



# NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF APPLIED CHEMISTRY

INORGANIC CHEMISTRY I

SCH 1101

Supplementary Examination Paper

AUGUST 2015

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Periodic Table

Examiner's Name: DR H. Chiririwa

## INSTRUCTIONS

1. Answer all four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

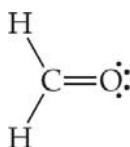
## MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
<b>TOTAL</b>	<b>100</b>

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SCH 1101

1. (a) Write the electronic configurations of the following elements in the periodic table and explain any anomalies you observed: Cr; Fe; Cu; Co; Ce. [10 marks]
- (b) What are the values of  $n$ ,  $l$ ,  $m$  and  $s$  for the valence electron of a potassium atom in its ground state? [4 marks]
- (c) Define **term** and **multiplicity** in electronic microstructure theory. Show examples. [6 marks]
- (d) Specify the set of quantum numbers used to describe an orbital and state what values of each are possible. [5 marks]
2. (a) The following are the approximate 1<sup>st</sup> ionization enthalpies of noble gases in kJ/mol: He (2372); Ne (2081); Ar (1521); Kr (1351); Xe (1170); Rn (1037). Plot a graph of the above data and using electronic structure of atoms explain the trend shown in your graph. [10 marks]
- (b) Calculate the density of an air mix of nitrogen, argon and carbon dioxide, if the mass of the components is 15, 50 and 35% respectively. ( $M_{\text{air}} = 29$ ) [4 marks]
- (c) Draw the energy diagram of  $\text{O}_2$  and explain which properties can be derived from the diagram. [6 marks]
- (d) Formaldehyde has the Lewis structure:



Describe how the bonds in formaldehyde are formed in terms of overlaps of hybrid and unhybridized orbitals. [5 marks]

3. (a) For each of the following five molecular species,
- count the number of valence electrons;
  - draw the Lewis Structures including all resonance structures;
  - identify the hybridization of the center atom;
  - draw out the shape of the molecule according to VSEPR; and
  - name the molecular geometry.
    - $\text{H}_3\text{PO}_4$
    - $\text{ICl}_4^-$
    - $\text{NNN}^-$
    - $\text{OSF}_4$
    - $[\text{PtCl}_6]^{2-}$
- [15 marks]
- (b) Balance the following reactions
- $\text{Na}_2\text{O} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
  - $\text{HNO}_3 + \text{NH}_4\text{OH} \rightarrow \text{NH}_4\text{NO}_3 + \text{H}_2\text{O}$
  - $\text{Al}(\text{OH})_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$
- [3 marks]
- (c) In what relative positions would s and p orbitals have cancelling overlap? Show with illustrations. [2 marks]
- (d) Which of the following bonds is most polar: S—Cl, S—Br, Se—Cl, or Se—Br ? [4 marks]
- (e) Draw two equivalent resonance structures for the formate ion,  $\text{HCO}_2^-$ . [2 marks]
4. (a) Calculate the formula weight of:
- $\text{Al}(\text{OH})_3$  and
  - $\text{CH}_3\text{OH}$
- [ 4 marks]

- (b) Write the balanced equations for the reaction that occurs when:
- (i) ethanol,  $C_2H_5OH(l)$  and
  - (ii) methanol,  $CH_3OH(l)$ , burn in air. [ 4 marks]
- (c) Calculate the percentage of nitrogen, by mass, in  $Ca(NO_3)_2$ . [ 3 marks]
- (d) How many moles of sodium bicarbonate ( $NaHCO_3$ ) are in 508 g of  $NaHCO_3$ ? [2 marks]
- (e) Calculate the mass, in grams, of 0.433 mol of calcium nitrate [2 marks]
- (f) Mesitylene, a hydrocarbon found in crude oil, has an empirical formula of  $C_3H_4$  and an experimentally determined molecular weight of 121 amu. What is its molecular formula? [4 marks]
- (g) Ethylene glycol, used in automobile antifreeze, is 38.7% C, 9.7% H, and 51.6% O by mass. Its molar mass is 62.1 g/mol.
- (i) What is the empirical formula of ethylene glycol?
  - (ii) What is its molecular formula? [6 marks]

*End of question Paper!!!*