JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

1ST YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

MAIN

COURSE CODE: SCH 3112

COURSE TITLE: INORGANIC CHEMISTRY

EXAM VENUE: LAB 3 **STREAM: (SBPS)**

DATE: 24/04/14 **EXAM SESSION: 9.00 – 11.00 AM**

TIME: 2.00 HOURS

Instructions:

1. **Answer ALL Questions in Section A and ANY other 2 questions**
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.**

Useful information

Plank's constant = 6.3×10^{-34} kg m^2 s^{-1}

Mass of an electron = 9.11×10^{-31} kg

Speed of light = 3.0×10^{-8} ms^{-1}

INSTRUCTIONS

Answer Question one (COMPULORY) and any other two questions.

SECTION A

QUESTION ONE (30 marks) Compulsory

a. Given that X has atomic number of 36, write the electron configuration starting with the nearest noble gas of :-
   i. X (1 mark)
   ii. X^+ (1 mark)
   iii. X^- (1 mark)

b. i). Differentiate between paramagnetism and diamagnetism (2 marks)
   ii). Arrange the species X, X^+, X^- in the order of decreasing radius. Explain the basis of your arrangement. (2 marks)

c. i). State the Heisenberg' uncertainity principle. (1 mark)
   ii). An electron in a hydrogen atom is known to have a velocity of 5.0×10^6 ms^{-1} $\pm$1 %. Calculate the minimum uncertainity in the position of the electron and comment on the magnitude of the uncertainity compared to the size of the atom given that the diameter of the hydrogen atom is less than 1Å (3 marks)

d. Differentiate between the following:-
   i). Bronsted acid and Lewis acid. (2 marks)
   ii). Monoprotic acid and polyprotic acid. (2 marks)
   iii). Referring to nitric acid and acetic acid, differentiate between a weak acid and a strong acid. (Show the relevant chemical equations). (2 marks)

e. Give the Lewis structure for the following:-
   i. Formaldehyde H_2CO (1 mark)
   ii. NOF_2 (1 mark)
   iii. OCl^- (1 mark)
   iv. BBr_2F (1 mark)
   v. Using an example describe valence electrons. (1 mark)
   vi. What is the importance of Lewis structures (1 mark)

f. Explain the following.
   i) Bond order of a covalent bond. (1 mark)
   ii) Bond Energy of a covalent bond (1 mark)

g. Derive the Schrodinger wave equation in three dimensions showing the kinetic energy and the potential energy parts. (5 marks)

SECTION B

QUESTION TWO (20 MARKS)

a) Explain and show in an energy level diagram how the following series of spectral lines are formed when hydrogen gas is subjected to high electrical potential difference in an evacuated vessel.

i. Lyman series (2 marks)
ii. Balmer series (2 marks)
iii. Bracket series. (2 marks)
iv. In which part of the electromagnetic spectrum do the Balmer series fall. (1 mark)

b). The Paschen series of lines in the hydrogen spectrum occurs in the infrared region. The electrons that produce them are moving from higher states to the n = 3 state.

i) Give $n_{(initial)}$ for the transition that would account for the least energetic line of the series. (1 mark)
ii) What is the energy involved in the least energetic transition. (2 marks)
iii) What is the frequency of the emitted light (2 marks)
iv) Calculate the wavelength of the emitted transition (2 marks)

c). i). Explain the photoelectric effect as brought forth by Albert Einstein. (2 marks)
ii). From the equations $E_{photon} = h\upsilon$ and $E = mc^2$ derive the De Broglie equation. (2 marks).
iii). Use the De Broglie equation to calculate the wavelength in nanometers of an electron of mass 9.11×10^{-31} kg moving at a speed of 2.74×10^6 ms^{-1} (2 marks)

QUESTION THREE (20 MARKS)

a) The following are principles that aid in electron distribution in atoms. Explain each of the rules for the build-up of electrons.

i) The Pauli Exclusion Principle. (2 marks)
ii) The Auf-bau principle. (2 marks)
iii) Hund's rule. (2 marks)

b). Using the "box" model, write the electron configurations of the following elements.

i) O (Atomic number 8) (1 mark)
ii) Ca (Atomic number 20) (1 mark)
iii) Mn (Atomic number 25) (1 mark)

c). From solutions of Schrödinger wave equation, atomic orbitals have been represented as 3-dimensional – cloud shapes.

i) What do these 3–dimensional cloud shapes represent (1 mark)
ii) Draw the different shapes of P- orbitals. (3 marks)

d). i). List and briefly explain the four quantum numbers needed to explain the structure of atoms according to the Bohr – Summerfield model. (4 marks)

ii). Characterize completely the electrons in the Carbon (C) atom. (1 mark)
iii). State the principal quantum numbers (n) at which s, p, d and f orbital's respectively start appearing (1 mark)
iv). What is the maximum number of electrons that occupy the f – orbital's. (1 mark)

QUESTION FOUR (20 MARKS)

a). Define the following terms.

i) Electronegativity. (1 mark)
ii) Electron affinity (1 mark).
iii) Dative (coordinate) bond (1 mark)
iv) Lone pair of electrons. (1 mark)

b). i). What is Ionization energy (IE) of an element (2 marks)
ii). Explain why the 2nd ionization energy of Na (4564 $kjmol^{-1}$) is much higher than its 1st ionization energy (494 $kjmol^{-1}$). [Note: Atomic number of Na is 11] (2 marks)

c). Explain the following:-
i). How ionic bonding occurs in the formation of NaCl from Na and Cl elements (2 marks)
ii). Formation of a coordinate covalent bond in the ammonium radical (2 marks)

d). In any atom, outermost energy level electron is screened from the nucleus by the inner orbital electrons.

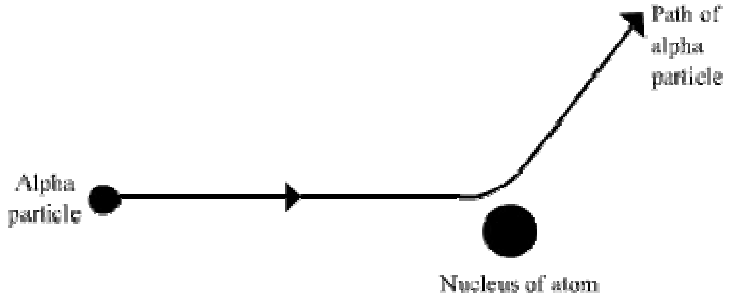
i) Arrange orbitals within the fourth shell of an atom in order of increasing screening effect. (1 mark)
ii) How can the difference in the screening effect capability of the orbitals in the fourth shell be explained. (2 marks).
iii) With refence to the screening effect, explain the changes in ionization energy down any group and across a period in the periodic table (2 marks)

e. $PbSO_4$ and $PbNO_3$ were mixed with water in different test tubes. Only one of the compounds dissolved.

i) Which of the two compounds dissolved in water. (1 mark)
ii) Explain how the compound in (i) above dissolves in water. (1 mark)
iii) Explain why one of the lead compounds dissolves in water while the other one does not. (1 mark)

QUESTION FIVE (20 MARKS)

a. A new model of an atom was suggested by Rutherford and Marsden. They fired alpha particles at thin metal foil. Alpha particles are positively charged. In their model each atom has a nucleus. The diagram below shows the path of an alpha particle as it passes the nucleus of an atom.



i. Explain why the alpha particle changes direction. (2 marks

ii. What was the main significance of this experiment in the development of the modern understanding of the atomic structure? (2 mark)

b. Draw Lewis structures to show bonds in the following polyatomic species. In each case, work out and state the possible bond hybridization of the central atom.

Species	**Lewis strucutre**
CO_3^{2-}	(2 marks)
SO_4^{2-}	(2 marks)

c. When n=4, l=2 and m_l= -2, where n, l and m_l are the principle, the azimuthal and the angular momentum quantum numbers, respectively,

i. Identify the orbital type represented by the above data (1 mark)

ii. Sketch the shape of the orbitals above. (2 marks)

d. Write the a stoichiometric equation for the reaction of copper(II) sulphate and zinc powder,(1 mark)

Giving reasons identify

i. the species that undergoes reduction (2 marks)

ii. The oxidizing species (2 marks)

e. Suggest reason(s) whys the ionization energy of

i. phosphorus (15) is greater than that of sulphur (16) and (2 marks)

ii. that of magnessium (24) is great than that of aluminium (27)(2 marks)