



**KIBABII UNIVERSITY**

**UNIVERSITY EXAMINATIONS  
2021/2022 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: 01/02/2022**

**TIME: 2-4PM**

---

**INSTRUCTIONS TO CANDIDATES**

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- This paper consists of **3** printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

### 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. (2)
- d) Give reasons for the following trends as observed among the p-block elements
- i) The atomic radius generally decreases across the period and increases down the group. (2)
- ii) The ionization energy increases across the period but decreases down the group (2)
- iii) 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:
- (i) Acidic and basic nature of the oxides. (2)
- (ii) 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 borohydroxide,  $NaBH_4$ .  
 $BF_3 + NaBH_4 \dots \dots \dots B_2H_6 + NaBF_4$ .  
Balance the equation (2)
- e) In borazine,  $B_3N_3H_6$ , the boron and nitrogen atoms alternate around the ring .Each ring atoms has a single hydrogen atom bounded to it. All boron-nitrogen bonds in borazine are 0.114nm in length, whereas in simple compounds, B-N, B=N bond lengths are 0.154nm and 0.136nm respectively. Suggest and draw the structure of borazine. (3)
- f) Boric acid consists of a planer  $BO_3^{2-}$  units bounds together through hydrogen bonds shaping a trigonal planer layer structure. Draw the structure. (5)

### Question 3

(a) The most important use of  $\text{BBr}_3$  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  $\text{BBr}_3$ . (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 increase 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  $\text{SiCl}_4$  and water.

(3)

(c) Explain the variation in bond angles of the following hydrides  $\text{NH}_3$ ,  $\text{PH}_3$ ,  $\text{AsH}_3$  and  $\text{SbH}_3$ .

(2) (d) Explain how the covalent character of halides of an element changes with its oxidation state. (2)

(e) Sketch the molecule  $\text{B}_2\text{H}_6$  and show the different bonding between the hydrogen and boron atoms.

(2)

(f) Draw the structures of  $\text{B}_5\text{H}_8$ ,  $\text{B}_4\text{H}_4^{2-}$  and  $\text{B}_{10}\text{H}_{14}$ . (6)

(g) What are metal clusters? Explain the structure of  $\{\text{Re}_2\text{X}_8\}^{2-}$  ion. (3)

### Question 5

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)

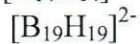
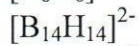
- i)  $\text{B}_6\text{H}_8$
- ii)  $\text{B}_2\text{H}_7^{1-}$
- iii)  $\text{C}_2\text{B}_8\text{H}_{10}^{4-}$
- iv)  $\text{GeC}_2\text{B}_9\text{H}_{11}$

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

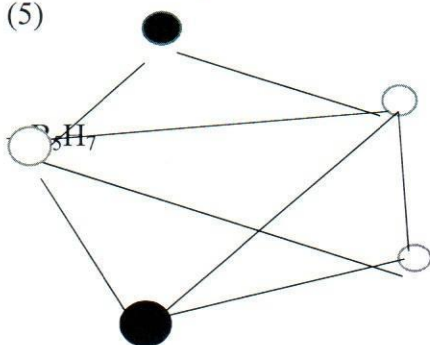
- i)  $\text{B}_{11}\text{H}_{17}$
- ii)  $\text{B}_{16}\text{H}_{20}$
- iii)  $\text{B}_{10}\text{H}_{16}$



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 -  $C_2B_3H_5$

