



# 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 2015**

**MEMORANDUM**

**MARKS/PUNTE: 150**

**This memorandum consists of 17 pages.  
*Hierdie memorandum bestaan uit 17 bladsye.***

**QUESTION 1/VRAAG 1**

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

**QUESTION 2/VRAAG 2**

- 2.1
- 2.1.1 B ✓ (1)
- 2.1.2  $\begin{array}{c} \text{O} \\ || \\ \text{---C---H} \end{array}$  ✓ (1)
- 2.1.3  $\text{C}_n\text{H}_{2n-2}$  ✓ (1)
- 2.1.4 4-ethyl-5-methylhept-2-yne / 4-ethyl-5-methyl-2-heptyne

*4-eties-5-metieshept-2-yn / 4-eties-5-meties-2-heptyn*

**Marking criteria/Nasienriglyne:**

- 4-ethyl / 4-eties ✓ **OR/OF** 4 ethyl / 4 etiel
- 5-methyl / 5-meties ✓ **OR/OF** 5 methyl / 5 metiel
- hept-2-yne / 2-heptyne / hept-2-yn / 2-heptyn ✓  
**OR/OF** hept 2 yne / 2 heptyne / hept 2 yn / 2 heptyn

**IF/INDIEN:**

Any error e.g. hyphens omitted and/or incorrect sequence:

*Enige fout bv. koppeltekens weggelaat en/of verkeerde volgorde:* Max./Maks.  $\frac{2}{3}$  (3)

- 2.1.5 Butan-2-one / 2-butanone / Butanone  
*Butan-2-oon / 2-butanoon / Butanoon*

**Marking criteria/Nasienriglyne:**

- Functional group / *Funksionele groep* ✓
- Whole name correct / *Hele naam korrek* ✓

(2)

2.2

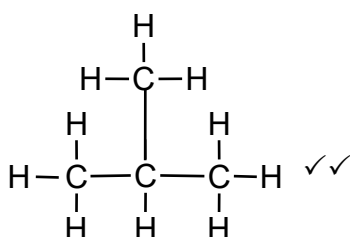
2.2.1 Alkanes / Alkane ✓

(1)

2.2.2 2-methylpropane ✓  
2-metielpropan ✓

**OR/OF**

Methylpropane ✓  
Metielpropan ✓



**Notes/Aantekeninge:**

**IF/INDIEN:**

2 methylpropane / 2 metielpropan ✓  $\frac{1}{2}$

IF sequence incorrect/**INDIEN** volgorde verkeerd: Max./Maks.  $\frac{1}{2}$

**Marking criteria structural formula:**

**Nasienglyne struktuurformule:**

- Three carbons in longest chain. ✓  
*Drie koolstowwe in die langste ketting.*
- Methyl group on second carbon.  
*Metielgroep op tweede koolstof.* ✓

**Notes/Aantekeninge:**

- One or more H atoms omitted:

*Een of meer H-atome uitgelaat:*  $\frac{1}{2}$

- Condensed or semi-structural formula:  
*Gekondenseerde of semi-struktuurformule:*  $\frac{1}{2}$

(4)

2.2.3 Chain / Ketting ✓

(1)

2.3

2.3.1 Haloalkanes / Alkyl halides ✓  
*Haloalkane / Alkielhaliede*

(1)

2.3.2 Substitution / halogenation / bromonation ✓  
*Substitusie / halogenering / halogenasie / bromonering*

(1)

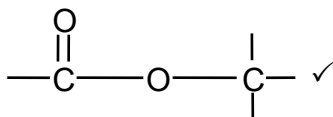
**[16]**

**QUESTION 3/VRAAG 3**

3.1

3.1.1 Esterification / Condensation ✓  
*Esterifikasie / Verestering / Kondensasie* (1)

3.1.2



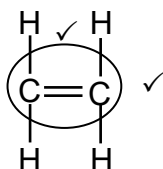
(1)

3.1.3 Propanoic acid / *Propanoësuur* ✓ (1)

3.1.4 Dehydration / elimination ✓  
*Dehidrasie / dehidratering / eliminasie* (1)

3.1.5 (Concentrated)  $H_2SO_4$  / sulphuric acid /  $H_3PO_4$  / phosphoric acid ✓  
*(Gekonsentreerde)  $H_2SO_4$  / swaelsuur / swawelsuur /  $H_3PO_4$  / fosforsuur* (1)

3.1.6



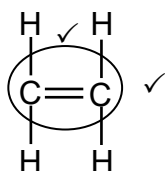
**Notes/Aantekeninge**

- Functional group: ✓  
*Funksionele groep:*
- Whole structure correct: ✓  
*Hele struktuur korrek:*

(2)

3.2

3.2.1



**Notes/Aantekeninge**

- Functional group: ✓  
*Funksionele groep:*
- Whole structure correct: ✓  
*Hele struktuur korrek:*

(2)

3.2.2 Addition / *Addisie* ✓ (1)

**[10]**

#### QUESTION 4/VRAAG 4

4.1 A bond/an atom or a group of atoms ✓ that determine(s) the (physical and chemical) properties of a group of organic compounds. ✓  
'n Binding of 'n atoom of 'n groep atome wat die (fisiese en chemiese) eienskappe van 'n groep organiese verbindings bepaal. (2)

4.2

4.2.1  D / ethanoic acid / etanoësuur ✓  
Lowest vapour pressure. ✓  
Laagste dampdruk. (2)

4.2.2 A / butane / butaan ✓ (1)

4.3

- Between molecules of **A** / butane / alkanes are London / induced dipole / dispersion forces. ✓  
*Tussen molekule van **A** / butaan / alkane is London / geïnduseerde dipole / dispersiekrigte.*
- Between molecules of **B** / propan-2-one / ketones are dipole-dipole forces ✓ in addition to London / induced dipole / dispersion forces.  
*Tussen molekule van **B** / propan-2-oon / ketone is dipool-dipool-krigte tesame met London / geïnduseerde dipool / dispersiekrigte.*
- Intermolecular forces in A are weaker than those in **B**. / Less energy is needed in **A** to break/overcome intermolecular forces. ✓  
*Intermolekulêre kragte in A is swakker as die in **B**. / Minder energie word by **A** benodig om intermolekulêre kragte te breek/oorkom.*

**OR/OF**

Intermolecular forces in B are stronger than those in **A**. / More energy is needed in **B** to break/overcome intermolecular forces.  
*Intermolekulêre kragte in B is sterker as die in **A**. / Meer energie word by **B** benodig om intermolekulêre kragte te breek/oorkom.*

**OR/OF**

- Between molecules of **A** / butane / alkanes are weak London / induced dipole / dispersion forces.  
*Tussen molekule van **A** / butaan/alkane is swak London / geïnduseerde dipool / dispersiekrigte.*
- Between molecules of **B** / propan-2-one / ketone are strong(er) dipole-dipole forces in addition to London/induced dipole / dispersion forces.  
*Tussen molekule van **B** / propan-2-oon / ketone is sterk(er) dipool-dipool/dispersiekrigte.* (3)

4.4 London forces/dispersion forces/induced dipole forces/dipole-dipole forces. ✓  
*Londonkrigte/dispersiekrigte/geïnduseerde dipoolkrigte/dipool-dipoolkrigte.*

**OR/OF**

**A** and **B** do not have hydrogen bonding./**C** and **D** have hydrogen bonding.  
***A** en **B** het nie waterstofbinding nie./**C** en **D** het waterstofbinding.* (1)

4.5 **OPTION 1/OPSIE 1**

- **D** has more sites for hydrogen bonding than **C** / forms dimers / is more polar than **C**. ✓  
*D het meer punte vir waterstofbinding as C / vorm dimere / is meer polêr as C.*
- **D** has stronger / more intermolecular forces / dipole-dipole forces. ✓  
*D het sterker / meer intermolekulêre kragte / dipool-dipoolkragte.*

**OR/OF**

**D** needs more energy to overcome/break the intermolecular forces.  
*D het meer energie nodig om die intermolekulêre kragte te oorkom/breek.*

**OPTION 2/OPSIE 2**

- **C** has less sites for hydrogen bonding than **D**. / **C** does not form dimers / **C** is less polar.  
*C het minder plekke vir waterstofbinding as D. / C vorm nie dimere nie / C is minder polêr.*
- **C** has weaker / less intermolecular forces / dipole-dipole forces. / **C** needs less energy to overcome/break intermolecular forces / dipole-dipole forces.  
*C het swakker / minder intermolekulêre kragte / dipool-dipoolkragte. / C benodig minder energie om intermolekulêre kragte / dipool-dipoolkragte te oorkom/breek.*

(2)

4.6

**Marking criteria/Nasiënriglyne**

- Mole ratio for V(CO<sub>2</sub>) correctly used. / Molverhouding vir V(CO<sub>2</sub>) korrek gebruik.
- Mole ratio for V(H<sub>2</sub>O) correctly used. / Molverhouding vir V(H<sub>2</sub>O) korrek gebruik.
- Mole ratio for V(O<sub>2</sub> reacted) correctly used. / Molverhouding vir V(O<sub>2</sub> reageer) korrek gebruik.
- V(O<sub>2</sub> excess/oormaat) = V(O<sub>2</sub> initial/aanvanklik) – V(O<sub>2</sub> change/verandering).
- V<sub>tot</sub> = 80 cm<sup>3</sup>

**OPTION 1/OPSIE 1**

$V(\text{CO}_2) = 4V(\text{C}_4\text{H}_{10})$ $= (4)(8) \checkmark$ $= 32 \text{ cm}^3$	$V(\text{H}_2\text{O}) = 5V(\text{C}_4\text{H}_{10})$ $= (5)(8) \checkmark$ $= 40 \text{ cm}^3$	$V(\text{O}_2 \text{ reacted/reageer}):$ $V(\text{O}_2) = \frac{13}{2} V(\text{C}_4\text{H}_{10})$ $= \left(\frac{13}{2}\right)(8) \checkmark = 52 \text{ cm}^3$
$V_{\text{tot}} = 32 + 40 + 8 = 80 \text{ cm}^3 \checkmark$		

**V(O<sub>2</sub> excess/oormaat):**  
 $V(\text{O}_2) = 60 - 52 \checkmark = 8 \text{ cm}^3$

**OPTION 2/OPSIE 2**

	C <sub>4</sub> H <sub>10</sub>	O <sub>2</sub>	CO <sub>2</sub>	H <sub>2</sub> O
Initial V (cm <sup>3</sup> ) <i>BeginV (cm<sup>3</sup>)</i>	8	60	0	0
Change in V (cm <sup>3</sup> ) <i>Verandering V (cm<sup>3</sup>)</i>	8	52 ✓	32 ✓	40 ✓
Final V (cm <sup>3</sup> ) <i>Finale V (cm<sup>3</sup>)</i>	0	8 ✓	32	40

Total/totale volume = 8 + 32 + 40 = 80 cm<sup>3</sup> ✓

**OPTION 3/OPSIE 3**

	C <sub>4</sub> H <sub>10</sub>	O <sub>2</sub>	CO <sub>2</sub>	H <sub>2</sub> O
Initial V (dm <sup>3</sup> ) Begin V (dm <sup>3</sup> )	0,008	0,06	0	0
Change in V (dm <sup>3</sup> ) Verandering V (dm <sup>3</sup> )	0,008	0,052 ✓	0,032 ✓	0,04 ✓
Final V (dm <sup>3</sup> ) Finale V (dm <sup>3</sup> )	0	0,008 ✓	0,032	0,04

Total/totale volume = 0,008 + 0,032 + 0,04 = 0,08 dm<sup>3</sup> ✓

(5)  
[16]

**QUESTION 5/VRAAG 5**

5.1 Time/Tyd: (Stop) watch / (Stop)horlosie ✓

Volume: (Gas) syringe / Burette / Measuring cylinder / (Chemical) balance /  
Erlenmeyer flask / Graduated flask ✓  
(Gas)sput / Buret / Maatsilinder / (Chemiese) balans /  
Erlenmeyer fles / Gegradueerde fles

**Notes/Aantekeninge**

- Only one mark per type of apparatus. / Slegs een punt per tipe apparaat.

(2)

5.2

5.2.1 t<sub>1</sub> ✓

(1)

5.2.2 t<sub>3</sub> ✓

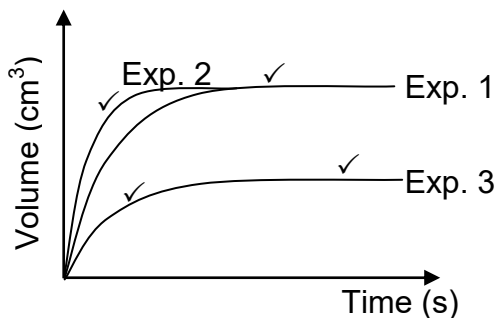
(1)

5.3 Between t<sub>1</sub> and t<sub>2</sub> ✓

Tussen t<sub>1</sub> en t<sub>2</sub>

(1)

5.4



**Marking criteria/Nasienriglyne**

Exp. 2	Initial gradient higher than that of Exp. 1. Aanvanklike gradient groter as die van Eksp 1.	✓
	Curve reaches same constant volume as for Exp. 1 (but earlier). Kurwe bereik dieselfde konstante volume as in Eksp 1 (maar gouer).	✓
Exp. 3	Initial gradient lower than that of Exp. 1. Aanvanklike gradient kleiner as die van Eksp. 1.	✓
	Curve reaches a smaller constant volume as for Exp. 1 (at a later stage). Kurwe bereik (later) 'n kleiner konstante volume as vir Eksp. 1.	✓

(4)

5.5.1

**Marking criteria/Nasienriglyne**

- $n(\text{HCl}) = (0,1)(100 \times 10^{-3})$
- Use mole ratio/Gebruik molverhouding:  $n(\text{Zn}) = \frac{1}{2}n(\text{HCl})$
- Substitute 65 into/ Vervang 65 in  $n = \frac{m}{M}$ .
- $n(\text{Zn}_{\text{final/finaal}}) = n(\text{Zn}_{\text{initial/aanvanklik}}) - n(\text{Zn}_{\text{used/gebruik}})$   
 $m(\text{Zn}_{\text{final/finaal}}) = m(\text{Zn}_{\text{initial/aanvanklik}}) - m(\text{Zn}_{\text{used/gebruik}})$
- Final answer/Finale antwoord: Range/gebied: 0,33 g – 0,48 g

**OPTION/OPSIE 1**

$$n(\text{HCl}) = cV$$

$$= (0,1)(100 \times 10^{-3}) \checkmark$$

$$= 0,01 \text{ mol}$$

↓

$$n(\text{Zn reacted/gereageer}):$$

$$n(\text{Zn}) = \frac{1}{2}n(\text{HCl})$$

$$= \frac{1}{2}(0,01) \checkmark$$

$$= 5 \times 10^{-3} \text{ mol}$$

↓

$$n(\text{Zn reacted/gereageer}):$$

$$m(\text{Zn}) = (5 \times 10^{-3})(65) \checkmark = 0,325 \text{ g}$$

↓

$$m(\text{Zn}_f) = 0,8 - 0,325 \checkmark$$

$$= 0,48 \text{ g} \checkmark (0,475 \text{ g})$$

**OPTION/OPSIE 2**

$$n(\text{HCl}) = cV$$

$$= (0,1)(100 \times 10^{-3}) \checkmark$$

$$= 0,01 \text{ mol}$$

↓

$$n(\text{Zn reacted/gereageer}) = \frac{1}{2}n(\text{HCl})$$

$$= \frac{1}{2}(0,01) \checkmark$$

$$= 5 \times 10^{-3} \text{ mol}$$

↓

$$n(\text{Zn})_i = \frac{m}{M}$$

$$= \frac{0,8}{65} \checkmark$$

$$= 1,23 \times 10^{-2} \text{ mol}$$

↓

$$n(\text{Zn})_f = 1,23 \times 10^{-2} - 5 \times 10^{-3} \checkmark$$

$$= 7,3 \times 10^{-3} \text{ mol}$$

↓

$$m(\text{Zn}) = nM$$

$$= (7,3 \times 10^{-3})(65) = 0,47 \text{ g} \checkmark$$

(5)

5.5.2 Smaller than / Kleiner as  $\checkmark$

(1)

[15]

**QUESTION 6/VRAAG 6**

6.1 Equal to / Gelyk aan  $\checkmark$

(1)

6.2

$$K_c = \frac{[X_3]^2}{[X_2]^3} \checkmark$$

$$= \frac{(0,226)^2}{(0,06)^3} \checkmark$$

$$= 236,46 \checkmark$$

No  $K_c$  expression, correct substitution / Geen  $K_c$ - uitdrukking, korrekte substitusie: Max./Maks.  $\frac{3}{4}$

Wrong  $K_c$  expression / Verkeerde  $K_c$ -uitdrukking Max./Maks.  $\frac{0}{4}$

If one or more exponents are omitted in substitution step but correct answer obtained: Max  $\frac{3}{4}$

Indien een of meer eksponente uitgelaat by substitusie stap, maar korrekte antwoord verkry: Maks  $\frac{3}{4}$

(4)

6.3

6.3.1 Increases / Vermeerder  $\checkmark$

(1)

6.3.2

- The increase in  $[X_3]$  is opposed. / Change is opposed.  $\checkmark$   
 Die verhoging in  $[X_3]$  word teengewerk. / Verandering word teenwerk.
- The reverse reaction is favoured. /  $X_3$  is used /  $[X_3]$  decreases.  $\checkmark$   
 Die terugwaartse reaksie word bevoordeel. /  $X_3$  word gebruik /  $[X_3]$  neem af.

(2)



6.4 Higher than / Hoër as ✓

(1)

6.5 Exothermic / Eksotermies ✓



- The concentration of the product/ $X_3(g)$  is lower / the concentration of the reactant /  $X_2(g)$  is higher. ✓  
*Die konsentrasie van die produkte/ $X_3(g)$  is laer / die konsentrasie van die reaktans /  $X_2(g)$  is hoër.*
- The increase in temperature favoured the reverse reaction. ✓  
*Die toename in temperatuur het die terugwaartse reaksie bevoordeel.*
- According to Le Chatelier's principle an increase in temperature favours the endothermic reaction. ✓  
*Volgens Le Chatelier se beginsel bevoordeel 'n toename in temperatuur die endotermiese reaksie.*

**OR/OF**

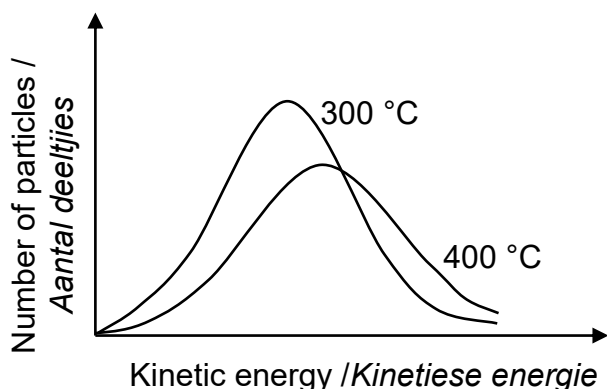
Exothermic / Eksotermies ✓



- $[X_3]$  decreases and  $[X_2]$  increases. /  $[X_3]$  neem af en  $[X_2]$  neem toe. ✓
- $K_c$  decreases if temperature increases. /  $K_c$  neem af as die temperatuur afneem. ✓
- Decrease in temperature favoured the forward reaction. / Verlaging in temperatuur het die voorwaartse reaksie bevoordeel. ✓

(4)

6.6



<b>Marking criteria/Nasienriglyne</b>	
Peak of curve at 400 °C lower than at 300 °C and shifted to the right. <i>Piek van kurwe by 400 °C laer as by 300 °C en skuif na regs.</i>	✓
Curve at 400 °C has larger area at the higher $E_k$ . <i>Kurwe by 400 °C het groter oppervlak by hoë <math>E_k</math>.</i>	✓

(2)  
[15]

**QUESTION 7/VRAAG 7**

7.1

7.1.1 Hydrolysis / *Hidrolise* ✓

(1)

7.1.2 Acidic / *Suur* ✓

(-)

Forms  $H_3O^+$  ions during hydrolysis. / *Vorm  $H_3O^+$  ione gedurende hidrolise.* ✓

**OR/OF**

Salt of strong acid and weak base. / *Sout van sterk suur en swak basis.*

**OR/OF**

$(NH_4^+)$  acts as proton donor. /  *$(NH_4^+)$  tree op as 'n protonskenker.*

(2)

7.2

7.2.1  $n = cV$  ✓  
=  $(0,1)(0,1)$  ✓  
=  $0,01 \text{ mol}$  ✓

(3)

7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1.**

**POSITIEWE NASIEN VAN VRAAG 7.2.1.**

**Marking criteria/Nasienriglyne**

- Substitute volume and concentration to calculate  $n(HCl)$  ✓  
*Vervang volume en konsentrasie om  $n(HCl)$  te bereken.*
- Use mole ratio/*Gebruik molverhouding*:  $n(NaOH) = n(HCl) = 1:1$  ✓
- $n(NaOH) \times 4$  **OR/OF**  $V(HCl) \times 4$  **OR/OF**  $n(HCl) \times 4$  ✓
- Subtraction/*Aftrekking*:  $n(NaOH)_{\text{initial/aanvanklik}} - n(NaOH)_{\text{excess/oormaat}}$  ✓
- Use mole ratio/*Gebruik molverhouding*:  $n(NaOH) = n(NH_4Cl) = 1:1$  ✓
- Substitute/*Vervang*  $53,5 \text{ g} \cdot \text{mol}^{-1}$  in  $n = \frac{m}{M}$ . ✓
- Percentage calculation/*Persentasieberekening* ✓
- Final answer/*Finale antwoord*:  $0,11 \text{ g} - 0,21 \text{ g}$  ✓

<p><b>OPTION 1/OPSIE 1</b></p> <p><math>n(\text{HCl}) = c_a V_a = (0,11)(14,55 \times 10^{-3}) \checkmark = 1,6 \times 10^{-3} \text{ mol}</math></p> <p><math>n(\text{NaOH}) = n(\text{HCl}) = 1,6 \times 10^{-3} \text{ mol} \checkmark</math></p> <p><math>n(\text{NaOH excess/oormaat}) \text{ in } 100 \text{ cm}^3 = 1,6 \times 10^{-3} \times 4 \checkmark</math> <math>= 6,4 \times 10^{-3} \text{ mol}</math></p> <p><math>n(\text{NaOH reacted/gereageer}) = 0,01 - 6,4 \times 10^{-3} \checkmark</math> <math>= 3,6 \times 10^{-3} \text{ mol}</math></p> <p><math>n(\text{NH}_4\text{Cl}) = n(\text{NaOH}) = 3,6 \times 10^{-3} \text{ mol} \checkmark \text{ (0,003598 mol)}</math></p>		
<p><math>m(\text{NH}_4\text{Cl}) = nM</math> <math>= (3,6 \times 10^{-3})(53,5) \checkmark</math> <math>= 0,193 \text{ g}</math></p> <p>92% : 0,193 g 100% : x</p> <p><math>\therefore x = \frac{0,193 \times 100}{92} \checkmark</math> <math>= 0,21 \text{ g} \checkmark</math></p>	<p><math>n(\text{NH}_4\text{Cl}) = 0,92 \frac{x}{53,5} \checkmark</math></p> <p><math>\therefore 3,6 \times 10^{-3} = 0,92 \frac{x}{53,5}</math></p> <p><math>\therefore x = 0,21 \text{ g} \checkmark</math></p>	<p><math>n(\text{NH}_4\text{Cl}) = \frac{m}{53,5} \checkmark</math></p> <p><math>\therefore 3,6 \times 10^{-3} = \frac{m}{53,5}</math></p> <p><math>n(\text{NH}_4\text{Cl}) = 0,192 \text{ g}</math></p> <p><math>m(\text{fertiliser/kunsmis}):</math> <math>m = \frac{0,192 \times 100}{92} \checkmark</math> <math>= 0,21 \text{ g} \checkmark</math></p>
<p><b>OPTION 2/OPSIE 2</b></p> <p><math>V(\text{HCl})</math> to neutralise <math>100 \text{ cm}^3 \text{ NaOH}</math>: <math>V(\text{HCl})</math> neutraliseer <math>100 \text{ cm}^3 \text{ NaOH}</math>: <math>V(\text{HCl}) = 14,55 \times 4 \checkmark</math> <math>= 58,2 \text{ cm}^3</math></p> <p><math>n(\text{HCl}) = cV</math> <math>= (0,11)(0,0582) \checkmark</math> <math>= 0,006402 \text{ mol}</math></p> <p><math>n(\text{NaOH}) = n(\text{HCl})</math> <math>= 0,006402 \text{ mol} \checkmark</math></p> <p><math>n(\text{NaOH reacted/gereageer}):</math> <math>n(\text{NaOH}) = 0,01 - 0,006402 \checkmark</math> <math>= 0,003598 \text{ mol}</math></p> <p><math>n(\text{NH}_4\text{Cl}) = n(\text{NaOH})</math> <math>= 0,003598 \text{ mol} \checkmark</math></p> <p><math>m(\text{NH}_4\text{Cl}) = nM</math> <math>= (0,003598)(53,5) \checkmark</math> <math>= 0,192 \text{ g}</math></p> <p>92% : 0,192 g 100% : <math>\frac{0,192 \times 100}{92} \checkmark = 0,21 \text{ g} \checkmark</math></p>		<p><b>OPTION 3/OPSIE 3</b></p> <p><math>n(\text{HCl})</math> to neutralise <math>100 \text{ cm}^3 \text{ NaOH}</math>: <math>n(\text{HCl})</math> neutraliseer <math>100 \text{ cm}^3 \text{ NaOH}</math>: <math>n(\text{HCl}) = cV</math> <math>= (0,11)(0,01455 \times 4) \checkmark</math> <math>= 0,006402 \text{ mol} (6,4 \times 10^{-3} \text{ mol})</math></p> <p><math>n(\text{NaOH excess/oormaat}):</math> <math>n(\text{NaOH}) = n(\text{HCl}) = 6,4 \times 10^{-3} \text{ mol} \checkmark</math></p> <p><math>n(\text{NaOH reacted/gereageer}):</math> <math>n(\text{NaOH}) = 0,01 - 0,006402 \checkmark</math> <math>= 0,003598 \text{ mol}</math></p> <p><math>n(\text{NH}_4\text{Cl}) = n(\text{NaOH})</math> <math>= 0,003598 \text{ mol} \checkmark</math></p> <p><math>m(\text{NH}_4\text{Cl}) = nM</math> <math>= (0,003598)(53,5) \checkmark</math> <math>= 0,192 \text{ g}</math></p> <p>92% : 0,192 g 100% : <math>0,192 \times \frac{100}{92} \checkmark = 0,21 \text{ g} \checkmark</math></p>

<b>OPTION 4/OPSIE 4</b>	<b>OPTION 5/OPSIE 5</b>
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25} = \frac{1}{1} \checkmark$ $c_b = 0,064 \text{ mol} \cdot \text{dm}^{-3}$ <p><math>n(\text{NaOH in excess in } 100 \text{ cm}^3):</math> <math>n(\text{NaOH in oormaat in } 100 \text{ cm}^3):</math></p> $n(\text{NaOH}) = cV$ $= (0,064)(0,1) \checkmark$ $= 6,4 \times 10^{-3} \text{ mol}$ <p><math>n(\text{NaOH reacted/gereageer}):</math> <math>n(\text{NaOH}) = 0,01 - 0,006402 \checkmark</math> <math>= 0,003598 \text{ mol}</math></p> $n(\text{NH}_4\text{Cl}) = n(\text{NaOH})$ $= 0,003598 \text{ mol} \checkmark$ <p><math>m(\text{NH}_4\text{Cl}) = nM</math> <math>= (0,003598)(53,5) \checkmark</math> <math>= 0,192 \text{ g}</math></p> <p>92% : 0,192 g 100% : <math>0,192 \times \frac{100}{92} \checkmark = 0,21 \text{ g} \checkmark</math></p>	$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25} = \frac{1}{1} \checkmark$ $\therefore c_b = 0,064 \text{ mol} \cdot \text{dm}^{-3}$ <p><math>\Delta c(\text{NaOH}) = 0,1 - 0,064 \checkmark \checkmark</math> <math>= 0,036 \text{ mol} \cdot \text{dm}^{-3}</math></p> <p><math>n(\text{NaOH reacted/gereageer}):</math> <math>n(\text{NaOH}) = cV</math> <math>= 0,036 \times 0,1</math> <math>= 0,0036 \text{ mol}</math></p> <p><math>n(\text{NH}_4\text{Cl}) = n(\text{NaOH}) = 0,0036 \text{ mol} \checkmark</math></p> $n = \frac{m}{M}$ <p><math>\therefore 0,0036 = \frac{92}{100} x \checkmark</math> <math>0,0036(53,5) = 0,92x</math> <math>x = 0,21 \text{ g} \checkmark</math></p>

(8)

7.3

<b>OPTION 1/OPSIE 1</b>	<b>OPTION 2/OPSIE 2</b>
<p><math>[\text{OH}^-] = [\text{NaOH}] = 0,5 \text{ mol} \cdot \text{dm}^{-3}</math></p> <p><math>K_w = [\text{H}_3\text{O}^+][\text{OH}^-]</math> <math>1 \times 10^{-14} = [\text{H}_3\text{O}^+]0,5 \checkmark</math> <math>\therefore [\text{H}_3\text{O}^+] = 2 \times 10^{-14} \text{ mol} \cdot \text{dm}^{-3}</math></p> <p><math>\text{pH} = -\log[\text{H}^+] \checkmark</math> <math>= -\log(2 \times 10^{-14}) \checkmark</math> <math>= 13,7 \checkmark</math></p>	<p><math>\text{pOH} = -\log[\text{OH}^-] \checkmark</math> <math>= -\log(0,5) \checkmark</math> <math>= 0,301</math></p> <p><math>\text{pH} + \text{pOH} = 14</math> <math>\text{pH} = 14 - 0,301 \checkmark</math> <math>= 13,7 \checkmark \quad (13,699)</math></p>
<p><b>Notes/Aantekeninge</b> IF/INDIEN: Wrong formula/Verkeerde formule: <math>\text{pH} = -\log[\text{OH}^-]</math>; <math>\text{pOH} = -\log[\text{NaOH}]</math> No marks for substitution and answer./Geen punte vir vervanging en antwoord.</p>	

(4)

[18]

**QUESTION 8/VRAAG 8**

- 8.1 Temperature/*Temperatuur*: 25 °C / 298 K ✓  
 Pressure/*Druk*: 101,3 kPa / 1,013 x 10<sup>5</sup> Pa / 1 atm / 100 kPa ✓  
 Concentration/*Konsentrasie*: 1 mol·dm<sup>-3</sup> ✓ (3)

8.2

- 8.2.1 Cd(s) / Cadmium / *Kadmium* / Cd|Cd<sup>2+</sup> / Cd<sup>2+</sup>|Cd ✓

**Notes/Aantekeninge**  
Ignore phases. / *Ignoreer fases.*

(1)

8.2.2  $E_{\text{cell}}^{\theta} = E_{\text{cathode}}^{\theta} - E_{\text{anode}}^{\theta}$  ✓  
 $0,13 = E_{\text{cathode}}^{\theta} - (-0,40)$  ✓  
 $E_{\text{cathode}}^{\theta} = 0,13 - 0,40$   
 $= -0,27 \text{ (V)}$  ✓

Q is Ni/nickel/*nikkel* ✓

**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.  $E_{\text{cell}}^{\circ} = E_{\text{OA}}^{\circ} - E_{\text{RA}}^{\circ}$  followed by correct substitutions: / *Enige ander formule wat onkonvensionele afkortings gebruik bv.  $E_{\text{sel}}^{\circ} = E_{\text{OM}}^{\circ} - E_{\text{RM}}^{\circ}$  gevolg deur korrekte vervangings:  $\frac{4}{5}$*

(5)

8.3

- 8.3.1 Cd(s) → Cd<sup>2+</sup>(aq) + 2e<sup>-</sup> ✓✓  
Ignore phases. / *Ignoreer fases.*

**Notes/Aantekeninge**



(2)

- 8.3.2 Pt/Platinum ✓

(1)

8.4 **OPTION 1/OPSIE 1**

Compare/Vergelyk $Q^{2+}$ & $Cd^{2+}$	$Q^{2+}$ is reduced / <b>Cd</b> is oxidised and therefore $Q^{2+}$ is a stronger oxidising agent than $Cd^{2+}$ . $Q^{2+}$ word gereduseer / <b>Cd</b> word geoksideer, en dus is $Q^{2+}$ 'n sterker oksideermiddel as $Cd^{2+}$ .	✓
Compare/Vergelyk $R_2$ & $Cd^{2+}$	$R_2$ is reduced / <b>Cd</b> is oxidised and therefore $R_2$ is a stronger oxidising agent than $Cd^{2+}$ . ✓ $R_2$ word gereduseer / <b>Cd</b> word geoksideer, dus is $R_2$ 'n sterker oksideermiddel as $Cd^{2+}$ .	✓
Compare/Vergelyk $R_2$ & $Q^{2+}$	The cell potential of combination <b>II</b> is higher than that of combination <b>I</b> , therefore $R_2$ is a stronger oxidising agent than $Q^{2+}$ . <i>Die selpotensiaal van kombinasie <b>II</b> is hoër as dié van kombinasie <b>I</b> en dus is <math>R_2</math> 'n sterker oksideermiddel as <math>Q^{2+}</math>.</i>	✓
Final answer/ Finale antwoord	$Cd^{2+}$ ; $Q^{2+}$ ; $R_2$ <b>OR/OF</b> $Cd^{2+}$ ; $Ni^{2+}$ ; $Cl_2$	✓

**OPTION 2/OPSIE 2**

- The reduction potential of  $Cl|Cl_2 = 1,36 V$  ✓ because the cell potential of combination II is 1,76 V and the reduction potential of  $Cd|Cd^{2+}$  is 0,4 V.  
*Die reduksiepotensiaal van  $Cl|Cl_2 = 1,36 V$  omdat die selpotensiaal van kombinasie II 1,76 V is en die reduksiepotensiaal van  $Cd|Cd^{2+}$  0,4 V is.*

**OR/OF**

$R_2$  is  $Cl_2$  because the cell potential of combination II is 1,76 V and the reduction potential of  $Cd|Cd^{2+}$  is 0,4 V. /  $R_2$  is  $Cl_2$  omdat die selpotensiaal van kombinasie II 1,76 V is en die reduksiepotensiaal van  $Cd|Cd^{2+}$  0,4 V is.

- $Cd|Cd^{2+}$  has the lowest reduction potential (-0,4 V) and therefore  $Cd^{2+}$  is the weakest oxidising agent. /  $Cd|Cd^{2+}$  het die laagste reduksiepotensiaal (0,4 V) en dus is  $Cd^{2+}$  die swakste oksideermiddel. ✓
- $Cl|Cl_2$  has the highest reduction potential and therefore  $Cl_2$  is the strongest oxidising agent. /  $Cl|Cl_2$  het die hoogste reduksiepotensiaal en dus is  $Cl_2$  die sterkste oksideermiddel. ✓
- Final answer/Finale antwoord:  $Cd^{2+}$ ;  $Q^{2+}$ ;  $R_2$  ✓ **OR/OF**  $Cd^{2+}$ ;  $Ni^{2+}$ ;  $Cl_2$

(4)  
[16]

**QUESTION 9/VRAAG 9**

9.1 **ANY ONE/ENIGE EEN:**

- The chemical process in which electrical energy is converted to chemical energy. ✓✓  
*Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.*
- The use of electrical energy to produce a chemical change.  
*Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.*
- Decomposition of an ionic compound by means of electrical energy.  
*Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.*
- The process during which and electric current passes through a solution/ionic liquid/molten ionic compound.  
*Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg.*

(2)

9.2 **ANY ONE/ENIGE EEN:**

- To keep the polarity of the electrodes the same. ✓  
*Om die polariteit van die elektrodes dieselfde te hou.*
- To prevent the anode and cathode from swopping.  
*Om te verhoed dat die anode en katode omruil.*
- DC provides a one way flow of electrons ensuring that the same chemical reaction occurs all the time at the electrodes.  
*GS verskaf 'n eenrigting vloei van elektrone en verseker dat dieselfde chemiese reaksie altyd by die elektrodes plaasvind.*
- If you use AC the polarity of the electrodes will keep changing.  
*Wanneer jy WS gebruik word hou die polariteit van die elektrodes aan om te verander.*
- Pure copper deposited on only one electrode.  
*Suiwer koper slaan slegs op een elektrode neer.*

(1)

- 9.3  $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$  ✓✓  
Ignore phases. / Ignoreer fases.

<b>Notes/Aantekeninge</b>			
$\text{Cu}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cu}$	$(\frac{1}{2})$	$\text{Cu} \leftarrow \text{Cu}^{2+} + 2\text{e}^{-}$	$(\frac{2}{2})$
$\text{Cu} \rightleftharpoons \text{Cu}^{2+} + 2\text{e}^{-}$	$(\frac{0}{2})$	$\text{Cu}^{2+} + 2\text{e}^{-} \leftarrow \text{Cu}$	$(\frac{0}{2})$

(2)

- 9.4
- Cu<sup>2+</sup> is a stronger oxidising agent ✓ than Zn<sup>2+</sup>. ✓  
Cu<sup>2+</sup> is 'n sterker oksideermiddel as Zn<sup>2+</sup>.
  - Cu<sup>2+</sup> will be reduced to Cu. / Cu<sup>2+</sup> sal gereduseer word na Cu. ✓

**OR/OF**

- Zn is a stronger reducing agent than Cu.  
Zn is 'n sterker reduseermiddel as Cu.
- Cu<sup>2+</sup> will be reduced to Cu. / Cu<sup>2+</sup> sal gereduseer word na Cu.

**OR/OF**

- The standard reduction potential of Cu<sup>2+</sup>|Cu is higher than that of Zn<sup>2+</sup>|Zn.  
Die standaard reduksie potensiaal van Cu<sup>2+</sup>|Cu is hoër as die van Zn<sup>2+</sup>|Zn.
- Cu<sup>2+</sup> will be reduced to Cu. / Cu<sup>2+</sup> sal gereduseer word na Cu.

**OR/OF**

- The standard reduction potential of Zn<sup>2+</sup>|Zn is lower than that of Cu<sup>2+</sup>|Cu.  
Die standaard reduksie potensiaal van Zn<sup>2+</sup>|Zn is laer as die van Cu<sup>2+</sup>|Cu.
- Cu<sup>2+</sup> will be reduced to Cu. / Cu<sup>2+</sup> sal gereduseer word na Cu.

(3)

9.5

$$n = \frac{m}{M}$$

$$2,85 \times 10^{-2} = \frac{m}{63,5} \checkmark$$

$$m = 1,81 \text{ g}$$

$$\% \text{ purity} = \frac{1,81}{2} \times 100 \checkmark$$

$$= 90,49 \% \checkmark$$

**Marking guidelines/Nasiemriglyne**

- Substitute 63,5 ✓ and 2,85 x 10<sup>-2</sup> ✓ in  $n = \frac{m}{M}$   
Vervang 63,5 en 2,85 x 10<sup>-2</sup> in  $n = \frac{m}{M}$
- Percentage purity. ✓  
Persentasie suiwerheid.
- Final answer/Finale antwoord:  
90,49% ✓ (Accept/Aanvaar: 90,5%)

(4)

**[12]**



**QUESTION 10/VRAAG 10**

10.1

10.1.1 Haber (process) / *Haber(proses)* ✓ (1)

10.1.2  $N_2 + 3H_2 \rightleftharpoons 2NH_3$  ✓ bal ✓

**Notes/Aantekeninge**

- Reactants ✓ Products ✓ Balancing ✓  
*Reaktanse ✓ Produkte ✓ Balansering ✓*
- Ignore/*Ignoreer* → and phases / *en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

10.1.3 Air / *Lug* ✓ (1)

10.2

10.2.1 40% ✓ (1)

10.2.2

- High yield / percentage ✓  
*Hoë opbrengs / persentasie*
- High rate due to higher concentration. ✓  
*Hoë tempo weens hoër konsentrasie.*

(2)

10.2.3 Low reaction rate / *Lae reaksietempo* ✓ (1)

10.3

**Marking guidelines/Nasienriglyne**

$\frac{28}{80}$  ✓ x 50 ✓ = 17,5 kg ✓

**OPTION 1/OPSIE 1**

% N in  $NH_4NO_3 = \frac{28}{80} \times 100$  ✓  
= 35%

m(N) in 50 kg:

$\frac{35}{100} \times 50 = 17,5$  kg ✓

**OPTION 2/OPSIE 2**

m(N in  $NH_4NO_3$ ) =  $\frac{28}{80} \times 50$  ✓  
= 17,5 kg ✓

(3)

**TOTAL/TOTAAL: 150**