education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL

SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

SEPTEMBER 2022

MARKING GUIDELINES

MARKS/PUNTE: 150

This memorandum consists of 14 pages.

Hierdie memorandum bestaan uit 14 bladsye.

QUESTION 1 / VRAAG 1

1.1 C ✓✓

1.2 D ✓✓

1.3 A ✓✓

1.4 B ✓✓

1.5 D ✓✓

1.6 B ✓✓

1.7 D ✓✓

1.8 C ✓✓

1.9 B ✓✓

1.10 A ✓✓

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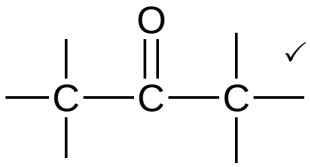
QUESTION 2 / VRAAG 2

2.1 A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds.✓✓ **(2 or 0)**

'n Binding of 'n atoom of 'n groep atome wat die fisiese en chemiese eienskappe van 'n groep organiese verbindings bepaal. ✓✓ **(2 or 0)** (2)

2.2.1



✓

(1)

2.2.2 F ✓ (1)

2.2.3 5-bromo-2-chloro-2-methylhexane
5-bromo-2-chloro-2-methylhexane

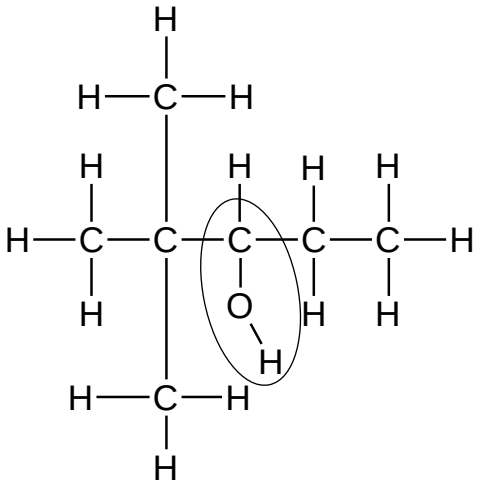
Marking criteria/*Nasienriglyne*:
- Correct stem i.e. hexane./*Korrekte stam d.i. heksaan*. ✓
- All substituents (bromo, chloro and methyl) correctly identified./*Alle substituente (bromo, chloro en metiel) korrek geïdentifiseer*. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas./*IUPAC-naam heeltemal korrek insluitende volgorde, koppeltekens en kommas .* ✓

(3)

2.2.4 Propanone / *Propanoon* ✓ (1)

2.2.5 Ketones/*Ketone* ✓ (1)

2.2.6



Marking criteria / *Nasienriglyne*
- Only functional group correct / *Slegs funksionele groep korrek* ✓
- Two methyl groups / Twee metielgroepe ✓
- Whole structure correct / *Hele struktuur korrek* ✓

(3)

2.2.7 Secondary/*Sekondêr*✓ (1)

2.3.1 Unsaturated/*Onversadig* ✓

It is a compound with <u>one or more multiple bonds between C atoms</u> in their hydrocarbon chains. ✓

Verbindings waarin <u>een of meer meervoudige bindings tussen C-atome</u> in hul koolwaterstofkettings voorkom. (2)

2.3.2 Bromine water / Br_2 (Accept $KMnO_4$) ✓
Broom water / Br_2 (Aanvaar $KMnO_4$) (1)

2.3.3 C_nH_{2n+2}✓ (1)

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QUESTION 3 / VRAAG 3

3.1 Propane / *Propaan* ✓ (1)

3.2.1 Organic molecules with the same molecular formula, ✓ but different structural formulae.✓
Organiese molekule met dieselfde molekulêre formule, maar verskillende struktuurformules. (2)

3.2.2 Chain isomer / *Kettingisomeer*✓ (1)

3.2.3 **Butane:**

- **Structure:**
  Chain length/surface area/molecular size/molecular mass/number of C-atoms in the chain increases. ✓
- **Intermolecular forces:**
  Strength of intermolecular forces/London forces/induced dipole/dispersion forces increases. ✓
- **Energy**
  More energy needed to overcome/break intermolecular forces. ✓

Butaan:

- ***Struktuur:***
  Kettinglengte/oppervlaksarea/molekulêre grootte/ molekulêre massa/aantal C-atome in ketting neem toe.
- ***Intermolekulêre kragte:***
  Sterkte van intermolekulêre kragte/London kragte/ geïnduseerde dipole/dispersie kragte vermeerder.
- ***Energie:***
  Meer energie benodig om intermolekulêre kragte te oorkom/breek.

OR

Ethane;

- **Structure:**
  The chain length/surface area/molecular size/molecular mass/number of C-atoms in the chain decreases.✓
- **Intermolecular forces**:
  Strength of intermolecular forces/London forces/induced dipole/dispersion forces decreases.✓
- **Energy**
  Less energy needed to overcome/break intermolecular forces. ✓

Etaan:

- *Kettinglengte/oppervlaksarea/molekulêre grootte/molekulêre massa/aantal C-atome in ketting neem af.*
- *Sterkte van intermolekulêre kragte/London kragte /geïnduseerde dipole/dispersie kragte verminder.*
- *Minder energie benodig om intermolekulêre kragte te oorkom/breek.*

3.3.1 **Marking criteria/*Nasienriglyne***
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af,*

The pressure exerted by a vapour at equilibrium with its liquid in a closed system.✓✓

Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem. (1)

3.3.2 D (1)

3.3.3
- Both compounds/**D** and **E** have (in addition to London forces and dipole-dipole forces) hydrogen bonding. ✓
  *Beide verbindings/**D** en **E** het waterstofbindings (behalwe Londonkragte en dipool-dipoolkragte).*

- Compound **D**/pentan-1-ol/alcohol has one site for hydrogen bonding and compound **E**/butanoic acid/carboxylic acid has two/more sites for hydrogen bonding. **OR D**/butanoic acid/carboxylic acid has two/more sites for hydrogen bonding.✓
  *Verbinding **D**/pentan-1-ol/alkohol het een punt vir waterstofbindings en verbinding B/buurutanoës/karboksielsuur het twee/meer punte vir waterstofbindings **O**F B/butanoësuur/karboksielsuur het twee/meer punte waterstofbindings*.

- Intermolecular forces in compound **E**/butanoic acid/carboxylic acid are stronger than intermolecular forces in compound **D**/ butan-1-ol/alcohol.✓
  Intermolekulêre kragte in verbinding **E**/butanoësuur/karboksielsuur is sterker as die intermolekulêre kragte in verbinding **D**/ pentan-1-ol/alkohol.
  OR/OF
  Intermolecular forces in compound **D**/pentan-1-ol/alcohol are weaker than intermolecular forces in compound **E**/butanoic acid/carboxylic acid.
  *Intermolekulêre kragte in verbinding **E**/pentan-1-ol/alkohol is swakker as intermolekulêre kragte in verbinding **D**/butanoësuur/karboksielsuur.*

- More energy is needed to overcome/break intermolecular forces in compound **E**/butanoic acid/carboxylic acid than in compound **D**/ pentan-1-ol/alcohol. ✓
  Meer energie word benodig om intermolekulêre kragte in verbinding **E**/butanoësuur as in verbinding **D**/ pentan-1-ol/alkohol te oorkom/breek.
  OR/*OF*
  Less energy is needed to overcome/break intermolecular forces in compound **D**/pentan-1-ol/alcohol than in compound **E**/butanoic acid/carboxylic acid.
  *Minder energie word benodig om intermolekulêre kragte in verbinding **D**/ pentan-1-ol/alkohol te oorkom/breek as in verbinding **E**/butanoësuur/karboksielsuur*. (4)

[14]

QUESTION 4/ *VRAAG 4*

4.1.1 **I:** Add/Halogenation✓
Substitusie/Halogenering/Halogenasie

II: Elimination/Dehydration✓
Eliminasie/Dehidrasie/Dehidratering

III: Addition/Hydration✓
Addisie/Hidrasie/Hidratering

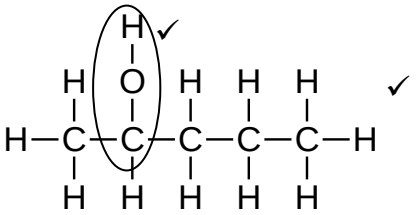
IV: Cracking✓
Kraking (4)

4.1.2 2-bromopropane / *2-bromo✓propaan* ✓ (2)

4.1.3 Alkene / *Alkeen* ✓ (1)

4.1.4 H_2O/water ✓ (1)

4.1.5



✓ ✓

Marking criteria / *Nasienriglyne*
- Only functional group correct / *Slegs funksionele groep korrek* ✓
- Whole structure correct / *Hele struktuur korrek* ✓

(2)

4.1.6 C_2H_6 ✓ Ethane/*Eteen*✓ (2)

4.2.1 Methyl✓ ethanoate✓ / *Metieletanoaat* (2)

4.2.2 A dehydrating agent/catalyst ✓
Dehidreermiddel/katalisator (1)

4.2.3

Marking criteria:
- Substitute 74 g·mol^{-1} into the correct formula ✓
- Use ratio: n(CH_4O) = n($C_3H_6O_2$) ✓
- Substitute 32 g·mol^{-1} into the correct formula ✓
- 60% of mass of CH_4O ✓
- Final answer: 49,64 g ✓

Nasienkriteria:
- Vervang 74 g·mol^{-1} in korrekte formule ✓
- Gebruik verhouding: n(CH_4O) = n($C_3H_6O_2$) ✓
- Vervang 32 g·mol^{-1} in korrekte formule ✓
- 60% of mass of CH_4O✓
- Finale antwoord: 49,64 g ✓

$$n = \frac{m}{M}$$
$$= \frac{68,88}{74}\checkmark$$
$$= 0,9308 \text{ mol}$$

$$n(CH_4O) = n(C_3H_6O_2)\checkmark$$
$$= 0,09308 \text{ mol}$$

$$m(CH_4O)_{\text{pure/}suiwer} = nM$$
$$= (0,09308)(32)\checkmark$$
$$= 29,79 \text{ g}$$

$$\text{Impure}(CH_4O) = \frac{(29,79)(100)}{60}\checkmark$$
$$= 49,69 \text{ g}\checkmark$$ (5)

[20]

QUESTION 5/ *VRAAG 5*

5.1

NOTE/LET WEL
Give the mark for per unit time only if in context of reaction rate.
Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.

ANY ONE/ENIGE EEN

- Change in concentration ✓ of products/reactants per (unit) time. ✓
  Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.

- 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 (eenheid) tyd.

- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd*.

- Rate of change in concentration/amount/number of moles/volume/mass. *Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa*. ✓✓ **(2 or/of 0)** (2)

5.2 Temperature/*Temperatuur* ✓ (1)

5.3.1 (Decreasing gradient indicates) rate of reaction is decreasing. ✓
(Afnemende gradiënt dui aan dat) reaksietempo afneem. (1)

5.3.2 (Gradient is zero, indicates) reaction rate is <u>zero</u> ✓
(Gradiënt is nul, wat aandui dat) reaksietempo <u>nul</u> is. (1)

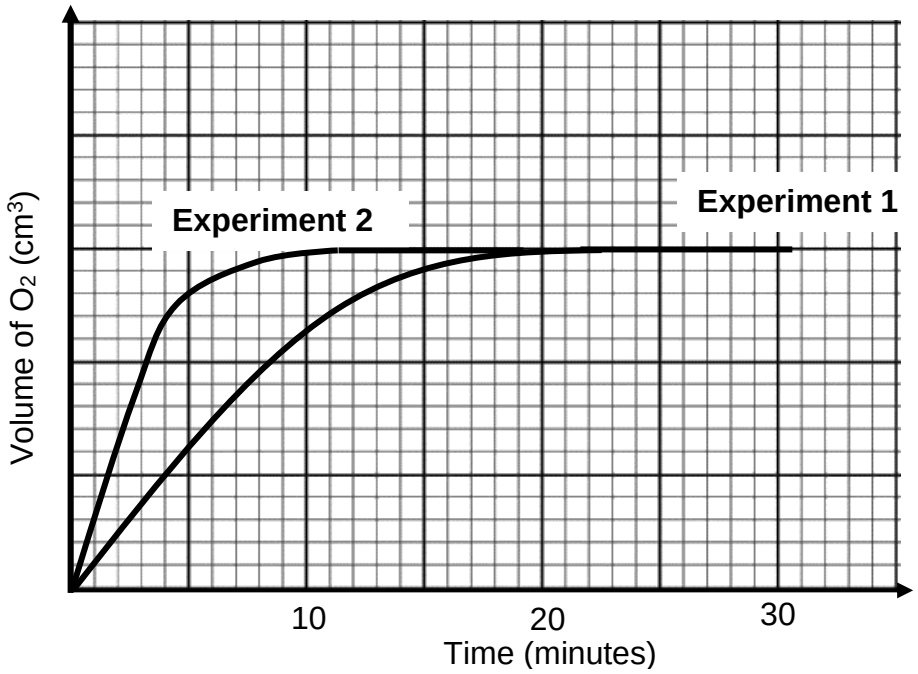
5.4
$$\text{Ave rate / } \textit{Gem. tempo} = \frac{\Delta V}{\Delta t}$$
$$10 = \frac{\Delta V}{20 - 0} \checkmark$$
$$V(O_2)_{\text{produced/}\textit{berei}} = 200 \text{ cm}^3$$

$$n(O_2)_{\text{produced/}\textit{berei}} = \frac{V}{V_m}$$
$$= \frac{200}{24000} \checkmark$$
$$= 0{,}0083 \text{ mol}$$

$$n(H_2O_2) = 2n(O_2) \checkmark$$
$$= (2)(0{,}0083)$$
$$= 0{,}017 \text{ mol}$$

$$c(H_2O_2)_{\text{used/}\textit{gebruik}} = \frac{n}{V}$$
$$= \frac{0{,}017}{0{,}04} \checkmark$$
$$= 0{,}42 \text{ mol·dm}^{-3} \checkmark$$ (5)

5.5 **<u>Marking criteria / *Nasienkriteria*</u>:**
- Graph of Experiment 2 is steeper than gradient of Experiment 2/ *Grafiek van Eksperiment 2 het 'n styler gradient as Eksperiment 2*✓
  Both graphs ends at the same place/ *Beide grafieke eindig op dieselfde plek* ✓



(2)

5.6.1 Catalyst ✓ **OR** Increases reaction rate
*Katalisator **OF** Toename in reaksie-tempo* (1)

5.6.2
- Catalyst lowers activation energy/provides an alternative path of lower activation energy ✓
  Katalisator verlaag die aktiveringsenergie/ bied 'n alternatiewe pad van laer aktiveringsenergie
- More particles have sufficient E_K **OR** more particles have $E_K \geq E_A$ ✓
  Meer deeltjies het genoegsame E_K OF meer deeltjie het $E_K \geq E_A$
- More effective collisions per unit time/Frequency of effective collisions increase✓✓
  Meer effektiewe botsings per eenheidstyd/ Frekwensie van die effektiewe botsings neem toe (3)

[16]

QUESTION 6 / *VRAAG 6*

6.1

Marking criteria:

- Calculate number of moles of H_2 and $C\ell_2$ ✓
- Use mole ratio 1:1:2 ✓
- Moles at equilibrium✓
- Divide equilibrium moles by Volume (0,5) ✓
- Correct K_c expression (formulae in square brackets) ✓
- Substitute 64 as K_c value ✓
- Substitution of equilibrium concentrations into Kc expression. ✓
- Substitute moles of $C\ell_2$ and in correct formula.✓
- Final answer: 71 g ✓

Nasienkriteria:

- *Bereken die aantal mol van H_2 en $C\ell_2$* ✓
- *Gebruik verhouding 1:1:2* ✓
- *Mol by ewewig* ✓
- *Deel mol by ewewig met volume (0,5)* ✓
- *Korrekte Kc - uitdrukking (formules in vierkanthakies)* ✓
- *Vervang 64 as K_c-waarde* ✓
- *Vervanging van ewewigskonsentrasies in K_c -uitdrukking.* ✓
- *Vervang mol van $C\ell_2$ en 71 g·mol^{-1} in korrekte formule* ✓
- *Finale antwoord: 71 g*✓

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

$= \frac{10}{2}$ $\quad$ $= \frac{355}{71}$

$= 5 \text{ mol } H_2$ $\quad$ $= 5 \text{ mol } Cl_2$

	$H_2(g)$	$C\ell_2(g)$	$HC\ell(g)$
Initial quantity (mol) Aanvangshoeveelheid (mol)	5 ✓	5	0
Change (mol) Verandering (mol)	x	x	2x
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	5 – x	5 – x	2x ✓
Equilibrium concentration ($mol \cdot dm^{-3}$) Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	$\frac{5-x}{0,5}$	$\frac{5-x}{0,5}$	$\frac{2x}{0,5}$ ✓

Ratio ✓

$K_c = \frac{[HCl]^2}{[H_2][Cl_2]}$ ✓

$64 ✓ = \frac{(\frac{2x}{0,5})^2}{(\frac{5-x}{0,5})(\frac{5-x}{0,5})}$ ✓

$x = 4$

No Kc expression, correct substitution/*Geen Kc-uitdrukking, korrekte substitusie*: Max./Maks. 8/9

Wrong Kc expres[sion/*Verkeerde Kc uitdrukking*: Max./Maks. 6/9

$n(Cl_2)_{\text{equilibrium/}ewewig} = 5 - 4$

$= 1 ✓$

$m_{Cl_2} = nM$

$= (1)(71)$

$= 71 \text{ g } ✓$

(9)

6.2 Positive/*Positief* ✓

- Decrease in temperature favours the exothermic reaction. ✓
  Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The forward reaction is favoured.✓
  Die voorwaartse reaksie word bevoordeel.
- Reaction is endothermic. ✓
  Die reaksie is eksotermies. (4)

6.3.1 Remains the same/*Bly dieselfde* ✓ (1)

6.3.2 Remains the same/*Bly dieselfde* ✓ (1)

[15]

QUESTION 7 / *VRAAG 7*

7.1.1 Dilute acids contain a small amount (number of moles) of acid in proportion to the volume of water. ✓✓ **(2 or 0)**
Verdunde sure bevat 'n klein hoeveelheid (getal mol) suur in verhouding met die volume water. (2)

7.1.2 Strong acids ionise completely in water ✓to form a high concentration of H_3O^+ ions. ✓
Sterk sure ioniseer volledig in water om 'n hoë konsentrasie H_3O^+ -ione te vorm. (2)

7.1.3 HSO_4^- ✓ (1)

7.1.4 $[H_3O^+] = 2[H_2SO_4]$
$= 2(0,2)$
$= 0,4 \text{ mol·dm}^{-3}$

$pH = -\log[H_3O^+]$✓
$= -\log[0,4]$✓
$= 0,398$✓ (3)

7.2.1 Basic/*Alkalies* ✓ (1)

7.2.2 $CO_3^{2-} + H_2O$ ✓$\rightarrow OH^- + HCO_3^-$ ✓ Balancing ✓

Marking criteria / *Nasienkriteria*:
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse *Produkte* *Balansering*
- Ignore phases / *Ignoreer fases.*

(3)

7.3

Marking criteria:
- Use of formula $c = \frac{n}{V}$ or $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ ✓
- Substitute 0,1 mol·dm^{-3} and 0,0248 dm^3 in correct formula✓
- Use ratio: $n(NaOH) = 2n(Na_2CO_3)$ ✓
- Substitute 0,5 dm^3 in correct formula ✓
- Use 286 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Final answer: 7,09 g ✓

Nasienkriteria:
- Gebruik van formule $c = \frac{n}{v}$ or $\frac{CaVa}{CbVb} = \frac{na}{nb}$ ✓
- Vervang 0,1 mol·dm^{-3} en 0,0248 dm^3 in korrekte formule✓
- Gebruik ratio: $n(NaOH) = 2n(Na_2CO_3)$ ✓
- Vervang 0,5 dm^3 in korrekte formule ✓
- Gebruik 286 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Finale antwoord: 7,09 g ✓

$n(HCl) = cV$✓
$= (0,1)(0,0248)$✓
$= 2,48 \times 10^{-3}$ mol

$n(Na_2CO_3) = 2n(HCl)$
$n(Na_2CO_3) = 1,24 \times 10^{-3}$mol ✓

$1,24 \times 10^{-3}$mol (Na_2CO_3) in 0,025 dm^3
∴ in 0,5 dm^3 $n(Na_2CO_3) = 0,0248$ mol ✓

$$n = \frac{m}{M}$$
$$0,0248 = \frac{m}{286}$$✓
$m_{(Na_2CO_3)} = 7,09$ g ✓

OPTION 2 / *OPSIE 2*

$$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$$✓
$$\frac{(0,1)(24,8)}{(c_b)(25)} = \frac{2}{1}$$✓
$c_a = 0,0496$ mol·dm^3

$n_{(Na_2CO_3)} = cV$
$n = (0,0496)(0,5)$✓
$= 0,0248$ mol

$$n = \frac{m}{M}$$
$$0,0248 = \frac{m}{286}$$✓
$m_{(Na_2CO_3)} = 7,09$ g ✓ (6)

[18]

QUESTION 8 / *VRAAG 8*

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

8.2
- To ensure electrical neutrality / *Verseker elektriese neutraliteit* ✓
- To separate the two electrolytes/*Om die elektroliete te skei* ✓ (2)

8.3 Ni to Ag ✓ (1)

8.4 $Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$ ✓ balancing ✓

Marking criteria / *Nasienkriteria*:
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows/*Ignoreer dubbel pyltjie*
- Ignore phases / *Ignoreer fases.* (3)

8.5 n(anode) = ½n(cathode)
n(anode) = ½(0,4)
= 0,2 mol✓

$$n = \frac{m}{M}$$
$$0,2 = \frac{m}{59✓}$$
$m_{decrease/afname} = 11,8$ g✓ (3)

8.6 B✓
Mg ✓is a stronger reducing agent than Ni.✓ Mg will be oxidized to Mg^{2+}✓
Mg is 'n sterker reduseermiddel as Ni en Mg sal dus geoksideer word tot Mg^{2+} (4)
[15]

QUESTION 9 / *VRAAG 9*

9.1 **ANY ONE/ENIGE EEN**

- The chemical process in which electrical energy is converted to chemical energy. ✓✓
- The use of electrical energy to produce a chemical change
- The process during which an electric current passes through a solution/ionic liquid/molten ionic compound.
- Decomposition of an ionic compound by means of electrical energy.

- *Die chemiese proses waarin elektriese energie gebruik word om 'n chemiese verandering te weeg te bring.* ✓✓
- *Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie*
- *Die proses waardeur 'n elektriese stroom deur 'n opplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg.*
- *Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.*

(2)

9.2 A ✓ (1)

9.3 B ✓ (1)

9.4 $Cu^{2+} + 2e^-$ ✓ Cu ✓✓

Marking criteria/*Nasienriglyne*	
$Cu \leftarrow Cu^{2+} + 2e^-$ $(^2/_2)$	$Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(^1/_2)$
$Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(^0/_2)$	$Cu^{2+} + 2e^- \leftarrow Cu$ $(^0/_2)$

(3)

9.5 True/*Waar* ✓
Rate of oxidation is equal to the rate of reduction✓
Tempo van oksidasie is gelyk aan die tempo van reduksie (2)

9.6 Carbon is unreactive ✓and can conduct electricity ✓
Koolstof is onreaktief en kan elektrisiteit gelei. (2)

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

Marking criteria/*Nasienriglyne*	
$C\ell_2 + 2e^- \leftarrow 2C\ell^-$ $(^2/_2)$	$2C\ell^- \leftarrow C\ell_2 + 2e^-$ $(^1/_2)$
$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $(^0/_2)$	$2C\ell^- \leftarrow C\ell_2 + 2e^-$ $(^0/_2)$

(3)

9.8 Decrease/*Afneem* ✓ (1)

[15]

TOTAL: 150