



# Technical University of Mombasa

Faculty of Applied and Health Sciences

## DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF  
TECHNOLOGY IN APPLIED CHEMISTRY (ANALYTICAL OPTION)  
BTAC12S

### ACH 4210: COMPARATIVE STUDY OF S AND P BLOCK ELEMENTS

SEMESTER EXAMINATION

DECEMBER 2013 SERIES

2 HOURS

Instructions to candidates:

This paper consist of **FIVE** questions

Answer question **ONE** (compulsory) and any other **TWO** questions

#### QUESTION ONE

- a) (i) Using balanced chemical equations, explain how the Group I elements react with oxygen, giving only the major products. **(6marks)**
- (ii) Give reasons for the preferred products in (i) above **(2marks)**
- b) (i) Give the structure of diborane and explain the concept of three-centre two-electron bonds in the bridges. **(5marks)**
- (ii) Outline **TWO** synthetic applications of diborane, using chemical equations as appropriate. **(4marks)**
- c) Explain why  $\text{MgSO}_4$  is readily soluble in water while  $\text{BaSO}_4$  is virtually insoluble **(7marks)**
- d) (i) Define the term “catenation” **(1mark)**

- (ii) Explain why in Group IV, carbon (first row element) has a stronger tendency to catenation than its homologues, while in group VI, sulphur (second row element) has a stronger tendency to catenation relative to the other group members.

**(5marks)**

## QUESTION TWO

- a) (i) Write the chemical equations for the reaction between the following oxides and water, and name the products:

$\text{Na}_2\text{O}$ ,  $\text{P}_4\text{O}_{10}$ ,  $\text{SO}_3$ ,  $\text{Cl}_2\text{O}_7$  **(6marks)**

- (ii) Comment on the nature of the above oxides in view of their reactions with water.

**(2marks)**

- b) (i) Explain the trend of acid strength of aqueous hydrogen halides. **(4marks)**

- (ii) Give FOUR factors to which differences between the chemistry of fluorine and the other halogens can be attributed. **(4marks)**

- (iii) State any FOUR applications of the Group II elements and their compounds.

**(4marks)**

## QUESTION THREE

- a) (i) Explain the trend of basicity of the oxides of group III elements **(8marks)**

- (ii) Give THREE applications of aluminium or its compounds, explaining the property exploited in each case. **(6marks)**

- b) Boiling points of the halogens and hydrogen halides are given in the following table

Element, X		F	Cl	Br	I
Boiling Point ( °C)	X	-188	-34	59	183
	HX	+20	-85	-67	-35

Explain the trend of:

- (i) The boiling point of the halogens **(2marks)**

- (ii) The boiling point of the hydrogen halides **(4marks)**

## QUESTION FOUR

- a) Elemental oxygen occurs in two allotropic forms: oxygen molecule and ozone.
- (i) Write the Lewis structures of the two allotropes. **(4marks)**
  - (ii) Explain the order of reactivity of the allotropes. **(3marks)**
  - (iii) State THREE common applications of oxygen and ONE application of ozone. **(4marks)**
- b) Explain the variation in the boiling points of the group VI hydrides in the following table
- | Hydride            | H <sub>2</sub> O | H <sub>2</sub> S | H <sub>2</sub> Se | H <sub>2</sub> Te |
|--------------------|------------------|------------------|-------------------|-------------------|
| Boiling point (°C) | 100              | -61              | -42               | -2                |
- (5marks)**
- c) Thallium (group III) forms both TlCl<sub>3</sub> and TlCl, the latter being more stable than the former. Explain. **(4marks)**

## QUESTION FIVE

- a) Explain the following observations
- (i) LiCl is only sparingly soluble in water, but very soluble in methanol. **(3marks)**
  - (ii) The O-O and O-F bonds are much weaker than S-S and S-F bonds, while O-H and O-C bonds are much stronger than S-H and S-C bonds. **(5marks)**
  - (iii) The solubility products of the carbonates of group II elements decrease, while those of fluorides increase as the group is descended. **(7marks)**
- b) Explain the trends in crystallographic and hydrated radii of the alkali metal ions in the following table.

Metal ion	Li <sup>+</sup>	Na <sup>+</sup>	K <sup>+</sup>	Rb <sup>+</sup>	Cs <sup>+</sup>
Crystal radius (Å°)	0.85	1.10	1.40	1.55	1.82
Hydrated radius (Å°)	3.40	2.75	2.30	2.25	2.21

**(5marks)**