MAASAI MARA UNIVERSITY

MAIN EXAMINATIONS 2018/2019

FIRST YEAR FIRST SEMESTER EXAMINATION

FOR

THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY, AND BACHELOR OF BACHELOR OF EDUCATION (SCIENCE)

CHE1103: ATOMIC STRUCTURE

DATE: 11TH/December/ 2018 **TIME: 11.00 AM – 1.00 PM**

Duration: 2 Hours

INSTRUCTIONS

1. This paper contains **FOUR** (4) questions in two sections A and B.
2. Section A is compulsory
3. Answer question **ONE (1)** in section A and any **Two** (2) questions from section B.
4. Do not forget to write your Registration Number.

List of Constants:

Planck's constant, $h = 6.63\times10^{-34}$ J · s; Rydberg constant for hydrogen $R = 1.097\times10^{7}$ m^{-1}; speed of light, $c = 3.00\times10^{8}$ m/s; Avogadro constant (L) = 6.022×10^{23} mol^{-1}. $\mathbf{R_H}$ is the Rydberg constant with a value of 2.18×10^{-18}J.

Question ONE (30 Marks)

a. Define/state the terms below:

i. The Heisenberg uncertainty principle ***(2 Marks)***
ii. An Orbital ***(2 Marks)***

iii. Hund's rule ***(2 Marks)***

b. i. At any given time, hydrogen's electron can occupy just one orbital. Given a quantum of energy and the hydrogen atom, explain the phenomena of ground and excited states of the hydrogen atom. ***(3 Marks)***

ii. A mass spectrometer can be used to investigate the isotopes in an element.

I. Define the term *relative atomic mass* of an element. ***(2 marks)***

II. Element **X** has a relative atomic mass of 47.9. Identify the block in the Periodic Table to which element **X** belongs and give the electron configuration of an atom of element **X**. Calculate the number of neutrons in the isotope of **X** which has a mass number 49. ***(3 marks)***

c. i. State and explain the general trend in the first ionisation energies of the Period 3 elements sodium to chlorine. ***(3 marks)***

ii. State how the element sulfur deviates from the general trend in first ionisation energies across Period 3. Explain your answer. ***(3 marks)***

iii. A general trend exists in the first ionization energies of the Period 2 elements lithium to fluorine. Identify **one** element which deviates from this general trend. ***(1 mark)***

d. Draw and label the five shapes of the d orbitals of the d subshell. ***(6 Marks)***

e. How much energy does one electron with a principal quantum number of n= 2 have? ***(3 Marks)***

Question TWO (20 marks)

a. Explain the impact of the following theories on the current view of electrons in atoms:
   i. Louis de Broglie's wave particle duality, ***(3 Marks)***
   ii. The Heisenberg uncertainty principle ***(3 Marks)***
   iii. Quantum mechanical model of the atom ***(6 Marks)***

b. i. Using pictorial diagrams of s orbitals, explain on how the s orbitals at the various energy levels differ. ***(4 Marks)***

ii. Explain the term degenerate orbitals using p sublevel. ***(4 Marks)***

Question THREE (20 Marks)

a. Articulate on how Ernest Rutherford's **gold foil experiment** contributed to the structure of the atom. ***(10 Marks)***

b. i. Write the electron configuration of the Mg^{+} ion. ***(2 marks)***

ii. State the meaning of the term *first ionization energy*. ***(2 marks)***

iii. Write an equation, including state symbols, to show the reaction that occurs ***(3 Marks)***

iv. Explain why the second ionization energy of magnesium is greater than the first ionization energy of magnesium. ***(3 marks)***

Question FOUR (20 Marks)

a. State and explain the three postulates of the Bohr model of the atom ***(5 Marks)***

b. How does Bohr's model of the atom explain the line spectrum of hydrogen? ***(10 Marks)***

c. An emission spectrum gives one of the lines in the Balmer series of the hydrogen atom at 410 nm. This wavelength results from a transition from an upper energy level to n=2. What is the principle quantum number of the upper level? ($R=1.097 \times 10^{7}\ m^{-1}$)

(5 Marks)

END