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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: CHE 210

COURSE TITLE: ATOMIC STRUCTURE AND BONDING

DATE: 27TH JANUARY, 2022 TIME: 0900 – 1200 HRS

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 3 PRINTED PAGES PLEASE TURN OVER

CHE 210: ATOMIC STRUCTURE AND BONDING

STREAM: BED (Science) DURATION: 3 Hours

INSTRUCTIONS TO CANDIDATES

Answer ALL questions

Question One

a) Einstein's theory of light's dual nature accounted for several unexplainable phenomena, but it did not explain why atomic emission spectra of elements were discontinuous. How did Neil Bohr describe the observed atomic line spectra? (3 Marks)

b) (i) What is the energy in joules required to shift the electron of the hydrogen atom from the first Bohr orbit to the fifth Bohr orbit and what is the wavelength of light emitted when the electron returns to the ground state? The ground state electronic energy is -2.18×10^{-11} ergs. (5 Marks)

(ii) Dual behaviour of matter proposed by de Broglie led to the discovery of electron microscope often used for the highly magnified images of biological molecules and other type of material. If the velocity of the electron in this microscope is 1.6×10^{6} m s^{-1}, calculate de Broglie wavelength associated with this electron (2 Marks)

c) The quantum numbers of six electrons are given below. For each, state the sublevel and arrange them in order of increasing energies. List if any of these combination(s) has/have the same energy (8 Marks)

(i) $n = 4, l = 2, m_l = -2, m_s = -½$

(ii) $n = 3, l = 2, m_l = 1, m_s = +½$

(iii) $n = 4, l = 1, m_l = 0, m_s = +½$

(iv) $n = 3, l = 2, m_l = -2, m_s = -½$

(v) $n = 3, l = 1, m_l = -1, m_s = +½$

(vi) $n = 4, l = 1, m_l = 0, m_s = +½$

Question Two

(a) Explain the formation of a chemical bond (2 Marks)

(b) Show how ionic bond is formed in sodium chloride and calcium fluoride (4 Marks)

(c) Draw the Lewis structures for the following molecules and ions: H_2S, BeF_2, and CO_3^{2-} (3 Marks)

(d) Discuss the shapes of the following molecules using the VSEPR model:, BCl_3, $SiCl_4$, AsF_5, PH_3 (4 Marks)

(e) Write the resonance structures for SO_3, NO_2 and NO_3 (4 Marks)

Question Three

(a)

(i) What is meant by hybridization of atomic orbitals? (2 Marks)

(ii) Describe the hybridization in case of PCl_5 (4 Marks)

(iii) Draw the molecular geometry of PCl_5 and explain why the axial bonds are longer than equatorial bonds (3 Marks)

(b)

(i) What conditions are required for the linear combination of atomic orbitals to form molecular orbitals? (3 Marks)

(ii) Use molecular orbital theory to explain why the Be_2 molecule does not exist (4 Marks)

Question Four

(a) Describe the two main classifications of solids on the basis of arrangement of constituent atoms/molecules, giving one example in each case. (5 ½ Marks)

(b) Give three major properties of ionic solids (3 Marks)

(c) Define the following terms (2 Marks)

(i) Lattice enthalpy

(ii) First electron affinity

(d) Draw a Born-Haber diagram for magnesium chloride and use the enthalpy values in the table below to calculate the value for the first electron affinity of chlorine (8 ½ Marks)

Enthalpy Change	Value in kJ mol^{-1}
Standard enthalpy of formation of magnesium chloride	-642
Standard enthalpy of atomisation of magnesium	+150
First ionisation energy of magnesium	+736
Second ionisation energy of magnesium	+1450
Standard atomisation energy of chlorine	+121
Lattice enthalpy of magnesium chloride	+2492

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