higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

CHEMISTRY N4

(15040004)

21 November 2023 (X-paper)
09:00–12:00

Drawing instruments may be used.

This question paper consists of 7 pages and a periodic table.

014Q1E2321

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
CHEMISTRY N4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Use only a black or a blue pen.
5. Write neatly and legibly.

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QUESTION 1: CHEMICAL BONDING

1.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1−1.1.5) in the ANSWER BOOK. Substantiate each answer.

1.1.1 Electrovalent compounds exist as soft crystals with high melting points and ions of opposite charges arranged in a symmetrical array.

1.1.2 When two atoms that are bound together by covalent bonds are different, the molecule so formed is said to possess an electrical dipole.

1.1.3 The physical picture of metallic structure accounts quite adequately for the two properties, malleability and ductility.

1.1.4 A bond formed between two atoms of similar electronegativity will be essentially electrovalent.

1.1.5 The liquefaction and eventual solidification of noble gases is explained by postulating so-called ionic forces.

(5 × 2) (10)

1.2 Choose a description from COLUMN B that matches an item in COLUMN A. Write only the letter (A−E) next to the question number (1.2.1−1.2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	Electrovalent compound	A	a measure of the power of an atom to attract electrons
1.2.2	Electronegativity	B	malleability and ductility properties
1.2.3	Metallic structure	C	holding together of cellulose molecules in the form of fibre
1.2.4	Hydrogen bonding	D	bringing together of sodium and chloride ions to form solid sodium chloride
1.2.5	Lattice energy	E	formed between the most reactive metals of group 1A and 2A and the most reactive non-metals of group 6B and 7B

(5 × 1) (5)

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1.3 Distinguish between *electrovalent* and *covalent* compounds with respect to structures. (2 × 2) (4)

1.4 Draw the Lewis structures for the following ions and indicate in each instance whether the octet rule has been obeyed or violated:

1.4.1 NO_3^-

1.4.2 NH_4^+

(2 × 3) (6)
[25]

QUESTION 2: CHEMICAL GEOMETRY

2.1 The radii of atoms and ions exhibit variations in the periodic table.

2.1.1 Which of the cations between Li^+ and Be^{2+} has a greater radius? Explain. (2)

2.1.2 Define the term, *iso-electropositive ions*. (1)

2.2 Apply the Sidgwick-Powell theory to draw the structures of the following compounds. Indicate lone pairs and state the shape of the structures.

2.2.1 SO_2

2.2.2 NH_3

2.2.3 PF_5

(3 × 3) (9)

2.3 The structures of NH_2^-, NH_3 and NH_4^+ have H-N-H bond angles of 105°,107° and 109° respectively.

Explain the variation in bond angles. (3)

2.4 Use the concept of resonance to explain the N-O bond length in the nitrate anion. (3)
[18]

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QUESTION 3: ACIDS AND BASES

3.1 State the Arrhenius theory of acids and bases. (2)

3.2 Consider the reaction:

$HNO_3(aq) + H_2O(l) \rightarrow H_3O^+(aq) + NO^{3-}(aq)$

3.2.1 Write down the equation for the equilibrium constant (Ka) for the reaction. (2)

3.2.2 Will the Ka value be large or small? Explain. (2)

3.2.3 Rewrite the equation and clearly indicate the conjugate acid-base pairs. (2)

3.2.4 Explain why HNO_3 in the above reaction acts as a Bronsted-Lowry acid. (1)

3.3 Consider the reaction between BF_3 and NH_3.

3.3.1 State the Lewis theory of acids and bases.

3.3.2 Which compound between BF_3 and NH_3 is a Lewis acid? Explain. (2 × 2) (4)

[13]

QUESTION 4: HYDROGEN

4.1 Write down THREE ways in which hydrogen can be prepared. (3)

4.2 Complete the following reactions:

4.2.1 $2Al(s) + 2OH^-(aq) + 6H_2O(l) \rightarrow$ (2)

4.2.2 $H_2(g) + S(l) \rightarrow$ (1)

4.2.3 $WO_3(s) + 3H_2 \rightarrow$ (2)

4.3 Name the THREE isotopes of hydrogen and write down the relative mass of each next to the isotope. (3)

[11]

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QUESTION 5: CARBON

5.1 Name TWO allotropes of carbon. (2)

5.2 Write down THREE uses of diamonds. (3)

5.3 Carbon forms more compounds than any other element.

5.3.1 Complete the reaction:

$CS_2(l) + Cl_2(g) \rightarrow$

5.3.2 State TWO uses of the product of the reaction in QUESTION 5.3.1.

(2 × 2) (4)

[9]

QUESTION 6: NITROGEN

6.1 Provide TWO uses of nitrogen. (2)

6.2 In industry, ammonia is prepared by reacting nitrogen and hydrogen.

6.2.1 Write down a balanced reaction for this process. (2)

6.2.2 Name the process used. (1)

6.3 Name TWO oxyacids of nitrogen. (2)

6.4 Indicate which of the following nitrides are ionic, covalent or interstitial:

6.4.1 Si_3N_4

6.4.2 Li_3N

6.4.3 Ni_3N

(3 × 1) (3)

[10]

QUESTION 7: OXYGEN

7.1 Describe how oxygen is prepared in industry. (3)

7.2 Describe how ozone is prepared in the laboratory. (2)

7.3 Nitrogen oxide emitted from the exhaust systems of supersonic aircrafts operating in the stratosphere combines very rapidly with ozone.

Explain what danger this poses in the upper atmosphere. (2)

7.4 Name ONE possible classification of oxides on the basis of their acid-base properties. (1)

7.5 Water is described as being hard if it forms an insoluble scum before it forms lather with soap.

7.5.1 Define *temporary hardness* in water.

7.5.2 Write down TWO processes used to remove temporary hardness in water.

(2 × 2) (4)

7.6 Write down TWO methods for producing pure water. (2)

[14]

TOTAL: 100

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THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE

