



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE
NASIONALE
SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)**

NOVEMBER 2014

MEMORANDUM

MARKS/PUNTE: 150

**This memorandum consists of 20 pages.
*Hierdie memorandum bestaan uit 20 bladsye.***

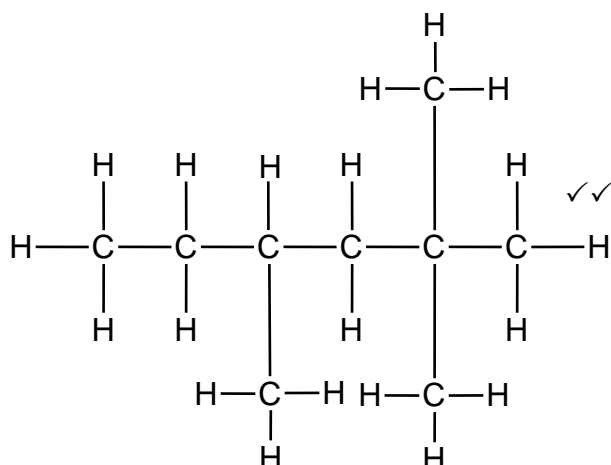
QUESTION 1 / VRAAG 1

- 1.1 C ✓✓ (2)
1.2 B ✓✓ (2)
1.3 D ✓✓ (2)
1.4 D ✓✓ (2)
1.5 A ✓✓ (2)
1.6 B ✓✓ (2)
1.7 B ✓✓ (2)
1.8 A ✓✓ (2)
1.9 D ✓✓ (2)
1.10 C ✓✓ (2)
[20]

QUESTION 2 / VRAAG 2

- 2.1
2.1.1 B ✓ (1)
2.1.2 E ✓ (1)
2.1.3 F ✓ (1)
2.2
2.2.1 2-bromo-3-chloro-4-methylpentane
2-bromo-3-chloro-4-metielpentaaan / 2-broom-3-chloor-4-metielpentaaan
Marking criteria / Nasienriglyne:
 - Correct stem i.e. pentane. / *Korrekte stam d.i. pentaan.* ✓
 - All substituents correctly identified. / *Alle substituenten korrek geïdentifiseer.* ✓
 - Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used. ✓
Substituenten korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik.(3)
2.2.2 Ethene / *Eteen* ✓ (1)

2.3
2.3.1



Marking criteria / Nasionriglyne:

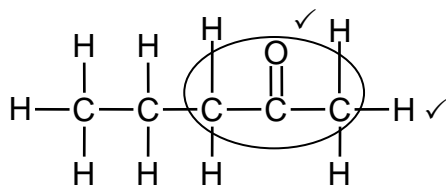
- Six saturated C atoms in longest chain i.e. hexane. ✓
Ses versadigde C-atome in langste ketting d.i. heksaan.
- Three methyl substituents on second C and fourth C. ✓
Drie metielsubstituente op tweede C en vierde C.

Notes / Aantekeninge:

- If correct structure, but H atoms omitted / *Indien korrekte struktuur, maar H-atome weggelaat:* Max / Maks. $\frac{1}{2}$
- Condensed or semi-structural formula: *Gekondenseerde of semistruktuurformule:* Max./Maks. $\frac{1}{2}$
- Molecular formula / *Molekulêre formule:* $\frac{0}{2}$

(2)

2.3.2



Marking criteria / Nasionriglyne:

- Whole structure correct / *Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct / *Slegs funksionele groep korrek:* $\frac{1}{2}$

Notes / Aantekeninge:

- If two or more functional groups/*Indien twee of meer funksionele groepe:* $\frac{0}{2}$
- Condensed or semi-structural formula: *Gekondenseerde of semistruktuurformule:* Max / Maks $\frac{1}{2}$
- Molecular formula / *Molekulêre formule:* $\frac{0}{2}$

(2)

2.4

2.4.1 (Compounds with) the same molecular formula ✓ but different functional groups / different homologous series. ✓
(Verbindings met) dieselfde molekulêre formule, maar verskillende funksionele groepe / verskillende homoloë reekse.

(2)

2.4.2 B & F ✓

(1)

[14]

QUESTION 3 / VRAAG 3

3.1 ANY ONE / ENIGE EEN:

- Alkanes have ONLY single bonds. ✓
Alkane het SLEGS enkelbindings.
- Alkanes have single bonds between C atoms.
Alkane het enkelbindings tussen C-atome.
- Alkanes have no double OR triple bonds OR multiple bonds.
- Alkane het geen dubbel- OF trippelbindings OF meervoudige bindings nie.*
- Alkanes contain the maximum number of H atoms bonded to C atoms.
Alkane bevat die maksimum getal H-atome gebind aan C-atome.

(1)

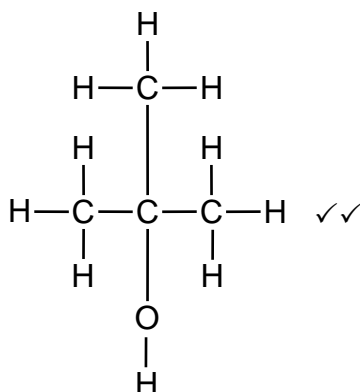
3.2

3.2.1 ANY ONE / ENIGE EEN:

$\begin{array}{c} \\ -C-O-H \checkmark \\ \end{array}$	$\begin{array}{c} \\ -C-OH \\ \end{array}$	-OH	-O-H
R-OH	R-O-H		

(1)

3.2.2



Marking criteria / Nasienriglyne:

- OH group on second C atom of longest chain. ✓
- OH-groep op tweede C-atoom van langste ketting.
- Tertiary group consisting of four C atoms with methyl group on 2nd C atom. ✓
Tersiêre groep bestaande uit vier C-atome met metielgroep op 2de C-atoom.
- If two or more functional groups / Indien twee of meer funksionele groepe: $\frac{0}{2}$

Notes / Aantekeninge:

- Accept / Aanvaar – OH
- If correct structure and number of bonds, but H atoms omitted / Indien korrekte struktuur en getal bindings, maar H-atome weggelaat: Max / Maks. $\frac{1}{2}$
- Condensed or semi-structural formula / Gekondenseerde of semistruktuurformule: Max / Maks. $\frac{1}{2}$
- Molecular formula / Molekulêre formule: $\frac{0}{2}$

(2)

3.3
3.3.1

Criteria for investigative question / Riglyne vir ondersoekende vraag:	
The <u>dependent</u> and <u>independent</u> variables are stated. <i>Die afhanklike en onafhanklike veranderlikes is genoem.</i>	✓
Ask a question about the relationship between the <u>independent</u> and <u>dependent</u> variables. <i>Vra 'n vraag oor die verwantskap tussen die <u>onafhanklike</u> en <u>afhanklike</u> veranderlikes.</i>	✓

Examples / Voorbeelde:

- How does an increase in chain length / molecular size / molecular structure / molecular mass / surface area influence boiling point?
Hoe beïnvloed 'n toename in kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / reaksieoppervlak die kookpunt?
- What is the relationship between chain length / molecular size / molecular structure / molecular mass / surface area and boiling point?
Wat is die verwantskap tussen kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte en kookpunt? (2)

3.3.2

- **Structure / Struktuur:**
The chain length / molecular size / molecular structure / molecular mass / surface area increases. ✓
Die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte neem toe.
- **Intermolecular forces / Intermolekulêre kragte:**
Increase in strength of intermolecular forces / induced dipole / London / dispersion / Van der Waals forces. ✓
Toename in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte / Van der Waalskragte.
- **Energy / Energie:**
More energy needed to overcome / break intermolecular forces. ✓
Meer energie benodig om intermolekulêre kragte te oorkom / breek.

OR / OF

- **Structure / Struktuur:**
From propane to methane the chain length / molecular size / molecular structure / molecular mass / surface area decreases. ✓
Van propaan na metaan neem die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte af.
- **Intermolecular forces / Intermolekulêre kragte:**
Decrease in strength of intermolecular forces / induced dipole forces / London forces / dispersion forces. ✓
Afname in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte.
- **Energy / Energie:**
Less energy needed to overcome / break intermolecular forces. ✓
Minder energie benodig om intermolekulêre kragte te oorkom / breek. (3)

- 3.4
- Between propane molecules are London forces / dispersion forces / induced dipole forces. ✓
Tussen propaanmolekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.
 - Between propan-1-ol molecules are London forces / dispersion forces / induced dipole forces and hydrogen bonds. ✓
Tussen propan-1-ol molekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en waterstofbindings.
 - Hydrogen bonds / Forces between alcohol molecules are stronger or need more energy than London forces / dispersion forces / induced dipole forces. ✓
Waterstofbindings / Kragte tussen alkoholmolekule is sterker of benodig meer energie om oorkom te word as Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.

OR/OF

Between propane molecules are weak London forces / dispersion forces / induced dipole forces ✓ and between propan-1-ol molecules are strong hydrogen bonds. ✓✓

Tussen propaanmolekule is swak Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en tussen propan-1-olmolekule is sterk waterstofbindings.

(3)
[12]

QUESTION 4 / VRAAG 4

4.1

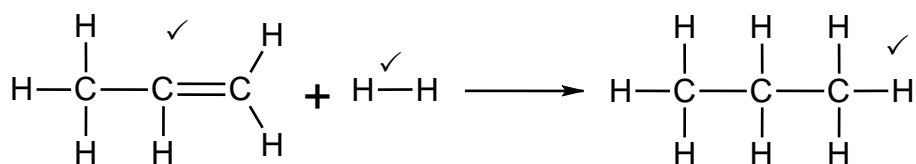
4.1.1 Substitution / chlorination / halogenation ✓
Substitusie / chlorering / halogenering / halogenasie (1)

4.1.2 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

4.2

4.2.1 Hydrogenation / *Hidrogenasie / Hidrogenering* ✓ (1)

4.2.2



Notes / Aantekeninge:

- Ignore/Ignoreer ⇌
- Accept H₂ if condensed. / Aanvaar H₂ as gekondenseerd.
- Any additional reactants and/or products

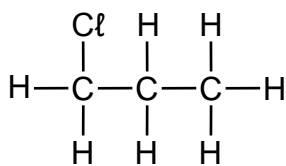
Enige addisionele reaktanse en / of produkte: Max./Maks. $\frac{2}{3}$

- Accept coefficients that are multiples.
Aanvaar koëffisiënte wat veelvoude is.
- Molecular / condensed formulae

Molekulêre-/ gekondenseerde formule: Max./Maks. $\frac{2}{3}$

(3)

4.3



Marking criteria / Nasienriglyne:

- Whole structure correct./ *Hele struktuur korrek:* $\frac{2}{2}$
- Only ONE Cl atom as functional group. / *Slegs EEN Cl-atoom as funksionele groep.* $\frac{1}{2}$

Notes / Aantekeninge:

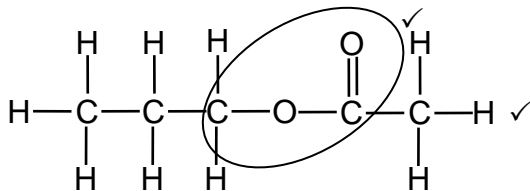
- Condensed or semi-structural formula
Gekondenseerde of semistruktuurformule: Max./Maks. $\frac{1}{2}$
 - Molecular formula. / *Molekulêre formule:* $\frac{0}{2}$
 - If functional group is incorrect. / *Indien funksionele groep verkeerd is:* $\frac{0}{2}$
- (2)

4.4

4.4.1 Esterification / Condensation ✓
Verestering / Esterifikasie / Kondensasie (1)

4.4.2 (Concentrated) H_2SO_4 / (Concentrated) sulphuric acid ✓
(Gekonsentreerde) H_2SO_4 / (Gekonsentreerde) swawelsuur of swaelsuur (1)

4.4.3



Marking criteria / Nasienriglyne:

- Whole structure correct / *Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct / *Slegs funksionele groep korrek:* $\frac{1}{2}$

Notes / Aantekeninge:

- If two or more functional groups/Indien twee of meer funksionele groepe: $\frac{0}{2}$
 - Condensed or semi-structural formula:
Gekondenseerde of semistruktuurformule: Max./Maks. $\frac{1}{2}$
 - Molecular formula / *Molekulêre formule:* $\frac{0}{2}$
 - If functional group is incorrect/Indien funksionele groep verkeerd is: $\frac{0}{2}$
- (2)

4.4.4 Propyl ✓ ethanoate ✓
Propieletanoaat (2)

4.5 Sulphuric acid / H_2SO_4 / Phosphoric acid / H_3PO_4 ✓
Swawelsuur / Swaelsuur / H_2SO_4 / Fosforsuur / H_3PO_4 (1)

[15]

QUESTION 5 / VRAAG 5

5.1 **ONLY ANY ONE OF/ SLEGS ENIGE EEN VAN:**

- Change in concentration of products / reactants ✓ per (unit) time. ✓
Verandering in konsentrasie van produkte / reaktanse per (eenheids)tyd.
- Rate of change in concentration. ✓✓
Tempo van verandering in konsentrasie.
- Change in amount / number of moles / volume / mass of products or reactants per (unit) time.
Verandering in hoeveelheid / getal mol/volume / massa van produkte of reaktanse per (eenheids)tyd.
- Amount / number of moles / volume / mass of products formed or reactants used per (unit) time.
Hoeveelheid / getal mol / volume / massa van produkte gevorm of reaktanse gebruik per (eenheids)tyd. (2)

5.2

5.2.1 Temperature / *Temperatuur* ✓ (1)

5.2.2 Rate of reaction / Volume of gas (formed) per (unit) time ✓
Reaksietempo / Volume gas (gevorm) per (eenheids)tyd (1)

- 5.3
- Larger mass / amount / surface area. ✓
Groter massa / hoeveelheid / reaksieoppervlak.
 - More effective collisions per (unit) time. / Frequency of effective collisions increase./ More particles collide with sufficient kinetic energy & correct orientation per (unit) time. ✓✓
Meer effektiewe botsings per (eenheids)tyd. / Frekwensie van effektiewe botsings verhoog./ Meer deeltjies bots met genoeg kinetiese energie & korrekte oriëntasie per tyd(seenheid).

IF / INDIEN:

- Larger mass / amount / surface area. ✓
Groter massa / hoeveelheid / reaksieoppervlak.
- More particles collide. / More collisions. ✓
Meer deeltjies bots. / Meer botsings.

Max./Maks. $\frac{2}{3}$

Notes / Aantekeninge:

IF/INDIEN:

No reference to mass / amount / surface area in answer:

Geen verwysing na massa / hoeveelheid / reaksieoppervlak in antwoord:

$\frac{0}{3}$

(3)

5.4 **Marking criteria / Nasienriglyne:**

Compare Exp.1 with Exp. 2: Vergelyk Eksp. 1 met Eksp. 2:	The reaction in <u>exp. 1</u> is <u>faster</u> in <u>exp. 1</u> than in <u>exp. 2</u> due to the <u>higher acid concentration</u> . <i>Die reaksie in <u>eksp. 1</u> is <u>vinniger</u> as dié in <u>eksp. 2</u> as gevolg van die <u>hoër suurkonsentrasie</u>.</i>	✓
	Therefore the <u>gradient</u> of the graph representing <u>exp. 1</u> is <u>greater / steeper</u> than that of <u>exp. 2</u> . / Graph of Exp. 1 reaches constant volume in shorter time than exp. 2. <i>Dus is die <u>gradiënt</u> van die grafiek wat <u>eksp. 1</u> voorstel, <u>groter/steiler</u> as dié vir <u>eksp. 2</u>. / Grafiek van exp. 1 bereik konstante volume in korter tyd as dié vir eksp. 2.</i>	✓
Compare Exp. 1 with Exp 3 & 4: Vergelyk Eksp. 1 met Eksp. 3 & 4:	The reaction in <u>exp. 3</u> is <u>faster</u> than that in <u>exp. 1</u> due to the <u>higher temperature</u> . <i>Die reaksie in <u>eks. 3</u> is <u>vinniger</u> as dié in <u>eksp. 1</u> as gevolg van die <u>hoër temperatuur</u>.</i>	✓
	The reaction in <u>exp. 4</u> is <u>faster</u> than that in <u>exp. 1</u> due to the <u>higher temperature / larger surface area</u> . <i>Die reaksie in <u>eks. 4</u> is <u>vinniger</u> as dié in <u>eksp. 1</u> as gevolg van die <u>hoër temperatuur / groter reaksieoppervlak</u>. OR/OF <i>Graph <u>A</u> represents <u>exp. 4</u> due to the <u>greater mass</u> of CaCO_3 - <u>greater yield</u> of CO_2 at a <u>faster rate</u>. <u>Grafiek A stel eksp. 4 voor as gevolg van die groter massa CaCO_3 - groter opbrengs CO_2 teen vinniger tempo.</u></i></i>	✓
	Therefore the <u>gradient</u> of the graphs of <u>exp. 3 & 4</u> are <u>greater/steeper</u> than that of <u>exp. 1</u> . / Graphs of Exp. 3 & 4 reaches constant volume in shorter time than exp. 1. <i>Dus is die <u>gradiënte</u> van die grafieke vir <u>eksp. 3 & 4</u> is <u>groter/steiler</u> as dié in <u>eksp. 1</u>. / Grafieke van exp. 3 & 4 bereik konstante volume in korter tyd as dié vir eksp. 1.</i>	✓
Final answer Finale antwoord	C	✓

(6)

Notes/Aantekeninge

- Compare exp. 1 with exp. 2 / Vergelyk eksp. 1 met eksp. 2:
 - Factor & rate / Faktor & tempo.
 - Gradient / volume CO_2 per time / gradient / volume CO_2 per tyd.
- Compare exp. 1 with exp. 3 / Vergelyk eksp. 1 met eksp. 3:
 - Factor & rate / Faktor & tempo.
- Compare exp. 1 with exp. 4 / Vergelyk eksp. 1 met eksp. 4:
 - Factor & rate / Faktor & tempo.
- Compare gradient / volume CO_2 per time of exp 1 with that of exp. 3 & 4
Vergelyk gradient/volume CO_2 per tyd van eksp 1 met die van eksp. 3 & 4
- Final answer / finale antwoord: C

5.5

<p>Marking criteria / Nasienriglyne:</p> <ul style="list-style-type: none"> • Divide volume by / Deel volume deur: 25,7 ✓ • Use ratio / Gebruik verhouding: $n(\text{CO}_2) = n(\text{CaCO}_3) = 1:1$ ✓ • Substitute / Vervang 100 in $n = \frac{m}{M}$. ✓ • Subtraction / Aftrekking. ✓ • Final answer / Finale antwoord: 7,00 g to/tot 7,5 g ✓ 	
<p>OPTION 1 / OPSIE 1</p> $n(\text{CO}_2) = \frac{V}{V_m}$ $= \frac{4,5}{25,7} \checkmark$ $= 0,18 \text{ mol (0,175 mol)}$ $n(\text{CaCO}_3) = n(\text{CO}_2) = 0,18 \text{ mol } \checkmark$ $n(\text{CaCO}_3) = \frac{m}{M}$ $0,18 = \frac{m}{100} \checkmark$ $\therefore m = 18 \text{ g (17,5 g)}$ <p>$m(\text{CaCO}_3)$ not reacted/nie gereageer nie): $25 - 18 \checkmark = 7,00 \text{ g } \checkmark$ (7,49 g)</p> <p>(Accept range: 7,00 g – 7,5 g) (Aanvaar gebied: 7.00 g – 7,5 g)</p>	<p>OPTION 2 / OPSIE 2</p> <p>Calculate mass of CO_2: Bereken massa CO_2:</p> $n(\text{CO}_2) = \frac{V}{V_m}$ $= \frac{4,5}{25,7} \checkmark$ $= 0,18 \text{ mol (0,175 mol)}$ $n(\text{CO}_2) = \frac{m}{M}$ $0,18 = \frac{m}{44}$ $\therefore m(\text{CO}_2) = 7,92 \text{ g (7,7043 g)}$ <p>Ratio/verhouding $m(\text{CaCO}_3 \text{ needed / benodig}) = \frac{7,92}{44} \times 100 \checkmark$ $= 18 \text{ g (17,5 g)}$</p> <p>$m(\text{CaCO}_3)$ not reacted/nie gereageer nie): $25 - 18,00 \checkmark = 7,00 \text{ g } \checkmark$ (7,49 g)</p> <p>(Accept range: 7,00 g – 7,5 g) (Aanvaar gebied: 7.00 g – 7,5 g)</p>
<p>OPTION 3 / OPSIE 3</p> $25,7 \text{ dm}^3 : 1 \text{ mol}$ $4,5 \text{ dm}^3 : 0,18 \text{ mol } \checkmark$ $100 \text{ g } \checkmark : 1 \text{ mol}$ $x : 0,18 \text{ mol } \checkmark$ $x = 18 \text{ g}$ <p>$m(\text{CaCO}_3)$ not reacted/nie gereageer nie): $25 - 18 \checkmark = 7,00 \text{ g } \checkmark$</p> <p>(Accept range: 7,00 g – 7,5 g) (Aanvaar gebied: 7,00 g – 7,5 g)</p>	<p>OPTION 4 / OPSIE 4</p> $100 \text{ g CaCO}_3 \rightarrow 25,7 \text{ dm}^3 \text{ CO}_2 \checkmark \checkmark$ $x \text{ g} \rightarrow 4,5 \text{ dm}^3 \text{ CO}_2 \checkmark$ $\therefore x = 17,51 \text{ g}$ <p>Mass not reacted/Massa nie gereageer nie $= 25 - 17,51 \checkmark$ $= 7,49 \text{ g } \checkmark$</p> <p>(Accept range: 7,00 g – 7,5 g) (Aanvaar gebied: 7,00 g – 7,5 g)</p>

(5)

(5)

QUESTION 6 / VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ✓✓

OR / OF

- The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly. ✓✓

(2)

6.2

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation / Puntetoekenning:

- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value / *Vervanging van K_c -waarde*. ✓
- Equilibrium concentration of both NO_2 & N_2O_4 multiplied by $0,08 \text{ dm}^3$. ✓
Ewewigskonsentrasie van beide NO_2 & N_2O_4 vermenigvuldig met $0,08 \text{ dm}^3$
- Change in $n(N_2O_4) = \text{equilibrium } n(N_2O_4) - \text{initial } n(N_2O_4)$ ✓
Verandering in $n(N_2O_4) = \text{ewewig } n(N_2O_4) - \text{aanvanklike } n(N_2O_4)$
- **USING** ratio / **GEBRUIK** *verhouding*: $NO_2 : N_2O_4 = 2 : 1$ ✓
- Initial $n(NO_2) = \text{equilibrium } n(NO_2) + \text{change } n(NO_2)$. ✓
Aanvanklike $n(NO_2) = \text{ewewig } n(NO_2) + \text{verandering } n(NO_2)$.
- Final answer / *Finale antwoord*: 1,11 (mol) ✓
Accept range/Aanvaar gebied: 1,11 – 1,12 (mol)

OPTION 1 / OPSIE 1

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2 = 6,84 \text{ mol}\cdot\text{dm}^{-3}$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. 7/8*

Wrong K_c expression / *Verkeerde K_c -uitdrukking: Max./Maks. 5/8*

(8)

	NO ₂	N ₂ O ₄	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	1,11 ✓	0	
Change (mol) <i>Verandering (mol)</i>	1,094	0,55 ✓	ratio ✓ <i>verhouding</i>
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,016	0,55	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,2	6,84	x 0,08 ✓

OPTION 2 / OPSIE 2

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2 = 6,84 \text{ mol}\cdot\text{dm}^{-3}$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. 7/8*

Wrong K_c expression / *Verkeerde K_c -uitdrukking: Max./Maks. 5/8*

Equilibrium moles / Ewewigsmol:

$$\left. \begin{aligned} n(N_2O_4) &= (6,84)(0,080) \\ &= 0,55 \text{ mol} \\ n(NO_2) &= (0,2)(0,080) \\ &= 0,016 \text{ mol} \end{aligned} \right\} \checkmark \times 0,08 \text{ dm}^3$$

$$n(N_2O_4 \text{ formed/gevorm}) = \underline{0,55 - 0} = 0,55 \text{ mol} \checkmark$$

Ratio / *Verhouding:*

$$n(NO_2 \text{ reacted / gereageer}) = 2n(N_2O_4 \text{ formed/gevorm}) = 2(0,55) = 1,094 \text{ mol} \checkmark$$

$$\text{Initial / Aanvanklike } n(NO_2) = 0,016 + 1,094 \checkmark = 1,11 \text{ (mol)} \checkmark$$

(8)

OPTION 3 / OPSIE 3

	NO ₂	N ₂ O ₄	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	2x + 0,016	0	
Change (mol) <i>Verandering (mol)</i>	2x	x	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,016	x	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,2	$\frac{x}{0,08}$	x 0,08 & ÷ 0,08 ✓

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{x}{(0,2)^2} \checkmark$$

$$\therefore x = 0,5472$$

$$\therefore n(\text{initial/aanvanklik}) = 2(0,5472) + 0,016 = 1,11 \text{ mol} \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{8}$

(8)

OPTION 4 / OPSIE 4

	NO ₂	N ₂ O ₄	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	x	0	
Change (mol) <i>Verandering (mol)</i>	x - 0,016	$\frac{x - 0,016}{2}$	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,016	$\frac{x - 0,016}{2}$	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,2	$\frac{x - 0,016}{0,16}$	x 0,08 & ÷ 0,08 ✓

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{x - 0,016}{(0,2)^2} \checkmark$$

$$\therefore x = 1,11 \text{ mol} \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{8}$

(8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Mark allocation / Punttoekenning:

- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value. / *Vervanging van K_c -waarde.* ✓
- Change in $[N_2O_4] = \text{equilibrium } [N_2O_4] - \text{initial } [N_2O_4]$. ✓
Verandering in $[N_2O_4] = \text{ewewig } [N_2O_4] - \text{aanvanklike } [N_2O_4]$.
- **USING** ratio/**GEBRUIK** verhouding: $NO_2 : N_2O_4 = 2 : 1$ ✓
- Initial $[NO_2] = \text{equilibrium } [NO_2] + \text{change in } [NO_2]$. ✓
Aanvanklike $[NO_2] = \text{ewewigs } [NO_2] + \text{verandering in } [NO_2]$.
- Equilibrium concentration of $[NO_2]$ multiplied by $0,08 \text{ dm}^3$. ✓
Ewewigskonsentrasie van $[NO_2]$ vermenigvuldig met $0,08 \text{ dm}^3$.
- Final answer/*Finale antwoord*: 1,11 (mol) ✓
Accept range/Aanvaar gebied: 1,11 – 1,12 (mol)

OPTION 5 / OPSIE 5

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2 = 6,84 \text{ mol}\cdot\text{dm}^{-3}$$

No K_c expression, correct substitution/*Geen K_c -uitdrukking, korrekte substitusie*: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/*Verkeerde K_c -uitdrukking*: Max./Maks. $\frac{5}{8}$

	NO_2	N_2O_4
Initial concentration ($\text{mol}\cdot\text{dm}^{-3}$) <i>Aanvangskonsentrasie ($\text{mol}\cdot\text{dm}^{-3}$)</i>	13,88	0
Change ($\text{mol}\cdot\text{dm}^{-3}$) <i>Verandering ($\text{mol}\cdot\text{dm}^{-3}$)</i>	13,68	6,84 ✓
Equilibrium concentration ($\text{mol}\cdot\text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,2	6,84

ratio ✓
verhouding

$$n(NO_2) = cV = (13,88)(0,08) \checkmark = 1,11 \text{ mol} \checkmark$$

(8)

OPTION 6 / OPSIE 6

	NO ₂	N ₂ O ₄	
Initial concentration (mol·dm ⁻³) <i>Aanvangskonsentrasie (mol·dm⁻³)</i>	x	0	
Change (mol·dm ⁻³) <i>Verandering (mol·dm⁻³)</i>	x - 0,2	$\frac{x - 0,2}{2}$ ✓	ratio ✓ <i>verhouding</i>
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,2	$\frac{x - 0,2}{2}$	

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{x - 0,2}{(0,2)^2} \checkmark$$

$$\therefore x = 13,88 \text{ mol}\cdot\text{dm}^{-3}$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. 7/8*

Wrong K_c expression/*Verkeerde K_c-uitdrukking: Max./Maks. 5/8*

$$n(\text{NO}_2) = cV = (13,88)(0,08) \checkmark = 1,11 \text{ mol} \checkmark \quad (8)$$

6.3

6.3.1 Concentration (of the gases) increases. / Molecules become more condensed or move closer to each other. ✓
Konsentrasie (van die gasse) verhoog. / Molekule word meer saamgepers of beweeg nader aan mekaar. (1)

- 6.3.2
- Increase in pressure favours the reaction that leads to smaller number of moles / volume of gas. ✓
Toename in druk bevoordeel die reaksie wat tot die kleiner getal mol / volume gas lei.
 - Forward reaction is favoured. / *Voorwaartse reaksie word bevoordeel.* ✓
 - Number of moles/amount of N₂O₄ / colourless gas increases. ✓
Aantal mol/hoeveelheid N₂O₄ / kleurlose gas neem toe.

OR / OF

Number of moles/amount of NO₂ / brown gas decreases. ✓
Aantal mol/hoeveelheid NO₂ / bruin gas neem af. (3)

6.4

6.4.1 Darker / *Donkerder* ✓ (1)

6.4.2 Decreases / *Verlaag* ✓ (1)

[16]

QUESTION 7/ VRAAG 7

**PENALISE ONCE FOR THE INCORRECT CONVERSION OF UNITS.
PENALISEER EENMALIG VIR VERKEERDE OMSKAKELING VAN EENHEDE.**

7.1

7.1.1 Ionises / dissociates completely (in water) ✓
Ioniseer / dissosieer volledig (in water). (1)

7.1.2 NO_3^- / Nitrate ion / *Nitraatioon* ✓ (1)

7.1.3 $\text{pH} = -\log[\text{H}_3\text{O}^+] / -\log[\text{H}^+]$ ✓
 $= -\log(0,3)$ ✓
 $= 0,52$ ✓

Notes/Aantekeninge:

- If no/incorrect formula/*Indien geen/foutiewe formule: Max./Maks: $\frac{2}{3}$*
- If no substitution step: 2 marks for correct answer./*Indien geen substitusie stap: 2 punte vir korrekte antwoord.*

(3)

7.2

7.2.1 $c = \frac{n}{V}$ ✓
 $2 = \frac{n}{0,1}$ ✓
 $\therefore n(\text{HCl}) = 0,2 \text{ mol}$ ✓ (3)

7.2.2 Burette / *Buret* ✓ (1)

7.2.3 B ✓
- Titration of strong acid and strong base. ✓✓
Titrasie van sterk suur en sterk basis.

OR/OF

The endpoint will be approximately at $\text{pH} = 7$ which is in the range of the indicator.

Die eindpunt sal ongeveer by $\text{pH} = 7$ wees wat in die gebied van die indikator is. (3)

7.2.4 The number of moles of acid in the flask remains constant. ✓
Die getal mol van die suur in die fles bly konstant. (1)

7.2.5

$$c = \frac{n}{V} \checkmark$$

$$0,2 = \frac{n}{0,021} \checkmark$$

$$n = 4,2 \times 10^{-3} \text{ mol} \checkmark$$

n(HCl in excess/in oormaat):

$$\begin{aligned} n(\text{HCl}) &= n(\text{NaOH}) \\ &= 4,2 \times 10^{-3} \text{ mol} \end{aligned}$$

(3)

7.2.6

POSITIVE MARKING FROM QUESTION 7.2.1 AND 7.2.5.
POSITIEWE NASIEN VAN VRAAG 7.2.1 EN 7.2.5.

<u>Marking criteria / Nasienriglyne:</u>	
<ul style="list-style-type: none"> • n(HCl reacted) = initial (from Q7.2.1) – excess (from Q7.2.5). ✓ n(HCl reageer) = begin (van Q7.2.1) – oormaat (van Q7.2.5). • Use mol ratio of acid: base = 2 : 1. ✓ Gebruik molverhouding suur : basis = 2 : 1. • Substitute / Vervang 40 into / in $n = \frac{m}{M}$ ✓ • $\frac{m(\text{MgO reacted / reageer})}{4,5} \times 100$. ✓ • Final answer / Finale antwoord: 87,11 % ✓ 	
<p><u>OPTION 1 / OPSIE 1</u></p> <p>n(HCl reacted/gereageer): <u>0,2</u> – $4,2 \times 10^{-3}$ ✓ = 0,196 mol</p> <p style="text-align: center;">↓</p> <p>n(MgO reacted/gereageer): $\frac{1}{2}n(\text{HCl}) = \frac{1}{2}(0,196)$ = $9,8 \times 10^{-2}$ mol ✓</p> <p style="text-align: center;">↙</p> <p>n(MgO reacted/gereageer) = $\frac{m}{M}$</p> <p>∴ $0,098 = \frac{m}{40}$ ✓</p> <p>∴ m = 3,92 g</p> <p style="text-align: center;">↘</p> <p>% purity/ suiwerheid = $\frac{3,92}{4,5} \times 100$ ✓ = 87,11% ✓</p> <p>(Accept range: 87 - 87,11 %.) (Aanvaar gebied: 87 – 87,11 %)</p>	<p><u>OPTION 2 / OPSIE 2</u></p> <p>n(HCl reacted/gereageer): <u>0,2</u> – $4,2 \times 10^{-3}$ ✓ = 0,196 mol</p> <p style="text-align: center;">↙</p> <p>n(HCl reacted/gereageer) = $\frac{m}{M}$</p> <p>$0,196 = \frac{m}{36,5}$</p> <p>∴ m(HCl reacted/gereageer) = 7,154 g</p> <p>40 g MgO ✓ 73 g HCl ✓ x g MgO 7,154 g</p> <p>∴ x = 3,92 g</p> <p style="text-align: center;">↘</p> <p>% purity/suiwerheid = $\frac{3,92}{4,5} \times 100$ ✓ = 87,11% ✓</p> <p>(Accept range: 87 - 87,11 %.) (Aanvaar gebied: 87 – 87,11 %)</p>

(5)
[21]

QUESTION 8 / VRAAG 8

- 8.1
- Pressure: 1 atmosphere (atm) / 101,3 kPa / $1,013 \times 10^5$ Pa ✓
Druk: 1 atmosfeer (atm) / 101,3 kPa / $1,013 \times 10^5$ Pa
 - Temperature/*Temperatuur*: 25 °C / 298 K ✓ (2)

- 8.2
- Platinum is inert / does not react with the H^+ ions OR acid. ✓
Platinum is onaktief / reageer nie met die H^+ -ione OF suur nie.
 - Platinum is a conductor (of electricity). ✓
Platinum is 'n geleier (van elektrisiteit). (2)

8.3

- 8.3.1 Salt bridge / *Soutbrug* ✓ (1)

- 8.3.2 -0,31 V ✓ (1)

- 8.3.3 $2H^+ + 2e^- \rightarrow H_2$ ✓✓

Marking guidelines / Nasienriglyne:

- | | | | |
|--|---------------|--------------------------------------|---------------|
| • $2H^+ + 2e^- \rightleftharpoons H_2$ | $\frac{1}{2}$ | $H_2 \rightleftharpoons 2H^+ + 2e^-$ | $\frac{0}{2}$ |
| $H_2 \leftarrow 2H^+ + 2e^-$ | $\frac{2}{2}$ | $H_2 \rightarrow 2H^+ + 2e^-$ | $\frac{0}{2}$ |
- (2)

8.4

- 8.4.1 **POSITIVE MARKING FROM QUESTION 8.3.2.**

POSITIEWE NASIEN VAN VRAAG 8.3.2.

$E_{\text{cell}}^{\theta} = E_{\text{reduction}}^{\theta} - E_{\text{oxidation}}^{\theta}$ ✓

$2,05$ ✓ = $-0,31$ ✓ - $E_{M/M^{2+}}^{\theta}$

$E_{M/M^{2+}}^{\theta} = -2,36$ (V) ✓

M is magnesium/ Mg. ✓

Option 2/ Opsie 2

✓ $\begin{cases} M \rightarrow M^{2+} + 2e^- & E^{\circ} = 2,36 \text{ (V)} \\ X^{2+} + 2e^- \rightarrow X & E^{\circ} = -0,31 \text{ (V)} \end{cases}$ ✓
 $E^{\circ} = 2,05 \text{ V}$ ✓

Thus/*Dus*: $E_{\text{reduction}}^{\theta} = -2,36$ (V) ✓

M is magnesium/ Mg. ✓

Notes / Aantekeninge:

Accept any other correct formula from the data sheet.

Aanvaar enige ander korrekte formule vanaf gegewensblad.

Any other formula using unconventional abbreviations, e.g. $E_{\text{cell}}^{\theta} = E_{\text{OA}}^{\theta} - E_{\text{RA}}^{\theta}$ followed

by correct substitutions: $\frac{4}{5}$

Enige ander formule wat onkonvensionele afkortings gebruik bv. $E_{\text{sel}}^{\theta} = E_{\text{OM}}^{\theta} - E_{\text{RM}}^{\theta}$

gevolg deur korrekte vervangings: $\frac{4}{5}$

Notes / Aantekeninge

Give mark for Mg / magnesium ONLY if concluded from -2,36 V.

Ken punt vir Mg / magnesium slegs toe indien afgelei uit -2,36 V

(5)

- 8.4.2 Exothermic / *Eksotermies* ✓ (1)

- 8.5 The cell reaction reaches equilibrium. ✓
Die selreaksie bereik ewewig.

Notes / Aantekeninge:

Accept: One or more of reactants are used up. / The cell reaction has run to completion.

Aanvaar: Een of meer van reaktanse word opgebruik. / Die selreaksie het volledig verloop.

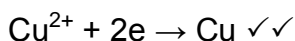
(1)
[15]

QUESTION 9 / VRAAG 9

- 9.1 Electrolytic / *Elektrolities* ✓

(1)

- 9.2 Q ✓ & T ✓



Notes / Aantekeninge:

IF more than TWO electrodes, mark first two.

Indien meer as TWEE elektrodes, sien eerste twee na.

Marking guidelines / Nasienriglyne



(4)

- 9.3

- 9.3.1 Cl_2 / chlorine (gas) / *chloor(gas)* ✓

(1)

- 9.3.2 Cu^{2+} (ions) / copper(II) ions / CuCl_2 / copper(II) chloride ✓

Cu^{2+} (ione) / *koper(II)-ione* / CuCl_2 / *koper(II)chloried*

(1)

- 9.4 Cu is a stronger reducing agent ✓ than Cl^- (ions) ✓ and Cu will be oxidised ✓ (to Cu^{2+}).

Cu is 'n sterker reduseermiddel as Cl^- (-ione) en Cu sal geoksideer word (na Cu^{2+}).

OR/OF

Cl^- (ions) is a weaker reducing agent ✓ than Cu ✓ and Cu will be oxidised ✓ (to Cu^{2+}).

Cl^- (-ione) is 'n swakker reduseermiddel as Cu en Cu sal geoksideer word (na Cu^{2+}).

(3)
[10]

QUESTION 10 / VRAAG 10

10.1

10.1.1 Nitrogen / N₂ / Stikstof ✓
 Hydrogen / H₂ / Waterstof ✓

(2)

10.1.2 NH₃ + HNO₃ ✓ → NH₄NO₃ ✓ Bal. ✓

Notes / Aantekeninge:

- Reactants ✓ Products ✓ Balancing: ✓
Reaktanse Produkte Balansering
- Ignore double arrows. / Ignoreer dubbelpyle.
- Marking rule 6.3.10. / Nasienreël 6.3.10.

(3)

10.2

Marking criteria / Nasienriglyne:

- Use ratio / gebruik verhouding: $\frac{3}{9}$ ✓
- x 20 kg ✓
- x 36 / 36 % ✓
- Final answer / Finale antwoord: 2,4 kg ✓

OPTION 1 / OPSIE 1:

$$\begin{aligned} \% \text{ N} &= \frac{3}{9} \checkmark (\times 36) \checkmark \\ &= 12 \% \\ \therefore m(\text{N}) &: \frac{12}{100} (\times 20 \checkmark \text{ kg}) \\ &= 2,4 \text{ kg } \checkmark \end{aligned}$$

OPTION 2 / OPSIE 2:

$$\begin{aligned} m(\text{nutrients/voedingstowwe}): \\ \frac{36}{100} \checkmark (\times 20) &= 7,2 \text{ kg} \\ \downarrow \\ \therefore m(\text{N}) &= \frac{3}{9} \checkmark \times 7,2 \\ &= 2,4 \text{ kg } \checkmark \end{aligned}$$

OPTION 3 / OPSIE 3:

$$\begin{aligned} m(\text{N}): \\ \frac{3}{9} \checkmark \times (\times 20) (\times \frac{36}{100} \checkmark) &= 2,4 \text{ kg } \checkmark \end{aligned}$$

(4)
 [9]

TOTAL/TOTAAL: 150