



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE),

BACHELOR OF SCIENCE (TELECOMMUNICATION AND TECHNOLOGY)

BACHELOR OF SCIENCE (MATHEMATICS)

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

BACHELOR OF SCIENCE (BIOLOGY)

SCH 100: FUNDAMENTALS OF INORGANIC CHEMISTRY

TIME: 26/9/2019

DATE: 11:00 – 1:00 PM

INSTRUCTIONS

Answer Question One and any other Two Questions

Some useful information

Speed of light $c = 2.997926 \times 10^8 \text{ ms}^{-1}$

Avogadro constant $N_A = 6.022045 \times 10^{23} \text{ mol}^{-1}$

Planck's constant $h = 6.626176 \times 10^{-34} \text{ J s}$

$1 \text{ nm} = 1 \times 10^{-9} \text{ m}$

Section A - Compulsory

- 1 a) Explain the following terminologies usually encountered in chemistry:
- i) Electronegativity (2 marks)
 - ii) Atomic orbitals (2 marks)
 - iii) Planck's Quantum Theory (2 marks)
- b) Explain the difference between electron affinity and ionization energy (2 marks)
- c) i) State the Pauli's Exclusion Principle (2 marks)
- ii) Which of the following sets of quantum numbers are unacceptable?
Explain your answers.
- I (2, 0, $\frac{1}{2}$, $-\frac{1}{2}$)
 - II (3, 2, 0, $+\frac{1}{2}$)
 - III (2, 2, 1, $+\frac{1}{2}$)
 - IV (3, 2, 1, 1) (4 marks)
- d) Give the values of the quantum numbers associated with the following orbitals:

- i) $3s$ (2 marks)
 ii) $4f$ (2 marks)
 e) State the failures of Bohr's model atom (3 marks)
 f) i) Explain the Heisenberg Uncertainty principle quantum theory (2 marks)
 ii) The red light has a wavelength of about 400nm.
 Calculate:
 I The frequency associated with this radiation (2 marks)
 II The energy in Joules of one mole of photons associated with this frequency (2 marks)
 g) i) State the *de Broglie* theorem (1 mark)
 ii) Calculate the *de Broglie* wavelength (in nanometers) associated with a beam of neutrons moving at a speed of 2.0×10^7 m/s. (mass of a neutron = 1.67495×10^{-24} g.) (2 marks)
 h) The change in energy in a hydrogen atom, ΔE , in electronic transition is given by:

$$\Delta E = 2.18 \times 10^{-18} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ Joules}$$

 Determine the energy for the transition $n=2$ to $n=9$ (2 marks)
 i) Sketch the orbitals for which $l = 2$: (3 marks)

Section B

Answer any two Questions

- 2 a) i) Explain the differences between chemical and nuclear reactions. (2 marks)
 ii) Complete the following nuclear reactions and identify X and Y.
 I) ${}_{12}^{26}\text{B} + {}_1^1\text{p} \rightarrow \text{X} + {}_2^4\text{He}$
 II) ${}_{8}^{20}\text{O} \rightarrow {}_{9}^{20}\text{Ca} + \text{Y}$ (2 marks)
 b) i) For each of the following identify the acid-base conjugate pairs (3 marks)
 I $\text{HClO}_{2(aq)} + \text{H}_2\text{O}_{(aq)} \rightleftharpoons \text{ClO}_{2(aq)}^- + \text{H}_3\text{O}_{(aq)}^+$
 II $\text{HSO}_4^-(aq) + \text{H}_2\text{O}_{(aq)} \rightleftharpoons \text{SO}_4^{2-}(aq) + \text{H}_3\text{O}_{(aq)}^+$
 III $\text{C}_6\text{H}_5\text{NH}_3^+(aq) + \text{OH}^-(aq) \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_2(aq) + \text{H}_2\text{O}_{(aq)}$
 c) Differentiate a Lewis acid and Lewis base (2 marks)
 d) Indicate the oxidation number of the underlined atoms in each of the following species:
 i) $\text{H}\underline{\text{C}}\text{IO}_4$ ii) $\underline{\text{S}}\text{O}_3^{2-}$ (2 marks)
 e) Using the VSEPR give the geometry / shape of the following molecules:
 i) CS_2 ii) NH_3 iii) SF_4 (3 marks)
 f) By use of a schematic diagram explain the observation and conclusions made by Ernest Rutherford in his planetary model of an atom. (6 marks)

- 3 a) An atom has atomic number 92
- Write its electronic configuration. (2 marks)
 - To which period and group does it belong? (2 marks)
- b) Write the electron configuration of the following species:
- W (z=74) (2 marks)
 - O²⁻ (z=8) (2 marks)
 - Ru⁺³ (z=44) (2 marks)
 - Ag (z=47) (2 marks)
- c) Draw the Lewis structure of the following compounds:
- N₂
 - CCl₄
 - Mg₃N₂ (3 marks)
- d) Account for the decrease in the first ionization energy between group 15 and group 16 elements. (1 marks)
- e) Balmer series is one of the series in the atomic spectrum of hydrogen atom, it involves transition from $n_2 = (3,4,5,6\dots)$ to $n_1=(2)$. Name the other 4 series in the hydrogen atomic spectra and the transitions involved (4 marks)
- 4 a) i) Explain the term hybridization of atomic orbitals (1 marks)
- ii) Using the concept of hybridization explains the bonding in BCl₃ (3 marks)
- b) The unbalanced equation of the reaction between permanganate ion and oxalic acid media can be written as
- $$\text{MnO}_4^- (\text{aq}) + \text{C}_2\text{O}_4^{2-} (\text{aq}) \longrightarrow \text{Mn}^{+2} (\text{aq}) + \text{CO}_2$$
- Identify the Oxidizing agent (1 mark)
 - Balance the equation (4 marks)
- c) A 0.128 g sample of Potassium hydrogen phthalate (HKC₈H₄O₄) required 28.54 cm³ of NaOH solution to reach a phenolphthalein end point.
- Write ionic equation for the reaction (1 mark)
 - Calculate the number of moles of Potassium hydrogen phthalate in 0.0128 g sample. (2 marks)
- (Given H=1.008, K=39.098 and O=19.999)
- Calculate the molarity of the NaOH. (2 marks)
- d) Each atomic orbital (Ψ) may be uniquely defined by a set of three quantum numbers, Give these quantum numbers and the kind of information obtained from these quantum numbers. (6 marks)
5. a) Give the five d orbitals and sketch any two of the five d orbitals (7 marks)
- b) Discuss the three set of rules guiding the filling order of orbitals (Aufbau principle) (6 marks)
- c) Explain why the first ionization energy of phosphorous is higher than that of oxygen. (2 marks)
- d) Differentiate between electron affinity and Ionization energy (2 marks)
- e) Differentiate between nuclear fission and nuclear fusion (2 marks)
- f) What is a Redox reaction (1 mark)