

CONFIDENTIAL



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2022/2023**

COURSE NAME : INORGANIC CHEMISTRY II

COURSE CODE : BWK 10503

PROGRAMME CODE : BWK

EXAMINATION DATE : JULY/AUGUST 2023

DURATION : 3 HOURS

INSTRUCTION

1. ANSWER ALL QUESTIONS
2. THIS FINAL EXAMINATION IS CONDUCTED **CLOSED BOOK**.
3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

CONFIDENTIAL

**TERBUKA**

- Q1** (a) Four coordinate cobalt (II) complexes of  $[\text{CoI}_4]^{2-}$  and  $[\text{Co}(\text{NO})_4]^{2+}$  have 3 and 1 paired electrons respectively.
- (i) Use the valence bond theory to determine the hybridization. (4 marks)
  - (ii) Sketch the structure of  $[\text{CoI}_4]^{2-}$  and  $[\text{Co}(\text{NO})_4]^{2+}$ . (4 marks)
  - (iii) Write the IUPAC names based on structure drawn in **Q1(a)(ii)**. (2 marks)
- (b) The complex ion  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$  represent monodentate ligands.
- (i) Sketch the structure of all possible cis and trans isomers of the complex ions. (6 marks)
  - (ii) Identify the number of geometrical isomers, plane of symmetry and number of stereoisomers based on structure drawn in **Q1(b)(i)**. (4 marks)
- Q2** (a) Co is a complex ion of  $[\text{Co}(\text{NH}_3)_6]^{3+}$ . Using crystal field theory:
- (i) Determination of oxidation state of Co. (1 mark)
  - (ii) Write the electron configuration of Co. (2 marks)
  - (iii) Classify the spin, magnetic properties and types of ligands. (3 marks)
  - (iv) Draw the crystal field splitting diagram of  $d$  orbitals (4 marks)
- (b) Calculate the pairing energy ( $\Pi$ ) and CFSE ( $\Delta_o$ ) of  $[\text{Co}(\text{NH}_3)_6]^{3+}$ . (8 marks)
- (c) Predict Jahn-Teller Distortions of  $[\text{Co}(\text{NH}_3)_6]^{3+}$ . (2 marks)
- Q3** (a) Microstate are the number of different possible arrangements of molecular position and kinetic energy at a particular thermodynamic state.
- (i) Calculate the number of microstates for  $[\text{V}(\text{H}_2\text{O})_6]^{3+}$ . (2 marks)

- (ii) Determine the possible values of  $M_L[\Sigma_{ML}]$  and  $M_S[\Sigma_{MS}]$ . (1 mark)
- (iii) Construct the possible microstates table for  $[V(H_2O)_6]^{3+}$  configuration. (12 marks)
- (iv) Calculate the degeneracy and identify the R-S terms. (5 marks)

**Q4** (a) Transition metal complexes undergo ligand substitution reactions by either associative (A) or dissociative (D) mechanisms.

(i) Describe the associative (A) and dissociative (D) reactions by explaining in terms of their mechanisms and coordination numbers. (6 marks)

(ii) Demonstrate the free energy diagram represented by each mechanism. (4 marks)

(b) Construct reaction schemes for the following inner-sphere reaction and explain the concept of the inner sphere and all of the steps involved. (10 marks)

**Q5** (a) The 18-electron rule is used primarily to predicting and rationalizing formulas for stable transition metal complexes. Calculate the electron and distinguish whether the following complex compounds obey 18 electron rule or not.

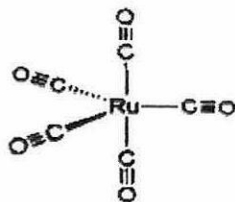
(i)  $Mn(CO)_5Cl$

(ii)  $Fe(CO)_5$

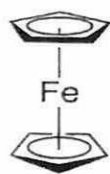
(iii)



(iv)



(v)



(10 marks)

- (b) Illustrate the orbital overlap diagrams to show the  $\sigma$ - and  $\pi$ - bonding interactions between ethane ( $\text{H}_2\text{C}=\text{CH}_2$ ) and a transition metal.

(10 marks)

**-END OF QUESTIONS-**

## FINAL EXAMINATION

SEMESTER / SESSION : SEM II 2022/2023

PROGRAMME CODE : BWK

COURSE NAME : INORGANIC CHEMISTRY II

COURSE CODE : BWK10503

Table: List of elements

Symbol	Name	Atomic Number	Atomic Mass	Symbol	Name	Atomic Number	Atomic Mass
H	Hydrogen	1	1.008	S	Sulfur	16	32.065
He	Helium	2	4.003	Cl	Chlorine	17	35.453
Li	Lithium	3	6.941	Ar	Argon	18	39.948
Be	Beryllium	4	9.012	K	Potassium	19	39.098
B	Boron	5	10.811	Ca	Calcium	20	40.078
C	Carbon	6	12.011	Sc	Scandium	21	44.960
N	Nitrogen	7	14.007	Ti	Titanium	22	47.880
O	Oxygen	8	15.999	V	Vanadium	23	50.940
F	Fluorine	9	18.998	Cr	Chromium	24	52.000
Ne	Neon	10	20.180	Mn	Maganese	25	54.940
Na	Sodium	11	22.990	Fe	Iron	26	55.850
Mg	Magnesium	12	24.305	Co	Cobalt	27	58.930
Al	Aluminium	13	26.982	Ni	Nickel	28	58.690
Si	Silicon	14	28.086	Cu	Copper	29	63.550
P	Phosphorus	15	30.974	Zn	Zinc	30	65.390