KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF CHEMISTRY

COURSE CODE: SCH 311

COURSE TITLE: COMPARATIVE STUDY OF S AND P BLOCK ELEMENTS

DURATION: 2 HOURS

DATE: 13/07/2021 **TIME:** 9:00-11:00AM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **5** printed pages. Please Turn Over

SECTION A (30 MARKS)

QUESTION 1

(a) Define the following terms as applied in the chemistry of S and P block elements. (5mks)

i. Electronegativity

ii. Ionization

iii. Allotropy

iv. Inert pair effect

v. Catenation

(b) Outline differences between S and P block elements in the periodic table. (3mks)

(c) Explain the trend of the atomic radius, first i.e electron affinity and electronegativity across the periodic table. (4mks)

(e) Explain each of the following observations;

i. Beryllium and Aluminium exhibit similar characteristics yet they belong to different groups of the periodic table. (1mk)

ii. Fluorine exhibits only -1 oxidation state whereas other halogens exhibit +1, +3, +5, +7 oxidation state also. (1mk)

iii. Group 2 elements show greater ionization energy than group 1 elements. (1mk)

(f) Water (H_2O) and hydrogen sulphide (H_2S) are compounds of group six elements. (O and S). Explain why water is a liquid at room temperature whereas H_2S is a gas. (2mks)

(g) Oxides of nitrogen from high flying aircraft can lead to depletion of ozone layer. By use of chemical equations, show how this is possible. (3mks)

(h) Lithium differs from the other group (I) elements in its chemical and physical properties. State two physical and two chemical differences between Lithium and other in group (I) elements. (4mks)

i) Explain the trivalency and monovalency of group (III) elements. (4mks)

(j) Explain why a diagonal relationship exists between lithium and magnesium. (2mks)

QUESTION 2 (20 MARKS)

a) Describe in details the extraction process of Aluminium from its principal ore outlining the role of each chemical used. (6 mks)

b) State 3 reasons why it is not possible to obtain F_2 by electrolysis of aqueous HF or anhydrous HF (3mks)

c) Describe how you would prepare a Grignard reagent from Mg and two different uses of the reagent in preparative reactions. (3mks)

d) (i) The Pauling's electronegativity values for oxygen and silicon are 3.5 and 1.8 respectively. Comment on the bond type between O and Si. (1mk)

(ii) State any two major applications of phosphates. (1mk)

e) The first step in the manufacture of nitric acid from ammonia involves the exothermic oxidation of ammonia to nitrogen oxide (NO) and steam.

i. Write the equation for the reaction of ammonia with oxygen to form nitrogen oxide steam. ($1^{1/2}$)

ii. Predict qualitatively the conditions of temperature and pressure for maximum yield of nitrogen oxide. ($1^{1/2}$)

iii. Describe with equations how nitrogen oxide produced by this process is converted to nitric acid. (3mks)

QUESTION 3 (20MARKS)

(a) i. Define the term bond angle.(1mk)

ii Explain why Beryllium chloride is a linear molecule whereas Tin chloride is a trigonal planar. (3mks)

(b). Compare the stability of oxo-salts of group 1 and group 2 elements with reference to;

i. Nitrates (1mk)

ii. Carbonates (2mks)

(c) With reference to reactions with alkalis and acids, show the difference in nature of Aluminium hydroxide with that of Magnesium hydroxide. (4mks)

(d) CO_2 and SiO_2 are both acidic but SiO_2 is a solid of high melting point whereas CO_2 is a gas at room temperature. Explain. (2mks)

(e) i. Explain the term Silicones. (2mks)

ii. List four applicants of Silicones. (4mks)

QUESTION 4 (20 MARKS)

(a) Sulphur catenates more than group (VI) elements.

I. Define the term catenation. (1/2mk)

ii. Give example of species in which Sulphur cartenates. (1/2mk)

(b) Beryllium chloride is a substantially covalent but the compounds of group 2A become more ionic on going down the group, such that Barium sulphate is almost purely ionic. Explain this observation. (2mks)

(c) The following table shows the physical data for the halogen hydrides.

Halogen hydrides	Boiling point (^{0}c)	ka	Bond dissociation energy KJ/mol
Hydrogen fluoride	19.5	154	562
Hydrogen chloride	-85.0	157	431
Hydrogen bromide	-67.0	157	366
Hydrogen iodide	-35.0	10''	298

i. Account for the boiling point of the hydrogen halides. (2mks)

ii. Arrange the hydrogen halides in order of increasing acidity and account for the order. (2mks)

iii. Explain why a solution of hydrogen chloride in methyl benzene does not conduct electricity, while in aqueous solution it behaves as a strong electrolyte. (1mk)

(d) Explain why Aluminium chloride is a covalent whereas Aluminium fluoride is ionic. (2mks)

(e) The behaviour of the hydrides of the elements Na-Ar with water is summarised below;

NaH | MgH_2 | AlH_3	SiH_4	PH_3	H_2S	HCl
React forming H_2 gas and an alkaloid solution	No reaction	Reacts forming a slight alkaline solution	Reacts to form a slightly acidic solution	Reacts to form an acidic solution

i. Write equations to summarise the reactions of NaH and MgH_2 with water. (2mks)

ii. Suggest a reason why SiH_4 has no reaction with water. (1mk)

iii. Write an equation to account for the formation of a slightly alkaline solution when PH_3 reacts with water. (2mks)

iv. Write an equation to account for the formation of an acidic solution when HCl reacts with water. (2mks)

(f) Beryllium shows certain properties that are not typical of the rest of the group. Mention two of these properties and suggest reasons why the difference should occur. (3mks)

QUESTION 5 (20 MARKS)

(a) Write a balanced chemical equation for the reaction between concentrated Sulphuric acid and;

i. Hydrogen sulphide. ($1^{1/2}$ mks)

ii. Sulphur. ($1^{1/2}$ mks)

(b) Three of the oxoacids of phosphorus have the formula H_3PO_3, H_3PO_4, H_3PO_2.

i. Name the three acids. ($1^{1/2}$ mks)

ii. Draw their full structural formulae. (2 mks)

iii. Draw a diagram to show the expected shape and bond in a molecule of phosphorus chloride. (2 mks)

iv. Phosphorus is also a penta chloride, PCl_5, which is thought to exist in the solid form as $[PCl_4]^+$,$[PCl_6]^-$ draw the shapes of these ions. (2marks)

(c) Elements frequently form hydrated salts unlike the corresponding compounds of group I elements are anhydrous. Suggest reasons for these difference. (2mks)

(d) Magnesium and calcium occur naturally in the mineral dolomite, $MgCO_3$, $CaCO_3$, a mixture of the insoluble magnesium and calcium carbonate which can be used to produce calcium sulphate and magnesium sulphate is used in the manufacturing of building materials such as plaster board. Magnesium sulphate is used in the fire proofing fabrics and an Epsom salts.

(i) Describe carefully how you would prepare samples of $Mg_3O_4.7H_2O$ and $CaSO_4$ from dolomite. (3mks)

You may find the following information useful.

Compound	Solubility per 100g of H_2O at 20^0
$MgCO_3$	0.01
CO_3	0.0014
$MgSO_4$	33.0
$CaSO_4$	0.21

(ii) How would you obtain pure $MgSO_4$ from crystals of $MgSO_4.7H_2O$. (2mks)