KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE)

COURSE CODE: SCH 210

COURSE TITLE: ATOMIC STRUCTURE AND CHEMICAL BONDING

DURATION: 2 HOURS

DATE: MONDAY 8TH JANUARY 2018 TIME: 9 – 11AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **3** printed pages. Please Turn Over

$h = 6.626 \times 10^{-34} js$

$c = 3.0 \times 10^{8} m/s$

SECTION A

Question 1

(a) Define the term atomic radius. [1marks]

(b) Distinguish between a covalent radius, van der waals radius and ionic radius. [2marks]

(c) Study the table below and use the information to answer the questions that follow

Element	Na	Mg	Al	Si	P	S	Cl
Atomic radius	1.90	1.60	1.43	1.32	1.28	1.27	0.98
Ionic radius	0.95	0.65	0.50	2.71	2.12	1.84	1.81
1^{st} Ionization energy	492	743	5.79	791	1060	1003	1254

(i) Explain the gradual decrease of atomic radius across the period. [2marks]

(ii) The ionic radius of Na^{+}, Mg^{2+} and Al^{3+} are less than the corresponding atomic radius while the ionic radius of Cl^{-} and S^{2-}. Explain . [4marks]

(iii) Explain the general increase in the first ionization energy across the period.[2marks]

(d) Briefly explain the concept of particle wave duality of matter. [2marks]

(e) What is the equation of De Broqlie wavelength? Define the terms. [3marks]

(f) Calculate the De Broqlie's wavelength of a photon with a mass of 1.6 x 10 -27kg travelling at 40 of the speed of light. [3marks]

(g) State four quantum numbers used to characterise an electron in an atom and also describe the information each give. [4marks]

(h) Draw all the shapes of 2p orbitals. [3marks]

(i) Using an equation, explain Heisenberg's uncertainity principle . [2marks]

(j) State the significance of the following. [3marks]

(i) Radial wave function

(ii) Radial distribution function

(iii) Angular wave function

Question 2

(a) Sketch all the 3d orbitals. [5marks]

(b) Explain the shielding effect of electrons. [2marks]

(c) List the line series in the hydrogen atomic spectrum. [5marks]

(d) State the significance of the square of the wave function. [2marks]

(e) Draw and predict the shapes of the following molecules

(i) Aluminium chloride. [2marks]

(ii) Phosphorus pentafluoride. [2marks]

(iii) Sulphur hexafluoride. [2marks]

Question 3

(a) Draw the molecular orbital diagrams for the following molecules and ions and each case, determine the bond order and magnetic properties. [10marks]

(i) O_2^{2-}

(ii) N_2^{+}

(b) Sketch and describe graphs of variation of ψ and ψ^2 with the length of a box X for n =1, 2,3 and 4 for a particle in one dimensional box. [8marks]

(c) State Hess' law. [2marks]

Question 4

(a) Predict and draw the molecular geometries of the molecules or ions. [10marks]

(i) CrO_4^{2-}

(ii) IF_6^{+}

(iii) ClF_3

(iv) H_2F^{+}

(v) PF_4^{-}

(b) Predict the hybridization of the central atom in the molecules/ ions in (a) above.[5marks]

(c) The speed of a 2.5g projectile is known to be within 1.0×10^{-6}m/s. From the concept of Heisenberg's uncertainty principle, determine the minimum uncertainty in position for this particle. [5marks]

Question 5

The table below gives single bond covalent radii (all in Å) for some atoms of main group elements.

Element	H	F	Cl	Br	I
Atomic radii,Å	0.37	0.72	0.99	1.14	1.33
Van der waals radii, Å	1.2	1.35	1.80	1.95	2.15
Electronegativity	2.20	4.10	2.83	2.74	2.21

Use it to answer the questions that follow

i) Why are values of van der waals radii of elements less than the corresponding values of covalent atomic radii? [2marks]

ii) Given the inter nuclear distance $d_{A-B} = r_A + r_B$, calculate the inter nuclear distance for the atoms in the following molecules. [2marks]

(i) HF

(ii) HCl

(iii) HBr

(iv) HI

iii) The experimental values for inter nuclear distance for the four molecules in the above question were found to be as follows

Molecule	HF	HCl	HBr	HI
d_{A-B}(Å)	0.919	1.28	1.42	1.61

How do the values compare with the mathematical values expected in the above calculated values? Explain the difference. [2marks]

iv) By using a suitable example, explain how multiplicity of bonds between atoms can influence the atomic size. [1mark]

v) Define the term ionization energy. [1mark]

vi) The table below shows successive ionization energies(kj/mol) of elements of the same periodic table. Use it to answer the questions that follow

Element (M)	IE $[M_{(g)} \rightarrow M^{+}_{(g)}$	$IE_2[M^{+}_{(g)} \rightarrow M^{+2}_{(g)}$	$IE_3[M^{2+}_{(g)} \rightarrow M^{+3}_{(g)}$
Li	520	7298	11814
Be	899	1757	14848
B	800	2427	3659
C	1086	2352	4620
N	1402	2856	4578
O	1314	3388	5300
F	1681	3374	6050
Ne	2080	3952	6122

a) Explain the trend in successive ionization energies for the elements in this period. [2marks]

b) Why is iE1 values for Be greater than that for B? [2marks]

c) Explain the general trend of magnitude of ionization energies across the period. [2marks]

v) Differentiate between electron affinity and electronegativity. [2marks]

The table below shows electron affinity values for elements in period 3

Element	Na	Mg	Al	Si	P	S	Cl	Ar
EA(kj/g-atom)	52.7	≤0	42.6	133.6	71.7	200.43	348.8	≤0

a) Explain the magnitude of EA values for Mg and Ar. [2marks]

b) Explain the general trend observed for EA values from left to right across the period. [2marks]