Indian Institute of Engineering Science and Technology, Shibpur

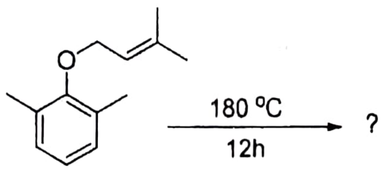
B.Tech. 2^{nd} Semester (Group I-IV) Mid-Semester Examination, February 2024

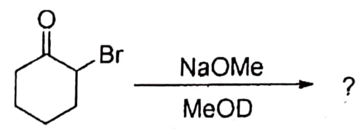
Chemistry (CH1201)

Full Marks: 30 **Time: 2 Hours**

<u>UNIT I (*Answer all questions*)</u>

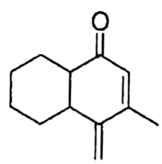
1. a) Identify the final products of the following reactions and give a suitable mechanism of reactions.

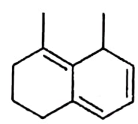
i) 

ii) 

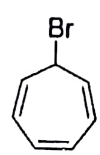
b) Define the terms with a suitable example:
i) Bathochromic shift, and ii) Auxochrome

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

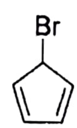
i) 

ii) 

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 $AgNO_3$ but B does not respond even under reflux condition.

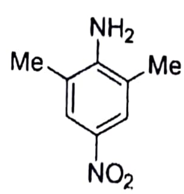


A

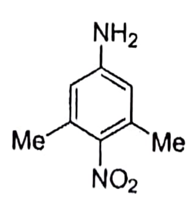


B

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



I



II

[(1½ x 2) +(1+1) +(1+1) +(1+1) +1]

UNIT II (*Answer any four*)

2. (a) $Fe(phen)_2(NCS)_2$ 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 $Co(NH_3)_6^{3+}$? Explain your answer.

(e) Calculate CFSE for $Ti(H_2O)_6^{3+}$ in $kJmol^{-1}$ (Given absorption maxima is at 20300 cm^{-1} and 1 $kJmol^{-1}$ = 83.7 cm^{-1}).

[2½ x 4]

UNIT III (*Answer all questions*)

(a) Many thermal decomposition and isomerization reactions follow the mechanism given below

$A + M \rightleftharpoons A^* + M$ (with forward and backward rate constans k_1 and k_{-1}, respectively)

$A^* \rightarrow$ Product (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:

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

Determine the order of the reaction when (i) $k_{-1} >> k_2$ and (ii) $k_2 >> k_{-1}$. 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 $H_2 + Br_2 \rightarrow 2HBr$, derive the final rate law. Show that the product slows down the rate of the process.

[4+3+3]