



MASINDE MULIRO UNIVERSITY OFSCIENCE AND TECHNOLOGY

(MMUST)

Main CAMPUS

UNIVERSITY EXAMINATIONS

2022/2023 ACADEMIC YEAR

Semester II

THIRD YEAR MAIN EXAMINATION

(BSC Chemistry & Industrial Chemistry)

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN CHEMISTRY

COURSE CODE:

SCH 313

COURSE TITLE:

Inorganic Reaction Mechanisms of Complex Compounds

DATE:

27/4/2023

TIME: 3.00 - 5.00 PM

INSTRUCTIONS TO CANDIDATES

Answer all the Questions

Find the attached periodic table

TIME: 2 HOURS

MMUST observes ZERO tolerance to examination cheating

Question One (19 Marks)

- (a) Differentiate between the following terms that are used to describe the types of Metal complex reactions
 - Associative interchange mechanism and Dissociative interchange mechanism.

(4 Marks)

ii. Inert and Labile metal complex

(2 Marks)

- iii. <u>Trans effect</u> and <u>Polarization theory</u> for ligand substitution in square planner (5 marks)
- (b) State and explain the types of reactions shown?

(8 Marks)

- i. $[Co(H_2O)_6]^{2+} + Cl \rightarrow [CoCl(H_2O)_5] + H_2O$
- ii. $10\text{FeSO}_4 + 2\text{KMnO}_4 + 8\text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{MnSO}_4 + 5\text{Fe}_2(\text{SO}_4)_3 + 8\text{H}_2\text{O}$ (Hint, for Fe complex)

iii.
$$[Cu(H_2O)_4]^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4] + 4H_2O$$

iv.
$$[Co(H_2O)_6]Cl_2 + 6NH3 \rightarrow [Co(NH_3)_6]Cl_2 + 6H_2O$$

v.
$$MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$$

vi.
$$2MnO_4^- + 10Cl + 16H^+ \rightarrow 2Mn^{2+} + 5Cl_2 + 8H_2O$$

vii.
$$[Co(H_2O)_6]Cl_2 \rightarrow 6H_2O + CoCl_2$$

viii.
$$[Fe(CN)_6]^{4-} + [IrCl_6]^{2-} \rightarrow [Fe(CN)_6]^{3-} + [IrCl_6]^{3-}$$

Question Two (17 Marks)

2. (a). Arrange the following octahedral complexes in order of their ligand

exchange rates

(8 Marks)

- i. $[Co(H_2O)_6]^{2+}$, $[Ir(H_2O)_6]^{2+}$, $[Rh(H_2O)_6]^{2+}$,
- $ii. \quad [AlF_6]^{3\text{-}} \,, \; [PF_6]^{\text{-}} \,, \; SF_6 \, [Na(H2O)_n]^{\text{+}}, \; [Mg(H_2O)_n]^{2\text{+}}, \; [Al(H_2O)_6]^{3\text{+}} \,, \; [SiF_6]^{2\text{-}}$
- iii. $[Ca(H_2O)_6]^{2^+} \,,\, [Sr(H_2O)_6]^{2^+} \,,\, [Rn(H2O)6]^{2^+} ,\, [Mg(H_2O)_6]^{2^+} ,$
- iv. Give reasons for your order of arrangement for i. and for ii, iii above
 (4 Marks)
- v. $[Ni]^{2+} + 6 NH_3 \iff [Ni (NH_3)_6]^{2+} \text{ and } [Ni]^{2+} + 3 \text{ en} \iff [Ni (en)_3]^{2+}$ (2 Marks)
- vi. Give reasons for your choice for iv above

(3 marks)

Question Three (17 Marks)

3. You are provided the Trans effect order of the following ligands as follows; Use the order to answer the following questions.

$$CN \sim CO \sim C_2H_4 > PH_3 > SH_2 > NO_2 > I > Br > Cl > NH_3 \sim py > OH > H_2O$$
.

(a). Predict the products of these reactions by drawing/sketching the square planner complexes products (a) to (h). (8 Marks)

i.
$$[PtCl_4]_2^{2-} + NO_2^- \rightarrow (a)$$

$$(a) + NH_3 \rightarrow (b)$$

ii.
$$[PtCl_3NH_3]^- + NO_2^- \rightarrow (c)$$

$$(c) + NO_2^- \rightarrow (d)$$

iii.
$$[PtCl(NH_3)_3]^+ + NO_2^- \rightarrow (e)$$

$$(e) + NO_2 \rightarrow (f)$$

iv.
$$[PtCl_4]^{2-} + I^- \rightarrow (g)$$

$$(g) + I^- \rightarrow (h)$$

- (b) Using Cu(II) with its d^9 configuration and Ni(II) with its d^8 configuration, explain how the Jahn-Teller Theorem causes Structural effects or distortion for the $[Cu(H_2O)_6]^{2+}$ and not for $[Ni(H_2O)_6]^{2+}$. (5 Marks)
- (c). When other ligands are added to an aqueous solution of a metal ion, replacement of water molecules in the coordination sphere may occur, with the resultant formation of other complexes. Such replacement is generally a <u>stepwise process</u>. Complete the following reaction of addition of ammonia to an aqueous solution of a nickel (2+) salt: to obtain the final product hexaamminenickel(2+) ion. (4 Marks)

$$[Ni(H_2O)_6]^{2+}+NH_3 \rightleftharpoons X+H_2O$$

Then;

$$Y + NH_3 \rightleftharpoons [Ni(NH_3)_6]^{2+} + H_2O$$

Question Four (18 marks)

4 (a) Explain the following terms

(3 Marks)

- i. Co-ordination is isomerism
- ii. Linkage isomerism
- iii. Geometrical isomerism

- (b) Between Tetrahedral geometry and Square planar geometry complexes, which geometry can give rise to geometrical isomers? Give reason for your answer. (3 Marks)
- (c). Pentaaminebromo cobalt (III) Sulphate and Pentaaminesulphato cobalt (III) bromide are each separately dissolved in water. (8 marks)
 - i. Explain how a student will differentiate these two isomers in the laboratory.
 - ii. Explain giving reasons for your choice experiment.
- (d) Isomer which rotates the plane polarized light to the right is called dextro rotatory (d-form) and the isomer which rotates the plane polarized light to the left is called laevorotatory (l-form). You are given a (Mabcdef) type complex: PtpyNH₃NO₂ClBrI. Sketch or draw to differentiate the d-form and I-form for the complex PtpyNH₃NO₂ClBrI.

Total 70 Marks	BOOK DESCRIPTION OF THE PROPERTY OF THE PROPER	
Total 70 Marks		
Total 70 Marks		
Total 70 Marks		
	Tota	d 70 Marks

[244]	2
[243]	1 11

[227]	Ac	89	actinium	138.91	a L	57	lanthanum
232.04	물	90	thorium	140.12	Ce	58	cerium
231.04	D a	91	protactinium	140.91	Pr	59	praseodymium
238.03	_	92	uranium	144.24	S O	60	neodymium
[237]	Z O	93	neplunium	[145]	PE	61	promethium
[244]	Pu	94	plutonium	150.36	Sm	62	samarium
[243]	Am	95	americium	151.96	m L	63	europium
[247]	Cm	96	curium	157.25	Gd	64	gadolinium
[247]	BK	97	berkelium	158.93	귱	65	terbium
[251]	Ç	98	californium	162.50	D	66	dysprosium
[252]	Es	99	einsteinium	164.93	To	67	holmium
[257]	Fm	100	fermium	167.26	Щ	68	erbium
[258]	Md	101	mendelevium	168.93	Tm Yb	69	thulium
[259]	N O	102	nobelium	173.04	_	70	ytterbium

		_		70-	1			_						_			_		
223	francium 87	132.91	CS	55	85.468	及り	rubidium 37	39,098	ス	19	22.990	a Z	11	6.941		ω	1.0079	I	hydrogen 1
ス	radlum 88	137.33	B	56	87.62	Sr	strontium 38	40.078	Ca	20	24.305	N Q	magnesium 12	9.0122	E P	4	bervillium		
*	89-102		*	57-70															
[262]	lawrencium 103	174.97		71	88.906	~	yttnum 39	44.956	Sc	21									
[26 <u>1</u>]	rutherfordium 104	178.49	ヸ	72	91.224	Zr	zirconium 40	47.867	=!	22									
D	dubnium 105	180.95	a a	73	92,906	B	41	50.942	<	23									
S ₂₀₀	seaborgium 106	183.84	5	74	95.94	M o	molybdenum 42	51.996	C _r	24									
<u>명</u>	tohrium	186.21	Re	75	[98]	Tc	43	54.938	Z n	25									
HS	hassium 108	190.23	Os	76	101.07	Ru	rumenum 44	55.845	Fe	26									
M€	meltnerium 109	192.22	7	77	102.91	R	45	58.933	Co	27	221-21								
Uun	ununnilium 110	195.08	Þ	78	106.42	Pd	46	58.693	Z	28									
Uuu	111	196.97	Au	79	107.87	Ag	47	63,546	Cu	29									
Uub	ununbium 112	200.59	H ₀	80	112.41	Cd	28 48	65.39	Zn	30	i.								
		204.38	크	81	114.82	5	49	69.723	Ga	31	26.982		_						
	ununquadium 114	207.2	РЬ	82 2	118.71	Sn	50	72.61	Ge	32	28.086	S	14	12.011	റ	6	carbon		
		208.98	Ψ	83	121.76	Sb	antimony 51	74.922	As	33	30.974	ס	phosphorus 15	14.007	Z	7	nlfrogen		
		209	Po	84	127.60	Te	52	78.96	Se	selenium 34	32.065	ഗ	16	15,999	0	8	nebyxo		
		[210]	At	85	126.90	termin	53	79.904	ᄧ	35	35.453	<u>ဂ</u>	chlorine 17	18.998	77	9	fluorina		
		[222]	R S	86	131.29	×e	senon 54	83.80	즛	36	39.948	A	argon 18	20.180	Ze	10	4.0026	He	helium 2