Indian Association for the Cultivation of Science
(Deemed to be University under *de novo* Category)
Integrated Bachelor's-Master's Program
Mid-Semester Examination-Autumn 2023

Subject: Chemical Reactivity ***Subject Code(s): CHS 2101***
Full Marks: 25 ***Time Allotted: 2 h***

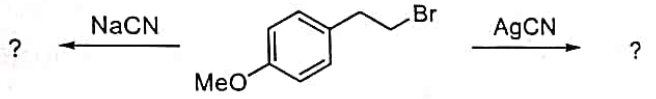
Section A

1. Answer any *three* of the following. [2x3]

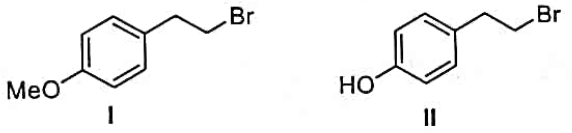
a) Explain the E1cB reaction with a proper example.

b) Upon changing solvent from methanol (CH_3OH) to acetonitrile (CH_3CN), the rate of the reaction of 1-bromopentane with sodium azide increases manyfold. Explain.

c) Predict the product(s) of the below given reactions. Justify your answer.



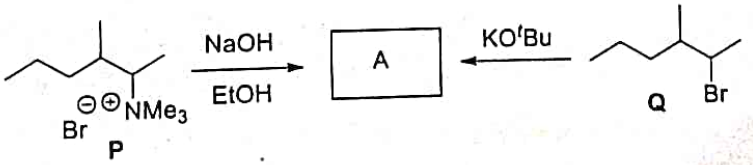
d) Among the given bromides **I** and **II**, which one would undergo substitution reaction with aqueous NaOH at the faster rate? Justify your answer.



e) Draw the most stable conformer of *trans*-hexachlorocyclohexane and explain why it undergoes E2 reaction at a very slow rate in a given condition.

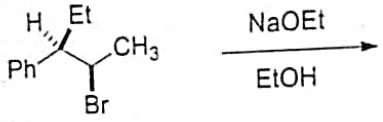
2. Answer the following:

a) Below shown reactions deliver a major product **A**. Draw the correct structure of **A** and explain the observation with proper reaction mechanism and justification. [3]



or

b) Predict the major product of the following reaction and explain the origin of product selectivity with a proper reaction mechanism of the following reaction. [3]



3. Answer the following:

a) Predict the structure of the expected products **X** and **Y** of the following reactions with proper reaction mechanisms and justification. How these products (**X** and **Y**) are related stereochemically? [4]

or

bi) Which one among *cis*- and *trans*-1-iodo-4-t-butylcyclohexane would form the corresponding alkene more rapidly when treated with sodium ethoxide? Provide an explanation. [2]

bii) Ethyl chloride (EtCl) is more reactive than chloroethene (CH_2=CHCl) towards substitution reaction for both S_N1 and S_N2 mechanisms. Explain. [2]

Section B

There are FOUR questions in this section. Q4 is COMPULSORY. Answer any TWO from Q5-Q7

4. Answer the following: [4x1.5]

(a) Write the electron-dot formulas for the molecules N_2H_4, N_2, and N_2F_2. Which molecule has the shortest nitrogen–nitrogen bond? Which has the longest nitrogen–nitrogen bond?

(b) What would be the geometry and point group of AB_4E_2 (E is the lone pair on the central atom) type molecules?

(c) Explain with a sketch why bonding (or anti-bonding) molecular orbitals cannot be constructed from the overlap of the 2s orbital on C and the 2py orbital on O.

(d) What symmetry operators are lost in going from NH_3 to NH_2Cl?

5. (a) Schematically show how the molecular orbitals would 'look' like when a sigma MO from p orbitals (pz) and a sigma MO from s orbitals mixed together as shown below: [1.5]

(b) What is the primary valency and secondary valency of $[Co(ethylenediamine)_2(Cl)_2]^+$? How many isomers are possible for this complex? [1.5]

6. Write down the Lewis dot formula of the oxo acid anion arsenate AsO_4^{3-}. What is the oxidation state of arsenic in the oxo acid? Consider the cation of arsenic in that oxidation state and show the formation of the oxo acid. Does the bonding between As and O match with that obtained from the Lewis structure? [3]

7. A compound of arsenic and fluorine is a gas. A sample weighing 0.100 g occupies 14.2 mL at 23C and 765 mmHg. What is the molecular mass of the compound? Write the Lewis formula for the molecule showing a formal charge on each atom. What would be the geometry and point group of the molecule? (Given: R = 8.314 $JK^{-1}mol^{-1}$, atomic mass of arsenic= 74.922 u) [3]

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