RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. Honours in Chemistry
Third Year - Semester I Examination – July / August 2023

CHE 3205 – ADVANCED INORGANIC CHEMISTRY I

Time: Two (02) hours

Answer all questions.

Use of a non-programmable calculator is permitted.

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1. a) $KMnO_4$ and $MnSO_4$ are two compounds containing the element manganese. Two compounds show two different colours, particularly the intensities. Explain the observation. Indicate their approximate molar absorptivity (ε). (20 marks)

b) With the use of ligand field theory, predict the d orbitals arrangement in the trigonal bipyramidal complex MX_5 in an energy level diagram. Include orbital diagram/s showing the x, y and z axes. Justify the order of arrangement. (30 marks)

c) Relate spectroscopic properties intensity, absorption wavelength to photonic properties. Imagine how to obtain a higher energy EMR source with the same wavelength. Give one practical application utilizes that technique. (25 marks)

d) The transition metal complex MX_2Y_4 shows bond lengths as indicated below.

2 (M-X) – 2.02 Å

2 (M-Y) – 2.29 Å

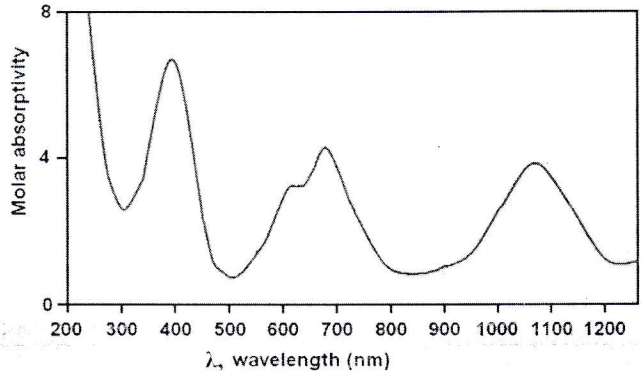
2 (M-Y) – 2.97 Å

Obtain the energy level diagram for the d orbitals of the complex. Predict plausible electronic spectra for the complex. Justify your answer. (25 marks)

2. a) Determine the term symbols for Boron atom at its most stable electronic configuration. Hint: Only open shell electrons needed to be considered. (14 marks)

b) Deduce the possible microstates for the complex $[Ni(OH)_6]Cl_2$ and identify the ground state. Justify your selection of ground state. (24 marks)

c) The complex $[Ni(OH)_6]Cl_2$ gives the spectrum below. Assign the transitions for the peaks using an Orgel diagram.



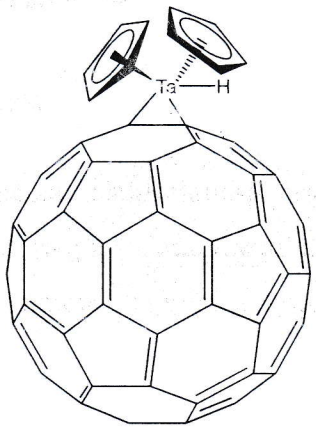
(25 marks)

d) Find the metal electron count and oxidation state of the central metal for each of the following compounds / ions.

i. $[Cp_2WH(C_2H_4)]^+$

ii. $[(\eta^5\text{-}C_5H_5)_2Co]^+$

iii.



(21 marks)

e) All the transition metals (M) given are first row elements. Identify the metal in each case.

i. $[(\eta^5\text{-}C_5H_5)M(PMe_3)_2(Me)]I$ — 18-electron species

ii. $[M(CO)_5]_2$ — 18-electron species (assume M-M single bond) (16 marks)

3. a) Discuss the bonding in transition metal-carbonyls in detail. Use orbital diagrams in your explanations. (20 marks)

b) In metal complexes NO ligand shows two binding modes. Illustrate. (20 marks)

c) With the UV irradiation, a Fisher carbene complex, $(CO)_5W{=}CMe(OMe)$ was converted into a reactive intermediate with evolving a gas. The reactive intermediate immediately transferred into an 18e complex. The latter transition involved a shift of OMe group, and the newly formed complex was no longer a carbene. Predict the intermediate and the final product. (30 marks)

d) Compare and contrast Fisher and Shrock carbene types. (30 marks)

4. a) Determine the specified quantity in each of the following. Indicate assumptions if any.

i. The metal-metal bond order in $[(C_5H_5)Co(\mu\text{-}CO)]_2$

ii. The expected charge, z on $[HRh(CO)(PPh_3)_3]^z$ (20 marks)

b) Propose a mechanism for the reaction given below which is catalyzed by the transition metal complex, $RhCl(PPh_3)_3$.

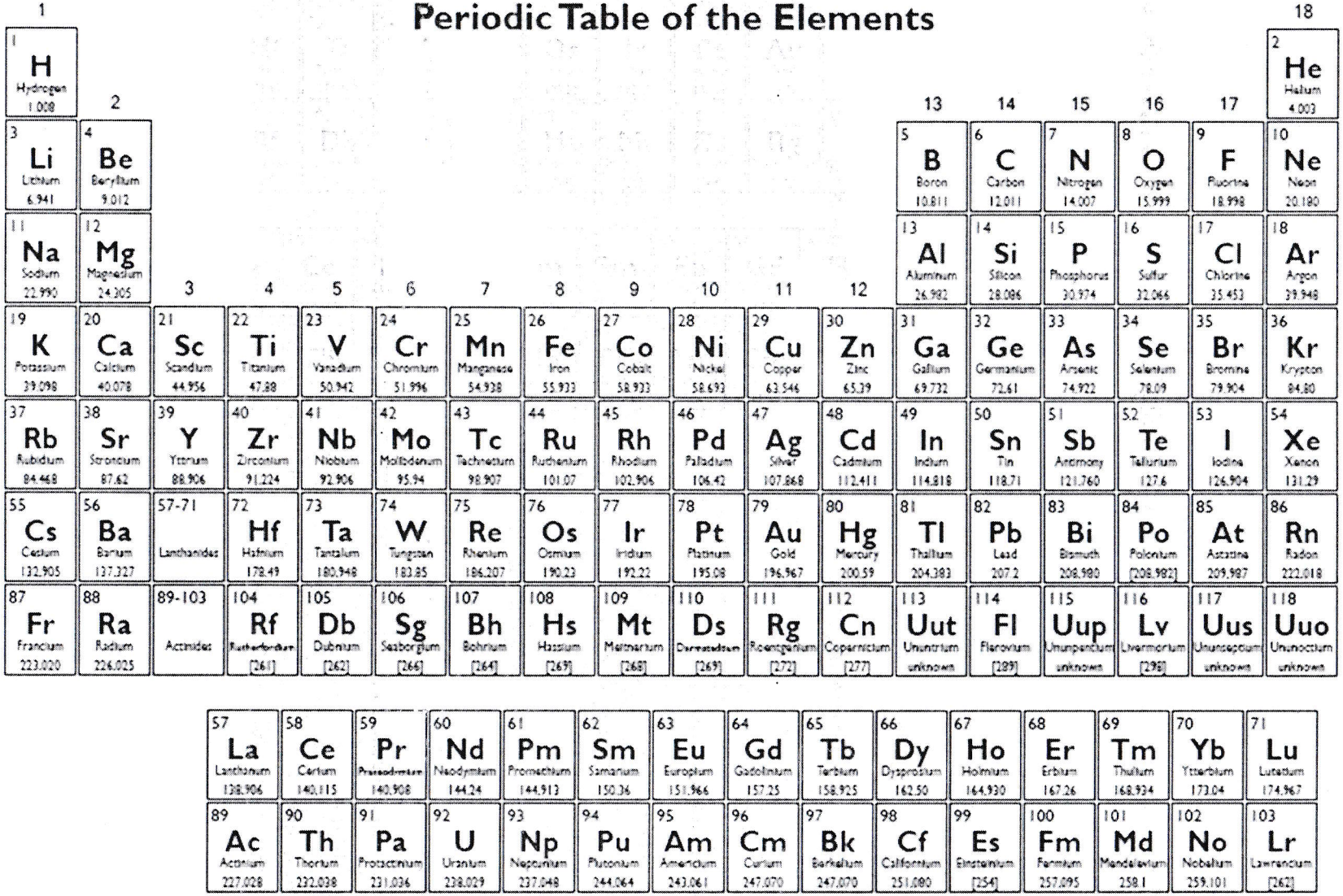
$CH_3CH{=}CH_2 + H_2 \rightarrow CH_3CH_2CH_3$

In the mechanism pathway, identifying followings in each step.

i. Oxidation state
ii. Coordination number
iii. Number of valance electrons
iv. Reaction type

(80 marks)

Periodic Table of the Elements



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