JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL & PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION SCIENCE

3RD YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

REGULAR

COURSE CODE: SCH 306

COURSE TITLE: INORGANIC CHEMISTRY III

EXAM VENUE:LAB 6 **STREAM: (BEd. Science)**

DATE: 18/08/14 **EXAM SESSION: 9.00-11.00AM**

TIME: 2.00 HOURS

Instructions:

1. **Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

IMPORTANT DATA

The following data is provided at the end of the question paper:

- ***d^2* Tunabe-Sugano Diagram**
- **List of chemical elements**

Section A This section contains ONE COMPULSORY question

Question one

a) Briefly explain each of the following terms: (8 marks)
   i. Transition elements
   ii. Lanthanide contraction
   iii. Coordation complex
   iv. Coordination number
   v. Effective atomic number
   vi. Splitting the crystal field
   vii. Energy of stabilization of the crystal field (ESCF)
   viii. Spectrochemical series of ligands

b) Briefly discuss the factors the influence the amount of crystal field splitting according to the crystal field theory. (7 marks)

c) Briefly outline classification of transition elements. (2 marks)

d) The instability constant of [Ag(CN)2]- ion is 1021-.calculate the concentration of silver ions in 0.05 M solution of K[Ag(CN)2] also containing 0.01 M potassium cyanide, KCN. (7 marks)

e) Draw the structure and give the name the complex: $[Pt(NH_3)_4(NO_2)Cl]SO_4$. (2 mark)

f) Giving specific examples, briefly explain the importance of complexes in biological systems (4 marks)

Question two

a) Briefly discuss the importance of coordination complexes in biological systems (5 marks)

b) Show that the energy difference or field splitting (Δ_0) from hypothetical complex in a perfect spherical ligand field to eg orbitals (i.e. E_{eg}) is $+0.6\Delta_0$ and to t_2g (i.e. E_{t2g}) is $0.4\Delta_0$. (5 marks)

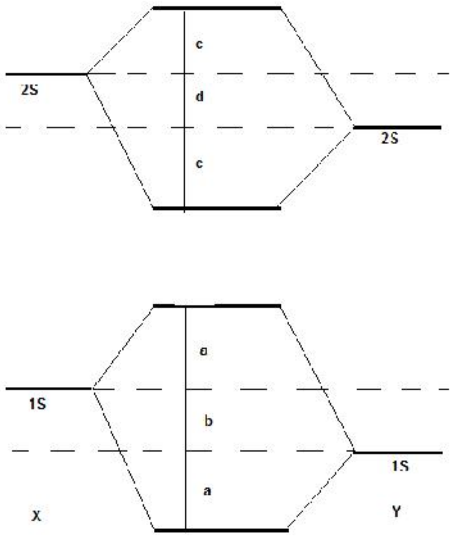
c) Draw the structure of the complex: potassium tetracyanonickelate(0) (2 mark)

d) Outline important selection rules in coupling electronic states according to the Russell-Saunders Coupling scheme. (5 marks)

e) One of the earliest attempts to explain coordination complexes was made by Blomstrand and Ergen in 1969. What was the main drawback of their explanation on metal complexes? (3 marks)

Question three

a) The Figure below is a sketch of an energy level diagram representing sigma bonding between the metal and ligand atomic orbitals (*ao*'s) to form coordination complex molecular orbitals (*MO*'s) according to the molecular orbital theory (MOT). Study it and answer the questions that follow.



   i. Which of the letters *x* and *y* most likely represent the ligand. Explain your answer. (2 marks)

   ii. Briefly explain the significance of the values represented by letters *a*, *b*, *c* and *d*. Explain how each of the values affect the bonds. (4 marks)

   iii. The value of the quantity *c* is always larger than that of *a*. By use of an appropriate diagram, explain. (3 marks)

b) For the complex ion: [CoF_6^{3-}],

   i. Write the electronic configurations according to each of the following theories: (3 marks)

      I. VBT
      II. CFT
      III. MOT

b)

  ii. Determine the (2 marks)

    I. Oxidation number of the complexing agent

    II. State the coordination number of cobalt

c) Briefly discuss the factors that influence occurrence of variable oxidation states among the *d*-block elements. (6 marks)

Question four

a) Transition metals have high tendency to form coordination complexes. Briefly explain. (4 marks)

b) Briefly outline the criteria used in classification of coordination complexes. (6 marks)

a) A solution of the complex $[Ti(H_2O)]^{3+}$, which is a d^1 complex, is colored red-violet because it absorbs yellow rays and allows blue and red rays. Sketch the absorption spectrum of the complex. (3 marks).

b) Give appropriate orbital hybridization associated with each of the following complexes according to the valency bond theory. (3 marks)

  i. Octahedral complexes

  ii. Tetrahedral complexes

  iii. Square planar complexes

c) Calculate the energy of stabilization of the crystal field (ESCF) for a d^5 metal ion configuration for: (4 marks)

  i. weak field

  ii. strong field ligands

Question five

a) Define the term "dentation" of a ligand (2 marks)

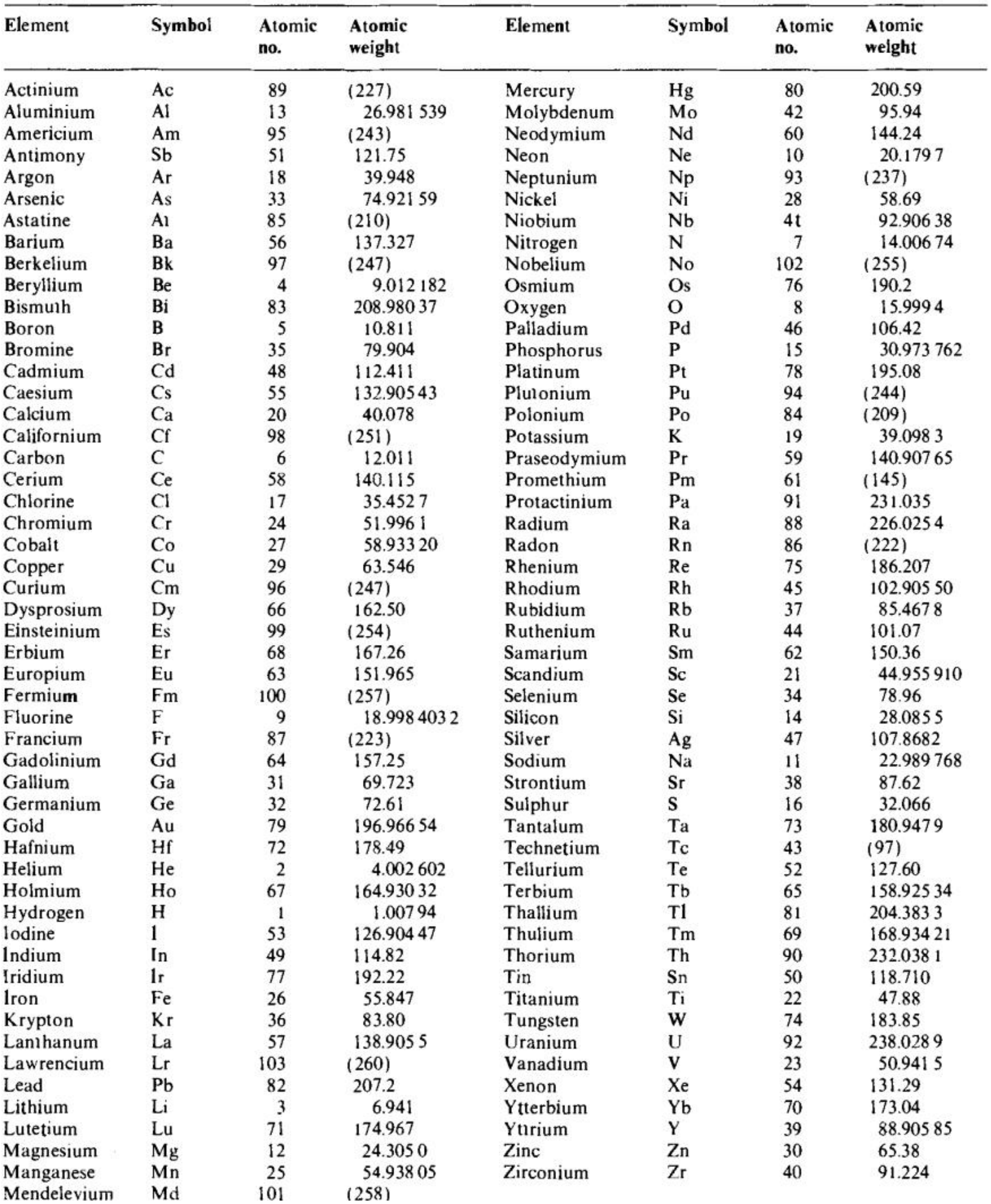
b) By giving appropriate examples where necessary, briefly discuss different types of isomerism in co-ordination complexes (7 marks)

c) Briefly outline the main short comings of the valency bond theory (VBT) in explaining coordination complexes. (4 marks)

d) A solution of $CoCl_3$.6NH3 added to a solution of $AgNO_3$ shows that all the chloride ions are precipitated. A similar experiment with $CoCl_3.5NH_3$, however, shows that only two-thirds of the chlorides precipitate. Explain. (3 marks)

e) The complex ion $[Ni(NH_3)_4]^{2+}$, forms on mixing aqueous solutions of ammonia and a nickel salt. If a solution contains 1.6 x 10^{-4} % of the nickel ions in the form of Ni^{2+} when the concentration of free NH_3 (aq) is 0.5M. What is the stability constant of the complex $[Ni(NH_3)_4]^{2+}$? (4 marks)

LIST OF CHEMICAL ELEMENTS



Element	Symbol	Atomic no.	Atomic weight	Element	Symbol	Atomic no.	Atomic weight
Actinium	Ac	89	(227)	Mercury	Hg	80	200.59
Aluminium	Al	13	26.981 539	Molybdenum	Mo	42	95.94
Americium	Am	95	(243)	Neodymium	Nd	60	144.24
Antimony	Sb	51	121.75	Neon	Ne	10	20.179 7
Argon	Ar	18	39.948	Neptunium	Np	93	(237)
Arsenic	As	33	74.921 59	Nickel	Ni	28	58.69
Astatine	At	85	(210)	Niobium	Nb	41	92.906 38
Barium	Ba	56	137.327	Nitrogen	N	7	14.006 74
Berkelium	Bk	97	(247)	Nobelium	No	102	(255)
Beryllium	Be	4	9.012 182	Osmium	Os	76	190.2
Bismuth	Bi	83	208.980 37	Oxygen	O	8	15.999 4
Boron	B	5	10.811	Palladium	Pd	46	106.42
Bromine	Br	35	79.904	Phosphorus	P	15	30.973 762
Cadmium	Cd	48	112.411	Platinum	Pt	78	195.08
Caesium	Cs	55	132.905 43	Plutonium	Pu	94	(244)
Calcium	Ca	20	40.078	Polonium	Po	84	(209)
Californium	Cf	98	(251)	Potassium	K	19	39.098 3
Carbon	C	6	12.011	Praseodymium	Pr	59	140.907 65
Cerium	Ce	58	140.115	Promethium	Pm	61	(145)
Chlorine	Cl	17	35.452 7	Protactinium	Pa	91	231.035
Chromium	Cr	24	51.996 1	Radium	Ra	88	226.025 4
Cobalt	Co	27	58.933 20	Radon	Rn	86	(222)
Copper	Cu	29	63.546	Rhenium	Re	75	186.207
Curium	Cm	96	(247)	Rhodium	Rh	45	102.905 50
Dysprosium	Dy	66	162.50	Rubidium	Rb	37	85.467 8
Einsteinium	Es	99	(254)	Ruthenium	Ru	44	101.07
Erbium	Er	68	167.26	Samarium	Sm	62	150.36
Europium	Eu	63	151.965	Scandium	Sc	21	44.955 910
Fermium	Fm	100	(257)	Selenium	Se	34	78.96
Fluorine	F	9	18.998 403 2	Silicon	Si	14	28.085 5
Francium	Fr	87	(223)	Silver	Ag	47	107.8682
Gadolinium	Gd	64	157.25	Sodium	Na	11	22.989 768
Gallium	Ga	31	69.723	Strontium	Sr	38	87.62
Germanium	Ge	32	72.61	Sulphur	S	16	32.066
Gold	Au	79	196.966 54	Tantalum	Ta	73	180.947 9
Hafnium	Hf	72	178.49	Technetium	Tc	43	(97)
Helium	He	2	4.002 602	Tellurium	Te	52	127.60
Holmium	Ho	67	164.930 32	Terbium	Tb	65	158.925 34
Hydrogen	H	1	1.007 94	Thallium	Tl	81	204.383 3
Iodine	I	53	126.904 47	Thulium	Tm	69	168.934 21
Indium	In	49	114.82	Thorium	Th	90	232.038 1
Iridium	Ir	77	192.22	Tin	Sn	50	118.710
Iron	Fe	26	55.847	Titanium	Ti	22	47.88
Krypton	Kr	36	83.80	Tungsten	W	74	183.85
Lanthanum	La	57	138.905 5	Uranium	U	92	238.028 9
Lawrencium	Lr	103	(260)	Vanadium	V	23	50.941 5
Lead	Pb	82	207.2	Xenon	Xe	54	131.29
Lithium	Li	3	6.941	Ytterbium	Yb	70	173.04
Lutetium	Lu	71	174.967	Yttrium	Y	39	88.905 85
Magnesium	Mg	12	24.305 0	Zinc	Zn	30	65.38
Manganese	Mn	25	54.938 05	Zirconium	Zr	40	91.224
Mendelevium	Md	101	(258)				