UNIVERSITY OF RUHUNA

FACULTY OF FISHERIES AND MARINE SCIENCES & TECHNOLOGY

Academic Year 2022/2023

Bachelor of Science Honours in Marine and Freshwater Sciences Degree

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Level I Semester II Examinations – April / May 2024

CHM 1212: Inorganic Chemistry - Theory **Time: 1 hour and 30 minutes**

Answer **three (03)** questions **only.**

1). Answer all parts

A.

i) Giving examples, explain the difference between double salts and coordination complexes.

ii.) Write two examples for each of the following types of ligands.

a) cationic
b) bidentate
c) ambidentate

iii) What are the two ways that a bidentate ligand can bind to a metal ion.

iv) Name the type of isomerism shown by complexes when ambidentate ligands are attached to a central metal ion.

(25 marks)

B.

i) What are the types of stereoisomerism?

ii) The complexes $[Co(NH_3)_6][Cr(CN)_6]$ and $[Co(CN)_6][Cr(NH_3)_6]$ are examples of which isomerism? Give reasons for your answer.

iii) What type of isomerism is shown by the complex $[CoCl_2(en)_2]^+$. Briefly explain.

(25 marks)

C.

i) A complex of the type $[M(AA)_2X_2]^{n+}$ is known to be optically active. What does this indicate about the structure of the complex? Give one example of such a complex.

ii) Write the chemical formulas for the coordination complexes with the following IUPAC names.

a. Potassium hexacyanoferrate (II)
b. Pentaammineaquacobalt (III)chloride

(20 marks)

D. Using valence bond theory, find each of the following, (a)-(d), pertaining to the complexes i) $[Co(NH_3)_6]^{3+}$ and ii) $[FeCl_6]^{4-}$.

a) Type of hybridization of central atom.
b) Whether inner or outer orbital complex.
c) Magnetic behavior.
d) Electron geometry

(30 mark

2). Answer all parts.

A.

i) Define the hapticity of a ligand.
ii) Write the classes that can be categorized as organometallic compounds depending on the ty of bonding between the metal and carbon.
iii) Giving reasons, write the sum of the coordination number and oxidation number of the met M in the complex $[M(en)_2(C_2O_4)]Cl$

(20 marks)

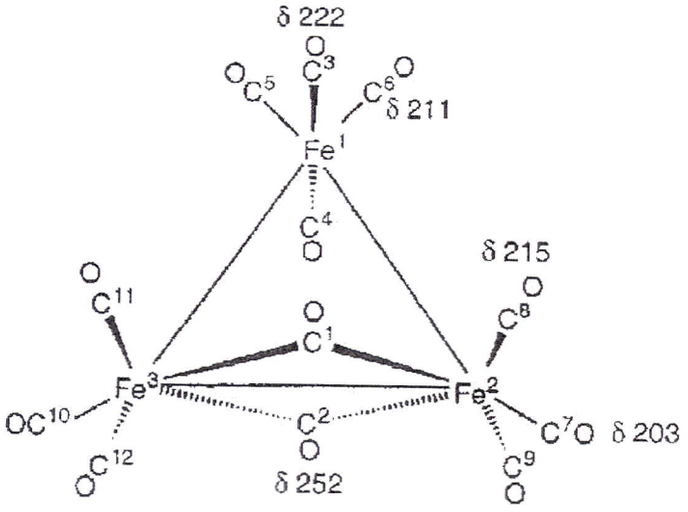
B. For the following questions, use the 18-electron rule as a guide.

i) Find the values for m, n in the following for the most stable complexes.
   a. $[(\eta^6\text{-}C_6H_6)_mCr(CO)_n]$
   b. $Fe(\eta^3\text{-allyl})(CO)_nCl]$

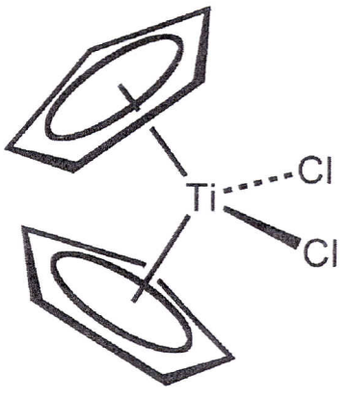
ii) Draw the stable structures of the $Fe_2(CO)_9$ metal carbonyl.
iii) Calculate the number of electrons present around the central metal ion.

a) $(CO)_5Mn–Mn(CO)_5$

b)



(c)



(35 marks)

C. Write the IUPAC names of the following complexes.

i) $[Co(NH_3)_6][Cr(C_2O_4)_3]$

ii) $[Cr(H_2O)(NH_3)_4(SCN)]Cl_2$ **(20 marks)**

D.

i) Draw the structure of cycloheptatriene which acts as η^6 ligand.

ii) Calculate the oxidation number of the central metal atom of the following compounds.

a. $[MnMe(CO)_5]$

b. Cp_2Fe

iii) The IR spectrum of an organometallic complex shows CO IR stretching frequency around 2000 cm^{-1} with regard to that of free CO which lies around 2145 cm^{-1}. Give reasons for this observation.

(25 marks)

3). Answer all parts.

A. Write balanced chemical reactions for the following.

i) Action of heat on $LiNO_3$

ii) Reaction of ionic nitride of Mg with water

iii) Dissociation of sulfurous acid

iv) Reaction of KO_2 in water

v) Reaction CaO_2 with dilute H_2SO_4

(20 marks)

B. Draw the structures of the following.

i) SO_3 cyclic trimer

ii) Crown structure of S_8

iii) Graphite

iv) Structure of XeF_4 indicating the correct molecular geometry

(20 marks)

C. Write a short account of the following.

i) Interhalogen compounds

ii) Fullerenes

iii) Variation of atomic and ionic radii of d block elements

(30 marks)

D.

i) Write five general properties of d block elements

ii) Cerium (Ce) electronic configuration can be written as [Xe] $4f^1\ 5d^1\ 6s^2$, write the electronic configuration of Lutetium.

iii) Giving reasons explain the following.

a. Ce^{4+} is a strong oxidizing agent

b. The silver atom has completely filled'd' orbitals ($4d^{10}$) in its ground state. Howeve it is considered as a transition element while Zn is not considered as a transition met

(30 mark

4). Answer all parts.

A.

i) Write the differences between natural radioactivity and artificial radioactivity.

ii) Define the terms nuclear fission and nuclear fusion.

iii) Write down the balanced equations for the following nuclear reactions

a. A nuclide undergoes β^- decay and changes to $^{133}_{55}Cs$

b. Alpha emission of $^{162}_{75}Re$

c. Formation of $^{11}_{5}B$ through positron emission

d. Electron capture by $^{145}_{62}Sm$

(35 marks)

B. Using crystal field theory predict the magnetic properties of the following two complexes.

i) $[Fe(NH_3)_6]$

ii) $[Co(F)_6]^{3-}$

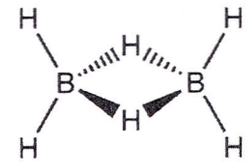
(20 marks)

C.

i) What are the three types of "Boranes"

ii) Categorize the following two molecules into appropriate types of boranes.

a.



b. B_4H_{10}

iii) Boron trihalides exist as monomeric molecules, while the trihalides of the other elements of the same group form dimeric structures. Explain.

(25 marks)

D.

i) Briefly discuss the trend of "Thermal stability of carbonates of Group 2 elements."

ii) What are the two types of water hardness and the species that contribute to each?

(20 marks)

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Periodic Table of the Elements

1 IA 1A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Lanthanide Series	57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]