

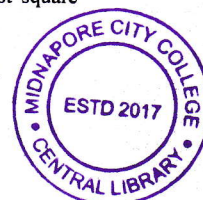
**PG CBCS**  
**M.Sc. Semester-II Examination, 2022**  
**CHEMISTRY**  
**PAPER: CEM 203**  
**(INORGANIC CHEMISTRY - II)**

Full Marks: 40

Time: 2 Hours

**GROUP-A**1. Answer any **four** questions of the following: 2×4=8

- a) Classify the following compounds with respect to closo, nido, arachno and hypo structure:  $B_{10}H_{12}$ ,  $B_6H_{14}$ ,  $C_2B_{10}H_{12}$  [ $CB_{11}H_{12}$ ]<sup>-</sup>
- b) NMR-spectroscopy is an useful technique to monitor fluxional behavior- Justify.
- c) The structure of cyclobutadiene itself is rectangular. However, it is almost square when coordinated to transition metal – comment.
- d) Write the standard reduction formula and characterize the term involved in it.
- e) Why no polarization effect is observed for cubic or higher symmetry group?
- f) State the spectral transition selection rules.

**GROUP-B**2. Answer any **four** questions of the following: 4×4=16

- a) What is boron neutron capture therapy? Give at least two examples of 1<sup>st</sup> and 2<sup>nd</sup> generation BNCT agents. (2+2)
- b) Propose the structure of the following compounds: (4)  
 (I)  $[(\eta^5-C_5H_5)Mo(CO)_2]_2$ , (II)  $Ir_4(CO)_{12}$ , (III)  $Os_4(CO)_{16}$ , (IV)  $[Ru_3(CO)_{10}(PPh_3)_2]$
- c) Discuss the phenomenon of 'Carbonyl scrambling' in  $[FeCp(CO)_2]_2$  complex.
- d) Complete the following reactions: 4
  - I.  $B_4H_{10} + NaH \rightarrow$
  - II.  $B_5H_{11} + 2CO \rightarrow$
  - III.  $B_5H_9 + LiH \longrightarrow$
  - IV.  $B_4H_{10} + CN^- \longrightarrow$
  - V.  $2B_4H_{10} + 2Na(Hg) + Et_2O \rightarrow$
  - VI.  $B_5H_9 + C_2H_4 + AlCl_3 \rightarrow$
  - VII.  $B_5H_{11} + 2Na(Hg) + Et_2O \rightarrow$
  - VIII.  $B_4H_{10} + NaBH_4 \rightarrow$

(P.T.O.)

(2)

e) Find the vibrational modes of  $\text{NH}_3$  molecule using group theory. Character table for  $C_{3v}$  point group is given below:

$C_{3v}$	$E$	$2C_3$	$3\sigma_v$	Basis components	
$A_1$	1	1	1	$z$	$x^2+y^2, z^2$
$A_2$	1	1	-1	$R_z$	
$E$	2	-1	0	$(x,y)$ $(R_x, R_y)$	$(x^2-y^2, xy)(yz, xz)$

f) Prove that the representation of direct product  $\Gamma_{AB}$ , will contain the totally symmetric representation if the irreducible  $\Gamma_A =$  irreducible  $\Gamma_B$ .

**GROUP-C**

3. Answer any two questions of the following:

8×2=16

a) (I) Show that  $n \rightarrow \pi^*$  electronic transition is forbidden but  $\pi \rightarrow \pi^*$  transition is allowed for  $\text{HCHO}$  molecule. Character table for  $C_{2v}$  point group is given below:

	$E$	$C_2(z)$	$\sigma_v(xz)$	$\sigma_v(yz)$	linear, rotations	quadratic
$A_1$	1	1	1	1	$z$	$x^2, y^2, z^2$
$A_2$	1	1	-1	-1	$R_z$	$xy$
$B_1$	1	-1	1	-1	$x, R_y$	$xz$
$B_2$	1	-1	-1	1	$y, R_x$	$yz$

(II) What is meant by "Mutually exclusion principle"? Justify this principle using  $\text{trans-N}_2\text{F}_2$  as an example. Character table for  $C_{2h}$  point group is given below: 4+4

$C_{2h}$	$E$	$C_2$	$i$	$\sigma_h$	
$A_g$	1	1	1	1	$R_x, x^2, y^2, z^2, xy$
$B_g$	1	-1	1	-1	$R_x, R_y, xz, yz$
$A_u$	1	1	-1	-1	$z$
$B_u$	1	-1	-1	1	$x, y$

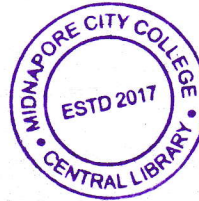
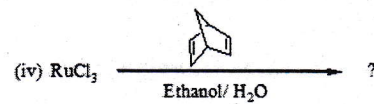
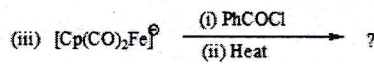
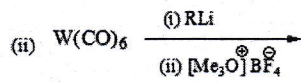
b) (I) Draw the M.O. diagram for  $\text{H}_2\text{O}$  molecule using projection operator technique. Character table for  $C_{2v}$  point group is given in the above question.

(P.T.O.)

(3)

- (II)  $\text{ClO}_2$  molecule is trapped in a solid. Its ground state is known to be  $B_1$ . Polarised light parallel to the Y-axis (parallel to oxygen-oxygen separation) excites the molecule to an upper state. What is the symmetry of the state? 4+4
- c) Given styx number are 0911 and 0630 for boron hydrides. With the help of these styx number identify and draw the probable structures of these boron hydride. 4+4
- d) (I) The *cis*-isomer of  $\text{L}_2\text{Pd}(\text{Et})_2$  decomposes immediately to give butane, but the *trans* isomer produces a 1:1 mixture of ethene and ethane. - Explain. 4+4

(II) Complete the following reactions:



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