



# higher education & training

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Department:  
Higher Education and Training  
**REPUBLIC OF SOUTH AFRICA**

## **MARKING GUIDELINE**

**NATIONAL CERTIFICATE**

**CHEMISTRY N4**

**19 November 2024**

**This marking guideline consists of 6 pages.**

### QUESTION 1: CHEMICAL BONDING

- |     |       |                                                                                                                                                                                                                                                                       |         |     |
|-----|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----|
| 1.1 | 1.1.1 | True                                                                                                                                                                                                                                                                  |         |     |
|     | 1.1.2 | False                                                                                                                                                                                                                                                                 |         |     |
|     | 1.1.3 | True                                                                                                                                                                                                                                                                  |         |     |
|     | 1.1.4 | True                                                                                                                                                                                                                                                                  |         |     |
|     | 1.1.5 | False                                                                                                                                                                                                                                                                 |         |     |
|     |       |                                                                                                                                                                                                                                                                       | (5 × 1) | (5) |
|     |       |                                                                                                                                                                                                                                                                       |         |     |
| 1.2 | 1.2.1 | E                                                                                                                                                                                                                                                                     |         |     |
|     | 1.2.2 | D                                                                                                                                                                                                                                                                     |         |     |
|     | 1.2.3 | B                                                                                                                                                                                                                                                                     |         |     |
|     | 1.2.4 | A                                                                                                                                                                                                                                                                     |         |     |
|     | 1.2.5 | C                                                                                                                                                                                                                                                                     |         |     |
|     |       |                                                                                                                                                                                                                                                                       | (5 × 1) | (5) |
|     |       |                                                                                                                                                                                                                                                                       |         |     |
| 1.3 | 1.3.1 | <ul style="list-style-type: none"> <li>• Large difference in electronegativity of groups 1A; 2A and 6B;7B.</li> <li>• Transfer of electrons takes place leading to formation of stable ions with electronic configuration similar to that of an inert gas.</li> </ul> |         | (2) |
|     |       |                                                                                                                                                                                                                                                                       |         |     |
|     | 1.3.2 | $\text{Ca}(2.8.8.2) \sqrt{+} \text{O}(2.6) \sqrt{\rightarrow} \text{Ca}^{2+} (2.8.8) \checkmark + \text{O}^{2-} (2.8) \checkmark$<br>OR<br>$\text{Ca}\sqrt{+} + \frac{1}{2} \text{O}_2\sqrt{\rightarrow} \text{Ca}^{2+}\checkmark \text{O}^{2-}\checkmark$            |         | (3) |
|     |       |                                                                                                                                                                                                                                                                       |         |     |
| 1.4 | 1.4.1 | Electronegativity is a measure of the power of an atom✓ to attract electrons.✓<br>OR<br>Arithmetic mean✓ of the first ionization energy and the electron affinity of an atom.✓                                                                                        |         | (2) |
|     |       |                                                                                                                                                                                                                                                                       |         |     |
|     | 1.4.2 | Electronegativity decreases down a particular group.✓<br>This is because the atom becomes larger and the inner electron shells decrease the attraction between the positive nucleus and peripheral electrons. ✓                                                       |         | (2) |
|     |       |                                                                                                                                                                                                                                                                       |         |     |
|     | 1.4.3 | Covalent bond                                                                                                                                                                                                                                                         |         | (1) |

- 1.5 A hydrogen bond is an electrostatic force of attraction between a hydrogen atom which is covalently bound to a more electronegative atom.

Hydrogen bonding generally only occurs between hydrogen and electronegative elements, fluorine, oxygen and nitrogen.

The electronegative atoms of these elements strongly attract the electron pair constituting the bond with the hydrogen, and consequently the hydrogen atom carries a net positive charge.

The hydrogen atom attracts the negative end of the other molecule.

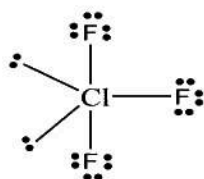
(4)  
[24]

## QUESTION 2: CHEMICAL GEOMETRY

- 2.1 The radius of  $\text{Na}^+$  is larger than that of  $\text{Mg}^{2+}$ . The two cations have the same number of electrons. The radii of isoelectronic positive ions decrease with increasing charge.

(2)

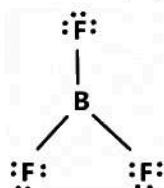
- 2.2 2.2.1



The trigonal bipyramidal shape.  
Chlorine trifluoride has ten valency electrons.

(3)

- 2.2.2



The trigonal planar shape.  
Boron trifluoride has six valency electrons.

(3)

- 2.3 2.3.1 An allotrope means each of the two or more different physical forms in which an element can exist.

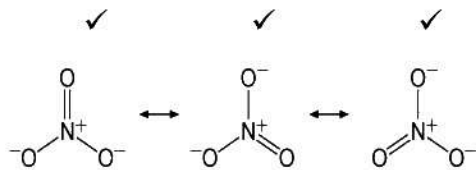
(2)

- 2.3.2 Graphite

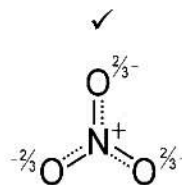
(1)

- 2.3.3 Diamond contains a three-dimensional array of carbon atoms with the valency bonds directed towards the apices of a regular tetrahedron. The bonding is strong and extended in three dimensions.

2.4



Three resonance structures



Hybrid resonance structure

(4)  
[18]

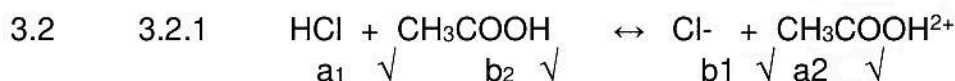
### QUESTION 3: ACIDS AND BASES

3.1      3.1.1      According to the Arrhenius theory, an acid is a substance which contains hydrogen, ✓ and gives hydrogen ions in an aqueous solution. ✓

3.1.2      The Bronsted-Lowry theory defines an acid as a substance existing as a molecule or an ion, ✓ that can donate protons. ✓

(2 × 2)

(4)



3.2.2       $K_a = \frac{[\text{CH}_3\text{COOH}_2^+][\text{Cl}^-]}{[\text{HCl}][\text{CH}_3\text{COOH}]}$       ✓✓

3.2.3      Hydrogen chloride is not such a strong acid in pure ethanoic acid, ✓ because ethanoic acid is not such a good proton acceptor as water. ✓ The  $K_a$  value will be small indicating that the equilibrium does not go much to the right. ✓

(3 × 2)

(6)

3.3       $\text{NH}_3$  is the Lewis base in the reaction. ✓ It provides a pair of electrons for sharing in bond formation. ✓

(2)  
[12]

### QUESTION 4: HYDROGEN

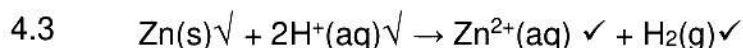
- 4.1      4.1.1      Accept a lone pair of electrons.  
4.1.2      Gain an additional electron.  
4.1.3      Sharing of electrons.

(3 × 1)

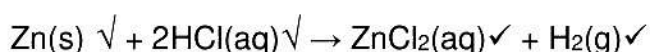
(3)

- 4.2      • Odourless gas without taste or smell.  
• Can be liquefied under compression and cooling.

(2)



OR



|     |       |                                                                                       |                        |             |
|-----|-------|---------------------------------------------------------------------------------------|------------------------|-------------|
| 4.4 | 4.4.1 | TiH <sub>1.73</sub> ✓<br>ZrH <sub>1.92</sub> ✓                                        | (Any 1 × 1)            |             |
|     | 4.4.2 | CH <sub>4</sub> ✓<br>NH <sub>3</sub> ✓<br>H <sub>2</sub> S✓<br>HCl✓                   | (Any 1 × 1)            |             |
|     | 4.4.3 | Na <sup>+</sup> H <sup>-</sup> ✓<br>Ca <sup>2+</sup> (H <sup>-</sup> ) <sub>2</sub> ✓ | (Any 1 × 1)<br>(3 × 1) | (3)<br>[11] |

### QUESTION 5: CARBON

|     |       |                                                                                                                         |             |             |
|-----|-------|-------------------------------------------------------------------------------------------------------------------------|-------------|-------------|
| 5.1 |       | <ul style="list-style-type: none"> <li>Charcoal</li> <li>Coke</li> <li>Animal charcoal</li> <li>Carbon black</li> </ul> | (Any 3 × 1) | (3)         |
| 5.2 | 5.2.1 | H <sub>2</sub> C=CH <sub>2</sub> + H <sub>2</sub> → H <sub>3</sub> C-CH <sub>3</sub> ✓                                  |             | (1)         |
|     | 5.2.2 | C + 4HNO <sub>3</sub> → 2H <sub>2</sub> O(l)✓ + 4NO <sub>2</sub> (g)✓ + CO <sub>2</sub> (g)✓                            |             | (3)         |
| 5.3 | 5.3.1 | Ionic carbide                                                                                                           |             |             |
|     | 5.3.2 | Interstitial carbide                                                                                                    |             |             |
|     | 5.3.3 | Covalent carbide                                                                                                        | (3 × 1)     | (3)<br>[10] |

### QUESTION 6: NITROGEN

|     |       |                                                                                                                                                                                                      |             |             |
|-----|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|
| 6.1 |       | <ul style="list-style-type: none"> <li>Used in agriculture as a fertilizer.</li> <li>Used in the manufacture of plastics, explosives and other chemicals.</li> <li>Used as a refrigerant.</li> </ul> | (Any 1 × 1) | (1)         |
| 6.2 | 6.2.1 | NH <sub>3</sub> (g) + H <sub>2</sub> O(l) ↔ NH <sub>4</sub> <sup>+</sup> (aq) ✓ + OH <sup>-</sup> (aq)✓                                                                                              |             | (2)         |
|     | 6.2.2 | $K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} \checkmark \checkmark$                                                                                                                     |             | (3)         |
|     | 6.2.3 | The aqueous solution of ammonia indicates ammonia as a weak alkali. ✓ This is indicated by the low value of the dissociation constant (K <sub>b</sub> ) ✓                                            |             | (2)         |
| 6.3 |       | 2NH <sub>3</sub> (g)✓ + 3CuO(s)✓ → N <sub>2</sub> (g)✓ + 3 H <sub>2</sub> O(l)✓ + 3Cu(s)✓                                                                                                            |             | (4)<br>[12] |

### QUESTION 7: OXYGEN

|     |                                                                                                   |                                                                                                                              |         |      |
|-----|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|---------|------|
| 7.1 | 7.1.1                                                                                             | A slow dry stream of oxygen✓ is passed through a silent electric discharge✓ and up to 10 percent conversion to ozone occurs. |         |      |
|     | 7.1.2                                                                                             | The ozone layer protects the earth's surface✓ from an excessive concentration of ultraviolet radiation.✓                     | (2 × 2) | (4)  |
| 7.2 | 7.2.1                                                                                             | E                                                                                                                            |         |      |
|     | 7.2.2                                                                                             | G                                                                                                                            |         |      |
|     | 7.2.3                                                                                             | F                                                                                                                            |         |      |
|     | 7.2.4                                                                                             | A                                                                                                                            |         |      |
|     | 7.2.5                                                                                             | B                                                                                                                            | (5 × 1) | (5)  |
| 7.3 | Temporary hardness in water exists when the water contains carbonates✓ of calcium and magnesium.✓ |                                                                                                                              |         |      |
|     | Permanent hardness in water exists when the water contains sulphates✓ of calcium and magnesium.✓  |                                                                                                                              |         | (4)  |
|     |                                                                                                   |                                                                                                                              |         | [13] |
|     |                                                                                                   |                                                                                                                              | TOTAL:  | 100  |