M.Sc. 2nd Semester Examination, 2023

CHEMISTRY

(*Inorganic*)

PAPER – CEM-203

Full Marks : 40

Time : 2 hours

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

GROUP–A

Answer any **four** of the following questions : 2×4

1. (*a*) Write down the product of the following reaction. Draw the geometry of the product.

$$Mo(g) + C_4H_6\,(g) \xrightarrow{-196^{\circ}C}$$

(*b*) Complete the following reaction. Here alkyne donates how many electrons ?

$$[CpNi(CO)]_2 + RC \equiv CR \longrightarrow$$

(*c*) Establish the relation

$$a_i = \frac{1}{h}\sum_R \chi_i(R)\chi(R)$$

(where the symbols have their usual meaning)

(*d*) What do you mean by character representation of a direct product ?

(*e*) Classify the following compounds for closo, nido, arachno, and hypo :

$CpCoC_2B_{10}H_{12}$, $Cp_2Fe_2Me_4C_4B_8H_8$, $H_6C_6B_6Et_6$, $C_2B_8H_{10}$-.

(*f*) Calculate the styx number of $[B_{10}H_{15}]^{1-}$.

GROUP–B

Answer any **four** of the following questions : 4×4

2. Explain the possible orbital interactions for the bonding in Fischer's carbene complex. 4

3. 'Highly explosive halogen substituted acetylenes can be stabilized by complex formation'– Justify the statement with a reaction. 4

4. Is p_x to p_y an allowed electric dipole transition in a tetrahedral environment ? Explain with the help of the group theoretical principle. 4

T_d	E	$8C_3$	$3C_2$	$6S_4$	$6\sigma_d$		
A_1	1	1	1	1	1		$x^2+y^2+z^2$
A_2	1	1	1	−1	−1		
E	2	−1	2	0	0		$(2z^2-x^2-y^2,\ x^2-y^2)$
T_1	3	0	−1	1	−1	(R_x, R_y, R_z)	
T_2	3	0	−1	−1	1	(x, y, z)	(xz, yz, xy)

5. Complete the following character table : 4

C_{2v}	E	C_2	$\sigma_v(xz)$	$\sigma_v^1(yz)$	
A_1					x^2, y^2, z^2
A_2					xy
B_1					xz
B_2					yz

6. With the help of styx numbers 1731 and 6060, derive the boron hydride formula and draw the probable structures of these. 4

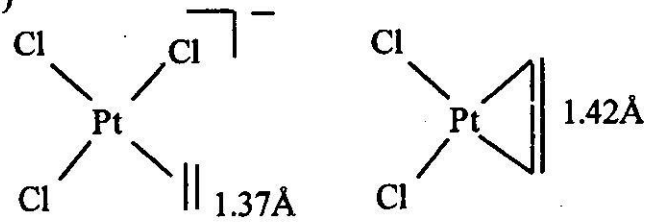
7. (*a*) What is boron neutron capture therapy ?

   (*b*) Give at least two examples of 1st and 2nd generation BNCT agents. 2 + 2

GROUP–C

Answer any **two** of the following questions : 8 × 2

8. (*a*)



Explain the C – C bond lengths in the above complexes by the orbital diagram.

(*b*) Complete the following reaction. Draw the product's structure and mention the oxidation state of the central metal atom.

$$Fe(Cp)_2 \xrightarrow[-50^\circ C,\ TMEDA]{Li,\ C_2H_4}$$

(*c*) Synthesize

$(OC)_5W{=}\overset{OMe}{\underset{R}{<}}$ from $W(CO)_6$.

3 + 3 + 2

9. (*a*) Verify that the wave functions of p_x and p_y orbitals, as a pair, provided the basis for an irreducible representation in the C_{3v} environment.

C_{3v}	E	$2C_3$	$3\sigma_v$		
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) (xz, yz)

(*b*) Based on the group theoretical principle, discuss on "spectral transition probabilities" of an electric dipole transition. 4 + 4

10. (*a*) Show that the representation of a direct product Γ_{XY}, will contain the totally symmetric representation only if the irreducible Γ_X = the irreducible Γ_Y.

(*b*) Decompose the following reducible representation into irreducible components

C_{3v}	E	$2C_3$	$3\sigma_v$
Γ	4	1	0

(Use character table of C_{3v} point group given in **Q.9**)

(*c*) Complete the following reactions :

(*i*) $B_5H_9 + C_2H_4 \xrightarrow{AlCl_3}$

(*ii*) $B_{10}H_{14} + LiMe \longrightarrow$ 4 + 2 + 2

11. (*a*) Outline the products of the polymerization reaction of the B_2H_6 molecule in a sealed glass tube.

(*b*) Give suitable techniques to separate them individually. 4 + 4