



JARAMOGI OGINGA ODONGA UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES
UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF
EDUCATION (SCIENCES)
3rd YEAR 1ST SEMESTER 2022/2023 ACADEMIC YEAR
MAIN REGULAR

COURSE CODE: SPB 9308

COURSE TITLE: Co-ordination Chemistry

EXAM VENUE:

STREAM: (BEd. Science)

DATE:

TIME:

EXAM SESSION:

INSTRUCTIONS:

- 1. Answer question 1 (Compulsory) in section A and ANY other 2 questions in Section B.**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**
- 4. Some important information/formulas are found on the last page of this question paper**

SECTION A

Question 1

a) Provide Chemical formulae for the following coordinated compounds

- i. Pentachlorotitanate(IV) ion (1 marks)
- ii. Hexachlorovanadate(IV) ion (1 marks)
- iii. Bromopentacarbonylmanganese(I) (1 marks)
- iv. Pentaquahydroxoiron(III) sulfate(VI) (1 marks)
- v. Hexaamminevanadium(III) ion (1 marks)

a) Discuss in brief the behavior of the following properties of transition elements across the first period (3-*d* elements)

- i. Boiling and melting points (3 marks)
- ii. Density (3 marks)
- iii. Electronegativity (3 marks)
- iv. Ionic radius (3 marks)

b) Give the electronic configuration for Sc, Cr, Mn, and Zn. Use this information to explain why compounds of Sc and Zn are not colored (5 marks)

c) Use the electron box and arrow configurations in combination with Pauli exclusion principle and Hund's rule to demonstrate the electronic configuration of V^+ , V^{2+} , V^{3+} , V^{4+} , and V^{5+} . (2 marks)

d) Draw the geometrical structures of $[Cu(Cl)_4]^{2-}$ and $[Cu(NH_3)_4]^{2+}$ Complex ions. (4 marks)

e) Determine the oxidation number and coordination number of $[Ag(NH_3)_2]^+$ and $[NiCl_2(NH_3)_2]$ complex ions (2 marks)

Section B. Answer any TWO questions

Question 2

- f) Briefly describe the differences between (6 marks)
- Monodentate and bidentate ligands
 - Anionic and neutral ligands
 - Neutral complexes, complex cations and complex anions
- b) Transition metals form-colored compounds and complexes. These colors can vary depending on the charge on the metal ion and the number and type of groups of atoms (ligands) attached to the metal ion. In aqueous solutions, the ions form complexes with different colors. Give an explanation for the coloration. (4 marks)
- c) Briefly describe bonding in H_2 and HF using molecular orbital theory. (10 marks)

Question 3

- a) Discuss in brief the limitations of the valency Bond Theory (5 marks)
- b) Using diagrams, illustrate the valence bond models for the following complex ions.
- Octahedral Complex e.g. $[Cr(NH_3)_6]^{3+}$ (5 marks)
 - Tetrahedral e.g. $[Zn(OH)_4]^{2-}$ (5 marks)
 - Square Planar e.g. $[Ni(CN)_4]^{2-}$ (5 marks)

Question 4

- a) In a tetrahedral crystal field, the 5 degenerate d orbitals are split into $3t_{2g}$ and $2e_g$ atomic orbitals. The two sets of degenerate orbitals are separated by an energy Δ_0 . Illustrate this energy and describe factors that affect its size. (10 marks)
- g) Ligand field theory (LFT) describes the bonding, orbital arrangement, and other characteristics of coordination complexes. It represents an application of molecular orbital theory to transition metal complexes. Briefly describe this theory. Use of diagrams is most preferred. (10 marks)

Question 5

- a) Briefly describe the Crystal Field Splitting Energy (CFSE) for the complex ion $[\text{Fe}(\text{CN})_6]^{3-}$. (10 marks)
- b) Given that the CFSE of $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ is $-0.8 \Delta_{\text{oct}}$, illustrate its spin state. (10 marks)

Periodic table

		1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18																																							
		Atomic number, Z		Element symbol		Relative atomic mass, A _r																																																																					
1	1	H	1.008	2	He	4.00	3	Li	6.94	4	Be	9.01	5	B	10.81	6	C	12.01	7	N	14.01	8	O	16.00	9	F	19.00	10	Ne	20.18	11	Na	22.99	12	Mg	24.31	13	Al	26.98	14	Si	28.09	15	P	30.97	16	S	32.06	17	Cl	35.45	18	Ar	39.95																					
19	20	K	39.10	21	Ca	40.08	22	Sc	44.96	23	Ti	47.90	24	V	50.94	25	Cr	52.01	26	Mn	54.94	27	Fe	55.85	28	Co	58.93	29	Ni	58.69	30	Cu	63.54	31	Zn	65.41	32	Ga	69.72	33	Ge	72.59	34	As	74.92	35	Se	78.96	36	Kr	83.80																								
37	38	Rb	85.47	39	Sr	87.62	40	Y	88.91	41	Zr	91.22	42	Nb	92.91	43	Mo	95.94	44	Ru	101.07	45	Rh	102.91	46	Pd	106.42	47	Ag	107.87	48	Cd	112.40	49	In	114.82	50	Sn	118.71	51	Sb	121.75	52	Te	127.60	53	I	126.90	54	Xe	131.30																								
55	56	Cs	132.91	57	Ba	137.34	58	La-Lu	178.49	59	Hf	178.49	60	Ta	180.95	61	W	183.85	62	Re	186.21	63	Os	190.23	64	Ir	192.22	65	Pt	195.08	66	Au	196.97	67	Hg	200.59	68	Tl	204.37	69	Pb	207.19	70	Bi	208.98	71	Po	210	72	At	210	73	Rn	222																					
87	88	Fr	223	89	Ra	226.03	90	Ac-Lr	227.03	91	Rf	261	92	Db	262	93	Sg	266	94	Bh	264	95	Hs	277	96	Mt	268	97	Ds	271	98	Rg	272	99	Uub	285	100	U	238.03	101	Np	237.05	102	Pm	146.92	103	Pu	239.05	104	Am	241.06	105	Cm	244.07	106	Bk	249.08	107	Cf	252.08	108	Es	252.09	109	Fm	257.10	110	Md	258.10	111	No	259	112	Lr	262
Lanthanoids		57	La	138.91	58	Ce	140.12	59	Pr	140.91	60	Nd	144.24	61	Pm	146.92	62	Sm	150.35	63	Eu	151.96	64	Gd	157.25	65	Tb	158.92	66	Dy	162.50	67	Ho	164.93	68	Er	167.26	69	Tm	168.93	70	Yb	173.04	71	Lu	174.97																													
Actinoids		89	Ac	227.03	90	Th	232.04	91	Pa	231.04	92	U	238.03	93	Np	237.05	94	Pu	239.05	95	Am	241.06	96	Cm	244.07	97	Bk	249.08	98	Cf	252.08	99	Es	252.09	100	Fm	257.10	101	Md	258.10	102	No	259	103	Lr	262																													

Geometry

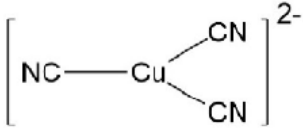
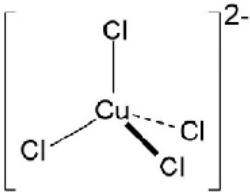
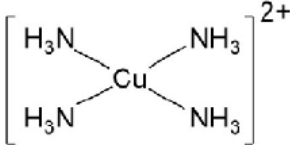
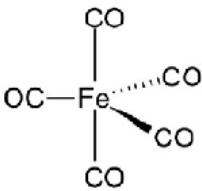
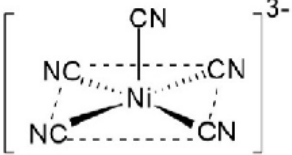
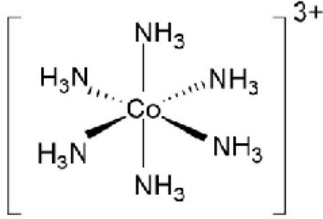
C.N.	Geometry (formula)	Example
2	Linear [ML ₂]	NC—Ag ⁻ —CN
3	Trigonal planar [ML ₃]	
4	Tetrahedral [ML ₄]	
4	Square planar [ML ₄]	
5	Trigonal bipyramidal [ML ₅]	
5	Square pyramidal [ML ₅]	
6	Octahedral [ML ₆]	

Table1: Variation of geometry with the coordination number of the metal