education

MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE EXAMINATION

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2017

MEMORANDUM

MARKS/PUNTE: 150

This memorandum consists of 14 pages

Hierdie memorandum bestaan uit 14 bladsye

GENERAL GUIDELINES

1   **CALCULATIONS**

1.1   **Marks will be awarded for:** correct formula, correct substitution, and correct answer with unit.

1.2   **NO marks** will be awarded if an **Incorrect or inappropriate formula is used**, even though there may be relevant symbols and applicable substitutions.

1.3   When an error is made during **substitution into a correct formula**, a mark will be awarded for the correct formula and for the correct substitutions, but **no further marks** will be given.

1.4   If **no formula** is given, but **all substitutions are correct**, a candidate will **forfeit one mark.**

Example:

No K_c expression, correct substitution

$K_C = \dfrac{(2)^2}{(2)(1)^3}$ ✓ $= 2$ ✓ $\left(\dfrac{2}{3}\right)$

1.5   Marks are only awarded for a formula if a **calculation has been attempted** i.e. substitution have been made or a numerical answer given.

1.6   Marks can only be allocated for substitutions when values are substituted into formulae and not when listed before a calculation starts.

1.7   All calculations, when not specified in the question, must be done to two decimal places.

1.8   If a final answer to a calculation is correct, full marks will not automatically be awarded. Marks will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.

2   **UNITS**

2.1   Candidates will only be penalised once for the repeated use of an incorrect unit **within a question**.

2.2   Units are only required in the final answer to a calculation.

2.3   Marks are only awarded for an answer and not for a unit *per se.* Candidates will therefore forfeit the mark allocated for the answer in each of the following situations:

   • Correct answer + wrong unit
   • Wrong answer + correct unit
   • Correct answer + no unit

2.4   Separate compound units with a multiplication dot, not a full stop, for example, $mol^.dm^{-3}$. Accept $mol.dm^{-3}$ (mol/dm^3) for marking purpose.

3   If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct. If two answers are required, only the first two will be marked, etc.

3.1   When a chemical **FORMULA** is asked, and the **NAME** is given as answer the candidate forfeits the marks. The same rule applies when the **NAME** is asked and the **FORMULA** is given.

3.2   When redox half- reactions are to be written, the correct arrow should be used.

   If the equation

   $H_2S \rightarrow S + H^+ + 2e^-$ $(^2/_2)$

   Is the correct answer, the marks must be given as follows:

   $H_2S \rightleftharpoons S + H^+ + 2e^-$ $(^1/_2)$

   $H_2S \leftarrow S + 2H^+ + 2e^-$ $(^0/_2)$

   $S + 2H^+ + 2e^- \leftarrow H_2S$ $(^2/_2)$

   $S + 2H^+ + 2e^- \rightleftharpoons H_2S$ $(^0/_2)$

3.4   One mark is forfeited when the charge of an ion is omitted per equation. (not for the charge on an electron)

3.6   The error carrying principle does not apply to chemical equations or half reactions. For example, if a learner writes the wrong oxidation/reduction half-reaction in the sub-question and carries the answer over to another sub-question (balancing of equations or calculation of E^o_{cell}) then the learner must not be credited for this substitution.

3.7   In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks must be deducted if hydrogen atoms are omitted.

When a structural formula is asked, marks must be deducted if the learner writes the condensed formula.

3.8   When an IUPAC name is asked and candidate omits the hyphen (e.g. instead of pent-1-ene or 1-pentene the candidate writes pent 1 ene or 1 pentene), marks must be forfeited.

3.9   When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing.

  If only a reactant(s) followed by an arrow, or only a product(s) preceded by an arrow, is/are written, marks may be awarded for the reactant(s) or products(s). if only a reactant(s) or only a product(s) are written, without an arrow, no marks are awarded for the reactants(s) or product(s).

Examples: $N_2 + 3H_2$ ✓ $\rightarrow 2NH_3$ ✓bal. ✓

$N_2 + H_2 \rightarrow$ ✓	$^1/_3$
$\rightarrow NH_3$ ✓	$^1/_3$
$N_2 + H_2$	$^0/_3$
NH_3	$^0/_3$

4   POSITIVE MARKING

4.1   Sub-question to sub-question:

When a certain variable is calculated in one sub-question (e.g. 3.1) and needs to be substituted in another (3.2 or 3.3), e.g. if the answer for 3.1 is incorrect and is substituted correctly in 3.2 or 3.3 **full marks** are to be awarded for the subsequent sub-question.

4.2   **A multi-step question:** if the candidate has to calculate, for example, current in the first and gets it wrong due to a substitution error, the mark for the substitution and the final answer will be forfeited.

5   NEGATIVE MARKING

  Normally an incorrect answer cannot be correctly motivated if on a conceptual mistake. If the candidate is therefore required to motivate in QUESTION 3.2 the answer given to QUESTION 3.2. However, if the answer for e.g. 3.1 is based on a calculation, the motivation for the incorrect answer in 3.2 could be considered.

QUESTION 1 / *VRAAG 1*

1.1   D ✓✓   (2)

1.2   A ✓✓   (2)

1.3   C ✓✓   (2)

1.4   D ✓✓   (2)

1.5   C ✓✓   (2)

1.6   B ✓✓   (2)

1.7   B ✓✓   (2)

1.8   A ✓✓   (2)

1.9   B ✓✓   (2)

1.10   A ✓✓   (2)

                                                                                        [20]

QUESTION 2 / *VRAAG 2*

2.1   Structural isomers are organic compounds that have the <u>same molecular formulae</u>,
        but <u>different structural formulae.</u> ✓✓

        *Struktuurisomere is organiese verbindings wat <u>dieselfde molekulêre formule</u> het,
        maar <u>verskillende struktuurformues</u>.*   (2)

2.2.1   B✓   (1)

2.2.2   H✓   (1)

2.3.1   2-methyl✓prop-1-ene✓/2-methylpropene / *2-metielprop-1-een / 2-metielpropeen*   (2)

2.3.2
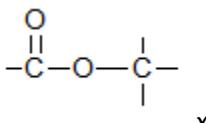
                                                                                           (1)

2.3.3   Butanoic acid✓/Butanoësuur   (1)

2.3.4   Aldehyde✓/*Aldehied*   (1)

2.4   UNSATURATED. ✓ It has a multiple bond between C atoms in the hydrocarbon
        chain. ✓   (2)

ONVERSADIG Besit meervoudige bindings tussen die C- atome in hul koolwaterstofketting.

2.5 $C_4H_8 + 6 O_2 \rightarrow 4 CO_2 + 4 H_2O$ ✓ Balancing/ *Balansering*   *(Accept multiples)*   (3)

2.6.1
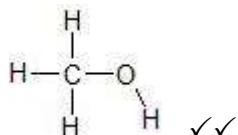
- *Functional group / Funksionele groep*
- *Whole structure correct / Hele struktuur korrek*

(2)

2.6.2   Heat✓ and (concentrated) sulphuric acid/H_2SO_4✓
*Hitte en (gekonsentreerde) swawelsuur/ H_2SO_4*   (2)

[18]

QUESTION 3 / *VRAAG 3*

3.1   The <u>temperature</u>✓ at which the <u>vapour pressure is equal to the atmospheric pressure.</u>✓
Die <u>temperatuur</u> waarby die <u>dampdruk van die stof gelyk is aan die atmosferiese druk.</u>   (2)

3.2   London forces /Dispersion forces✓
Londonkragte / Dispersiekragte   (1)

3.3   A: Alcohol – Hydrogen bond ✓ and London forces
C: Halo-alkane – Dipole-dipole forces✓ and London forces
Hydrogen bond is stronger than dipole-dipole forces ✓

A: Alkohol – Waterstofbinding en Londonkragte✓
C: Halo-alkaan – Dipool- dipoolkragte ✓ en Londonkragte
Waterstofbindings is sterker as dipool-dipool kragte✓   (3)

3.4.1   Substitution/ Halogenation✓ *Substitusie/ Halogenering.* ✓   (1)

3.4.2 $CH_4 \rightarrow CH_3C\ell$

> **_Marking criteria/Nasienriglyne_**
>
> - _Formula / Formule :_ $n = \frac{m}{M}$
> - _0,8 mol_
> - _Substitution of 50,5g / Substitusie van 50,5 g_
> - _Percentage calculation /Persentasie berekening_
> - _Answer/ Antwoord: 86,6 %_

12,8 g

$$n = \frac{m}{M} \quad \checkmark \qquad\qquad m = n \times M$$

$$\qquad\qquad = 0,8 \times 50,5 \;\checkmark \qquad\qquad \checkmark \qquad\qquad \checkmark$$

$$= \frac{12,8}{16} \qquad\qquad = 40,4 \text{ g} \qquad \frac{35}{40,4} \times 100 \;=\; 86,6\%$$

$$\checkmark \quad 1{:}1$$

$$= 0,8 \text{ mol} \longrightarrow 0,8 \text{ mol}$$

(5)
[12]

QUESTION 4 / _VRAAG 4_

4.1.1   Elimination✓ _Eliminasie_   (1)

4.1.2   2-methyl✓pent-2-ene ✓ / _2-metielpent-2-een_   (2)

4.1.3

> **_Marking criteria Nasienriglyne_**
>
> - _Functional group / Funksionele groep_
> - _Whole structure correct / Hele struktuur korrek_
> - _KCl_

(3)
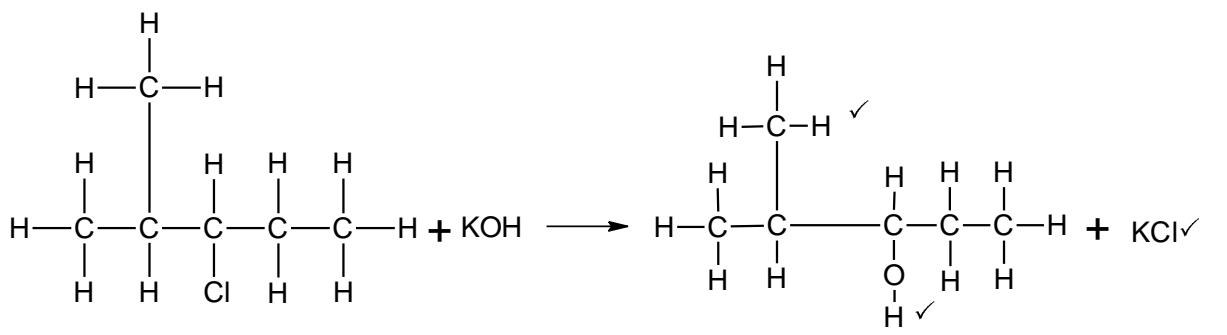
4.1.4   2-methyl✓ pentan-3-ol✓ / *2-metielpentan-3-ol*   (2)

4.2.1   Cracking / *Kraking*✓   (1)

4.2.2   Addition polymerisation / *Addisiepolimerisasie* ✓   (1)

4.2.3
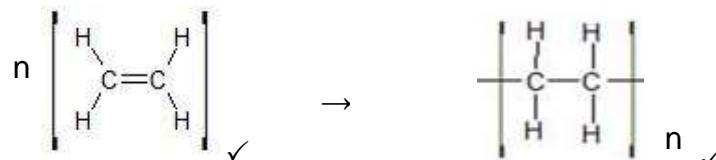
(2)

[13]

QUESTION 5 / VRAAG 5

5.1   The reaction rate indicates the change in the concentration of the reactants or the products per unit time. ✓✓
*Die verandering in konsentrasie van reaktante of produkte per eenheidstyd*   (2)

5.2.1   Temperature/State of division/Mass of magnesium✓ *(Any one)*
Temperatuur / Toestand van verdeeldheid / Massa van magnesium (Enige een)   (1)

5.2.2   The higher the concentration of the sulphuric acid, the higher the rate of reaction. /
Hoe hoër die konsentrasie van swawelsuur, hoe hoër die tempo van reaksie. ✓✓   (2)

5.2.3   Decrease / *Afneem* ✓   (1)

5.2.4   If lumps of magnesium are used, the contact/surface area decreases. ✓
Less effective collisions per unit time. ✓
Less particles with $E_k < E_a$. ✓
As magnesiumstukkies gebruik word gaan die kontak / area oppervlakte verklein
Minder effektiewe botsings per tydseenheid
Minder deeltjies met $E_k < E_a$

(3)

5.2.5
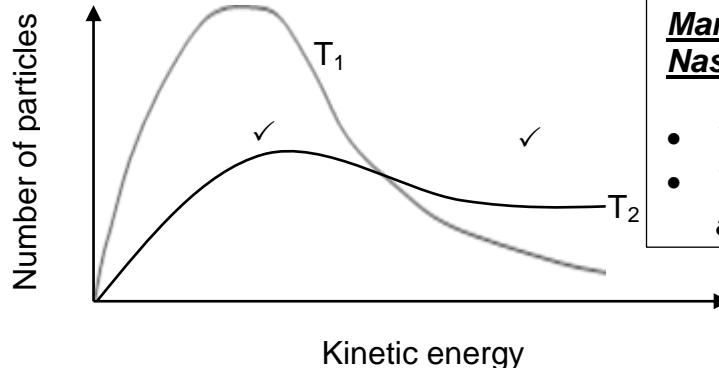
Marking criteria/
Nasienriglyne

- *T_2 maximum below T_1*
- *T_2 at higher energy above T_1*

Kinetic energy

(2)

5.3
- *Formula / Formule* $n = \frac{V}{V_m}$ *or/of* $n = \frac{m}{M}$
- *0,004 mol*
- *Substituting 24 g / Vervang 24g*
- *Ratio 1:1*
- *Answer 0,096 g (0,096 – 0,10) / Antwoord 0,096g (0,096 – 0,10)*

Mg   →   H$_2$
                                                                                100 cm^3

m = n X M
   = 0,004 X 24   ✓ $n = \frac{V}{V_m}$ ✓
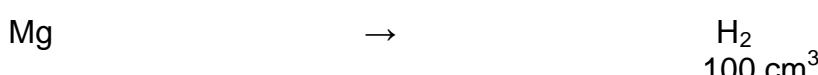
   = 0,096 g ✓ *(0,096 – 0,10)*

     ↑ $= \frac{0,1}{24,04}$

  0,004 mol ✓   ⟵   = 0,004 mol ✓

(5)

[16]

QUESTION 6 / *VRAAG 6*

6.1.1   DECREASES / *VERLAAG* ✓   (1)

6.1.2   INCREASES / *VERHOOG* ✓   (1)

6.1.3   If the temperature is decreased, the system will react in such a way to increase the temperature. ✓
The exothermic ✓, forward reaction ✓ is favoured.
As die temperatuur verlaag, gaan die sisteem so reageer om die temperatuur te verhoog.
Die eksotermiese, voorwaartse reaksie, word bevoordeel   (3)

6.2   **CALCULATIONS USING NUMBER OF MOLES**
 BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation/*Puntetoekenning*
- USING ratio 1:3:2 ✓
  Gebruik die verhouding 1:3:2
- Equilibrium: $n(N_2)$ = 2,5 mol; $n(H_2)$ = 2 mol (initial - change) ✓
  Ewewig: $n(N_2)$ = 2,5 mol; $n(H_2)$ = 2 mol (aanvanklik – verandering)
- Equilibrium: $n(NH_3)$ = 3 mol (initial + change) ✓
  Ewewig: $n(NH_3)$ = 3 mol (aanvanklik + verandering)
- Divide by volume = 2,0 dm^3 ✓
  Gedeel deur volume = 2,0 dm^3
- Correct K$_c$ expression (<u>formulae in square brackets</u>) ✓
  Korrekte K$_c$-uitdrukking (<u>formules in vierkanthakies</u>)
- Correct substitution in K$_c$ expression ✓
  Korrekte vervanging in K$_c$-uitdrukking
- Substitution of / *Vervanging van* 2 g·mol^{-1} in m =nM ✓
- Final answer / *Finale antwoord* :13 g ✓

	N_2	$3\,H_2$	$2\,NH_3$
Mole start **Mol begin**	4	n=6,5	0
Mole react/form *Mol reageer/ vorm*	-1,5	-4,5	+3 ✓
Mole equilibrium *Mol by ewewig*	2,5✓	2	3✓
[ ]	1,25	1	1,5✓

$K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^2}$✓

$1,8 = \dfrac{(1,5)^2}{(1,25)[H_2]^3}$✓

$[H_2] = 1$ mol·dm^{-3}

m = n X M
= 6,5 X 2✓
= 13 g✓

(8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Mark allocation/*Puntetoekenning*

- Divide/multiply by volume = 2,0 dm^3 ✓
  Deel / vermedigvuldig met volume = 2,0 dm^3
- USING ratio: 1:3:2 ✓
  Gebruik die verhouding: 1:3:2
- Equilibrium: $[N_2]$ = 0.75 mol/dm^3 $[H_2]$ = 2,25 mol/dm^3 (initial – change)✓
  Ewewig: $[N_2]$ = 0.75 mol/dm^3 $[H_2]$ = 2,25 mol/dm^3 (aanvanklik – verandering)
- Equilibrium: $[NH_3]$ = 1,5 mol/dm^3(initial + change) ✓
  Ewewig: $[NH_3]$ = 1,5 mol/dm^3(aanvanklik + verandering)
- Correct K_c expression (<u>formulae in square brackets</u>) ✓
  Korrekte K_c-uitdrukking (<u>formules in vierkanthakies)</u>
- Correct substitution in K_c expression✓
  Korrekte vervanging in K_c-uitdrukking
- Substitution of 2 g·mol^{-1} in m =nM✓
  Vervanging van 2 g·mol^{-1} in m =nM
- Final answer: 13 g✓
  Finale antwoord: 13g

	N$_2$	**3 H$_2$**	**2 NH$_3$**
[ ] start / *begin*	2	3.25✓	0
[ ] react/form [ ] *reageer / vorm*	-0,75	-2,25 ✓	+1,5 ✓
[ ] equilibrium [ ] *ewewig*	1,25	1✓	1,5

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^2} ✓$$

$$1,8 = \frac{(1,5)^2}{(1,25)[H_2]^3} ✓$$
$$[H_2] = 1 \text{ mol·dm}^{-3}$$

$$m = n \times M$$
$$= 6,5 \times 2 ✓$$
$$= 13 \text{ g} ✓$$

[13]

QUESTION 7 / *VRAAG 7*

7.1.1   H$_3$O$^+$ acts as a proton donor. ✓✓   (2)
      H$_3$O$^+$ tree as 'n protonskenker op.

7.1.2   HPO$_4^-$ ✓   (1)

7.1.3   Ampholyte / *Amfoliet* ✓   (1)

7.2.1   **OPTION 1 / *OPSIE 1***   **OPTION 2 / *OPSIE 2***

OPTION 1:

$$pH = -\log[H_3O^+]$$
$$13,6 = -\log[H_3O^+]$$
$$[H_3O^+] = 2,51189 \times 10^{-14} ✓$$

$$[H_3O^+][OH^-] = 1 \times 10^{-14}$$

$$[OH^-] = \frac{1 \times 10^{-14}}{2,51189 \times 10^{-14}} ✓$$

$$= 0,4 \text{ mol·dm}^{-3} ✓$$

$$[Ba(OH)_2] = \frac{1}{2} \times 0,4 = 0,2 \; mol \cdot dm^{-3} ✓$$

OPTION 2:

$$pH + pOH = 14$$
$$pOH = 14 - 13,6 ✓$$
$$= 0,4$$
$$pOH = -\log[OH^-]$$
$$0,4 = -\log[OH^-] ✓$$
$$[OH^-] = 10^{-0,4}$$
$$= 0,4 \text{ mol·dm}^{-3} ✓$$

$$[Ba(OH)_2] = \frac{1}{2} \times 0,4 = 0,2 \; mol \cdot dm^{-3} ✓$$

(4)

7.2.2   n = c × V ✓
      = 0,2 × 0,025 ✓
      = 0,005 mol ✓   (3)

7.2.3 **POSITIVE MARKING FROM QUESTION 7.2.1**

H_2SO_4 : n = cV = 0,15 X 0,04 = 0,006 mol ✓

H_2SO_4 + $Ba(OH)_2$
0,005 mol ✓   +   0,005 mol
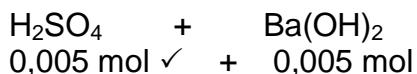
$n(H_2SO_4)$ excess / *oormaat* = 0,006 - 0,005
                                    = 0,001 mol✓

$c = \dfrac{n}{V}$

$= \dfrac{0,001}{0,065}$ ✓

$= 0,0154\ mol \cdot dm^{-3}$

<div style="border:1px solid black; padding:10px;">

Marking criteria/Nasienriglyne

- *0,006 mol*
- *Ratio*
- *Subtraction: 0,006 – 0,005 mol*
  Trek af: 0,006 – 0,005 mol
- *0.065 dm^{-3}*
- *pH formula / formule*
- *2 x 0,0154 mol*
- *Answer / Antwoord: 1,51*

</div>

$[H_3O^+]$ = 2 x 0,0154 mol·dm^{-3} ✓

pH = - log $[H_3O^+]$ ✓
   = - log (0.0308)
   = 1,51 ✓   (7)

7.3.1 The <u>reaction of a salt</u>✓ <u>with water</u>.✓
       Die reaksie van 'n sout met water.   (2)

7.3.2 Neutral / *Neutraal* ✓   (1)
                                                                                          [21]

  QUESTION 8 / *VRAAG 8*

8.1   No reaction. ✓
        Ag is a weaker reducing agent than copper✓ and will not reduce Cu^{2+} to Cu.
        Geen reaksie
   *Ag is 'n swakker reduseermiddel as koper en sal nie gereduseer word van Cu^{2+}*
        na Cu toe nie.   (2)

8.2.1   Pt. ✓ Reduction takes place at the platinum electrode. ✓
   *Pt. Reduksie vind plaas by die platinum elektrode*   (2)

8.2.2   Fe → Fe^{2+} + 2e⁻ ✓✓   (2)
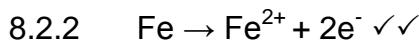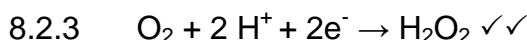
8.2.3 O_2 + 2 H⁺ + 2e⁻ → H_2O_2 ✓✓   (2)

8.2.4 E°_{cell} = E°$_{reduction}$ - E°$_{oxidation}$ ✓   *OR any formula in the formula sheet*
         = 0,68 ✓ – (-0,44) ✓   *OF enige formule op formuleblad*
         = 1,12 V✓   (4)

8.2.5 $\checkmark$ $\checkmark$ $\checkmark$

Fe(s) | Fe^{2+}(aq) || O_2(g) | H_2O_2(aq) | Pt (s)

OR / *OF*

$\checkmark$ $\checkmark$ $\checkmark$

Fe(s) | Fe^{2+}(1 mol.dm^{-3}) || O_2(g) | H_2O_2(1 mol.dm^{-3})| Pt (s)

OR / *OF*

Fe | Fe^{2+} || O_2| H_2O_2 | Pt

(3)
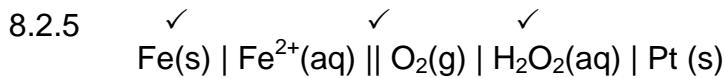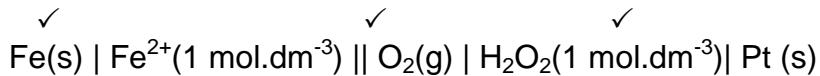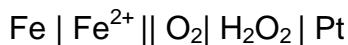
8.2.6 K^+ $\checkmark$ (1)

[16]

QUESTION 9 / *VRAAG 9*

9.1 $A\ell^{3+}$ $\checkmark$ and / *en* O^{2-} $\checkmark$ (2)

9.2   An electrolyte is a solution/liquid that has free ions$\checkmark$ and conducts electricity. $\checkmark$
'n Elektroliet is 'n oplossing/vloeistof/opgeloste stof wat elektrisiteit gelei deur die beweging van ione

An electrolyte is a solution that conducts electricity (through the movement of ions). $\checkmark\checkmark$
'n Oplossing wat elektrisiteit gelei (deur die beweging van ione).

A solution/melt that consists of ions. $\checkmark\checkmark$
'n Oplossing/gesmelte stof wat ione bevat.   (2)

9.3   To lower the melting point of the aluminium oxide / to make the aluminium oxide soluble.$\checkmark$
Om die smeltpunt van die aluminiumoksied te verlaag / om aluminiumoksied oplosbaar te maak.   (1)

9.4 $2 O^{2-} \rightarrow O_2 + 4 e^-$ $\checkmark\checkmark$ (2)
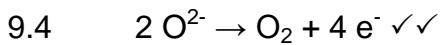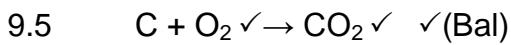
9.5 $C + O_2$ $\checkmark$ $\rightarrow CO_2$ $\checkmark$ $\checkmark$(Bal)   (3)

[10]

QUESTION 10 / *VRAAG 10*

10.1.1 $2\,NO + O_2$ ✓ $\rightleftharpoons 2\,NO_2$ ✓   Balancing / *Balansering*✓ *(Ignore ⇌ / Ignoreer ⇌)*   (3)

10.1.2   Catalytic oxidation of ammonia. ✓
Katalitiese oksidasie van ammoniak   (1)

10.1.3 HNO_3 ✓   (1)

10.1.4 $(NH_4)_2SO_4$ ✓   (1)

10.1.5   Ammonium nitrate / *Ammoniumnitraat* ✓   (1)

10.1.6   Eutrophication / *Eutrofikasie* ✓   (1)

10.2.1   N   : P   : K
18,75 : 7,5   ✓ : X

Total /*Totale* % fertilizer / *kunsmis* = 30% ✓

% K = 30 – 18,75 – 7,5 = 3,75% ✓

N   : P   :   K
18,75 : 7,5 :   3,75
5   : 2   :   1 ✓   (4)

[12]
TOTAL / *TOTAAL*:   150