

SET 2013
PAPER – III

CHEMICAL SCIENCES

Signature of the Invigilator

Question Booklet No.

1.

OMR Sheet No..

Subject Code

ROLL No.

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Time Allowed : 150 Minutes

Max. Marks : 150

No. of pages in this Booklet : 12

No. of Questions : 75

INSTRUCTIONS FOR CANDIDATES

1. Write your Roll No and the OMR Sheet No in the spaces provided on top of this page.
2. Fill in the necessary information in the spaces provided on the OMR response sheet.
3. This booklet consists of seventy five (75) compulsory questions each carrying 2 marks.
4. Examine the question booklet carefully and tally the number of pages/questions in the booklet with the information printed above. **Do not accept a damaged or open booklet.** Damaged or faulty booklet may be got replaced within the first 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time given.
5. Each Question has four alternative responses marked (A), (B), (C) and (D) in the OMR sheet. You have to completely darken the circle indicating the most appropriate response against each item as in the illustration.



6. All entries in the OMR response sheet are to be recorded in the original copy only.
7. Use only Blue/Black Ball point pen.
8. Rough Work is to be done on the blank pages provided at the end of this booklet.
9. If you write your Name, Roll Number, Phone Number or put any mark on any part of the OMR Sheet, except in the spaces allotted for the relevant entries, which may disclose your identity, or use abusive language or employ any other unfair means, you will render yourself liable to disqualification.
10. You have to return the Original OMR Sheet to the invigilators at the end of the examination compulsorily and must not carry it with you outside the Examination Hall. **You are, however, allowed to carry the test booklet and the duplicate copy of OMR Sheet** on conclusion of examination.
11. Use of any calculator, mobile phone or log table etc. is strictly prohibited.
12. **There is no negative marking.**

01-13

CHEMICAL SCIENCES
PAPER - III

Note : This paper contains **seventy five (75)** objective type questions of **two (2)** marks each.

All questions are compulsory.

1. Which of the following molecules has a S_4 symmetry element ?
(A) PoCl_3
(B) SiCl_4
(C) BF_3
(D) SO_2Cl_2
2. The point group symmetry of allene, $\text{CH}_2=\text{C}=\text{CH}_2$ is :
(A) D_{2h}
(B) D_{2d}
(C) D_2
(D) C_{3v}
3. The number of distinct symmetry operations that can be performed on a molecule is :
(A) 2
(B) 4
(C) 6
(D) 8
4. Possible point group of a chiral and polar molecule will be :
(A) C_n
(B) D_n
(C) C_s
(D) S_n
5. Isothermal which has fractional coverage, linearly dependent on pressure at low pressure but almost independent at higher pressure is called :
(A) BET isotherm
(B) Langmuir isotherm
(C) Freundlich isotherm
(D) Temkin isotherm
6. Water is heated to boiling point under a pressure of 1.0 atm when an electric current of 0.50 A from 12 V supply is passed for 300 s through a resistance in thermal contact with it, it is found 0.798 gm water is vapourised. The molar internal change is :
(A) 41 KJ/mole
(B) 38 KJ/mole
(C) ≈ 2 KJ/mole
(D) ≈ 20 KJ/mole
7. A process is carried out at constant volume and at constant entropy. It will be spontaneous if :
(A) $\Delta G < 0$
(B) $\Delta H < 0$
(C) $\Delta U < 0$
(D) $\Delta A < 0$
8. At room temperature, which molecules has the maximum rotational entropy ?
(A) H_2
(B) O_2
(C) D_2
(D) N_2
9. An ideal gas expands following the equation $PV^a = \text{constant}$. In which case does one expect heating ?
(A) $3 > a > 2$
(B) $2 > a > 1$
(C) $0 < a < 1$
(D) $-1 < a < 0$
10. In the below given chemical reaction carried out at low pressure, the order of reaction is :
 $\text{A(s)} + \text{B(g)} \leftrightarrow \text{C(g)}$
(A) $1/2$
(B) 2
(C) 1
(D) 3

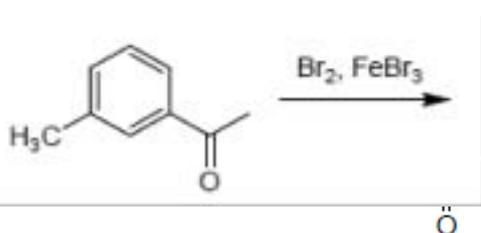
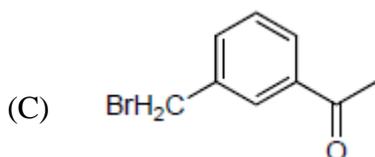
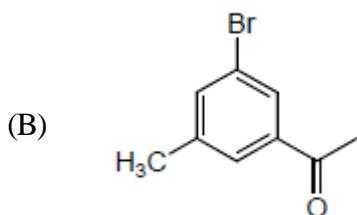
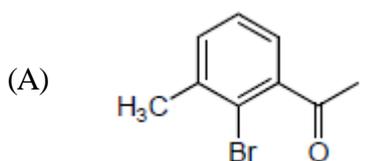
11. For a given first order reaction, the reactant reduces to $1/4^{\text{th}}$ its initial value in 10 minutes. The rate constant of the reaction is :
- (A) 0.1386 min^{-1}
 (B) 0.0693 min^{-1}
 (C) $0.1386 \text{ mol L}^{-1} \text{ min}^{-1}$.
 (D) $0.0693 \text{ mol L}^{-1} \text{ min}^{-1}$
12. A first order reaction is 75% completed in 100 minutes. How long time will it take for its 87.5% completion ?
- (A) 125 min
 (B) 150 min
 (C) 175 min
 (D) 200 min
13. Consider the standard voltaic (or galvanic) cell: Fe, Fe^{2+} versus Au, Au^{3+} . Which answer identifies the cathode and gives the E° for the cell ?
- (A) Fe, -0.44 V
 (B) Au, 1.94 V
 (C) Fe, 1.06 V
 (D) Fe, 1.94 V
14. A concentration cell is constructed by placing identical Cu electrodes in two Cu^{2+} solutions. If the concentrations of the two Cu^{2+} solutions are 1.0M and 0.0020 M, calculate the potential of the cell.
- (A) 0.020 V
 (B) 1.2 V
 (C) 0.080 V
 (D) 1.0 V
15. The mean ionic activity coefficient of $0.0005 \text{ mol kg}^{-1} \text{ CaCl}_2$ in water at 25°C is :
- (A) 0.98
 (B) 0.67
 (C) 0.81
 (D) 0.9
16. Which one of the following exhibits rotational spectra ?
- (A) H_2
 (B) N_2
 (C) CO
 (D) CO_2
17. Incorrect statement about photoelectron spectroscopy is :
- (A) Auger effect can be observed in X-rays PES only
 (B) PES is applicable for surface study
 (C) UV-PES can be used for chemical analysis and also known ESCA
 (D) UV-PES cannot show Auger effect
18. In $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion, the d-electron is located in the orbital :
- (A) d_{z^2}
 (B) $d_{x^2-y^2}$
 (C) d_{xy} or d_{xz} or d_{yz}
 (D) None of these
19. The structure of perhalic acid is :
- (A) Tetrahedral with no unpaired electron
 (B) Pyramidal with one unpaired electron
 (C) Tetrahedral with one unpaired electron
 (D) Pyramidal with no unpaired electron
20. The orange red colour of Ce^{4+} ion is due to the electronic transition :
- (A) $4f \leftarrow 4f$
 (B) $5d \leftarrow 4f$
 (C) $4f \leftarrow \text{ligand}$
 (D) $\text{Ligand} \leftarrow 4f$
21. The following ions are arranged in order of decreasing ionic radius. The correct order is :
- (A) Se^{2-} , I $^-$, F^- , O^{2-}
 (B) O^{2-} , Se^{2-} , F^- , I $^-$
 (C) I $^-$, F^- , Se^{2-} , O^{2-}
 (D) I $^-$, Se^{2-} , O^{2-} , F^-

22. Of the complexes $[\text{Co}(\text{CN})_6]^{4-}$, $[\text{CoCl}]^{4+}$, $[\text{Co}(\text{en})_3]^{2+}$, and $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$, the one having the lowest crystal field splitting will be :
- (A) $[\text{Co}(\text{en})_3]^{2+}$
 (B) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$
 (C) $[\text{Co}(\text{CN})_6]^{4-}$
 (D) $[\text{CoCl}]^{4+}$
23. Among the following complex ions, the one having the highest magnetic moment will be :
- (A) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
 (B) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
 (C) $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$
 (D) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
24. In dsp^3 hybridisation, the d orbital which takes part in the hybridization is :
- (A) d_{xz}
 (B) d_{z^2}
 (C) $d_{x^2-y^2}$
 (D) d_{xy}
25. The yellow colour of Eu^{3+} compound containing a reducing anion is due to the electronic transition :
- (A) $4f \leftarrow 4f$
 (B) $5d \leftarrow 4f$
 (C) $4f \leftarrow \text{ligand}$
 (D) $\text{Ligand} \leftarrow 4f$
26. Which pair of lanthanide ions exhibits the same colour ?
- (A) Pr^{3+} and Tm^{3+}
 (B) Nd^{3+} and Ho^{3+}
 (C) Sm^{3+} and Er^{3+}
 (D) Dy^{3+} and Eu^{3+}
27. In pyrosilicates, the basic silicate unit is :
- (A) $(\text{SiO}_4)^{4-}$
 (B) $(\text{Si}_4\text{O}_{11})^{6-}$
 (C) $(\text{SiO}_3)^{2-}$
 (D) $(\text{Si}_2\text{O}_7)^{6-}$
28. Which of the following oxo-acids of phosphorous contains four O-H bonds ?
- (A) Phosphorous acid
 (B) Hypophosphoric acid
 (C) Hypophosphorous acid
 (D) Phosphoric acid
29. Which of the following actinide ions is colorless ?
- (A) Am^{3+}
 (B) Cm^{3+}
 (C) U^{3+}
 (D) Pu^{3+}
30. Which of the following sets is isoelectronic with Xe ?
- (A) Br^- , I^- , Cs^+ , Cs^+
 (B) I^- , Cs^+ , Ba^{2+} , La^{3+}
 (C) Sn^{2+} , Sb^{3+} , Te^{2-} , I^-
 (D) Sn^{4+} , Sb^{5+} , Te^{2-} , I^-
31. In the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ion, the single absorption band that is observed is not symmetrical. This is due to :
- (A) Dynamic Jahn-Teller effect
 (B) Static Jahn-Teller effect
 (C) Crystal field effect
 (D) Nephelauxetic effect
32. Which of the following complexes can show optical isomerism ?
- (A) $\text{trans}-[\text{Co}(\text{en})_2\text{Cl}_2]^{2+}$
 (B) $[\text{Co}(\text{en})_3]^{2+}$
 (C) $\text{trans}-[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$
 (D) $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$

33. Enzyme carboxypeptidase contains :
- Cobalt
 - Zinc
 - Iron
 - Copper
34. Crystal field stabilization energy (CFSE) will be largest in:
- d^6 (low-spin, octahedral) complex
 - d^6 (high-spin, octahedral) complex
 - d^2 (tetrahedral) complex
 - d^7 (tetrahedral) complex
35. Electronic configuration of actinides cannot be assigned with high degree of certainty because of :
- Actinide contraction
 - Smaller energy difference between 5f and 6d orbitals
 - Imperfect shielding effect of 5f electrons
 - Overlapping of the inner orbitals
36. Amongst the following complex ions, the most stable one is :
- $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
 - $[\text{Fe}(\text{NH}_3)_6]^{3+}$
 - $[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$
 - $[\text{FeCl}_6]^{3-}$
37. Which of the following statement is not true ?
- Thermodynamically stable complex may be kinetically labile or inert
 - Thermodynamically unstable complexes may be kinetically inert
 - Labile complexes undergo fast substitution reactions
 - Inert complexes undergo fast substitution reactions
38. Among the following metal carbonyls, the C-O stretching frequency will be lowest in :
- $[\text{Mn}(\text{CO})_6]^+$
 - $[\text{Fe}(\text{CO})_5]$
 - $[\text{Cr}(\text{CO})_6]$
 - $[\text{V}(\text{CO})_6]^-$
39. The expected number of electronic transitions in the spectra of octahedral $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$ complex ion is :
- 2
 - 3
 - 4
 - 6
40. The phenomenon responsible for Russell-Saunders coupling is :
- Spin-orbit coupling
 - Ligand (or crystal) field effects
 - Spin-spin coupling
 - Electron-electron repulsion
41. The 18-electron rule is not obeyed in :
- $[\text{Cr}(\text{CO})_6]$
 - $[\text{Ni}(\text{CO})_4]$
 - $[\text{Ru}(\text{CO})_5]$
 - $[\text{V}(\text{CO})_6]$
42. The ligand field stabilization energies of the weak-field and high-field complexes respectively, would be highest for :
- d^6, d^3 ions
 - d^3, d^6 ions
 - d^8, d^2 ions
 - d^4, d^9 ions

43. A certain radioactive isotope ${}_Z X^A$ ($t_{1/2}=100$ days) decays to ${}_{Z-2} Y^{A-8}$. If 1 mole of ${}_Z X^A$ is kept in sealed container, how much He gas will accumulate at STP in 200 days ?
 (A) 11.2 litre
 (B) 33.6 litre
 (C) 22.4 litre
 (D) 44.8 litre
44. Which group of molecules in the solid state have a non- zero entropy at 0 K (ignore isotropic admixture) ?
 (A) H_2O , N_2 , $FCIO_3$, CO_2
 (B) H_2O , CO , $FCIO_3$, N_2O
 (C) CO_2 , H_2O , CO , N_2O
 (D) $FCIO_3$, N_2 , CO_2 , CO
45. In a closed packed (hcp, ccp) arrangement of a lattice comprising of n atoms of a kind, the number of tetrahedral and octahedral holes present respectively are :
 (A) $2n$ and $2n$
 (B) n and n
 (C) n and $2n$
 (D) $2n$ and n
46. What is the monomer of orlon and orlon is which types of polymer ?
 (A) Pthalic acid condensation polymer
 (B) Ethylene glycol and chain polymer
 (C) Vinyl cyanide and addition polymer
 (D) Vinyl chloride and addition polymer
47. What is the pH of a buffer solution that is 0.010 M in HCN and 0.020 M in NaCN (where $K_a = 6.2 \times 10^{-10}$) ?
 (A) 5.3
 (B) 5.1
 (C) 5.4
 (D) 5.0
48. Calculate the translational partition function for hydrogen atom at 1,000 K and 1 atmosphere.
 (A) 5.94×10^{29}
 (B) 4.94×10^{29}
 (C) 6.94×10^{29}
 (D) 3.94×10^{29}
49. Calculate the contour length (i.e., the length of the extended polymer chain) and the root-mean-square end-to-end distance of a polyethylene molecule with molar mass equal to 280 kg mol^{-1} . Assume that the length of the monomer is 154 pm.
 (A) 15.4 nm
 (B) 14.4 nm
 (C) 13.4 nm
 (D) 16.4 nm
50. A system absorbs 2.0×10^{16} quanta of radiation per second. When it is irradiated for 15 minutes it is found that 3.0×10^{-4} moles of the reactant has reacted. What is the quantum yield of the reaction ?
 (A) 10.03
 (B) 9.03
 (C) 10.89
 (D) 11.89
51. What sequence of reactions could be used to prepare cis-1,2-cyclopentanediol from cyclopentane ?
 (A) (1) Cl_2 , hv; (2) t-BuOK/t-BuOH; (3) OsO_4 ; (4) $NaHSO_3/H_2O$
 (B) (1) t-BuOK/t-BuOH; (2) Cl_2 , hv; (3) NaOH/ H_2O
 (C) (1) Cl_2 , hv; (2) t-BuOK/t-BuOH; (3) H_2O_2
 (D) (1) NaOH/ H_2O ; (2) Br_2 ; (3) $NaNH_2$ (2eq.)/liq. NH_3 ; (4) $KMnO_4$, NaOH/ H_2O , $5^\circ C$

52. Which is expected to be the major product for the following reaction ?



53. Rank the following compounds in order of increasing reactivity in electrophilic aromatic substitution reactions :

(a) C_6H_6 (b) C_6H_5Cl (c) C_6H_5CHO

(A) $c < b < a$

(B) $b < a < c$

(C) $a < c < b$

(D) $a < b < c$

54. Which of the following can be used to convert benzyl alcohol to benzoic acid ?

(A) $LiAlH_4$, ether

(B) CrO_3, H_3O^+ (Jones' Reagent)

(C) Pyridinium chlorochromate (PCC), CH_2Cl_2

(D) $Hg(O_2CCH_3)_2$

55. Which of the following reagents will react with (S)-3-methyl-3-octanol to give an optically active product ?

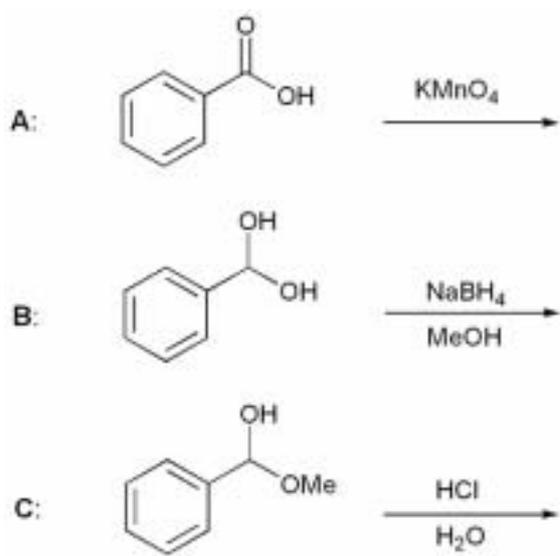
(A) $POCl_3$, pyridine

(B) HBr

(C) NaH , THF, CH_3I

(D) All of the above

56. Pick out from the following reaction(s) which give benzyl alcohol as the product :



(A) A

(B) B

(C) C

(D) A and C

57. An optically active compound is composed of 75% of the (*R*) enantiomer and 25% of the (*S*) enantiomer. The enantiomeric excess (ee) is equal to :

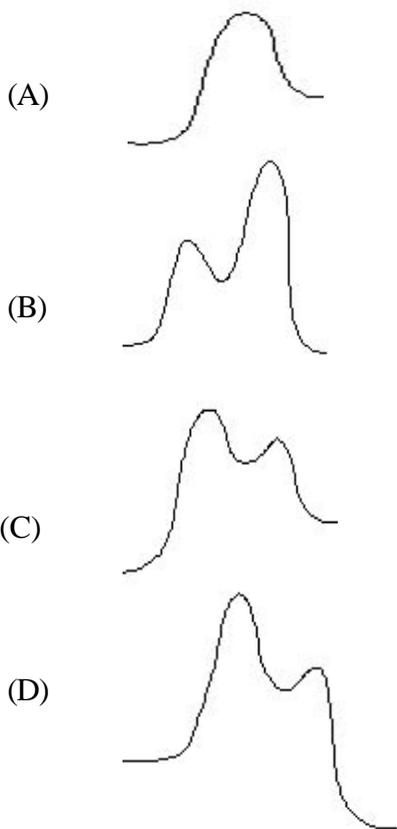
- (A) 87.5%.
- (B) 75%.
- (C) 50%.
- (D) 37.5%.

58. Which reagents are needed to carry out the following transformation efficiently ?

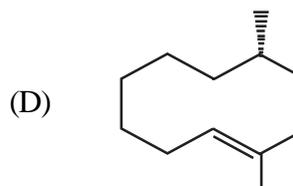
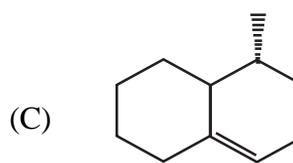
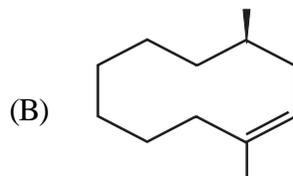
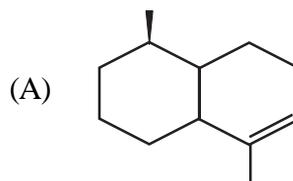


- (A) (1) H_2SO_4 , H_2O , warm (2) Neutralization
- (B) (1) H_2SO_4 , HOAc , warm (2) KOH , H_2O , warm
- (C) (1) B_2H_6 (2) H_2O_2 , NaOH
- (D) (1) O_3 (2) Me_2S

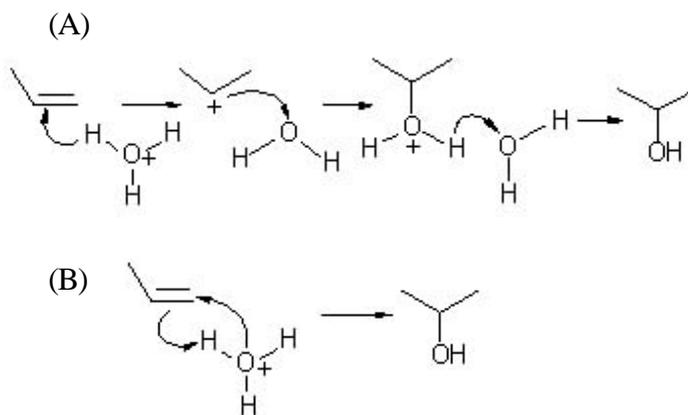
59. Which energy diagram best describes the electrophilic addition of hydrogen halides to alkenes ?

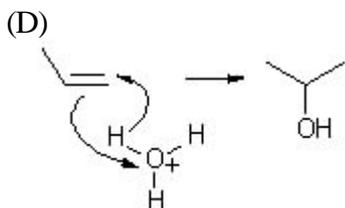
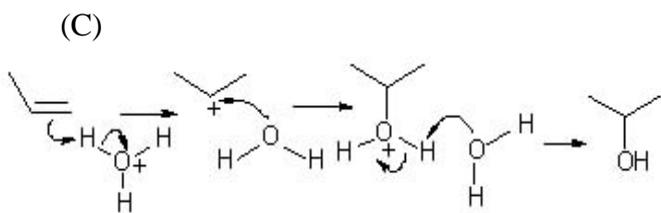


60. Which of the following alkenes is (1*Z*,4*R*)-1,4-dimethylcyclohexene ?



61. What is the proper electron-pushing mechanism for the acid-catalyzed hydration of an alkene ?

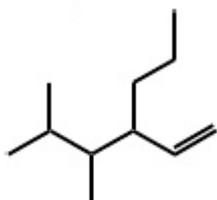




62. A ^1H - ^1H coupling constant for a doublet in a compound X is measured as 5.0 Hz on a 500 MHz NMR spectrometer. Which of the following statements is *incorrect* ?

- (A) The difference $\Delta\delta$ for the two components of this doublet depends on the field strength of the spectrometer.
- (B) For this doublet, the coupling constant is 5.0 Hz when the spectrum of X is recorded on a 250 MHz NMR spectrometer.
- (C) For this doublet, the coupling constant measured in Hz depends on the field strength of the spectrometer.
- (D) The difference $\Delta\delta$ for the two components of this doublet is 0.05 ppm when measured on a 100 MHz spectrometer.

63. The correct IUPAC name for the following compound is :



- (A) 4,5-Dimethyl-3-propyl-2-hexene
- (B) 4,5-Dimethyl-3-propyl-1-hexene
- (C) 3-(2,3-Dimethylpropyl)-1-hexene
- (D) 2,3-Dimethyl-4-isopropyl-5-hexene

64. Choose the right test for identification of anthraquinones :

- (A) Marquis test
- (B) Froehde test
- (C) Liebermann-Burchard test
- (D) Bornträger test

65. Which of the following is the right skeleton for Cinchona alkaloids ?

- (A) Tropane
- (B) Isoquinoline
- (C) Rubanol
- (D) Dammarane

66. E2 eliminations proceed via :

- a. Syn elimination
- b. Anti-periplanar elimination
- c. Anti-elimination
- d. Syn- periplanar elimination

- (A) a and c
- (B) b
- (C) b and d
- (D) a and d

67. Provide the reagents necessary to complete the following transformation :

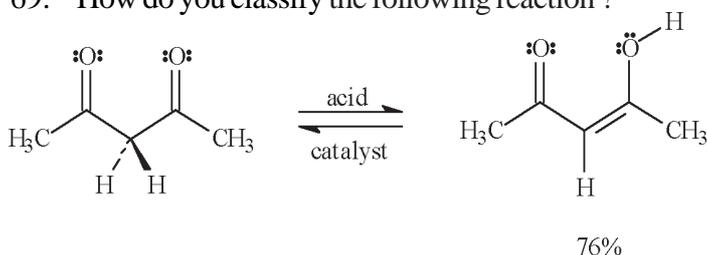
- (A) KOH/ethanol
- (B) $\text{KMnO}_4/\text{H}_3\text{O}^+$
- (C) $\text{CH}_2\text{I}_2/\text{Zn}(\text{Cu})$
- (D) None of these

68. For which of the following compounds does radical chlorination give a single monochloro product ?

(I) (II) (III) (IV)

- (A) (I)
 (B) (II)
 (C) (III)
 (D) (IV)

69. How do you classify the following reaction ?



- (A) Rearrangement
 (B) Elimination
 (C) Substitution
 (D) Addition

70. Which of the following compounds has the most signals in the noise-decoupled ^{13}C NMR spectrum ?

- (A) o-dibromobenzene
 (B) m-dibromobenzene
 (C) 1,2,3,4-tetrabromobenzene
 (D) 1,3,5-tribromobenzene

71. Which of the following has a $\text{C}\rightarrow\text{H}$ stretch that occurs at the highest stretching frequency ?

- (A) Hex-1-ene
 (B) (E)-hex-2-ene
 (C) Hex-2-yne
 (D) Hex-1-yne

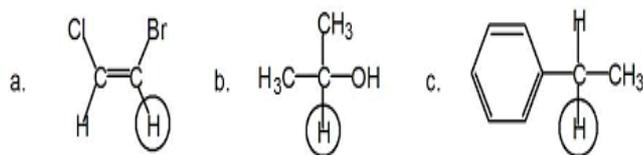
72. The two most abundant isotopes of boron are ^{10}B and ^{11}B , with ^{11}B being about 4 times more abundant. In the mass spectrum of trimethylborate $[(\text{CH}_3\text{O})_3\text{B}]$:

- (A) The peak at m/z 103 has an intensity which is $1/4$ the intensity of the peak at m/z 104
 (B) The peaks at m/z 103 and m/z 104 have equivalent intensities
 (C) The peak at m/z 103 has an intensity which is 4 times that of the m/z 104 peak
 (D) None of the above

73. In the UV-visible spectra of the following compounds, in which does λ_{max} appear at the highest wavelength ?

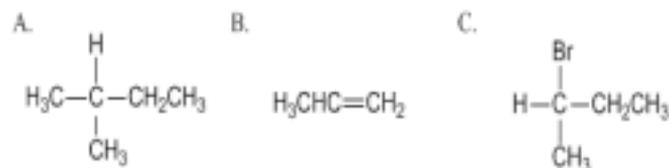
- (A) Isopropylbenzene
 (B) 1-Phenylpropene
 (C) 3-Phenylpropene
 (D) Benzene

74. How many peaks will be observed in the signals due to the circled hydrogens in the ^1H -NMR spectra of the following compounds ?



- (A) a: 3; b: 7; c: 4
 (B) a: 2; b: 6; c: 4
 (C) a: 2; b: 7; c: 4
 (D) a: 2; b: 8; c: 4

75. Which compounds give four signals in their ^1H NMR spectra ?



- (A) A and B
 (B) B and C
 (C) A and C
 (D) All of them

ROUGH WORK

ROUGH WORK