higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

CHEMISTRY N4

(15040004)

19 November 2024 (X-paper)
09:00–12:00

Drawing instruments may be used.

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

014Q1E2419

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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 question on a new page.
5. Use only a black or blue pen.
6. 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.

1.1.1 The unreactive nature of noble gases is due to their particular electronic configurations. They all have an outer shell containing eight electrons except for helium.

1.1.2 Kossel visualized the hypothetical reaction between the atoms of sodium and chlorine as a sharing of electrons.

1.1.3 An example of an electrovalent compound formation is:
Li (2,1) + F (2,7) → Li^+ (2) + F^- (2,8).

1.1.4 X-ray examination of sodium chloride shows that each sodium ion is surrounded by six equidistant chloride ions and each chloride ion is surrounded by six equidistant sodium ions.

1.1.5 Covalent compounds exist as hard crystals of high melting points, with ions of opposite charge arranged in a symmetrical array.

(5 × 1) (5)

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

COLUMN A		COLUMN B	
1.2.1	Chemical bonding	A	Atoms visualised altering their positions as though they slip over each other
1.2.2	Covalent compounds	B	A boiling point higher than would otherwise be
1.2.3	Electrical dipole	C	Deviation of actual gases from ideal behaviour
1.2.4	Malleability and ductility	D	Weak force of attraction between individual molecules
1.2.5	Van der Waal's forces	E	Reaction of elements to attain the stable electronic configuration of a noble gas

(5 × 1) (5)

1.3 Electrovalent bonding occurs between metals of group 1A and 2A of the Periodic Table and non-metals of group 6B and 7B.

1.3.1 Explain why the electrovalent bonding in QUESTION 1.3 occurs. (2)

1.3.2 Use calcium and oxygen to illustrate the bonding stated in QUESTION 1.3, clearly indicating the ions formed. (3)

1.4 Chemical bonding can take place between atoms with similar or different electronegativities.

1.4.1 Define *electronegativity*. (2)

1.4.2 How does electronegativity change down a group in the periodic table? Explain. (2)

1.4.3 Name the type of bond formed when atoms with similar electronegativities bond. (1)

1.5 Explain *hydrogen bond*. (4)

[24]

QUESTION 2: CHEMICAL GEOMETRY

2.1 Radii of atomic ions vary in the periodic table. Compare the radii of the Na^{+} and the Mg^{2+} and explain the difference in length. (2)

2.2 Draw the shapes of the following molecules and indicate the number of valency electrons in each.

2.2.1 Chlorine trifluoride (3)

2.2.2 Boron trifluoride (3)

2.3 Diamond, an allotrope of carbon, is used in a number of applications.

2.3.1 Define *allotrope*. (2)

2.3.2 Name the other allotropic form of carbon. (1)

2.3.3 Discuss the structure of diamond. (3)

2.4 Draw the nitrate anion resonance structures, and the resonance hybrid structure. (4)

[18]

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QUESTION 3: ACIDS AND BASES

3.1 Define acids according to the following theories:

3.1.1 Arrhenius theory

3.1.2 Bronsted-Lowry theory

(2 × 2) (4)

3.2 Consider the reaction:
$HCl + CH_3COOH \leftrightarrow Cl^- + CH_3COOH_2^+$

3.2.1 Indicate the conjugate acid-base pairs in the reaction in QUESTION 3.2.

3.2.2 Write down the dissociation constant (K_a) for the reaction in QUESTION 3.2.

3.2.3 Discuss the position of the equilibrium for the hydrogen chloride-ethanoic acid reaction.

(3 × 2) (6)

3.3 Identify the Lewis base in the reaction between BF_3 and NH_3 and motivate the selection. (2)

[12]

QUESTION 4: HYDROGEN

4.1 State how hydrogen has reacted in the formation of each of the following compounds:

4.1.1 NH_4^+

4.1.2 $Ca(H)_2$

4.1.3 CH_4

(3 × 1) (3)

4.2 State two physical properties of hydrogen. (2)

4.3 Write down a balanced reaction to indicate how hydrogen is prepared through the action of dilute hydrochloric acid on zinc metal. (3)

4.4 Give one example of a compound for each of the following definitions:

4.4.1 Interstitial hydride

4.4.2 Covalent hydride

4.4.3 Ionic hydride

(3 × 1) (3)

[11]

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QUESTION 5: CARBON

5.1 Name three impure forms of carbon. (3)

5.2 Complete and balance the following reactions:

5.2.1 $H_2C=CH_2 + H_2 \rightarrow$ (1)

5.2.2 $C + 4HNO_3 \rightarrow$ (3)

5.3 Name the classification of the carbide represented by each of the following compounds, in terms of bonding:

5.3.1 $Ca^{2+}(C\equiv C)^{2-}$

5.3.2 Ni_3C

5.3.3 B_4C

(3 × 1) (3)

[10]

QUESTION 6: NITROGEN

6.1 Give one use of ammonia. (1)

6.2 Ammonia is readily soluble in water and the solution turns red litmus blue.

6.2.1 Complete the reaction: $NH_3(g) + H_2O(l) \leftrightarrow$ (2)

6.2.2 Write down the dissociation constant (K_b) for the reaction. (3)

6.2.3 Is the aqueous solution of ammonia a strong or weak alkali? Explain. (2)

6.3 Write down a balanced reaction for the oxidation of ammonia by copper (II) oxide. (4)

[12]

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QUESTION 7: OXYGEN

7.1 Ozone, an allotrope of oxygen is formed from atmospheric oxygen by the energy of sunlight.

7.1.1 State how ozone can be prepared in a laboratory.

7.1.2 State one function of the ozone layer.

(2 × 2) (4)

7.2 Choose a compound from COLUMN B that matches the description in COLUMN A. Write only the answer (A–G) next to the question number (7.2.1–7.2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
7.2.1	Normal oxide	A	H_2O
7.2.2	Peroxide	B	SiO_2
7.2.3	Mixed oxide	C	CaO
7.2.4	Amphoteric oxide	D	N_2O
7.2.5	Acidic oxide	E	MgO
		F	Pb_3O_4
		G	BaO_2

(5 × 1) (5)

7.3 Differentiate between temporary hardness and permanent hardness in water. (4)

[13]

TOTAL: 100

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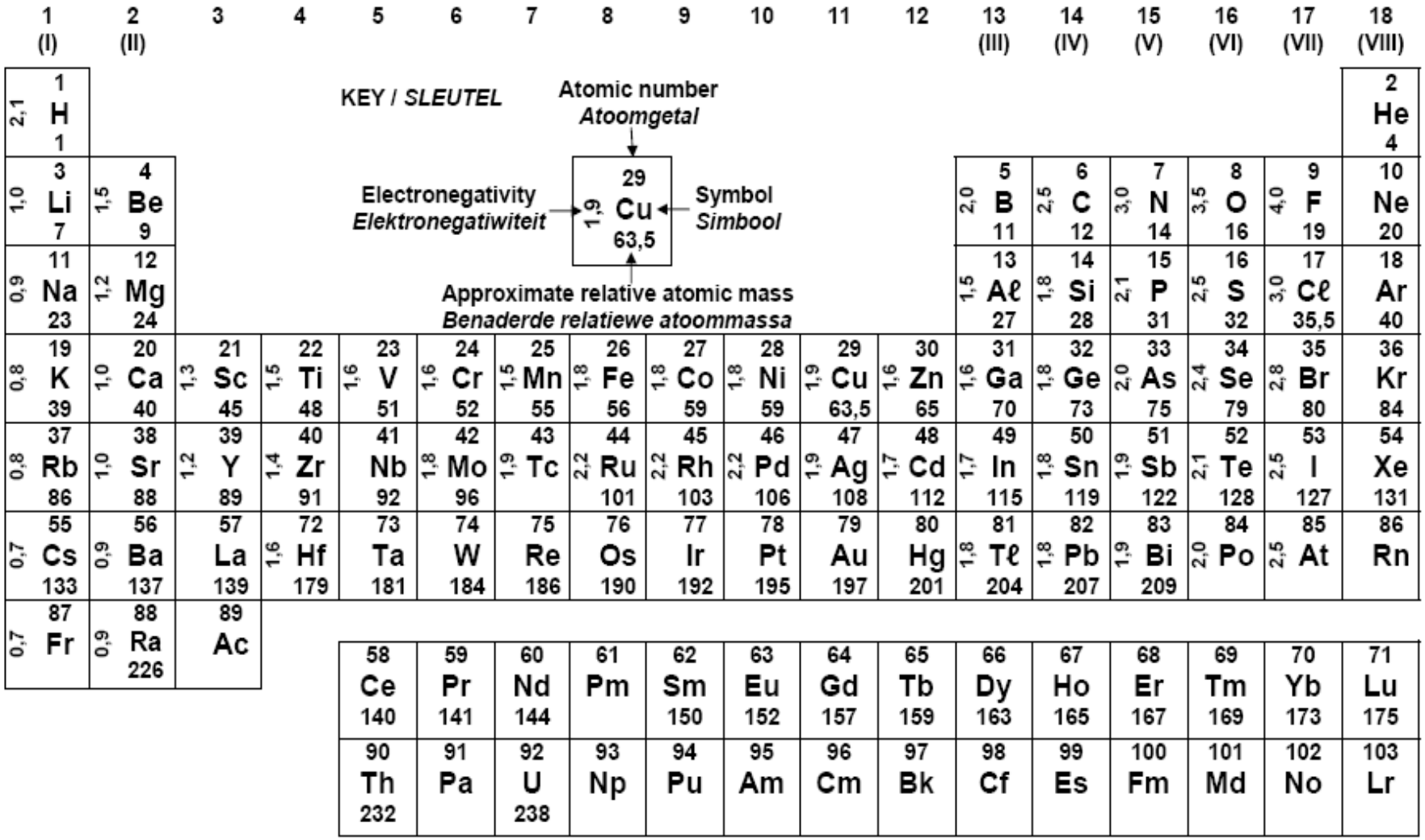
THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE



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