

JAMIA HAMDARD
Department of Chemistry
School of Chemical and Life Sciences (SCLS)
M. Sc. Chemistry, I Semester
End-term Examination 2023

Paper Name: Inorganic Chemistry I
Time: 3 hours

Paper Code: MCHCC103
Maximum Marks: 60

Note: This paper has 3 sections A, B, and C, Attempt all the three sections

Section A: Answer all the questions; **Section B:** Answer any 2 out of 4; **Section C:** Answer all the questions, each question has an internal choice

Abbreviations Used

CLO- Course Learning Outcome, PLO- Program learning Outcome, BTL- Bloom Taxonomy Level: BT level 1-Remember; BT level 2-Understand; BT level 3-Apply; BT level 4-Analyse; BT level 5-Evaluate, BT level 6-Create

Section A

Attempt all questions

10x1.5 = 15 Marks

Q.No. Question

		BTL	PLO	CLO
A1	Predict and explain which way the following equilibrium will lie. $\text{Hb} + \text{Hb}(\text{O}_2)_4 \rightleftharpoons 2\text{Hb}(\text{O}_2)_2$	1/2	1	2
A2	Indicate the number of unpaired electrons in the following cations- (i) Ce^{4+} (ii) Yb^{2+} (iii) Eu^{2+} (iv) Lu^{3+}	1/3	1	2
A3	Using crystal field theory, draw the structure of following complexes - (a) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ (b) $[\text{Fe}(\text{CN})_6]^{4-}$	1/3	2	3
A4	Why free radical CF_3° is sp^3 hybridized, whereas CH_3° is sp^2 hybridized?	2/3	2	3
A5	Calculate the Effective Atomic Number of the central metal atom in the following complexes- (a) $[\text{Ni}(\text{CN})_4]^{2-}$ (b) $[\text{Mn}(\text{CO})_5]^-$	3/5	2	2
A6	What are the advantages and limitations of liquid ammonia as solvent?	1	2	3
A7	Arrange the following compounds according to the Lewis acidity from low to high. (a) BCl_3 , BI_3 , BF_3 (b) BF_3 , B_2H_6 , BPh_3	3	1	2
A8	Classify $^3\text{A}_{2g}(\text{F})$ $^1\text{T}_{1g}(\text{F})$ transition (octahedral) as allowed or forbidden. Justify your answer.	1/3	2	3
A9	Complete the following reactions- $\begin{array}{c} \text{ThO}_2 + 2\text{C} + 2\text{F}_2 \xrightarrow{\hspace{2cm}} \\ 7\text{U} + 6\text{H}_2\text{O} \xrightarrow[150-250^\circ \text{C}]{\hspace{2cm}} \\ (\text{Steam}) \end{array}$	1/2	2	3
A10	Which of the following matches of metalloenzymes and metal cofactors are incorrect? A. Tyrosinase: Copper B. Catechol dioxygenase: Iron C. Dopamine β -hydroxylase: Nickel D. Urease: Copper	2/3	2	3

Section B

Attempt any two out of four

2x10 = 20 Marks

B1 a) Define the role of the following metals in biological systems.

1-3/6 2/5- 3/5-6
 6

- i. Cobalt (Co)
- ii. Copper (Cu)
- iii. Potassium (K)
- iv. Calcium (Ca)
- v. Zinc (Zn)

b) How does the size of the metal change with its oxidation state? Explain with examples. How can we enhance symbiotic nitrogen fixation in agricultural soils?

B2	Why crystal field theory is considered superior over valence bond theory? Explain in detail. How does CFT account for the fact that $[\text{CoF}_6]^{3-}$ is paramagnetic but $[\text{Co}(\text{NH}_3)_6]^{3+}$ is diamagnetic, though both are octahedral?	2/3	4	3
B3	a) Bring out the important structural features of the active sites of metal centers of the following: i) Deoxyhemoglobin ii) Cytochrome <i>c</i> iii) Vitamin B ₁₂ b) Derive a ground state term symbol for i) Nitrogen ii) d^{10}	1/2/3	3	3
B4	a) The absorption spectra of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ shows three absorption bands at 8500, 15400 and 2600 cm^{-1} respectively. b) Assign these bands and calculate B and 10 Dq values for the complex. c) Sketch the structures of 3 allotropes of sulfur.	1/3/5/6	4	4

Section C

Attempt all questions, each question has an Internal choice.

5x5=25 Marks

C1	Describe the role of the following metalloenzymes in biological systems: a) Carbonic anhydrase b) Carboxypeptidase	1/2/3/6	2/5/6	3/5/6
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OR

With the number of skeletal electrons, give the structural features of

C2	a) B_4H_{10} b) B_5H_{11} Explain the following: a) Filling of the 4f sublevel is not regular in the lanthanide series. b) The +3-oxidation state is the characteristic oxidation state of lanthanides though their atoms contain only two ($6s^2$) outermost electrons.	1/2/3/6	3/4/5	4/5/6
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OR

a) The hexaquo manganese (II) ion contains five unpaired electrons, while the hexacyano- ion contains only one unpaired electron. Explain, using Crystal Field Theory.

b) What is the spin multiplicity of the ground state of Ti^{3+} and V^{3+} ion?

C3	What is Laporte selection rules? Explain it with a suitable example.	1/3	4/3	4/3
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OR

How do the following properties characterize non-aqueous solvents?

- a) Dipole moment b) Dielectric constant c) Melting and Boiling points
d) Heat of fusion e) heat of vaporization

C4	Give balanced reactions for the following i. Hydrolysis of phosphorus sulphide ii. Hydrolysis of borazine iii. Diborane with ammonia iv. Chlorine with ammonia v. Reaction of boron trioxide with cobalt oxide	2/3	3-4	4-6
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OR

Discuss the electronic spectra of transition metal ions, V^{3+} , Cr^{3+} and Mn^{2+} in their aqueous solution.

C5	a) Why do actinides show a greater multiplicity of oxidation states? b) "All Arrhenius acids are Bronsted acids but all Arrhenius bases are not Bronsted bases." Comment on the statement.	1-4	3-4	4-6
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OR

Sketch and explain the Orgel diagram for d^1 and d^9 systems in an octahedral field and show all possible transitions.

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A6	What are the advantages and limitations of liquid ammonia as solvent?	1	2	3
A7	Arrange the following compounds according to the Lewis acidity from low to high. (a) BCl_3 , BI_3 , BF_3 (b) BF_3 , B_2H_6 , BPh_3	3	1	2
A8	Classify $^3\text{A}_{2g}(\text{F})$ $^1\text{T}_{1g}(\text{F})$ transition (octahedral) as allowed or forbidden. Justify your answer.	1/3	2	3
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b) How does the size of the metal change with its oxidation state? Explain with examples. How can we enhance symbiotic nitrogen fixation in agricultural soils?

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| B2 | Why crystal field theory is considered superior over valence bond theory?
Explain in detail. | 2/3 | 4 | 3 |
| | How does CFT account for the fact that $[\text{CoF}_6]^{3-}$ is paramagnetic but $[\text{Co}(\text{NH}_3)_6]^{3+}$ is diamagnetic, though both are octahedral? | 3/5 | | |
| B3 | a) Bring out the important structural features of the active sites of metal centers of the following:
i) Deoxyhemoglobin ii) Cytochrome <i>c</i> iii) Vitamin B ₁₂
b) Derive a ground state term symbol for
i) Nitrogen ii) d^{10} | 1/2/3 | 3 | 3 |
| B4 | a) The absorption spectra of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ shows three absorption bands at 8500, 15400 and 2600 cm^{-1} respectively.
b) Assign these bands and calculate B and 10 Dq values for the complex.
c) Sketch the structures of 3 allotropes of sulfur. | 1/3/5/6 | 4 | 4 |

Section C

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| C1 | Describe the role of the following metalloenzymes in biological systems:
a) Carbonic anhydrase b) Carboxypeptidase | 1/2/3/6 | 2/5/6 | 3/5/6 |
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Explain the following:
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OR

How do the following properties characterize non-aqueous solvents?

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b) "All Arrhenius acids are Bronsted acids but all Arrhenius bases are not Bronsted bases." Comment on the statement. | 1-4 | 3-4 | 4-6 |
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