Will the reaction lead to the completion with the conversion of whole reactant into product at reaction conditions? If a strong acid is added to the reaction mixture what will be the effect on concentration of the product and why?

50. When liquid 'A' is treated with a freshly prepared ammoniacal silver nitrate solution, it gives bright silver mirror. The liquid forms a white crystalline solid on treatment with sodium hydrogensulphite. Liquid 'B' also forms a white crystalline solid with sodium hydrogensulphite but it does not give test with ammoniacal silver nitrate. Which of the two liquids is aldehyde? Write the chemical equations of these reactions also.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii)	2. (i)	3. (iii)	4. (ii)	5. (iii)	6. (iv)
7. (ii)	8. (iv)	9. (ii)	10. (iii)	11. (ii)	12. (i)

II. Multiple Choice Questions (Type-II)

13. (ii), (iv); [**Hint :** in compounds (ii) and (iv) α-hydrogen is absent.]

14. (ii), (iii) 15. (ii), (iv) 16. (i), (iii) 17. (i), (ii) 18. (i), (ii)

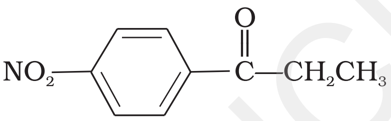
III. Short Answer Type

19. [**Hint :** Butan-1-ol has higher boiling point due to intermolecular hydrogen bonding.]

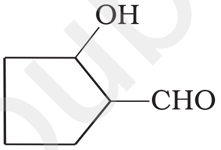
20. [**Hint :** Iodoform test]

21. (i) 3-Phenylprop-2-enal (ii) Cyclohexanecarbaldehyde
(iii) 3-oxopentanal (iv) But -2-enal

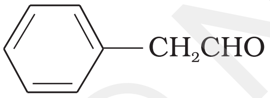
22. (i)



(ii)



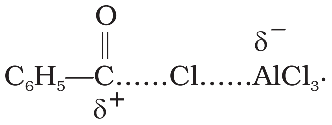
(iii)



23. (i) Ethane-1, 2 – dial (ii) Benzene-1, 4-dicarbaldehyde
(iii) 3-Bromobenzaldehyde

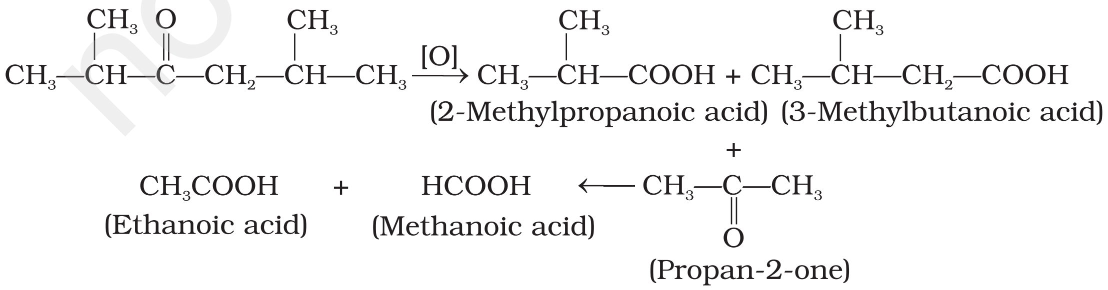
24. See NCERT textbook for Class XII

25. $C_6H_5\overset{\oplus}{C}O$ benzoyliumcation or



$C_6H_5-\overset{\overset{\displaystyle O}{\|}}{\underset{\delta+}{C}}\ldots\ldots Cl\ldots\ldots \overset{\delta^-}{AlCl_3}$. Friedel Craft's acylation reaction.

26.



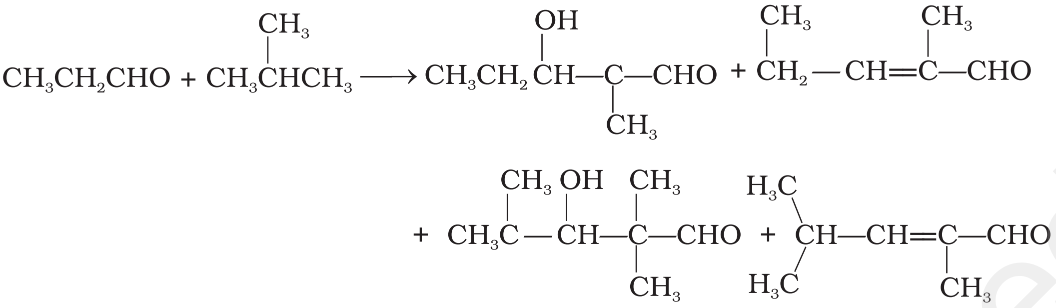
$$CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}H-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle CH_3}{|}}{C}H-CH_3 \xrightarrow{[O]} \underset{\text{(2-Methylpropanoic acid)}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}H-COOH} + \underset{\text{(3-Methylbutanoic acid)}}{CH_3-\overset{\overset{\displaystyle CH_3}{|}}{C}H-CH_2-COOH}$$

$$+$$

$$\underset{\text{(Ethanoic acid)}}{CH_3COOH} + \underset{\text{(Methanoic acid)}}{HCOOH} \longleftarrow \underset{\text{(Propan-2-one)}}{CH_3-\underset{\underset{\displaystyle O}{\|}}{C}-CH_3}$$

27. **Hint :** $FCH_2COOH > ClCH_2COOH > C_6H_5CH_2COOH > CH_3COOH > CH_3CH_2OH$

28. It is cross Aldol condensation



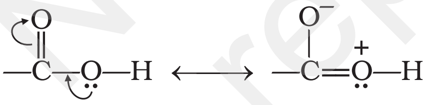
29. 'A' is a carboxylic acid, 'B' is an alcohol and 'C' is an ester.

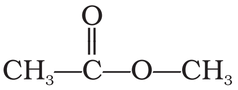
30. $NO_2CH_2COOH > FCH_2COOH > C_6H_5COOH$

[**Hint :** electron withdrawing effect.]

31. [**Hint :** Carbon atom in carbonyl compounds acquires slight positive charge and is attacked by nucleophile.]

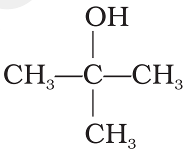
32. [**Hint :** Due to resonance as shown below the partial positive charge on carbonyl carbon atom is reduced.]



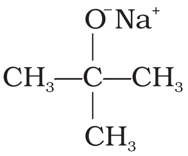
33. A = CH_3MgBr B = CH_3COOH C = 

$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-O-CH_3$

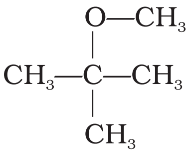
34. **Hint :** Compare the stability of anion formed after the loss of H^+ ion. More stable the anion formed, more easy will be the dissociation of O—H bond, stronger will be the acids.

35. **Hint :** A = 

$CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle OH}{C}}-CH_3$

B = 

$CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle O^-Na^+}{C}}-CH_3$

C = 

$CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle O-CH_3}{C}}-CH_3$

IV. Matching Type

38. (i) — (d), (ii) — (e), (iii) — (a), (iv) — (b), (v) — (c)

39. (i) — (b), (ii) — (e), (iii) — (d), (iv) — (a), (v) — (c)

40. (i) — (c), (ii) — (d), (iii) — (a), (iv) — (b)

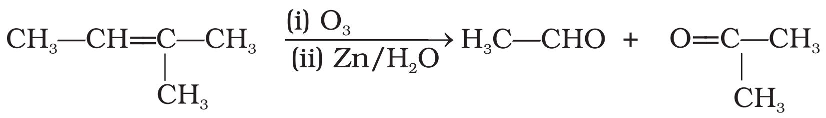
41. (i) — (e), (ii) — (d), (iii) — (a), (iv) — (b), (v) — (f), (vi) — (c)

V. Assertion and Reason Type

42. (i) 43. (v) 44. (iv) 45. (iii) 46. (iv)

VI. Long Answer Type

47.



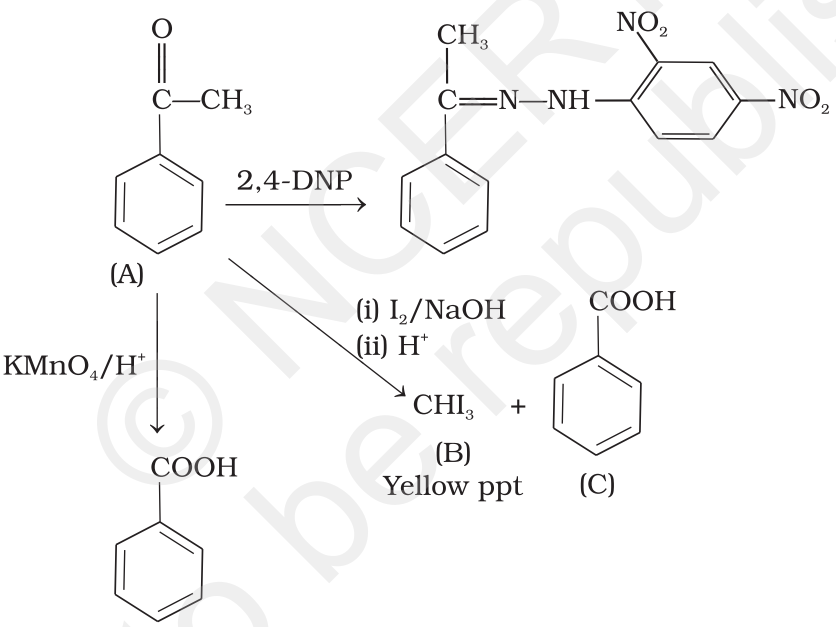
$$\underset{\substack{\text{2-Methylbut-2-ene}\\ \text{(A)}}}{CH_3{-}CH{=}\underset{\underset{CH_3}{|}}{C}{-}CH_3} \xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } O_3} \underset{\text{(B)}}{H_3C{-}CHO} + \underset{\text{(C)}}{O{=}\underset{\underset{CH_3}{|}}{C}{-}CH_3}$$

2-Methylbut-2-ene

(A) (B) (C)

Other isomers of 'A' will not give products corresponding to the given test.

48. **Hint :**



49. CH_3CH_2CHO (I) CH_3COCH_3 (II)

- Compound I will react faster with HCN due to less steric hinderance and electronic reasons than II.
- No, It is a reversible reaction. Hence equilibrium is established.
- Addition of acid inhibits the reaction because the formation of ^-CN ions is prevented.

50. **Hint :** Liquid 'A'

Unit 13

AMINES

I. Multiple Choice Questions (Type-I)

1. Which of the following is a 3° amine?

(i) 1-methylcyclohexylamine

(ii) Triethylamine

(iii) *tert*-butylamine

(iv) N-methylaniline

2. The correct IUPAC name for $CH_2{=}CHCH_2\,NHCH_3$ is

(i) Allylmethylamine

(ii) 2-amino-4-pentene

(iii) 4-aminopent-1-ene

(iv) N-methylprop-2-en-1-amine

3. Amongst the following, the strongest base in aqueous medium is ____________.

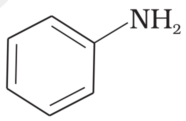
(i) CH_3NH_2

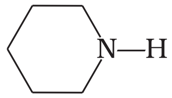
(ii) $NCCH_2NH_2$

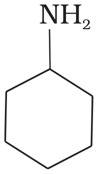
(iii) $(CH_3)_2\,NH$

(iv) $C_6H_5NHCH_3$

4. Which of the following is the weakest Brönsted base?

(i) 

(ii) 

(iii) 

(iv) CH_3NH_2

5. Benzylamine may be alkylated as shown in the following equation :

$$C_6H_5CH_2NH_2 + R—X \longrightarrow C_6H_5CH_2NHR$$

Which of the following alkylhalides is best suited for this reaction through S_N1 mechanism?

(i) CH_3Br

(ii) C_6H_5Br

(iii) $C_6H_5CH_2Br$

(iv) C_2H_5 Br

6. Which of the following reagents would **not** be a good choice for reducing an aryl nitro compound to an amine?

(i) H_2 (excess)/Pt

(ii) $LiAlH_4$ in ether

(iii) Fe and HCl

(iv) Sn and HCl

7. In order to prepare a 1° amine from an alkyl halide with simultaneous addition of one CH_2 group in the carbon chain, the reagent used as source of nitrogen is ___________.

(i) Sodium amide, $NaNH_2$

(ii) Sodium azide, NaN_3

(iii) Potassium cyanide, KCN

(iv) Potassium phthalimide, $C_6H_4(CO)_2N^-K^+$

8. The source of nitrogen in Gabriel synthesis of amines is ____________.

(i) Sodium azide, NaN_3

(ii) Sodium nitrite, $NaNO_2$

(iii) Potassium cyanide, KCN

(iv) Potassium phthalimide, $C_6H_4(CO)_2N^-K^+$

9. Amongst the given set of reactants, the most appropriate for preparing 2° amine is _____.

(i) 2° R—Br + NH_3

(ii) 2° R—Br + NaCN followed by H_2/Pt

(iii) 1° R—NH_2 + RCHO followed by H_2/Pt

(iv) 1° R—Br (2 mol) + potassium phthalimide followed by H_3O^+/heat

10. The best reagent for converting 2–phenylpropanamide into 2-phenylpropanamine is _____.

(i) excess H_2

(ii) Br_2 in aqueous NaOH

(iii) iodine in the presence of red phosphorus

(iv) $LiAlH_4$ in ether

11. The best reagent for converting, 2-phenylpropanamide into 1- phenylethanamine is ____.

(i) excess H_2/Pt

(ii) NaOH/Br_2

(iii) $NaBH_4$/methanol

(iv) $LiAlH_4$/ether

12. Hoffmann Bromamide Degradation reaction is shown by _________.

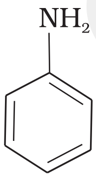
(i) $ArNH_2$

(ii) $ArCONH_2$

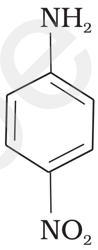
(iii) $ArNO_2$

(iv) $ArCH_2NH_2$

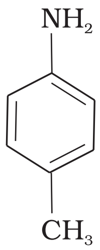
13. The correct increasing order of basic strength for the following compounds is _________.



(I)



(II)



(III)

(i) II < III < I

(ii) III < I < II

(iii) III < II < I

(iv) II < I < III

14. Methylamine reacts with HNO_2 to form _________.

(i) $CH_3—O—N{=}O$

(ii) $CH_3—O—CH_3$

(iii) CH_3OH

(iv) CH_3CHO

15. The gas evolved when methylamine reacts with nitrous acid is __________.

(i) NH_3

(ii) N_2

(iii) H_2

(iv) C_2H_6

16. In the nitration of benzene using a mixture of conc. H_2SO_4 and conc. HNO_3, the species which initiates the reaction is __________.

(i) NO_2

(ii) NO^+

(iii) NO_2^+

(iv) NO_2^-

17. Reduction of aromatic nitro compounds using Fe and HCl gives __________.

(i) aromatic oxime

(ii) aromatic hydrocarbon

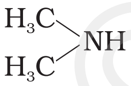
(iii) aromatic primary amine

(iv) aromatic amide

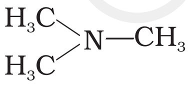
18. The most reactive amine towards dilute hydrochloric acid is ___________.

(i) $CH_3—NH_2$

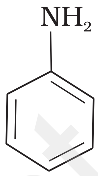
(ii)



(iii)



(iv)



19. Acid anhydrides on reaction with primary amines give ____________.

(i) amide

(ii) imide

(iii) secondary amine

(iv) imine

20. The reaction $\mathrm{Ar}\overset{+}{\mathrm{N}}_2\mathrm{Cl}^- \xrightarrow{\mathrm{Cu/HCl}} \mathrm{ArCl} + \mathrm{N}_2 + \mathrm{CuCl}$ is named as _________.

(i) Sandmeyer reaction
(ii) Gatterman reaction
(iii) Claisen reaction
(iv) Carbylamine reaction

21. Best method for preparing primary amines from alkyl halides without changing the number of carbon atoms in the chain is

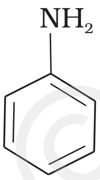
(i) Hoffmann Bromamide reaction
(ii) Gabriel phthalimide synthesis
(iii) Sandmeyer reaction
(iv) Reaction with NH_3

22. Which of the following compound will not undergo azo coupling reaction with benzene diazonium chloride.

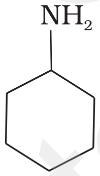
(i) Aniline
(ii) Phenol
(iii) Anisole
(iv) Nitrobenzene

23. Which of the following compounds is the weakest Brönsted base?

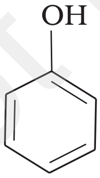
(i)



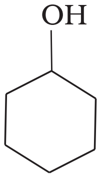
(ii)



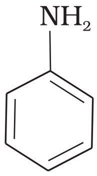
(iii)



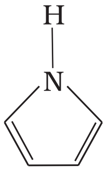
(iv)

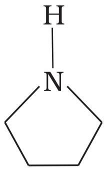


24. Among the following amines, the strongest Brönsted base is __________.

(i) 

(ii) NH_3

(iii) 

(iv) 

25. The correct decreasing order of basic strength of the following species is _______.
H_2O, NH_3, OH^-, NH_2^-

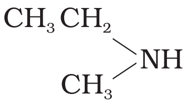
(i) $NH_2^- > OH^- > NH_3 > H_2O$

(ii) $OH^- > NH_2^- > H_2O > NH_3$

(iii) $NH_3 > H_2O > NH_2^- > OH^-$

(iv) $H_2O > NH_3 > OH^- > NH_2^-$

26. Which of the following should be most volatile?

(I) $CH_3CH_2CH_2NH_2$ (II) $(CH_3)_3N$ (III)  $\begin{matrix} CH_3CH_2 \\ CH_3 \end{matrix}\!\!>NH$ (IV) $CH_3CH_2CH_3$

(i) II

(ii) IV

(iii) I

(iv) III

27. Which of the following methods of preparation of amines will give same number of carbon atoms in the chain of amines as in the reactant?

(i) Reaction of nitrite with $LiAlH_4$.

(ii) Reaction of amide with $LiAlH_4$ followed by treatment with water.

(iii) Heating alkylhalide with potassium salt of phthalimide followed by hydrolysis.

(iv) Treatment of amide with bromine in aqueous solution of sodium hydroxide.

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

28. Which of the following cannot be prepared by Sandmeyer's reaction?

(i) Chlorobenzene

(ii) Bromobenzene

(iii) Iodobenzene

(iv) Fluorobenzene

29. Reduction of nitrobenzene by which of the following reagent gives aniline?

(i) Sn/HCl

(ii) Fe/HCl

(iii) H_2-Pd

(iv) Sn/NH_4OH

30. Which of the following species are involved in the carbylamine test?

(i) R—NC

(ii) $CHCl_3$

(iii) $COCl_2$

(iv) $NaNO_2$ + HCl

31. The reagents that can be used to convert benzenediazonium chloride to benzene are _________.

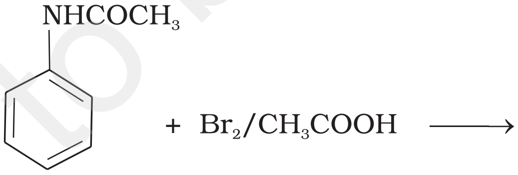
(i) $SnCl_2/HCl$

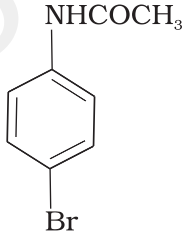
(ii) CH_3CH_2OH

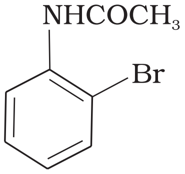
(iii) H_3PO_2

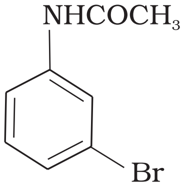
(iv) $LiAlH_4$

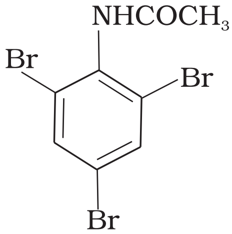
32. The product of the following reaction is _________.



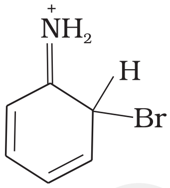
(i) 

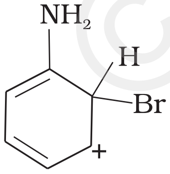
(ii) 

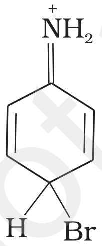
(iii) 

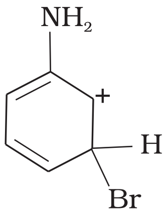
(iv) 

33. Arenium ion involved in the bromination of aniline is __________.

(i) 

(ii) 

(iii) 

(iv) 

34. Which of the following amines can be prepared by Gabriel synthesis.

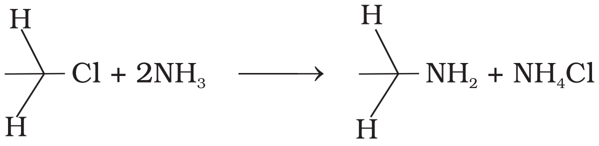
(i) Isobutyl amine

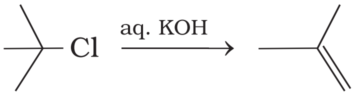
(ii) 2-Phenylethylamine

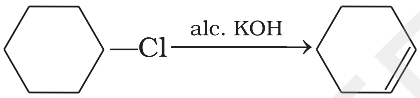
(iii) N-methylbenzylamine

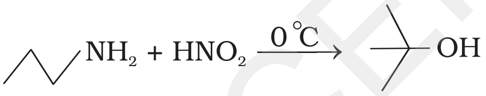
(iv) Aniline

35. Which of the following reactions are correct?

(i) 

(ii) 

(iii) 

(iv) 

36. Under which of the following reaction conditions, aniline gives *p*-nitro derivative as the major product?

(i) Acetyl chloride/pyridine followed by reaction with conc. H_2SO_4 + conc. HNO_3.

(ii) Acetic anyhdride/pyridine followed by conc. H_2SO_4 + conc. HNO_3.

(iii) Dil. HCl followed by reaction with conc. H_2SO_4 + conc. HNO_3.

(iv) Reaction with conc. HNO_3 + conc.H_2SO_4.

37. Which of the following reactions belong to electrophilic aromatic substitution?

(i) Bromination of acetanilide

(ii) Coupling reaction of aryldiazonium salts

(iii) Diazotisation of aniline

(iv) Acylation of aniline

III. Short Answer Type

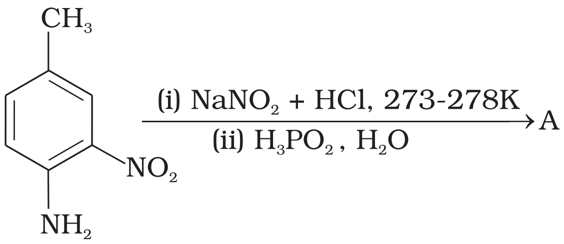
38. What is the role of HNO_3 in the nitrating mixture used for nitration of benzene?

39. Why is NH_2 group of aniline acetylated before carrying out nitration?

40. What is the product when $C_6H_5CH_2NH_2$ reacts with HNO_2?

41. What is the best reagent to convert nitrile to primary amine?

42. Give the structure of 'A' in the following reaction.



43. What is Hinsberg reagent?

44. Why is benzene diazonium chloride not stored and is used immediately after its preparation?

45. Why does acetylation of —NH_2 group of aniline reduce its activating effect?

46. Explain why $MeNH_2$ is stronger base than MeOH?

47. What is the role of pyridine in the acylation reaction of amines?

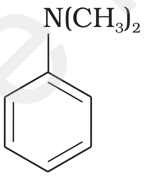
48. Under what reaction conditions (acidic/basic), the coupling reaction of aryldiazonium chloride with aniline is carried out?

49. Predict the product of reaction of aniline with bromine in non-polar solvent such as CS_2.

50. Arrange the following compounds in increasing order of dipole moment.

$CH_3CH_2CH_3$, $CH_3CH_2NH_2$, CH_3CH_2OH

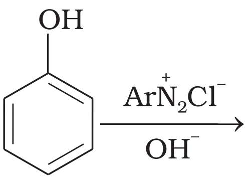
51. What is the structure and IUPAC name of the compound, allyl amine?

52. Write down the IUPAC name of 

53. A compound Z with molecular formula C_3H_9N reacts with $C_6H_5SO_2Cl$ to give a solid, insoluble in alkali. Identify Z.

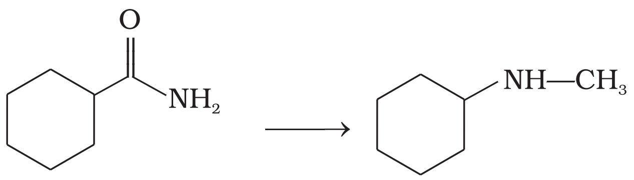
54. A primary amine, RNH_2 can be reacted with CH_3—X to get secondary amine, R—$NHCH_3$ but the only disadvantage is that 3° amine and quaternary ammonium salts are also obtained as side products. Can you suggest a method where RNH_2 forms only 2° amine?

55. Complete the following reaction.

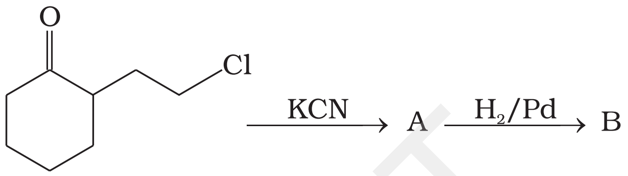


56. Why is aniline soluble in aqueous HCl?

57. Suggest a route by which the following conversion can be accomplished.



58. Identify A and B in the following reaction.



59. How will you carry out the following conversions?

(i) toluene ⟶ *p*-toluidine

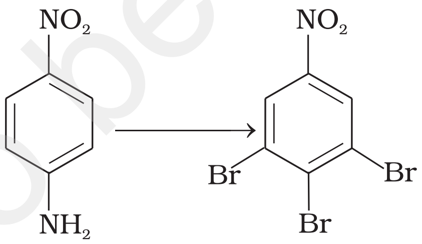
(ii) *p*-toluidine diazonium chloride ⟶ *p*-toluic acid

60. Write following conversions:

(i) nitrobenzene ⟶ acetanilide (ii) acetanilide ⟶ *p*-nitroaniline

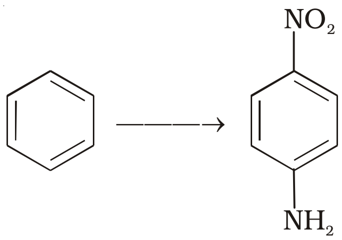
61. A solution contains 1 g mol. each of p-toluene diazonium chloride and *p*-nitrophenyl diazonium chloride. To this 1 g mol. of alkaline solution of phenol is added. Predict the major product. Explain your answer.

62. How will you bring out the following conversion?

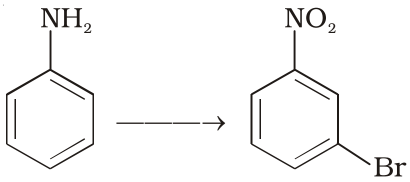


p-Nitroaniline 3,4,5-Tribromonitrobenzene

63. How will you carry out the following conversion?

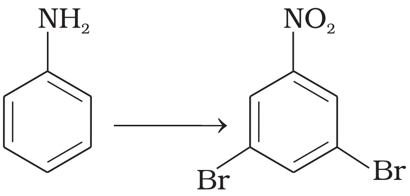


64. How will you carry out the following conversion?

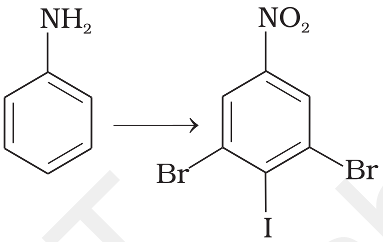


65. How will you carry out the following conversions?

(i)



(ii)



IV. Matching Type

Note : Match the items of Column I and Column II in the following questions.

66. Match the reactions given in Column I with the statements given in Column II.

Column I	**Column II**
(i) Ammonolysis	(a) Amine with lesser number of carbon atoms
(ii) Gabriel phthalimide synthesis	(b) Detection test for primary amines.
(iii) Hoffmann Bromamide reaction	(c) Reaction of phthalimide with KOH and R—X
(iv) Carbylamine reaction	(d) Reaction of alkylhalides with NH_3

67. Match the compounds given in Column I with the items given in Column II.

Column I	**Column II**
(i) Benzene sulphonyl chloride	(a) Zwitter ion
(ii) Sulphanilic acid	(b) Hinsberg reagent
(iii) Alkyl diazonium salts	(c) Dyes
(iv) Aryl diazonium salts	(d) Conversion to alcohols

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Both assertion and reason are wrong.

(ii) Both assertion and reason are correct statements but reason is not correct explanation of assertion.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Both assertion and reason are correct statements and reason is correct explanation of assertion.

(v) Assertion is wrong statement but reason is correct statement.

68. Assertion : Acylation of amines gives a monosubstituted product whereas alkylation of amines gives polysubstituted product.

Reason : Acyl group sterically hinders the approach of further acyl groups.

69. Assertion : Hoffmann's bromamide reaction is given by primary amines.

Reason : Primary amines are more basic than secondary amines.

70. Assertion : N-Ethylbenzene sulphonamide is soluble in alkali.

Reason : Hydrogen attached to nitrogen in sulphonamide is strongly acidic.

71. Assertion : N, N-Diethylbenzene sulphonamide is insoluble in alkali.

Reason : Sulphonyl group attached to nitrogen atom is strong electron withdrawing group.

72. Assertion : Only a small amount of HCl is required in the reduction of nitro compounds with iron scrap and HCl in the presence of steam.

Reason : $FeCl_2$ formed gets hydrolysed to release HCl during the reaction.

73. Assertion : Aromatic 1° amines can be prepared by Gabriel Phthalimide Synthesis.

Reason : Aryl halides undergo nucleophilic substitution with anion formed by phthalimide.

74. Assertion : Acetanilide is less basic than aniline.

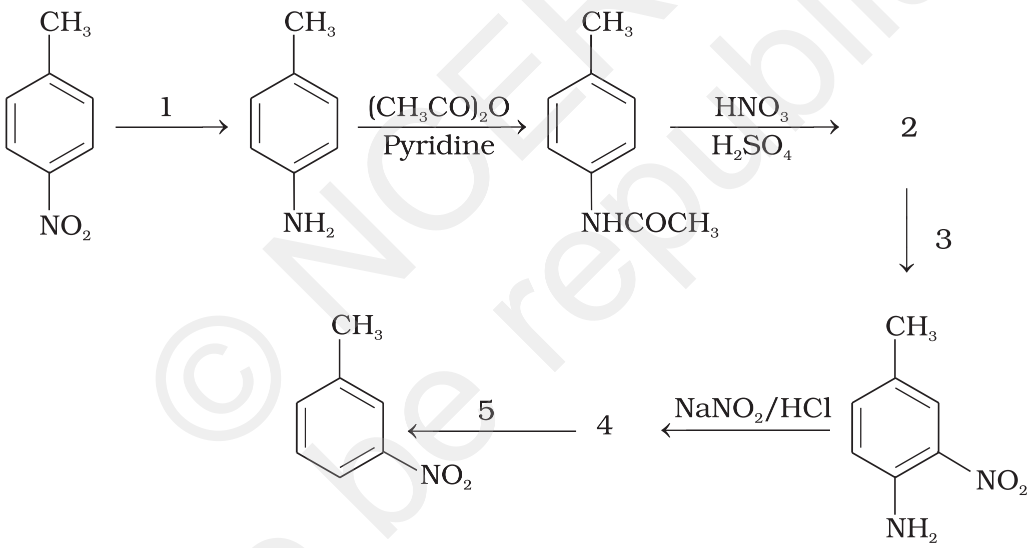
Reason : Acetylation of aniline results in decrease of electron density on nitrogen.

VI. Long Answer Type

75. A hydrocarbon ‘A’, (C_4H_8) on reaction with HCl gives a compound ‘B’, (C_4H_9Cl), which on reaction with 1 mol of NH_3 gives compound ‘C’, ($C_4H_{11}N$). On reacting with $NaNO_2$ and HCl followed by treatment with water, compound ‘C’ yields an optically active alcohol, ‘D’. Ozonolysis of ‘A’ gives 2 mols of acetaldehyde. Identify compounds ‘A’ to ‘D’. Explain the reactions involved.

76. A colourless substance ‘A’ (C_6H_7N) is sparingly soluble in water and gives a water soluble compound ‘B’ on treating with mineral acid. On reacting with $CHCl_3$ and alcoholic potash ‘A’ produces an obnoxious smell due to the formation of compound ‘C’. Reaction of ‘A’ with benzenesulphonyl chloride gives compound ‘D’ which is soluble in alkali. With $NaNO_2$ and HCl, ‘A’ forms compound ‘E’ which reacts with phenol in alkaline medium to give an orange dye ‘F’. Identify compounds ‘A’ to ‘F’.

77. Predict the reagent or the product in the following reaction sequence.



ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii)
2. (iv)
3. (iii)
4. (i)
5. (iii)
6. (ii)
7. (iii)
8. (iv)
9. (iii)
10. (iv)
11. (ii)
12. (ii)
13. (iv)
14. (iii)
15. (ii)
16. (iii)
17. (iii)
18. (ii)
19. (i)
20. (ii)
21. (ii)
22. (iv)
23. (iii)
24. (iv)
25. (i)
26. (ii)
27. (iii)

II. Multiple Choice Questions (Type-II)

28. (iii), (iv)
29. (i), (ii), (iii)
30. (i), (ii)
31. (ii), (iii)
32. (i), (ii)
33. (i), (ii), (iii)
34. (i), (ii)
35. (i), (iii)
36. (i), (ii)
37. (i), (ii)

III. Short Answer Type

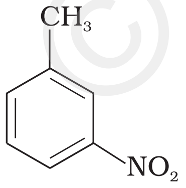
38. HNO_3 acts as a base in the nitrating mixture and provides the electrophile, NO_2^+ .

39. See NCERT textbook for Class XII.

40. $C_6H_5CH_2OH$

41. Reduction of nitriles with sodium/alcohol or $LiAlH_4$ gives primary amine.

42.



43. Benzene sulphonylchloride.

44. Benzene diazonium chloride is very unstable.

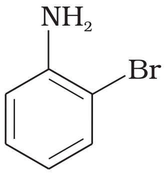
45. See NCERT textbook for Class XII.

46. Nitrogen is less electronegative than oxygen therefore lone pair of electrons on nitrogen is readily available for donation. Hence, $MeNH_2$ is more basic than MeOH.

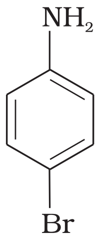
47. Pyridine and other bases are used to remove the side product i.e. HCl from the reaction mixture.

48. Reaction is done in mild basic conditions.

49. A mixture of 2-bromoaniline and 4-bromoaniline is formed.



(2-Bromoaniline)



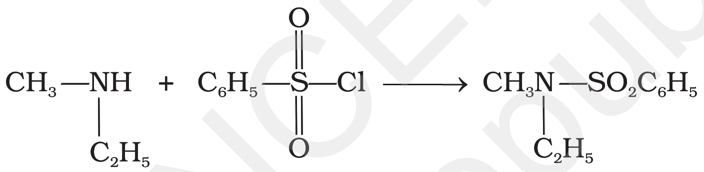
(4-Bromoaniline)

50. $CH_3CH_2CH_3 < CH_3CH_2NH_2 < CH_3CH_2OH$

51. $CH_2{=}CH{-}CH_2{-}NH_2$, prop-2-en-1-amine

52. N, N-Dimethylbenzenamine

53. Z is an aliphatic amine which gives a solid insoluble in base. This implies that reaction with $C_6H_5SO_2Cl$ must give a product without any replaceable hydrogen attached to nitrogen. In other words, the amine must be a secondary amine. i.e. Z is ethylmethylamine.



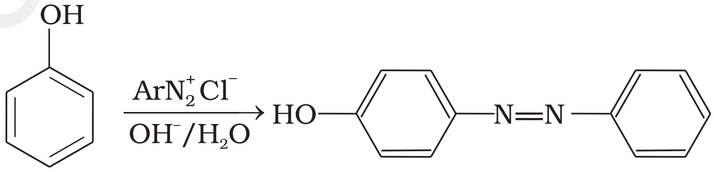
$$CH_3{-}\underset{C_2H_5}{\underset{|}{N}}H + C_6H_5{-}\overset{O}{\overset{\|}{\underset{\underset{O}{\|}}{S}}}{-}Cl \longrightarrow CH_3\underset{C_2H_5}{\underset{|}{N}}{-}SO_2C_6H_5$$

N-Ethyl-N-methyl benzene sulphonamide

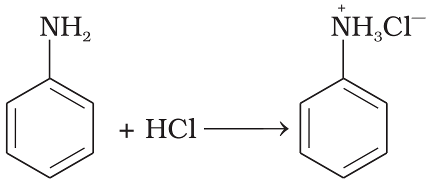
54. $RNH_2 \xrightarrow{KOH/CHCl_3} RNC \xrightarrow{H_2/Pd} RNHCH_3$

Carbylamine reaction is shown by 1° amine only which results in the replacement of two hydrogen atoms attached to nitrogen atom of NH_2 group by one carbon atom. On catalytic reduction the isocyanide will give a secondary amine with one methyl group.

55. The reaction exhibits azo-coupling of phenols. In mild alkaline conditions phenol moiety participates in the azo-coupling and para position of phenol is occupied.



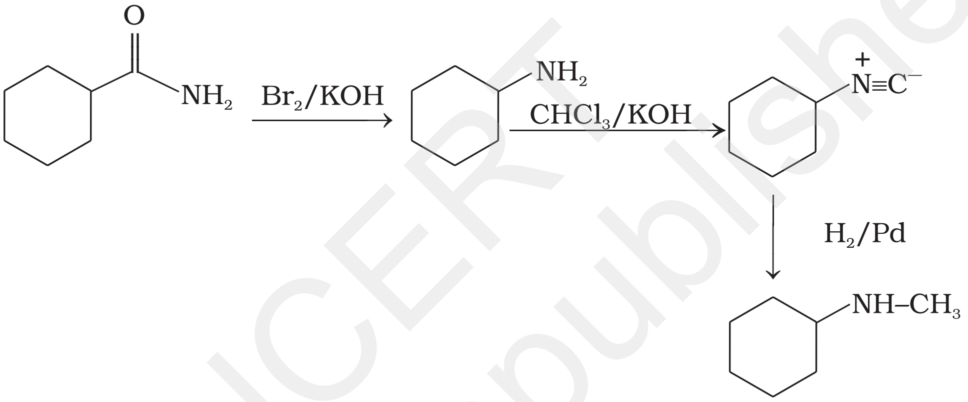
56. Aniline forms the salt anilinium chloride which is water soluble.



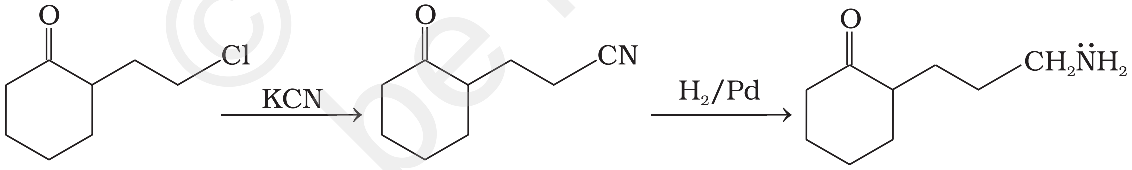
(A)
Aniline
(Colourless liquid,
sparingly soluble
in water)

(B)
Anilinium chloride
(Water soluble salt)

57.



58.

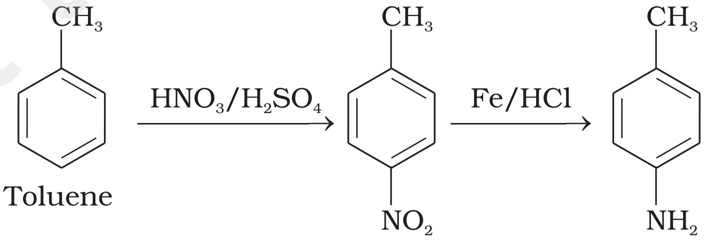


(A)

(B)

59.

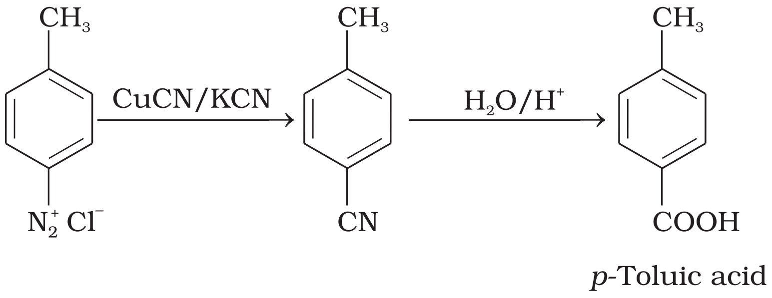
(i)



Toluene

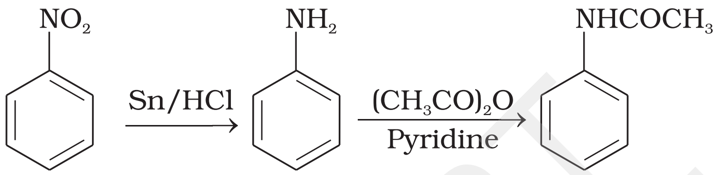
p-Toluidine

(ii)

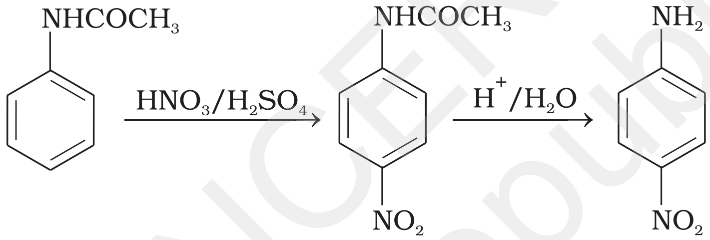


60.

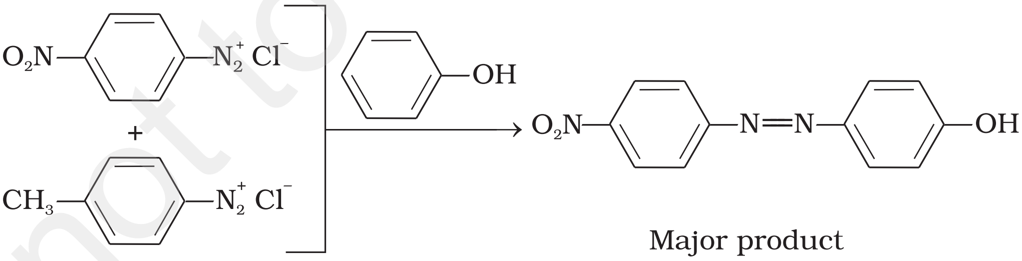
(i)



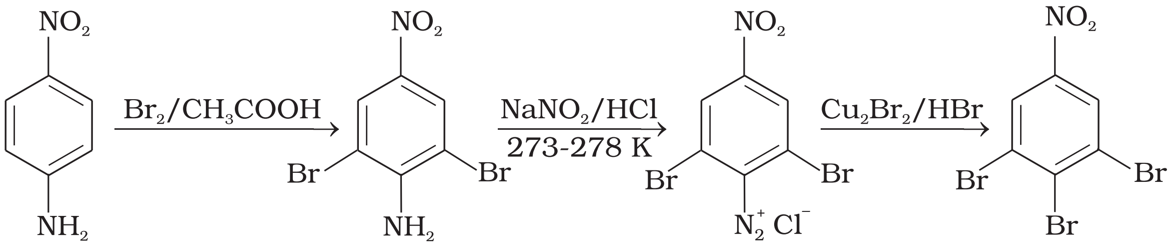
(ii)



61. This reaction is an example of electrophilic aromatic substitution. In alkaline medium, phenol generates phenoxide ion which is more electron rich than phenol and hence more reactive for electrophilic attack. The electrophile in this reaction is aryldiazonium cation. Stronger the electrophile faster is the reaction. *p*-Nitrophenyldiazonium cation is a stronger electrophile than *p*-toluene diazonium cation. Therefore, it couples preferentially with phenol.

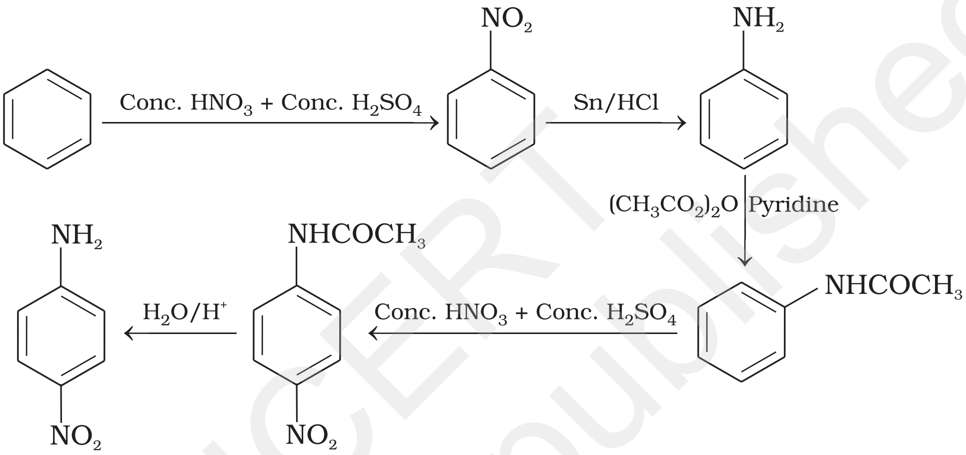


62.



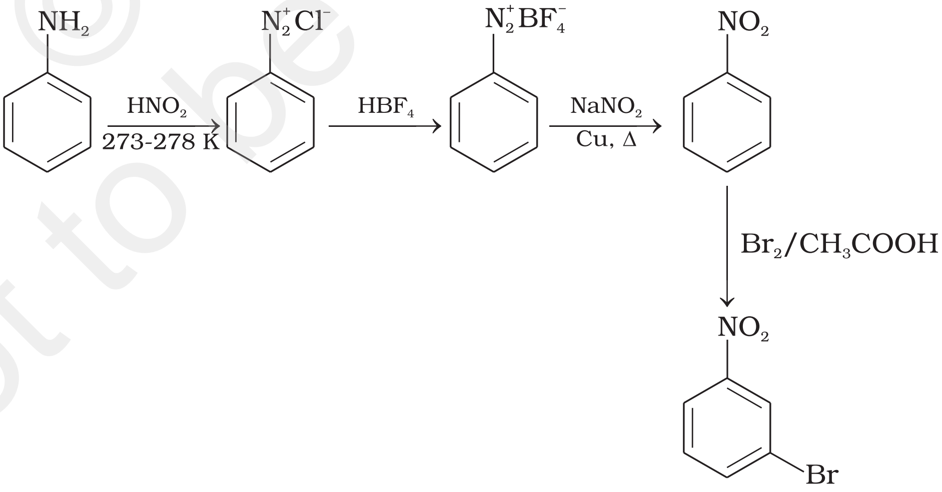
NO2
NH2
Br2/CH3COOH
NO2
Br
Br
NH2
NaNO2/HCl
273-278 K
NO2
Br
Br
N2+ Cl−
Cu2Br2/HBr
NO2
Br
Br
Br

63.



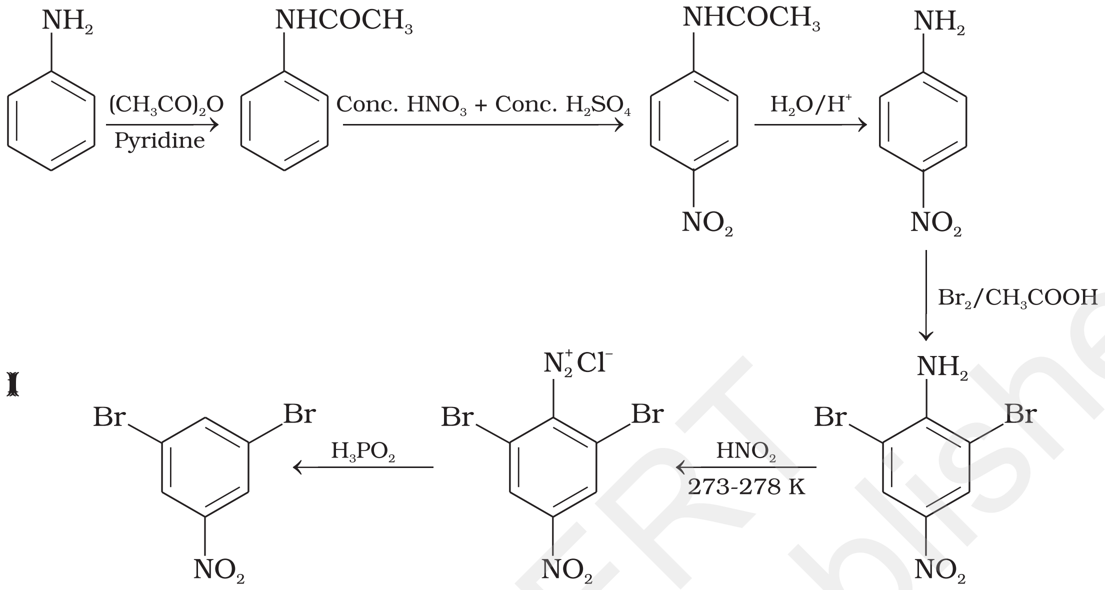
Conc. HNO3 + Conc. H2SO4
NO2
Sn/HCl
NH2
(CH3CO2)2O Pyridine
NHCOCH3
Conc. HNO3 + Conc. H2SO4
NHCOCH3
NO2
H2O/H+
NH2
NO2

64.



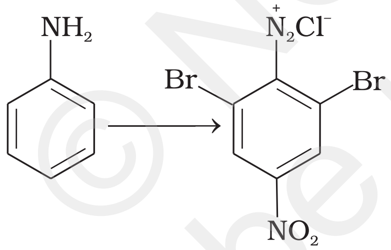
NH2
HNO2
273-278 K
N2+Cl−
HBF4
N2+BF4−
NaNO2
Cu, Δ
NO2
Br2/CH3COOH
NO2
Br

65. (i)

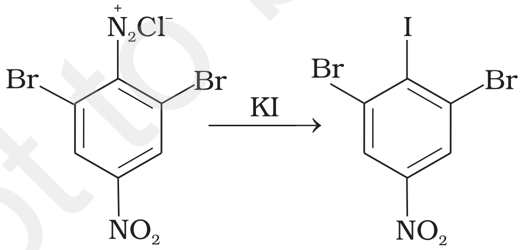


(ii) Conversion (A) given below is same as in part (i) given above after that reaction (B) can be carried out.

(A)



(B)



IV. Matching Type

66. (i) → (d) (ii) → (c) (iii) → (a) (iv) → (b)
67. (i) → (b) (ii) → (a) (iii) → (d) (iv) → (c)

V. Assertion and Reason Type

68. (iii) 69. (iii) 70. (iv) 71. (ii) 72. (iv) 73. (i) 74. (iv)

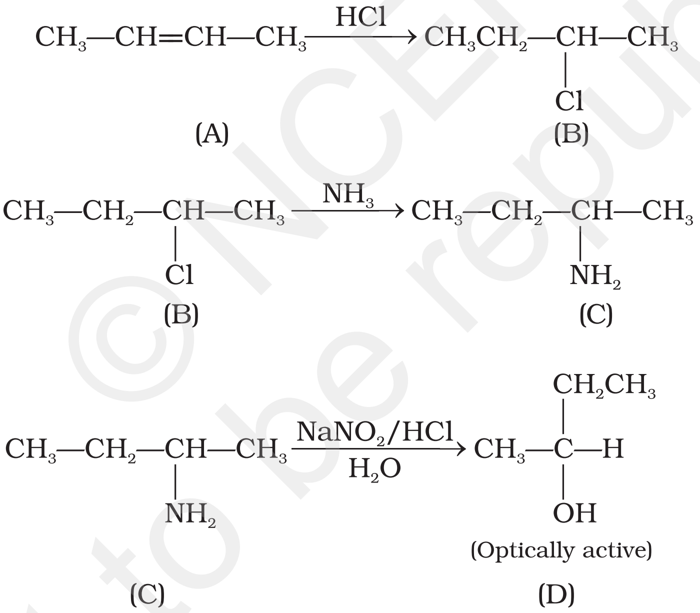
VI. Long Answer Type

75. $(A) \xrightarrow{\text{Ozonolysis}} 2CH_3CHO$

$\underset{(A)}{C_4H_8} \xrightarrow{HCl} \underset{(B)}{C_4H_9Cl}$	Addition of HCl has occurred on 'A'. This implies 'A' is an alkene.
$\underset{(B)}{C_4H_9Cl} \xrightarrow{NH_3} \underset{(C)}{C_4H_{11}N}$	Cl in compound 'B' is substituted by NH_2 to give 'C'.
$(C) \xrightarrow[H_2O]{NaNO_2/HCl} (D)$	'C' gives a diazonium salt with $NaNO_2/HCl$ that liberates N_2 to give optically active alcohol. This means that 'C' is an aliphatic amine. Number of carbon atoms in amine is same as in compound 'A'.

Since products of ozonolysis of compound 'A' are $CH_3{—}CH{=}O$ and $O{=}CH{—}CH_3$. The compound 'A' is $CH_3{—}CH{=}CH{—}CH_3$

On the basis of structure of 'A' reactions can be explained as follows :

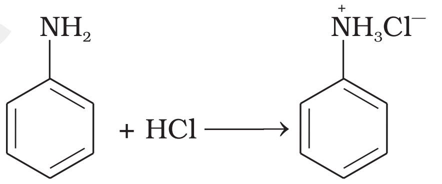


$$\underset{(A)}{CH_3{—}CH{=}CH{—}CH_3} \xrightarrow{HCl} \underset{(B)}{CH_3CH_2{—}\underset{\substack{|\\ Cl}}{CH}{—}CH_3}$$

$$\underset{(B)}{CH_3{—}CH_2{—}\underset{\substack{|\\ Cl}}{CH}{—}CH_3} \xrightarrow{NH_3} \underset{(C)}{CH_3{—}CH_2{—}\underset{\substack{|\\ NH_2}}{CH}{—}CH_3}$$

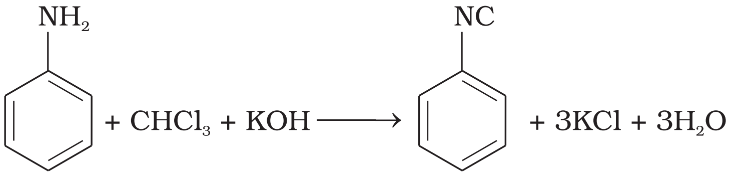
$$\underset{(C)}{CH_3{—}CH_2{—}\underset{\substack{|\\ NH_2}}{CH}{—}CH_3} \xrightarrow[H_2O]{NaNO_2/HCl} \underset{(D)}{\underset{\text{(Optically active)}}{CH_3{—}\overset{\substack{CH_2CH_3\\ |}}{\underset{\substack{|\\ OH}}{C}}{—}H}}$$

76.



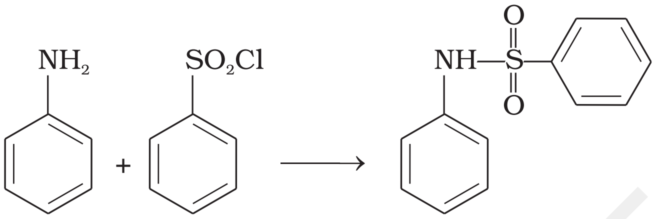
(A)
Aniline
(Colourless liquid, sparingly soluble in water)

(B)
Anilinium chloride
(Water soluble salt)



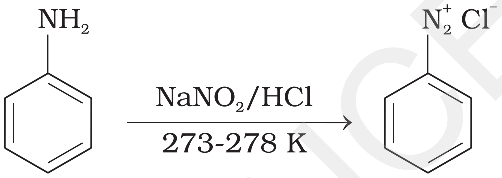
(A) (C)

Benzene isonitrile

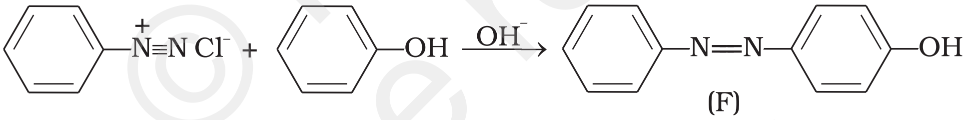


(A) (D)

N-Phenylbenzenesulphonamide
(soluble in alkali)



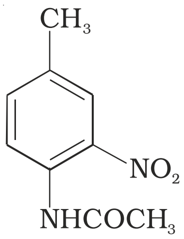
(A) (E)



(F)
Orange dye

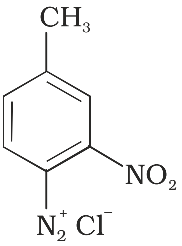
77. 1. Sn-HCl

2.



3. H_2O/H^+

4.



5. H_3PO_2/H_2O

Unit

14

BIOMOLECULES

I. Multiple Choice Questions (Type-I)

1. Glycogen is a branched chain polymer of α-D-glucose units in which chain is formed by C1—C4 glycosidic linkage whereas branching occurs by the formation of C1-C6 glycosidic linkage. Structure of glycogen is similar to __________.

(i) Amylose
(ii) Amylopectin
(iii) Cellulose
(iv) Glucose

2. Which of the following polymer is stored in the liver of animals?

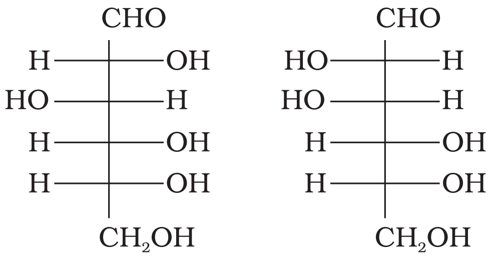
(i) Amylose
(ii) Cellulose
(iii) Amylopectin
(iv) Glycogen

3. Sucrose (cane sugar) is a disaccharide. One molecule of sucrose on hydrolysis gives _________.

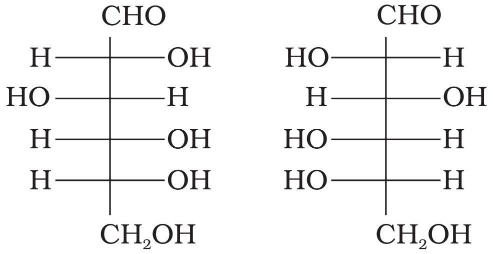
(i) 2 molecules of glucose
(ii) 2 molecules of glucose + 1 molecule of fructose
(iii) 1 molecule of glucose + 1 molecule of fructose
(iv) 2 molecules of fructose

4. Which of the following pairs represents anomers?

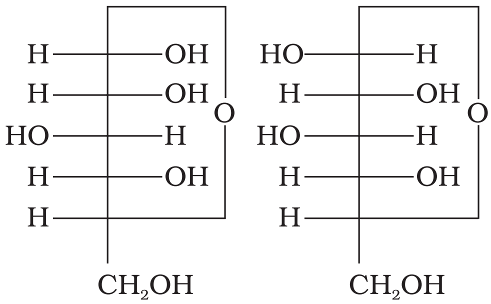
(i)



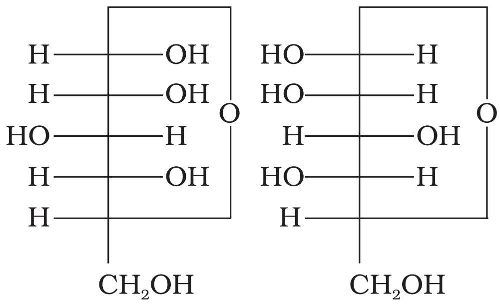
(ii)



(iii)



(iv)



5. Proteins are found to have two different types of secondary structures viz. α-helix and β-pleated sheet structure. α-helix structure of protein is stabilised by :

(i) Peptide bonds

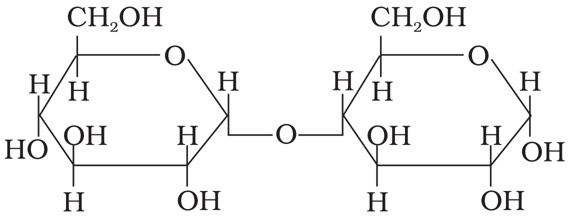
(ii) van der Waals forces

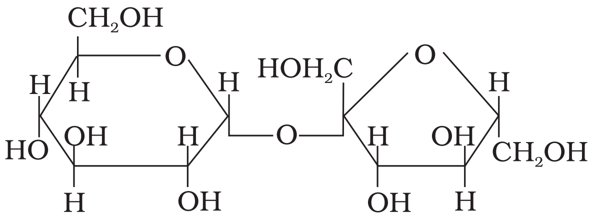
(iii) Hydrogen bonds

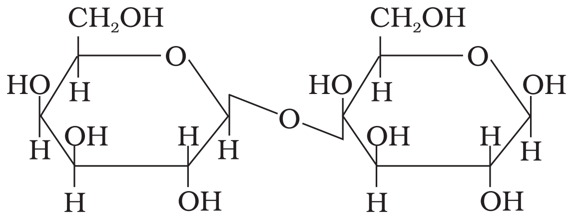
(iv) Dipole-dipole interactions

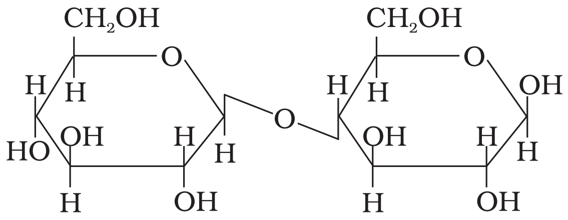
6. In disaccharides, if the reducing groups of monosaccharides i.e. aldehydic or ketonic groups are bonded, these are non-reducing sugars. Which of the following disaccharide is a non-reducing sugar?

(i)



(ii) 

(iii) 

(iv) 

7. Which of the following acids is a vitamin?

(i) Aspartic acid

(ii) Ascorbic acid

(iii) Adipic acid

(iv) Saccharic acid

8. Dinucleotide is obtained by joining two nucleotides together by phosphodiester linkage. Between which carbon atoms of pentose sugars of nucleotides are these linkages present?

(i) 5′ and 3′

(ii) 1′ and 5′

(iii) 5′ and 5′

(iv) 3′ and 3′

9. Nucleic acids are the polymers of ______________.

(i) Nucleosides

(ii) Nucleotides

(iii) Bases

(iv) Sugars

10. Which of the following statements is **not** true about glucose?

(i) It is an aldohexose.

(ii) On heating with HI it forms *n*-hexane.

(iii) It is present in furanose form.

(iv) It does not give 2,4-DNP test.

11. Each polypeptide in a protein has aminoacids linked with each other in a specific sequence. This sequence of amino acids is said to be ____________.

(i) primary structure of proteins.

(ii) secondary structure of proteins.

(iii) tertiary structure of proteins.

(iv) quaternary structure of proteins.

12. DNA and RNA contain four bases each. Which of the following bases is **not** present in RNA?

(i) Adenine

(ii) Uracil

(iii) Thymine

(iv) Cytosine

13. Which of the following B group vitamins can be stored in our body?

(i) Vitamin B_1

(ii) Vitamin B_2

(iii) Vitamin B_6

(iv) Vitamin B_{12}

14. Which of the following bases is **not** present in DNA?

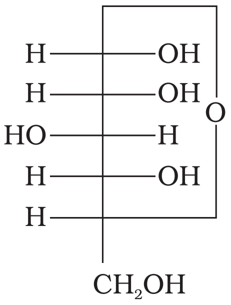
(i) Adenine

(ii) Thymine

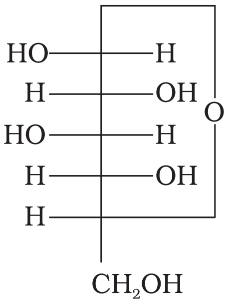
(iii) Cytosine

(iv) Uracil

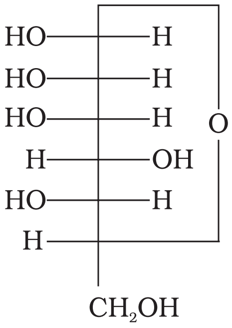
15. Three cyclic structures of monosaccharides are given below which of these are anomers.



(I)



(II)



(III)

(i) I and II

(ii) II and III

(iii) I and III

(iv) III is anomer of I and II

16. Which of the following reactions of glucose can be explained only by its cyclic structure?

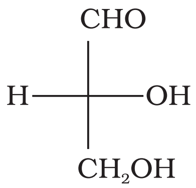
(i) Glucose forms pentaacetate.

(ii) Glucose reacts with hydroxylamine to form an oxime.

(iii) Pentaacetate of glucose does not react with hydroxylamine.

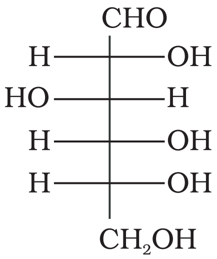
(iv) Glucose is oxidised by nitric acid to gluconic acid.

17. Optical rotations of some compounds along with their structures are given below which of them have D configuration.



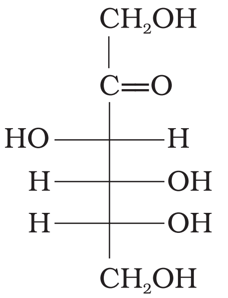
(+) rotation

(I)



(+) rotation

(II)



(–) rotation

(III)

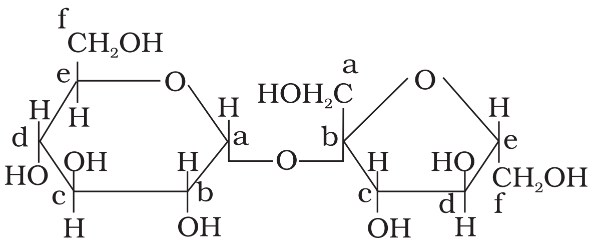
(i) I, II, III

(ii) II, III

(iii) I, II

(iv) III

18. Structure of a disaccharide formed by glucose and fructose is given below. Identify anomeric carbon atoms in monosaccharide units.



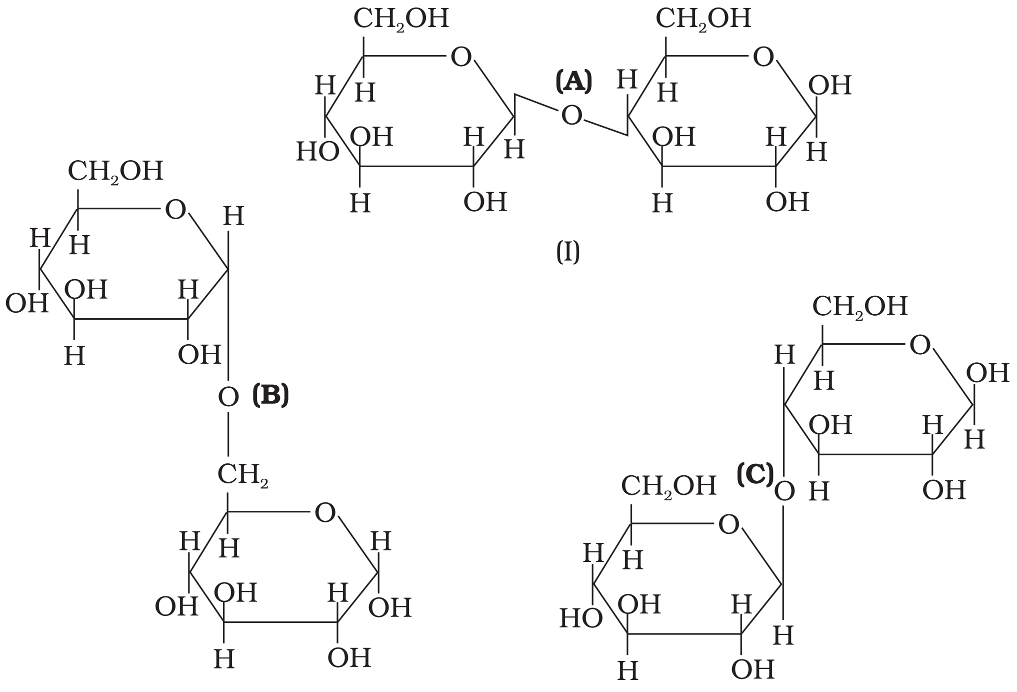
(i) 'a' carbon of glucose and 'a' carbon of fructose.

(ii) 'a' carbon of glucose and 'e' carbon of fructose.

(iii) 'a' carbon of glucose and 'b' carbon of fructose.

(iv) 'f' carbon of glucose and 'f' carbon of fructose.

19. Three structures are given below in which two glucose units are linked. Which of these linkages between glucose units are between C1 and C4 and which linkages are between C1 and C6?



(I)

(II)

(III)

(i) (A) is between C1 and C4, (B) and (C) are between C1 and C6

(ii) (A) and (B) are between C1 and C4, (C) is between C1 and C6

(iii) (A) and (C) are between C1 and C4, (B) is between C1 and C6

(iv) (A) and (C) are between C1 and C6, (B) is between C1 and C4

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

20. Carbohydrates are classified on the basis of their behaviour on hydrolysis and also as reducing or non-reducing sugar. Sucrose is a __________.

(i) monosaccharide

(ii) disaccharide

(iii) reducing sugar

(iv) non-reducing sugar

21. Proteins can be classified into two types on the basis of their molecular shape i.e., fibrous proteins and globular proteins. Examples of globular proteins are :

(i) Insulin

(ii) Keratin

(iii) Albumin

(iv) Myosin

22. Which of the following carbohydrates are branched polymer of glucose?

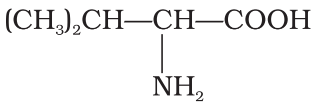
(i) Amylose

(ii) Amylopectin

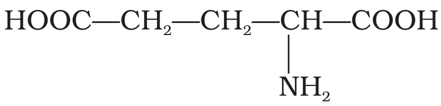
(iii) Cellulose

(iv) Glycogen

23. Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino and carboxyl groups in their molecule. Which of the following are acidic?

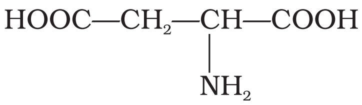
(i) 

$(CH_3)_2CH-\underset{\underset{NH_2}{|}}{CH}-COOH$

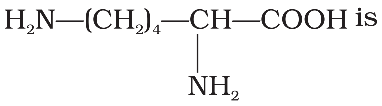
(ii) 

$HOOC-CH_2-CH_2-\underset{\underset{NH_2}{|}}{CH}-COOH$

(iii) $H_2N-CH_2-CH_2-CH_2-COOH$

(iv) 

$HOOC-CH_2-\underset{\underset{NH_2}{|}}{CH}-COOH$

24. Lysine,  is _______________.

$H_2N-(CH_2)_4-\underset{\underset{NH_2}{|}}{CH}-COOH$

(i) α-Amino acid

(ii) Basic amino acid

(iii) Amino acid synthesised in body

(iv) β-Amino acid

25. Which of the following monosaccharides are present as five membered cyclic structure (furanose structure)?

(i) Ribose

(ii) Glucose

(iii) Fructose

(iv) Galactose

26. In fibrous proteins, polypeptide chains are held together by ___________.

(i) van der Waals forces

(ii) disulphide linkage

(iii) electrostatic forces of attraction

(iv) hydrogen bonds

27. Which of the following are purine bases?

(i) Guanine

(ii) Adenine

(iii) Thymine

(iv) Uracil

28. Which of the following terms are correct about enzyme?

(i) Proteins

(ii) Dinucleotides

(iii) Nucleic acids

(iv) Biocatalysts

III. Short Answer Type

29. Name the sugar present in milk. How many monosaccharide units are present in it? What are such oligosaccharides called?

30. How do you explain the presence of all the six carbon atoms in glucose in a straight chain?

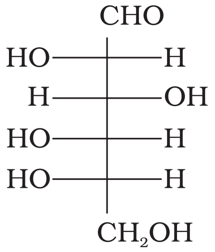
31. In nucleoside a base is attached at $1'$ position of sugar moiety. Nucleotide is formed by linking of phosphoric acid unit to the sugar unit of nucleoside. At which position of sugar unit is the phosphoric acid linked in a nucleoside to give a nucleotide?

32. Name the linkage connecting monosaccharide units in polysaccharides.

33. Under what conditions glucose is converted to gluconic and saccharic acid?

34. Monosaccharides contain carbonyl group hence are classified, as aldose or ketose. The number of carbon atoms present in the monosaccharide molecule are also considered for classification. In which class of monosaccharide will you place fructose?

35. The letters 'D' or 'L' before the name of a stereoisomer of a compound indicate the correlation of configuration of that particular stereoisomer. This refers to their relation with one of the isomers of glyceraldehyde. Predict whether the following compound has 'D' or 'L' configuration.



36. Aldopentoses named as ribose and 2-deoxyribose are found in nucleic acids. What is their relative configuration?

37. Which sugar is called invert sugar? Why is it called so?

38. Amino acids can be classified as α-, β-, γ-, δ- and so on depending upon the relative position of amino group with respect to carboxyl group. Which type of amino acids form polypetide chain in proteins?

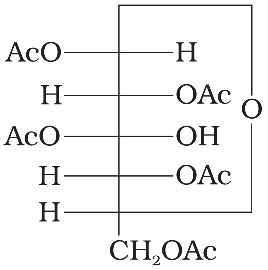
39. α-Helix is a secondary structure of proteins formed by twisting of polypeptide chain into right handed screw like structures. Which type of interactions are responsible for making the α-helix structure stable?

40. Some enzymes are named after the reaction, where they are used. What name is given to the class of enzymes which catalyse the oxidation of one substrate with simultaneous reduction of another substrate.

41. During curdling of milk, what happens to sugar present in it?

42. How do you explain the presence of five —OH groups in glucose molecule?

43. Why does compound (A) given below not form an oxime?



(A)

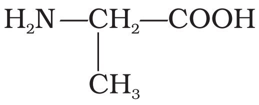
44. Why must vitamin C be supplied regularly in diet?

45. Sucrose is dextrorotatory but the mixture obtained after hydrolysis is laevorotatory. Explain.

46. Amino acids behave like salts rather than simple amines or carboxylic acids. Explain.

47. Structures of glycine and alanine are given below. Show the peptide linkage in glycylalanine.

$H_2N—CH_2—COOH$;



$$\begin{array}{c} H_2N—CH_2—COOH \\ | \\ CH_3 \end{array}$$

(Glycine) (Alanine)

48. Protein found in a biological system with a unique three-dimensional structure and biological activity is called a native protein. When a protein in its native form, is subjected to a physical change like change in temperature or a chemical change like, change in pH, denaturation of protein takes place. Explain the cause.

49. Activation energy for the acid catalysed hydrolysis of sucrose is 6.22 kJ mol^{-1}, while the activation energy is only 2.15 kJ mol^{-1} when hydrolysis is catalysed by the enzyme sucrase. Explain.

50. How do you explain the presence of an aldehydic group in a glucose molecule?

51. Which moieties of nucleosides are involved in the formation of phosphodiester linkages present in dinucleotides? What does the word diester in the name of linkage indicate? Which acid is involved in the formation of this linkage?

52. What are glycosidic linkages? In which type of biomolecules are they present?

53. Which monosaccharide units are present in starch, cellulose and glucose and which linkages link these units?

54. How do enzymes help a substrate to be attacked by the reagent effectively?

55. Describe the term D- and L- configuration used for amino acids with examples.

56. How will you distinguish 1° and 2° hydroxyl groups present in glucose? Explain with reactions.

57. Coagulation of egg white on boiling is an example of denaturation of protein. Explain it in terms of structural changes.

IV. Matching Type

Note : Match the items of Column I and Column II in the following questions. More than one option in Column II may match with the items given in Column I.

58. Match the vitamins given in Column I with the deficiency disease they cause given in Column II.

Column I (Vitamins)	**Column II (Diseases)**
(i) Vitamin A	(a) Pernicious anaemia
(ii) Vitamin B_1	(b) Increased blood clotting time
(iii) Vitamin B_{12}	(c) Xerophthalmia
(iv) Vitamin C	(d) Rickets
(v) Vitamin D	(e) Muscular weakness
(vi) Vitamin E	(f) Night blindness
(vii) Vitamin K	(g) Beri Beri
	(h) Bleeding gums
	(i) Osteomalacia

59. Match the following enzyms given in Column I with the reactions they catalyse given in Column II.

Column I (Enzymes)		**Column II (Reactions)**	
(i)	Invertase	(a)	Decomposition of urea into NH_3 and CO_2
(ii)	Maltase	(b)	Conversion of glucose into ethyl alcohol
(iii)	Pepsin	(c)	Hydrolysis of maltose into glucose
(iv)	Urease	(d)	Hydrolysis of cane sugar
(v)	Zymase	(e)	Hydrolysis of proteins into peptides

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statements and reason explains the assertion.

(ii) Both assertion and reason are wrong statements.

(iii) Assertion is correct statement and reason is wrong statement.

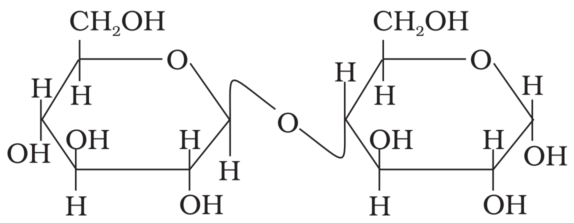
(iv) Assertion is wrong statement and reason is correct statement.

(v) Assertion and reason both are correct statements but reason does not explain assertion.

60. Assertion : D (+) – Glucose is dextrorotatory in nature.
Reason : ‘D’ represents its dextrorotatory nature.

61. Assertion : Vitamin D can be stored in our body.
Reason : Vitamin D is fat soluble vitamin.

62. Assertion : β-glycosidic linkage is present in maltose,



Reason : Maltose is composed of two glucose units in which C–1 of one glucose unit is linked to C–4 of another glucose unit.

63. **Assertion** : All naturally occurring α-aminoacids except glycine are optically active.

Reason : Most naturally occurring amino acids have L-configuration.

64. **Assertion** : Deoxyribose, $C_5H_{10}O_4$ is not a carbohydrate.

Reason : Carbohydrates are hydrates of carbon so compounds which follow $C_x(H_2O)_y$ formula are carbohydrates.

65. **Assertion** : Glycine must be taken through diet.

Reason : It is an essential amino acid.

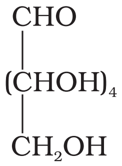
66. **Assertion** : In presence of enzyme, substrate molecule can be attacked by the reagent effectively.

Reason : Active sites of enzymes hold the substrate molecule in a suitable position.

VI. Long Answer Type

67. Write the reactions of D-glucose which can't be explained by its open-chain structure. How can cyclic structure of glucose explain these reactions?

68. On the basis of which evidences D-glucose was assigned the following structure?



$$\begin{array}{l} \mathrm{CHO} \\ | \\ \mathrm{(CHOH)_4} \\ | \\ \mathrm{CH_2OH} \end{array}$$

69. Carbohydrates are essential for life in both plants and animals. Name the carbohydrates that are used as storage molecules in plants and animals, also name the carbohydrate which is present in wood or in the fibre of cotton cloth.

70. Explain the terms primary and secondary structure of proteins. What is the difference between α-helix and β-pleated sheet structure of proteins?

71. Write the structures of fragments produced on complete hydrolysis of DNA. How are they linked in DNA molecule? Draw a diagram to show pairing of nucleotide bases in double helix of DNA.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (ii) 2. (iv) 3. (iii)

4. (iii), **Hint :** Cyclic hemiacetal forms of monosaccharide which differ only in the configuration of the hydroxyl group at C1 are anomers.

5. (iii), **Hint :** In α-helix, hydrogen bonds are present between –NH group of one amino acid residue to the >C═O group of another aminoacid residue.

6. (ii) 7. (ii) 8. (i) 9. (ii) 10. (iii) 11. (i)

12. (iii) 13. (iv) 14. (iv) 15. (i) 16. (iii) 17. (i)

18. (iii) 19. (iii)

II. Multiple Choice Questions (Type-II)

20. (ii), (iv) 21. (i), (iii) 22. (ii), (iv) 23. (ii), (iv)

24. (i), (ii) 25. (i), (iii) 26. (ii), (iv) 27. (i), (ii) 28. (i), (iv)

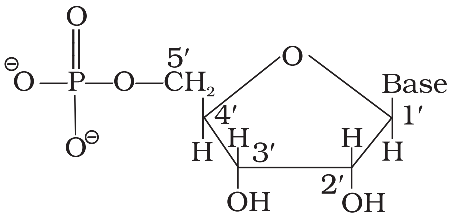
III. Short Answer Type

29. Lactose, two monosaccharide units are present. Such oligosaccharides are called disaccharides.

30. On prolonged heating with HI, glucose gives *n*-hexane.

$$\text{Glucose} \xrightarrow[\Delta]{\text{HI}} \underset{(n\text{-Hexane})}{CH_3—CH_2—CH_2—CH_2—CH_2—CH_3}$$

31. Phosphoric acid is linked at 5′-position of sugar moiety of nucleoside to give a nucleotide.



(Nucleotide)

32. Glycosidic linkage.

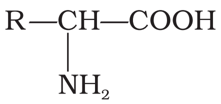
33. Glucose is converted to gluconic acid by bromine water and to saccharic acid by conc. HNO_3.

34. Fructose is a ketohexose.

35. ‘L’ configuration

36. ‘D’ configuration

37. Sucrose, see page no. 409 of NCERT textbook for the explanation.

38. α-amino acids, 

$$R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-COOH$$

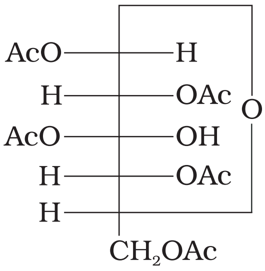
39. In α-helix,a polypeptide chain is stabilised by the formation of hydrogen bonds between —NH— group of amino acids in one turn with the >C= O groups of amino acids belonging to adjacent turn.

40. Oxidoreductase

41. Lactic acid.

42. Glucose gives pentaacetate derivative on acetylation with acetic anhydride. This confirms the presence of five —OH groups.

43. Glucose pentaacetate (structure A) doesn't have a free —OH group at C1 and so can't be converted to the open chain form to give —CHO group and hence doesn't form the oxime.

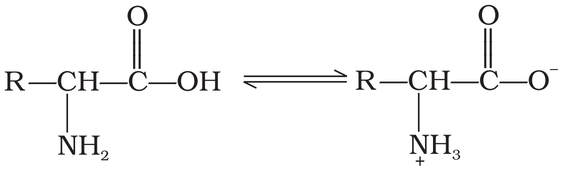


(Structure A)

44. Vitamin C is water soluble therefore it is readily excreted in urine and can't be stored in our body.

45. On hydrolysis sucrose (dextrorotatory), gives glucose (dextrorotatory, + 52.5°) and fructose (laevorotatory, – 92.4°). Since laevorotation of fructose is more than the dextrorotation of glucose, the mixture is laevorotatory.

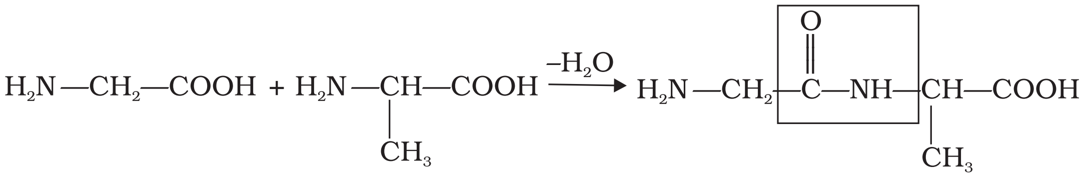
46. In aqueous solution, the carboxyl group loses a proton and amino group accepts a proton to form a zwitter ion.



$$R-\underset{\displaystyle NH_2}{\underset{|}{CH}}-\overset{\displaystyle O}{\overset{\|}{C}}-OH \rightleftharpoons R-\underset{\displaystyle \overset{+}{N}H_3}{\underset{|}{CH}}-\overset{\displaystyle O}{\overset{\|}{C}}-O^-$$

(Zwitter ion)

47. In glycylalanine, carboxyl group of glycine combines with the amino group of alanine.



$$H_2N-CH_2-COOH + H_2N-\underset{\displaystyle CH_3}{\underset{|}{CH}}-COOH \xrightarrow{-H_2O} H_2N-CH_2-\boxed{\overset{\displaystyle O}{\overset{\|}{C}}-NH}-\underset{\displaystyle CH_3}{\underset{|}{CH}}-COOH$$

(Glycine) (Alanine) (Glycylalanine)

48. Due to physical or chemical change, hydrogen bonds in proteins are disturbed, globules unfold and helix gets uncoiled therefore protein loses its biological activity. This is called denaturation of proteins.

49. Enzymes, the biocatalysts, reduce the magnitude of activation energy by providing alternative path. In the hydrolysis of sucrose the enzyme sucrase reduces the activation energy from 6.22 kJ mol^{-1} to 2.15 kJ mol^{-1}.

50. Glucose reacts with hydroxylamine to form a monoxime and adds one molecule of hydrogen cyanide to give cyanohydrin so it contains a carbonyl group which can be an aldehyde or a ketone. On mild oxidation with bromine water, glucose gives gluconic acid which is a six carbon carboxylic acid. This indicates that carbonyl group present in glucose is an aldehydic group.

51. See page no. 420 of NCERT textbook.

52. See page no. 409 of NCERT textbook.

53. In starch and glycogen, glycosidic α-linkage is present and in cellulose, glycosidic β-linkage is present between glucose units.

54. Active site of enzymes hold the substrate molecule in a suitable position, so that it can be attacked by the reagent effectively.

55. See the NCERT textbook for Class XII.

56. For answer see page no. 406 of NCERT textbook for Class XII.

57. For answer see page no. 416-417 of NCERT textbook for Class XII.

IV. Matching Type

58. (i) → (c), (f) (ii) → (g) (iii) → (a) (iv) → (h) (v) → (d), (i)
(vi) → (e), (vii) → (b)

59. (i) → (d) (ii) → (c) (iii) → (e) (iv) → (a) (v) → (b)

V. Assertion and Reason Type

60. (iii) 61. (i) 62. (iv) 63. (v) 64. (ii) 65. (ii) 66. (i)

VI. Long Answer Type

67. See NCERT textbook for Class XII.

68. See NCERT textbook for Class XII.

69. **Hint :** Carbohydrate used as storage molecule in plants is starch and in animals, it is glycogen. Cellulose is present in wood or in the fibre of cotton cloth.

70. See NCERT textbook for Class XII.

71. See NCERT textbook for Class XII.

Unit 15

POLYMERS

I. Multiple Choice Questions (Type-I)

1. Which of the following polymers of glucose is stored by animals?

(i) Cellulose
(ii) Amylose
(iii) Amylopectin
(iv) Glycogen

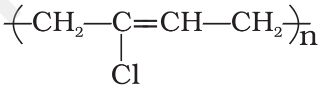
2. Which of the following is **not** a semisynthetic polymer?

(i) *cis*-polyisoprene
(ii) Cellulose nitrate
(iii) Cellulose acetate
(iv) Vulcanised rubber

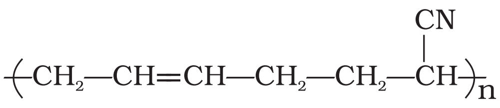
3. The commercial name of polyacrylonitrile is ______________.

(i) Dacron
(ii) Orlon (acrilan)
(iii) PVC
(iv) Bakelite

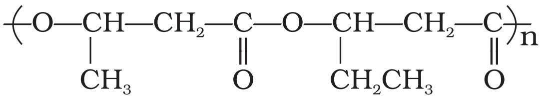
4. Which of the following polymer is biodegradable?

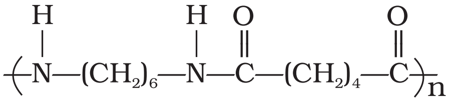
(i) 

$\left(CH_2-\underset{Cl}{\underset{|}{C}}=CH-CH_2 \right)_n$

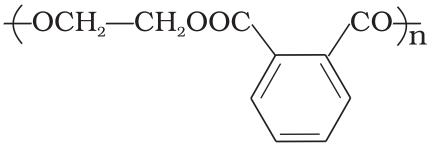
(ii) 

$\left(CH_2-CH=CH-CH_2-CH_2-\overset{CN}{\overset{|}{CH}} \right)_n$

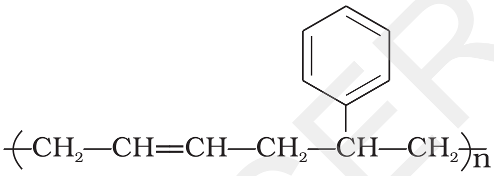
(iii) 
$\left(-O-\underset{CH_3}{\underset{|}{CH}}-CH_2-\underset{O}{\underset{\|}{C}}-O-\underset{CH_2CH_3}{\underset{|}{CH}}-CH_2-\underset{O}{\underset{\|}{C}}-\right)_n$

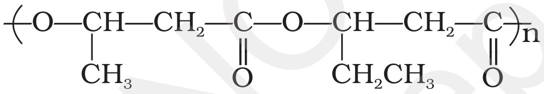
(iv) 
$\left(-\overset{H}{\overset{|}{N}}-(CH_2)_6-\overset{H}{\overset{|}{N}}-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-\right)_n$

5. In which of the following polymers ethylene glycol is one of the monomer units?

(i) 

(ii) $\left(-CH_2-CH_2-\right)_n$

(iii) 

(iv) 
$\left(-O-\underset{CH_3}{\underset{|}{CH}}-CH_2-\underset{O}{\underset{\|}{C}}-O-\underset{CH_2CH_3}{\underset{|}{CH}}-CH_2-\underset{O}{\underset{\|}{C}}-\right)_n$

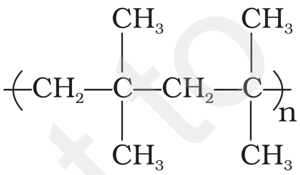
6. Which of the following statements is **not** true about low density polythene?

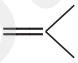
(i) Tough

(ii) Hard

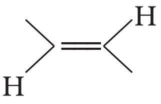
(iii) Poor conductor of electricity

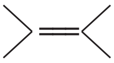
(iv) Highly branched structure

7. 
$\left(-CH_2-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-CH_2-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-\right)_n$ is a polymer having monomer units ____________.

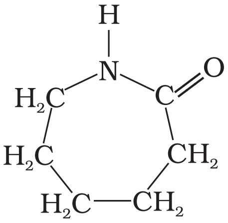
(i) 

(ii) 

(iii) 

(iv) 

8. Which of the following polymer can be formed by using the following monomer unit?



(i) Nylon 6, 6
(ii) Nylon 2–nylon 6
(iii) Melamine polymer
(iv) Nylon-6

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

9. Which of the following polymers, need atleast one diene monomer for their preparation?

(i) Dacron
(ii) Buna-S
(iii) Neoprene
(iv) Novolac

10. Which of the folloiwng are characteristics of thermosetting polymers?

(i) Heavily branched cross linked polymers.
(ii) Linear slightly branched long chain molecules.
(iii) Become infusible on moulding so cannot be reused.
(iv) Soften on heating and harden on cooling, can be reused.

11. Which of the following polymers are thermoplastic?

(i) Teflon
(ii) Natural rubber
(iii) Neoprene
(iv) Polystyrene

12. Which of the following polymers are used as fibre?

(i) Polytetrafluoroethane
(ii) Polychloroprene
(iii) Nylon
(iv) Terylene

13. Which of the following are addition polymers?

(i) Nylon

(ii) Melamine formaldehyde resin

(iii) Orlon

(iv) Polystyrene

14. Which of the following polymers are condensation polymers?

(i) Bakelite

(ii) Teflon

(iii) Butyl rubber

(iv) Melamine formaldehyde resin

15. Which of the following monomers form biodegradable polymers?

(i) 3-hydroxybutanoic acid + 3-hydroxypentanoic acid

(ii) Glycine + amino caproic acid

(iii) Ethylene glycol + phthalic acid

(iv) Caprolactum

16. Which of the following are example of synthetic rubber?

(i) Polychloroprene

(ii) Polyacrylonitrile

(iii) Buna-N

(iv) *cis*-polyisoprene

17. Which of the following polymers can have strong intermolecular forces?

(i) Nylon

(ii) Polystyrene

(iii) Rubber

(iv) Polyesters

18. Which of the following polymers have vinylic monomer units?

(i) Acrilan

(ii) Polystyrene

(iii) Nylon

(iv) Teflon

19. Vulcanisation makes rubber ______________.

(i) more elastic

(ii) soluble in inorganic solvent

(iii) crystalline

(iv) more stiff

III. Short Answer Type

20. A natural linear polymer of 2-methyl-1, 3-butadiene becomes hard on treatment with sulphur between 373 to 415 K and —S—S— bonds are formed between chains. Write the structure of the product of this treatment?

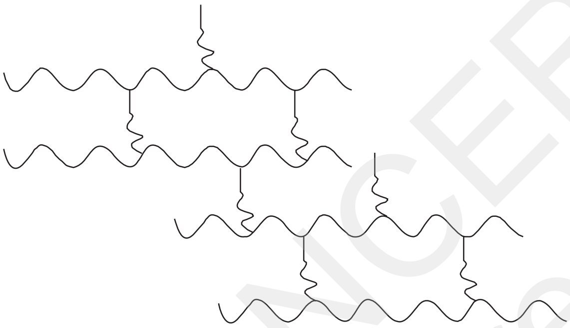
21. Identify the type of polymer.
—A—A—A—A—A—A—

22. Identify the type of polymer.
—A—B—B—A—A—A—B—A—

23. Out of chain growth polymerisation and step growth polymerisation, in which type will you place the following.

$$\left(A \right)_m + \left(A \right)_n \longrightarrow \left(A \right)_m \left(A \right)_n \text{ or } \left(A - A \right)_{m+n}$$

24. Identify the type of polymer given in the following figure.



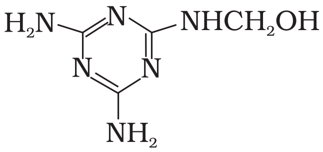
25. Identify the polymer given below :

26. Why are rubbers called elastomers?

27. Can enzyme be called a polymer?

28. Can nucleic acids, proteins and starch be considered as step growth polymers?

29. How is the following resin intermediate prepared and which polymer is formed by this monomer unit?



(Resin intermediate)

30. To have practical applications why are cross links required in rubber?

31. Why does *cis*-polyisoprene possess elastic property?

32. What is the structural difference between HDP and LDP? How does the structure account for different behaviour and nature, hence the use of a polymer?

33. What is the role of benzoyl peroxide in addition polymerisation of alkenes? Explain its mode of action with the help of an example.

34. Which factor imparts crystalline nature to a polymer like nylon?

35. Name the polymers used in laminated sheets and give the name of monomeric units involved in its formation.

36. Which type of biomolecules have some structural similarity with synthetic polyamides? What is this similarity?

37. Why should the monomers used in addition polymerisation through free radical pathway be very pure?

IV. Matching Type

Note : Match the items of Column I with the items in Column II.

38. Match the polymer of column I with correct monomer of column II.

	Column I		Column II
(i)	High density polythene	(a)	Isoprene
(ii)	Neoprene	(b)	Tetrafluoroethene
(iii)	Natural rubber	(c)	Chloroprene
(iv)	Teflon	(d)	Acrylonitrile
(v)	Acrilan	(e)	Ethene

39. Match the polymers given in Column I with their chemical names given in Column II.

	Column I		Column II
(i)	Nylon 6	(a)	Polyvinyl chloride
(ii)	PVC	(b)	Polyacrylonitrile
(iii)	Acrilan	(c)	Polycaprolactum
(iv)	Natural rubber	(d)	Low density polythene
(v)	LDP	(e)	*cis*-polyisoprene

40. Match the polymers given in Column I with their commercial names given in Column II.

	Column I		Column II
(i)	Polyester of glycol and phthalic acid	(a)	Novolac
(ii)	Copolymer of 1, 3-butadiene and styrene	(b)	Glyptal
(iii)	Phenol and formaldehyde resin	(c)	Buna-S

(iv)	Polyester of glycol and terephthalic acid	(d)	Buna-N
(v)	Copolymer of 1, 3-butadiene and acrylonitrile	(e)	Dacron

41. Match the polymers given in Column I with their main applications given in Column II.

	Column I		Column II
(i)	Bakelite	(a)	Unbreakable crockery
(ii)	Low density polythene	(b)	Non-stick cookwares
(iii)	Melamine-formaldehyde resin	(c)	Packaging material for shock absorbance
(iv)	Nylon 6	(d)	Electrical switches
(v)	Polytetrafluoroethane	(e)	Squeeze bottles
(vi)	Polystyrene	(f)	Tyre, cords

42. Match the polymers given in Column I with the preferred mode of polymerisation followed by their monomers.

	Column I		Column II
(i)	Nylon-6,6	(a)	Free radical polymerisation
(ii)	PVC	(b)	Ziegler-Natta polymerisation or coordination polymerisation
(iii)	HDP	(c)	Anionic polymerisation
		(d)	Condensation polymerisation

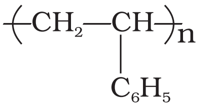
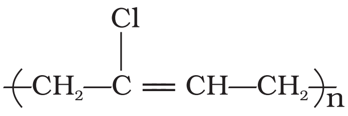
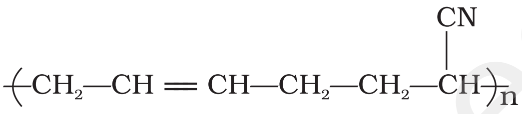
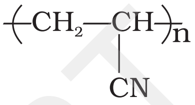
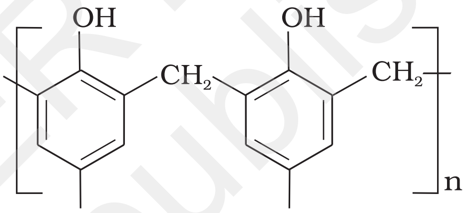
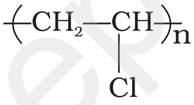
43. Match the polymers given in Column I with the type of linkage present in them given in Column II.

	Column I		Column II
(i)	Terylene	(a)	Glycosidic linkage
(ii)	Nylon	(b)	Ester linkage
(iii)	Cellulose	(c)	Phosphodiester linkage
(iv)	Protein	(d)	Amide linkage
(v)	RNA		

44. Match materials given in Column I with the polymers given in Column II.

	Column I		Column II
(i)	Natural rubber latex	(a)	Nylon
(ii)	Wood laminates	(b)	Neoprene
(iii)	Ropes and fibres	(c)	Dacron
(iv)	Polyester fabric	(d)	Melamine formaldehyde resins
(v)	Synthetic rubber	(e)	Urea-formaldehyde resins
(vi)	Unbreakable crockery	(f)	cis-polyisoprene

45. Match the polymers given in Column I with their repeating units given in Column II.

Column I	**Column II**
(i) Acrilan	(a)  $\left(CH_2-\underset{C_6H_5}{\underset{\vert}{CH}}\right)_n$
(ii) Polystyrene	(b)  $\left(CH_2-\overset{Cl}{\overset{\vert}{C}}=CH-CH_2\right)_n$
(iii) Neoprene	(c)  $\left(CH_2-CH=CH-CH_2-CH_2-\overset{CN}{\overset{\vert}{CH}}\right)_n$
(iv) Novolac	(d)  $\left(CH_2-\underset{CN}{\underset{\vert}{CH}}\right)_n$
(v) Buna—N	(e) 
	(f)  $\left(CH_2-\underset{Cl}{\underset{\vert}{CH}}\right)_n$

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statement but reason does not explain assertion.

(ii) Assertion and reason both are correct statements and reason explains the assertion.

(iii) Both assertion and reason are wrong statement.

(iv) Assertion is correct statement and reason is wrong statement.

(v) Assertion is wrong statement and reason is correct statement.

46. Assertion : Rayon is a semi synthetic polymer and is taken as a better choice than cotton fabric.

Reason : Mechanical and aesthetic properties of cellulose can be improved by acetylation.

47. **Assertion** : Most of the Synthetic polymers are not biodegradable.
Reason : Polymerisation process induces toxic character in organic molecules.

48. **Assertion** : Olefinic monomers undergo addition polymerisation.
Reason : Polymerisation of vinylchloride is initiated by peroxides/ persulphates.

49. **Assertion** : Polyamides are best used as fibres because of high tensile strength.
Reason : Strong intermolecular forces (like hydrogen bonding within polyamides) lead to close packing of chains and increase the crystalline character, hence, provide high tensile strength to polymers.

50. **Assertion** : For making rubber synthetically, isoprene molecules are polymerised.
Reason : Neoprene (a polymer of chloroprene) is a synthetic rubber.

51. **Assertion** : Network polymers are thermosetting.
Reason : Network polymers have high molecular mass.

52. **Assertion** : Polytetrafluoroethene is used in making non-stick cookwares.
Reason : Fluorine has highest electronegativity.

VI. Long Answer Type

53. Synthetic polymers do not degrade in the environment for a long time. How can biodegradable synthetic polymers be made. Differentiate between biopolymers and biodegradable polymers and give examples of each type.

54. Differentiate between rubbers and plastics on the basis of intermolecular forces.

55. Phenol and formaldehyde undergo condensation to give a polymar (A) which on heating with formaldehyde gives a thermosetting polymer (B). Name the polymers. Write the reactions involved in the formation of (A). What is the structural difference between two polymers?

56. Low density polythene and high density polythene, both are polymers of ethene but there is marked difference in their properties. Explain.

57. Which of the following polymers soften on heating and harden on cooling? What are the polymers with this property collectively called? What are the structural similarities between such polymers? Bakelite, urea-formaldehyde resin, polythene, polyvinyls, polystyrene.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iv)	2. (i)	3. (ii)	4. (iv)	5. (i)	6. (iii)
7. (i)	8. (iv)				

II. Multiple Choice Questions (Type-II)

9. (ii), (iii)	10. (i), (iii)	11. (i), (iv)	12. (iii), (iv)
13. (iii), (iv)	14. (i), (iv)	15. (i), (ii)	16. (i), (iii)
17. (i), (iv)	18. (i), (ii), (iv)	19. (i), (iv)	

III. Short Answer Type

20. Vulcanised rubber. For structure see Class XII NCERT textbook.

21. Homopolymer

22. Copolymer

23. Chain growth polymerisation

24. Cross-linked polymer

25. Polyisoprene/Natural rubber

26. Rubbers are stretched on application of force and regain original state after the force is removed. Therefore these are called elastomers.

27. Enzymes are biocatalysts which are proteins and are thus polymers.

28. [**Hint :** Yes, step growth polymers are condensation polymers and they are formed by the loss of simple molecule like water leading to the formation of high molecular mass polymers.]

29. Melamine and formaldehyde are starting materials for this intermediate. Its polymerisation gives melamine polymer.

30. Cross links bind the planar polymer sheets thus increasing its elastomeric properties.

31. See Class XII, NCERT text book, page no.434.

32. See Class-XII NCERT textbook, page no. 429-30.

33. See Class-XII NCERT textbook, page no. 428.

34. Strong intermolecular forces like hydrogen-bonding, lead to close packing of chains that imparts crystalline character.

35. Urea formaldehyde resins. Monomer units are urea and formaldehyde.

36. Proteins. Polyamides and proteins both contain amide linkage.

37. Pure monomers are required because even the traces of impurities may act like inhibitors which leads to the formation of polymers with shorter chain length.

IV. Matching Type

38. (i) → (e) (ii) → (c) (iii) → (a) (iv) → (b) (v) → (d)

39. (i) → (c) (ii) → (a) (iii) → (b) (iv) → (e) (v) → (d)

40. (i) → (b) (ii) → (c) (iii) → (a) (iv) → (e) (v) → (d)

41. (i) → (d) (ii) → (e) (iii) → (a) (iv) → (f) (v) → (b)
(vi) → (c)

42. (i) → (d) (ii) → (a) (iii) → (b)

43. (i) → (b) (ii) → (d) (iii) → (a) (iv) → (d) (v) → (c)

44. (i) → (f) (ii) → (e) (iii) → (a) (iv) → (c) (v) → (b)
(vi) → (d)

45. (i) → (d) (ii) → (a) (iii) → (b) (iv) → (e) (v) → (c)

V. Assertion and Reason Type

46. (ii) 47. (iv) 48. (i) 49. (ii) 50. (v) 51. (i)
52. (i)

VI. Long Answer Type

53. See NCERT textbook for Class XII.

54. See NCERT textbook for Class XII.

55. ‘A’ is novolac, ‘B’ is bakelite.

56. **Hint :** Low density and high density polythenes are obtained under different conditions. These differ in their structural features. Low density polythenes are highly branched structures while high density polythene consists of closely packed linear molecules. Close packing increases the density.

57. **Hint :** Polythene, polyvinyls and polystyrene soften on heating and harden on cooling. Such polymers are called thermoplastic polymers. These polymers are linear or slightly branched long chain molecules. These possess intermolecular forces whose strength lies between strength of intermolecular forces of elastomers and fibres.

Unit

16

CHEMISTRY IN EVERYDAY LIFE

I. Multiple Choice Questions (Type-I)

1. Which of the following statements is **not** correct.

(i) Some antiseptics can be added to soaps.

(ii) Dilute solutions of some disinfectants can be used as antiseptic.

(iii) Disinfectants are antimicrobial drugs.

(iv) Antiseptic medicines can be ingested.

2. Which is the correct statement about birth control pills?

(i) Contain estrogen only.

(ii) Contain progesterone only.

(iii) Contain a mixture of estrogen and progesterone derivatives.

(iv) Progesterone enhances ovulation.

3. Which statement about aspirin is **not** true

(i) Aspirin belongs to narcotic analgesics.

(ii) It is effective in relieving pain.

(iii) It has antiblood clotting action.

(iv) It is a neurologically active drug.

4. The most useful classification of drugs for medicinal chemists is _________.

(i) on the basis of chemical structure.

(ii) on the basis of drug action.

(iii) on the basis of molecular targets.
(iv) on the basis of pharmacological effect.

5. Which of the following statements is correct?

(i) Some tranquilisers function by inhibiting the enzymes which catalyse the degradation of noradrenaline.
(ii) Tranquilisers are narcotic drugs.
(iii) Transquilisers are chemical compounds that do not affect the message transfer from nerve to receptor.
(iv) Tranquilisers are chemical compounds that can relieve pain and fever.

6. Salvarsan is arsenic containing drug which was first used for the treatment of ____________.

(i) syphilis
(ii) typhoid
(iii) meningitis
(iv) dysentry

7. A narrow spectrum antibiotic is active against _______________.

(i) gram positive or gram negative bacteria.
(ii) gram negative bacteria only.
(iii) single organism or one disease.
(iv) both gram positive and gram negative bacteria.

8. The compound that causes general antidepressant action on the central nervous system belongs to the class of _____________.

(i) analgesics
(ii) tranquilizers
(iii) narcotic analgesics
(iv) antihistamines

9. Compound which is added to soap to impart antiseptic properties is __________.

(i) sodium laurylsulphate
(ii) sodium dodecylbenzenesulphonate
(iii) rosin
(iv) bithional

10. Equanil is __________.

(i) artificial sweetener
(ii) tranquilizer
(iii) antihistamine
(iv) antifertility drug

11. Which of the following enhances leathering property of soap?

- (i) Sodium carbonate
- (ii) Sodium rosinate
- (iii) Sodium stearate
- (iv) Trisodium phosphate

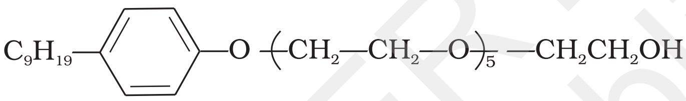
12. Glycerol is added to soap. It functions ______________.

- (i) as a filler.
- (ii) to increase leathering.
- (iii) to prevent rapid drying.
- (iv) to make soap granules.

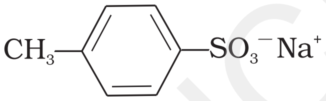
13. Which of the following is an example of liquid dishwashing detergent?

(i) $CH_3(CH_2)_{10}—CH_2OSO_3^- Na^+$

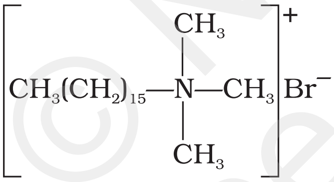
(ii)



(iii)



(iv)



$\left[CH_3(CH_2)_{15}—\overset{CH_3}{\underset{CH_3}{N}}—CH_3\right]^+ Br^-$

14. Polyethyleneglycols are used in the preparation of which type of detergents?

- (i) Cationic detergents
- (ii) Anionic detergents
- (iii) Non-ionic detergents
- (iv) Soaps

15. Which of the following is **not** a target molecule for drug function in body?

- (i) Carbohydrates
- (ii) Lipids
- (iii) Vitamins
- (iv) Proteins

16. Which of the following statements is **not** true about enzyme inhibitors?

(i) Inhibit the catalytic activity of the enzyme.

(ii) Prevent the binding of substrate.

(iii) Generally a strong covalent bond is formed between an inhibitor and an enzyme.

(iv) Inhibitors can be competitive or non-competitive.

17. Which of the following chemicals can be added for sweetening of food items at cooking temperature and does not provide calories?

(i) Sucrose

(ii) Glucose

(iii) Aspartame

(iv) Sucrolose

18. Which of the following will **not** enhance nutritional value of food?

(i) Minerals

(ii) Artificial sweeteners

(iii) Vitamins

(iv) Aminoacids

II. Multiple Choice Questions (Type-II)

Note : In the following questions two or more options may be correct.

19. Which of the following statements are **incorrect** about receptor proteins?

(i) Majority of receptor proteins are embedded in the cell membranes.

(ii) The active site of receptor proteins opens on the inside region of the cell.

(iii) Chemical messengers are received at the binding sites of receptor proteins.

(iv) Shape of receptor doesn't change during attachment of messenger.

20. Which of the following are **not** used as food preservatives?

(i) Table salt

(ii) Sodium hydrogencarbonate

(iii) Cane sugar

(iv) Benzoic acid

21. Compounds with antiseptic properties are _____________.

(i) $CHCl_3$

(ii) CHI_3

(iii) Boric acid

(iv) 0.3 ppm aqueous solution of Cl_2

22. Which of the following statements are correct about barbiturates?

(i) Hypnotics or sleep producing agents.

(ii) These are tranquilizers.

(iii) Non-narcotic analgesics.

(iv) Pain reducing without disturbing the nervous system.

23. Which of the following are sulpha drugs?

(i) Sulphapyridine

(ii) Prontosil

(iii) Salvarsan

(iv) Nardil

24. Which of the following are antidepressants?

(i) Iproniazid

(ii) Phenelzine

(iii) Equanil

(iv) Salvarsan

25. Which of the following statements are **incorrect** about penicillin?

(i) An antibacterial fungus.

(ii) Ampicillin is its synthetic modification.

(iii) It has bacteriostatic effect.

(iv) It is a broad spectrum antibiotic.

26. Which of the following compounds are administered as antacids?

(i) Sodium carbonate

(ii) Sodium hydrogencarbonate

(iii) Aluminium carbonate

(iv) Magnesium hydroxide

27. Amongst the following antihistamines, which are antacids?

(i) Ranitidine

(ii) Brompheniramine

(iii) Terfenadine

(iv) Cimetidine

28. Veronal and luminal are derivatives of barbituric acid which are __________.

(i) Tranquilizers

(ii) Non-narcotic analgesic

(iii) Antiallergic drugs

(iv) Neurologically active drugs

29. Which of the following are anionic detergents?

(i) Sodium salts of sulphonated long chain alcohol.

(ii) Ester of stearic acid and polyethylene glycol.

(iii) Quarternary ammonium salt of amine with acetate ion.

(iv) Sodium salts of sulphonated long chain hydrocarbons.

30. Which of the following statements are correct?

(i) Cationic detergents have germicidal properties

(ii) Bacteria can degrade the detergents containing highly branched chains.

(iii) Some synthetic detergents can give foam even in ice cold water.

(iv) Synthetic detergents are not soaps.

III. Short Answer Type

31. What is the average molecular mass of drugs?

32. Write the uses of medicines.

33. What are antiseptics?

34. Which type of drugs come under antimicrobial drugs?

35. Where are receptors located?

36. What is the harmful effect of hyperacidity?

37. Which site of an enzyme is called allosteric site?

38. What type of forces are involved in binding of substrate to the active site of enzyme?

39. What is the commonality between the antibiotic arsphenamine and azodye?

40. Which class of drugs is used in sleeping pills?

41. Aspirin is pain relieving antipyretic drug but can be used to prevent heart attack. Explain.

42. Both antacids and antiallergic drugs are antihistamines but they cannot replace each other. Explain why?

43. What is a soft soap?

44. If soap has high alkali content it irritates skin. How can the amount of excess alkali be determined? What can be the source of excess alkali?

45. Explain why some times foaming is seen in river water near the place where sewage water is poured after treatment?

46. Which category of the synthetic detergents is used in toothpaste?

47. Hair shampoos belong to which class of synthetic detergent?

48. Dishwashing soaps are synthetic detergents. What is their chemical nature?

49. Draw the diagram showing micelle formation by the following detergent.

$CH_3(CH_2)_{10}CH_2OS\overset{-}{O}_3\overset{+}{Na}$

50. How does the branching of hydrocarbon chain of synthetic detergents affect their biodegradability?

51. Why is it safer to use soap from the environmental point of view?

52. What are analgesics?

53. What is the scientific explanation for the feeling of depression?

54. What is the basic difference between antiseptics and disinfectants?

55. Between sodiumhydrogencarbonate and magnesium hydroxide which is a better antacid and why?

56. Which analgesics are called opiates?

57. What is the medicinal use of narcotic drugs?

58. What are antagonistic drugs?

59. What is the mode of action of antimicrobial drugs?

60. What is the side product of soap industry? Give reactions showing soap formation.

61. What is the difference between bathing soap and washing soaps?

62. How are transparent soaps manufactured?

63. What is the advantage of using antihistamines over antacids in the treatment of acidity?

64. What are the functions performed by histamine in the body?

65. With the help of an example explain how do tranquilizers control the feeling of depression?

66. Why are certain drugs called enzyme inhibitors?

67. What are fillers and what role these fillers play in soap?

68. Sugar is the main source of energy as it produces energy on metabolic decomposition. But these days low calorie drinks are more popular, why?

69. Pickles have a long shelf life and do not get spoiled for months, why?

70. What is the difference between saccharin and saccharic acid?

71. Name an artificial sweetener which is derivative of sucrose.

72. Name two α-amino acids which form a dipeptide which is 100 times more sweet than cane sugar?

73. Aspartame is unstable at cooking temperature, where would you suggest aspartame to be used for sweetening?

74. Sodium salts of some acids are very useful as food preservatives. Suggest a few such acids.

75. Explain the role of allosteric site in enzyme inhibition?

76. How are receptor proteins located in the cell membrane?

77. What happens when the bond formed between an enzyme and an inhibitor is a strong covalent bond?

IV. Matching Type

Note : Match the items given in Column I with the items given in Column II.

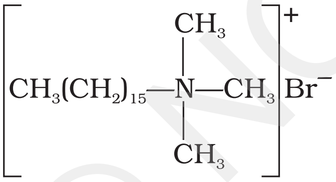
78. Match the medicines given in Column I with their use given in Column II.

Column I	**Column II**
(i) Ranitidine	(a) Tranquilizer
(ii) Furacine	(b) Antibiotic
(iii) Phenelzine	(c) Antihistamine
(iv) Chloramphenicol	(d) Antiseptic
	(e) Antifertility drug

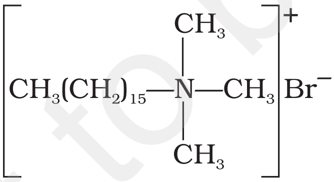
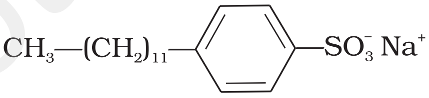
79. Match the soaps given in Column I with items given in Column II.

	Column I		Column II
(i)	Soap chips	(a)	dried miniature soap bubbles
(ii)	Soap granules	(b)	small broken pieces of soap formed from melted soaps
(iii)	Soap powder	(c)	soap powder + abrasives + builders (Na_2CO_3, Na_3PO_4)
(iv)	Scouring soap	(d)	soap powder + builders like Na_2CO_3 and Na_3PO_4

80. Match structures given in Column I with the type of detergents given in Column II.

	Column I		Column II
(i)	$CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$	(a)	Cationic detergent
(ii)	$C_{17}H_{35}\,COO^-Na^+$	(b)	Anionic detergent
(iii)	$CH_3—(CH_2)_{10}CH_2SO_3^-Na^+$	(c)	Nonionic detergent
(iv)	 $\left[CH_3(CH_2)_{15}—\underset{CH_3}{\overset{CH_3}{N}}—CH_3\right]^+Br^-$	(d)	Soap

81. Match the detergents given in Column I with their uses given in Column II.

	Column I		Column II
(i)	 $\left[CH_3(CH_2)_{15}—\underset{CH_3}{\overset{CH_3}{N}}—CH_3\right]^+Br^-$	(a)	Dishwashing powder
(ii)		(b)	Laundry soap
(iii)	$C_{17}H_{35}CO\overset{-}{O}\overset{+}{N}a + Na_2CO_3 + Rosin$	(c)	Hair conditioners
(iv)	$CH_3(CH_2)_{16}COO(CH_2CH_2O)_nCH_2CH_2OH$	(d)	Toothpaste

82. Match the class of compounds given in Column I with their functions given in Column II.

Column I	Column II
(i) Antagonists	(a) Communicate message between two neurons and that between neurons to muscles
(ii) Agonists	(b) Bind to the receptor site and inhibit its natural function
(iii) Chemical messenger	(c) Crucial to body's communication process
(iv) Inhibitors	(d) Mimic the natural messenger
(v) Receptors	(e) Inhibit activities of enzymes.

83. Match the classes of drugs given in Column I with their action given in Column II.

Column I	Column II
(i) Analgesics	(a) Inhibit the growth of microorganisms can be given orally.
(ii) Antiseptics	(b) Treatment of stress
(iii) Antihistamines	(c) Applied to inanimate objects
(iv) Antacids	(d) Prevents the interaction of histamine with its receptor
(v) Tranquilisers	(e) Pain killing effect
(vi) Antibiotics	(f) Applied to diseased skin surfaces
(vii) Disinfectants	(g) Treatment of acidity

V. Assertion and Reason Type

Note : In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(i) Assertion and reason both are correct statement but reason does not explain assertion.

(ii) Assertion and reason both are correct and reason explains the assertion.

(iii) Both assertion and reason are wrong statement.

(iv) Assertion is correct statement reason is wrong statement.

(v) Assertion is wrong statement reason is correct statement.

84. Assertion : Penicillin (G) is an antihistamine

Reason : Penicillin (G) is effective against gram positive as well as gram negative bacteria.

85. Assertion : Sulpha drug contain sulphonamide group.

Reason : Salvarsan is a sulpha drug.

86. Assertion : Receptors are crucial to body's communication process.

Reason : Receptors are proteins.

87. Assertion : Enzymes have active sites that hold substrate molecule for a chemical reaction.

Reason : Drugs compete with natural substrate by attaching covalently to the active site of enzyme.

88. Assertion : Chemical messengers are chemicals that enable communication of message between two neurons or between neurons and muscles.

Reason : Chemicals enter the cell through receptor.

89. Assertion : Transparent soaps are made by dissolving soaps in ethanol.

Reason : Ethanol makes things invisible.

90. Assertion : Sodium chloride is added to precipitate soap after saponification.

Reason : Hydrolysis of esters of long chain fatty acids by alkali produces soap in colloidal form.

91. Assertion : Competitive inhibitors compete with natural substrate for their attachment on the active sites of enzymes.

Reason : In competitive inhibition, inhibitor binds to the allosteric site of the enzyme.

92. Assertion : Non-competitive inhibitor inhibits the catalyic activity of enzyme by binding with its active site.

Reason : Non-competitive inhibitor changes the shape of the active site in such a way that substrate can't recognise it.

93. Assertion : Chemical messenger gives message to the cell without entering the cell.

Reason : Chemical messenger is received at the binding site of receptor proteins.

94. Assertion : Receptor proteins show selectivity for one chemical messenger over the other.

Reason : Chemical messenger binds to the receptor site and inhibits its natural function.

95. Assertion : All chemicals added to food items are called food preservatives.

Reason : All these chemicals increase the nutritive value of the food.

96. Assertion : Preservative are added to food items.

Reason : Preservatives inhibit the growth of microorganisms.

97. Assertion : Artificial sweeteners are added to the food to control the intake of calories.

Reason : Most of the artificial sweeteners are inert and do not metabolise in the body.

VI. Long Answer Type

98. In what respect do prontosil and salvarsan resemble. Is there any resemblance between azo dye and prontsil? Explain.

99. How do enzymes catalyse a chemical reaction in the living system? Explain drug target interaction taking the example of enzyme as target.

100. Synthetic detergents have advantage over usual soaps as far as cleansing power is concerned. But use of synthetic detergents over a long time creates environmental pollution. How can the pollution caused by synthetic detergents be minimised? Classify the detergents according to their chemical nature.

101. What are enzyme inhibitors? Classify them on the basis of their mode of attachments on the active site of enzymes. With the help of diagrams explain how do inhibitors inhibit the enzymatic activity.

ANSWERS

I. Multiple Choice Questions (Type-I)

1. (iv) 2. (iii) 3. (i) 4. (iii) 5. (i) 6. (i)
7. (i) 8. (ii) 9. (iv) 10. (ii) 11. (ii) 12. (iii)
13. (ii) 14. (iii) 15. (iii) 16. (iii) 17. (iv) 18. (ii)

II. Multiple Choice Questions (Type-II)

19. (ii), (iv) 20. (i), (iii) 21.(ii), (iii) 22. (i), (ii)

23. (i), (ii) 24. (i), (ii), (iii) 25. (iii), (iv) 26. (ii), (iv)

27. (i), (iv) 28. (i), (iv) 29. (i), (iv) 30. (i), (iii), (iv)

III. Short Answer Type

31. ~100–500u.

32. Medicines are used in diagnosis, prevention and treatment of diseases.

33. Antiseptics are chemicals which either kill or prevent the growth of microorganisms and are applied to living tissues.

34. Antiseptics, antibiotics and disinfectants.

35. Receptors are embedded in cell membrane.

36. Ulcer development in stomach.

37. Sites different from active site of enzyme where a molecule can bind and affect the active site is called allosteric site. Some drugs may also bind at this site.

38. Ionic bonding, hydrogen bonding, van der Waals interaction, dipole-dipole interaction.

39. Arsphenamine possesses $-\mathrm{As}{=}\mathrm{As}-$ linkage that resembles $-\mathrm{N}{=}\mathrm{N}-$ linkages in azodyes.

40. Tranquilizers

41. Aspirin prevents platelet coagulation and thus has antiblood clotting action therefore can prevent blood clogging in heart.

42. See page no. 444 of NCERT textbook for Class XII.

43. These are potassium salts of fatty acids.

44. Acid-base titration can be used to determine the excess amount of alkali in soap. The excess alkali left after hydrolysis of oil can be the source of alkalinity in soap.

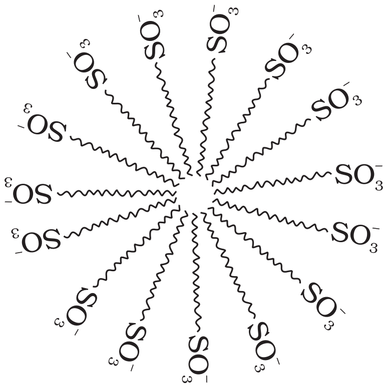
45. Detergents persist in water even after sewage treatment and cause foaming in river water.

46. Anionic detergent.

47. Cationic detergent.

48. Non-ionic detergents

49.



50. Less branching leads to easy biodegradability.

51. Soaps are biodegradable while detergents are quite stable because of branching in hydrocarbon chain hence cause water pollution.

52. Analgesics are neurologically active pain killing drugs that reduce or abolish pain without causing impairment of consciousness, mental confusion, coordination or paralysis or some other disturbances of nervous system.

53. A person suffers from depression when he has low levels of noradrenaline. Noradrenaline is a neurotransmitter that plays a role in mood changes. Low levels of noradrenaline lower the signal-sending activity and make the person suffer from depression.

54. Antiseptics are applied to living tissues whereas disinfectants are applied to non living objects.

55. Magnesium hydroxide is a better antacid because being insoluble it does not allow the pH to increase above neutral. Hydrogencarbonate being soluble, its excess can make the stomach alkaline and trigger the production of even more acid.

56. Narcotic analgesics which are obtained from opium poppy are called opiates. Examples are morphine and its derivatives like heroin and codeine.

57. Since narcotic drugs relieve pain and produce sleep, these are chiefly used for the relief of postoperative pain, cardaic pain and pain of terminal cancer and in child birth.

58. Drugs that bind to the receptor site and inhibit its natural function are called antagonistic drugs.

59. Antimicrobial drugs can kill the microorganism such as bacteria, virus, fungi or other parasites. They can, alternatively, inhibit the pathogenic action of microbes.

60. [**Hint :** Glycerol.]

61. Bathing soaps are potassium salts of long chain fatty acids while washing soaps are sodium salts of long chain fatty acids.

62. Dissolving soap in ethanol followed by evaporating the excess solvent.

63. Antacids control only the symptoms and not the cause. They work by neutralising the acid produced in the stomach. They do not control the cause of production of more acid. Antihistamines are the drugs that suppress the action of histamine which is the chemical responsible for stimulation of secretion of pepsin and HCl in the stomach. Antihistamines influence and prevent the binding of histamine with the receptors present in the stomach wall resulting in lower acid production and therefore, better treatment.

64. Histamine is a potent vasodilator. It contracts muscles in the gut and bronchi. It relaxes some other muscles e.g. in the walls of blood vessels. Histamine is also responsible for congestion in the nose associated with common cold and allergies. Also, histamine stimulates the release of pepsin and hydrochloric acid in the stomach.

65. See Class-XII NCERT, textbook page no. 444.

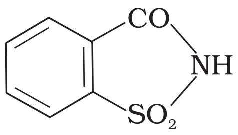
66. Enzymes have active sites that bind the substrate for effective and quick chemical reaction. The functional groups present at the active site of enzyme interact with functional groups of substrate via ionic bonding, hydrogen bonding, van der Waal interaction etc. Some drugs interfere with this interaction by blocking the binding site of enzyme and prevent the binding of actual substrate with enzyme. This inhibits the catalytic activity of the enzyme, therefore, these are called inhibitors.

67. Some substances are added to soap to affect the properties in order to make it useful for a particular application. Examples are sodium rosinate, sodium carbonate, etc. Sodium rosinate is added in laundry soaps, to increase lather and glycerol is added in shaving soaps, to prevent it from drying.

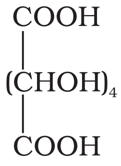
68. [**Hint :** In such drinks artificial sweetening agents are present which do not metabolise hence do not produce any energy.]

69. [**Hint :** Plenty of salt and cover of oil act as preservative. These do not allow bacteria to thrive on them.]

70.



Saccharin
(Artificial sweetener)



$$\begin{array}{c} COOH \\ | \\ (CHOH)_4 \\ | \\ COOH \end{array}$$

Saccharic acid
(obtained from oxidation of glucose by conc. HNO_3)

71. Sucrolose

72. Aspartic acid and phenylalanine.

73. In cold foods and soft drinks.

74. Benzoic acid, sorbic acid, propanoic acid.

75. **Hint :** For answer see page no. 441 of NCERT textbook for Class XII.

76. **Hint :** For answer see page no. 442 of NCERT textbook for Class XII.

77. **Hint :** For answer see page no. 442 of NCERT textbook for Class XII.

IV. Matching Type

78. (i) → (c) (ii) → (d) (iii) → (a) (iv) → (b)
79. (i) → (b) (ii) → (a) (iii) → (d) (iv) → (c)
80. (i) → (c) (ii) → (d) (iii) → (b) (iv) → (a)
81. (i) → (c) (ii) → (d) (iii) → (b) (iv) → (a)
82. (i) → (b) (ii) → (d) (iii) → (a) (iv) → (e) (v) → (c)
83. (i) → (e) (ii) → (f) (iii) → (d) (iv) → (g) (v) → (b)
(vi) → (a) (vii) → (c)

V. Assertion and Reason Type

84. (iii) 85. (iv) 86. (i) 87. (iv) 88. (iv) 89. (iv)
90. (ii) 91. (iv) 92. (v) 93. (ii) 94. (iv) 95. (iii)
96. (ii) 97. (ii)

VI. Long Answer Type

98. **Hint:** For answer see NCERT textbook for Class XII.

99. **Hint:** For answer see NCERT textbook for Class XII.

100. **Hint:** For answer see NCERT textbook for Class XII.

101. **Hint:** For answer see NCERT textbook for Class XII.

I. Design of the Sample Question Paper

BLUE PRINT OF SAMPLE QUESTION PAPER (CHEMISTRY)
for CLASS XII

TIME : 3 HOURS **MAX. MARKS : 70**

Unit/Questions Type	Weightage to Content Unit (Marks)	Unitwise Weightage to Different Forms of Questions								Distribution of Different Types of Questions over the Units						
		MCQ		Short Answer			Assertion Reason	Long Answer								
		1 mark	2 mark	1 mark	2 mark	3 mark				MCQ 1	MCQ 2	SA 1	SA 2	SA 3	AR	LA
1. Solid State	3	1×1=1			1×2 = 2					1			1			
2. Solutions	5					1×3=3	1×2 = 2							1	1	
3. Electrochemistry	5		1×2=2			1×3 = 3					1			1		
4. Chemical Kinetics	5							1×5=5								1
5. Surface Chemistry	3		1×2 = 2	1×1=1							1	1				
6. General Principles and Processes of Isolation of Elements	5	1×1 = 1		1×1 = 1		1×3 = 3				1		1		1		
7. The *p*-Block Elements	6	1×1=1			1×2 = 2	1×3 = 3				1			1	1		
8. The *d*– and *f*– Block Elements	5							1×5 = 5								1
9. Coordination Compounds	5				1×2 = 2	1×3 = 3							1	1		
10. Haloalkanes and Haloarenes	5				1×2 = 2	1×3 = 3							1	1		
11. Alcohols, Phenols and Ethers	5					1×3 = 3	1×2 = 2							1	1	
12. Aldehydes, Ketones and Carboxylic Acids	5							1×5 = 5								1
13. Amines	4	1×1=1				1×3 = 3				1				1		
14. Biomolecules	3					1×3 = 3								1		
15. Polymers	3			1×1=1	1×2 = 2							1	1			
16. Chemistry in Everyday Life	3			1×1=1	1×2 = 2							1	1			
TOTAL	**70**	**4**	**4**	**4**	**12**	**27**	**4**	**15**	**Total Number of Questions of Each Type** →	**4**	**2**	**4**	**6**	**9**	**2**	**3**

II. Expected Length of Answer and Time Required for Each Form of Question shall be as Follows :

Sl. No.	Forms of Questions	Expected Length	Expected Time for Each Question	Total Number of Questions	Total Time Expected
1.	MCQ (I)	-	2 minutes	4	08 minutes
2.	MCQ (II)	-	3 minutes	2	06 minutes
3.	SA (I)	one line	3 minutes	4	12 minutes
4.	SA (II)	20-30 words	4 minutes	6	24 minutes
4.	SA (III)	30-50 words	7 minutes	9	63 minutes
6.	Assertion-Reason	-	3 minutes	2	06 minutes
7.	Long Answer Type	70-100 words	15 minutes	3	45 minutes
8.	Revision	-			16 minutes
		TOTAL	**-**	**30**	**180 minutes**

III. Weightage to Difficulty Level of Questions

Sl. No.	Estimated Difficulty Level of Questions	Percentage
1.	Easy	18
2.	Average	64
3.	Difficult	18

MODEL QUESTION PAPER-I

CHEMISTRY

Class XII

Time : 3 Hours *Maximum Marks : 70*

General Instructions :

- *(i) All the questions are compulsory.*
- *(ii) Questions 1 to 4, carry one mark each and questions 5 to 6, carry 2 marks each.*
- *(iii) Questions 7 to 10 are short answer questions carrying 1 mark each.*
- *(iv) Questions 11 to 16 are short answer questions carrying 2 mark each.*
- *(v) Questions 17 to 25 are also short answer questions carrying 3 marks each.*
- *(vi) Questions 26 to 27 are assertion- reason questions carrying 2 marks each.*
- *(vii) Questions 28 to 30 are long answer questions carrying 5 marks each.*
- *(viii) Use log tables for calculations if necessary.*

Note : Choose one correct option for questions 1 to 4.

1. Which of the following substance will have lowest melting point? **(1)**

(i) H_2O (ice)
(ii) Quartz
(iii) Diamond
(iv) CO_2 (dry ice)

2. Which of the following reactions is an example of autoreduction? **(1)**

(i) $FeS + \frac{3}{2} O_2 \longrightarrow FeO + SO_2$

(ii) $FeO + SiO_2 \longrightarrow FeSiO_3$

(iii) $Cu_2O + \frac{1}{2} Cu_2S \longrightarrow 3Cu + \frac{1}{2} SO_2$

(iv) $Cu_2S + \frac{3}{2} O_2 \longrightarrow Cu_2O + SO_2$

3. In the titration of Mohr salt solution with $KMnO_4$ solution, dilute H_2SO_4 is used to provide acidic medium. The titration gives unsatisfactory result when we use HCl in place of H_2SO_4. This is because. **(1)**

(i) MnO_4^- oxidises HCl to Cl_2.
(ii) HCl oxidises MnO_4^- to Mn^{2+}
(iii) HCl forms chlorocomplex with Mn^{2+}
(iv) Fe^{2+} is reduced to Fe^{3+} in the presence of HCl

4. The correct IUPAC name for $CH_2{=}CHCH_2\ NHCH_3$ is ______________. **(1)**

(i) Allylmethylamine

(ii) N-methylprop-2-en-1-amine

(iii) 4-amino-pent-1-ene

(iv) 2-amino-4-pentene

Note : Choose two correct options for questions 5 and 6.

5. Conductivity of an electrolylic solution depends on ____________. **(2)**

(i) nature of electrolyte.

(ii) concentration of electrolyte.

(iii) area of cross section of the electrode.

(iv) distance between the electrodes.

6. Which of the following are correct statements? **(2)**

(i) Mixing two oppositly charged sols in equal amount neutralises charges and stabalises colloid.

(ii) Presence of equal and similar charges on colloidal particles provides stability to the colloidal solution.

(iii) Any amount of dispersed liquid can be added to emulsion without destabilising it.

(iv) Brownian movement stabilises sols.

7. Why does prolonged dialysis destabilise the colloids? **(1)**

8. Although carbon and hydrogen are better reducing agents but they are not used to reduce metallic oxides at high temperatures. Why? **(1)**

9. Which forces impart crystalline nature to a polymer like nylon? **(1)**

10. Name an artificial sweetener which is derivative of sucrose. **(1)**

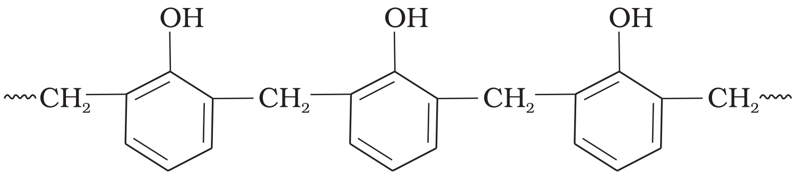
11. Explain why does conductivity of germanium crystals increases on doping with gallium. **(2)**

12. Explain why NCl_3 gets easily hydrolysed but NF_3 does not. **(2)**

13. Explain why $[Fe(H_2O)_6]^{3+}$ has high magnetic moment value of 5.92 BM whereas magnetic moment of $[Fe(CN)_6]^{3-}$ has value of only 1.74 BM. **(2)**

14. Why can arylhalide not be prepared by reaction of phenol with HCl in the presence of $ZnCl_2$? **(2)**

15. Write the name of starting materials used for the synthesis of following polymer and idntify its monomer unit. **(2)**



16. How do antidepressant drugs counteract feeling of depression? **(2)**

17. Components of a binary mixture of two liquids A and B were being separated by distillation. After some time separation of components stopped and composition of vapour phase became same as that of liquid phase. Both the components started coming in the distillate. Explain why this happened. **(3)**

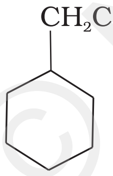
18. Identify the cathode and anode in the cell written below. **(3)**
$Cu \mid Cu^{2+} \parallel Cl^{-} \mid Cl_2, Pt$
Write the reduction half reaction and oxidation half reaction of the cell.

19. With the help of an example explain how one can separate two sulphide ores by Froth Floatation method. **(3)**

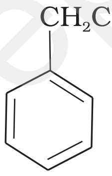
20. White phosphorus reacts with chlorine and the product gets hydrolysed in the presence of water to produce HCl. Calculate the mass of HCl obtained by the hydrolysis of the product formed by the reactions of 62 g of white phosphorus with chlorine in the presence of water. **(3)**

21. A coordination compound $CrCl_3 \cdot 4H_2O$ precipitates AgCl when treated with $AgNO_3$. The molar conductance of the solution of coordination compound corresponds to a total of two ions. Write structural formula of the compound and name it. **(3)**

22. Which of the following compounds would undergo S_N1 reaction faster and why? **(3)**



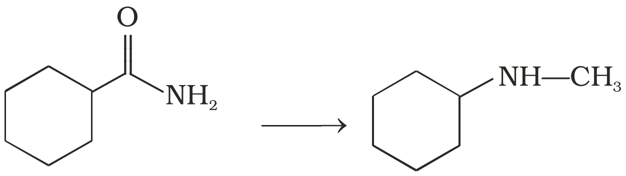
(A)



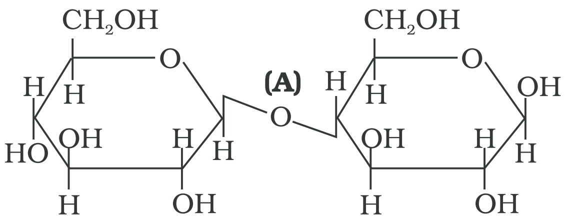
(B)

23. Ethers can be prepared by Williamson synthesis in which an alkyl halide is reacted with sodium alkoxide. Explain why di-*tert*-butyl ether can't be prepared by this method. **(3)**

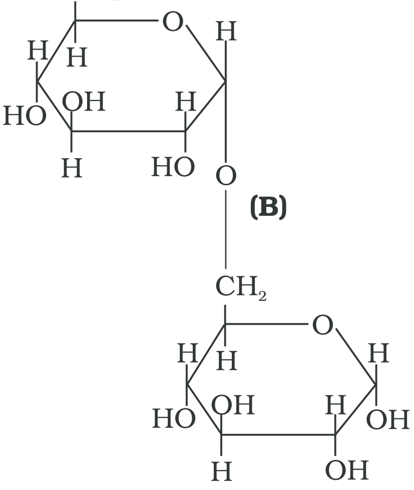
24. Suggest a route by which the following conversion can be accomplished. **(3)**



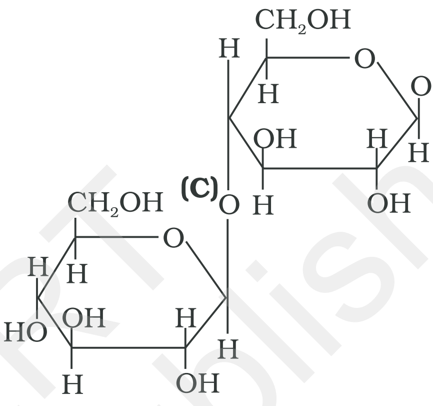
25. Three structures are given below in which two glucose units are linked. Which of these linkages between glucose units are between C1 and C4 and which linkages are between C1 and C6. Is the compound (I) reducing in nature? Explain. **(3)**



(I)



(II)



(III)

Note : In question 26 and 27. A statement of assertion followed by a statement of reason is given. Choose the correct option out of the options given below each equation.

26. Assertion : Molarity of a solution in liquid state changes with temperature.

Reason : The volume of a solution changes with change in temperature. **(2)**

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Assertion and reason both are incorrect statements.

(v) Assertion is wrong statement but reason is correct statement.

27. Assertion : *p*-nitrophenol is more acidic than phenol.

Reason : Nitro group helps in the stabilisation of the phenoxide ion by dispersal of negative charge due to resonance. **(2)**

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Assertion and reason both are incorrect statements.

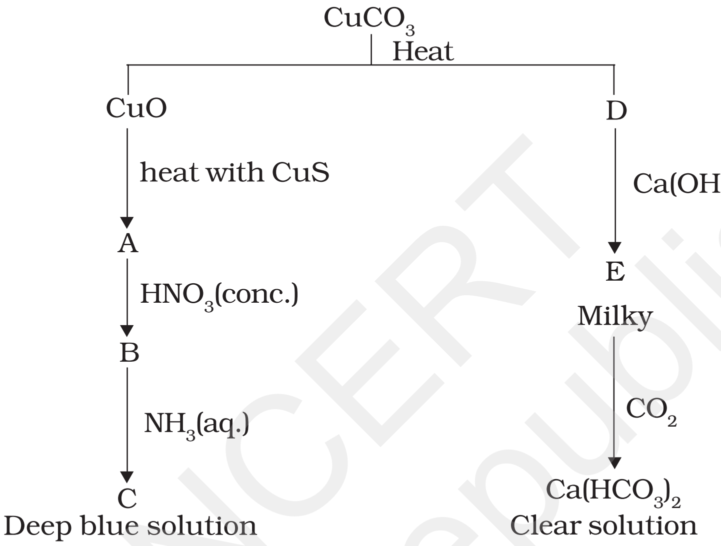
(v) Assertion is wrong statement but reason is correct statement.

28. How are most probable kinetic energy and the energy of activation affected with increase in temperature. **(5)**

or

Explain the difference between instantaneous rate of a reaction and average rate of a reaction.

29. Identify compounds A to E and also explain the reactions involved. **(5)**



or

A violet compound of manganese (A) decomposes on heating to liberate oxygen and compounds (B) and (C) of manganese are formed. Compound (C) reacts with KOH in the presence of KNO_3 to give compound (B). On heating compound (C) with a mixture of conc. H_2SO_4 and NaCl, chlorine gas is liberated and a compound (D) of manganese along with other products is formed. Identify compounds (A) to (D) and also explain the reaction invovled.

30. An alkene 'A' (Molecular formula C_5H_{10}) on ozonolysis gives a mixture of two compounds 'B' and 'C'. Compound 'B' gives positive Fehling's test and also forms iodoform on treatment with iodine and NaOH solution. Compound 'C', does not give Fehling's test but forms iodoform. Identify the compounds 'A', 'B' and 'C' giving suitable explanation and write the reactions of ozonolysis and iodoform formation from either 'B' or 'C'. **(5)**

or

Explain the reactivity of α-hydrogen atoms in ethanal. Write the reaction when (a) a mixture of ethanal and benzaldehyde is treated with NaOH (aq) and (b) when only benzaldehyde is treated with conc. KOH solution. Write the names of reaction in both the cases.

Guidelines for Evaluation (Marking Scheme)

1. (iv) (1)

2. (iii) (1)

3. (i) (1)

4. (ii) (1)

5. (i), (ii) (2)

6. (ii), (iv) (2)

7. Traces of electrolytes stabilise the colloids. On prolonged dialysis electrolyte is completely removed thus making the colloide unstable. (1)

8. At high temperature carbon and hydrogen react with metals to form carbides and hydrides respectively. (1)

9. Strong intermolecular forces like hydrogen-bonding, lead to close packing of chains that imparts crystalline character to polymers like nylon. (1)

10. Sucrolose (1)

11. On doping germanium with galium some of the positions of lattice of germenium are occupied by galium. Galium atom has only three valence electrons. Therefore, fourth valency of nearby germanium atom is not satisfied. These places remain vacant. This place is deficient of electrons and is therefore called electron hole or electron vacancy. Electron from neighbouring atom can come and fills the gap, thereby creating a hole in its original position. Under the influence of electric field electrons move towards positively charged plates using these holes and conduct electricity. The holes appear to move towards negatively charged plates. (2)

12. NCl_3 is unstable in comparison to NF_3 because N—Cl bond is weak in comparison to N—O bond while N—F bond is strong in comparison to N—O bond. (2)

13. Iron in $[Fe(CN)_6]^{3-}$ involves d^2sp^3 hybridisation with one unpaired electron and iron in $[Fe(H_2O)_6]^{3+}$ involves sp^3d^2 hybridisation with five unpaired electrons. This difference is due to the presence of strong ligand CN^- in $[Fe(CN)_6^{3-}]$ and weak ligand H_2O in $[Fe(H_2O)_6]^{3+}$ (2)

    Distribution of marks

• Writing hybridisation	(1 mark)
• Explanation	(1 mark)

14. C—O bond in phenols is more stable due to resonance effect and it has double bond character hence breaking of this bond is difficult.

    Distribution of marks

• Writing structure of phenol and aryl halide	(½ mark)
• Writing resonance structure	(½ mark)
• Explanation	(1 mark)

15. **Distribution of marks**

• Monomer Unit	(1 mark)
• Starting materials phenol and formaldehyde	(½ × 2 =1)

16. Antidepressent drugs inhibit the enzyme which catalyses the degradation of noradrenaline. Thus noradrenaline which acts as a nurotransmitter is slowly metabolised and continues to activate its receptor for a longer period of time. This activation of receptor for a long time counteracts the effect of depression.

17. Since both the components are appearing in the distillate and composition of liquid and vapour is same, this shows that liquids have formed azeotropic mixture. Hence, this cannot be separated at this stage by distillation.

Distribution of marks

• Recognising that azeotropic mixture has formed	(1 mark)
• Explanation	(2 mark)

18. Anode : $Cu \longrightarrow Cu^{2+} + 2e^{-}$

Cathode : $Cl_2 + 2e^{-} \longrightarrow 2Cl^{-}$

Copper is anode as it is getting oxidised

Cl_2 is the cathode as it is getting reduced.

Distribution of marks

• Anode reaction	(1 mark)
• Cathode reaction	(1 mark)
• Recognising electrodes on which oxidation and reduction occur	(½ + ½ =1 mark)

19. Two sulphide ores can be separated by adjusting proportion of oil to water or by using depressants. For example, in case of an ore containing ZnS and PbS, the depressant NaCN is used. It forms complex with ZnS and prevents its coming with froth, but PbS remains with froth and can be separated.

20.
$$\begin{array}{l} P_4 + 6Cl_2 \longrightarrow 4PCl_3 \\ [PCl_3 + 3H_2O \longrightarrow H_3PO_3 + 3HCl] \times 4 \\ \hline P_4 + 6Cl_2 + 12H_2O \longrightarrow 4H_3PO_3 + 12HCl \end{array}$$

1 mol of white phosphorus produces 12 mol HCl

62g of white phosphorus has been taken which is equivalent to $\frac{62}{124} = \frac{1}{2}$ mol.

Therefore 6 mol HCl will be formed.

6 mol HCl = 6 × 36.5 = 219.0 g HCl

Distribution of marks

• For writing overall reaction	(1 mark)
• Calculation of number of moles of HCl formed	(1 mark)
• Calculation of mass of HCl formed	(1 mark)

21. **Distribution of marks**

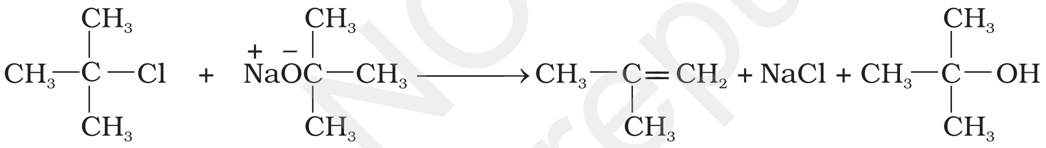
• Identification : $[Co(H_2O)_4Cl_2]Cl$	(1 mark)
• Name : Tetraaquadichlorocobalt(III)chloride	(1 mark)
• Explanation	(1 mark)

22. (B) Undergoes S_N1 reaction faster than (A) because in case of (B) the carbocation formed after the loss of Cl^- ion is stabilised by resonance, whereas, no such stabilisation is possible in the carbocation obtained from (A).

Distribution of marks

• Resonance structures	(1½ mark)
• Reason	(1½ mark)

23. In tert-butyl halides, elimination is favoured over substitution therefore alkene is the only reaction product and no ether is formed.



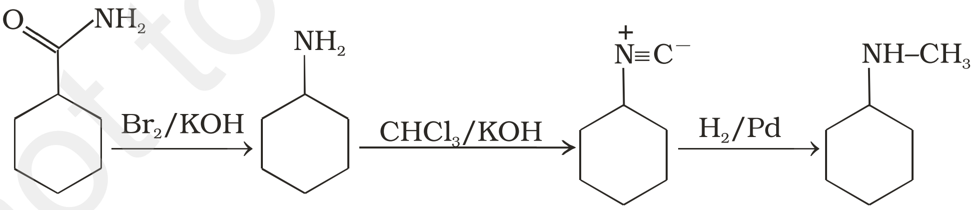
$$CH_3-\underset{CH_3}{\overset{CH_3}{C}}-Cl + \overset{+}{Na}\overset{-}{O}\underset{CH_3}{\overset{CH_3}{C}}-CH_3 \longrightarrow CH_3-\underset{CH_3}{C}=CH_2 + NaCl + CH_3-\underset{CH_3}{\overset{CH_3}{C}}-OH$$

(*tert*-Butylchloride) (2-Methylprop-1-ene)

Distribution of marks

• Reaction	(1½ mark)
• Explanation	(1½ mark)

24.



Distribution of marks

• One mark for each step	(1 × 3 = 3 marks)

25. (A) and (C) are between C1 and C4. (B) is between C1 and C6.

Distribution of marks

• ½ mark for each correct identification	(½×3=1½marks)

- Yes, compound is reducing in nature (½ mark)
- Explanation (1 marks)

26. (i) (2)

27. (i) (2)

28. **Distribution of marks**

- Graph for distribution of energy (2 marks)
- Explanation (3 marks)

or

Distribution of marks

- Graph for instantaneous rate (1 mark)
- Graph for average rate (1 mark)
- Explanation (3 marks)

29. A = Cu B = Cu $(NO_3)_2$ C = $[Cu(NH_3)_4]^{2+}$ D = CO_2 E = $CaCO_3$

(i) $CuCO_3 \xrightarrow{\Delta} CuO + \underset{(D)}{CO_2}$

(ii) $2CuO + CuS \longrightarrow \underset{(A)}{3Cu} + SO_2$

(iii) $3Cu + 8HNO_3 \longrightarrow \underset{(B)}{3Cu\,(NO_3)_2} + 2NO_2 + 2H_2O$

(iv) $Cu^{2+}\,(aq.) + 4NH_3(aq.) \longrightarrow \underset{\text{Deep blue}}{\underset{(C)}{[Cu(NH_3)_4]^{2+}}}\,(aq.)$

(v) $Ca(OH)_2\,(aq.) + \underset{(D)}{CO_2} \longrightarrow \underset{(E)}{CaCO_3} + H_2O \xrightarrow{CO_2} Ca\,(HCO_3)_2$

Distribution of marks

- Identification (5×½ = 2½ marks)
- Reactions (5×½ = 2½ marks)

or

A = $KMnO_4$ B = K_2MnO_4 C = MnO_2 D = $MnCl_2$

$$\underset{(A)}{KMnO_4} \xrightarrow{\Delta} \underset{(B)}{K_2MnO_4} + \underset{(C)}{MnO_2} + O_2$$

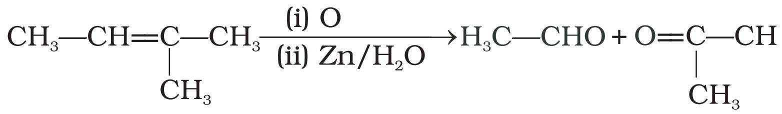
$$MnO_2 + KOH + O_2 \longrightarrow \underset{(B)}{2K_2\,MnO_4} + 2H_2O$$

$$MnO_2 + 4NaCl + 4H_2SO_4 \longrightarrow \underset{(D)}{MnCl_2} + 2NaHSO_4 + 2H_2O + Cl_2$$

Distribution of marks

• Identification	(½×4 = 2 marks)
• Reactions	(½×3 = 1½ marks)
• Explanation	(1½ marks)

30.



$$CH_3-CH=\underset{\underset{CH_3}{|}}{C}-CH_3 \xrightarrow[\text{(ii) } Zn/H_2O]{\text{(i) } O} H_3C-CHO + O=\underset{\underset{CH_3}{|}}{C}-CH$$

(A) 2-Methylbut-2-ene (B) (C)

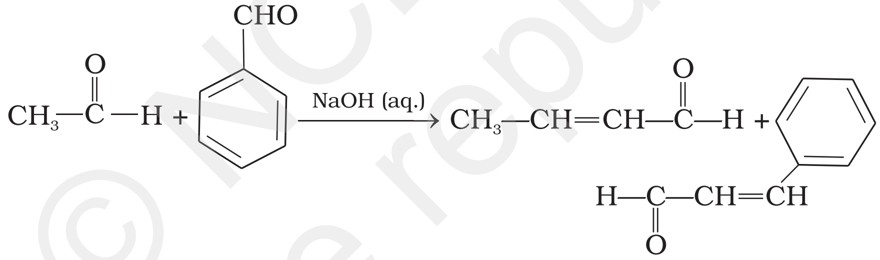
Distribution of marks

• Identification	(½ + ½+ ½ = 1½ marks)
• Reason	(½ + ½ + ½ =1½ marks)
• Reactions	(2 × 1 = 2 marks)

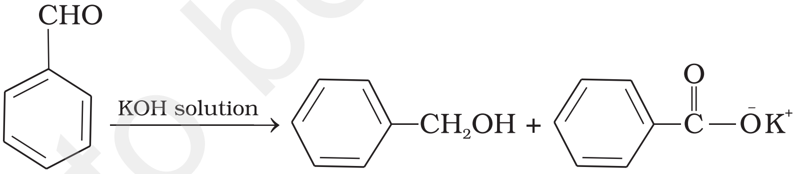
Other isomers of 'A' will not give products corresponding to the given test.

or

(a)



(b)



Names : (a) Aldol condensation

(b) Cannizaro's reaction

Distribution of marks

• Electron withdrawing effect of >C=O group	(1 mark)
• For showing resonance	(1 mark)
• Writing 2 products in each reaction	(½ × 4 = 2 mark)
• Names of two reactions	(½ × 2 = 1 mark)

MODEL QUESTION PAPER-II

CHEMISTRY

Class XII

Time : 3 Hours *Maximum Marks : 70*

General Instructions :

(i) *All the questions are compulsory.*
(ii) *Questions 1 to 4, carry one mark each and questions 5 to 6, carry 2 marks each.*
(iii) *Questions 7 to 10 are short answer questions carrying 1 mark each.*
(iv) *Questions 11 to 16 are short answer questions carrying 2 mark each.*
(v) *Questions 17 to 25 are also short answer questions carrying 3 marks each.*
(vi) *Questions 26 to 27 are assertion- reason questions carrying 2 marks each.*
(vii) *Questions 28 to 30 are long answer questions carrying 5 marks each.*
(viii) *Use log tables for calculations if necessary.*

Note : Choose one correct option for questions 1 to 4.

1. Which of the following statements is **not** true for hexagonal close packing? **(1)**

(i) The coordination number is 12
(ii) It has 74% packing efficiency
(iii) Octahedral voids of second layer are covered by spheres of the third layer.
(iv) In this arrangement third layer is identical with the first layer.

2. Brine is electrolysed using inert electrodes. The reaction at anode is _____. **(1)**

(i) $Cl^-\ (aq.) \longrightarrow \frac{1}{2} Cl_2\ (g) + e^-$; $E^{\ominus}_{\text{Cell}} = 1.36V$

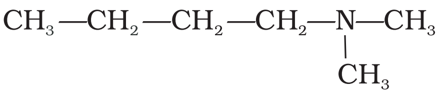
(ii) $2H_2O\ (l) \longrightarrow O_2\ (g) + 4H^+ + 4e^-$; $E^{\ominus}_{\text{Cell}} = 1.23V$

(iii) $Na+\ (aq.) + e^- \longrightarrow Na(s)$; $E^{\ominus}_{\text{Cell}} = 2.71V$

(iv) $H^+\ (aq.) + e^- \longrightarrow \frac{1}{2} H_2\ (g)$; $E^{\ominus}_{\text{Cell}} = 0.00V$

3. In a qualitative analysis when H_2S is passed through the solution of a salt acidified with HCl, a black precipitate is obtained. On boiling the precipitate with dil. HNO_3, it forms a solution of blue colour. Addition of excess of aqueous solution of ammonia to this solution will give ________. **(1)**

(i) Deep blue precipitate of $Cu\ (OH)_2$.
(ii) Deep blue solution of $[Cu\ (NH_3)_4]^{2+}$.
(iii) Deep blue solution of $Cu(NO_3)_2$.
(iv) Deep blue solution of $Cu(OH)_2.Cu(NO_3)_2$.

4. What is the IUPAC name of the compound  $CH_3—CH_2—CH_2—CH_2—\underset{\displaystyle CH_3}{\underset{|}{N}}—CH_3$? **(1)**

(i) N, N-Dimethylaminobutane
(ii) N, N-Dimethylbutan-1-amine
(iii) N, N-Dimethylbutylamine
(iv) N-methylpentan-2-amine

Note : Choose two correct options for questions 5 and 6.

5. $E^{\ominus}_{\text{Cell}}$ for some half cell reactions are given below. On the basis of these mark the correct answer. **(2)**

(a) $H^+ (aq.) + e^- \longrightarrow \frac{1}{2} H_2 (g)$; $E^{\ominus}_{\text{Cell}} = 0.00V$

(b) $2H_2O (l) \longrightarrow O_2 (g) + 4H^+ (aq.) + 4e^-$; $E^{\ominus}_{\text{Cell}} = 1.23V$

(c) $2SO_4^{2-} (aq.) \longrightarrow S_2O_8^{2-} (aq.) + 2e^-$; $E^{\ominus}_{\text{Cell}} = 1.96$ V

(i) In dilute sulphuric acid solution, hydrogen will be reduced at cathode.
(ii) In concentrated sulphuric acid solution, water will be oxidised at anode.
(iii) In dilute sulphuric acid solution, SO_4^{2-} ion will be oxidised to tetrathionate ion at anode.
(iv) In dilute sulphuric acid solution, water will be oxidised at anode.

6. What happens when a lyophilic sol is added to a lyophobic sol? **(2)**

(i) Lyophobic sol is protected.
(ii) Lyophilic sol is protected.
(iii) Film of lyophilic sol is formed over lyophobic sol.
(iv) Film of lyophobic sol is formed over lyophilic sol.

7. How do emulsifying agents stabilise emulsion? **(1)**

8. On what principle is the zone refining based? **(1)**

9. Why cross links are required in rubber to have practical applications? **(1)**

10. Name an artificial sweetener which has dipeptide linkage between two aminoacids. **(1)**

11. Why does electrical conductivity of semiconductors increase with rise in temperature? **(2)**

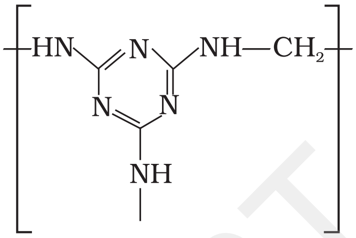
12. In the ring test of NO_3^- ion, Fe^{2+} ion reduces nitrate ion to nitric oxide, which combines with Fe^{2+} (aq.) ions to form brown complex. Write reactions involved in the formation of brown ring. **(2)**

13. Arrange the following complex ions in increasing order of crystal field splitting energy Δ_0.

$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$ **(2)**

14. Explain why allyl chloride is hydrolysed more readily than *n*-propylchloride? **(2)**

15. Write name(s) of starting materials for the following polymer and identify its monomer unit. **(2)**



16. What is the advantage of using antihistamines instead of antacids in the treatment of hyperacidity. **(2)**

17. When 1 mol of NaCl is added to 1 litre of water, the boiling point of water increases. On the other hand, addition of 1 mol of methyl alcohol to one litre of water decreases the boiling point of water. Explain why does this happen. **(3)**

18. Value of standard electrode potential for the oxidation of Cl^- ion is more positive than that of water, even then in the electrolysis of aqueous sodium chloride solution, why is Cl^- oxidised at anode instead of water? **(3)**

19. How copper is extracted from low grade copper ores? **(3)**

20. Calculate the volume of 0.1 M NaOH solution required to neutralise the products formed by dissolving 1.1 g of P_4O_6 in H_2O. **(3)**

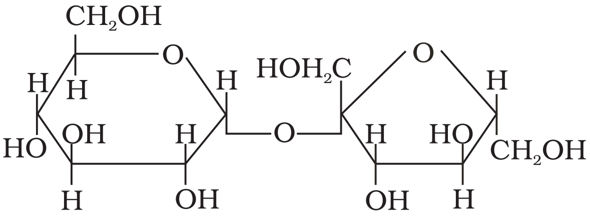
21. A complex of the type $[M(AA)_2X_2]^{n+}$ is known to be optically active. What does this indicate about the structure of the complex? Give one example of such complex. **(3)**

22. Predict the major product formed on adding HCl to isobutylene and write the IUPAC name of the product. Explain the mechanism of the reaction. **(3)**

23. Explain why rate of reaction of Lucas reagent with three classes of alcohols different? Give chemical equations wherever required. **(3)**

24. A primary amine, $R—NH_2$ can be reacted with alkyl halide, RX, to get secondary amine, R_2NH, but the only disadvantage is that 3° amine and quaternary ammonium salts are also obtained as side products. Can you suggest a method where CH_3NH_2 forms only 2° amine? **(3)**

25. Label the glucose and fructose units in the following disaccharide and identify anomeric carbon atoms in these units. Is the sugar reducing in nature? Explain. **(3)**



Note : In question 26 and 27. A statement of assertion followed by a statement of reason is given. Choose the correct answer out of the option given below each equation.

26. **Assertion** : When NaCl is added to water a depression in freezing point is observed.

Reason : The lowering of vapour pressure of a solution causes depression in the freezing point. **(2)**

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Assertion and reason both are incorrect statements.

(v) Assertion is wrong statement but reason is correct statement.

27. **Assertion** : Bond angle in ethers is slightly less than the tetrahedral angle.

Reason : There is repulsion between the two bulky (—R) groups. **(2)**

(i) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(ii) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(iii) Assertion is correct statement but reason is wrong statement.

(iv) Assertion and reason both are incorrect statements.

(v) Assertion is wrong statement but reason is correct statement.

28. Explain why does the enthalpy change of a reaction remain unchanged even when a catalyst is used in the reaction. **(5)**

or

With the help of an example explain what is meant by pseudo first order reaction.

29. When a chromite ore (A) is fused with sodium carbonate in free excess of air and the product is dissolved in water, a yellow solution of compound (B) is obtained. After treatment of this yellow solution with sulphuric acid, compound (C) can be crystallised from the solution. When compound (C) is treated with KCl solution, orange crystals of compound (D) crystallise out. Identify compounds A to D and also explain the reactions. **(5)**

or

An oxide of mangnese (A) is fused with KOH in the presence of an oxidising agent and dissolved in water. A dark green solution of compound (B) is obtained. Compound (B) disproportionates in neutral or acidic solution to give purple compound (C). Alkaline solution of (C) oxidises potassium iodide solution to a compound (D) and compound (A) is also formed. Identify compounds A to D and also explain the reactions involved. **(5)**

30. An aromatic compound 'A' (Molecular formula C_8H_8O) gives positive 2, 4-DNP test. The compound gives a yellow precipitate of compound 'B' on treatment with iodine and sodium hydroxide solution. It does not give Tollen's or Fehling's test. On drastic oxidation with potassium permanganate it forms a carboxylic acid 'C' (Molecular formula $C_7H_6O_2$) which is also formed along with the yellow compound in the above reaction. Identify compounds A, B and C and write all the reactions involved. **(5)**

or

An organic compud 'A' (C_3H_4) on hyration in presence of $H_2SO_4/HgSO_4$ gives compound 'B' (C_3H_6O). Compound 'B' gives white crystalline product (D) with sodium hydrogensulphite. It gives negative Tollen's test and positive iodoform's test. On drastic oxidation 'B' gives compound 'C' ($C_2H_4O_2$) along with formic acid. Identify compounds 'A', 'B' and 'C' and explain all the reactions.

Guidelines for Evaluation (Marking Scheme)

1. (iii) (1)

2. (i) (1)

3. (ii) (1)

4. (ii) (1)

5. (i), (iv) (2)

6. (i), (iii) (2)

7. Emulsifying agent forms an interfacial film between suspended particles and the particles of dispersion medium. (1)

8. Zone refining is based on the principle that impurities are more soluble in melt than in the solid state of metals. (1)

9. Cross links bind the polymer chains. These help the polymer to come to the original position after the stretching force is released. Thus, increase its elastomeric properties. (1)

10. Aspartame (1)

11. In semiconductors, the gap between the valence band and the conduction band is small. On increasing temperature, more electrons can jump from valence band to conduction band and conductivity increases. (2)

12. $NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow NO + 3Fe^{3+} + 2H_2O$

    $[Fe(H_2O)_6]^{2+} + NO \longrightarrow [Fe(H_2O)_5(NO)]^{2+} + H_2O$

    Distribution of marks

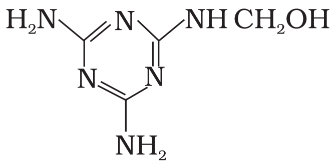
    - 1 mark for each equation (1 × 2 = 2 marks)

13. Increasing order is $[Cr(Cl)_6]^{3-} < [Cr(NH_3)_6]^{3+} < [Cr(CN)_6]^{3-}$

    Distribution of marks

    - Correct order (2 marks)

14. Allyl chloride shows high reactivity as the carbocation formed by hydrolysis is stabilised by resonance where as no resonance stabilisation of carbocation formed by *n*-propyl chloride is possible. (2 makrs)

15. 

(Monomer, an intermediate)

Distribution of marks

• Monomer unit	(1 mark)
• Starting material melamine and formaldehyde	(½ × 2 = 1 mark)

16. Antacids control only the symptoms and not the cause. They work by neutralising the acid produced in the stomach. Antihistamines control the cause of production of more acid. These suppress the action of histamine which stimulates of secretion of pepsin and HCl in the stomach. Antihistamines prevent the binding of histamine with its receptors present in the stomach wall. As a result acid production is lowered and are thus better treatment. (2 marks)

17. NaCl is a non volatile solute. Addition of NaCl in water therefore lowers the vapour pressure of water. As a result boiling point of water increases. Methyl alcohol on the other hand is more volatile than water. Therefore, its addition increases the total vapour pressure over the solution and a decrease in boiling point of water results. (3 marks)

18. Under the conditions of electrolysis of aqueous sodium chloride, oxidation of water at anode requires overpotential hence Cl^- is oxidised instead of water.

Distribution of marks

• Explanation	(2 marks)
• Reaction	(1 mark)

19. Copper is extracted by hydrometallurgy from low grade copper ores. It is leached out using acid or bacteria. The solution containing Cu^{2+} is treated with scrap iron, Zn or H_2.

$$Cu^{2+}(aq) + H_2(g) \longrightarrow Cu(s) + 2H^+(aq)$$

$$Cu^{2+} + Fe(s) \longrightarrow Fe^{2+}(aq) + Cu(s)$$

Distribution of marks

• Reactions	(1 × 2 = 2 marks)
• Explanation	(1 mark)

20. $$P_4O_6 + 6H_2O \longrightarrow 4H_3PO_3$$

$$[H_3PO_3 + 2NaOH \longrightarrow Na_2HPO_3 + 2H_2O] \times 4$$

$$\underset{1mol}{P_4O_6} + \underset{8\ mol}{8NaOH} \longrightarrow 4Na_2HPO_4 + 2H_2O$$

Product formed by 1 mol P_4O_6 is neutralised by 8 mol NaOH

$\therefore$ Product formed by $\frac{1.1}{220}$ mol P_4O_6 will be neutralised by $\frac{1.1}{220} \times 8$ mol NaOH

Molarity of NaOH solution is 0.1M

$\Rightarrow$ 0.1 mol NaOH is present in 1 L solution

$$\therefore \frac{1.1}{220}\times 8 \text{ mol NaOH is present in } \frac{1.1\times 8}{220\times 0.1}\text{L} = \frac{88}{220}\text{L} = \frac{4}{10}\text{L}$$

$$= 0.4 \text{ L}$$

$$= 400 \text{ mL NaOH solution}$$

Distribution of marks

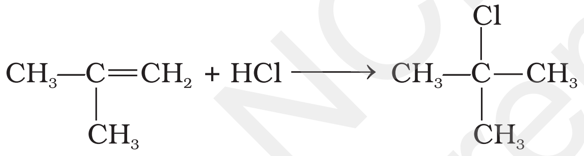
• Correct chemical euqations	(½ × 3 = 1½ mark)
• Correct method of calculation	(1 mark)
• Correct answer	(½ mark)

21. Since complex of the type $[M(AA)_2 X_2]^{n+}$ is optically active it indicates that complex has cis-octahedral structure. e.g. *cis*-$[Pt(en)_2(Cl)_2]^{2+}$ or *cis*-$[Cr(en)_2(Cl)_2]^{+}$.

Distribution of marks

• Electronic configuration in the presence of weak field ligand	(1 marks)
• Electronic configuration in the presence of strong field ligand	(1 mark)
• Explanation	(1 mark)

22.

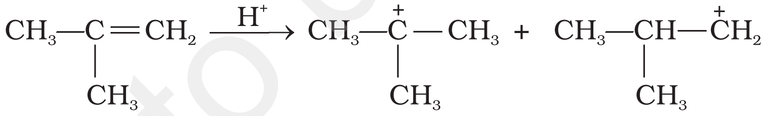


$$CH_3-\underset{\underset{CH_3}{|}}{C}=CH_2 + HCl \longrightarrow CH_3-\overset{\overset{Cl}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$$

Isobutylene *2-Chloro-2-methylpropane*

The mechanism involved in this reaction is as follows :

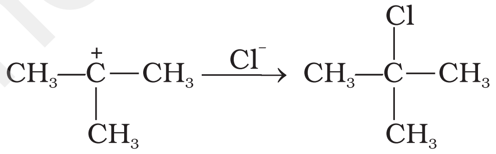
Step I :



$$CH_3-\underset{\underset{CH_3}{|}}{C}=CH_2 \xrightarrow{H^+} CH_3-\underset{\underset{CH_3}{|}}{\overset{+}{C}}-CH_3 + CH_3-\underset{\underset{CH_3}{|}}{CH}-\overset{+}{C}H_2$$

Isobutylene *3° Carbocation (More stable)* *1° Carbocation (Less stable)*

Step II:



$$CH_3-\underset{\underset{CH_3}{|}}{\overset{+}{C}}-CH_3 \xrightarrow{Cl^-} CH_3-\overset{\overset{Cl}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$$

Distribution of marks

• Structure of isobutylene	(½ mark)

• IUPAC name of the product	(½ mark)
• 2 steps of mechanism	(2 marks)

23. The reaction of alochol with Lucas reagent proceeds through carbocation formation. More stable is the carbocation, faster is the reaction. Carbocation formed by 1° alochol is least stable hence reaction is slow.

Distribution of marks

• Reaction	(½ × 3 = 1½ mark)
• Reason	(1½ mark)

24. $H_3CNH_2 \xrightarrow{KOH/CHCl_3} H_3CNC \xrightarrow{H_2/Pd} H_3CNHCH_3$

Carbylamine reaction is shown by 1° amine only which results in the formation of isocyanide. The isocynide on catalytic reduction will give a methyl group containing secondary amine.

Distribution of marks

• Writing correct reagent	(½ + ½ = 1 mark)
• 1 mark for each step	(1 × 2 = 2 marks)

25. C1 of glucose unit and C2 of fructose unit are anomeric carbon atoms in this disaccharide. The disaccharide is non reducing sugar because —OH groups attached to anomeric carbon atoms are involved in the formation of glycoside bond.

Distribution of marks

• Recognising glucose and fructose units correctly	(½ mark)
• Identification of anomeric carbon	(½ × 2 = 1 mark)
• Proper explanation for non reducing nature	(1½ marks)

26. (i) (1)

27. (v) (1)

28. **Distribution of marks**

• Correct diagram	(2 marks)
• Correct explanation	(3 marks)

or

Distribution of marks

• Correct example	(2 marks)
• Correct explanation	(3 marks)

29. $A = FeCr_2O_4$ $B =. Na_2CrO_4$ $C = Na_2Cr_2O_7.2H_2O$ $D = K_2Cr_2O_7$

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \longrightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

$$2NaCrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$$

$$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$$

or

$A = MnO_2$ (B) K_2MnO_4 (C) $KMnO_4$ (D) KIO_3

$$2\underset{(A)}{MnO_2} + 4KOH + O_2 \longrightarrow \underset{(B)}{2K_2MnO_4} + 2H_2O$$

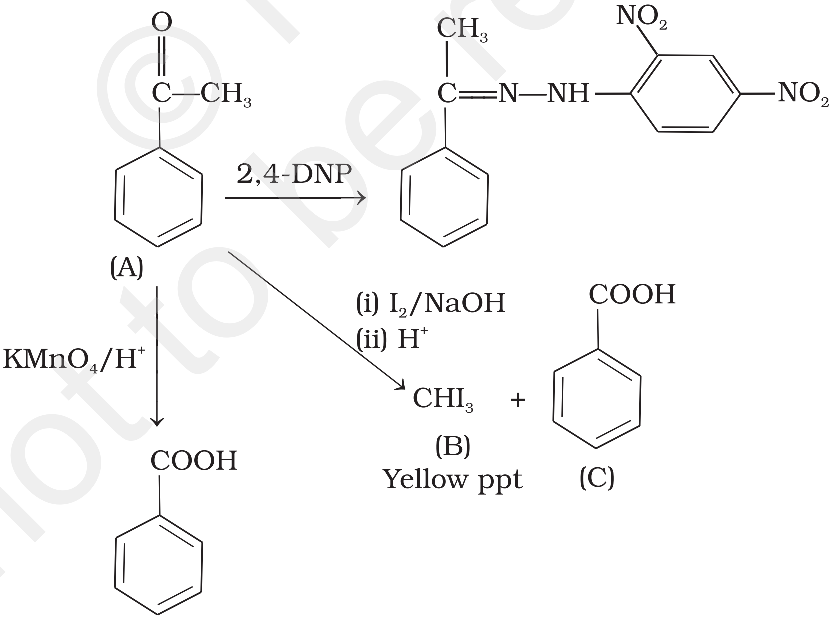
$$3MnO_4^{2-} + 4H^+ \longrightarrow \underset{(C)}{2MnO_4^-} + MnO_2 + 2H_2O$$

$$2MnO_4^- + H_2O + KI \longrightarrow \underset{(A)}{2MnO_2} + 2OH^- + \underset{(D)}{KIO_3}$$

Distribution of marks

- ½ mark for each correct identification (½ × 4 = 2 marks)
- 1 mark for each correct chemical equation with explanation (1 × 3 = 3 marks)

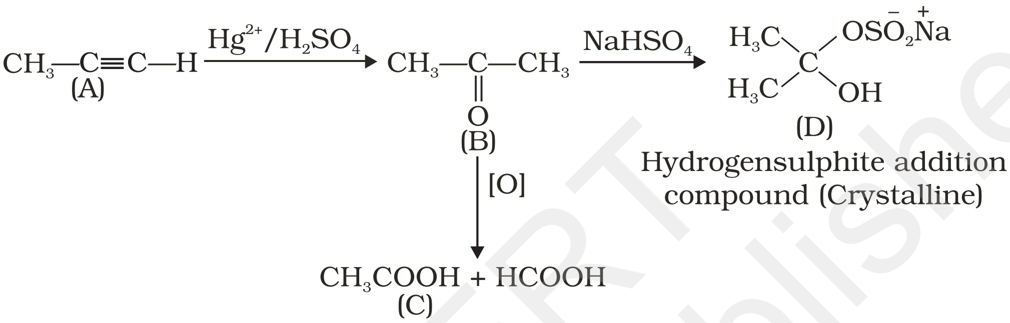
30. **Hint :**



Distribution of marks

• Recognising presence of carbonyl group	(½ mark)
• Recognising presence of ketonic group	(½ mark)
• Structure of 2,4–DNP derivative and benzoic acid	(1 mark)
• Structures of compounds ‘A’, ‘B’ and ‘C’	(1 × 3 = 3 marks)

or



Compound B is a ketone therefore Fehling’s test and tollens tests are negative.

Distribution of marks

• For identification of compounds ‘A’, ‘B’, ‘C’, ‘D’ half mark of each	(½ × 4 = 2 marks)
• 1 Mark each for writing three chemical equation	(1 × 3 = 3 marks)