education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION
VOORBEREIDENDE EKSAMEN

GRADE/*GRAAD* 12

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



SEPTEMBER 2024

MARKS/*PUNTE*: 150

MARKING GUIDELINES/*NASIENRIGLYNE*

These marking guidelines consist of 14 pages.
Hierdie nasienriglyne bestaan uit 14 bladsye.

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QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 C ✓✓ (2)

1.4 D ✓✓ (2)

1.5 B ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 C ✓✓ (2)

1.9 A ✓✓ (2)

1.10 A ✓✓ (2)
[20]

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QUESTION 2/*VRAAG 2*

2.1.1 A ✓ (1)

2.1.2 E ✓ (1)

2.1.3 D ✓ (1)

2.2.1 Tertiary (alcohol) / *Tersiêre (alkohol)* ✓
The carbon atom bonded to the hydroxyl group is bonded to three other carbon atoms. ✓
Die koolstofatoom wat aan die hidroksielgroep gebind is, is aan drie ander koolstofatome gebind. (2)

2.2.2 3-methylheptan-3-ol / *metielheptaan-3-ol*

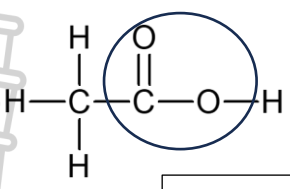
Marking criteria/*Nasienkriteria:*
- Correct stem of alcohol, i.e. heptanol. ✓
- Substituent correctly identified, i.e. methyl. ✓
- IUPAC name completely correct including numbering and hyphens. ✓

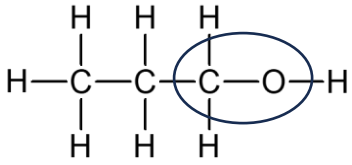
- *Korrekte stam van alkohol, d.i. heptanol.*
- *Substituent korrek geïdentifiseer, d.i. metiel.*
- *IUPAC-naam heeltemal korrek, insluitend nommering en koppeltekens.*

(3)

2.2.3 Hydroxyl (group) / *Hydroksiel (groep)* ✓ (1)

2.3.1



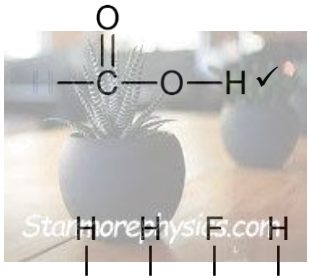


Marking criteria/Nasienkriteria:
- Correct functional group of carboxylic acid. ✓
- Whole structure of carboxylic acid correct. ✓
- Correct functional group of alcohol. ✓
- Whole structure of alcohol correct. ✓

- *Korrekte funksionele groep karboksielsuur.*
- *Hele struktuur van karboksielsuur korrek.*
- *Korrekte funksionele groep alkohol.*
- *Hele struktuur van alkohol korrek.*

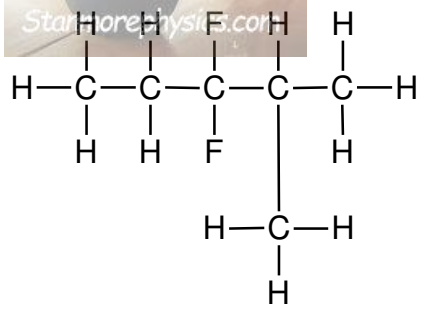
(4)

2.3.2



(1)

2.4



Marking criteria/Nasienkriteria:
- Methyl substituent on second C atom. ✓
- Two fluorine atoms on third C atom. ✓
- Whole structure correct. ✓

- *Metielsubstituent op tweede C-atoom.*
- *Twee fluooratome op derde C-atoom.*
- *Hele struktuur korrek.*

(3)

2.5 $n(CO_2) = \frac{m}{M}$ ✓(a)

$= \frac{2750}{44}$ ✓(b)

$= 62,5$ mol

$n(CH_4) = n(CO_2)$ ✓ (c)

$= 62,5$ mol

$m(CH_4) = n(CH_4) \times M(CH_4)$

$= 62,5 \times 16$ ✓ (d)

$= 1000$g/ 1kg ✓ (e)

Marking criteria/Nasienkriteria:
(a) Formula/*Formule* $n = \frac{m}{M}$ ✓
(b) Substitute/*Vervanging* $M = 44$ g·mol^{-1} in $n = \frac{m}{M}$ ✓
(c) Use mole ratio/*Gebruik molverhouding:* $n(CH_4) = n(CO_2)$ ✓
(d) Substitute/*Vervanging* $M = 16$ g·mol^{-1} in $n = \frac{m}{M}$ ✓
(e) Correct final answer/*Korrekte finale antwoord*: 1 000 g OR 1 kg ✓

(5)
[22]

QUESTION 3/*VRAAG 3*

3.1 **Marking criteria/*Nasienkriteria*:**

If any of the underlined key phrases in the correct context is omitted, deduct 1 mark. *Indien enige van die onderstreepte sleutelfrases in die korrekte konteks weggelaat word, trek 1 punt af.*

The temperature at which the vapour pressure of a liquid is equal to the atmospheric pressure.✓✓
Die temperatuur waarby die dampdruk van 'n vloeistof gelyk is aan die atmosferiese druk. (2)

3.2.1 **FROM A TO C**
- Increase branching/smaller surface area/more compact ✓
- Weaker intermolecular forces ✓
- Less energy needed to break the intermolecular forces ✓
- Boiling point decreases ✓

VANAF A TOT C
- *Vergroot vertakking/kleiner oppervlakte/meer kompak*
- *Swakker intermolekulêre kragte*
- *Minder energie benodig om die intermolekulêre kragte te breek*
- *Kookpunt neem af* (4)

3.2.2 C/2,2-dimethylpropane / *dimetielpropaan* ✓ (1)

3.2.3 Lowest boing point / *Laagste kookpunt* ✓ (1)

3.3 Greater than (103 °C) ✓
- Between compound D/pentanal molecules are dipole-dipole forces✓ (and London forces) and between compound E/butanoic acid are hydrogen bonds✓ (dipole-dipole and London forces).
- Dipole-dipole forces are weaker than hydrogen bonds. ✓
  OR
  Intermolecular forces between compound D/pentanal molecules are weaker than those between compound E/butanoic acid molecules.
  OR
  Less energy is needed to break the intermolecular forces between pentanal molecules.

Groter as (103 °C)
- *Tussen verbinding D/pentanale molekules is dipool-dipoolkragte (en Londen-kragte) en tussen verbinding E/butaansuur is waterstofbindings (dipool-dipool en Londen-kragte).*
- *Dipool-dipoolkragte is swakker as waterstofbindings.*
  OF

Intermolekulêre kragte tussen verbinding D/pentanale molekules is swakker as dié tussen verbinding E/butaansuurmolekules.
OF
Minder energie benodig om die intermolekulêre kragte tussen pentanale molekules te breek. (4)

3.4 Yes/*Ja* ✓ (1)

3.5 Comparable molecular masses AND only functional group (homologous series) changed/only 1 independent variable ✓

Vergelykbare molekulêre massas EN enigste funksionele groep (homoloë reeks) verander/slegs 1 onafhanklike veranderlike. (1)
[14]

QUESTION 4/*VRAAG 4*

4.1 A reaction of a halogen with a compound. ✓✓
'n Reaksie van 'n halogeen met 'n verbinding. (2)

4.2.1 Heat/Sunlight/UV light / *Hitte/Sonlig/UV-lig* ✓ (1)

4.2.2 HBr ✓ (1)

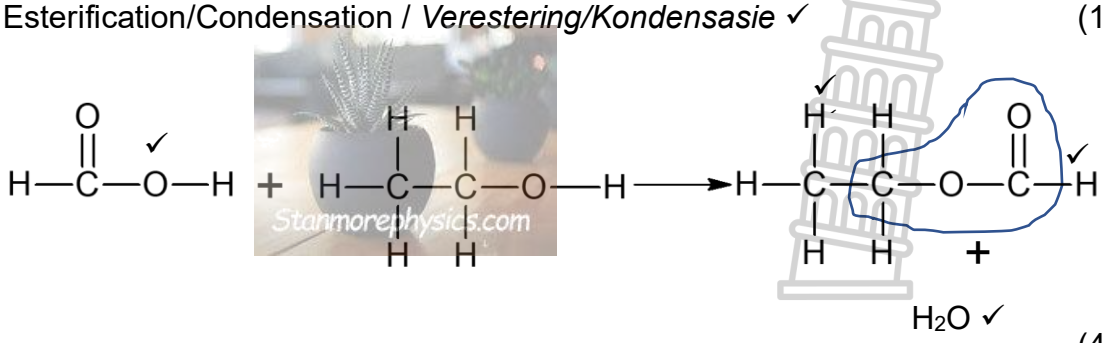
4.3 CH_3CH_2Br ✓ + NaOH/ ✓ KOH/LiOH ⟶ CH_2CH_2 ✓ + NaBr/ ✓ KBr/LiBr + H_2O ✓ (5)

4.4 Addition/Hydration / *Addisie/Hidrasie* ✓ (1)

4.5 Methanoic acid / *Metanoësuur* ✓✓ (2)

4.6 Esterification/Condensation / *Verestering/Kondensasie* ✓ (1)

4.7



(4)
[17]

QUESTION 5/*VRAAG 5*

5.1 Mass meter/Scale / *Massameter/Skaal* ✓ (1)

5.2 Calcium carbonate / *Kalsiumkarbonaat* ✓ (1)

5.3
- Change in concentration/mass/amount/volume ✓ of reactants/products per unit time. ✓
- Concentration/amount/mass/volume of reactants used/products formed per unit time.
- Rate of change in concentration/amount/mass/volume. **(2 or 0)**

- *Verandering in konsentrasie/massa/hoeveelheid/volume van reaktante/ produkte per tydseenheid.*
- *Konsentrasie/hoeveelheid/massa/volume van reaktante gebruik/produkte gevorm per tydseenheid.*
- *Tempo van verandering in konsentrasie/hoeveelheid/massa/volume.* (2)

5.4

Marking criteria/*Nasienriglyne:*
- Mass of CO_2 formed/*Massa van CO_2 gevorm*: 270-268,4 or/*of* 1,6g ✓
- Substituting/*Vervanging* 44 in $n = \frac{m}{M}$ ✓
- Substitute number of moles of CO_2 in the rate formula ✓
  Vervang die aantal mol CO2 in die tempoformule
- Substitute time in the rate formula / *Vervang tyd in die tempoformule* ✓
- Correct final answer/*Korrekte finale antwoord* ✓
- Range/*Gebied*: 0,001 to 0,0013 mol·s^{-1}

$n(CO_2) = \frac{m}{M}$ ✓ (a)
$= \frac{1,6}{44}$ ✓ (b)
$= 0,03636$ mol

Rate/*Tempo* $= \left(\frac{\triangle n}{\triangle t}\right)$
$= \left(\frac{0,03636-0}{30-0}\right)$ ✓ (c) ✓ (d)
$= 1,21 \times 10^{-3}$ (mol·s^{-1}) ✓ (e) (5)

5.5 Experiment 1/*Eksperiment 1* ✓ (1)

5.6
- High concentration results in more particles per unit volume ✓
- More effective collisions per unit time/frequency of effective collisions increases ✓
- Higher rate of reaction ✓/Higher rate of formation of CO_2.

- *Hoë konsentrasie lei tot meer deeltjies per eenheid volume*
- *Meer effektiewe botsings per tydseenheid/frekwensie van effektiewe botsings neem toe*
- *Hoër reaksietempo/Hoër tempo van vorming van CO_2.* (3)

[13]

QUESTION 6/*VRAAG 6*

6.1.1 Rate of forward reaction is equal to rate of reverse reaction. ✓✓
Tempo van voorwaartse reaksie is gelyk aan tempo van terugwaartse reaksie. (2)

6.1.2 Addition of a catalyst / *Addisie van 'n katalisator* ✓✓ (2)

6.1.3 (a) Decreased / *Toeneem* ✓ (1)

(b) Exothermic / *Eksotermies* ✓ (1)

(c)
- Decrease in temperature favours an exothermic reaction . ✓
- The forward reaction is favoured ✓/rate of forward reaction decreased less than that of the reverse reaction.

- *Verlaging in temperatuur bevoordeel 'n eksotermiese reaksie.*
- *Die voorwaartse reaksie word bevoordeel/tempo van voorwaartse reaksie het minder afgeneem as dié van die terugwaartse reaksie* (2)

6.2.1 When the products can be converted back to reactants ✓
Wanneer die produkte terug na reaktante omgeskakel kan word (1)

6.2.2 **CALCULATIONS USING NUMBER OF MOLES/**
Mark allocation:
(a) USING ratio NOCℓ : NO : $Cℓ_2$= 2:2:1✓
(b) Change in number of moles of NO = equilibrium moles of NO
Equilibrium number moles of $Cℓ_2$ = change in moles of $Cℓ_2$
(c) Equilibrium moles NOCℓ = initial moles NOCℓ – change moles of NOCℓ ✓
(d) Dividing equilibrium moles NOCℓ and $Cℓ_2$ by 2 AND mutiplying equilibrium concentration NO by 2 ✓
(e) Correct K_c expression (formulae in square brackets) ✓
(f) Correct substitution of concentrations into K_c correct expression ✓
(g) Final answer : 0,33 ✓
} ✓

BEREKENINGE MET GEBRUIK VAN AANTAL MOL
Puntetoekenning:
(a) GEBRUIK verhouding NOCℓ : NO : $Cℓ_2$= 2:2:1
(b) Verandering in aantal mol NO = ewewigsmol NO
Ekwilibriumgetal mol $Cℓ_2$ = verandering in mol $Cℓ_2$
(c) Ekwilibrium mol NOCℓ = aanvanklike mol NOCℓ – verander mol van NOCℓ
(d) Deel ewewigsmol NOCℓ en $Cℓ_2$ deur 2 EN vermenigvuldig ewewigkonsentrasie NO met 2
(e) Korrekte K_c-uitdrukking (formules tussen vierkantige hakies)
(f) Korrekte vervanging van konsentrasies in K_c korrekte uitdrukking
(g) Finale antwoord : 0,33

	NOCℓ	**NO**	**$Cℓ_2$**
Initial quantity (mol) *Aanvanklike hoeveelheid (mol)*	4	0	0
Change *Verander* (mol)	1,8	1,8	0,9
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	2,2 ✓ (c)	1,8	0,9 ✓(b)
Equilibrium concentration (mol·dm^{-3}) *Ekwilibriumkonsentrasie (mol·dm-^{3})*	1,1	0,9	0,45

Ratio ✓ (a)
Verhouding
✓(d)
÷ & x 2

$$Kc = \frac{[NO]^2[Cl_2]}{[NOCl]^2}$$ ✓ (e)

$$Kc = \frac{(0,9)^2(0,45)}{1,1}$$ ✓(f)

Kc = 0,33 ✓(g)

Wrong K_c expression / *Verkeerde K_c uitdrukking* Max/*Maks:* $^4/_7$
No K_c expression followed by correct substitutions / *Geen K_c-uitdrukking gevolg deur korrekte vervangings* Max/*Maks*: $^6/_7$

(7)

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CALCULATIONS USING CONCENTRATIONS
Mark allocation*:*
(a) Initial concentration of NOCℓ = initial moles of NOCℓ ÷ 2 ✓
(b) USING ratio NOCℓ : NO: $C\ell_2$ = 2:2:1✓
(c) Change in concentration of NO = equilibrium concentration of NO
Equilibrium concentration of $C\ell_2$ = change in concentration of $C\ell_2$ } ✓
(d) Equilibrium concentration of NOCℓ = initial concentration of NOCℓ – change in concentration of NOCℓ ✓
(e) Correct K_c expression (formulae in square brackets) ✓
(f) Correct substitution of concentrations into K_c expression ✓
(g) Final answer : 0,33 ✓

BEREKENINGE DEUR KONSENTRASIES
Puntetoekenning:
(a) Aanvanklike konsentrasie van NOCℓ = aanvanklike mol NOCℓ ÷ 2
(b) GEBRUIK verhouding NOCℓ : NO: $C\ell_2$ = 2:2:1
(c) Verandering in konsentrasie van NO = ewewigskonsentrasie van NO
Ekwilibriumkonsentrasie van $C\ell_2$ = verandering in konsentrasie van $C\ell_2$
(d) Ekwilibriumkonsentrasie van NOCℓ = aanvanklike konsentrasie NOC – verandering in konsentrasie van NOCℓ
(e) Korrekte K_c-uitdrukking (formules tussen vierkantige hakies)
(f) Korrekte vervanging van konsentrasies in K_c uitdrukking
(g) Finale antwoord: 0,33

	NOCℓ	**NO**	**$C\ell_2$**
Initial concentration (mol·dm^{-3}l) Aa*nvanklike konsentrasie (mol·dm-^{3}l)*	2 ✓ (a)	0	0
Change concentration (mol·dm^{-3}) *Verander konsentrasie (mol·dm-^{3})*	0,9	✓(c) 0,9	0,45
Equilibrium concentration (mol·dm^{-3}) *Ekwilibriumkonsentrasie (mol·dm-^{3})*	1,1 ✓ (d)	0,9	0,45

Ratio ✓ (b)
Verhouding

$$K_c = \frac{[NO]^2[Cl_2]}{[NOCl]^2}$$ ✓ (e)

$$K_c = \frac{(0,9)^2(0,45)}{1,1}$$ ✓(f)

K_c = 0,33 ✓(g)

Wrong K_c expression / *Verkeerde* K_c *uitdrukking*	Max/*Maks:* $^4/_7$
No K_c expression followed by correct substitutions / *Geen K_c-uitdrukking gevolg deur korrekte vervangings*	Max/*Maks*: $^6/_7$

(7)
[16]

QUESTION 7/*VRAAG 7*

7.1.1 The reaction of salt with water ✓✓
Die reaksie van soutwater met water (2)

7.1.2 Acidic/*Suur* ✓ (1)

7.1.3 $NH_4^+(aq) + H_2O(\ell)$ ✓ $\rightarrow NH_3 + H_3O^+(aq)$ ✓✓
OR / *OF*
$NH_4^+(aq) + 2H_2O(\ell)$ ✓ $\rightarrow NH_4OH + H_3O^+(aq)$ ✓✓ (3)

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7.2.1 Strong (acid) / *Sterk (suur)*✓ (1)

7.2.2 Ionises/dissociate completely in water✓to form a high concentration of H_3O^+ ions. ✓
Ioneer/dissosieer heeltemal in water om 'n hoë konsentrasie van H_3O^+ ione te vorm. (2)

7.2.3 Methyl orange / *Metiel oranje* ✓ (1)

7.2.4 Titration of strong acid ✓ and weak base ✓
Titrasie van sterk suur en swak basis (2)

7.2.5

Marking criteria/*Nasienriglyne:*

- Formula / *Formule* $c = \frac{n}{V}$ ✓
- Substitute / *Vervang* 0,1 AND / *EN* 25×10^{-3} in $n = cV$ ✓
- Final answer/*Finale antwoord:* 0,0025 mol ✓

$c = \frac{n}{V}$ ✓
$n = 0,1 \times 25 \times 10^{-3}$ ✓
$n = 2,5 \times 10^{-3}$ mol✓ / 0,0025 mol (ACCEPT/*AANVAAR*: 0,003 mol) (3)

7.2.6

Marking criteria/*Nasienriglyne:*

(a) Ratio / *Verhouding* $n(HC\ell) = n(NH_3)$ ✓
(b) Formula / *Formule* $c = \frac{n}{V}$ / $pH = -\log[H_3O^+]$ ✓
(c) Substituting $n(NH_3)$ and volume of $0,04dm^3$ / *Vervang n(NH₃) en volume van 0,04dm³*
(d) Subtraction / *Aftrekking*: $c(HC\ell)_{initial} - c(HC\ell)_{used}$ ✓✓
(e) $c(H_3O^+) = c(HC\ell)$ ✓
(f) Substituting / *Vervanging* $c(H_3O^+)$ in $pH = -\log[H_3O^+]$ ✓
(g) Final answer / *Finale antwoord* = 1,43 ✓

$n(HC\ell) = n(NH_3)$ ✓(a)
$= 2,5 \times 10^{-3}$

$c(HC\ell) = \frac{n}{V}$

$= \frac{2,5 \times 10^{-3}}{0,04}$ ✓(c)

$= 0,0625\ mol \cdot dm^{-3}$

$c(HC\ell)$ excess/*oormaat* $= 0,1 - 0,0625$ ✓✓(d)
$= 0,0375\ mol \cdot dm^{-3}$

ANY/*ENIGE* 1 ✓(b)

$c(H_3O^+) = c(HC\ell)$ ✓(e)
$= 0,0375$

$pH = -\log[H_3O^+]$
$= -\log(0,0375)$ ✓(f)
$= 1,43$ ✓(g)

(8)
[23]

QUESTION 8/*VRAAG 8*

8.1 Concentration / *Konsentrasie* = 1 mol·dm^{-3} ✓
Temperature / *Temperatuur* = 25 °C ✓ (2)

8.2.1 Potassium nitrate/KNO_3/Any soluble salt ✓✓
Kaliumnitraat/KNO_3/Enige oplosbare sout (2)

8.2.2 $C\ell^-$ ✓ (1)

8.2.3 $Pt(s) \mid C\ell^-(aq) \mid C\ell_2(g)$ ✓ $\| Au^{3+}(aq) \mid Au(s)$ ✓ (3)

8.3 **OPTION/*OPSIE* 1**

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
$0,14 = E^\theta_{reduction}$ ✓ $- 1,36$ ✓
$E^\theta_{reduction} = 1,5$ V ✓

$E^\theta_{sel} = E^\theta_{redukusie} - E^\theta_{oksidasie}$ ✓
$0,14 = E^\theta_{reduksie}$ ✓ $- 1,36$ ✓
$E^\theta_{reduksie} = 1,5$ V ✓

Notes/*Aantekeninge:*
Accept any other correct formula from the data sheet.
Aanvaar enige ander korrekte formule uit die datablad.

Any other formula using unconventional abbreviations, e.g. $E^\theta_{cell} = E^\theta_{OA} - E^\theta_{R}$ followed by correct substitutions: $^3/_4$
Enige ander formule wat onkonvensionele afkortings gebruik, bv. $E^\theta_{sel} = E^\theta_{OA} - E^\theta_{R}$ *gevolg deur korrekte vervangings:* $^3/_4$

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OPTION/*OPSIE* 2

✓ $Au^{3+} + 3e^- \rightarrow Au$ $E^\theta = 1,5$ V ✓
$2C\ell^- \rightarrow C\ell_2 + 2e^-$ $E^\theta = -1,36$ (V) ✓
$6\ C\ell^- + 2Au^{3+} \rightarrow 3C\ell_2 + 2Au$ $E^\theta = 0,14$ (V) ✓ (4)

[12]

QUESTION 9/*VRAAG 9*

9.1 The chemical process in which electrical energy is converted to chemical energy/ use of electrical energy to produce a chemical reaction. ✓✓

Die chemiese proses *waarin elektriese energie na chemiese energie omgeskakel word/gebruik van elektriese energie om 'n chemiese reaksie te produseer*. (2)

9.2 X ✓ (1)

9.3.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓

Marking criteria/*Nasienkriteria:*
- $2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ $\frac{1}{2}$ $C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $\frac{0}{2}$
  $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ $\frac{0}{2}$ $C\ell_2 + 2e^- \leftarrow 2C\ell^-$ $\frac{2}{2}$
- Ignore if charge omitted on electron/*Ignoreer as lading op electron weggelaat is*
- If charge (-) omitted on $C\ell^-$/*Indien lading (+) weggelaat is op* $C\ell^-$*:*
  Max./*Maks:* $\frac{1}{2}$
  Example/*Voorbeeld*: $2C\ell \rightarrow C\ell_2 + 2e^-$

(2)

9.3.2 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓✓

Marking criteria/*Nasienkriteria:*
- $2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$ $\frac{1}{2}$ $H_2 + 2OH^- \rightleftharpoons 2H_2O + 2e^-$ $\frac{0}{2}$
  $H_2 + 2OH^- \leftarrow 2H_2O + 2e^-$ $\frac{2}{2}$ $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ $\frac{0}{2}$
- Ignore if charge omitted on electron / *Ignoreer as lading op elektron weggelaat is*
- If charge (-) omitted on OH^-
  Indien lading (-) op OH^- *weggelaat is* Max./*Maks:* $\frac{1}{2}$
  Example / *Voorbeeld*: $2H_2O + 2e^- \rightarrow H_2 + 2OH$

(2)

9.4

Marking criteria/*Nasienriglyne:*
(a) Substitute / *Vervang* 0,5 x 18 000 ✓
(b) Dividing charge by / *Deel lading deur* 1,6 x 10^{-19} ✓
(c) Dividing number of electrons by Avogadro's constant. ✓
Deel die aantal elektrone deur Avogadro se konstante.
(d) Using ratio / *Gebruik verhouding* n(Cℓ) : n(e^-) = 1:2 ✓
(e) Substituting / *Vervanging* n(Cℓ_2) and / *en* 22,4 in $n = \frac{V}{V_m}$ ✓
(f) Final answer / *Finale antwoord* 1,04 dm^3 ✓

$Q = I\triangle t$
$= 0,5 \times 18\,000$ ✓(a)
$= 9\,000$ C

$n = \frac{Q}{q_e}$

$n = \frac{9\,000}{1,6 \times 10^{-19}}$ ✓ (b)

$= 5,625 \times 10^{22}$ electrons / *elektrone*

$n(\text{electrons}) = \frac{5,625 \times 10^{22}}{6,02 \times 10^{23}}$ ✓ (c)
$= 0,093$ mol

$n(C\ell_2) = \frac{1}{2}n(e^-)$
$= 0,093 \div 2$ ✓(d)
$= 0,0465$ mol

$n = \frac{V}{V_m}$
$V = 0,0465 \times 22,4$ ✓(e)
$= 1,04\ dm^3$ ✓(f)

(6)
[13]

TOTAL/*TOTAAL*: 150

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