Province of the EASTERN CAPE EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2026

PHYSICAL SCIENCES P2: (CHEMISTRY)

MARKS: 150

TIME: 3 hours

This question paper consists of 20 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and surname in the appropriate space on the ANSWER BOOK.

2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 E.

1.1 The name of the functional group of CARBOXYLIC ACIDS is, the ...

A formyl group.

B carboxyl group.

C carbonyl group.

D hydroxyl group. (2)

1.2 Which ONE of the following compounds has the LOWEST melting point?

A Propane

B Butane

C Pentane

D Hexane (2)

1.3 Consider the organic compound below:

The IUPAC name of the compound above is ...

A 4,4-dimethylpent-4-ene

B 2,2-dimethylpent-1-ene

C 2,2-dimethylpent-4-ene

D 4,4-dimethylpent-1-ene (2)

 Please turn over

1.4 What is the IUPAC NAME of the major product that will be formed when pentan-2-ol is heated in the presence of an acid catalyst?

A Pentane

B Pent-2-ene

C Pent-1-ene

D Pentanal (2)

1.5 The activated complex can best be described as the …

A energy absorbed or released in a chemical reaction.

B minimum energy needed for a reaction to take place.

C unstable transition state from reactants to products.

D increase in the kinetic energy of reactants. (2)

1.6 Consider the following equilibrium:

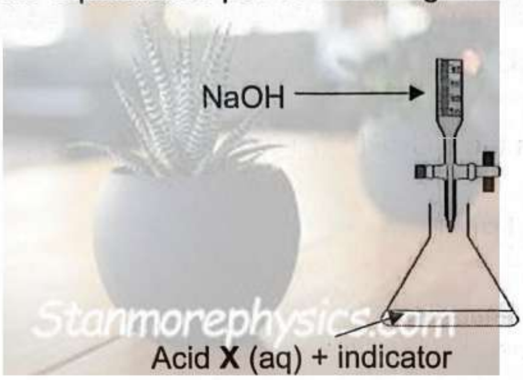
$$COBr_2\,(g) \rightleftharpoons CO\,(g) + Br_2\,(g) \qquad \Delta H > 0$$

The pressure of the equilibrium mixture is increased. Which ONE of the following combinations are CORRECT at the new equilibrium?

	$[COBr_2]$	K_c VALUE
A	DECREASE	REMAINS THE SAME
B	INCREASE	REMAINS THE SAME
C	INCREASE	DECREASE
D	DECREASE	INCREASE

(2)

1.7 Sodium hydroxide (NaOH) is titrated against acid **X** as shown in the diagram below. At the equivalence point the Ph is greater than 7.

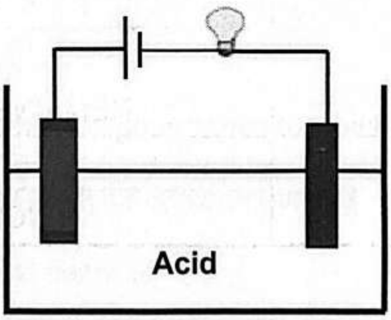


Which ONE of the following combinations CORRECTLY identifies the acid **X** and the most SUITABLE indicator in the Erlenmeyer flask?

	Acid X	Indicator
A	HCℓ	Bromothymol blue
B	CH_3COOH	Phenolphthalein
C	CH_3COOH	Bromothymol blue
D	HCℓ	Phenolphthalein

(2)

1.8 The conductivity of three acid solutions with the same concentration, **CH_3COOH**, **HNO_3** and **H_2SO_4**, is investigated as shown below.



The INCREASING order of the brightness of the lightbulb due to the conductivity of the acids is given by:

A HNO_3, CH_3COOH, H_2SO_4

B CH_3COOH, HNO_3, H_2SO_4

C H_2SO_4, HNO_3, CH_3COOH

D H_2SO_4, CH_3COOH, HNO_3 (2)

1.9 Consider the balanced net ionic equation for the reaction that occurs in a galvanic cell:

$$Fe^{2+} + C\ell_2 \longrightarrow Fe^{3+} + 2\,C\ell^-$$

Which ONE of the following is the CORRECT cell notation for the galvanic cell?

A $Pt\,|\,Fe^{3+}, Fe^{2+}\,||\,C\ell^-\,|\,C\ell_2\,|\,Pt$

B $Pt\,|\,C\ell^-\,|\,C\ell_2\,||\,Fe^{3+}, Fe^{2+}\,|\,Pt$

C $Pt\,|\,Fe^{2+}, Fe^{3+}\,||\,C\ell_2\,|\,C\ell^-\,|\,Pt$

D $Pt\,|\,C\ell_2\,|\,C\ell^-\,||\,Fe^{2+}, Fe^{3+}\,|\,Pt$ (2)

1.10 Consider the following statements regarding an electrolytic cell.

I Electrons flow from anode to cathode.
II The anode is the negative electrode.
II The oxidising agent is reduced at the cathode.

Which of the above statement(s) is/are TRUE?

A **I** and **II** only

B **III** only

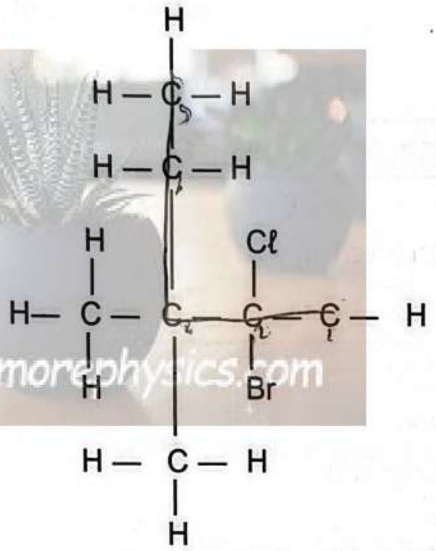
C **II** and **III** only

D **I** and **III** only (2)

[20]

QUESTION 2 (Start on a new page.)

The table below shows organic molecules (**A–D**) from different homologous series.

A	$CH_3CH_2C(CH_3)_2CH_3$	**B**	$C(CH_3)_3OH$
C		**D**	Butyl ethanoate

2.1 Define the term *functional group.* (2)

2.2 Write down the:

2.2.1 Name of the homologous series to which compound **C** belong (1)

2.2.2 GENERAL FORMULA of compound **B** (1)

2.3 Write down the IUPAC name of:

2.3.1 Compound **A** (2)

2.3.2 Compound **C** (3)

2.4 Consider compound **B**.

2.4.1 Is compound **B** a PRIMARY, SECONDARY or TERTIARY ALCOHOL?

Give a reason for the answer. (2)

2.4.2 Write down its IUPAC name. (2)

2.5 Draw the CONDENSED STRUCTURAL FORMULA of the functional isomer of compound **D**. (2)

2.6 Compound **A** undergoes complete combustion. Write down the balancing equation for this reaction by using MOLECULAR FORMULAE. (3)
[18]

QUESTION 3 (Start on a new page.)

Three compounds of used to investigate one of the factors that affect the boiling point of organic compounds.

The table below shows the results obtained.

ORGANIC COMPOUND	BOILING POINT (°C)
Butanone	79,6
Butan-1-ol	117,7
Propanoic acid	141

3.1 Define the term *boiling point*. (2)

3.2 Write down the controlled variable for this investigation. (1)

3.3 Fully explain the difference in the boiling points of the compounds. (4)

3.4 Butan-1-ol is now compared to its chain isomer.

3.4.1 Write down the IUPAC name of the chain isomer of butan-1-ol. (2)

3.4.2 How will the vapour pressure of the chain isomer compare to that of butan-1-ol?

Write down only HIGHER THAN, LOWER THAN or EQUAL TO.

Fully explain the answer. (4)
[13]

QUESTION 4 (Start on a new page.)

Consider the flow diagram below.

$\boxed{\text{Propene}} \xrightarrow{\text{Reaction I}} \boxed{\text{Saturated organic compound } \mathbf{P}} \xrightarrow[\text{Br}_2]{\text{Reaction II}} \boxed{\text{Secondary haloalkane } \mathbf{Q}}$

4.1 Consider reaction **I**:

Write down the:

4.1.1 Name of reaction (1)

4.1.2 Name or formula of catalyst needed for the reaction (1)

4.2 Consider reaction **II**:

Write down the:

4.2.1 Reaction condition required (1)

4.2.2 IUPAC name of the organic compound **Q** (2)

4.2.3 Draw the STRUCTURAL FORMULA of the minor product produced in reaction **II**. (2)

4.3 Write down the balanced equation by using STRUCTURAL FORMULAE for the reaction between organic compound **Q** that is strongly heated in concentration NaOH. (6)

4.4 Consider the incomplete reaction below:

CH_3CH_2OH + carboxylic acid **R** $\rightarrow$ organic compound **S** + H_2O

Organic compound **S** has a molar mass of 88 $g \cdot mol^{-1}$.

4.4.1 Write down the name of the reaction. (1)

4.4.2 Name ONE piece of evidence that confirms the production of the organic compound **S**. (1)

4.4.3 Determine the IUPAC name organic compound **S**. (3)
[18]

QUESTION 5 (Start on a new page.)

The reaction between sodium carbonate (Na_2CO_3) and EXCESS hydrochloric acid ($HC\ell$) is used to investigate factors that affect the rate of a chemical reaction. The balanced equation for the reaction is:

$$Na_2CO_3\,(s) + 2\,HC\ell\,(aq) \rightarrow 2\,NaC\ell\,(aq) + H_2O\,(\ell) + CO_2\,(g)$$

In the investigation 2,3 g of sodium carbonate is added to hydrochloric acid in all four experiments.

The table below summarises the reaction conditions in each experiment.

EXP.	CONCENTRATION OF $HC\ell$ ($mol\cdot dm^{-3}$)	VOLUME OF $HC\ell$ (cm^3)	STATE OF DIVISION OF Na_2CO_3	INITIAL TEMPERATURE OF ACID (°C)
1	1	100	Lumps	25
2	0,5	100	Lumps	25
3	1	100	Powder	25
4	1	100	Powder	35

5.1 Define the term *reaction rate*. (2)

5.2 For the investigation between experiment **1** and **2**, write down the:

5.2.1 Independent variable (1)

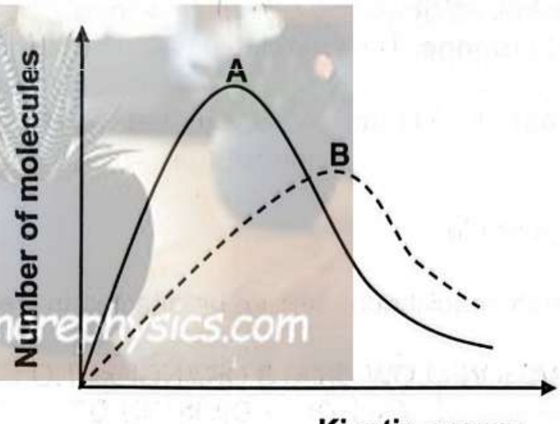
5.2.2 Dependent variable (1)

5.3 How will the volume of $CO_2(g)$ produce in experiment **2** compare to that produced in experiment **3**?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

5.4 Use the collision theory to explain why the reaction rate in experiment **3** will be higher than that in experiment **1**. (3)

5.5 The Maxwell-Boltzmann energy distribution curves for particles in each of experiments **3** and **4** are shown below.



5.5.1 Which experiment, **3** or **4**, is represented by **B**? (1)

5.5.2 Explain the answer to QUESTION 5.5.1. (2)

5.6 Calculate the average rate at which hydrochloric acid ($HC\ell$) in experiment **3** reacts in $mol{\cdot}dm^{-3}{\cdot}s^{-1}$ if the reaction takes 20 s to reach completion.

Assume the volume remains constant. (5)

[16]

QUESTION 6 (Start on a new page.)

A few crystals of potassium chromate (K_2CrO_4) are dissolved in water in a test tube. The solution is yellow in colour. With addition of a little amount of concentrated nitric acid the solution changes to **orange**. The following equilibrium reaction occurs:

$$\underset{\textbf{yellow}}{2\,CrO_4^{2-}(aq)} + 6\,H^+(aq) \rightleftharpoons \underset{\textbf{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(\ell) \qquad \Delta H < 0$$

6.1 State Le Chatelier's principle. (2)

6.2 How will the colour of the equilibrium mixture be affected in the following?

Choose from BECOMES YELLOW, STAYS ORANGE or NO CHANGE

6.2.1 The test tube is placed in ice-cold water for a few minutes. (1)

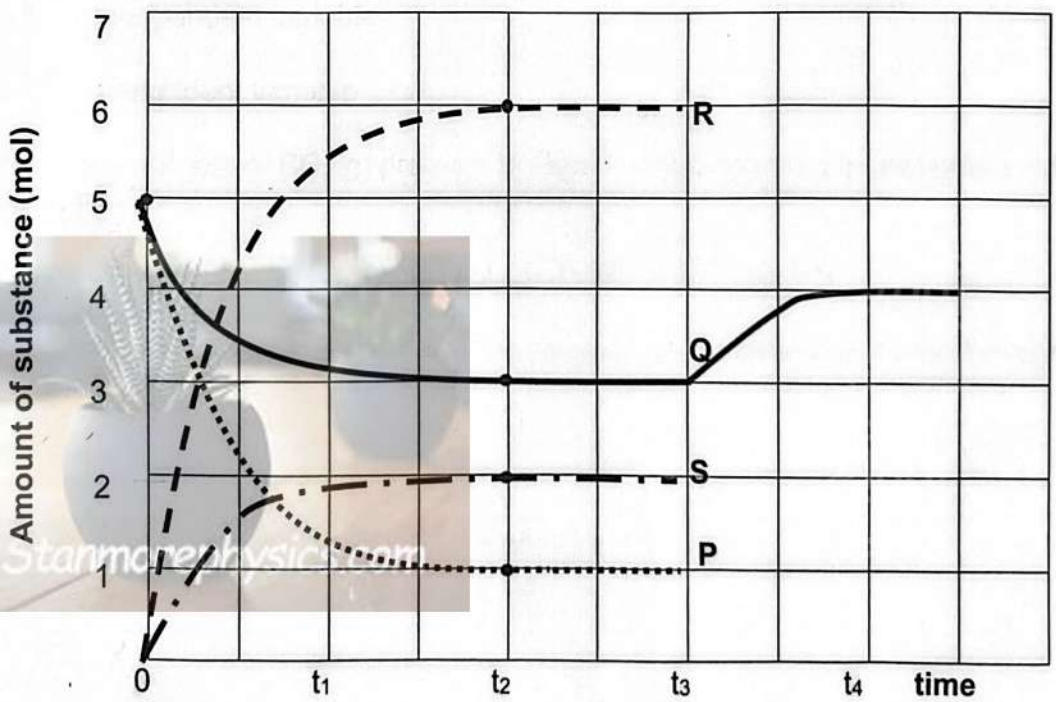
6.2.2 If the pH of the solution is increased. (1)

6.2.3 Explain the answer to QUESTION 6.2.2 by referring to Le Chatelier's principle. (2)

6.3 Consider the following hypothetical reaction that takes place in a 2 dm^3 container.

$$\boldsymbol{a}\,P(g) + \boldsymbol{b}\,Q(g) \rightleftharpoons \boldsymbol{c}\,R(g) + \boldsymbol{d}\,S(g)$$

The graph below represents the change in mole of the substances.



6.3.1 Determine the values of ***a***, ***b***, ***c*** and ***d***. (2)

At t_3 the temperature of the equilibrium mixture is increased.

6.3.2 Is the forward reaction EXOTHERMIC or ENDOTHERMIC?

Fully explain the answer. (4)

6.3.3 Calculate the equilibrium constant, K_c after t_4. (7)

[19]

QUESTION 7 (Start on a new page.)

7.1 Consider the following ionisation reactions:

I	$HSO_4^-(aq) + H_2O(\ell) \rightarrow SO_4^{2-}(aq) + H_3O^+(aq)$	$K_a = 1,3 \times 10^{-2}$
II	$HCO_3^-(aq) + H_2O(\ell) \rightarrow CO_3^{2-}(aq) + H_3O^+(aq)$	$K_a = 4,8 \times 10^{-11}$

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (1)

7.1.2 Which ONE of HSO_4^- or HCO_3^- is the stronger acid?

Give a reason for the answer by referring to the given data. (2)

7.1.3 Write down ONE conjugate acid-base pair in reaction **II**. (2)

7.2 Is sodium oxalate ($Na_2C_2O_4$) ACIDIC, NEUTRAL or ALKALINE in aqueous solution?

Explain the answer with an aid of a chemical equation. (3)

7.3 90 cm^3 of a 0,45 $mol{\cdot}dm^{-3}$ HBr, which is a strong acid, reacts with a 1,6 g unknown metal hydroxide $M(OH)_2$ according to the following balanced equation:

$$2\,HBr\,(aq) + M(OH)_2\,(s) \rightarrow MBr_2\,(aq) + 2\,H_2O(\ell)$$

7.3.1 Calculate the total number of moles of HBr. (3)

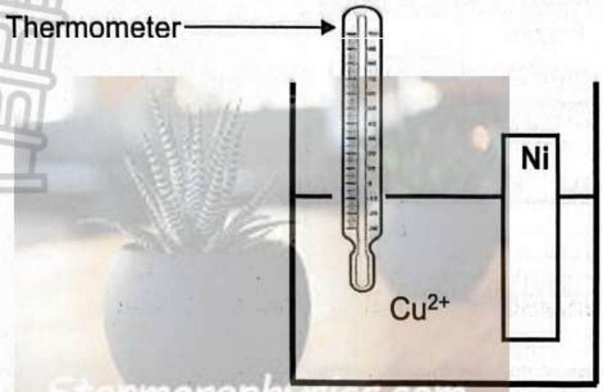
The final solution has a pH of 1,04.

7.3.2 Determine the unknown metal **M** with the aid of relevant calculations (8)

[19]

QUESTION 8 (Start on a new page.)

8.1 A clean piece of nickel (Ni) is placed in a beaker containing copper (Cu^{2+}) solution as shown in the diagram below.



It is observed that the reading on the thermometer increases which indicates that a spontaneous redox reaction had taken place.

8.1.1 Define the term *reduction* in terms of electron transfer. (2)

8.1.2 Refer to the relevant strengths of the reducing agents to explain why a redox reaction had taken place. (3)

8.2 A galvanic cell is set-up under standard conditions using $Cu^{2+}|Cu$ as a fixed half-cell. Half-cell **B** is changed and connected to the standard $Cu^{2+}|Cu$ half-cell and the initial voltmeter reading is recorded. The results are shown in table below.

EXP.	HALF-CELL B	INITIAL VOLTMETER READING (V)
1	$Ni \mid Ni^{2+}$	0,61
2	$Fe \mid Fe^{2+}$	0,78
3	**X** $\mid$ **X**$^{2+}$	2,00

8.2.1 State ONE standard condition that is applicable to these cells. (1)

8.2.2 Will the concentration of Fe^{2+} in experiment **2** INCREASE, DECREASE or REMAIN THE SAME as the cell is in operation?

Give a reason for the answer. (2)

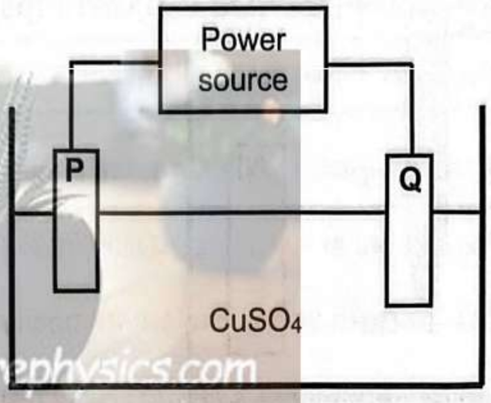
8.2.3 Write down the conclusion regarding the relevant strength of the reducing agents and the initial voltmeter readings for experiments **1** and **2**. (2)

8.2.4 Identify **X** using relevant calculation (5)

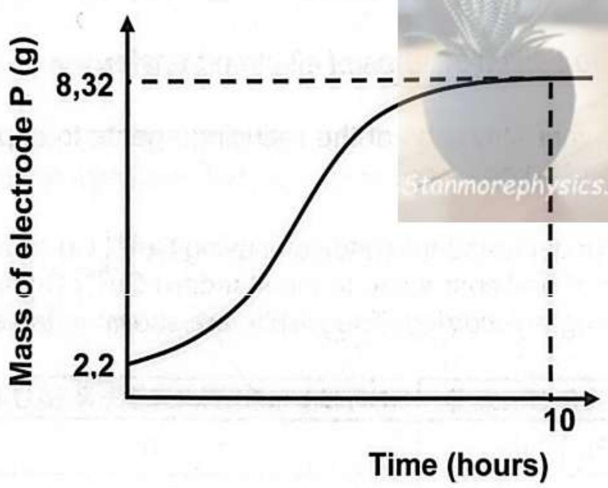
[15]

QUESTION 9 (Start on a new page.)

The electrolytic cell below is set up to obtain pure copper from a piece of impure copper. The impure copper contains platinum and silver.



The graph below, NOT drawn to scale, represents the changes in the mass of electrode **P** during electrolysis.



9.1 Is the power source an AC or DC? Give a reason for the answer. (2)

9.2 Which electrode, **P** or **Q**, contains the impure copper?

Give a reason for the answer. (2)

9.3 Write down the half-reaction that occurs at electrode **P.** (2)

9.4 How will the concentration of $CuSO_4$ at the start of the process compare to that after 10 hours?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

9.5 Calculate the number of electrons transferred during the process. (5)
[12]

TOTAL: 150

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NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

SEPTEMBER 2026

PHYSICAL SCIENCES P2: CHEMISTRY AMENDED MARKING GUIDELINE/ *FISIESE WETENSKAPPE V2: CHEMIE AANGEWYSE NASIENRIGLYN*

MARKS/*PUNTE*:

150

This amended marking guideline consists of 19 pages./
Hierdie aangewyse nasienriglyn bestaan uit 19 bladsye.

QUESTION/*VRAAG 1*

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

QUESTION/*VRAAG* 2

2.1

Marking criteria/ Nasienkriteria If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die korrekte konteks weggelaat word:* *- 1 punt per word/frase*

A bond or 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)

2.2 2.2.1 Haloalkanes / *Haloalkane* alkyl halide ✓ (1)

2.2.2 $C_nH_{2n+1}OH$ / $C_nH_{2n+2}O$ ✓ (1)

2.3.1 2,2-dimethylbutane ✓✓
2,2-dimetielbutaan

Marking criteria/*Nasienkriteria* • Correct stem – butane • Whole name correct • *Stam korrek – butaan* • *Hele naam korrek*

(2)

2.3 2.3.2 2-bromo-2-chloro-3,3-dimethylpentane ✓✓✓
2-bromo-2-chloro-3,3-dimetielpentaan

Marking criteria/*Nasienkriteria* • Correct stem – pentane / *Stam korrek* – *pentaan* • Substituents correctly identified / Substituente korrek geïdentifiseer • Whole name correct / *Hele naam korrek*

(3)

2.4 2.4.1 Tertiary alcohol ✓
The functional group / hydroxyl group/ OH group is bonded to three other carbon atoms / a tertiary carbon atom ✓

The function group (– C – O – H) is bonded to three other carbon atoms

Tersiêre alkohol
Die koolstof wat die funksionele / hidroksielgroep / OH-groep bevat, is aan drie ander koolstofatome verbind / is verbind aan 'n tersiêre koolstofatoom

Die funksionele groep (– C – O – H) is verbind aan 'n koolstofatoom wat aan drie ander koolstof atome verbind is (2)

2.4.2 2-methylpropan-2-ol / 2-methyl-2-propanol ✓✓
2-metielpropan-2-ol / 2-metiel-2-propan-2-ol (2)

2.5 $CH_3CH_2CH_2CH_2CH_2COOH$ / $CH_3CH_2CH_2CH_2CH_2CO_2H$ / $CH_3(CH_2)_4CO_2H$ ✓✓

Accept: $CH_3CH_2C(CH_3)_2COOH$, $CH_3CH_2CH_2CH(CH_3)COOH$,
$CH_3CH_2CH(CH_3)CH_2COOH$, $CH_3CH(CH_3)CH_2CH_2COOH$ (2)

2.6 $2\,C_6H_{14} + 19\,O_2$ ✓ $\rightarrow 12\,CO_2 + 14\,H_2O$ ✓ (✓ bal)
Reactant, products, balancing
Reaktanse, Produkte, balansering (3)

[18]

QUESTION/*VRAAG* 3

3.1

Marking criteria/ Nasienkriteria
If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase. *Indien enige van die sleutelwoorde/frases in die* ***korrekte konteks*** *weggelaat word: - 1 punt per word/frase*

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

3.2 Comparable Molar mass / Strength of the London forces / *Vergelykbare Molêre massa / Sterkte van die Londonkragte* ✓ (1)

3.3

MARKING CRITERIA/*NASIENKRITERIA*
• State dipole-dipole forces in butanone ✓ • State the one site for hydrogen bonding in butan-1-ol and two sites propanoic acid ✓ • Compare the strength of the hydrogen bonding to dipole-dipole forces and the hydrogen bonding in propanoic acid to butan-1-ol ✓ • Compare the energy required to overcome the intermolecular forces ✓ • *Stel van dipool-dipoolkragte in butanoon* • *Stel eenplek vir waterstofbinding in butan-1-ol en twee plekke propanoësuur* • *Vergelyk die sterkte van die waterstofbinding met dipool-dipoolkragte en sterkte van die waterstofbinding in propanoësuur met butan-1-ol* • *Vergelyk die energie om die intermolekulêrekragte te oorkom*

- **Type of intermolecular forces**

- Butanone has dipole-dipole forces ✓
- Butan-1-ol has 1 site of hydrogen bonding and Propanoic acid has 2 sites of hydrogen bonding ✓

Comparision of intermolecular forces

- Dipole-dipole forces are weaker than hydrogen bonding / Hydrogen bonding is stronger than the dipole-dipole forces and The 2 sites of hydrogen bonding in propanoic acid are stronger than the 1-site of hydrogen bonding in butan-1-ol / The 1 – site for hydrogen bonding in butan-1-ol is weaker than the 2-sites for hydrogen bonding in propanoic acid ✓

Energy

- More energy is needed to overcome the intermolecular forces from propanoic acid to butanone ✓

- ***Tipe intermolekulêrekragte***

- *Butanoon het dipool-dipoolkragte*
- *Butan-1-ol het 1 plek van waterstofbinding en propanoësuur het 2 plekke van waterstofbinding*

Vergelyk intermolekulêrekragte

- *Dipool-dipoolkragte is swakker as waterstofbinding / Waterstofbinding is sterker as die dipool-dipoolkragte en Die 2 plekke vir waterstofbindings in propanoësuur is sterker as die 1-plek vir waterstofbinding in butan-1-ol / Die 1-plek vir waterstofbinding in butan-1-ol is swakker as die 2-plekke vir waterstofbinding in propanoësuur*

Energie

- *Meer energie word benodig om die intermolekulêrekragte te oorkom vanaf propanoësuur na butanoon* (4)

3.4 3.4.1 2-methylpropan-1-ol / 2-methyl-1-propanol/methylpropan-1-ol ✓✓
2-metielpropan-1-ol / 2-metiel-1-propanol (2)

3.4.2 **MARKING CRITERIA/*NASIENKRITERIA***

- HIGHER THAN ✓
- Compare the surface area / chain length / of butan-1-ol to 2-methylpropan-1-ol ✓
- Relate the strength of the intermolecular / London forces to chain length / surface area correctly ✓
- State the correct relationship between strength of the intermolecular forces to vapour pressure ✓

- *HOËR AS*
- *Vergelyk die oppervlakarea / kettinglengte / van butan-1-ol met 2-metielpropan-1-ol*
- *Stel die sterkte van die intermolekulêre / Londonkragte korrek met kettinglengte / oppervlakarea*
- *Stel die verhouding tussen die sterkte van die intermolekulêre kragte met dampdruk korrek*

HIGHER THAN ✓

- 2-methyl propan-1-ol is branched / has a shorter chain length/ smaller surface area/ than butan-1-ol ✓
- Strength of London forces / intermolecular forces increases with an increase in chain length/ surface area. ✓
- The stronger the intermolecular forces the lower the vapour pressure ✓

OR

- Butan-1-ol is not is branched/ has a longer chain length/ larger surface area than 2-methyl propan-1-ol ✓
- Strength of London forces / intermolecular forces decreases with a decrease in chain length/ surface area. ✓
- The weaker the intermolecular forces the higher the vapour pressure ✓

HOËR AS

- *2-metielpropan-1-ol is vertak/ het 'n korter kettinglengte/ kleiner oppervlakarea/ as butan-1-ol*
- *Sterkte van Londonkragte / intermolekulêrekragte neem toe met 'n toename in kettinglengte / oppervlakarea.*
- *Hoe sterker die intermolekulêrekragte, hoe laer die dampdruk*

OF

- *Butan-1-ol is nie vertak nie/ het 'n langer kettinglengte/ groter oppervlakarea as 2-metielpropan-1-ol*
- *Sterkte van Londonkragte / intermolekulêrekragte neem af met 'n afname in kettinglengte/ oppervlakarea.*
- *Hoe swakker die intermolekulêrekragte, hoe hoër die dampdruk* (4)

[13]

QUESTION/*VRAAG* 4

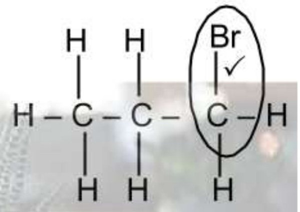
4.1 4.1.1 Addition / Hydrogenation / *Addisie / Hidrogenering / Hidrogansie* ✓ (1)

4.1.2 Platinum / Nickel / Palladium / Pt / Ni/ Pd ✓ (1)

4.2 4.2.1 Heat / (UV)-light /Sunlight *Hitte / UV-lig* ✓ (1)

4.2.2 2-bromopropane / *2-bromopropaan* ✓✓ (0 or 2) (2)

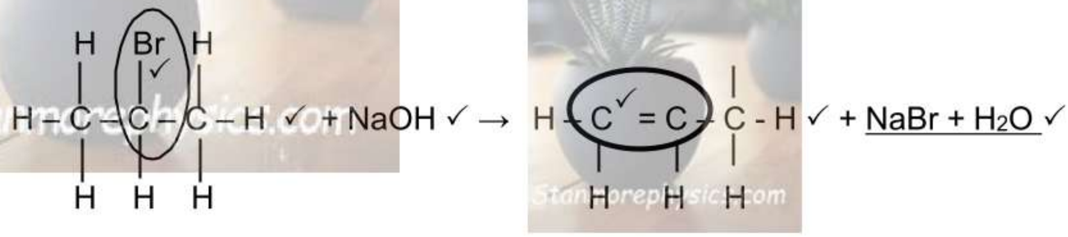
4.2.3



Marking criteria/*Nasienkriteria*
- Correct functional group
- Whole structure is correct
- *Korrek funksionele groep*
- *Hele struktuur korrek*

(2)

4.3



Marking criteria for organic compounds/*Nasienkriteria vir organiese verbindings*
- Functional group correct / *Funksionele groep korrek*
- Whole structure is correct / *Hele struktuur korrek*

Marking criteria for inorganic compounds/*Nasienkriteria vir anorganiese verbindings*
- NaOH ✓, NaBr , H_2O ✓
  IF / *INDIEN*
- Condensed structural formulae are used / *Gekondenseerde formules gebruik*: Max / *maks 4 / 6*
- Molecular formulae are used/ *Molekulêre formule gebruik : Max / Maks 2 / 6*

(6)

4.4 4.4.1 Esterification / Condensation / *Verestering / Esterifikasie* ✓ (1)

4.4.2 Smell / odour/*Reuk* / *Two layers when placed in water* ✓ (1)

4.4.3 12n +2n + 32 = 88 ✓
n = 4
Ethyl ✓ethanoate ✓ *etieletanoaat* (3)

[18]

QUESTION/*VRAAG* 5

5.1

> **Marking criteria/Nasienkriteria**
> If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase.
> *Indien enige van die sleutelwoorde/frases in die **korrekte konteks** weggelaat word: - 1 punt per word/frase*

ANY ONE

- Change in concentration of reactants or products per (unit) time. ✓✓
- Change in amount/number of moles/volume/mass of reactants or products per (unit) time. ✓✓
- Change in amount/number of moles/volume/mass of products formed or reactants used per (unit) time. ✓✓

ENIGE EEN

- *Verandering in konsentrasie van reaktante of produkte per (eenheid) tyd.*
- *Verandering in hoeveelheid/aantal mol/volume/massa van reaktante of produkte per (eenheid) tyd.*
- *Verandering in hoeveelheid/aantal mol/volume/massa van produkte wat gevorm word of reaktante wat per (eenheid) tyd gebruik word.*

OR/*OF*

The rate of change in concentration/amount of moles/mumber of moles/volume/mass of reactants or products. ✓✓ **(2 or 0)**
Die tempo van veranderinge in konsentrasie/hoeveelheid mol/aantal mol/volume/massa van reaktante of produkte. ***(2 of 0)*** (2)

5.2 5.2.1 Concentration/*Konsentrasie* ✓ (1)

5.2.2 Reaction rate/*Reaksietempo* ✓ (1)

5.3 EQUAL TO/*GELYK AAN* ✓ (1)

5.4

- Larger exposed surface area / larger state of division of (Na_2CO_3) particles in experiment **3**/ ✓
- More (Na_2CO_3) particles collide with the correct orientation ✓
- More effective collisions per (unit) time. /Frequency of effective collisions increase. ✓

- *Groter blootgestelde oppervlakarea van (Na_2CO_3) deeltjies in eksperiment **3***
- *Meer (Na_2CO_3) deeltjies met die korrekte oriëntasie bots*
- *Meer effektiewe botsings per (eenheid) tyd. /Frekwensie van effektiewe botsings neem toe.* (3)

5.5 5.5.1 (Experiment / *Eksperiment*) **4** ✓ (1)

5.5.2
- Experiment **4** has a higher temperature. ✓
- Curve **B** has more particles with higher (average) kinetic energy. ✓

- *Eksperiment **4** het 'n hoër temperatuur.*
- *Kurwe **B** het meer deeltjies met hoër (gemiddelde) kinetiese energie.* (2)

5.6

Marking criteria/*Nasienkriteria*

(a) Substitution into/*Vervanging in* n = m / M
(b) Use of mole ratio to determine / *Gebruik van molverhouding om* te bepaal n (HCℓ)
(c) Substitution into/*Vervanging in* c = n / V
(d) Substitution into rate equation/ *Vervanging in reaksietempo vergelyking*
(e) Final answer/*Finale antwoord*

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

$$n = \frac{2,3}{106} \checkmark \text{ (a)}$$

$$n = 0,0217 \text{ mol}$$

n (HCℓ) = 2 n (Na_2CO_3) = 2 x 0,0217 (b) ✓

n (HCℓ) = 0,0434 mol

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

$$c = \frac{0,0434}{0,1} \text{ (c)} \checkmark$$

c = 0,434 mol·dm^{-3}

$$\text{Rate / } \textit{Tempo} = -\frac{\Delta c}{\Delta t}$$

$$\text{Rate / } \textit{Tempo} = -\frac{(-0,434)}{20} \text{ (d)} \checkmark$$

Rate / *Tempo* = 0,0217 (mol·dm^{-3}·s^{-1}) (e) ✓

Range / *gebied* = 0,02 – 0,02 (5)

[16]

QUESTION/*VRAAG* 6

6.1

Marking criteria/ Nasienriglyne
If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase
Indien enige van die sleutelwoorde/frases in die ***korrekte konteks*** *weggelaat word: - 1 punt per word/frase*

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig herstel deur die reaksie wat die versteuring teenwerk, te bevoordeel. (2)

6.2 6.2.1 STAYS ORANGE / *BLY ORANJE* ✓ (1)

6.2.2 BECOMES YELLOW / WORD GEEL ✓ (1)

6.2.3
- As the pH increases the concentration of H_3O^+ / H^+ decreases ✓
- According to Le Chaterlier's principle the reverse reaction will be favoured / the equilibrium (position) will shift towards the left / the system will counter this change by increasing the concentration of H_3O^+ / H^+ ✓

- *Soos die pH styg, neem die konsentrasie van H_3O^+ / H^+ af*
- *Volgens Le Chaterlier se beginsel sal die terugwaartse reaksie bevoordeel word / die ewewig (posisie) sal na links verskuif / die stelsel sal hierdie verandering teenwerk deur die konsentrasie van H_3O^+ / H^+ te Verhoog* (2)

6.3 6.3.1

	a P (g)	b Q(g)	⇌	c R (g)	d S (g)
RATIO	a	b		c	D
n_i	5	5		-	-
Δn	**4**	**2**		**6**	**2** ✓
n_e	1	3		6	2

Number of moles of P that reacted = 5 – 1 = 4
Number of moles of Q that reacted = 5 – 3 = 2
Number of moles of R produced = 6
Number of moles of S produced = 2
Reaction: 4P + 2Q ↔ 6R + 2S
Simplified reaction: 2P + Q ↔ 3R + S

a = 2 b = 1 c = 3 d = 1 ✓

Marking criteria/*Nasienkriteria*
- Calculate Δ n for a, b, c, d
- Final answer
- *Bereken Δn vir a, b, c, d*
- *Final antwoord*

(2)

6.3.2 Exothermic ✓
- Amount of **Q** increased ✓
- The reverse reaction was favoured/equilibrium position shifted towards the left. ✓
- An increase in temperature favours the endothermic reaction. ✓

Eksotermies
- *Hoeveelheid van **Q** het toegeneem*
- *Die terugwaartse reaksie is bevoordeel/ewewigsposisie het na links verskuif.*
- *'n Toename in temperatuur bevoordeel die endotermiese reaksie.* (4)

6.3.3 **POSITIVE MARKING FROM QUESTION 6.3.1**
OPTION 1: MOLE OPTION

(a) Calculating the change in mole of Q
(b) Use the ratio to calculate the change in mole of P, R and S
(c) Calculating the equilibrium mole of P, R and S
(d) Calculating the equilibrium concentration of P, R and S
(e) Correct Kc expression with square brackets
(f) Substitution of equilibrium concentrations into Kc expression.
(g) Final answer

POSITIEWE NASIEN VANAF VRAAG 6.3.1
OPSIE 1: MOL-OPSIE

(a) Bereken die verandering in mol Q
(b) Gebruik die verhouding om die verandering in mol van P, R en S te bereken
(c) Bereken die ewewigsmol van P, R en S
(d) Bereken die ewewigsmol van P, R en S
(e) Korrekte Kc-uitdrukking met vierkantige hakies
(f) Vervanging van ewewigskonsentrasies in Kc-uitdrukking.
(g) Finale antwoord

	2 P (g)	Q (g)	⇌	3 R (g)	S (g)
Initial amount (mol) *Aanvangshoeveelheid (mol)*	1	3		6	2
Change (mol) Verandering (mol)	2	1 (a) ✓		3	1 (b) ✓
Equilibrium amount (mol) *Hoeveelheid by ewewig (mol)*	3	4		3	1 (c) ✓
Equilibrium concentration ($mol\cdot dm^{-3}$) Ewewigskonsentrasie ($mol\cdot dm^{-3}$)	= 3 / 2 = 1,5	= 4 / 2 = 2		= 3 / 2 = 1,5	= 1 / 2 (d) ✓ = 0,5

$$Kc = \frac{[R]^3[S]}{[P]^2[Q]} \quad (e) ✓$$

$$Kc = \frac{(1,5)^3(0,5)}{(1,5)^2(2)} \quad (f) ✓$$

Kc = 0,375 (g) ✓

NOTE/*LET WEL:*
No K_C expression, correct substitution/ *Geen Kc-uitdrukking, korrekte substitusie:* Max./*Maks.* 6/7

Wrong K_C expression /*Verkeerde Kc-uitdrukking:* Max./*Maks.* 4/7

OPTION 2: CONCENTRATION

(a) Calculating the initial concentration of P, Q, R, S and equilibrium concentration of Q.
(b) Determine the change in concentration of Q
(c) Use the ratio to calculate the change in conc of P, R and S
(d) Calculating the equilibrium concentration of P, R and S
(e) Correct Kc expression with square brackets
(f) Substitution of equilibrium concentrations into Kc expression
(g) Final answer

OPSIE 2: KONSENTRASIE

(a) Bereken die aanvanklike konsentrasie van P, Q, R, S en ewewig konsentrasie van Q
(b) Bepaal die verandering in konsentrasie Q
(c) Gebruik die verhouding om die verandering in konsentrasie van P, R en S te bereken
(d) Bereken die ewewigskonsentrasie van P, R en S
(e) Korrekte Kc-uitdrukking met vierkantige hakies
(f) Vervanging van ewewigskonsentrasies in Kc-uitdrukking
(g) Finale antwoord

	2 P (g)	Q (g)	⇌	3 R (g)	S (g)
Initial concentration *Aanvangskonsentrasie*	1 / 2 = 0,5	3 / 2 = 1,5		6 / 2 = 3	2 /2 (a) ✓ = 1
Change in concentration *Verandering in konsentrasie*	<u>1</u>	<u>0,5</u> (b) ✓		<u>1,5</u>	0,5 (c) ✓
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie ($mol·dm^{-3}$)*	<u>1,5</u>	= 2		1,5	0,5 (d) ✓

$$Kc = \frac{[R]^3[S]}{[P]^2[Q]} \quad (e) ✓$$

$$Kc = \frac{(1,5)^3(0,5)}{(1,5)^2(2)} \quad (f) ✓$$

Kc = 0,375 (g) ✓

NOTE/*LET WEL*:

No K_C expression, correct substitution/*Geen Kc-uitdrukking, korrekte substitusie:* Max./*Maks.* 6/7

Wrong K_C expression /*Verkeerde Kc-uitdrukking:* Max./*Maks.* 4/7

(7)
[19]

QUESTION/*VRAAG* 7

7.1 7.1.1 An acid is a proton / H^+ donor / *'n Suur is 'n proton / H^+ skenker* ✓ (1)

7.1.2 HSO_4^- ✓
It has the larger/higher K_a value / *Dit het die groter K_a-waarde* ✓ (2)

7.1.3 HCO_3^- and / *en* CO_3^{2-} ✓✓ **OR/*OF*** H_3O^+ and / *en* H_2O ✓✓ (2)

7.2 $C_2O_4^{2-}(aq) + H_2O(\ell)$ ✓ $\rightarrow HC_2O_4^-(aq) + OH^-$ ✓

Alkaline / *Alkalies* ✓ (3)

7.3 7.3.1 $n = cV$ ✓
$n = (0{,}45)(0{,}09)$ ✓
$n = 0{,}0405$ mol ✓ (3)

7.3.2 **POSITIVE MARKING FROM QUESTION 7.3.1 / *POSITIEWE NASIEN VANAF VRAAG 7.3.1***
Marking criteria / *Nasienkriteria*

(a) Substitution in pH formula / *Vervanging in pH-formule*
(b) Use of mol ratio / *Gebruik van molverhouding* [HBr] : [H_3O^+]
(c) Calculate n (HBr) excess / *Bereken n (HBr) oormaat*
(d) Calculating n (HBr) reacting / *Bereken n (HBr) wat reageer*
(e) Use the mol ratio / *Gebruik van molverhouding* HBr reacting/*reageer*: $M(OH)_2$
(f) Substituting into / *Vervanging in* n = m/M
(g) Calculating Molar mass for / *Bereken die molêre massa vir* $M(OH)_2$
(h) Identifying (name or formula)/*Identifisering (naam of formule)* M

$pH = -\log[H_3O^+]$
$1{,}04 = -\log[H_3O^+]$ (a) ✓
$[H_3O^+] = 10^{-1{,}04}$
$[H_3O^+] = 0{,}0912\ mol\cdot dm^{-3}$

$[H_3O^+] : [HBr]$
1 : 1
0,0912: [HBr] (b) ✓

EXCESS / *OORMAAT*
n(HBr) = cV
n(HBr) = (0,0912) (0,09) (c) ✓
n(HBr) = 0,0082 mol

n(used/ *gebruik*) = n(total/ *totaal*) – n(excess / *oormaat*)
n(used/ *gebruik*) = 0,0405 – 0,0082 (d) ✓
n(used/ *gebruik*) = 0,0323 mol

$n(M(OH)_2) = \frac{1}{2}(0,0323)$ (e) ✓ $= 0,01615$ mol

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

$0,0615 = \frac{1,6}{M}$ (f) ✓

$M = 99,071\ g{\cdot}mol^{-1}$

$99,071 = M + (16 \times 2) + (1 \times 2)$ (g) ✓

$M = 65,071\ g{\cdot}mol^{-1}$

M = Zinc / *Sink* / Zn (h) ✓ (8)

[19]

QUESTION/*VRAAG* 8

8.1 8.1.1 Reduction is a gain of electrons / *Reduksie is 'n wins van elektrone* ✓✓ (2)

8.1.2 Ni is a stronger reducing agent ✓ than Cu ✓ and it will reduce Cu^{2+} to Cu ✓

OR

Cu is a weaker reducing agent ✓ than Ni. ✓ and therefore, Ni will be oxidised to Ni^{2+} ✓

Ni is 'n sterker reduseermiddel as Cu en dit sal Cu^{2+} na Cu reduseer.

OF

Cu is 'n swakker reduseermiddel as Ni en daarom sal Ni na Ni^{2+} geoksideer word. (3)

8.2 8.2.1 Temperature/ *Temperatuur*: 25 °C /298 K ✓

OR / *OF*

Concentration (of electrolyte)/*Konsentrasie van elektroliet*: 1 $mol{\cdot}dm^{-3}$ ✓ (1)

8.2.2 INCREASES/*TONEEM* ✓
Fe is oxidised to/*geoksidder na* Fe^{2+} ✓ (2)

8.2.3 The stronger the reducing agents the higher the initial voltmeter reading. ✓✓
Hoe sterker die reduseermiddels is, hoe hoër die aanvanklike voltmeterlesing. (2)

8.2.4	$E^{\theta}_{cell/sel} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓ 2 ✓ $= 0,34$ ✓ $- E^{\theta}_{anode}$ ✓ $E^{\theta}_{anode} = -1,66\ V$ ✓	**NOTE/LET WEL:** • Accept any other correct formula from the data sheet. /Aanvaar enige ander korrekte formule vanaf gegewensblad. • Any other formula using unconventional abbreviations, e.g. $E^{\theta}_{cell} = E^{\theta}_{OA} - E^{\theta}_{RA}$ followed by correct substitutions: /Enige ander formule wat gebruik, onkonvensionele bv. $E^{\theta}_{sel} = E^{\theta}_{OA} - E^{\theta}_{RA}$ gevolg deur korrekte max/ *maks* 4/5

(5)

[15]

QUESTION/*VRAAG* 9

9.1 DC / *GS* ✓

To keep the electrodes from changing polarity ✓
To ensure current flows in one direction only.
To ensure reversible / redox reaction only occur in one direction.
Om seker te maak dat die polariteit van die elektrodes nie verander nie
Om seker te maak dat stroom slegs in een rigting vloei
Om seker te maak dat die omkeerbare / redoks reaksie slegs in een rigting plaasvind (2)

9.2 **Q** ✓
Decrease in mass /increase in mass of electrode P / *afname in massa /*
'n toename in die massa van electrode P ✓ (2)

9.3 $Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓

<u>Marking guidelines/Nasienriglyne</u>
- $Cu \rightleftharpoons Cu^{2+} + 2\bar{e}$ (0/2)
- $Cu^{2+} + 2\bar{e} \rightleftharpoons Cu$ (1/2)
- $Cu \leftarrow Cu^{2+} + 2\bar{e}$ (2/2)
- Ignore if charge on electron is omitted / *Ignoreer as lading op elektron weggelaat word*
- If a charge of an ion is omitted / *As 'n lading van 'n ioon weggelaat word* (1/2)
- Marking rule 6.3.10/ *Nasienreël 6.3.10*

(2)

9.4 REMAINS THE SAME / *BLY DIESELFDE* ✓ (1)

9.5 **<u>OPTION 1 / *OPSIE 1*</u>**
<u>Marking criteria / *Nasienkriteria*</u>

(a) Calculate the change in mass / *Bereken die verandering in massa*

(b) Substitute the change in mass (16,12 g) and 63,5 into / *Vervang die verandering in massa (16,12 g) en 63,5 in* $n = m / M$

(c) Use the mole ratio / *Gebruik die molverhouding* $Cu : e^-$

(d) Substitute into mole of electron and Avogadro's constant into / *Vervang in mol van elektrone en Avogadro se konstante* in $N = nN_A$

(e) Final answer / *Finale antwoord*

$\Delta m(Cu) = 8,32 - 2,2$ (a) ✓ $= 6,12$ g

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

$n = \frac{6,12}{63,5}$ (b) ✓

$n = 0,0964$ mol

$n(e^-) = 0,0964 \times 2$ (c) ✓n

$(e^-) = 0,1928$ mol

$n = \frac{N}{N_A}$

$0,1928 = \frac{N}{6,02 \times 10^{23}}$ (d) ✓

$N = 1,16 \times 10^{23}$ (e) ✓

OPTION 1 / *OPSIE 1*

Marking criteria / *Nasienkriteria*

(a) Calculate the change in mass / *Bereken die verandering in massa*

(b) Substitute the change in mass (16,12 g) and 63,5 into / *Vervang die verandering in massa (16,12 g) en 63,5 in* n = m /M

(c) Substitute into mole of copper and Avogadro's constant into / *Vervang in mol van koper en Avogadro se konstante* in $N = nN_A$

(d) Use the mole ratio / *Gebruik die molverhouding* Cu : e^-

(e) Final answer / *Finale antwoord*

Δm (Cu) = 8,32 – 2,2 (a) ✓ = 6,12 g

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

$n = \frac{6,12}{63,5}$ (b)✓

n = 0,0964 mol

$n = \frac{N}{N_A}$

$0,0964 = \frac{N}{6,03 \times 10^{23}}$ (c)✓

N = 5,813 x 10^{22} Cu particles

N (e^-) = 5,813 x 10^{22} x 2(d)✓

N(e^-) = 1,162 x 10^{23} (e)✓

(5)

[12]

TOTAL/ *TOTAAL* [150]