JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL & PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF EDUCATION SCIENCE

1ST YEAR 1st SEMESTER 2018/2019 ACADEMIC YEAR

REGULAR

COURSE CODE: SCH 102

COURSE TITLE: BASIC INORGANIC CHEMISTRY

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**
5. **Periodic table provided in the last page**

Important Constants for Question One

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

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

Rydberg's constant, $R_H = 2.178 \times 10^{-18} j\}$

SECTION A (COMPULSARY)

QUESTION 1

a) Using your periodic table and the atomic radius chart, determine which of the elements in each pair has a larger atomic radius: **3 Marks**

i) Cesium (Cs) and Potassium (K)
ii) Calcium (Ca) and Gold (Au)
iii) Rubidium (Rb) and Strontium (Sr)
iv) Oxygen (O) and Sulfur (S)
v) Xenon (Xe) and Neon (Ne)
vi) Aluminum (Al) and Tin (Sn)

b) The table below shows the ionization energies in KJ/mol for the first 20 elements of the periodic table. Use it to answer the questions that follow.

Ionization Energies of First 20 Elements (kJ/mol)

Symbol	First	Second	Third
Li	520	7297	11,810
Be	899	1757	14,840
B	801	2430	3659
C	1086	2352	4619
N	1402	2857	4577
O	1314	3391	5301
F	1681	3375	6045
Ne	2080	3963	6276
Na	496	4565	6912
Mg	738	1450	7732
Al	578	1816	2744
Si	786	1577	3229
P	1012	1896	2910
S	999	2260	3380
Cl	1256	2297	3850

i) What is the difference between ionization energy and electron affinity **1 Mark**
ii) What are the reasons for the difference in the first ionization energies between Beryllium and magnesium? **1 Mark**
iii) What are the reasons for the difference in the second ionization energies between Magnesium and aluminium? **1 Mark**
iv) Why are the third ionization energies for lithium and beryllium much higher than that of boron yet all these elements belong to the same period? **1 Mark**
v) Explain why the first ionization energy is highest for neon in the in period 2. **1 Mark**

c) Carefully study the electronic configurations given below and then answer the questions that follow

A - $1s^2 2s^2 2p^6 3s^2 3p^4$
B - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^{10} 4p^5$
C - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1$
D - [Ar] $4s^2 3d^7$
E - [Ra] $7s^2 5f^8$
F - [Xe] $6s^2 4f^{14} 5d^6$

i) For each of the given electronic configurations determine, whether or not they are valid. **3 Marks**
ii) For those not valid, give the correct electronic configurations and then give elements associated with all the electronic configurations **A** through **F**. **8 Marks**

d) Consider the two compounds given below.

NH_3 **ii) $^+NH_4$**

i) Draw Lewis structures for both **1 Mark**

ii) Draw the electronic structures for both compounds **1 Marks**

iii) Draw the molecular geometries of both compounds clearly showing the approximate bond angles **3 Marks**

iv) Give reason for the observed differences in bond angles between the two compounds. **2 Marks**

e) Answer the following question related to acid base reactions

i) Explain the terms *acid* and *conjugate base* according to the Brønsted-Lowry theory. **2 Marks**

ii) For each of the following reactions, give the formula of the acid and of its conjugate base.

A $NH_3 + HBr \rightleftharpoons NH_4^+ + Br^-$ **1 Mark**

B $H_2SO_4 + HNO_3 \rightleftharpoons HSO_4^- + H_2NO_3^+$ **1 Mark**

SECTION B (ANSWER ANY TWO QUESTIONS)

QUESTION 2

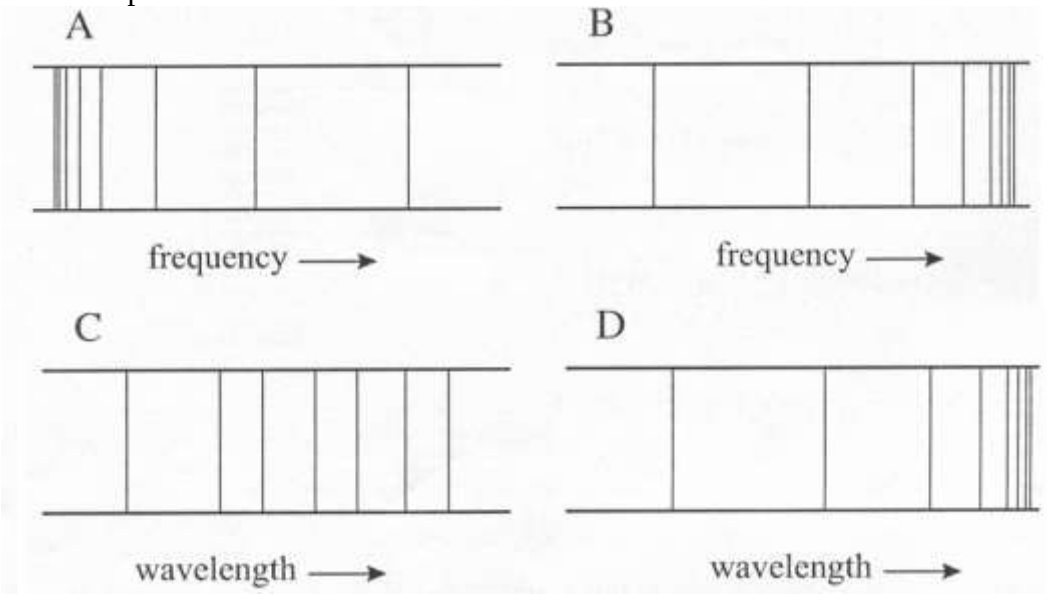
a) Bromine is a halogen and a non-metal placed in period 4 of the periodic table

i. Give its electronic configuration. **1 Mark**

ii. Using appropriate diagram clearly draw an energy level diagram to show the arrangement of its electrons in the various orbitals? **6 Marks**

iii. Consider an electron in the 3s and another in the 3p-orbitals. Give the four sets of quantum numbers that relate to these. **4 Marks**

b) When visible light is passed through hydrogen gas and then through a prism dark lines are seen against the normal continuous spectrum.



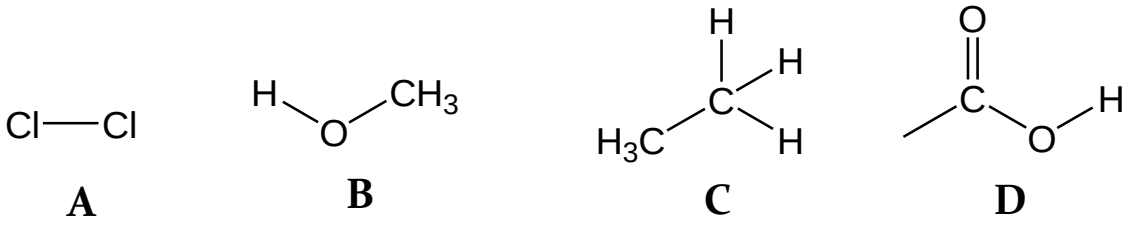
i) Which of the diagrams labelled A through D represents the line emission spectrum for hydrogen. Explain. **2 Marks**

ii) Explain the origin of the dark lines and why they are unique to each element? **3 Marks**

iii) One of these lines is at a wavelength of 480 nm. Determine the frequency and the energy of this radiation? ($c = 3.0 \times 10^8 ms^{-1}$; $h = 6.6 \times 10^{-34}$ J·s) **4 Marks**

QUESTION 3

a) Consider the compounds given below



A **B** **C** **D**

i) Classify the compounds given as either polar or non-polar. **2 Marks**

ii) For compounds identified as polar indicate the position of polar bonds. **2 Marks**

iii) Draw the Lewis structures for compound **B**. **2 Marks**

b) Silicon tetrachloride (SiCl4) is a colourless inorganic compound used to produce high purity silicon and silica for commercial applications.

i) How many electrons are there in the outer shell of a silicon atom? **1 Mark**

ii) How many electrons are there in the outer shell after it has bonded with the four chlorine atoms? **1 Mark**

iii) How many of the electron pairs are bond pairs and how many lone pairs? **1 Mark**

iv) Giving details draw a diagram to show the shape of a molecule of SiCl4. **2 Marks**

c) The molecules BF3 and NF3 have similar formulae, but completely different shapes. Draw diagrams to show the shapes of the two molecules, and explain carefully why they are different. **4 Marks**

d) In the molecules CH4, NH3 and H2O, the bond angles are as follows:

H-C-H	H-N-H	H-O-H
109.5°	107°	104.5°

i) Draw the electronic shape of these molecules **1.5 Marks**

ii) Draw the molecular shapes of these molecules **1.5 Marks**

iii) Explain the differences in the bond angles as observed **2 Marks**

QUESTION 4

a) Potasium manganate readily oxidises titanium (III) in an acidic medium as per the reaction given below.

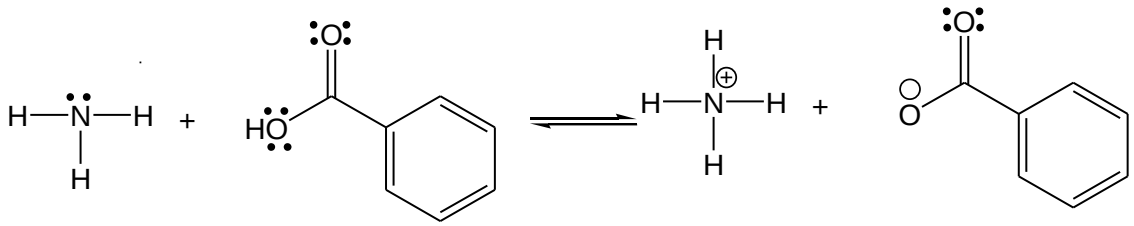
$$MnO_4^- + Ti^{3+} \rightarrow Mn^{2+} + Ti^{4+}$$

(i) Write a balanced redox equation for the reaction **4 Marks**

(ii) Identify both the reducing and oxidizing agents **2 Marks**

(iii) Determine the oxidation number of Mn in MnO_4^-. **1 Mark**

b) Benzoic acid reacts with ammonia to give a neutral salt as shown below. This presents benzoic acid as a *Br□nsted-Lowry acid*



i) Define the term *Br□nsted-Lowry acid.* **1 Mark**

ii) Identify the conjugate acid-base pairs involved in this reaction. **1 Mark**

iii) Describe concentrations of the reactions at equilibrium if K for this reaction is 2.4×10^6 at 25 °C **1 Mark**

iv) What is meant by the term *strong* when describing an acid? **1 Mark**

v) Given the K value in b), ii) above compare the acid strengths of benzoic acid and the ammonium salt. Explain. **2 Marks**

c) At 298 K, 25.0 cm^3 of a solution of a strong acid contained 1.50×10^{-3} mol of hydrogen ions.

i) Calculate the hydrogen ion concentration in this solution and hence its pH. **3 Marks**

ii) Calculate the pH of the solution formed after the addition of 50.0 cm^3 of 0.150 M NaOH to the original 25.0 cm^3 of acid. **4 Marks**

APPENDIX II

Elements of the Periodic Table