MUEO

MOI UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR
(ACADEMICS, RESEARCH & EXTENSION)

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER EXAMINATION

FOR THE DEGREE OF

BACHELOR OF EDUCATION (SCIENCE)

COURSE CODE: CHE 110

COURSE TITLE: FUNDAMENTALS OF CHEMISTRY

DATE: 14TH FEBRUARY, 2018 **TIME:** 11.40 A.M. – 2.40 P.M.

INSTRUCTION TO CANDIDATES

- SEE INSIDE.

THIS PAPER CONSISTS OF (7) PRINTED PAGES

PLEASE TUR N OVER

FUNDAMENTAL OF CHEMISTRY CHE 110

INSTRUCTIONS TO CANDIDATES

Answer **Question one** and **any other two** questions
Appendices **I** and **II** are the ionization potentials of the first 20 elements and the periodic table respectively
Duration: 3 hours

SOME USEFUL INFORMATION

Speed of light c = 2.997926×10^{8} ms^{-1}
Plank constant, h = 6.626176×10^{-34} J .s
Mass of an electron, M_e = $9.1093897 \times 10^{-31}$kg

QUESTION ONE (30 MARKS)

a) Define the following terms
   i. Atomic number (1 mark)
   ii. Mass number (1 mark)
   iii. Electron (1 mark)
b) Sketch the orbitals for which l = 1 (6 marks)
c) Describe the four quantum numbers used to characterize an electron in an atom (8 marks)
d) Which of the following sets of quantum numbers are unacceptable? Explain your answer
   i. (2,1,-1,$^{-}$½) (2 marks)
   ii. (3, 3, 1, $^{+}$½) (2 marks)
   iii. (2, 0, 0, $^{-}$½) (2 marks)
e) What type of orbital (e.g. 3s, 4p) is designated by the following quantum numbers?
   i. (n=3, l=1) (1 mark)
   ii. (n=2, l=0) (1 mark)
   iii. (n=4, l=2) (1 mark)
   iv. (n=1, l=0) (1 mark)
f) Calculate the wavelength associated with an electron travelling at a speed of 2.19×10^{6} m/s (3 marks)

QUESTION TWO (20 MARKS)

a) The energy difference for electrons in hydrogen like atom is given by

$$\Delta E = 2.179x10^{-18}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \text{ J}$$

Determine the wavelength in nm for the line produced when an electron from n= 5 to n= 2. (5 marks)

b) Atom X (not its actual chemical symbol) has atomic number 52.

i) write its electronic configuration (2 marks)
ii) state its period and group number (2 marks)

c) Write the electron configuration of the following species:

i) Mo^{3+} (2 marks)
ii) Ag (2 marks)

d) The following ions are isoelectronic; Ti^{4+}, Sc^{3+}, Ca^{2+}, and S^{2-}. List them according increasing size and explain your answer (3 marks)

e) i) What are possible values of l, m_l when n=4 (2 marks)

ii) what are the possible values of n, l, m_l, m_s quantum numbers of the electron in the outermost energy level of Sc in its ground state (2 marks)

QUESTION THREE (20 MARKS)

a) Explain the following terms:

i) Electronegativity (1 mark)
ii) Ionization energy (1 mark)

b) i) What are the failures of the Bohr's theory? (4 marks)
ii) State Pauli's Exclusion Principle (2 marks)

c) State the three assumptions used in Bohr's theory of the hydrogen atom (6 marks)

d) A laser produces red light of wavelength 632.8 nm. Calculate the energy in kilojoules of one mole of photon of this red light. (3 marks)

e) State the
i) Hund's rule (2 marks)
ii) Heisenberg principle (1 mark)

QUESTION FOUR (20 MARKS)

a) Using the concept of hybridization explain how carbon form four equivalent bonds in CCl_4. (4 marks)

b) Write the Lewis structure for the following compounds:

i. Al_2O_3 (1 mark)
ii. CO_2 (1 mark)
iii. H_2O (1 mark)

c) i) Explain the dual nature of light (2 marks)
ii) How the Bohr's theory explains appearance of an emission spectrum? (3 marks)

d) Using the VSEPR model predict the molecular geometry of the following compounds:

i) BF_3 (2 marks)
ii) H_2S (2 marks)
iii) PF_5 (2 marks)
iv) CCl_4 (2 marks)

QUESTION FIVE (20 MARKS)

a) Indicate the oxidation number of the underlined atoms in each of the following species:

i) $\underline{Cl}O_4^-$ ii) $\underline{S}O_4^{2-}$ iii) $K\underline{Mn}O_4$ (3 marks)

b) Refer to appendix1 and answer the following:

i) Account for the decrease in the first ionization energy between nitrogen and oxygen. (2 marks)
ii) Explain why the first ionization energy of magnesium is higher than that of Aluminum (2 marks)
iii) Why is the third ionization energy of magnesium exceptionally higher than the second ionization? (2 marks)

c) The blue color in fireworks is achieved by heating copper (i) chloride to about 1200° C. The hot compound emits blue light at a wavelength of 450nm. Calculate the energy emitted by CuCl? (4 marks)

APPENDIX 1

IONIZATION POTENTIAL (ENERGY) FOR THE FIRST 20 ELEMENTS

Z	Element	First	Second	Third	Fourth	Fifth	Sixth
1	H	1312					
2	He	2373	5248				
3	Li	520	7300	11808			
4	Be	899	1757	14850	20992		
5	B	801	2430	3660	25000	32800	
6	C	1086	2350	4620	6220	38000	47232
7	N	1400	2860	4580	7500	9400	53000
8	O	1314	3390	5300	7470	11000	13000
9	F	1680	3370	6050	8400	11000	15200
10	Ne	2080	3950	6120	9370	12200	15000
11	Na	495.9	4560	6900	9540	23400	16600
12	Mg	738.1	1450	7730	10500	13600	18000
13	Al	577.9	1820	2750	11600	14800	18400
14	Si	786.3	1580	3230	4360	16000	20000
15	P	1012	1904	2910	4960	6240	21000
16	S	999.5	2250	3360	3660	6990	8500
17	Cl	1251	2297	3820	5160	6540	9300
18	Ar	1521	2666	3900	5770	7240	8800
19	K	418.7	3052	4410	5900	8000	9600
20	Ca	589.5	1145	4900	6500	8100	11000

APPENDIX II

PERIODIC TABLE