

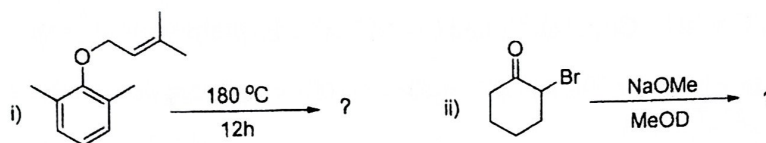
Indian Institute of Engineering Science and Technology, Shibpur
B.Tech. 2nd Semester (Group I-IV) Mid-Semester Examination, February 2024
Chemistry (CH1201)

Full Marks: 30

Time: 2 Hours

UNIT I (Answer all questions)

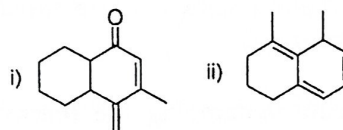
1. a) Identify the final products of the following reactions and give a suitable mechanism of reactions.



b) Define the terms with a suitable example:

i) Bathochromic shift, and ii) Auxochrome

c) Calculate the λ_{\max} value for the following compounds:

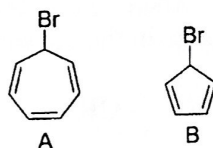


d) Explain the following (any two):

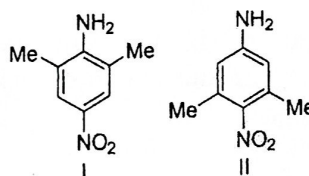
i) N,N-Dimethyl aminopyridine (DMAP) is often used as a catalyst in organic synthesis.

ii) Phenols are fairly acidic while aliphatic alcohols can't turn blue litmus red.

iii) Compound A gives immediate precipitation of AgBr in aqueous ethanolic solution of AgNO₃ but B does not respond even under reflux condition.



e) Among structure I and II (given below) which one is more basic and why?



$$[(1\frac{1}{2} \times 2) + (1+1) + (1+1) + (1+1) + 1]$$

UNIT II (Answer any four)

2. (a) $\text{Fe(phen)}_2(\text{NCS})_2$ is found to be diamagnetic at low temperatures and paramagnetic at high temperatures. Explain
- (b) Among these two compounds viz. Co(CN)_6^{3-} and Ni(CO)_4 which one has a larger CFSE?
- (c) Why do M(II) metal ions generally prefer tetrahedral geometry whereas M(III) metal ions prefer octahedral holes in spinel structures?
- (d) What will be the correct order of absorption wavelength in the visible region, for these complexes, CoCl_6^{3-} , Co(CN)_6^{3-} , and $\text{Co(NH}_3)_6^{3+}$? Explain your answer.
- (e) Calculate CFSE for $\text{Ti(H}_2\text{O)}_6^{3+}$ in kJ mol^{-1} (Given absorption maxima is at 20300 cm^{-1} and $1 \text{ kJ mol}^{-1} = 83.7 \text{ cm}^{-1}$).

[2½ x 4]

UNIT III (Answer all questions)

3. (a) Many thermal decomposition and isomerization reactions follow the mechanism given below
- $$\text{A} + \text{M} \rightleftharpoons \text{A}^* + \text{M} \quad (\text{with forward and backward rate constants } k_1 \text{ and } k_{-1}, \text{ respectively})$$
- $$\text{A}^* \rightarrow \text{Product} \quad (\text{with rate constant } k_2)$$

where A represents the molecule undergoing the thermal decomposition or isomerization reaction and M represents any other molecule. Show that the above mechanism leads to the following differential rate law:

$$\frac{d([\text{product}])}{dt} = \frac{k_2 k_1 [\text{A}][\text{M}]}{k_{-1} [\text{M}] + k_2}$$

Determine the order of the reaction when (i) $k_{-1} \gg k_2$ and (ii) $k_2 \gg k_{-1}$. Does the order of the reaction change with the change in the concentration of the reactant, A?

OR

- Using Michaelis-Menten mechanism show that the enzyme reaction is first-order and zero-order with respect to the substrate (S) at low- and high-concentrations of S, respectively.
- (b) Explain the terms involved in Arrhenius equation. What effect does temperature have on the rate of chemical reactions as per this equation? What type of graph do you expect between $\ln(k)$ and $\frac{1}{T}$? What is its slope?
- (c) For the thermal reaction of $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$, derive the final rate law. Show that the product slows down the rate of the process.

[4+3+3]