JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL & PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION SCIENCE

2nd YEAR 1st SEMESTER 2018/2019 ACADEMIC YEAR

REGULAR

COURSE CODE: SCH 202

COURSE TITLE: INORGANIC CHEMISTRY I

EXAM VENUE: STREAM: (BEd. Science)

DATE: **EXAM SESSION:**

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.**
4. **Important constants are given here below and the periodic table at the back page**

IMPORTANT CONSTANTS:

Plank's constant, $h = 6.626 \times 10^{-34} J.S$

Speed of light (in a vacuum), $C = 2.998 \times 10^{8} ms^{-1}$

Mass of electron, $m_e = 9.11 \times 10^{-31} kg$

Rydberg constant = $3.29 \times 10^{15} s^{-1}$

$R_H = 1.097 \times 10^{7} m^{-1}$

$1J = 1 kgm^2 s^{-2}$

SECTION A (COMPULSARY)

QUESTION 1

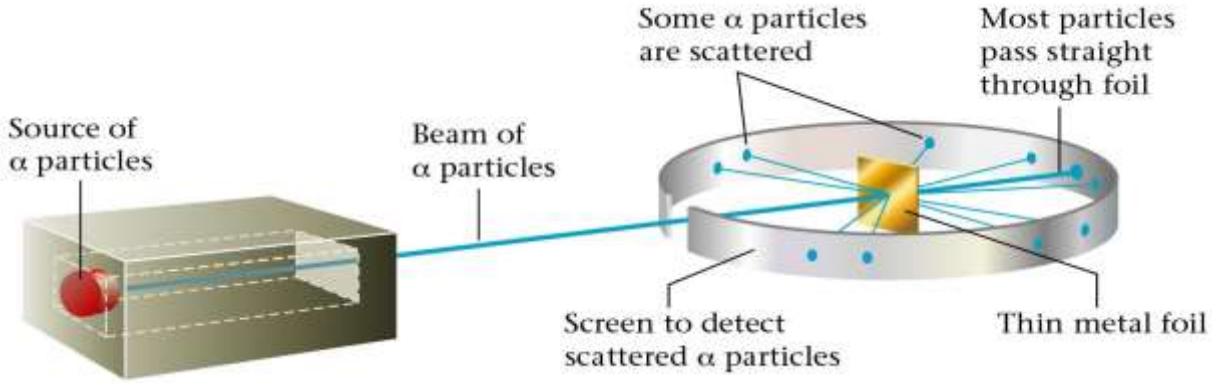
a) Explain the following terms using relevant examples
   i) Polar covalent bond **2 Marks**
   ii) Hybridization **2 Marks**

b) According to molecular orbital theory
   i) What is an antibonding molecular orbital? **2 Marks**
   ii) Which molecular orbital would be lower in energy? Explain **2 Marks**

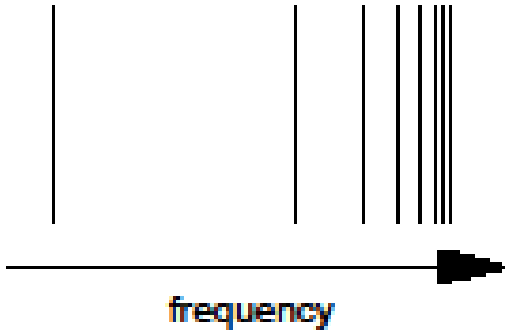
c) The bond angle for the compounds below increases in the order shown yet in all the molecules four pairs of electrons surround the central atom (octet achieved). Explain clearly using appropriate diagrams to illustrate. **4 Marks**

$$H_2O < NH_3 < CH_4$$

d) In one of the early experiments done by Rutherford aimed at understanding the structure of an atom he directed α-particles towards a metal foil. He discovered that the particles were scattered but most of them passed through as shown in the diagram below. Explain this observation. **2 Marks**



e) The diagram below shows the pattern of lines in the Lyman series of the atomic hydrogen spectrum.



   i) Which part of the electromagnetic spectrum (UV, visible or IR) is the Lyman series found in? **1 Mark**
   ii) Why does the series consist of a number of individual lines rather than a continuous spectrum? **1 Mark**
   iii) Which of the lines in the Lyman series has the lowest energy of light? Explain your answer. **2 Marks**

iv) Why are the frequencies closer as one progresses to the right **1 Mark**

f) A line having a wavelength of 656nm exists in the atomic emission spectra of hydrogen. For the line, calculate the following values and specify their units.

i) Frequency **2 Marks**

ii) Energy of a photon **2 Marks**

iii) Energy of a mole of photons **2 Marks**

g) Answer the following questions in relation to Bond energy

i) Giving examples define Bond dissociation energy. **1 Mark**

ii) Identify the bond with higher bond dissociation energies for the molecules given below. **1 Marks**

H—Cl or H—Br

H_3C—SH or H_3C—OH

iii) Calculate ΔH for each of the reaction given below, knowing ΔH of O_2 = 498 KJmol^{-1} and O-H = 464 KJmol^{-1}, ΔH of C-H = 414 KJmol^{-1} and ΔH of one C=O = 738 KJmol^{-1} **3 Marks**

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

SECTION B (ANSWER ANY TWO QUESTIONS)

QUESTION 2

a) Bohr atomic model describe the atom as having discrete energy levels.

i) Explain this **1 Mark**

ii) A certain line in the spectrum of atomic hydrogen is associated with the electronic transition in the H atom from the sixth energy level (n = 6) to lower energy levels. Indicate whether the H atom emits energy or whether it absorbs energy during the transition. Justify your answer. **2 Marks**

iii) One of the transitions involving the visible lines in the spectrum of hydrogen in ii) above occurs at 486 nm. What is the energy of a photon of this wavelength? **2 Marks**

b) The emission spectrum of hydrogen consists of several series of sharp emission lines in the ultraviolet (Lyman series) in the visible (Balmer series) and in the infrared (Paschen series, Brackett series, etc,) regions of the spectrum.

i) What feature of the electronic energies of the hydrogen atom explains why the emission spectrum consists of discrete wavelengths rather than a continuum of wavelengths? **1 Mark**

ii) Account for the existence of several series of lines in the spectrum. What quantity distinguishes one series of lines from another? **1 Mark**

iii) Draw an electronic energy level diagram for the hydrogen atom and indicate on it the transition corresponding to the line of lowest frequency in the Balmer series.**3 Marks**

c) The Rydberg equation enables you to calculate the frequency of a line in the hydrogen spectrum. The version of the Rydberg equation in terms of frequency is

$$\nu = cR_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

i) Calculate the frequency of the line produced when an electron falls back from the infinity level to the 1-level. **2 Marks**

ii) Write the equation which relates the energy gap between two levels and the frequency of light emitted. **2 Marks**

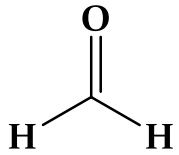
iii) Ionisation of a hydrogen atom happens when an electron is promoted from the ground state (the 1-level) to the infinity level. Use the equation you have written in ii) to calculate the energy needed to move an electron from the 1-level to the infinity level. State clearly any assumptions you are making. **4 Marks**

iv) Calculate the ionisation energy of hydrogen in kJ mol-1. **2 Marks**

QUESTION 3

a) Consider the compounds N_2, Cl_2, HF and NaBr. List the type of bonding (ionic, nonpolar covalent, and polar covalent) each would be expected to have. **2 Marks**

b) The structure given below is for formaldehyde



i) Using boxes to represent atomic orbitals show how bonding takes place in this molecule following the **valence bond theory**. **3 Marks**

ii) Using diagrams explain bonding in this molecule following **molecular bond theory**. **4 Marks**

iii) Given that this molecules is experimental described as having a planar geometry with bond angles of approximately 120° which of the two theories best describes bonding here. Give a one line explanation. **1 Mark**

c) Consider the molecule $\mathbf{N_2}$.

i) Draw its molecular orbital diagram labelling all the levels specifically. **3 Marks**

ii) Calculate the bond order for this molecule **2 Marks**

iii) Calculate the bond order of the molecules $\mathbf{N_2^+}$ and $\mathbf{N_2^-}$. **2 Marks**

iv) Arrange the three molecules in increasing order of C-F bond length **1 Mark**

v) Categorize the molecules as either para- or diamagnetic. Explain **2 Marks**

QUESTION 4

a) Identify the hybrid orbitals used for the phosphorus atoms in the species given below. **4 Marks**

$$\mathbf{PCl_4^+} \qquad \mathbf{PCl_6^-} \qquad \mathbf{PCl_5} \qquad \mathbf{PCl_3}$$

b) Consider the molecules given below and answers the following questions

$$\mathbf{PH^+_4} \qquad \mathbf{PF_5} \qquad \mathbf{PF^-_6}$$

i) Draw the Lewis structures of all the molecules **3 Marks**

ii) Draw and name the electronic structure of these molecules **6 Marks**

iii) Draw and name the molecular geometry of these molecules predicting the bond angles in each case **7 Marks**

APPENDIX

Elements of the Periodic Table