KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2015/2016 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: SCH 21

COURSE TITLE: ATOMIC STRUCTURE AND CHEMICAL BONDING

DURATION: 2 HOURS

DATE: FRIDAY 13TH MAY 2016 TIME: 8.– 10AM

INSTRUCTIONS TO CANDIDATES

- Answer Question one(1) 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 **5** printed pages. Please Turn Over

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a) What is atomic radius (1mks)

b) Differentiate between(2mks)

i) Covalent radius

ii) Van der waals radius

c)The covalent radius of C-atom is 0.77Å and the inter nuclear distance between C and H atoms in CH_4 is 1.14 Å. Calculate the covalent radius of H-atom. (1m.

d) 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 waal'sraddii *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 questions that follow

i) Why are values of Van der waals radii of elements less than corresponding values of covalent atomic radii? (1mks)

ii) Given inter nuclear distance $d_{A\text{-}B} = r_A - r_B$calculate the inter nuclear distance for the atoms in the following molecules(3mks)

-HF
-HCl
-HBr

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

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

-How do the values compare with the mathematical values expected in (ii) above? Explain the difference(2mks)

iv) By using a suitable example explain how multiplicity of bonds between atoms can influence the atomic size. (3mks)

e). The table below shows elements of the alkali metals of the periodic table and their corresponding values of atomic radii (*Å*)

Element	Li	Na	K	Rb
Atomic radii *Å*	1.23	1.54	2.03	2.16

i) Explain the trend in atomic radii down the alkali metal group. (2mks)

ii) Why is the size of a cation smaller than that of its parent atom? (1mks)

iii) In the following pairs, which species is smaller in size and why? (4mks)

i) Cl, Cl^-

ii) Fe^{3+}, Fe^{2+}

f) i) What is ionization energy? (1mks)

ii) The table below shows successive ionization energies (*kJ/mol*) of elements of the same period in the periodic table.

Element (M)	IE_1 [$M_{(g)} \rightarrow M^+_{(g)}$]	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

-Explain the trend in successive ionization energies for the elements in this period. (2mks)

-Why is IE_1 values for Be greater than that for B? (2mks)

g) i) Differentiate between electron affinity and electronegativity. (2mks)

ii) The table below shows electron affinity values for elements in period III

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

-Explain the magnitude of EA values for Mg and Ar(3mks)

2. a) In terms of valence bond theory, how a chemical bond is formed? (2mks)
   b) When one *s* and two *p* atomic orbitals are used to generate hybrid orbitals, how many hybrid orbitals will be generated? (2mks)
   c) In the structures of SO_2 and NO_2, what are the values of the bond angles? (2mks)
   d) What is the geometrical shape of the molecule CH_4, methane? (2mks)
   e) What do you expect the bond angles to be in the NH_4^+ ion? (2mks)
   f) What hybrid orbitals does the C atom use in the compound H-C≡C-H, in which the molecule is linear? (2mks)
   g) What hybrid orbitals does C use in the molecule:

      $O{=}CH_2$(1mks)

   h) What is the shape of the molecule SF_6? (1mks)

   i) Phosphorus often forms a five coordinated compound PX_5. What hybrid orbitals does P use in these compounds? (2mks)
   j) What is a covalent bond? Differentiate between Non polar covalent bonds, polar covalent bonds and dative covalent bonds giving at least one example of each.(4mks)

3 a) Briefly summarize Molecular orbital Theory (2 mks)
   b) What is the molecular orbital diagram for for the diatomic hydrogen molecule, H_2? How stable is the molecule? Is it diamagnetic or paramagnetic?(6 mks)
   c) What is the molecular orbital diagram for the diatomic oxygen molecule, O_2? How stable is the molecule? Diamagnetic or paramagnetic?(6 mks)
   d) What is the molecular orbital diagram for the diatomic fluorine molecule, F_2? How stable is the molecule? Diamagnetic or paramagnetic? (6 mks)

4 a) Draw the Lewis structures HF, CO_2, and C_2H_2. Which orbitals are involved with bonding for HF? Now, use hybridization to explain the bonds of CO_2 and C_2H_2. Can you account for the single, double, and triple bonds via orbitals overlapping and hybridization? It is not required to draw the hybridization process, but it might help you in your thinking. (6 mks)

b) Using VSEPR, one can derive that IBr_5 has an octahedral parent shape. Now, use Valence Bond Theory to account for all of the bonds and verify that the parent shape is indeed an octahedral. Why can you determine the parent shape of a molecule based on Valence Bond Theory? Show your work. (6 mks)

c) Determine the family shapes correlated with the sp^3, sp^3d, and sp^3d^2 hybridization. Does this mean that all molecules with the respectable hybridization will have the same shape? Explain. (6 mks)

d) Predict which of these atoms/molecules is diamagnetic using Valence Bond Theory: H, H_2, and NO.(2 mks)

5. The following table shows melting points and conductivity of five elements/ substances

Substance	Melting point/k	Conductivity in solid state	Conductivity in molten state
MgO	3173	Poor	Good
NaCl	1081	Poor	Good
Mg	923	Good	Good
CO_2	217	Poor	Poor
SiO_2	1883	Poor	Poor

a) Why is conductivity of $MgO_{(l)}$ good but that of $MgO_{(s)}$ poor? (2 mks)
b) Why is the melting point of MgO much higher than that of NaCl even though both are ionic compounds? (2 mks)
c) Why is the conductivity of Mg good in both solid and liquid states? (2 mks)
d) By illustration using suitable examples explain how the following bonds are formed;
   i) Metallic bond. (3 mks) –
   ii) Ionic bond. (3mks)

e) Briefly describe the band theory and use it to differatiate between conductors, semiconductors and insulators. (4 mks)

ii)Differantiate between Intrinsic Semiconductors and Extrinsic Semiconductors(4 mks)