higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

CHEMISTRY N4

(15040004)

15 November 2022 (X-paper)
09:00–12:00

Drawing instruments may be used.

This question paper consists of 7 pages and 1 periodic table.

016Q1E2215

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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. Start each section on a new page.
5. Use only a black or a blue pen.
6. Write neatly and legibly.

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QUESTION 1

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.

1.1.1 Elements tend to react together to attain the stable electronic configurations of noble gas.

1.1.2 As a group, noble gases enter into chemical combinations far less readily than other elements.

1.1.3 In a reaction between sodium and chlorine, the resulting charged species are covalently bonded.

1.1.4 A molecule which possesses an electric dipole will have a lower boiling point than it would otherwise have had.

1.1.5 The physical structure of a non-metallic structure accounts for the ductility and malleability properties.

(5 × 1) (5)

1.2 Consider the following reaction:

$$Na(s) + \tfrac{1}{2}\, Cl2(g) \rightarrow Na+Cl- (s); \Delta H\Theta\ (298K) = -\ 411kJmol\text{-}1$$

1.2.1 The reaction can be broken down into a number of hypothetical stages, each involving an energy change.

Write down the stages in sequence. (5)

1.2.2 Write down the THREE most important terms that indicate that a compound is likely to be electrovalent. (3)

1.2.3 Discuss TWO distinguishing features of *electrovalent* and *covalent compounds*. (4)

1.2.4 Define *electronegativity of an atom.* (2)

1.3 Consider the $BeCl_2$ molecule.

1.3.1 Write down the ground state electronic configuration of beryllium, its valency state and the valency state of chlorine. (3)

1.3.2 Does the beryllium chloride compound conform to the octet rule? Explain your answer.. (2)

1.3.3 Name the forces that operate between individual molecules in molecular crystals. (1)

[25]

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QUESTION 2: CHEMICAL GEOMETRY

2.1 The lengths of atomic and ionic radii change according to a particular periodic group.

2.1.1 Do the lengths decrease or increase? (1)

2.1.2 Explain the reason for the answer to QUESTION 2.1.1. (2)

2.1.3 Which of cations Li^+ and Be^{2+} has a shorter radius? (1)

2.2 Consider the molecule BF_3 :

2.2.1 Name this molecule. (1)

2.2.2 Explain the *Sidgwick and Powell theory*. (3)

2.2.3 How many pairs of electrons does the BF_3 molecule contain? (1)

2.2.4 What is the shape of the BF_3 molecule? (1)

2.2.5 Write down the bond angle in BF_3. (1)

2.2.6 Draw the structure of the BF_3 molecule. (3)

2.3 Name the geometric shape of each of the following:

2.3.1 CO_2

2.3.2 H_2O

2.3.3 PF_5

2.3.4 SF_6

2.3.5 IF_7

(5 × 1) (5)

2.4 Explain the concept of *resonance* by using the structural formula for a bicarbonate ion and indicate the limiting structure. (4)

2.5 What is the effect of resonance in a compound? (2)

[25]

QUESTION 3: ACIDS AND BASES

3.1 Define the following:

3.1.1 Arrhenius base

3.1.2 Bronsted-Lowry acid

3.1.3 Lewis base

(3 × 1) (3)

3.2 Consider the interaction of ethanoic acid and water where it is known that an equilibrium is set up:

$CH_3COOH\ (aq) + H_2O\ (l) \rightarrow$

3.2.1 Complete the reaction.

3.2.2 Write down the conjugate acid-base pair for the equation.

(2 × 2) (4)

3.3 Consider the acids H_2SO_3 and H_2SO_4.

3.3.1 Which of the two acids is stronger?

3.3.2 Provide a reason for the difference in the strengths of the two acids.

3.3.3 Provide the general class name of the inorganic acids that contain an oxygen atom.

(3 × 1) (3)

[10]

QUESTION 4: HYDROGEN

4.1 Some stars are composed almost entirely of hydrogen, and the extremely high temperatures that are commonplace in stars enable nuclear fusion of hydrogen to form helium.

4.1.1 Write down the balanced fusion reaction. (2)

4.1.2 Write down the balanced reaction between magnesium and steam. (2)

4.2 Name the type of hydride formed in each of the following compounds:

4.2.1 NaH

4.2.2 NH_3

4.2.3 $ZrH_{1.92}$

(3 × 1) (3)

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4.3 Name the radioactive isotope of hydrogen. (1)

4.4 Give TWO uses of hydrogen. (2)
[10]

QUESTION 5: CARBON

5.1 Consider the reaction: $C_{(diam)} \rightarrow C_{(g)}$; $\Delta H = +171,4$ kcal/mol C atoms

5.1.1 Name the TWO crystalline forms of carbon. (2)

5.1.2 Write down TWO uses of graphite. (2)

5.2 Complete and balance the reaction:
$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow$ (2)

5.3 Define *interstitial carbides* and give ONE example. (3)

5.4 Give ONE use of a synthesis gas. (1)
[10]

QUESTION 6: NITROGEN

6.1 Complete and balance the following reaction:
$NH_3\ (g) + CuO(s) \rightarrow$ (3)

6.2 Name the process involved in the industrial preparation of ammonia. (1)

6.3 The Kb value for the dissociation of ammonia in water is $1,81 \times 10^{-5}$ mol/dm^3 (at 298K).

Explain what this low value informs about an aqueous solution of ammonia. (1)

6.4 Name the oxide of nitrogen which only exists in the pure condition as a pale blue solid at low temperatures of which the liquid is also blue. (1)

6.5 Give TWO uses of nitric acid. (2)

6.6 Define *aqua regia* and state what it is used for. (2)
[10]

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QUESTION 7: OXYGEN

7.1 Discuss the industrial preparation of oxygen. (2)

7.2 Nitrogen oxide emissions from exhaust systems of supersonic aircrafts operating in the stratosphere might slowly deplete the concentration of the ozone layer.

Write down a balanced chemical equation between nitrogen oxide and ozone. (2)

7.3 Give ONE example each of a *suboxide* and a *mixed oxide*. (2)

7.4 Explain permanent hardness in water. (2)

7.5 Complete and balance the reaction :

Ba^{2+} $(O\text{-}O)^{2-}$(s) + $(H^{+})_2SO4^{2-}$ (aq) → (2)

[10]

TOTAL: 100

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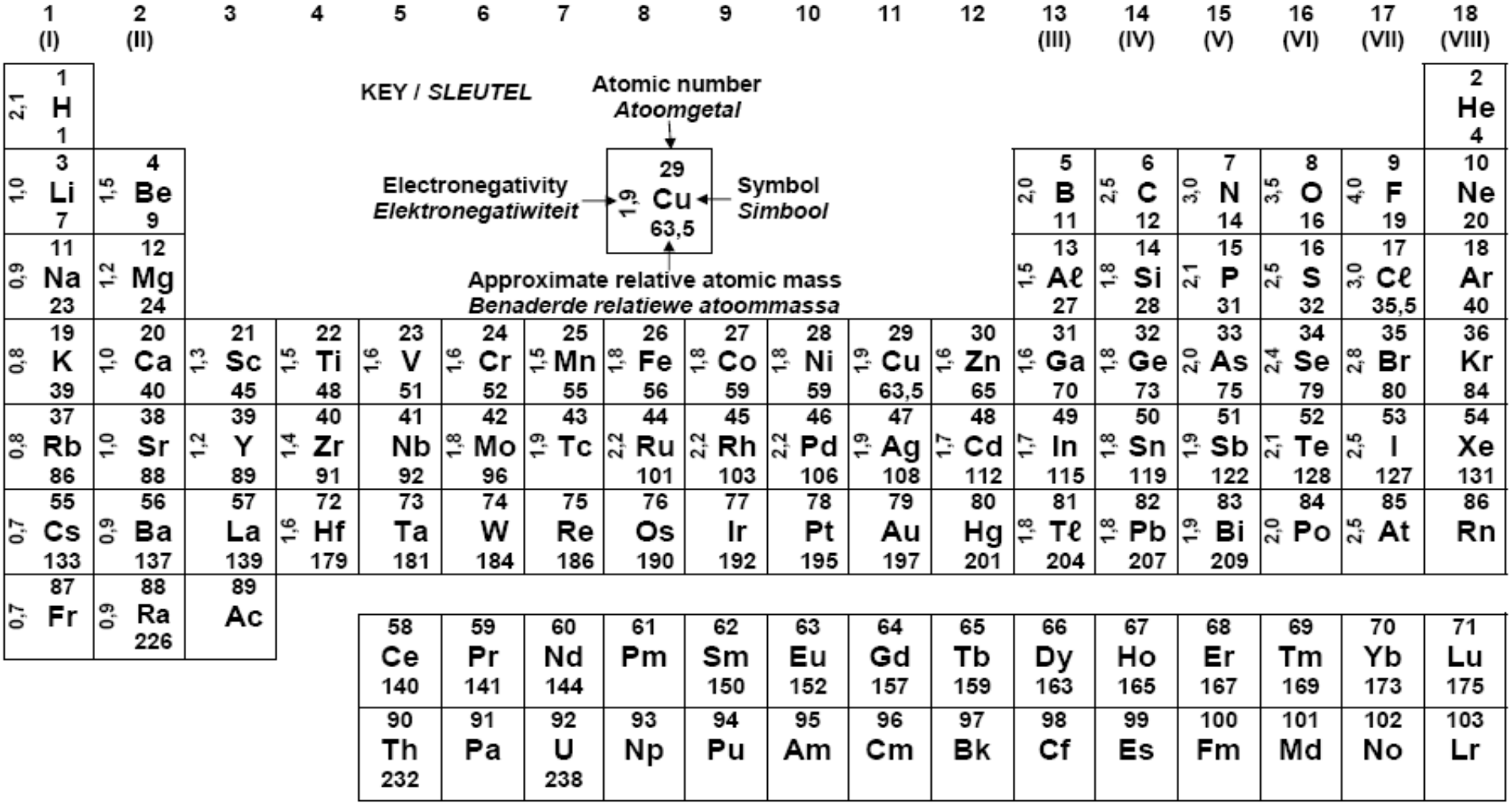
(15040004)

THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE



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