LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

SECOND SEMESTER 2023/2024 ACADEMIC YEAR

FOURTH YEAR EXAMINATION FOR THE DEGREES OF BACHELOR OF SCIENCE (GENERAL) AND BACHELOR OF EDUCATION (SCIENCE)

CHEM 421: COMPARATIVE STUDY OF d and f BLOCK ELEMENTS

STREAM: R ***TIME: 2 HRS***

DAY: MONDAY [2.30 P.M - 4.30P.M] ***DATE: 15/04/2024***

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

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INTRUCTIONS:

ANSWER ALL THE QUESTIONS

QUESTION ONE (30 Marks)

a) Define d block elements. **(1 Mark)**

b) Write the general electronic configuration of f- block elements. **(1 Mark)**

c) Explain why the outer electronic configuration of Cu is $3d^{10}\ 4s^1$ instead of $3d^9 4s^2$ **(1 Mark)**

d) Calculate the oxidation state of Pd in $Pd(PPh_3)_4$. **(2 Marks)**

e) i) What are organometallic compounds **(1 Mark)**

ii). Compare the CO (Carbonyl) and NO (Nitrosyl) in forming metal complexes. **(2 Marks)**

f) In reference to Wacker process:

i. What is the general product of Wacker process? **(1 Mark)**
ii. Which catalyst and the co-catalyst is used in Wacker process **(2 Marks)**
iii. Differentiate between a catalyst and a co-catalyst **(2 Marks)**
iv. Write an equation for preparation of acetone(CH_3COCH_3) with a catalyst only (without a co-catalyst). **(1 Mark)**

g) By using 18 electron rule determine whether the following is stable. **(1 Mark)**

$Fe(CO)_5$

h) Draw the structure of ferrocene $Fe(C_5H_5)_2$ and using the 18 electron rule determine whether it is stable: **(2 Marks)**

i) Mention three properties of the organometallic compounds. **(3 Marks)**

j) List two applications of organometallic compounds. **(2 Marks)**

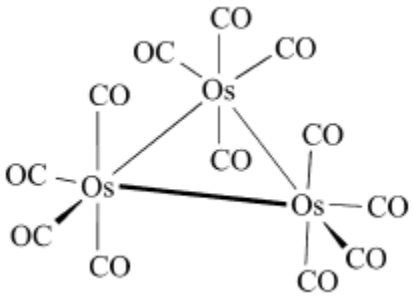
k) Describe the following reactions with the aid of a suitable example. **(4 Marks)**

(i) Migratory insertion (ii) oxidative addition

l) Define metal cluster **(1 Mark)**

i) Draw the structure of $Mn_2(CO)_{10}$. **(1 Mark)**
ii) Give the cluster electron counts of: **(2 Marks)**

I. $Os_3(CO)_{12}$):



II. $Re_4H_4(CO)_{12}$

QUESTION TWO (20 MARKS)

a) Explain what metal carbonyls are and give an example? **(2 Marks)**

b) Why is cis-platinum not considered as an organometallic compound? **(1 Mark)**

c) Account for the following:
Transition metals form large number of complex compounds. **(2 Marks)**

d) Explain the characterization of organometallic compounds with the help of IR, NMR and Mass spectrometry. **(5 Marks)**

e) Explain the following:
i) Scandium can't show an oxidation state of +1 or +2. **(2 Marks)**

ii) Zinc only shows an oxidation state of +2. **(2 Marks)**

f) Discuss $Ni(CO)_4$ - Nickel tetracarbonyl in reference to: **(6 Marks)**
i. Electron configuration of Ni
ii. Preparation
iii. Properties
iv. Reactions:
v. Structure and bonding

QUESTION THREE (20 Marks)

a) List **two** (2) applications of lanthanide and of actinide elements or their compounds. **(2 Marks)**

b) In the 3d series (Sc = 21 to Zn = 30) :

i. Which element shows maximum number of oxidation states? (**1 Mark)**

ii. Which element shows only +3 oxidation state? (**1 Mark)**

iii. Which element has the lowest enthalpy of atomization? (**1 Mark)**

iv. Write the electronic configuration of Sc, Mn and Zn. **(3 Marks)**

c) Outline the classification of organometallic compounds on this basis of nature of metal-carbon bond. **(2 Marks)**

d) Compare and contrast homogeneous and heterogeneous catalysis. **(6 Marks)**

e) What is lanthanoid contraction? Write any one consequence of lanthanoid contraction. (**2 Marks)**

f) Why do transition elements show variable oxidation states? (2 Marks)

Appendix

TABLE 2.2 Common Ligands and Their Electron Counts

Ligand	Type	Covalent Model	Ionic Model
Me, Cl, Ph, H, η^1-allyl, NO (bent)[a]	X	le	2e
Lone-pair donors: CO, NH_3, PPh_3	L	2e	2e
π-Bond donors: C_2H_4	L	2e	2e
σ-Bond donors: H_2	L	2e	2e
M–Cl (bridging)	L	2e	2e
η^3-Allyl, κ^2-acetate	LX	3e	4e
NO (linear)[a]		3e	2e[a]
η^4-Butadiene	L_2[b]	4e	4e
=O (oxo)	X_2[c]	2e	4e
η^5-Cp	L_2X	5e	6e
η^6-Benzene	L_3	6e	6e