# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2019/2020 ACADEMIC YEAR

### SECOND YEAR FIRST SEMESTER
### SUPPLEMENTARYEXAMINATIONS

**FOR THE DEGREE OF B.ED (SCIENCE)**

**COURSE CODE:** **SCH 211**

**COURSE TITLE:** **ATOMIC STRUCTURE AND CHEMICAL BONDING**

**DATE:** 15/2/21 **TIME:** 8-10 AM

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**INSTRUCTIONS TO CANDIDATES:**

TIME: 2 Hours

Answer **question ONE**and **any TWO** of the remaining

Plank's constant, $h = 6.626 \times 10^{-34}$ Js

Speed of light(in vacuum), $c = 2.998 \times 10^{8} ms^{-1}$

Rydberg's constant, $R_H = 1.0968 \times 10^{7} m^{-1}$

Mass of electron, $m_e = 9.11 \times 10^{-31} kg$

$1A = 10^{-10} m$ and $1J = 1\ kgm^2s^{-2}$

Electronic charge, $e = 1.602 \times 10^{-19} C$

Permittivity, $\varepsilon_0 = 8.854188 \times 10^{-12}\ C^2/Jm$

**Question one (30marks)**

a) Briefly explain the discovery of protons as illustrated by Rutherfold gold foil experiment**(3marks)**

b) State any two limitations of the Bohr atom**(2marks)**

c) An electromagnetic radiation causes an electron to jump from the second energy level to the fourth energy level. Calculate; $E_n = -\frac{Z^2 me^4}{8h^2\varepsilon_0^2}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

i) Its energy**(3marks)**

ii)Hence its wavelength**(3marks)**

d) State two quantum numbers and the significance of each of them**(4marks)**

e) Provide the electronic configuration of the following species**(2marks)**

i) $Fe^{3+}$

ii) Al

f) Draw diagrams to show the shapes of s, $p_x$, $p_y$ and the $p_z$ orbitals**(4marks)**

g) i)Construct the correlation diagram for dicarbon**(4marks)**

ii) Calculate the bond order**(3marks)**

iii) Write the ground state valence-electron configuration of $C_2$ **(2marks)**

**Question two (20 marks)**

a) Define the following terms

i) Electronegativity**(2marks)**

ii) Electron affinity **(2marks)**

b) Whereas sulphur has a low melting point, calcium oxide has high melting points. Explain**(4marks)**

c i) Differentiate between pi ($\pi$) and sigma ($\delta$) covalent bonds**(4marks)**

ii) Use ethene ($CH_2CH_2$) molecule to show how sigma and pi bonds are formed**(4marks)**

d) Describe intramolecular hydrogen bond **(2marks)**

e) Distinguish between the following terms;'hybrid atomic orbital and molecular orbital'.Illustrate your answer with a relevant example**(2marks)**

**Question three (20 marks)**

a) State Pauli's exclusive principle**(1mark)**

b) Calculate the effective nuclear charge ($Z_{eff}$) for a 4s electron versus a 3d electron in Zinc **(4marks)**

c) Using boron trifluoride ($BF_3$), show how $sp^2$ hybridization occurs and account for its molecular shape**(5marks)**

d) Give 3 limitations of the valence bond theory**(3marks)**

e) Describe the delocalization and shape of molecular orbital using benzene molecule**(3marks)**

f) Draw the resonance structure for $CO_3^{2-}$**(4marks)**

**Question four (20 marks)**

a) Define the following terms;

i)Lattice energy**(2marks)**

ii) Polarity **(2marks)**

b) Construct a Born Haber cycle for the formation of calcium chloride given that the enthalpy of formation is -796 kJ/mole and calculate the lattice energy of the calcium chloride from the following data; $Ca^{2+}_{(g)} + 2Cl^{-}_{(g)}$ ~~$CaCl_{2(s)}$~~ **(4 marks)**

$Ca_{(s)}$ ~~$Ca_{(g)}$ ΔH atomization~~ = 178 kJ/mole

$Ca_{(g)}$ ~~$Ca^{+}_{(g)} + e$ $\Delta H_{IE}$ = 590 kJ~~/mole

$Ca^{+}_{(g)}$ ~~$Ca^{2+}_{(g)} + e$ ; $\Delta H_{IE}$ = 1145 kJ/mole~~

$Cl_{2(g)}$ ~~$2Cl_{(g)}$ ; ΔH of atomization~~=121 kJ/mole

$Cl_{(g)}$ ⟶ $Cl^{-}_{(g)}$ $\Delta H_{EA}$ =364 kJ/mole

c) Two important concepts that relate to the behavior of electrons in atom systems are the Heisenberg principle and the wave particle duality of matter.

i) State the Heisenberg uncertainty principle as it relates to the determination of the position and momentum of an object**(2marks)**

ii)What aspect of the Bohr Theory of the atom is considered unsatisfactory as aresult of the Heisenberg uncertainty principle**(3marks)**

d) A radioactive material emits photons, each having energy of $1.6 \times 10^{-13}$J. Calculate the frequency of the electromagnetic radiation emitted by the radioactive material**(4marks)**

e) Use De Broglie equation below to calculate the wavelength of an electron with a velocity of $5.97 \times 10^{6} ms^{-1}$**(3marks)**

$$\lambda = \frac{h}{m \times V}$$

**QUESTION 5 (20 MARKS)**

a)Use De Broglie hypothesis to discuss the relationship between quantum mechanics and quantum theory **(6marks)**

b) Show the consequence of penetration effect on orbital energy level diagrams for multielectron atoms**(6marks)**

c) State the shapes and bond angles of the following molecules using the VSEPR model**(6marks)**

i) $BCl_3$

ii) $SiCl_4$

iii) $AsF_5$

d) What is a black body**(2marks)**