# MAASAI MARA UNIVERSITY

## REGULAR UNIVERSITY EXAMINATIONS
## 2018/2019 ACADEMIC YEAR
## FIRST YEAR SECOND SEMESTER

## SCHOOL OF SCIENCE AND INFORMATION SCIENCES
## BACHELOR OF SCIENCE IN CHEMISTRY

**COURSE CODE: CHE 1206**

**COURSE TITLE: BASIC CONCEPTS IN CHEMICAL BONDING AND STRUCTURE**

**DATE: 15TH APRIL 2019** **TIME: 8.30AM -10.30AM**

**INSTRUCTIONS TO CANDIDATES**

1. Answer Question **ONE** and any other **TWO** questions.
2. All Examination Rules Apply.

***This paper consists of 4 printed pages. Please turn over.***

## SECTION A

## Question One (30mks)

a) In the Lewis theory, Lewis symbols and Lewis structures are used to represent elements and compounds respectively. State what the following represent in a Lewis symbol;
   (i) Chemical symbol (1 mk)
   (ii) Dots around the chemical symbol (1 mk)

b) Draw Lewis symbols of the following elements;
   (i) Carbon-6 (1 mk)
   (ii) Oxygen-8 (1 mk)
   (iii) Nitrogen-7 (1 mk)

c) Draw Lewis structures of the following compounds;
   (i) Hydrogen Chloride (H=1,Cl=17) (1 mk)
   (ii) Chlorine gas (1 mk)
   (iii) Methane (C = 12) (1 mk)

d) (i) How does the valence shell electron pair repulsion theory (VSEPR) explain the geometry of a compound (2 mks)
   (ii) Using VSEPR theory, explain the geometry in $BCl_3$ (2 mks)

e) (i) State the two steps often observed when constructing hybrid orbitals (2 mks)
   (ii) In the formation of $BF_3$, there is hybridization before formation of the final covalent bonds. Illustrate the hybridization stating the number and type of hybrid orbitals formed (4 mks)

f) Distinguish between the two types of covalent bonds, π-bond and σ-bond based on the orientation, strength and extent of overlap (3 mks)

g) Complete the following table that shows the valence electron pair geometry, number of hybrid orbitals involved and the corresponding hybrid orbitals (5 mks)

| **Valence electron pair geometry** | **Number of orbitals** | **Hybrid orbitals** |
|---|---|---|
| | 2 | Sp |
| Trigonal planar | | $Sp^2$ |
| Tetrahedral | 4 | |
| Trigonal bipyramidal | 5 | |
| | 6 | $Sp^3d^2$ |

h) (i) When certain elements come into contact, an ionic bond is formed. State the processes that lead to the formation of the bond (2 mks)

   (ii) State the natures of the elements in h) (i) above and their respective positions on the periodic table (2 mks)

## SECTION B

Answer any TWO questions from this section, each question carries 20 marks

### Question Two (20mks)

a) Using the Lewis theory, illustrate the formation of the dative covalent bond in hydronium ion (H = 1, O = 8) (2 mks)

b) State the nature of covalent bond formed when the difference in electronegativity between bonding atoms is;

(i) Large (1 mk)

(ii) Small (1 mk)

e) Describe how a polar covalent bond is formed (1 mk)

f) Calculate the formal charges of the atoms in the compound $[O\text{-}N{=}O]^{+}$ (2 mks)

g) State the four general rules for formal charges (4 mks)

h) Define the following terms as used in covalent bonding;

(i) Bond order (1 mk)
(ii) Bond length (1 mk)
(iii) Define bond dissociation energy and state its relationship with the two quantities in h) (i), (ii) above (2 mks)

i) State whether the following molecules are polar or non-polar;

(i) $O = C = O$ (1 mk)

(ii) $H - O - H$ (1 mk)

(iv) $\begin{matrix} F \\ F \end{matrix} > B - F$ (1 mk)

j) Describe the orientation of the following types of molecules in an electric field;

(i) Polar molecules (1 mk)

(ii) Non-polar molecule (1 mk)

### Question Three (20mks)

a) State any four properties of metals (4 mks)
b) Explain why polarizability increases with atomic/molecular size (2 mks)
c) (i) Discuss the origin of dipole-dipole interactions in covalent molecules (2 mks)

(ii) Explain why a substance would persist as solid or liquid at higher temperatures than normal based on dipole-dipole interactions (2 mks)

d) (i) Describe the formation of a hydrogen bond (2 mks)

(ii) In terms of hydrogen bonding explain how the density of water varies as ice is heated from $0^{O}$ C to above $4^{O}$ C (4 mks)

e) Explain the difference in viscosity between the following alcohols;
- Ethylene glycol, HO-$CH_2CH_2$-OH –Ethyl alcohol, $CH_3CH_2$-OH (4 mks)

## Question Four (20mks)

a) The heat of vaporization of acetic acid could be abnormally low due to the existence of hydrogen bonds in the molecule. Explain (2 mks)

b) Explain the existence of the following metallic properties using the electron sea model;

(i) Good electrical conductivity (1 mk)

(ii) Metallic lustre (1 mk)

c) Define the following terms as used in bonding;

(i) Electronegativity (1 mk)

(ii) Electron Affinity (1 mk)

(iii) Ionization energy (1 mk)

d) State the relationship between electron affinity, electronegativity and ionization nergy (1 mk)

e) The sum of formal charges of all the atoms in a Lewis structure equals ---------- for neutral molecules and ----------for ionic species (2 mks)

f) The unusual freezing point behavior of water causes ponds to freeze from the top. Explain (3 mks)

g) Draw the resonance structures of $CH_3COO^-$ (1 mk)

h) (i)State one application of bond energies (1 mk)

(ii)A certain covalent bond has a dipole moment of 3.01 D and a bond length of $130.1x10^{-12}$m. Calculate the partial charge of the molecule (D = 3.34 x $10^{-30}$ C m $D^{-1}$) (3 mks)

(i) State the difference between a dative covalent bond and a normal covalent bond (2 mks)

J) Explain the origin of instantaneous dipole-induced dipole molecular interactions (2 mks)

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