

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF CHEMISTRY

COURSE CODE: SCH 211*

COURSE TITLE: INORGANIC CHEMISTRY

DURATION: 2 HOURS

DATE: 19/12/2022 **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 3 printed pages. Please Turn Over



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Question 1

- (a) Give three reasons why the first element of the p-block elements is different from other members of the group (3)
- b) Explain why the first members of each group among the p-block elements exhibits only a maximum oxidation state of four whereas the others display higher oxidation numbers. (2)
- c) Explain why the p-block elements display two oxidation states whereas the s-block elements only displays only one. (3)
- d) Give reasons for the following trends as observed among the p-block elements
- The atomic radius generally decreases across the period and increases down the group. (2)
 - The ionization energy increases across the period but decreases down the group (2)
 - Electronegativity increases along the period and decreases down group. (2)
- e) List four uses of boron and its compounds. (4)
- f) Boric acid behave like a weak monobasic acid ($K_a=1 \times 10^{-9}$), upon accepting hydroxyl ion, it behaves like a Lewis acid. Write a balanced equation that describes this reaction. (2)
- g) Write a balanced equation to show the reaction of carbon on B_2O_3 to produce B_4C . (3)
- h) The physical structure of BC gives rise to correspondingly unique properties, highlight any three of them. (3)
- I) State any three organic synthesis reactions in which BF_3 is used as a catalyst. (3)
- k) Comment on the nature (ionic/covalent) of the hydroxides of the p-block elements. (1)

Question 2

- (a) Discuss the trends in the chemistry of p-block elements with respect to:
- Acidic and basic nature of the oxides. (2)
 - Ionic and covalent nature of the hydroxides. (2)
- (b) Explain why compounds of boron are mostly covalent. (3)
- (c) A borane is a compound containing only boron and hydrogen. If borane is found to contain 88.45% boron, what is its empirical formula? (3)
- (d) The compound diborane, B_2H_6 can be useful as a rocket fuel. It can be prepared by the reaction of boron trifluoride BF_3 with sodium borohydride, $NaBH_4$.



Balance the equation

(2)

e) In borazine, $\text{B}_3\text{N}_3\text{H}_6$, the boron and nitrogen atoms alternate around the ring. Each ring atom has a single hydrogen atom bonded to it. All boron-nitrogen bonds in borazine are 0.114 nm in length, whereas in simple compounds, B-N, B=N bond lengths are 0.154 nm and 0.136 nm respectively. Suggest and draw the structure of borazine.

(3)

f) Boric acid consists of a planar BO_3^{2-} units bound together through hydrogen bonds forming a trigonal planar layer structure. Draw the structure.

(5)

Question 3

(a) The most important use of BBr_3 is the cleavage of C-O bonds of alkyl ethers. The mechanism of this reaction goes through a complex formation at the boron center with the ether oxygen followed by alkyl bromide elimination to yield dibromo organoborane. This on further hydrolysis will result in alcohol. Write a balanced equation for this scheme.

(5)

b) State three applications of BBr_3 .

(3)

c) How does the covalent character of halide of an element change with oxidation state of the element.

(2)

d) Explain why among the p-block elements, metallic character decreases along the period but increases on moving down the group.

(3)

e) Discuss the trends in the chemistry of p-block elements with respect to:

i) Acidic and basic nature of the oxides.

(3)

ii) Ionic and covalent nature of the hydroxide.

(3)

f) State any one use of borax.

(1)

Question 4

(a) Explain the consequence of "inert pair effect" on the oxidation state of Thallium and lead.

(2)

(b) Write a complete chemical equation for the reaction between SiCl_4 and water.

(3)

(c) Explain the variation in bond angles of the following hydrides NH_3 , PH_3 , AsH_3 and SbH_3 .

(2)

(d) Explain how the covalent character of halides of an element changes with its oxidation state.

(2)

(e) Sketch the molecule B_2H_6 and show the different bonding between the hydrogen and boron atoms. (2)

(f) Draw the structures of B_5H_8 , $B_4H_4^{2-}$ and $B_{10}H_{14}$. (6)

(g) What are metal clusters? Explain the structure of $\{Re_2X_8\}^{2-}$ ion. (3)

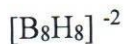
5) (a) For each of the following boranes below, use wades rule to predict whether they will be closo, nido, archno or hypho boranes. Clearly show how you determine the correct structure. (8)



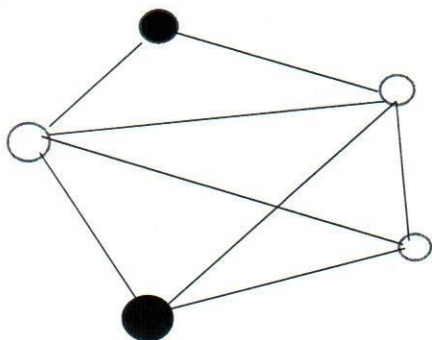
(b) How many electrons are used for skeletal bonding in the following boranes? (4)



c) For the borane structures given below, determine the number of vertices, edges and triangular faces. (3)



d) Below are two different borane compounds. Describe the shape of each with regards to geometric shapes and determine if the borane is a closo, nido, archno or hypho-borane. (5)



1, 5 - $C_2B_3H_5$

