



higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CHEMISTRY N4

25 March 2025

This marking guideline consists of 6 pages.

QUESTION 1: CHEMICAL BONDING

- 1.1 1.1.1 True
- 1.1.2 True
- 1.1.3 False. The forces are weak and the substances are soft if they are solid.
- 1.1.4 True
- 1.1.5 False. The high thermal and electrical conductivities of metals. (5 × 1) (5)
- 1.2 • The fluorine atom is more electronegative than the chlorine atom.✓
 • The fluoride ion is smaller than the chloride ion✓ and the lattice energy of $\text{Al}^{3+}(\text{F}^-)_3$ ✓ would be greater than that of $\text{Al}^{3+}(\text{Cl}^-)_3$.✓ (4)
- 1.3 1.3.1 Main group elements tend to bond in such a way that each atom has eight electrons in its valence shell,✓ giving the same electronic configuration as that of a noble gas.✓ (2)
- 1.3.2 Phosphorus violates✓ the octet rule because it has ten electrons around it,✓ while F has eight. (2)
- 1.4 1.4.1 Hydrogen bonds
 1.4.2 Molecular bonds or Van der Waals bonds (2 × 1) (2)
- 1.5 • The 3d levels are not accessible for elements with a principal quantum number of $n=2$.✓
 • Oxygen, with a principal quantum number of $n=2$, cannot use 3d orbitals in bonding.✓
 • Sulphur, with a principal quantum number of $n=3$, can access✓ and use 3d orbitals to form valencies of 4 and 6.✓ (4)
- 1.6 The high thermal and electrical conductivities of copper are due to the presence of free electrons✓ that can move through the metal structure.✓ Electrons are small compared to the gaps between positive ions.✓ (3)

[22]

QUESTION 2: CHEMICAL GEOMETRY

2.1 The lithium cation (Li^+) has a larger radius than the beryllium cation (Be^{2+}).
 Li^+ and Be^{2+} are isoelectronic positive ions i.e. have the same number of electrons. The radii decrease with an increasing nuclear charge. (3)

2.2 2.2.1 The arrangement in space of covalent bonds in multi covalent atoms are simply related to the number of electrons in their valency shells. (3)

2.2.2 The ammonium ion



Eight valency electrons

✓✓✓

(3)

2.3 2.3.1 The bonding between the atoms is strong and extended in three dimensions.

- 2.3.2
- Diamond is used as jewels
 - Used in oil-well drills
 - Used in cutting tools
 - Used in glass cutters
 - Used in watch bearings
 - Used in dies and abrasives

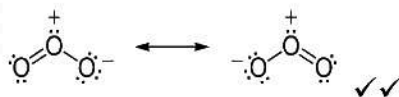
(Any 1 × 1)

(2 × 1)

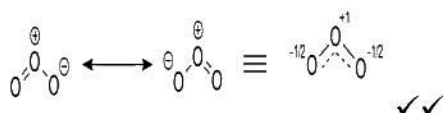
(2)

2.4 2.4.1 The two oxygen-oxygen bond lengths in the ozone molecule are identical. The molecule is best represented as a resonance hybrid or in terms of delocalised electrons.

2.4.2



OR



(2 × 2)

(4)

[15]

QUESTION 3: ACIDS AND BASIS

- 3.1 3.1.1 $\text{HCl(aq)} \checkmark + \text{H}_2\text{O(l)} \checkmark \rightarrow \text{Cl}^-(\text{aq}) \checkmark + \text{H}_3\text{O}^+(\text{aq}) \checkmark$ (2)
- 3.1.2 HCl contains hydrogen $\checkmark$ and gives hydrogen in aqueous solutions. $\checkmark$ (1)
- 3.1.3 $K_a = \frac{[\text{Cl}^-][\text{H}_3\text{O}^+]}{[\text{HCl}]} \checkmark \checkmark$ (2)
- 3.1.4 The K_a value will be big. $\checkmark$ HCl is a strong acid $\checkmark$. (2)
- 3.1.5 $\text{HCl(aq)} \checkmark + \text{H}_2\text{O(l)} \checkmark \leftrightarrow \text{Cl}^-(\text{aq}) \checkmark + \text{H}_3\text{O}^+(\text{aq}) \checkmark$
 Acid 1 Base 2 Base 1 Acid 2
- The Bronsted-Lowry theory defines an acid as a substance existing as a molecule or ion that can donate protons. (2)
- 3.2 3.2.1 $\text{H}_2\text{O(l)} + \text{CO}_3^{2-}(\text{aq}) \leftrightarrow \text{OH}^-(\text{aq}) \checkmark + \text{HCO}_3^-(\text{aq}) \checkmark$
 Acid 1 Base 2 Base 1 Acid 2
- 3.2.2 $\text{H}_2\text{O(l)} + \text{H}_2\text{O(l)} \leftrightarrow \text{OH}^-(\text{aq}) \checkmark + \text{H}_3\text{O}^+(\text{aq}) \checkmark$
 Acid 1 Base 2 Base 1 Acid 2 (2 × 1) (2)
- 3.3 3.3.1 SO_3 is a Lewis acid. $\checkmark$ It accepts a pair of electrons by combining with O^{2-} to form SO_4^{2-} . $\checkmark$
- 3.3.2 SO_3 does not donate $\checkmark$ protons. $\checkmark$ (2 × 2) (4)

[15]

QUESTION 4: HYDROGEN

- 4.1 4.1.1 $\text{Na(s)} + \text{H}_2\text{O(l)} \rightarrow \text{NaOH(aq)} \checkmark + \text{H}_2(\text{g}) \checkmark$ (2)
- 4.1.2 $\text{CO(g)} + \text{H}_2(\text{g}) + \text{H}_2\text{O(g)} \leftrightarrow \text{CO}_2(\text{g}) \checkmark + 2\text{H}_2(\text{g}) \checkmark \checkmark$ (3)
- 4.2
- Protium(H), $\checkmark$ relative atomic mass is 1 $\checkmark$
 - Deuterium (D), $\checkmark$ relative atomic mass is 2 $\checkmark$
 - Tritium (T), $\checkmark$ relative atomic mass is 3 $\checkmark$

OR



hydrogen-1
(protium)

$\checkmark \checkmark$



hydrogen-2
(deuterium)

$\checkmark \checkmark$



hydrogen-3
(tritium)

$\checkmark \checkmark$

(Any 2 × 1)

4.3	4.3.1	Deuterium		
	4.3.2	Tritium		
	4.3.3	Protium		(3 × 1)
4.4	The Haber process			(1)
[11]				

QUESTION 5: CARBON

5.1	5.1.1	Acheson process		(1)
	5.1.2	$\text{SiO}_2(\text{s}) + \text{C}(\text{s})_{\text{coke}} \rightarrow \text{SiC}(\text{s})\checkmark + 2\text{CO}(\text{g})\checkmark$ $\text{SiC}(\text{s}) \rightarrow \text{Si}(\text{s})\checkmark + \text{C}(\text{s})_{\text{graphite}}\checkmark$		(4)
	5.1.3	- Used as a lubricant. - Mixed with clay and used in lead pencils. - Used as an anode material in electrolytic processes. - Used as crucibles.	(Any 2 × 1)	(2)
5.2	5.2.1	Animal charcoal is obtained by charring bones✓ and consists of finely divided carbon supported on calcium phosphate.		
	5.2.2	Carbon black is obtained by burning hydrocarbons e.g. methane in a deficiency of oxygen.✓	(2 × 1)	(2)
5.3	5.3.1	$\text{CS}_2(\text{l}) + 3\text{Cl}_2(\text{g}) \rightarrow \text{S}_2\text{Cl}_2(\text{l})\checkmark + \text{CCl}_4(\text{l})\checkmark$		(2)
	5.3.2	Carbon tetrachloride or tetrachloromethane✓		(1)
	5.3.3	Used as a solvent. Used as a fire extinguisher.		(2)
				[14]

QUESTION 6: NITROGEN

- 6.1 6.1.1 $2\text{NH}_3(\text{g}) + 3\text{CuO}(\text{s}) \rightarrow \text{N}_2(\text{g}) \checkmark + 3\text{H}_2\text{O}(\text{l}) \checkmark + 3\text{Cu}(\text{s}) \checkmark$
Allocate ONE mark if the equation is balanced.✓ (4)
- 6.1.2
- Used to prepare ammonia using the Haber process✓
 - Used to absorb oxygen sparks in the industry:✓ $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$
 - Used as a carrier gas in gas chromatography.✓ (Any 1 × 1) (1)
- 6.1.3
- Preparation of nitric acid, urea and nitrogenous fertilisers.
 - Liquid ammonia is used as a refrigerant. (2)
- 6.2 6.2.1 $\text{NH}_4\text{NO}_3(\text{s}) + \text{heat} \rightarrow \text{N}_2\text{O}(\text{g}) \checkmark + 2\text{H}_2\text{O}(\text{l}) \checkmark$ (2)
- 6.2.2 Dinitrogen oxide✓ (1)
- 6.3 $\text{NaNO}_3(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{NaHSO}_4(\text{aq}) \checkmark + \text{HNO}_3(\text{l}) \checkmark$ (2)
- [12]**

QUESTION 7: OXYGEN

- 7.1 7.1.1
- Carbon dioxide and water vapour is removed first.
 - Remaining gases are liquefied.
 - Fractional distillation is carried out to separate nitrogen and oxygen. (3)
- 7.1.2
- Assists in normal respirations and combustion processes.
 - Used in the oxy-acetylene welding and cutting of metals.
 - Used in hospitals.
 - Used in high altitude flying. (Any 2 × 1) (2)
- 7.2 7.2.1
- By boiling
 - By adding slaked lime (Any 1 × 1) (1)
- 7.2.2
- Magnesium sulphate
 - Calcium sulphate (2)
- 7.3
- Distillation
 - Use of ion exchange resins (2)
- 7.4
- As a bleaching agent
 - Preparation of organic peroxides
 - Preparation of antiseptics
 - Liquid peroxide in conjunction with liquid hydrazine used for rocket propulsion (Any 1 × 1) (1)
- [11]**

TOTAL: 100