



MACHAKOS UNIVERSITY COLLEGE

(A Constituent College of Kenyatta University)
University Examinations for 2015/2016 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF
EDUCATION (SCIENCE)

SCH 100: FUNDAMENTALS OF INORGANIC CHEMISTRY

DATE: SCHOOLBASED

TIME:

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory**.
- Answer any **two** questions from section **B**.
- Find Periodic Table on the last Page.

REQUIRED DATA/INFORMATION

- Mass of electron (m) = 9.1079×10^{-31} Kg, electronic charge (e^-) = 1.602×10^{-19} C
- Rydberg's constant (R) = $10\,973\,731.6\text{ m}^{-1}$, Planck's constant (h) = 6.63×10^{-34} Js,
Speed of light in a vacuum (C) = 2.998×10^8 m/s
- ϵ_0 – permittivity of free space $8.854188 \times 10^{-12} \text{ C}^2 \text{ s}^2 \text{ Kg}^{-1} \text{ m}^{-3}$
- Z - nuclear charge, Smallest Bohr atomic radius (r_1) = $5.29 \times 10^{-11} \text{ m}$
- $1\text{ eV} = 1.6022 \times 10^{-19} \text{ J}$; $1\text{ mile} = 1609\text{ m}$. $1\text{ m} = 1 \times 10^9 \text{ nm}$



This Paper Consists of 6 Printed Pages. Please Turn Over.

SECTION A (30 MARKS) COMPULSARY

QUESTION ONE

- a) Briefly describe the following;
- i. J. J Thomson's atomic model (4 marks)
 - ii. Rutherford's atomic structure model (5 marks)
- b) A beryllium atom has 4 protons, 5 neutrons and 4 electrons. What is the mass number of this atom? (2 marks)
- c) Sketch and explain for quantities of photoelectric effect of kinetic energy (max) versus intensity of three different metals at constant frequency assuming frequency is greater than the threshold frequency. (4 marks)
- d) Explain the two factors affecting maximum kinetic energy of photoelectrons. (4 marks)
- e) Write the electron configuration of mercury ($Z=80$), showing all the inner orbitals (2 marks)
- f) Calculate the energy of an electron in a hydrogen, $n=2$ level. (4 marks)
- g) List all the allowed combinations of the four quantum numbers (n, l, m_l, m_s) for a $6d$ orbital, and predict the total number of electrons it can contain. (5 marks)

SECTION B:

ATTEMPT ANY TWO QUESTIONS (20 MARKS EACH)

QUESTION TWO

- a) Define the following terms;
- i. Paschen series (2 marks)
 - ii. Quanta (2 marks)
- b) Show that Rydberg's constant (R) = $1.097 \times 10^7 \text{ m}^{-1}$ (4 marks)
- c) Explain why elements produce their own characteristic colors when they emit photons (2 marks)
- d) An electron falls from energy level 6 to 3 in a hydrogen emission spectrum;
- i. Which series does it represent (1 mark)
 - ii. Calculate its corresponding wavelength and frequency. (4 marks)

- e) Which electromagnetic waves have the shortest wavelengths and highest frequencies? (1 mark)
- f) One of the electron transitions in a hydrogen atom produces infrared light with a wavelength of 746.4 nm. What amount of energy causes this transition? (4 marks)

QUESTION THREE

- a) Define the following terms;
- i. Acid dissociation constant, (2 marks)
 - ii. Lewis acid, (2 marks)
- b) Using a relevant equation, show auto ionization of water. (2 marks)
- c) A solution of 0.050 M acetic acid and 0.035 M NaOH is prepared. What is the pH? (4 marks)
- d) What mass of $\text{Ba}(\text{OH})_2$ (171.34 g/mole) is required to prepare 150 mL of a solution with a pH of 13.50? (4 marks)
- e) Hypochlorous acid, HOCl , has a pK_a of 7.52. What is the pH of 0.25 M solution of HOCl ? What is the percent ionization? (4 marks)
- f) Arrange the following acids in order of increasing acid strength. Explain your answer; HI , HCl , HBr , H_2S . (2 marks)

QUESTION FOUR

- a) In Quantum mechanics, quantum numbers are needed to characterize completely each electron in an atom. List and describe any three quantum numbers. (6 marks)
- b) Write the quantum numbers that represent the following electrons: (2 marks)
- i. $3s^2$
 - ii. $4f^6$
- c) Which of the following are allowable sets of quantum numbers for an orbital? Explain. (6 marks)
- i. $n = 4, l = 4, m_l = 0$
 - ii. $n = 3, l = 2, m_l = 1$
 - iii. $n = 5, l = 3, m_l = -4$

- d) Two of the three electrons in a lithium atom have quantum numbers of $n=1$, $l=0$, $m_l=0$, $m_s=-1/2$. What quantum numbers can the third electron have if the atom is in;
- Its ground state (2 marks)
 - Its first excited state (2 marks)
- e) Draw the following orbitals clearly showing the respective coordinates
- $3p_z$ (1 mark)
 - d_{xy} orbitals (1 mark)

QUESTION FIVE

- a) Define the following terms;
- Aufbaue principle (2 marks)
 - Hunds rule (2 marks)
- b) Although element 114 is not stable enough to occur in nature, two isotopes of element 114 were created first time in a nuclear reactor in 1999 by a team of Russian and American scientists. Write the complete electron configuration for element 114. (2 marks)
- c) According to the periodic table provided, arrange the following elements in order of the increasing atomic radius; nickel, cobalt, calcium and potassium. Explain your answer. (2 marks)
- d) Study group 15 in the periodic table and indicate which element has the strongest metallic character. Explain your answer. (2 marks)
- e) Calculate the effective nuclear charge on a 4d electron in a Palladium (Pd) atom. Given that the number of neutrons and mass number of Pd is 60 and 106 respectively. (3 marks)
- f) Periodic table is a chart in which elements having similar chemical and physical properties are arranged in groups.
- Elements Y (not its actual symbol) has atomic number 83. To which period and group does it belong? Show how you arrived at your answer. (3 marks)
 - Draw and label energy level diagram for Hydrogen atom and a multi-electron atom like copper. (4 marks)

1																		18																	
1 H 1.0079		2												13				14		15		16		17		2 He 4.0026									
3 Li 6.941		4 Be 9.0122														5 B 10.811		6 C 12.011		7 N 14.007		8 O 15.999		9 F 18.998		10 Ne 20.180									
11 Na 22.990		12 Mg 24.305														13 Al 26.982		14 Si 28.086		15 P 30.974		16 S 32.065		17 Cl 35.453		18 Ar 39.948									
19 K 39.098		20 Ca 40.078		21 Sc 44.956		22 Ti 47.867		23 V 50.942		24 Cr 51.996		25 Mn 54.938		26 Fe 55.845		27 Co 58.933		28 Ni 58.693		29 Cu 63.546		30 Zn 65.409		31 Ga 69.723		32 Ge 72.64		33 As 74.922		34 Se 78.96		35 Br 79.904		36 Kr 83.798	
37 Rb 85.468		38 Sr 87.62		39 Y 88.906		40 Zr 91.224		41 Nb 92.906		42 Mo 95.94		43 Tc (98)		44 Ru 101.07		45 Rh 102.91		46 Pd 106.42		47 Ag 107.87		48 Cd 112.41		49 In 114.82		50 Sn 118.71		51 Sb 121.76		52 Te 127.60		53 I 126.90		54 Xe 131.29	
55 Cs 132.91		56 Ba 137.33		57-71 *		72 Hf 178.49		73 Ta 180.95		74 W 183.84		75 Re 186.21		76 Os 190.23		77 Ir 192.22		78 Pt 195.08		79 Au 196.97		80 Hg 200.59		81 Tl 204.38		82 Pb 207.2		83 Bi 208.98		84 Po (209)		85 At (210)		86 Rn (222)	
87 Fr (223)		88 Ra (226)		89-103 #		104 Rf (261)		105 Db (262)		106 Sg (266)		107 Bh (264)		108 Hs (270)		109 Mt (268)		110 Ds (281)		111 Rg (272)		112 Uub (285)		113 Uut (284)		114 Uuq (289)		115 Uup (288)		116 Uuh (291)		118 Uuo (294)			

* Lanthanide series	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
	138.91	140.12	140.91	144.24	(145)	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04	174.97
# Actinide series	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
	(227)	232.04	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(262)