# 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: 9/8 2018  TIME: 9 – 11AM

## QUESTION 1

(a) Given that the sublimation energy of a solid potassium is 90kJ/mol, dissociation energy of chlorine is 121.5kJ/mol, ionization energy of potassium is 420kJ/moland the electron affinity -355KJ/mol. Lattice energy = - 703kJ/mol. Sketch the Born-Haber cycle for the formation of potassium chloride from which to determine the enthalpy of formation.................................................................................. (5)

(b) The lattice energies of some ionic compounds are given below:

$NaCl = 600kJ/mol$

$LiF = 10400kJ/mol$

$CaCl_2 = 2200kJ/mol$

    (i)      Define lattice of an ionic compound........................................... (2)

    (ii)    Briefly explain why LiF has higher lattice energy than NaCl............. (2)

    (iii)   The lattice of $CaCl_2$ is almost three times that of NaCl...................... (2)

    (iv)   Calculate the wave number if $n_1 = 3$ and $n_2 = 4$ and $n_1 = 2$ and $n_2 = 6$.. (2)

(c) Define the terms:

    (i)      Polar covalent bond.......................................................... (1)

    (ii)    Hybrid orbitals................................................................... $(1^1/_2)$

    (iii)   Molecular orbitals.............................................................. $(1^1/_2)$

(d) Give the difference between

    (i)      A sigma bond and a $\pi$ –bond............................................... (2)

    (ii)    A diamagnetic and a paramagnetic substance................................. (2)

(e) Plot the shape of orbitals for which $l = 1$..................................... (2)

(f) What is the characteristic wavelength of an electron with a velocity of 5.97 x $10^6$m/s................................................................................. (3)

(g) (i) Give the difference between valence bond theory and molecular bond theory...(2)

    (ii)Differenciate between antibonding and bonding molecular orbitals......... (2)

## Question 2

(a) Formaldehyde, $H_2CO$, is a colourless pungent gas used to make plastics. Give the valence bond description of the formaldehyde molecule. ( Bond hydrogen atoms are attached to the carbon atoms)........................................................... (2)

(b) Solution to the equation above gives rise to four quantum numbers. State these numbers, give their acceptable values and what they determine........................... (6)

(c) Write down the electron configuration of the following elements and state the block of the periodic table in which they belong to. (Atomic numbers; Cr = 24, Sb = 51, Ce = 58)..................................................................................... (3)

(d) IR light emitted from a TV remote control has a wavelength of 805nm.Calculate:

(i)The frequency of its photons........................................................ (3)

(ii)The energy of its photons.......................................................... (2)

(e) Spectral line is produced when the hydrogen atom jumps from n = 3 to n = 2. Calculate;

(i)The wave number of the spectral line produced................................... (2)

(ii)The energy of the radiation produced.................................................. (2)

(f) (i)Define orbital hybridization.................................................................. (1)

(ii)Complete the table below for hybridization in carbon......................... (6)

| Hybridization state | Number of hybrid orbitals | Number of σ bonds | Number of π bonds | Geometry around carbon |
|---|---|---|---|---|
| SP³ | - | - | - | - |
| SP² | - | - | - | - |
| SP | - | - | - | - |

## Question 3

(a) Explain the meaning of the following.................................................. (6)

(i)Photoelectron

(ii)Black body

(iii)Degenerate orbitals

(b) Outline the four postulates upon which Bohr's atomic model is based... (2)

(c) State the limitations of Bohr's theory....................................................... (2)

(d) Calculate the radius of Bohr's orbit for a hydrogen atom...................... (3)

Calculate the frequency of the radiation required to eject photoelectrons at a velocity of $9 \times 10^5$m/s from a sodium metal surface having a threshold frequency of $4.61 \times 10^{14}$Hz.................................................................................. (3)

(e) The speed of a 1.75g projectile is known to be within $1.0 \times 10^{-6}$m/s. Given that the Plank's constant, $h = 6.626 \times 10^{-34}$Js, calculate the minimum uncertainity in position for this particle. (Mass of electron = $9.11 \times 10^{-31}$kg).        [2marks]
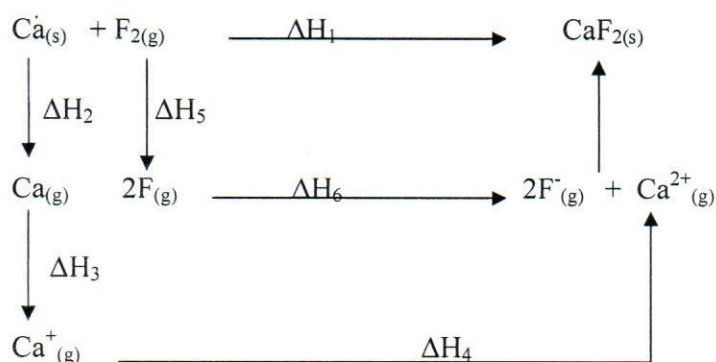
(f) Calculate the wavelength of the 12th line in the Balmer series of hydrogen spectrum        [2marks]

## Question 4

(a) Define each of the following........................................................................ (4)

(i)Electronegativity

(ii)The standard enthalpy of formation

(iii)The standard enthalpy of atomization

(iv)Electron affinity

(b) Calculate the value of the lattice energy of $CaF_2$ from the following data.... (2)

$$Ca_{(s)} + F_{2(g)} \xrightarrow{\Delta H_1} CaF_{2(s)}$$

$$\downarrow \Delta H_2 \quad \downarrow \Delta H_5 \quad\quad \uparrow$$

$$Ca_{(g)} \quad 2F_{(g)} \xrightarrow{\Delta H_6} 2F^-_{(g)} + Ca^{2+}_{(g)}$$

$$\downarrow \Delta H_3 \quad\quad\quad\quad\quad\quad \uparrow$$

$$Ca^+_{(g)} \xrightarrow{\hspace{3cm} \Delta H_4 \hspace{3cm}}$$

(c) (i) Briefly explain how a molecular orbital is a major factor in the formation of a metallic bond.................................................................................(2)

(ii) Draw Lewis structures that represents an ionic bond that exists between Ca and Br⁻ ions................................................................................................. (2)

(iii) Write down the schrodinger equation in three dimensions indicating what m, $\psi$, E, V stand for................................................................................................. (4)

(iv) Write down two possible sets of quantum numbers that describe an electron in a 2S atomic orbital............................................................................. (2)

(d) Use the following data, which are in Kj/mol to calculate the lattice energy of Magnesium Bromide. [4marks]

Sublimation energy of Magnesium ........................... +2187

Vapourization energy of $Br_{2(l)}$ ................................ +31

Dissociation energy of Bromine gas.......................... +193

Electron affinity of Bromine gas ............................... -331

Enthalpy of formation, $\Delta H_f$ ($MgBr_2$) ........................ - 524

## Question 5

(a) Predict and draw the molecular geometries of the molecules or ions.................................... (10)
   (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...(5)

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