JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THEDEGREE OF BACHELOR OF EDUCATION (SCIENCE)

2ND YEAR 1ST SEMESTER 2013/2014 ACADEMIC YEAR

MAIN

COURSE CODE: SCH 202

COURSE TITLE: INORGANIC CHEMISTRY I

EXAM VENUE :LAB 3 **STREAM: (Biological Sciences)**

DATE: 25/04/14 **EXAM SESSION: 11.30 – 1.30 PM**

TIME: 2.00 HOURS

Instructions:

1. **Answer ALL Questions 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.**

Useful information:

Constant A $= 2.18 \times 10^{-18}$ J
Planck's constant, h $= 6.625 \times 10^{-34}$ Js
Mass of an electron, m $= 9.11 \times 10^{-31}$ kg
Speed of light, C $= 3.0 \times 10^{8}$ ms^{-1}
Reydenerg's constant, R_H $= 109678$ cm^{-1}

Section A

Question 1

a) Briefly explain each of the following terms: (7 marks)
   i. Energy quantization
   ii. Work function
   iii. Electromagnetic series
   iv. Angular momentum
   v. Heisenberg's uncertainty principle
   vi. Spherical harmonics
   vii. Lattice energy

b) Briefly explain the term moments of inertia. (2 marks)

c) Briefly discuss de Broglie's postulates about the wave nature of matter. (4 marks)

d) Draw the crystal rutile structure and use it to work out the formula of titanium oxide. (5 marks)

e) The time-independent Schrödinger wave equation is given by :

$$\nabla^2\Psi(x,y,z)+\frac{8\pi^2 m}{h^2}(E-V)\Psi(x,y,z)=0$$

   i. Define all the terms. (3 marks)
   ii. Write the corresponding Schrödinger wave equation for a hydrogen atom (3 marks)

f) Write Albert Einstein's relativity equation and define all the terms (2 marks)

g) Sketch each of the following orbitals:
   i. dxz (2 marks)
   ii. dz^2 (2 marks)

Section B:

Question 2 (20 marks)

a) Identify the main shortcomings of classical physics at the turn of the 20th century, which lead to the development of the quantum mechanics (2 marks)

b) Show that the angular velocity for any stable orbit is $\omega = \frac{v}{r}$, where, v is linear velocity and r is the radius. (4 marks)

c) For the species NO^+:

i. Draw the molecular orbital energy level diagram (6 marks)

ii. Write the electronic configuration (1 mark)

iii. Calculate the magnetic moments and the bond order (2 marks)

d) By using appropriate illustration(s), briefly explain the term spherical polar coordinates (3 marks)

Question 3 (20 marks)

a) Outline the general characteristics of waves (4 marks)

b) Work out and sketch p_y-orbitals. (5 marks)

c) For a neutral and stable atom with nuclear charge +Ze and electronic charge, e-, show that the total energy holding an electron with electronic charge, e, in a stable orbit of radius, r, about the nucleus of charge, +Ze, is given by, $E = -\frac{1}{2}.\frac{Ze}{r}$.

(8 marks)

d) Explain the main contribution of the Rutherford-Geiger Experiment in the modern understanding of the structure of the atom. (3 marks)

Question 4 (20 marks)

a) Briefly discuss classification of molecular orbitals according to the molecular orbital theory (4 marks

b) With the aid of a well labeled diagram, illustrate the production and measurement of photoelectrons (6 marks)

c) What is the momentum and the corresponding de Broglie wavelength of electron when the accelerating voltage is 56 V? (9 marks)

d) Although copper (Z=29) and zinc (Z=30) both have $3d^{10}$ configurations, copper in normally classified as a transition element but zinc is sometimes classified with main-block elements. Briefly explain. (1 mark)

Question 5 (20 marks)

a) Write the Reydeberg's formular and define all the terms involved. (3 mark)

i. Determine the wavelength of radiation emitted when a hydrogen electron moves from the second energy level to the first energy level (3 marks)

ii. Identify the series of emission in question 5. a) i. above (1 mark)

b) Suppose the velocities of an electron (mass= 9.11×10^{-31} kg) and that of a rifle bullet (mass 0.03 kg) are each measured with uncertainties of $\Delta v = 10^{-3}\ ms^{-1}$, what is the minimum uncertainties in their positions according to the uncertainty principles? (9 marks)

c) Briefly explain the quantum numbers that characterize the position of an electron in the atom (4 marks)