



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF APPLIED SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY AND BACHELOR OF EDUCATION (SCIENCE)

ACH101 – INTRODUCTION TO INORGANIC CHEMISTRY

DURATION: 2 HOURS

DATE: 13TH DECEMBER 2017

TIME: 9.00AM – 11.00AM

Instructions to Candidates:

1. Answer **all** questions in Section A and **Any Other Two** questions in Section B.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

Useful Information

Speed of light = $2.998 \times 10^8 \text{ ms}^{-1}$

Plank's Constant = $6.626 \times 10^{-34} \text{ J.S}$

Mass of an electron = $9.11 \times 10^{-31} \text{ kg}$

Reydberg Constant = $1.10 \times 10^7 \text{ m}^{-1}$

Avogadro's number = 6.022×10^{23}

SECTION A (Compulsory)

QUESTION ONE (30 Marks)

- a) Given that X (not the actual symbol) is a transition element with atomic number 47;
- Write the electronic configuration of X , X^+ and X^- (3 Marks)
 - What would happen if X , X^+ and X^- were subjected to a magnetic field? Explain your answer. (3 Marks)
- b) Compare and explain the difference the atomic and ionic radii of Chlorine (2 Marks)
- c) Name the four (4) quantum numbers and state what each of them represent. (4 Marks)
- d) Define the following terms:
- Emission Spectrum
 - Hybridization
 - Steric number (3 marks)
- e) In a laboratory flame test experiment, Na had a yellow flame while K had a purple flame. Explain why the two ions/elements gave flames of different colours. (2 Marks)
- f) Use Lewis dot symbols to show transfer of electrons between the following atoms to form ionic compounds (Atomic no are: Mg=12, N=7, Cl=17):
- Mg and N*
 - Mg and Cl* (4 Marks)
- g) Using valence bond theory, explain how HCl molecule is formed from H and Cl atoms. (3 Marks)
- h) State the following;
- Pauli Exclusion Principle
 - Hunds' rule
 - Heisenberg's Uncertainty Principle (3 Marks)
- i) Calculate the minimum uncertainty in the position of an electron moving at the speed of light given that the uncertainty in the velocity is $\pm 1\%$. (3 Marks)

SECTION B (Answer any two (2) questions)

QUESTION TWO (20 Marks)

- a) i) Calculate the energy in joules (J) emitted when an electron in a hydrogen atom makes a transition from $n = 5$ to $n = 2$. (3 Marks)

- ii) Calculate the wavelength of light that corresponds to the energy change in a (i) above. (3 Marks)
- b) What is the significance of a node in a d-orbital? Show that the total number of nodes in the $6d_{xy}$ orbital is equal to $n = 1$. (3 Marks)
- c) Determine the total number of orbitals associated with the principle quantum number $n = 4$. Describe the shapes of the S and P orbitals. (4 Marks)
- d) The blue colour of the sky results from scattering of sunlight by air molecules. Blue light has a frequency of about $7.5 \times 10^{14} \text{ Hz}$.
- Calculate the energy of a single photon associated with this frequency. (2 Marks)
 - Photochemical reactions are reactions which are initiated by light energy. Calculate the energy of a mole of photons with this energy (3 Marks)
- e) State any two properties of ionic compounds (2 Marks)

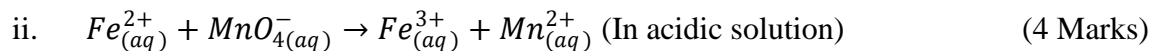
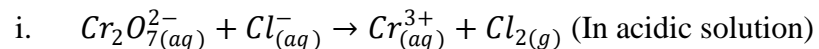
QUESTION THREE (20 Marks)

- a) Distinguish between electron affinity and electronegativity. (2 Marks)
- b) Write the electronic configuration of oxygen and nitrogen given that the atomic no are 8 & 7 respectively and draw their corresponding electron orbital diagram. (3 Marks)
- c) Compare the electron affinities of oxygen and nitrogen. Explain your answer. (2 Marks)
- d) Draw the resonance forms of the thiocyanate (SCN^-) ion and assign the corresponding formal charges. (3 Marks)
- e) Define the term isoelectronic species. Write the Lewis structures of any three (3) species that are isoelectronic. (4 Marks)
- f) State and explain the variation in the first ionization energy;
- Across a period in the periodic table
 - Down a group in the periodic table. (2 Marks)
- g) List the four (4) postulates upon which Bohr's atomic theory is based. (4 Marks)

QUESTION FOUR (20 Marks)

- a) Assign oxidation numbers to Li-atom in each of the following hypothetical compounds.
- Li_2O_2
 - LiO_2 (4 Marks)

b) Balance the following redox reactive equations (show all the steps)



c) Use the species below to answer the questions that follow;



i. Predict the hybridization of the central atom in I-IV. (4 Marks)

d) Arrange the following molecules in order of decreasing bond angles: CH_4 , H_2O and NH_3 .

Explain your answer. (4 Marks)

e) i) Using Lewis structures show the reaction between NH_3 and $AlCl_3$. (Current Atomic numbers (2) N(z=7), H(z=1), Al(z=13) and Cl(z=17)

ii) Identify the acid in the reaction in e(i) above (4 marks)