



KISII UNIVERSITY

UNIVERSITY EXAMINATIONS

SPECIAL/SUPPLEMENTARY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF THE

DEGREE OF BACHELOR OF EDUCATION

FIRST SEMESTER, 2022/2023

(NOVEMBER/DECEMBER, 2022)

CHEM 110: INORGANIC CHEMISTRY

STREAM: Y1 S1

TIME: 2 HOURS

DAY: THURSDAY, 11:00-1:00 PM

DATE: 24/11/2022

INSTRUCTIONS

- 1. Do not write anything on this question paper.***
- 2. Answer ALL the questions in section A and any TWO questions in section B.***

Some useful information

Speed of light (c) = 3.0×10^8 m/s

Avogadro constant (N_A) = 6.022045×10^{23} mol⁻¹

Planck's constant (h) = 6.62617×10^{-34} J/s

SECTION A: 30 MARKS

- a) i) Describe the Rutherford's postulates of atomic structure

(4 marks)

- ii) Explain any two shortcomings of Bohr model of the atom

(4 marks)

- b) Draw shapes of each of the following orbitals $1s$, $2p_x$, $2p_y$, $2p_z$
(4 marks)
- c) Indicate the oxidation numbers of the underlined atoms in each of the following species
- i) ClO_4^-
- ii) $\text{S}_2\text{O}_7^{2-}$
- iii) $\text{K}_2\text{Cr}_2\text{O}_7$ (3 marks)
- d) Briefly explain the following.
- i) Define lattice energy (1 mark)
- ii) Describe the trend in ionic radii across the periodic table (2 marks)
- e) An atom X (not its actual chemical symbol) has atomic number 82.
- i) Write its electronic structure (1 mark)
- ii) State its period and group number (1 mark)
- f) Draw the Lewis structure of the following molecules
- i) CO_2 (2 marks)
- ii) H_2O (2 marks)
- g) Describe the four quantum numbers used to characterize an electron in an atom (4 marks)
- h) What type of orbital (i.e. $3s$, $4p$) is designated by the following quantum numbers
- i) $(n = 5, l = 1, m_l = 0)$ (1 mark)
- ii) $(n = 4, l = 2, m_l = 2)$ (1 mark)
- i) The energy difference in a hydrogen – like atom given by

$$\Delta E = 2.179 \times 10^{-18} (1/n_1^2 - 1/n_2^2)$$

Calculate the frequency and the wavelength of the emitted photon when an electron drops from $n = 4$ to $n = 2$ (4 marks)

j) i) What is your understanding of the dual nature of matter

(2 marks)

iii) State an experiment that supports the dual nature of matter

(2 marks)

k) What is electromagnetic radiation?

(2 marks)

SECTION B (30 MARKS)

QUESTION TWO

Draw the Lewis structures of the following and hence:

a) predict the hybridization involved in their formation and

b) state their molecular geometry

i) NO_3^-

(5 marks)

ii) ClO_2^-

(5 marks)

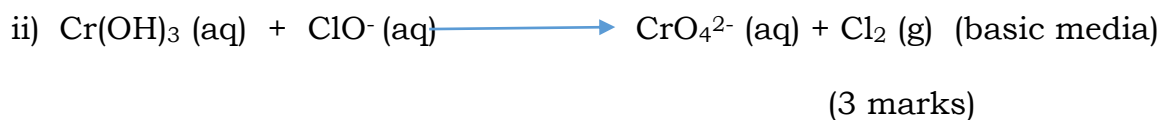
iii) BrF_3

(5 marks)

QUESTION THREE

a) Balance the following redox reactions





b) Using Aufbau principle, write the expanded electronic configuration of the following species

i) Sc^+ (3 marks)

ii) Ni^- (3 marks)

iii) Co (3 marks)

QUESTION FOUR

a) Urea is prepared by the reaction between ammonia and carbon dioxide



In one of the processes, 637.5g of ammonia were allowed to react with 1142g of CO_2 .

i) Which of the two reactants is in excess (2 marks)

ii) Calculate the mass of $(\text{NH}_2)_2\text{CO}$ formed (3 marks)

b) Draw a sketch of the atomic spectrum of hydrogen showing clearly the Lyman, Balmer and Paschen series (5 marks)

c) Rubidium has two naturally occurring isotopes, ^{85}Rb (relative mass 84.9118 amu) and ^{87}Rb (relative mass of 86.9092 amu). If rubidium has an average atomic mass of 85.47 amu, what is the abundance of each isotope (in percent) (5 marks)