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

T.B.C. : FTRE–F–CHE

Test Booklet Series

Serial No. 1012313

TEST BOOKLET

A

PAPER—II

(Chemistry)

Time Allowed : Two Hours

Maximum Marks : 300

INSTRUCTIONS

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET *DOES NOT* HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.

2. **Please note that it is the candidate's responsibility to encode and fill in the Roll Number and Test Booklet Series A, B, C or D carefully and without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.**

3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. *DO NOT* write *anything else* on the Test Booklet.

4. This Test Booklet contains **120** items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case, you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose *ONLY ONE* response for each item.

5. You have to mark your responses *ONLY* on the separate Answer Sheet provided. See directions in the Answer Sheet.

6. *All* items carry equal marks.

7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.

8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator *only the Answer Sheet*. You are permitted to take away with you the Test Booklet.

9. Sheets for rough work are appended in the Test Booklet at the end.

10. **Penalty for wrong answers :**

    THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE.

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

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

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

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1. The numbers of radial nodes, planar angular nodes and non-planar angular nodes in $3d_{z^2}$, $3s$ and $3p_x$ orbitals are

   (a) (0, 0, 2), (2, 0, 0), (1, 1, 0) respectively

   (b) (0, 2, 0), (2, 0, 0), (1, 1, 0) respectively

   (c) (2, 0, 0), (2, 0, 0), (0, 1, 1) respectively

   (d) (0, 2, 0), (0, 2, 0), (1, 1, 0) respectively

2. The angular wave function for hydrogen atom depends upon the quantum number(s)

   (a) n and l only

   (b) l and m_l only

   (c) m_l only

   (d) l, m_l and n

3. The total number of nodal planes possible for all the atomic orbitals with a value of principal quantum $(n) = 3$ is

   (a) 8

   (b) 9

   (c) 11

   (d) 14

4. The covalent radius of C atom is 0·77 Å and that of H atom is 0·37 Å. What is the internuclear distance between C and H atoms in CH_4 molecule?

   (a) 1·14 Å

   (b) 1·20 Å

   (c) 1·25 Å

   (d) 1·41 Å

5. The bond distance in Cl_2 molecule is 1·98 Å. What will be its covalent radius?

   (a) 0·99 Å

   (b) 1·00 Å

   (c) 0·98 Å

   (d) 1·10 Å

6. Which one of the following represents the correct order of size among O^{2-}, F^-, Na^+ and Mg^{2+} isoelectronic ions?

   (a) $O^{2-} < F^- < Na^+ < Mg^{2+}$

   (b) $Mg^{2+} < Na^+ < F^- < O^{2-}$

   (c) $Mg^{2+} < Na^+ < O^{2-} < F^-$

   (d) $O^{2-} < F^- < Mg^{2+} < Na^+$

7. Graphite is used as a dry lubricant in machines running at high temperature where oil cannot be used as lubricant, because

   (a) graphite has layered structure and the layers are held by van der Waals' forces and cleaves easily between layers

   (b) graphite is a crystalline substance

   (c) graphite conducts electricity and is thermodynamically stable

   (d) each carbon atom in the hexagonal ring undergoes sp^2 hybridization

8. The effective nuclear charges for $4s$ and $3d$ electrons in nickel are

   (a) 4·05 and 7·55 respectively

   (b) 7·55 and 4·05 respectively

   (c) 4·75 and 7·95 respectively

   (d) 4·25 and 7·65 respectively

9. Consider the following statements regarding periodic properties of elements :

   Statement–1 :

   Atomic radius increases down a group in the periodic table.

   Statement–2 :

   On descending a group, the valence electrons are found in orbitals of successively higher principal quantum number.

   Which one of the following is correct in respect of the above statements?

   (a) Both Statement–1 and Statement–2 are true and Statement–2 is the correct explanation of Statement–1

   (b) Both Statement–1 and Statement–2 are true but Statement–2 is not the correct explanation of Statement–1

   (c) Statement–1 is true but Statement–2 is false

   (d) Statement–1 is false but Statement–2 is true

10. Consider the following statements in respect of *ortho* and *para* form of hydrogen molecule :

    1. *Ortho* hydrogen molecules have nuclear spin vectors parallel.

    2. At high temperature, hydrogen gas contains about 75% *ortho* hydrogen.

3. In *para* form of hydrogen, nuclear spins exist in opposite manner.

4. *Para* form has the lower energy and at absolute zero, the gas contains 100% of *para* form.

   Which of the statements given above are correct?

   (a) 1 and 3 only

   (b) 2 and 4 only

   (c) 1, 3 and 4 only

   (d) 1, 2, 3 and 4

11. Which one of the following represents the correct order of electron gain enthalpy (electron affinity) among F, Cl, Br and I ?

    (a) $Cl > F > Br > I$

    (b) $F > Cl > Br > I$

    (c) $I > Br > Cl > F$

    (d) $I > Br > F > Cl$

12. How many orbitals are there in an atom having atomic weight 23 and atomic number 11?

    (a) 14

    (b) 12

    (c) 9

    (d) 6

3

13. Which one of the following complexes will have the maximum spin-only value?

(a) $[Cr(H_2O)_6]^{3+}$

(b) $[Fe(H_2O)_6]^{2+}$

(c) $[Cu(H_2O)_6]^{2+}$

(d) $[Zn(H_2O)_6]^{2+}$
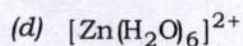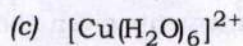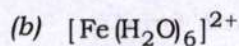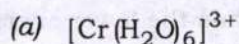
14. Consider the following statements regarding lanthanide series metals :

1. They are silvery white.

2. They are electropositive.

3. They are non-reactive.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) 1 and 2 only

(d) 1, 2 and 3

15. Which one of the following is **not** valid for oxoacids of phosphorus?

(a) All oxoacids contain tetrahedral four-coordinate phosphorus

(b) All oxoacids contain at least one P=O unit and one P—OH group

(c) Orthophosphoric acid is used in the manufacture of triple superphosphate

(d) Hypophosphorous acid is a diprotic acid

16. Consider the following statements regarding alkali metal halides :

Statement–1 :

Among all alkali metal halides, lithium iodide (LiI) is the most covalent in nature.

Statement–2 :

Li^+ being very small in size has high tendency to distort electron cloud around the negative large I^- ion.

Which one of the following is correct in respect of the above statements?

(a) Both Statement–1 and Statement–2 are true and Statement–2 is the correct explanation of Statement–1

(b) Both Statement–1 and Statement–2 are true and Statement–2 is not the correct explanation of Statement–1

(c) Statement–1 is true but Statement–2 is false

(d) Statement–1 is false but Statement–2 is true

17. The hybridizations of B^1 and B^2 atoms in diborane are
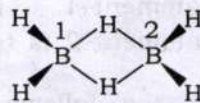
(a) sp^3 and sp^2 respectively

(b) sp^2 and sp^2

(c) sp^3 and sp^3

(d) sp^2 and sp^3 respectively

18. Which one of the following is correct regarding an ionic compound MX?

(a) High value of lattice energy of M^+X^- ionic crystal

(b) Electronegativity difference between M and X atoms is very small

(c) High ionization energy of atom M

(d) Low electron affinity of atom X

19. Which one of the following represents the correct order of lattice energy of oxides among the given alkaline earth metals?

(a) BeO < MgO < CaO < SrO < BaO

(b) BeO < SrO < MgO < CaO < BaO

(c) BaO < MgO < CaO < SrO < BeO

(d) BaO < SrO < CaO < MgO < BeO

20. According to Fajans' rule, which one of the following conditions is necessary to form a covalent bond?

(a) Large cation and large anion

(b) Small cation and small anion

(c) Small cation and large anion

(d) Large cation and small anion

21. Consider the following statements regarding defects in crystals :

1. Schottky defect occurs in highly ionic compounds where positive and negative ions are of similar size with high coordination number.

2. Frenkel defect is found in ionic crystal having low coordination number and large difference in size between the positive and negative ions.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

22. Which one of the following represents the correct bond order among the given nitrogen species?

(a) $N_2^- < N_2^{2-} < N_2$

(b) $N_2^- < N_2 < N_2^{2-}$

(c) $N_2^{2-} < N_2^- < N_2$

(d) $N_2 < N_2^{2-} < N_2^-$

23. Which one of the following is the correct electronic configuration of O_2^{2-}?

(a) $1\sigma_g^2\ 1\sigma_u^2\ 2\sigma_g^2\ 1\pi_u^4\ 1\pi_g^4$

(b) $1\sigma_g^2\ 1\sigma_u^2\ 1\pi_u^4\ 2\sigma_g^2\ 1\pi_g^4$

(c) $1\sigma_g^2\ 1\sigma_u^2\ 1\pi_u^4\ 1\pi_g^4\ 2\sigma_g^2$

(d) $1\sigma_u^2\ 1\sigma_g^2\ 2\sigma_g^2\ 1\pi_u^4\ 1\pi_g^4$

24. Which one of the following is **not** a resonance structure of thiocyanate (SCN^-)?

(a) $:\ddot{S}=C=\bar{N}:$

(b) $:\ddot{S}^--C\equiv N:$

(c) $:\overset{+}{S}\equiv C-\ddot{N}:^{2-}$

(d) $S^{2-}-C\equiv \bar{N}:$

25. Which one of the following is an inner orbital complex that also shows diamagnetism?

(a) $[Cr(NH_3)_6]^{2+}$

(b) $[Zn(NH_3)_6]^{2+}$

(c) $[Ni(NH_3)_6]^{2+}$

(d) $[Co(NH_3)_6]^{3+}$

26. Which one of the following is an example of neutral bidentate ligand?

(a) Oxalato

(b) o-Phenanthroline

(c) Glycinato

(d) Nitrilotriacetate

27. Which one of the following is the correct IUPAC name of $K_3[Fe(CN)_5NO]$?

(a) Tripotassium pentacyanonitrosylferrate(III)

(b) Potassium pentacyanonitrosyliron(II)

(c) Potassium pentacyanonitrosylferrate(II)

(d) Tripotassium pentacyanonitrosyliron(III)

28. The number of geometrical isomers that can exist for a square planar complex $[Pt(Cl)(py)(NH_3)(NH_2OH)]^+$ is

(a) 2

(b) 3

(c) 4

(d) 6

29. Which of the following types of isomerism are exhibited by $[Co(NH_3)_4(NO_2)_2]Cl$?

(a) Linkage isomerism, geometrical isomerism and optical isomerism

(b) Linkage isomerism, ionization isomerism and geometrical isomerism

(c) Ionization isomerism, geometrical isomerism and optical isomerism

(d) Linkage isomerism, ionization isomerism and optical isomerism

30. The molar equilibrium constant of pure water (K_w) at 25 °C is

(a) 1.0×10^{-7}

(b) 1.0

(c) 1.0×10^{-14}

(d) 1.0×10^7

31. Which one of the following represents the correct order of acidic strength among BBr_3, BCl_3, BF_3 and BI_3?

(a) $BI_3 < BBr_3 < BCl_3 < BF_3$

(b) $BF_3 < BCl_3 < BBr_3 < BI_3$

(c) $BF_3 < BBr_3 < BCl_3 < BI_3$

(d) $BF_3 < BCl_3 < BI_3 < BBr_3$

32. What is the degree of dissociation of a $0 \cdot 01\, M$ aqueous solution of acetic acid at 25 °C having a specific conductance $1 \cdot 63 \times 10^{-2}\, S\, m^{-1}$ and molar conductance of acetic acid at infinite dilution $390 \cdot 7 \times 10^{-4}\, S\, m^2\, mol^{-1}$?

(a) $1 \cdot 82 \times 10^{-5}$

(b) $1 \cdot 82 \times 10^{5}$

(c) $0 \cdot 0417$

(d) $4 \cdot 17$

33. Which of the following factors affect the ionization energy?

1. Atomic size

2. Nuclear charge

3. Type of electrons involved

Select the correct answer using the code given below.

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

34. The pOH and pH of a $6 \times 10^{-2}\, M$ solution of NaOH will be $(\log 6 = 0 \cdot 77)$

(a) 6 and 8 respectively

(b) 8 and 6 respectively

(c) $1 \cdot 23$ and $12 \cdot 77$ respectively

(d) $12 \cdot 77$ and $1 \cdot 23$ respectively

35. Which one of the following is used for the calibration of pH electrodes?

(a) Acidic solution

(b) Basic solution

(c) Buffer solution

(d) Water

36. What will be the pH of a buffer solution, prepared by mixing of 10 mL of $0 \cdot 1\, M$ acetic acid and 10 mL of $0 \cdot 01\, M$ sodium acetate? (pK_a of acetic acid $= 4 \cdot 76$)

(a) Approximately $2 \cdot 6$

(b) Approximately $3 \cdot 8$

(c) Approximately $4 \cdot 2$

(d) Approximately $5 \cdot 8$

37. 25 mL of H_2SO_4 solution requires $48 \cdot 75$ mL of $0 \cdot 02\, M$ NaOH for complete titration. What will be the molarity of H_2SO_4?

(a) $0 \cdot 0201\, M$

(b) $0 \cdot 0161\, M$

(c) $0 \cdot 0180\, M$

(d) $0 \cdot 0195\, M$

38. In which one of the following titrimetric analyses, $AgNO_3$ is used as a primary standard?

    (a) Acid-base titration

    (b) Complexometric titration

    (c) Precipitation titration

    (d) Redox titration

39. Which one of the following pairs about titrimetric quantitative estimation is *not* correctly matched?

    (a) Complexometric titration :
$$EDTA/Ca^{2+}$$

    (b) Acid-base titration :
$$Na_2CO_3/Na_2B_4O_7$$

    (c) Redox titration : $K_2Cr_2O_7/KBrO_3$

    (d) Precipitation titration :
$$NaNO_3/KNO_2$$

40. 1,10-Phenanthroline-iron(II) complex is

    (a) acid-base indicator

    (b) metal ion indicator

    (c) redox indicator

    (d) internal indicator

41. The pressure exerted by 10^{20} gas particles, each of mass 10^{-22} g in a container of volume $1\,dm^3$ and root mean square speed $10^3\ m\,s^{-1}$, is

    (a) 10 Pa

    (b) $\frac{1}{3} \times 10$ Pa

    (c) 10^4 Pa

    (d) $\frac{1}{3} \times 10^4$ Pa

42. Consider the following statements :

Statement–1 :

    At the zero of the absolute scale of temperature, the limiting value of pV [denoted by $(pV_m)_0$] is zero.

Statement–2 :

    The temperature $-273 \cdot 15\ °C$ is the natural or true zero.

Which one of the following is correct in respect of the above statements?

    (a) Both Statement–1 and Statement–2 are true

    (b) Statement–1 is true but Statement–2 is false

    (c) Statement–1 is false but Statement–2 is true

    (d) Both Statement–1 and Statement–2 are false

43. The translational kinetic energy of an ideal gas is

    (a) inversely proportional to the absolute temperature

    (b) independent of the absolute temperature

    (c) directly proportional to the absolute temperature

    (d) directly proportional to square root of the absolute temperature

44. The temperature at which the average speed of hydrogen (H_2) equals that of oxygen (O_2) at 480 K is

(a) 10 K

(b) 20 K

(c) 30 K

(d) 40 K

45. Consider the following statements :

Statement–1 :

The speed distribution of O_2 molecules at temperature T is the same as that of SO_2 molecules at temperature $2T$.

Statement–2 :

The distribution of speeds, in general, depends upon the value of M/T.

Which one of the following is correct in respect of the above statements?

(a) Both Statement–1 and Statement–2 are true and Statement–2 is the correct explanation of Statement–1

(b) Both Statement–1 and Statement–2 are true and Statement–2 is not the correct explanation of Statement–1

(c) Statement–1 is true but Statement–2 is false

(d) Statement–1 is false but Statement–2 is true

46. The mean free path of a gas is

(a) directly proportional to pressure (p) and inversely proportional to temperature (T)

(b) directly proportional to T and inversely proportional to p

(c) directly proportional to $\sqrt{T}$ and inversely proportional to $\sqrt{p}$

(d) directly proportional to $\sqrt{pT}$

47. The ratio of the rate of effusion of a nitrogen (N_2) molecule and a carbon dioxide (CO_2) molecule through a small hole at room temperature and one atmospheric pressure is

(a) $\sqrt{\dfrac{11}{7}} : 1$

(b) $\sqrt{\dfrac{7}{11}} : 1$

(c) $\dfrac{11}{7} : 1$

(d) $\dfrac{7}{11} : 1$

48. For a reversible adiabatic expansion of an ideal gas, the plot of $\log p$ *versus* $\log V$ is a straight line of slope

(a) $+\gamma$

(b) $-\gamma$

(c) -1

(d) $+1$

(where $\gamma = \dfrac{C_p}{C_V}$)

49. Which one of the following represents a pair of extensive variables?

(a) Dipole moment and vapour pressure

(b) Entropy and enthalpy

(c) Free energy and concentration

(d) Heat capacity and e.m.f. of a dry cell

50. If the internal energy (U) of a system is dependent on the pressure (p) and volume (V) of the system, then, according to the cyclic rule

$$\left(\frac{\partial U}{\partial p}\right)_V \left(\frac{\partial p}{\partial V}\right)_U \left(\frac{\partial V}{\partial U}\right)_p$$

is equal to

(a) zero

(b) +1

(c) −1

(d) ∞

51. Which of the following are essential criteria of a state function?

1. The change in the value of a state function depends only on the initial and final states and not on the path taken to go from the initial to the final state.

2. The cyclic integration involving a state function is zero.

3. The state function has an exact differential.

4. Entropy, enthalpy and chemical potential satisfy the requirements of state function.

Select the correct answer using the code given below.

(a) 1, 2 and 3 only

(b) 1 and 4 only

(c) 2, 3 and 4 only

(d) 1, 2, 3 and 4

52. Consider the following statements :

Statement−1 :
For hydrogen gas at room temperature, there is heating in the Joule-Thomson expansion.

Statement−2 :
For hydrogen gas at room temperature, $\frac{2a}{RT} < b$ (where a and b are the van der Waals' constants, R = universal gas constant).

Which one of the following is correct in respect of the above statements?

(a) Both Statement−1 and Statement−2 are true and Statement−2 is the correct explanation of Statement−1

(b) Both Statement−1 and Statement−2 are true and Statement−2 is not the correct explanation of Statement−1

(c) Statement−1 is true but Statement−2 is false

(d) Statement−1 is false but Statement−2 is true

53. At the inversion temperature of a gas, the value of $\left(\dfrac{\partial (pV)}{\partial p}\right)_T$ is

   (a) positive and equal to the magnitude of $\left(\dfrac{\partial U}{\partial V}\right)_T \left(\dfrac{\partial V}{\partial p}\right)_T$

   (b) negative only

   (c) positive and is greater than the magnitude of $\left(\dfrac{\partial U}{\partial V}\right)_T \left(\dfrac{\partial V}{\partial p}\right)_T$

   (d) negative and is less than the magnitude of $\left(\dfrac{\partial U}{\partial V}\right)_T \left(\dfrac{\partial V}{\partial p}\right)_T$

54. For the adiabatic irreversible free expansion of an ideal gas

   (a) $w = 0$ only

   (b) $\Delta U = 0$ only

   (c) $\Delta U = 0,\ \Delta T = 0,\ \Delta H = 0$ only

   (d) $w = 0,\ \Delta T = 0,\ \Delta U = 0$ and $\Delta H = 0$

55. What will be the enthalpy change when one mole of HCl (g) is dissolved in a large amount of water at room temperature for the following change in state?

$$HCl\,(g) + aq \rightarrow H^+\,(aq) + Cl^-\,(aq)$$
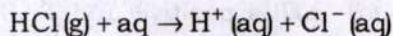
[where $\Delta_f H^\circ$ (HCl, g) = $-92 \cdot 3$ kJ mol^{-1}; $\Delta_f H^\circ$(Cl$^-$, aq) = $-167 \cdot 2$ kJ mol^{-1}]

   (a) $-74 \cdot 9$ kJ mol^{-1}

   (b) $-259 \cdot 5$ kJ mol^{-1}

   (c) $+74 \cdot 9$ kJ mol^{-1}

   (d) $+259 \cdot 5$ kJ mol^{-1}

56. Consider the following statements regarding efficiency of a Carnot engine :

  1. The efficiency of the heat engine is dependent on the working substance.

  2. The efficiency of a reversible heat engine is greater than that of an irreversible engine.

  3. With an increase in the difference of the temperature between the source and the sink, the efficiency increases (keeping the temperature of the sink constant).

Which of the statements given above are correct?

   (a) 1 and 2 only

   (b) 1 and 3 only

   (c) 2 and 3 only

   (d) 1, 2 and 3

57. Which one of the following Maxwell thermodynamic relations is *not* correct?

   (a) $\left(\dfrac{\partial S}{\partial V}\right)_T = \left(\dfrac{\partial p}{\partial T}\right)_V$

   (b) $\left(\dfrac{\partial S}{\partial p}\right)_T = -\left(\dfrac{\partial V}{\partial T}\right)_p$

   (c) $\left(\dfrac{\partial T}{\partial p}\right)_S = \left(\dfrac{\partial V}{\partial S}\right)_p$

   (d) $\left(\dfrac{\partial T}{\partial V}\right)_S = \left(\dfrac{\partial p}{\partial S}\right)_V$

58. The values of $\oint \dfrac{dq_{(rev.)}}{T}$ and $\oint \dfrac{dq_{(irrev.)}}{T}$ for a system are respectively (where q = heat absorbed by the system at temperature T)

(a) zero and less than zero

(b) less than zero and zero

(c) greater than zero and zero

(d) zero and greater than zero

59. Which one of the following expressions represents Gibbs-Helmholtz equation?

(a) $\Delta_r G = \Delta_r H + T\left(\dfrac{\partial G}{\partial T}\right)_P$

(b) $\Delta_r H = \Delta_r G - T\left(\dfrac{\partial(\Delta_r G)}{\partial T}\right)_P$

(c) $\Delta_r A = \Delta_r U + p\left(\dfrac{\partial(\Delta_r A)}{\partial T}\right)_V$

(d) $\Delta_r U = \Delta_r A + T\left(\dfrac{\partial(\Delta_r A)}{\partial T}\right)_P$

60. The change in the Gibbs free energy (ΔG) at constant pressure (p) in a certain process is $-83 \cdot 7\,kJ$ at $32\,°C$ and $-80 \cdot 7\,kJ$ at $42\,°C$. The value of the change in enthalpy of the process at $37\,°C$ is

(a) $-148 \cdot 0\,kJ$

(b) $-82 \cdot 2\,kJ$

(c) $+175 \cdot 2\,kJ$

(d) $-175 \cdot 2\,kJ$

61. The variation of $\log_{10} K$ with $1/T$ is shown in the following graph in which the straight line is at $45°$ (where K is the equilibrium constant, $R = 8 \cdot 3\,JK^{-1}\,mol^{-1}$; $\tan 45° = 1$; $\ln 10 = 2 \cdot 303$) :
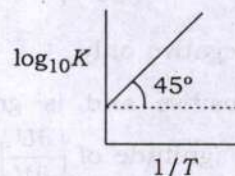
The value of $\Delta H°$ is approximately

(a) $+19 \cdot 1\,J\,mol^{-1}$

(b) $-19 \cdot 1\,J\,mol^{-1}$

(c) $+8 \cdot 3\,J\,mol^{-1}$

(d) $-8 \cdot 3\,J\,mol^{-1}$

62. Which one of the following is correct for an endothermic reaction $A \to B$ that proceeds spontaneously?

(a) ΔS is positive and $T\Delta S > \Delta H$

(b) ΔH is positive and $\Delta H > T\Delta S$

(c) ΔS is negative and $T\Delta S > \Delta H$

(d) ΔH is positive and $T\Delta S = \Delta H$

63. Which one of the following solutions in water possesses the lowest vapour pressure?

(a) $0 \cdot 1\,M\ BaCl_2$

(b) $0 \cdot 1\,M\ NaCl$

(c) $0 \cdot 1\,M\ KCl$

(d) $0 \cdot 1\,M\ Urea$

64. The mass of a solute of molar mass $360\,g\,mol^{-1}$ that should be dissolved in $180\,g$ of water to reduce its vapour pressure to 23 torr at $25\,°C$ is approximately (the vapour pressure of water at $25\,°C = 24$ torr)

(a) $120\,g$

(b) $150\,g$

(c) $128\,g$

(d) $114\,g$

65. For a binary $(A + B)$ ideal liquid solution, the total vapour pressure of the solution is given as

(a) $p_{total} = p_A^* + (p_A^* - p_B^*)\,x_A$

(b) $p_{total} = p_B^* + (p_A^* - p_B^*)\,x_A$

(c) $p_{total} = p_A^* + (p_B^* - p_A^*)\,x_A$

(d) $p_{total} = p_B^* + (p_B^* - p_A^*)\,x_B$

(where x_A and x_B are the mole fractions of the components A and B)

66. A $0.002\,M$ sugar solution in water is separated from pure water by an osmotic membrane. The osmotic pressure developed at $27\,°C$ is (where $R = 0.083\,dm^3\,bar\,K^{-1}\,mol^{-1}$)

(a) $1.9\,kPa$

(b) $2.5\,kPa$

(c) $3.7\,kPa$

(d) $5.0\,kPa$

67. A 0.1 molal solution of a monobasic acid HX is 10% ionized in water. The freezing point of the resultant solution is (where K_f for water = $1.86\,K\,molal^{-1}$)

(a) $-0.45\,°C$

(b) $-0.205\,°C$

(c) $+0.45\,°C$

(d) $+0.312\,°C$

68. The Henry's law constants for the solubilities of O_2 and N_2 gases in water are $880\,Pa$ and $440\,Pa$ respectively at $25\,°C$. What will be the ratio of the mole fractions of O_2 and N_2 dissolved in water at $25\,°C$? (The mole fractions of O_2 and N_2 present in the atmosphere are 0.20 and 0.80 respectively)

(a) 0.25

(b) 0.125

(c) 0.20

(d) 0.50

69. Which of the following statements are **not** correct with respect to solubility of gases in a liquid solvent?

1. Gases which are easily liquefied are less stable in common solvents.

2. Gases forming ions in water are more soluble in water.

3. Under constant pressure, the solubility of a gas increases with rise in temperature.

4. The solubility of a gas in a liquid is highly dependent on the pressure of the system.

Select the correct answer using the code given below.

(a) 1 and 2

(b) 1 and 3

(c) 1 and 4

(d) 3 and 4

70. Which of the following statements about solutions of electrolytes is/are correct?

1. Conductivity of solution depends upon the size of the ions.

2. Conductivity depends upon the viscosity of solution.

3. Conductivity does not depend upon the solvation of ions present in solution.

4. Conductivity of solution varies with the temperature.

Select the correct answer using the code given below.

(a) 1 and 2 only

(b) 3 only

(c) 1, 2 and 4

(d) 2, 3 and 4

71. The resistance of a $0.10\ N$ solution of an electrolyte occupying a volume between two platinum electrodes of cell constant $39\ m^{-1}$ is $30\ \Omega$. The specific conductance and equivalent conductance of the solution will be respectively

(a) $0.013\ \Omega^{-1} m^{-1}$ and $1.3\ \Omega^{-1} m^2\ eq^{-1}$

(b) $1.3\ \Omega^{-1} m^{-1}$ and $0.013\ \Omega^{-1} m^2\ eq^{-1}$

(c) $2.5\ \Omega^{-1} m^{-1}$ and $0.25\ \Omega^{-1} m^2\ eq^{-1}$

(d) $1.3\ \Omega^{-1} m^{-1}$ and $130\ \Omega^{-1} m^2\ eq^{-1}$

72. Consider the following statements :

Statement–1 :

Near the lower value of the concentration, Λ_m (molar conductivity) of CH_3COOH increases sharply on dilution.

Statement–2 :

Λ_m° (limiting molar conductivity) is obtained by using the Kohlrausch law of independent migration of ions.

Which one of the following is correct in respect of the above statements?

(a) Both Statement–1 and Statement–2 are correct

(b) Statement–1 is correct but Statement–2 is incorrect

(c) Both Statement–1 and Statement–2 are incorrect

(d) Statement–1 is incorrect but Statement–2 is correct

73. Which one of the following statements is correct with respect to ionic mobilities in solution?

(a) Ionic mobilities in solution have similar magnitudes as the speed of gaseous molecules in gas.

(b) Solvation increases the ionic mobility in a solution.

(c) Sodium ions have low ionic mobility due to extensive hydration of the Na^+ ions in aqueous solution.

(d) Ionic mobility reduces the degree of dissolution of strong electrolytes in solution.

74. Consider the following statements :

1. Molar conductivity increases with dilution.

2. Conductivity decreases with decrease in concentration.

3. For strong electrolyte, the molar conductivity increases very sharply with decrease in concentration.

Which of the statements given above is/are correct?

(a) 1 and 2

(b) 1 and 3

(c) 2 and 3

(d) 3 only

75. Which one of the following statements is **not** correct in relation to the Debye-Hückel theory of electrolytic solutions?

(a) The Debye-Hückel theory assumes the ions in a solution to be in constant motion.

(b) The Debye-Hückel limiting law is applicable for concentrated solutions only.

(c) The ionic strength of a solution does not depend on the dielectric constant of the solvent.

(d) The Debye-Hückel limiting law plots for NaCl and KCl should be identical.

76. In a conductivity cell of cell constant $0.003 \ cm^{-1}$ containing a $0.01 \ M$ solution of acetic acid, the resistance against ionic mobility is $20 \ \Omega$ at 25 °C. The degree of dissociation of the acid is (where the molar conductance at infinite dilution = $390 \times 10^{-4} \ \Omega^{-1} \ m^2 \ mol^{-1}$ at 25 °C)

(a) 0·015

(b) 0·027

(c) 0·038

(d) 0·047

77. The specific conductance of a saturated solution of the sparingly soluble salt AgCl in water at 25 °C, after subtracting the specific conductance of pure water, is $1·82 \times 10^{-4} \ \Omega^{-1} m^{-1}$. What will be the approximate value of solubility of AgCl at this temperature, given that the molar conductance of AgCl at infinite dilution is $1·38 \times 10^{-2} \ \Omega^{-1} \ m^2 \ mol^{-1}$?

(a) $1·32 \times 10^{-2} \ mol \ m^{-3}$

(b) $1·43 \times 10^{-5} \ mol \ m^{-3}$

(c) $2·52 \times 10^{-6} \ \Omega^{-2} \ m \ mol$

(d) $2·52 \times 10^{-10} \ \Omega^{-2} \ m \ mol$

78. Which of the following statements regarding conductometric titrations involving acids and bases is/are *not* correct? [In each case, the base (alkali) is added to the acid contained in the conductivity cell as the titration progresses]

1. The electrical conductance depends only on the mobility, but not on the number of ions.

2. The titration of a strong acid against a strong base yields a V-shaped plot.

3. Titrations of a strong acid against a weak base and a weak acid against a strong base yield identical-shaped plots.

4. In a titration involving a mixture of a strong acid and a weak acid against a strong base, the strong acid is neutralized first.

Select the correct answer using the code given below.

(a) 1 and 4

(b) 1 only

(c) 2

(d) 1 and 3

79. Consider the following conductometric titration curve of HCl with NaOH :
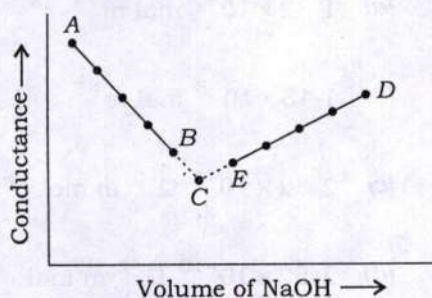
80. Which one of the following statements is *not* correct in respect of the given conductometric titration curve?

(a) At point B, the solution contains a mixture of HCl and NaCl salt.

(b) At point C, the solution contains a mixture of NaOH and NaCl salt.

(c) At point E, the solution contains a mixture of HCl and NaCl salt.

(d) At point A, the solution contains HCl only.

80. What will be the transport number of H^+ ions in an aqueous solution of $0.050\ M$ HCl using the moving boundary method, with $CdCl_2$ as the indicator electrode? Here, the boundary moves by $7.5\ cm$ in a tube of cross-sectional area of $2.5\ cm^2$, upon flowing of 1.1×10^{-3} faraday of electricity in the circuit.

(a) 0·85

(b) 0·17

(c) 0·085

(d) 0·72

81. Which one of the following statements is *not* true about the molecules I and II?
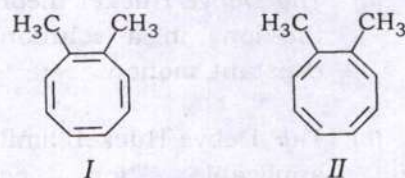
(a) The structures of I and II are simply two resonance forms of the same molecule.

(b) The structures of I and II represent different molecules.

(c) I and II are non-aromatic in nature.

(d) The dianions of I and II are aromatic in nature.

82. Rank the following dienes in order of increasing heat of hydrogenation :
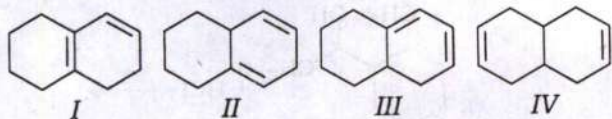
I   II   III   IV

(a) $I < III < IV < II$

(b) $IV < II < I < III$

(c) $III < I < IV < II$

(d) $I < III < II < IV$

83. The hybridization of nitrogen present in the following imine is
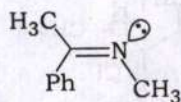
(a) sp^3 (b) sp^2

(c) sp (d) sp^3d

84. Which of the indicated C—H bonds in each of the following pairs of compounds would yield a more stable free radical upon homolytic cleavage?

Pair X:

1   2

Pair Y:

3   4
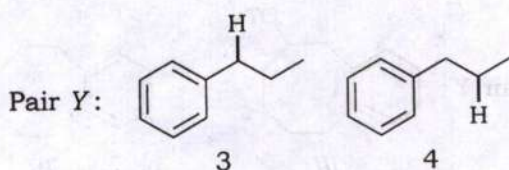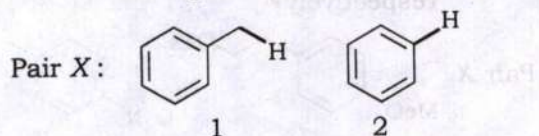
(a) 1 and 3

(b) 1 and 4

(c) 2 and 3

(d) 2 and 4

85. The mechanism of reactions at Stage *I*, Stage *II* and Stage *III* in the following reaction sequence is
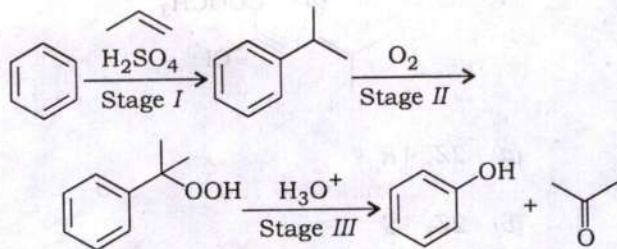
(a) Stage *I* : Radical, Stage *II* : Radical, Stage *III* : Polar

(b) Stage *I* : Polar, Stage *II* : Radical, Stage *III* : Polar

(c) Stage *I* : Polar, Stage *II* : Polar, Stage *III* : Radical

(d) Stage *I* : Radical, Stage *II* : Polar, Stage *III* : Polar

86. Which one of the following molecules is chiral?
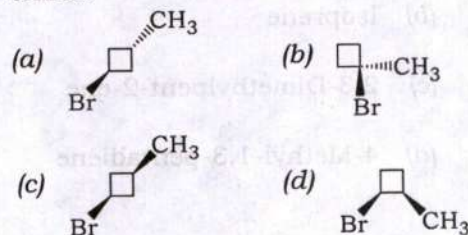
87. Which one of the following is **not** a *meso* compound?

FTRE–F–CHE/**43A**   17   [P.T.O.
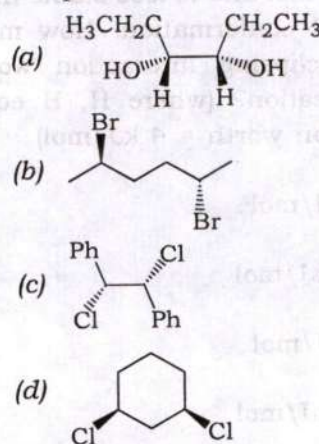
88. The stereochemical notations for the following compound are
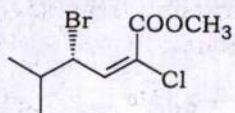
(a) $2Z, 4R$

(b) $2Z, 4S$

(c) $2E, 4R$

(d) $2E, 4S$

89. Which one of the following compounds shows geometrical isomerism?

(a) Cyclooctene

(b) Isoprene

(c) 2,3-Dimethylpent-2-ene

(d) 4-Methyl-1,3-pentadiene

90. The eclipsed conformation of CH_3CH_2Cl is 15 kJ/mol and is less stable than the staggered conformation. How much is H, Cl eclipsing interaction worth in destabilization? (where H, H eclipsing interaction worth = 4 kJ/mol)

(a) 8 kJ/mol

(b) 11 kJ/mol

(c) 7 kJ/mol

(d) 12 kJ/mol

91. The major product formed in the following reaction is

(a)

(b)

(c)

(d)
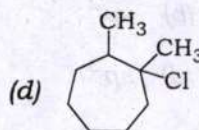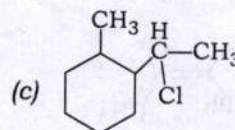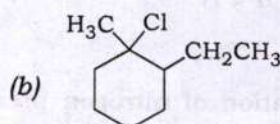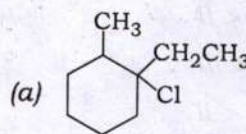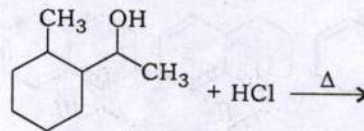
92. Which of the following substrates will be more reactive in solvolysis conditions using formic acid in Pair X and Pair Y respectively?

Pair X:

Pair Y:
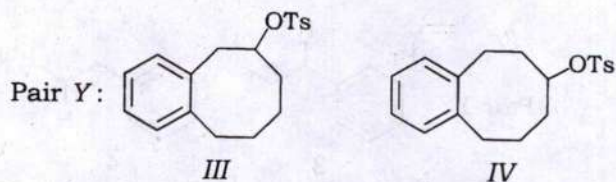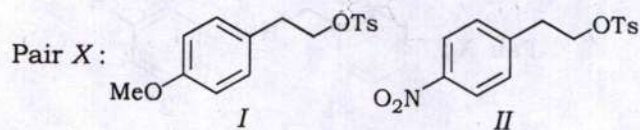
(a) I and III

(b) I and IV

(c) II and III

(d) II and IV

93. The relative order of reactivity of the following bromides in S_N1 reaction is

    1   2   3
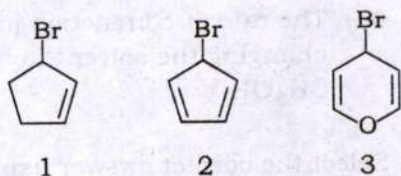
(a) $3 > 2 > 1$

(b) $2 > 3 > 1$

(c) $3 > 1 > 2$

(d) $2 > 1 > 3$

94. Which one of the following compounds would react most readily by S_N2 mechanism?

(a)

(b)

(c)
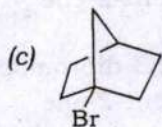
(d) None of the above

95. Rank the following alkyl bromides from most reactive to least reactive in a solvolysis reaction using aqueous acetone :
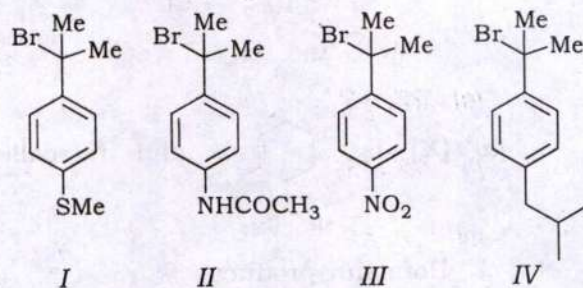
    I   II   III   IV

(a) $II > IV > I > III$

(b) $I > II > IV > III$

(c) $III > IV > II > I$

(d) $III > IV > I > II$

96. The major products $[X]$ and $[Y]$ formed in the following reactions are

(a) $[X] =$ $[Y] =$

(b) $[X] =$ $[Y] =$

(c) $[X] = [Y] =$

(d) $[X] = [Y] =$
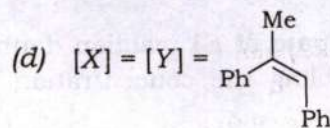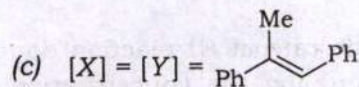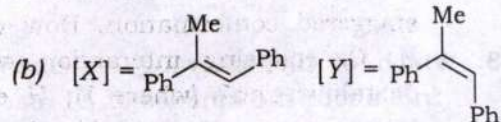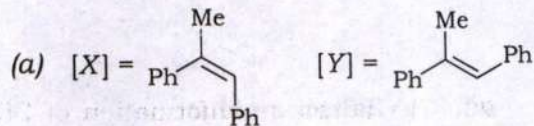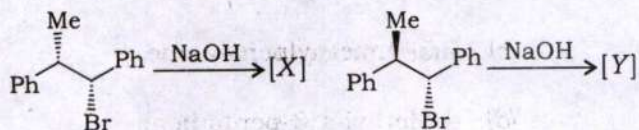
97. Which one of the following is true for the reaction given below?

$\xrightarrow{\text{NaOMe}}$ [X]
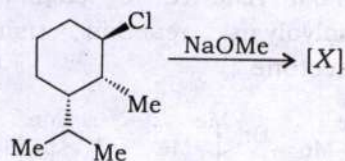
(a) [X] is and is called

Hofmann product

(b) [X] is and is called

Hofmann product

(c) [X] is and is called

Zaitsev product

(d) [X] is and is called

Zaitsev product

98. Which of the following statements are true about the kinetics of $E1$ reaction of an alkyl halide in presence of base?

1.   The rate of $E1$ reaction doubles by doubling the concentration of the alkyl halide.

2.   The rate of $E1$ reaction doubles by doubling the concentration of the base.

3.   The rate of $E1$ reaction decreases by changing the alkyl halide from $(CH_3)_3CBr$ to $CH_3CH_2CH_2Br$.

4.   The rate of $E1$ reaction increases by changing the solvent from DMSO to CH_3OH.

Select the correct answer using the code given below.

(a) 1, 2 and 3

(b) 2, 3 and 4

(c) 1, 3 and 4

(d) 1 and 2 only

99. The IUPAC names of the substrate [X] and the product [Y] formed in the following reaction are
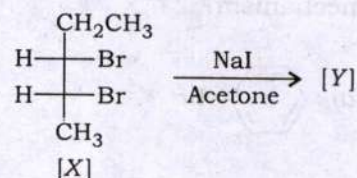
$\xrightarrow[\text{Acetone}]{\text{NaI}}$ [Y]

[X]

(a) [X] is (2R, 3S)-2,3-dibromopentane and [Y] is (E)-pent-2-ene

(b) [X] is (2R, 3S)-2,3-dibromopentane and [Y] is (Z)-pent-2-ene

(c) [X] is (2S, 3S)-2,3-dibromopentane and [Y] is (E)-pent-2-ene

(d) [X] is (2R, 3R)-2,3-dibromopentane and [Y] is (Z)-pent-2-ene

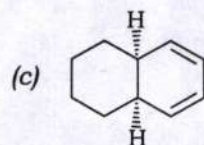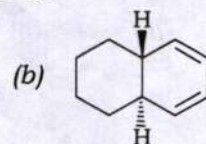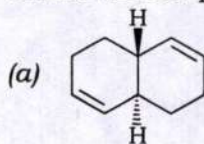**100.** The major product formed in the following reaction sequence is


i) MeO⁻, MeOH
ii) H⁺, H₂O

(a)

(b)

(c)

(d)
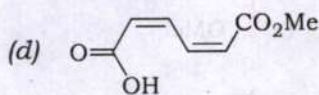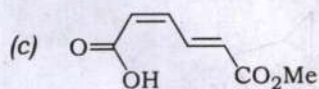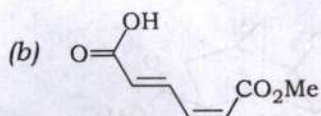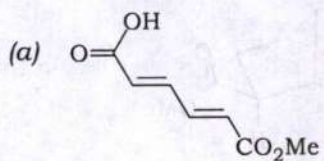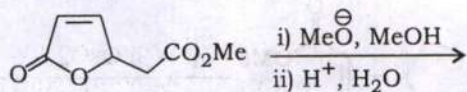
101. The major product formed in the following reaction sequence is

i) Br₂, H₂O
ii) H₂SO₄, Δ

(a)

(b)

(c)

(d)
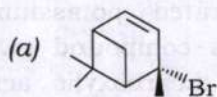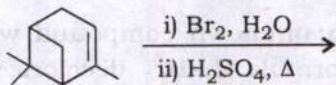
102. The precursor [X] in the following reaction is

[X] →
i) NaOMe
ii) H₂O

(a)

(b)

(c)

(d)
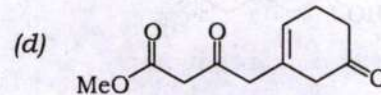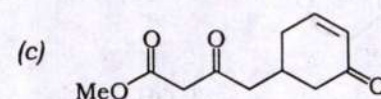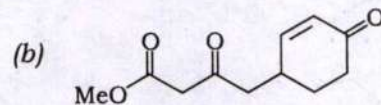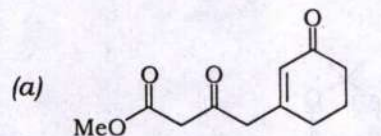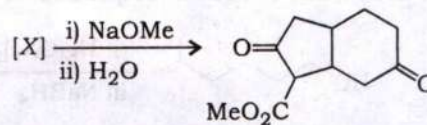
103. The major products formed in the following reaction sequence are

i) Hg(OAc)₂, MeOH
ii) NaBH₄, MeOH

(a)

(b)

(c)

(d)
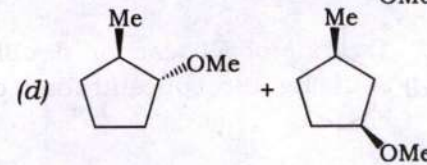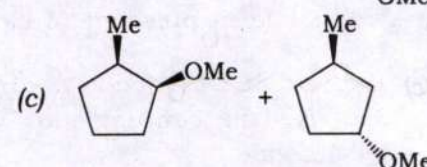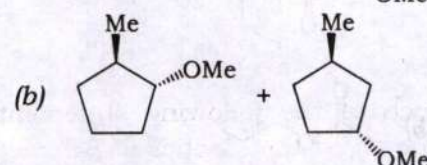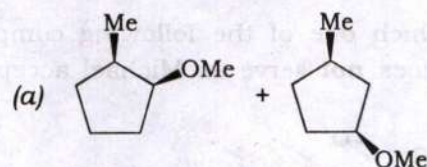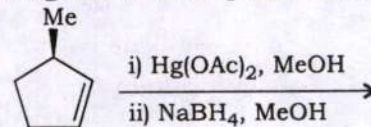
104. The major product formed in the following reaction sequence is

i) Hg(OAc)$_2$
ii) NaBH$_4$

(a)

(b)

(c)

(d)
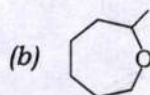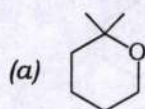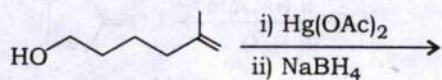
105. Which one of the following compounds does **not** serve as Michael acceptor?

(a)

(b)

(c)

(d)
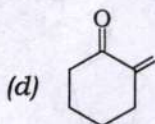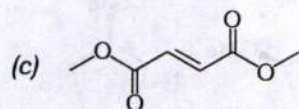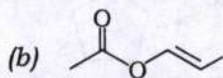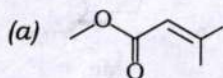
106. The final product [X] formed in the following reaction sequence is

Δ
i) OsO$_4$
ii) NaHSO$_3$, H$_2$O
[X]

(a)

(b)

(c)

(d)
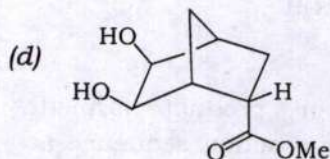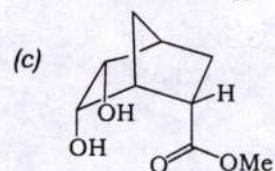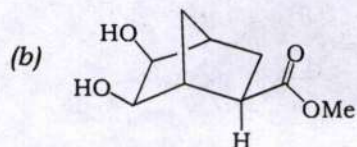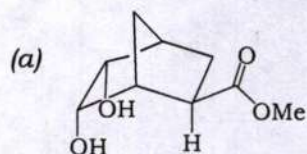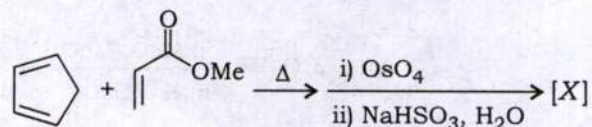
107. An unknown compound with molecular formula C$_{10}$H$_{14}$ decolorizes bromine in carbon tetrachloride. When treated with warm, concentrated potassium permanganate, this compound gives cis-cyclohexane-1,2-dicarboxylic acid and oxalic acid. The structure for the unknown compound is

(a)   (b)

(c)   (d)

22
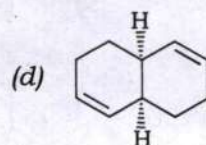
108. The major product formed in the following reaction is

$$\xrightarrow{Br_2/H_2O}$$

(a)

(b)

(c)

(d)
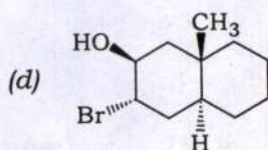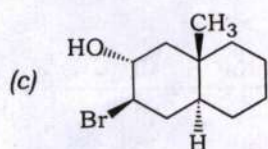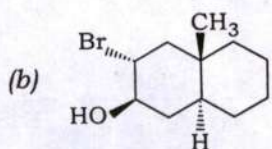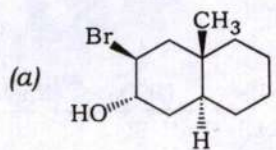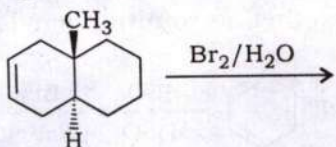
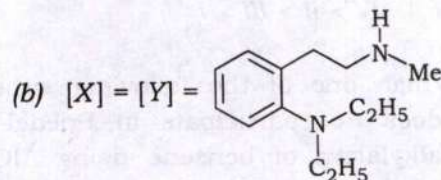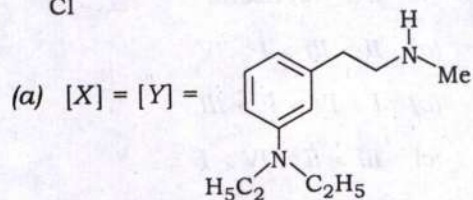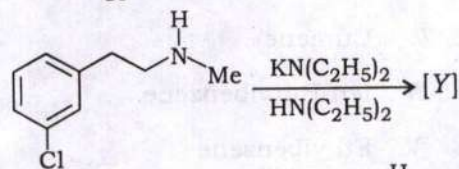**109.** Which is the most stable intermediate in the following Pair X and Pair Y respectively?
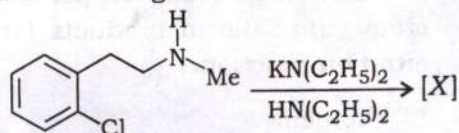

Pair X: I, II   Pair Y: III, IV
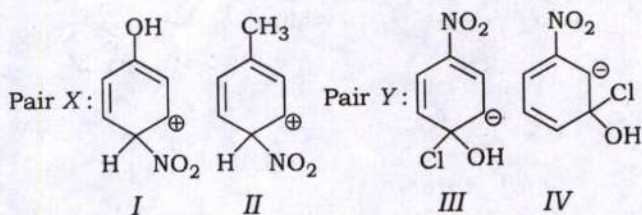
(a) I and III

(b) I and IV

(c) II and III

(d) II and IV

110. The major products [X] and [Y] formed in the following reactions are

$$\xrightarrow[HN(C_2H_5)_2]{KN(C_2H_5)_2} [X]$$

$$\xrightarrow[HN(C_2H_5)_2]{KN(C_2H_5)_2} [Y]$$

(a) [X] = [Y] =

(b) [X] = [Y] =

(c) [X] = [Y] =

(d) [X] = [Y] =
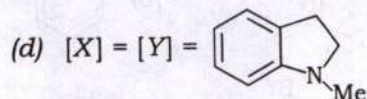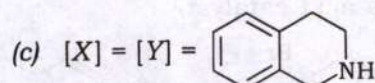
111. The major product formed in the following reaction is

$$\xrightarrow{NH_3}$$

(a)

(b)

(c)

(d)
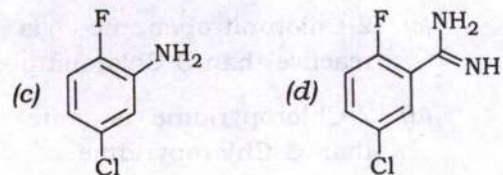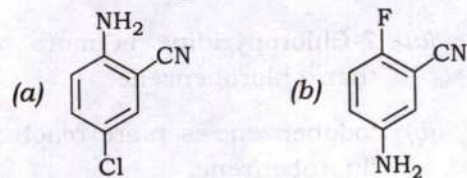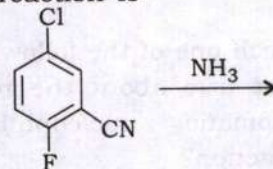
112. Arrange the following alkyl benzenes in decreasing order of percentage of *ortho/para* ratio of products formed in nitration reaction :

I. Toluene

II. Cumene

III. *tert*-Butylbenzene

IV. Ethylbenzene

(a) II > III > I > IV

(b) I > IV > II > III

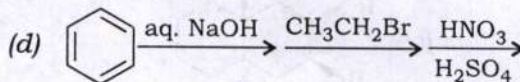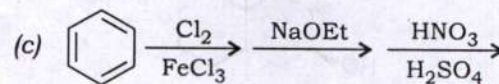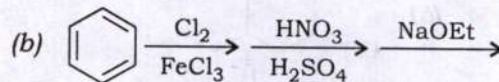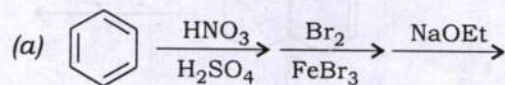(c) III > II > IV > I

(d) IV > II > III > I

113. Which one of the following substrates does **not** participate in Friedel-Crafts alkylation of benzene using $AlCl_3$ as Lewis acid catalyst?

(a)

(b)

(c)

(d)
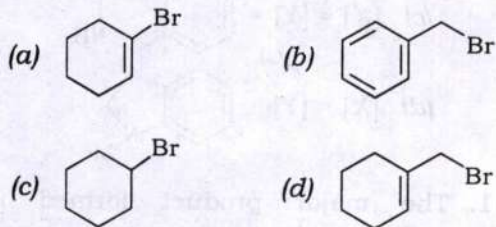
114. Which one of the following statements is **not** true about the reactivity towards aromatic nucleophilic substitution reaction?

(a) 2-Chloropyridine is more reactive than chlorobenzene.

(b) Iodobenzene is more reactive than fluorobenzene.

(c) 2-Chloronitrobenzene is more reactive than 3-Chloronitrobenzene.

(d) 2-Chloropyridine is more reactive than 3-Chloropyridine.

115. Which one of the following is the correct sequence of events for the preparation of ethyl 2,4-dinitrophenyl ether?
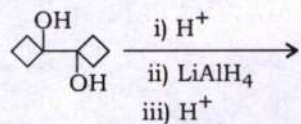
(a) $\xrightarrow[H_2SO_4]{HNO_3}$ $\xrightarrow[FeBr_3]{Br_2}$ $\xrightarrow{NaOEt}$

(b) $\xrightarrow[FeCl_3]{Cl_2}$ $\xrightarrow[H_2SO_4]{HNO_3}$ $\xrightarrow{NaOEt}$

(c) $\xrightarrow[FeCl_3]{Cl_2}$ $\xrightarrow{NaOEt}$ $\xrightarrow[H_2SO_4]{HNO_3}$

(d) $\xrightarrow{aq.\ NaOH}$ $\xrightarrow{CH_3CH_2Br}$ $\xrightarrow[H_2SO_4]{HNO_3}$

116. The number of [1, 2]-rearrangements occurring in the following transformation is
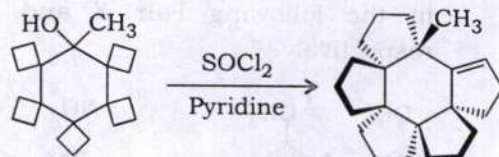
(a) three

(b) four

(c) five

(d) six

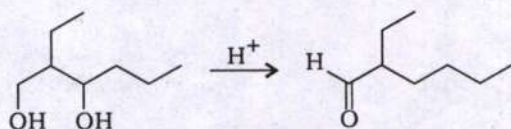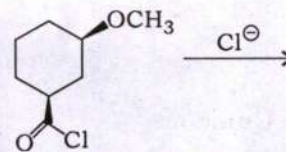**117.** The major product formed in the following reaction sequence is

i) H^+
ii) $LiAlH_4$
iii) H^+

(a)

(b)

(c)

(d)

118. The intermediate which is less likely to be formed in the mechanism of the following reaction is

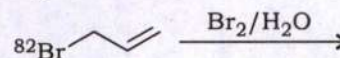 $\xrightarrow{H^+}$

(a)

(b)

(c)

(d)

119. The product formed due to neighbouring group participation in the following reaction is

 $\xrightarrow{Cl^{\ominus}}$

(a)

(b)

(c)

(d)

120. The major product formed in the following reaction is

^{82}Br $\xrightarrow{Br_2/H_2O}$

(a)

(b)

(c)

(d)

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