Range Forest Officer (Main / Written) Examination, 2021

CHEMISTRY

Time Allowed: Three Hours | Maximum Marks: 200

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

1. There are 08 (eight) questions in all, out of which FIVE are to be attempted.
2. Question Nos.1 and 5 are compulsory. Out of the remaining SIX questions, THREE are to be attempted selecting at least ONE question from each of the two Sections I and II.
3. All questions carry equal marks. The number of marks carried by a question / part is indicated against it.
4. Answers must be written in legible handwriting. Each part of the question must be answered in sequence and in the same continuation.
5. Assume suitable data, if necessary, and indicate the same clearly. Unless otherwise mentioned, symbols and notations carry their usual standard meanings.
6. Neat sketches may be drawn, wherever required.
7. Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Answer Booklet must be clearly struck off.
8. Re-evaluation / Re-checking of answer book of candidate is not allowed.

SECTION-I

1. (a) (i) On the basis of the molecular orbital approach, show that, among O_2^+ and O_2^-, which one would be expected to be paramagnetic? (5)

   (ii) What are the most probable position of a particle in a box of length a in the state $n = 2$? (5)

   (b) Write the name, the structure and the magnetic behavior of each one of the following complexes:

   (i) $[CO(NH_3)_4Cl_2]Cl$ (4)

   (ii) $[Cu(NH_3)_4]^{2+}$ (3)

   (iii) $[MnCl_4]^{2-}$ (3)

(c) Explain the formation of sigma and pi bonds. Why are pi bonds formed only after sigma bonds? (10)

(d) Using the Lewis concept, determine the trend in the:

(i) acid strengths in the series: (5)
$HClO_4$, $HClO_3$, $HClO_2$

(ii) basic strengths in the series: (5)
ClO_4^-, ClO_3^-, ClO_2^-

2. (a) What are fuel cells? Describe the functioning of Hydrogen-Oxygen fuel cells. What are the important roles of this cell in modern day life? (10)

(b) Explain and discuss octahedral coordination compound with the help of Crystal field theory. (10)

(c) Draw the normalized wave functions and corresponding probability functions for a particle in a one – dimensional box at the n = 1, 2 and 3 energy levels. (10)

(d) Explain and discuss the types of termination involved in Free radical polymerization. (10)

3. (a) Given, (10)

$Cu^{2+} + 2e^- \rightarrow Cu$, $E^0 = + 0.350$ V
$Zn^{2+} + 2e^- \rightarrow Zn$, $E^0 = - 0.763$ V

Construct the cell, using these reactions.
Find:

(i) Write and balance the total cell reaction.
(ii) The emf of the cell.
(iii) State whether the cell reaction will be spontaneous or not?

(b) Consider the following mechanism for an enzyme catalysis: (14)

$$E + S \underset{K_{-1}}{\overset{K_1}{\rightleftharpoons}} ES \xrightarrow{K_2} P + E$$

(Enzyme) (Substrate) Complex Product Enzyme

Derive the rate of reaction. Explain why the reaction rate becomes 1st order as the substrate concentration decreases.

(c) What does overvoltage mean in electrochemistry? (8)

(d) How do you estimate the specific surface area using Langmuir isotherm method? (8)

4. (a) Write IUPAC names of the following co-ordination compounds:

(i) $[Co(NH_3)_3)(NO_2)Cl(CN)]$ (4)
(ii) $[Cu(NH_3)_4]_3[Fe(CN)_6]_2$ (4)
(iii) Predict the number of unpaired electrons in tetrahedral $[Ni(CO)_4]$ complex (2)

(b) Why are the following pi-acceptor ligand? Justify your answer. (10)
CO, NH_3, PH_3, CN^-, and C = C

(c) A heat pump working on the Carnot cycle maintains the inside temperature of a house at 22^0C by supplying 450 kJ/s. If the outside temperature is 0^0C, find the heat taken from the outside air in kJ/s. (10)

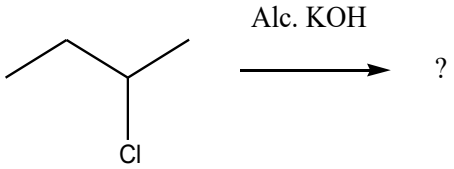
(d) (i) Actinides do not exhibit +2 oxidation state, contrary to that of some of the lanthanide elements. Why? (5)

(ii) What are different types of Non Aqueous Solvents? (5)

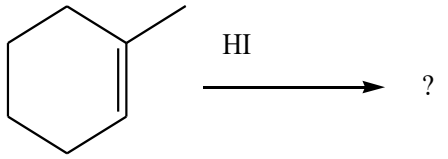
SECTION-II

5. Find out the product formed in following reactions and also explain about reason for their stereochemistry (in case of optically active product obtained) and regiochemistry (in case of products obtained): (5x8=40)

(a)



(b)



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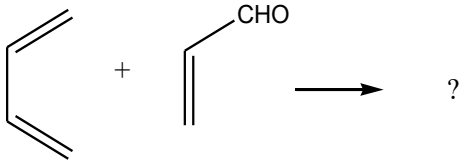
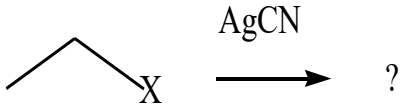
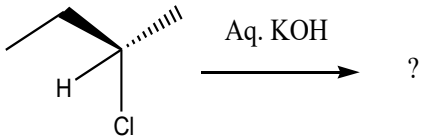


(d)

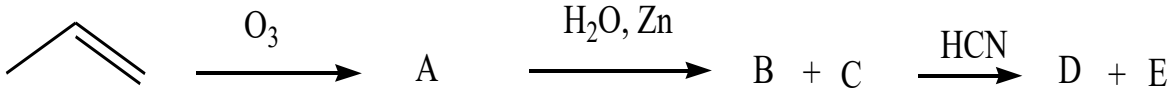


(e)

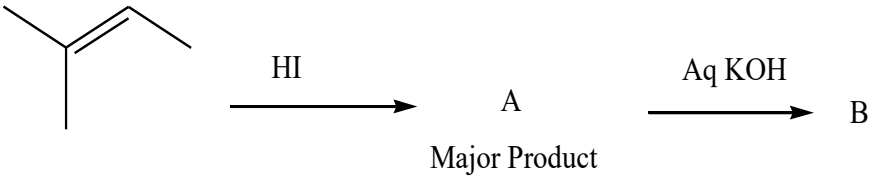


6. Find out the products obtained in every step and also explain about the optical activity of chiral compound (if obtained).

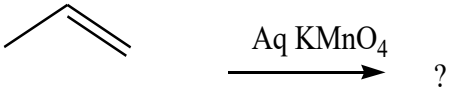
(a) (10)



(b) (10)



(c) (10)



(d) Explain the order of aromaticity among the pyrrole, furan and thiophene? (10)

7. Complete the following reactions with suitable mechanism: (4x10=40)
   (a) Hofmann Bromamide reaction
   (b) Carbylamine reaction
   (c) Aldol Condensation
   (d) Friedel-Craft Acylation

8. (a) Explain Blanc's rule with suitable examples? (10)
   (b) Why is the phosphorescence spectrum significantly red shifted compared to the fluorescence spectrum? (5)
   (c) Find the wave length of the light absorbed when an electron in a linear molecule 10 A^0 long makes from the energy level, n = 1 to the level n = 2. Given m_e (mass of an electron) = 9.102 x 10^{-31} kg, and h (Planck constant) = 6.627x 10^{-34} J s (10)
   (d) Discuss the viscosity method for the determination of molar masses of polymer solutions. (10)
   (e) Calculate the molar mass of a polyisobutylene in benzene solutions at $25^0_{C.}$ Given K = 3.60 x 10^{-2} dL/g, a = 0.64 and intrinsic viscosity [η] = 180dL/g. (5)

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