MACHAKOS UNIVERSITY

University Examinations for 2020/2021

SCHOOL OF ENGINEERING AND TECHNOLOGY

FIRST YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE IN TELECOMMUNICATION AND INFORMATION TECHNOLOGY

BACHELOR OF SCIENCE APPLIED PHYSICS AND TECHNOLOGY

BACHHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY

BACHELOR OF EDUCATION (SPECIAL NEEDS)

BACHELOR OF SCIENCE IN MATHEMATICS

BACHELOR OF EDUCATION SCIENCE

BACHELOR OF SCIENCE IN BIOLOGY

SCH 100: INTRODUCTION TO FUNDAMENTALS OF INORGANIC CHEMISTRY

DATE: 12/8/2021 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS:

The paper consists of **two** sections.

- Section **A** is **compulsory** (30 marks)
- Answer any **two** questions from section **B** (each 20 marks)

A table of useful constants

$R_H = 1.09737\times10^{7}\, m^{-1}$	$h = 6.626\times10^{-34}$ Js	$r_n = \dfrac{\varepsilon_0 n_n^2 h^2}{\pi m_e e^2}$
$\varepsilon_O = 8.85418\times10^{-12}\, C^2 J^{-1} m^{-1}$	$m_e = 9.11\times10^{-31}$ kg	
$c = 3.0\times10^{8}$ m/s	$1\ eV = 1.602\times10^{-19}$	

SECTION A

QUESTION ONE (30 MARKS)

(a) State the following Principle's:

(i) Aufbau Principle

(ii) Pauli Exclusion Principle

(iii) Hund's Rule of maximum multiplicity (3 marks)

(b) Write the electron configuration of the following ions using the spdf notation

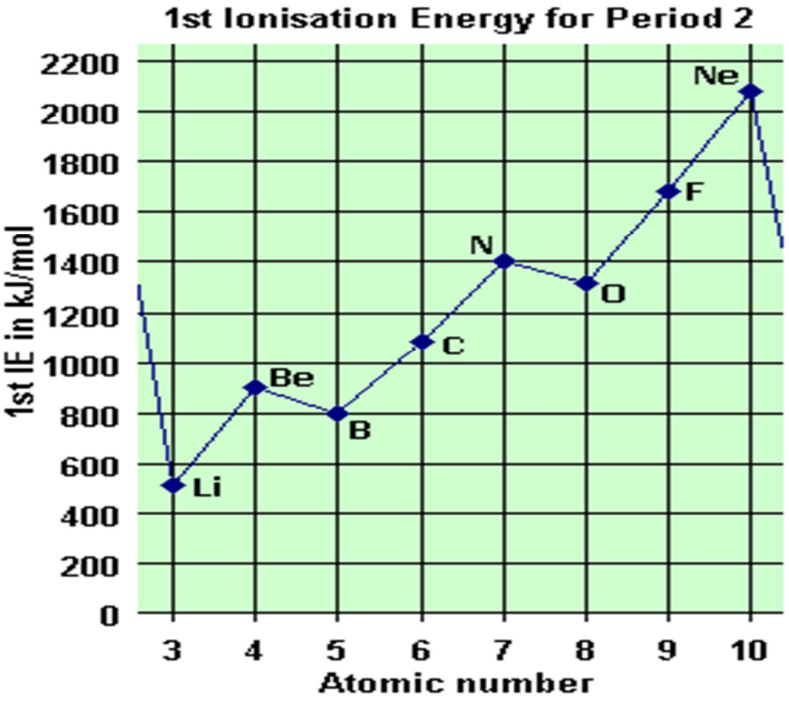
(i) Mn^{3+}

(ii) Mn^{7+} (2 marks)

(c) State limitations of Bohr's Atomic Theory (3 marks)

(d) (i) Calculate the shortest wavelength in Balmer series (3 marks)

(ii) Calculate the wavelength associated with an electron that travels at 40 % of the speed of light. (3 marks)



(e) (i) Explain the trend in the first ionization energies of elements across the second period of the periodic table.

(ii) Account for the anomalies between Be and B and between N and O in Figure 1 above (6 marks)

(f) Balance the following redox reactions using the half-reaction method

(i) $Cr_2O_7^{2-}{}_{(aq)} + HNO_{2\ (aq)} \rightarrow Cr^{3+}\ (aq) + NO_3^-{}_{(aq)}$ [acidic medium] (2 marks)

(ii) $MnO_4^- + C_2O_4^{2-} \rightarrow MnO_2 + CO_2$ [basic medium] (2 marks)

(g) The work function for cesium is 1.35 eV.

(i) What is the longest wavelength that can cause photo-emission from cesium surface? (3 marks)

(ii) What is the maximum velocity with which photoelectrons will be emitted from the cesium surface illuminated with light of wavelength 400 nm? (3 marks)

SECTION B

QUESTION TWO (20 MARKS)

(a) Explain two reasons of Neil Bohr's objection to Rutherford's atomic model (4 marks)

(b) Sodium lamp emits light of 589.0 nm. Calculate :

(i) The frequency of the light (2 marks)

(ii) The wavenumber of the light (2 marks)

(iii) The energy of the photons in J and eV (2 marks)

(iv) The momentum of the photons (2 marks)

(c) The molecules BF_3 and NF_3 have similar formulae, but completely different shapes. Draw diagrams to show the shapes of the two molecules, and explain why they are different. (4 marks)

(d) (i) Define isotopes? (1 mark)

(ii) Copper (Cu = 63.546) is made up of two isotopes, Cu (62.9296 amu) and Cu (64.9278 amu). Determine the percentage abundance of each isotope? (3 marks)

QUESTION THREE (20 MARKS)

(a) An experiment was carried out to determine the percentage of water of crystallization and the degree of water of crystallization x, in a sample of hydrated sodium carbonate crystals $(Na_2CO_3.xH_2O)$. An 8.20 g sample of the crystals was weighed accurately on a clock glass and then made up to 500 cm^3 of solution in a volumetric flask. A pipette was used to transfer 25.0 cm^3 portions of this solution to a conical flask. A previously standardised 0.11 M hydrochloric acid (HCl) solution was used in titration of each sample. The average volume of hydrochloric acid solution required in these titrations was 26.05 cm^3. The titration was described by the equation:

$$Na_2CO_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

(i) Name the indicator suitable for this titration and explain why not more than 1-2 drops of indicator should be used. (2 marks)

(ii) From the titration data, calculate the concentration of sodium carbonate in the solution in moles per litre and in grams per dm^3. (3 marks)

(iii) Calculate the percentage of water of crystallization and determine the value of x in $Na_2CO_3.xH_2O$ (6 marks)

(b) State **five** demerits of Dalton's Atomic Theory (5 marks)

(c) Explain why NH_3 act as a Lewis base? (2 marks)

(d) Draw the Lewis structure of Al_2Cl_6. (2 marks)

QUESTION FOUR (20 MARKS)

(a) (i) Define orbital degeneracy using a relevant example (2 marks)

(ii) Using phosphorus as an example briefly explain the rules for filling electrons into orbitals of this atom. (2 marks)

(b) Calculate the energy emitted when electrons of 1.0 g atom of hydrogen undergo transition giving the spectral lines of lowest energy in the visible region of its atomic spectra.

(4 marks)

(c) Give the number of orbitals in each of the *s, p, d, f* and *g* subshells of the shell with $n = 5$.

(3 marks)

(d) Calculate the de Broglie wavelength of an electron in the first Bohr orbit in the hydrogen atom

(4 marks)

(e) Calculate the pH of 0.10 M solution NH_4Cl solution (K_b for $NH_3 = 1.8 \times 10^{-5}$) (5 marks)

QUESTION FIVE (20 MARKS)

(a) Use the VSEPR model to predict the shapes of the following molecules

(i) SF_4

(ii) SF_6

(iii) $AsCl_5$

(iv) CCl_4

(v) $BeCl_2$ (5 marks)

(b) In the molecules CH_4, NH_3 and H_2O, the bond angles are as follows:

H-C-H	H-N-H	H-O-H
109.5°	107°	104.5°

(i) Explain why the bond angles are different. (3 marks)

(ii) Explain why copper is paramagnetic and zinc is not. (2 marks)

(c) Draw the Lewis structures of the following molecules/ions: (6 marks)

(i) H_3PO_4

(ii) C_2H_2

(iii) C_6H_6

(d) Calculate the pH of the following solutions: (4 marks)

(i) 0.020 M $Ba(OH)_2$

(ii) 0.0025 M H_2SO_4