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)

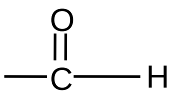
1.10 C ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1

2.1.1 B ✓ (1)

2.1.2


✓ (1)

2.1.3 C_nH_{2n-2} ✓ (1)

2.1.4 4-ethyl-5-methylhept-2-yne / 4-ethyl-5-methyl-2-heptyne

4-etiel-5-metielhept-2-yn / 4-etiel-5-metiel-2-heptyn

Marking criteria/*Nasienriglyne:*
- 4-ethyl / *4-etiel* ✓ **OR/*OF*** 4 ethyl / *4 etiel*
- 5-methyl / *5-metiel* ✓ **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:
E*nige 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)

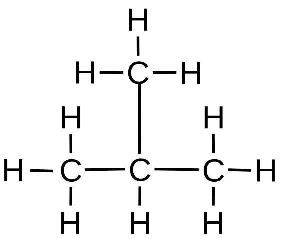
2.2

2.2.1 Alkanes / *Alkane* ✓ (1)

2.2.2 <u>2-methyl</u>propane ✓ ✓
<u>*2-metiel*</u>*propaan*

OR/*OF*

<u>Methyl</u>propane ✓ ✓
<u>*Metiel*</u>*propaan*



✓✓

<u>Notes/*Aantekeninge:*</u>
IF/*INDIEN*:
2 methylpropane / *2 metielpropaan* ✓ $\frac{1}{2}$

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

<u>Marking criteria structural formula:</u>
<u>*Nasienriglyne struktuurformule:*</u>
- Three carbons in longest chain. ✓
  Drie koolstowwe in die langste ketting.
- Methyl group on second carbon.
  Metielgroep op tweede koolstof. ✓

<u>Notes/*Aantekeninge*</u>:
- One or more H atoms omitted:
  Een of meer H-atome uitgelaat: $\frac{1}{2}$
- Condensed or semi-structural formula:
  Gekondenseerde of semi-struktuur-formule: $\frac{1}{2}$

(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)

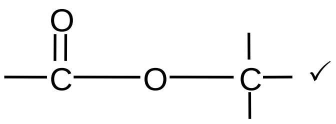
[16]

QUESTION 3/*VRAAG 3*

3.1

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

3.1.2



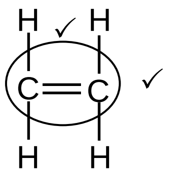
(1)

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

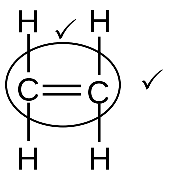


<u>Notes/*Aantekeninge*</u>
- Functional group: ✓
  Funksionele groep:
- Whole structure correct: ✓
  Hele struktuur korrek:

(2)

3.2

3.2.1



<u>Notes/*Aantekeninge*</u>
- 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 / dispersiekragte.*
- 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-kragte tesame met London / geïnduseerde dipool /dispersiekragte.*
- 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 / dispersiekragte.*
- 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/dispersiekragte.* (3)

4.4 London forces/dispersion forces/induced dipole forces/dipole-dipole forces. ✓
Londonkragte/dispersiekragte/geïnduseerde dipoolkragte/dipool-dipoolkragte.

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 **<u>OPTION 1/*OPSIE 1*</u>**

- **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.*

<u>OPTION 2/*OPSIE 2*</u>

- **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 **<u>Marking criteria/*Nasienriglyne*</u>**

- Mole ratio for V(CO_2) correctly used. / *Molverhouding vir* V(CO_2) *korrek gebruik.*
- Mole ratio for V(H_2O) correctly used. / *Molverhouding vir* V(H_2O) *korrek gebruik.*
- Mole ratio for V(O_2 reacted) correctly used. / *Molverhouding vir* V(O_2 *reageer*) *korrek gebruik.*
- V(O_2 excess/*oormaat*) = V(O_2 initial/*aanvanklik*) – V(O_2 change/*verandering*).
- V_{tot} = 80 cm^3

<u>OPTION 1/*OPSIE 1*</u>

$V(CO_2) = 4V(C_4H_{10})$
$= (4)(8)$ ✓
$= 32\ cm^3$

$V(H_2O) = 5V(C_4H_{10})$
$= (5)(8)$ ✓
$= 40\ cm^3$

V(O_2 reacted/*reageer*):
$V(O_2) = \frac{13}{2}V(C_4H_{10})$
$= (\frac{13}{2})(8)$ ✓ $= 52\ cm^3$

V(O_2 excess/*oormaat*):
$V(O_2) = 60 – 52$ ✓ $= 8\ cm^3$

$V_{tot} = 32 + 40 + 8 = 80\ cm^3$ ✓

<u>OPTION 2/*OPSIE 2*</u>

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (cm^3) *Begin*V (cm^3)	8	60	0	0
Change in V (cm^3) *Verandering* V (cm^3)	8	52 ✓	32 ✓	40 ✓
Final V (cm^3) *Finale* V (cm^3)	0	8 ✓	32	40

Total/*totale* volume = 8 + 32 + 40 = 80 cm^3 ✓

OPTION 3/*OPSIE 3*

	C_4H_{10}	O_2	CO_2	H_2O
Initial V (dm^3) *Begin* V (dm^3)	0,008	0,06	0	0
Change in V (dm^3) *Verandering* V (dm^3)	0,008	0,052 ✓	0,032 ✓	0,04 ✓
Final V (dm^3) *Finale* V (dm^3)	0	0,008 ✓	0,032	0,04

Total/*totale* volume = 0,008 + 0,032 + 0,04 = 0,08 dm^3 ✓ (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)spuit / Buret / Maatsilinder / (Chemiese) balans / Erlenmeyer fles / Gegradueerde fles

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

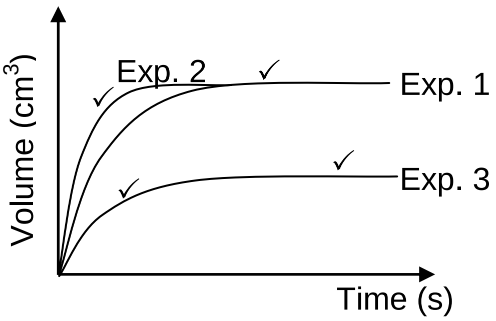
(2)

5.2
5.2.1 t_1 ✓ (1)

5.2.2 t_3 ✓ (1)

5.3 Between t_1 and t_2 ✓
Tussen t_1 en t_2 (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

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Marking criteria/*Nasienriglyne*

- $n(HC\ell) = (0,1)(100 \times 10^{-3})$
- Use mole ratio/*Gebruik molverhouding:* $n(Zn) = ½n(HC\ell)$
- Substitute 65 into/ Vervang 65 in $n = \frac{m}{M}$.
- $n(Zn_{final/finaal}) = n(Zn_{initial/aanvanklik}) – n(Zn_{used/gebruik})$
$m(Zn_{final/finaal}) = m(Zn_{initial/aanvanklik}) – m(Zn_{used/gebruik})$
- Final answer/Finale antwoord: Range/*gebied*: 0,33 g – 0,48 g

</td></tr>
<tr><td>

OPTION/*OPSIE 1*

$n(HC\ell) = cV$
$= (0,1)(100 \times 10^{-3})$ ✓
$= 0,01$ mol

n(Zn reacted/*gereageer):*
$n(Zn) = ½n(HC\ell)$
$= ½(0,01)$ ✓
$= 5 \times 10^{-3}$ mol

n(Zn reacted/*gereageer):*
$m(Zn) = (5 \times 10^{-3})(65)$ ✓ $= 0,325$ g

$m(Zn_f) = 0,8 – 0,325$ ✓
$= 0,48$ g ✓ (0,475 g)

</td><td>

OPTION/*OPSIE 2*

$n(HC\ell) = cV$
$= (0,1)(100 \times 10^{-3})$ ✓
$= 0,01$ mol

n(Zn reacted/*gereageer)* $= ½n(HC\ell)$
$= ½(0,01)$ ✓
$= 5 \times 10^{-3}$ mol

$n(Zn)_i = \frac{m}{M}$
$= \frac{0,8}{65}$ ✓
$= 1,23 \times 10^{-2}$ mol

$n(Zn)_f = 1,23 \times 10^{-2} – 5 \times 10^{-3}$ ✓
$= 7,3 \times 10^{-3}$ mol

$m(Zn) = nM$
$= (7,3 \times 10^{-3})(65) = 0,47$ g ✓

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</table>

(5)

5.5.2 Smaller than / *Kleiner as* ✓ (1)

[15]

QUESTION 6/*VRAAG 6*

6.1 Equal to / *Gelyk aan* ✓ (1)

6.2

$$K_c = \frac{[X_3]^2}{[X_2]^3} \checkmark$$
$$= \frac{(0,226)^2 \checkmark}{(0,06)^3 \checkmark}$$
$$= 236,46 \checkmark$$

<table>
<tr><td>No K_C expression, correct substitution /Geen K_c- uitdrukking, korrekte substitusie: Max./Maks. 3/4
Wrong K_C expression /Verkeerde K_c-uitdrukking Max./Maks. 0/4</td></tr>
<tr><td>If one or more exponents are omitted in substitution step but correct answer obtained: Max 3/4
Indien een of meer eksponente uitgelaat by substitusie stap, maar korrekte antwoord verkry: Maks 3/4</td></tr>
</table>

(4)

6.3 (1)

6.3.1 Increases / *Vermeerder* ✓

6.3.2
- The increase in $[X_3]$ is opposed. / Change is opposed. ✓
Die verhoging in $[X_3]$ word teengewerk. / Verandering word teenwerk.
- The reverse reaction is favoured. / X_3 is used / $[X_3]$ decreases. ✓
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* ✓

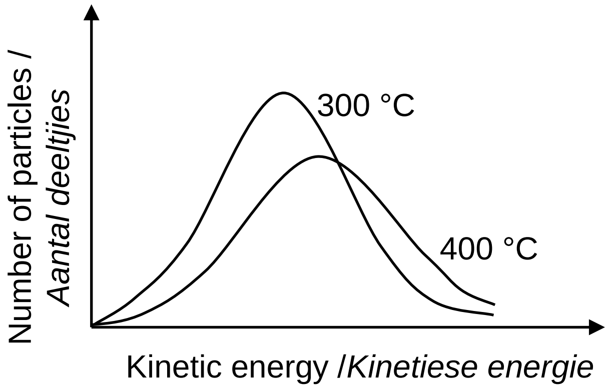
- The <u>concentration of the product/X_3(g) is lower</u> / the concentration of the reactant / X_2(g) is higher. ✓
  Die <u>konsentrasie van die produkte/X_3(g) is laer</u> / die konsentrasie van die reaktans / X_2(g) is *hoër.*
- The increase in temperature <u>favoured the reverse reaction.</u> ✓
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

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



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

(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 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) x 4 **OR/*OF*** V(HCℓ) x 4 **OR/*OF*** n(HCℓ) x 4 ✓
- Subtraction/*Aftrekking:* $n(NaOH_{initial/aanvanklik})$ - $n(NaOH_{excess/oormaat})$ ✓
- Use mole ratio/*Gebruik molverhouding:* n(NaOH) = $n(NH_4C\ell)$ = 1:1 ✓
- Substitute/*Vervang* 53,5 $g \cdot mol^{-1}$ in $n = \frac{m}{M}$. ✓
- Percentage calculation/*Persentasieberekening* ✓
- Final answer/*Finale antwoord*: 0,11 g - 0,21 g ✓

<u>OPTION 1/*OPSIE 1*</u>

$n(HC\ell) = c_aV_a = (0,11)(14,55 \times 10^{-3})$ ✓ $= 1,6 \times 10^{-3}$ mol

$n(NaOH) = n(HC\ell) = 1,6 \times 10^{-3}$ mol ✓

n(NaOH excess/*oormaat*) in 100 cm^3 $= 1,6 \times 10^{-3}$ <u>x 4</u> ✓
$= 6,4 \times 10^{-3}$ mol

n(NaOH reacted/*gereageer*) $= 0,01 - 6,4 \times 10^{-3}$ ✓
$= 3,6 \times 10^{-3}$ mol

$n(NH_4C\ell) = n(NaOH) = 3,6 \times 10^{-3}$ mol ✓ (0,003598 mol)

$m(NH_4C\ell) = nM$
$= (3,6 \times 10^{-3})(53,5)$ ✓
$= 0,193$ g

92% : 0,193 g
100% : x

$\therefore x = \dfrac{0,193 \times 100}{92}$ ✓
$= 0,21$ g ✓

$n(NH_4C\ell) = 0,92\dfrac{x}{53,5}$ ✓ ✓

$\therefore 3,6 \times 10^{-3} = 0,92\dfrac{x}{53,5}$

$\therefore x = 0,21$ g ✓

$n(NH_4C\ell) = \dfrac{m}{53,5}$ ✓

$\therefore 3,6 \times 10^{-3} = \dfrac{m}{53,5}$

$n(NH_4C\ell) = 0,192$ g

m(fertiliser/*kunsmis*):
$m = \dfrac{0,192 \times 100}{92}$ ✓
$= 0,21$ g ✓

<u>OPTION 2/*OPSIE 2*</u>

$V(HC\ell)$ to neutralise 100 cm^3 NaOH:
$V(HC\ell)$ neutraliseer 100 cm^3 *NaOH:*
$V(HC\ell) = 14,55$ <u>x 4</u> ✓
$= 58,2$ cm^3

$n(HC\ell) = cV$
$= (0,11)(0,0582)$ ✓
$= 0,006402$ mol

$n(NaOH) = n(HC\ell)$
$= 0,006402$ mol ✓

n(NaOH reacted/*gereageer):*
$n(NaOH) = 0,01 - 0,006402$ ✓
$= 0,003598$ mol

$n(NH_4C\ell) = n(NaOH)$
$= 0,003598$ mol ✓

$m(NH_4C\ell) = nM$
$= (0,003598)(53,5)$ ✓
$= 0,192$ g

92% : 0,192 g

100% : $\dfrac{0,192 \times 100}{92}$ ✓ $= 0,21$ g ✓

<u>OPTION 3/*OPSIE 3*</u>

$n(HC\ell)$ to neutralise 100 cm^3 NaOH:
$n(HC\ell)$ neutraliseer 100 cm^3 *NaOH:*
$n(HC\ell) = cV$
$= (0,11)(0,01455$ <u>x 4</u>✓$)$ ✓
$= 0,006402$ mol $(6,4 \times 10^{-3}$ mol$)$

n(NaOH excess/*oormaat):*
$n(NaOH) = n(HC\ell) = 6,4 \times 10^{-3}$ mol ✓

n(NaOH reacted/*gereageer*):
$n(NaOH) = 0,01 - 0,006402$ ✓
$= 0,003598$ mol

$n(NH_4C\ell) = n(NaOH)$
$= 0,003598$ mol ✓

$m(NH_4C\ell) = nM$
$= (0,003598)(53,5)$ ✓
$= 0,192$ g

92% : 0,192 g

100% : $0,192 \times \dfrac{100}{92}$ ✓ $= 0,21$ g ✓

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<u>OPTION 4/*OPSIE 4*</u>

$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25} = \frac{1}{1}$ ✓ ✓

$c_b = 0,064\ mol·dm^{-3}$

n(NaOH in excess in 100 cm^3):
n(NaOH in oormaat in 100 cm^3):

n(NaOH) = cV
= (0,064)(0,1) ✓
= 6,4 x 10^{-3} mol

n(NaOH reacted/*gereageer*):
n(NaOH) = 0,01 - 0,006402 ✓
= 0,003598 mol

$n(NH_4Cℓ)$ = n(NaOH)
= 0,003598 mol ✓

$m(NH_4Cℓ)$ = nM
= (0,003598)(53,5) ✓
= 0,192 g

92% : 0,192 g
100% : 0,192 x $\frac{100}{92}$ ✓ = 0,21 g ✓

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<u>OPTION 5/*OPSIE 5*</u>

$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b} \therefore \frac{0,11 \times 14,55}{c_b \times 25} = \frac{1}{1}$ ✓ ✓

$\therefore c_b = 0,064\ mol·dm^{-3}$

Δc(NaOH) = 0,1 - 0,064 ✓✓
= 0,036 mol·dm^{-3}

n(NaOH reacted/*gereageer*):
n(NaOH) = cV
= 0,036 x 0,1
= 0,0036 mol

$n(NH_4Cℓ)$ = n(NaOH) = 0,0036 mol ✓

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

$\therefore 0,0036 = \frac{\frac{92}{100}x}{53,5}$ ✓ ✓

0,0036(53,5) = 0,92x
x = 0,21 g ✓

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</table>

(8)

7.3

<table>
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<u>OPTION 1/*OPSIE 1*</u>

$[OH^-] = [NaOH] = 0,5\ mol·dm^{-3}$

$K_w = [H_3O^+][OH^-]$
$1 \times 10^{-14} = [H_3O^+]0,5$ ✓
$\therefore [H_3O^+] = 2 \times 10^{-14}\ mol·dm^{-3}$

$pH = -log[H^+]$ ✓
$= -log(2 \times 10^{-14})$ ✓
= 13,7 ✓

</td>
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<u>OPTION 2/*OPSIE 2*</u>

$pOH = -log[OH^-]$ ✓
= -log(0,5) ✓
= 0,301

pH + pOH = 14
pH = 14 – 0,301 ✓
= 13,7 ✓ (13,699)

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<u>Notes/*Aantekeninge*</u>
IF/*INDIEN:*
Wrong formula/*Verkeerde formule*: $pH = -log[OH^-]$; pOH = -log[NaOH]
No marks for substitution and answer./*Geen punte vir vervanging en antwoord.*

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(4)
[18]

QUESTION 8/*VRAAG 8*

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

8.2
8.2.1 Cd(s) / Cadmium / *Kadmium* / Cd|Cd^{2+} / Cd^{2+}|Cd ✓

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

(1)

8.2.2
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓
$0{,}13 = E^{\theta}_{cathode} - (-0{,}40)$ ✓ ✓
$E^{\theta}_{cathode} = 0{,}13 - 0{,}40$
$= -0{,}27$ (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. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions: / *Enige ander formule wat onkonvensionele afkortings gebruik bv. $E°_{sel} = E°_{OM} - E°_{RM}$ gevolg deur korrekte vervangings:* $\frac{4}{5}$

(5)

8.3
8.3.1 Cd(s) → Cd^{2+}(aq) + 2e^- ✓✓
Ignore phases. / *Ignoreer fases*.

Notes/*Aantekeninge*

$Cd^{2+} + 2e^- \leftarrow Cd$ ($\frac{2}{2}$)	$Cd \rightleftharpoons Cd^{2+} + 2e^-$ ($\frac{1}{2}$)
$Cd \leftarrow Cd^{2+} + 2e^-$ ($\frac{0}{2}$)	$Cd^{2+} + 2e^- \rightleftharpoons Cd$ ($\frac{0}{2}$)

(2)

8.3.2 Pt/Platinum ✓ (1)

8.4 **<u>OPTION 1/*OPSIE 1*</u>**

Compare/*Vergelyk* **Q^{2+}** *&* **Cd^{2+}**	**Q^{2+}** is reduced / **Cd** is oxidised and therefore <u>**Q^{2+}** is a stronger oxidising agent than **Cd^{2+}**</u>. ***Q^{2+}*** *word gereduseer /* ***Cd*** *word geoksideer, en dus is* <u>***Q^{2+}*** *'n sterker oksideermiddel as* ***Cd^{2+}***</u>*.*	✓
Compare/*Vergelyk* **R_2** & **Cd^{2+}**	***R_2*** *is reduced /* ***Cd*** is oxidised and therefore <u>***R_2*** is a stronger oxidising agent than *Cd^{2+}*</u>. ✓ ***R_2*** *word gereduseer /* ***Cd*** *word geoksideer, dus is* <u>***R_2*** *'n sterker oksideermiddel as* ***Cd^{2+}***</u>*.*	✓
Compare/*Vergelyk* **R_2** & **Q^{2+}**	<u>The cell potential of combination **II** is higher than that of combination **I**, therefore **R_2** is a stronger oxidising agent than **Q^{2+}**</u>. <u>*Die selpotensiaal van kombinasie* ***II*** *is hoër as dié van kombinasie* ***I*** *en dus is* ***R_2*** *'n sterker oksideermiddel as* ***Q^{2+}***</u>*.*	✓
Final answer/ *Finale antwoord*	Cd^{2+}; Q^{2+};R_2 **OR/*OF*** Cd^{2+} ; Ni^{2+} ; $C\ell_2$	✓

<u>OPTION 2/*OPSIE 2*</u>

- The reduction potential of <u>$C\ell^-|C\ell_2$ = 1,36 V</u> ✓ 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 <u>$C\ell^-/C\ell_2$ = 1,36 V</u> omdat die selpotensiaal van kombinasie II 1,76 V is en die reduksiepotensiaal van Cd/Cd^{2+} 0,4 V is.

  OR/*OF*
  <u>*R_2 is $C\ell_2$*</u> because the cell potential of combination II is 1,76 V and the reduction potential of Cd|Cd^{2+} is 0,4 V./ <u>*R_2 is $C\ell_2$*</u> *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.* ✓

- $C\ell^-|C\ell_2$ has the highest reduction potential and therefore $C\ell_2$ is the strongest oxidising agent. / $C\ell^-|C\ell_2$ *het die hoogste reduksiepotensiaal en dus is* $C\ell_2$ *die sterkste oksideermiddel.* ✓

- Final answer/*Finale antwoord*: Cd^{2+}; Q^{2+};R_2 ✓ **OR/*OF*** Cd^{2+} ; Ni^{2+} ; $C\ell_2$ (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 Cu^{2+} (aq) + $2e^-$ → Cu (s) ✓✓
Ignore phases. / *Ignoreer fases*.

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

(2)

9.4

- Cu^{2+} is a stronger oxidising agent ✓ than Zn^{2+}. ✓
  Cu^{2+} is 'n sterker oksideermiddel as Zn^{2+}.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.* ✓

OR/*OF*

- Zn is a stronger reducing agent than Cu.
  Zn is 'n sterker reduseermiddel as Cu.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.*

OR/*OF*

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

OR/*OF*

- The standard reduction potential of $Zn^{2+}|Zn$ is lower than that of $Cu^{2+}|Cu$.
  Die standaard reduksie potensiaal van $Zn^{2+}|Zn$ is laer as die van $Cu^{2+}|Cu$.
- Cu^{2+} will be reduced to Cu. / *Cu^{2+} sal gereduseer word na Cu.* (3)

9.5

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

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

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

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

$$= 90{,}49\ \%\ ✓$$

Marking guidelines/*Nasienriglyne*

- Substitute 63,5 ✓and 2,85 x 10^{-2} ✓ in $n = \frac{m}{M}$
  Vervang 63,5 en 2,85 x 10^{-2} 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 $N_2 + 3H_2$ ✓ ⇌ $2NH_3$ ✓ bal ✓

Notes/*Aantekeninge*		
• Reactants ✓ *Reaktanse* ✓	Products ✓ *Produkte* ✓	Balancing ✓ *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*	**OPTION 2/*OPSIE 2***
% N in NH_4NO_3 = $\frac{28}{80}$ ✓ $\times 100$ = 35% m(N) in 50 kg: $\frac{35}{100} \times 50$ ✓ = 17,5 kg ✓	m(N in NH_4NO_3) = $\frac{28}{80}$ ✓ x 50 ✓ = 17,5 kg ✓

(3)

TOTAL/*TOTAAL*: 150