basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
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PHYSICAL SCIENCES: CHEMISTRY (P2)

MAY/JUNE 2026

MARKS: 150

TIME: 3 hours

PHYSICAL SCIENCES: Paper 2

10842E

X10

This question paper consists of 16 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces 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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Consider the following reaction.

$$CH_3(CH_2)_6CH_3 \xrightarrow{Heat} CH_3CH_3 + 2CH_2CHCH_3$$

This is an example of a/an ... reaction.

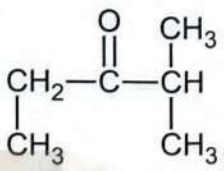
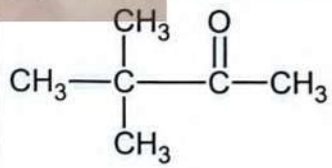
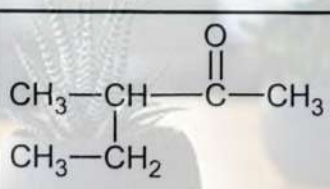
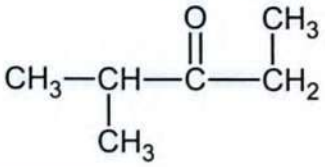
A cracking

B addition

C hydrolysis

D substitution (2)

1.2 Four organic compounds are shown below.

I		II	
III		IV	

Which of the compounds above have the same IUPAC name?

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

B **II** and **III**

C **I** and **IV**

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

1.3 Consider the equation for the reaction below. **R** is the MAJOR PRODUCT.

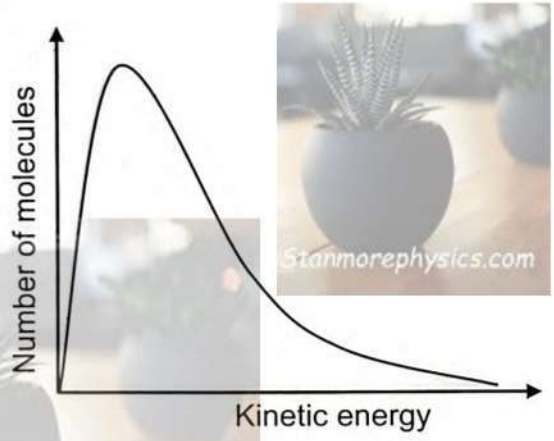
$$CH_3CH_2CHC(CH_3)CH_3 + HBr \rightarrow \mathbf{R}$$

Which ONE of the following is the CORRECT combination for the type of reaction and the formula of **R**?

	TYPE OF REACTION	FORMULA OF R
A	Addition	$CH_3CH_2CHBrCH(CH_3)CH_3$
B	Substitution	$CH_3CH_2CH_2CBr(CH_3)CH_3$
C	Addition	$CH_3CH_2CH_2CBr(CH_3)CH_3$
D	Substitution	$CH_3CH_2CHBrCH(CH_3)CH_3$

(2)

1.4 The Maxwell-Boltzmann distribution curve for a sample of a gas in a container is shown below.



Which ONE of the following will change the area under the curve?

A The addition of a catalyst

B A decrease in temperature

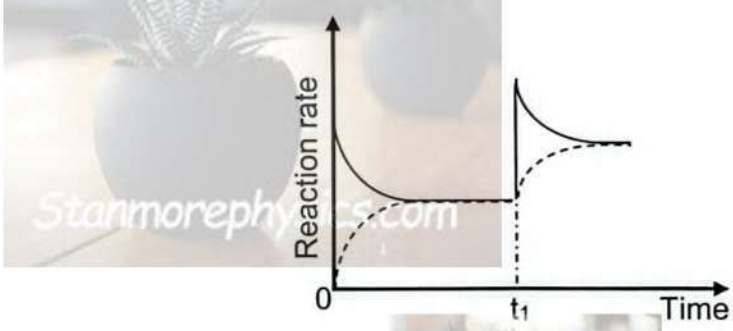
C Gas particles escaping from the container

D A decrease in concentration by increasing the volume of the container (2)

1.5 The reaction below reaches equilibrium in a closed system.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

A change is made to the system at time t_1. The reaction rate versus time graph is given below.



Which ONE of the following changes was made to the system at time t_1?

A A catalyst was added.

B The pressure was decreased at constant temperature.

C The temperature was increased.

D The concentration of the $H_2(g)$ was increased. (2)

1.6 The equilibrium constant, K_c, for a hypothetical reaction is given by the following expression:

$$K_c = \frac{[A]^2}{[C]^3[D_2]}$$

The equation for this reaction is:

A $3C(g) + D_2(g) \rightleftharpoons 2A(g) + B(s)$

B $2A(g) + B(s) \rightleftharpoons 3C(g) + D_2(g)$

C $3C(g) + D_2(g) \rightleftharpoons 2A(g) + B(g)$

D $2A(\ell) + B(s) \rightleftharpoons 3C(g) + D_2(g)$ (2)

1.7 According to the Arrhenius theory, an acid is …

A a source of H^+ ions in water.

B a source of OH^- ions in water.

C a substance that can accept a proton.

D a substance that can donate a proton. (2)

1.8 A property of sodium nitrate solution, $NaNO_3(aq)$, is that it is…

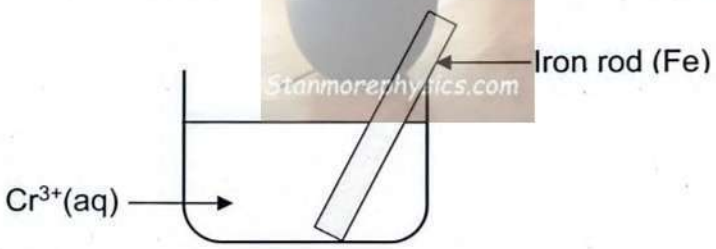
A acidic.

B basic.

C ampholytic.

D neutral. (2)

1.9 An iron rod, Fe(s), is placed in a beaker containing chromium(III) ions, $Cr^{3+}(aq)$.



Which ONE of the following is the CORRECT combination of products formed?

A $Fe^{2+}(aq)$ and Cr(s)

B $Fe^{2+}(aq)$ and $Cr^{2+}(aq)$

C $Fe^{3+}(aq)$ and $Cr^{2+}(aq)$

D $Fe^{3+}(aq)$ and Cr(aq) (2)

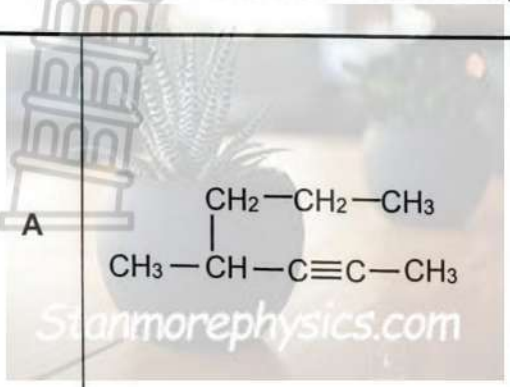
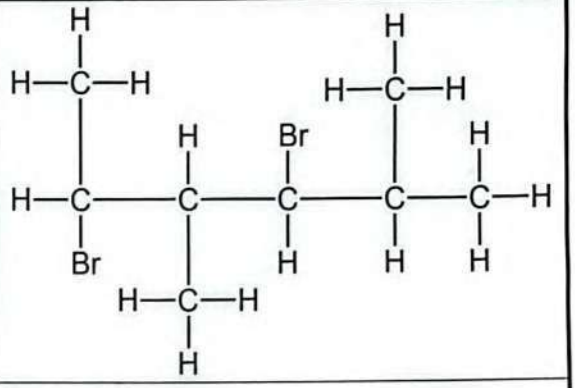
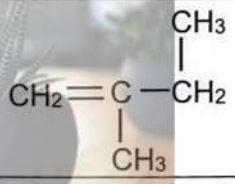
1.10 Which ONE of the following combinations CORRECTLY shows a product formed at the cathode and the change in pH during the electrolysis of a concentrated sodium chloride solution? Stanmorephysics.com

	PRODUCT FORMED AT CATHODE	CHANGE IN pH
A	Hydrogen	Decreases
B	Hydrogen	Increases
C	Chlorine	Decreases
D	Chlorine	Increases

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **G** in the table below represent organic compounds.

A		**B**	
C	$C_5H_{10}O_2$	**D**	Hexanal
E	$CH_3COCH_2CH_2CH_2CH_3$	**F**	
G	C_5H_{12}		

2.1 Define the term *saturated compound*. (2)

2.2 Write down the letter(s) that represent(s):

2.2.1 A compound with a carbonyl group bonded to two carbon atoms (1)

2.2.2 The compound that is an isomer of compound **E** (1)

2.2.3 Two unsaturated hydrocarbons (1)

2.3 Write down the:

2.3.1 IUPAC name of compound **A** (3)

2.3.2 IUPAC name of compound **B** (3)

2.4 The molecular formula of compound **C**, $C_5H_{10}O_2$, represents two compounds that are functional isomers of each other.

2.4.1 Define the term *functional isomers.* (2)

Write down the:

2.4.2 STRUCTURAL FORMULA for the functional isomer with the stronger intermolecular forces (2)

2.4.3 CONDENSED FORMULA of the functional isomer with the lower boiling point (2)

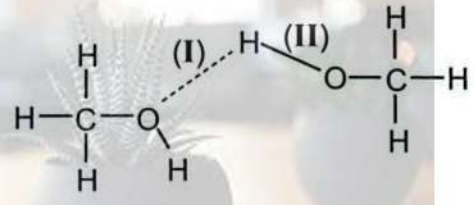
2.5 Is compound **B** a PRIMARY, SECONDARY or TERTIARY haloalkane?

Give a reason for the answer. (2)

2.6 Using MOLECULAR FORMULAE, write down a balanced equation for the combustion of compound **G** in EXCESS oxygen. (3)
[22]

QUESTION 3 (Start on a new page.)

3.1 Consider the diagram of two methanol molecules shown below. **I** and **II** are forces.



Choose **I** OR **II** for EACH of the following:

3.1.1 The force, when broken or overcome, results in a chemical change (1)

3.1.2 The force that requires more energy to overcome (1)

3.1.3 The force responsible for the boiling point of methanol (1)

3.2 In an investigation, the boiling points of four compounds are compared. The boiling points of compounds **A**, **B** and **C** are given below. The boiling point of **D** is indicated as **X**.

	COMPOUNDS	BOILING POINT (°C)
A	Methanol	64,7
B	Ethanol	78,3
C	Butan-1-ol	117,7
D	Butanal	**X**

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

The boiling points of compounds **A**, **B** and **C** are compared.

3.2.2 With reference to molecular structure, give the reason why this is a fair comparison. Stanmorephysics.com (1)

3.2.3 Name the intermolecular force responsible for the difference in these boiling points. (1)

3.2.4 Give a reason for the increase in boiling points in terms of the molecular structure of the compounds. (1)

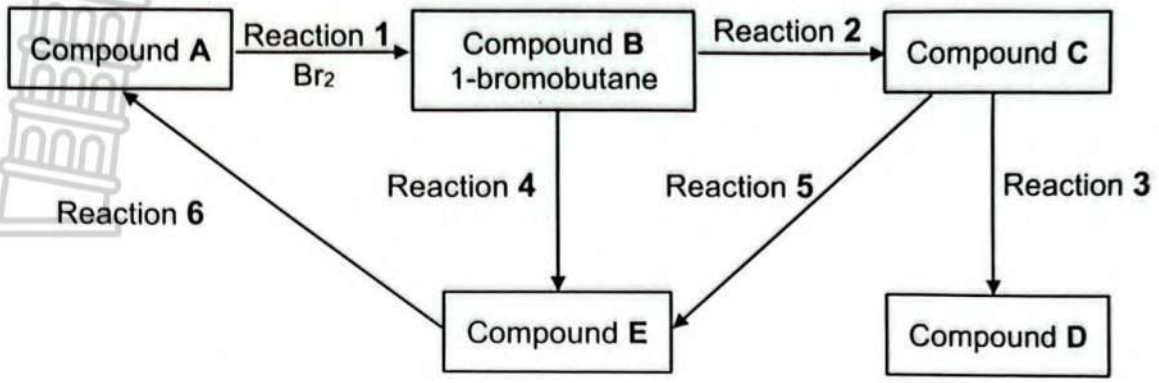
The boiling points of compounds **C** and **D** are compared.

3.2.5 Will **X**, the boiling point of **D**, be GREATER THAN, LESS THAN or EQUAL TO 117,7 °C?

Fully explain the answer. (4)
[12]

QUESTION 4 (Start on a new page.)

Study the flow diagram below. Compounds **A**, **B**, **C**, **D** and **E** are organic compounds.



Reaction **6** is an addition reaction.

4.1 Write down the:

4.1.1 Type of reaction represented by reaction **1** (2)

4.1.2 Reaction condition for reaction **1** (1)

4.2 In reaction **3**, compound **C** reacts with HCOOH, in the presence of concentrated H_2SO_4.

Write down the:

4.2.1 STRUCTURAL FORMULA of compound **C** (2)

4.2.2 Type of reaction represented by reaction **3** (1)

4.2.3 IUPAC name of compound **D** (2)

4.3 Write down TWO terms for the type of reaction represented by reaction **2**. (2)

4.4 Compound **C** can be converted back to compound **B**.

Write down the FORMULA or NAME of the inorganic reagent needed for this conversion. (1)

4.5 Compounds **B** and **C** can be converted to compound **E**.

4.5.1 Write down ONE term for the type of organic reaction for BOTH reactions **4** and **5**. (1)

Besides heat, write down a reaction condition for:

4.5.2 Reaction **4** (1)

4.5.3 Reaction **5** (1)

Consider reaction **4**:

4.5.4 Using STRUCTURAL FORMULAE, write down the balanced equation. (4)

[18]

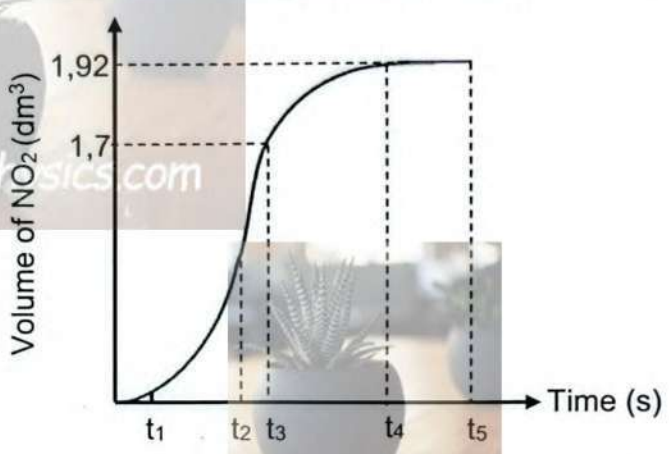
QUESTION 5 (Start on a new page.)

Pure powdered copper, Cu(s), is oxidised IN EXCESS concentrated nitric acid, HNO_3(conc.), as shown by the balanced equation below.

$$Cu(s) + 4HNO_3(conc.) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(\ell) \quad \Delta H < 0$$

5.1 Explain what is meant by 'IN EXCESS' in the statement above. (2)

5.2 The volume of nitrogen dioxide gas produced is shown in the graph below.



5.2.1 Use the collision theory to explain the decrease in the rate of the reaction between t_3 and t_4. (3)

5.2.2 How does the rate of the reaction at t_2 compare to that at t_1? Choose from HIGHER THAN, LOWER THAN or REMAINS THE SAME. (1)

5.2.3 Give a reason for the answer to QUESTION 5.2.2 by referring to the graph. Stanmorephysics.com (1)

5.2.4 Calculate the value of time t_3 if the average rate for the production of 1,7 dm^3 of NO_2(g) is 0,02 $dm^3 \cdot s^{-1}$. (2)

5.2.5 The initial concentration of the nitric acid is 12 $mol \cdot dm^{-3}$. If 20 cm^3 of nitric acid is used, calculate the hydronium ion concentration after the reaction is completed. (Assume the volume of the acid does not change.)

Take the molar gas volume to be 25 $dm^3 \cdot mol^{-1}$. (6)

A change is made to the reaction conditions and the reaction is repeated.

5.2.6 Which ONE of the following changes will result in more NO_2 gas being produced when the reaction is completed?
Choose from A, B or C. (Write down only the letter.)

A	A piece of pure copper with the same mass is used.
B	Impure copper with greater mass is used.
C	Higher concentration HNO_3 in excess is used.

(2)

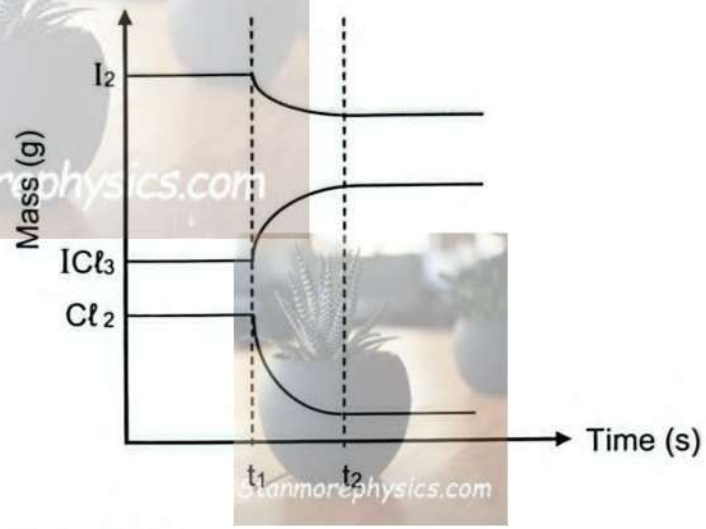
5.3 Determine the oxidation number of nitrogen in HNO_3. (2)
[19]

QUESTION 6 (Start on a new page.)

Iodine gas, $I_2(g)$, reacts with chlorine gas, $C\ell_2(g)$, in a sealed container at temperature T. Equilibrium is reached according to the balanced equation below.

$$I_2(g) + 3C\ell_2(g) \rightleftharpoons 2IC\ell_3(g) \qquad \Delta H = -390\ kJ\cdot mol^{-1}$$

The graph below shows the masses of $I_2(g)$, $C\ell_2(g)$ and $IC\ell_3(g)$ versus time during the course of the reaction.



6.1 State Le Chatelier's principle. (2)

6.2 Why are the masses constant after t_2? (1)

6.3 At t_1, the pressure is adjusted by changing the volume of the container at constant temperature.

Was the volume of the container INCREASED or DECREASED?

Explain the answer. (3)

6.4 What other change to the equilibrium system will produce a SIMILAR change to the masses at t_1? (2)

6.5 The volume of the container is 2 dm^3. At t_2 the concentrations of the gases are:

$[I_2] = 0,15\ mol\cdot dm^{-3}$
$[C\ell_2] = 0,36\ mol\cdot dm^{-3}$
$[IC\ell_3] = 0,05\ mol\cdot dm^{-3}$

More I_2 is now added to the container. When a new equilibrium is reached, the concentration of $IC\ell_3$ is $0,09\ mol\cdot dm^{-3}$. If the equilibrium constant, K_c, is 0,357, calculate the number of moles of I_2 added. (8)
[16]

QUESTION 7 (Start on a new page.)

7.1 Water ionises according to the balanced equation:

$$2H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

The equilibrium constant for the ionisation of water, K_w, varies with temperature, as shown in the table below.

TEMPERATURE (°C)	K_w
25	$1,00 \times 10^{-14}$
50	$5,48 \times 10^{-14}$

7.1.1 Is the ionisation of water EXOTHERMIC or ENDOTHERMIC?

Explain the answer. (3)

7.1.2 Calculate the concentration of H_3O^+ ions in water at 50 °C. (2)

7.1.3 How will the pH of water be affected when the temperature increases? Choose from INCREASES, DECREASES or STAYS THE SAME. Give a reason for the answer by referring to the formula used to calculate pH. (2)

7.2 Water is an ampholyte.

Write down the balanced equation for the reaction of water with $HCO_3^-(aq)$ where:

7.2.1 Water acts as an acid (2)

7.2.2 Water acts as a base (2)

7.3 The table below shows the equilibrium constants, K_a, of four acids, each having a concentration of 0,1 mol·dm^{-3} at 25 °C. The acids are used as electrolytes.

ACID	K_a
H_2CO_3	$4,3 \times 10^{-7}$
CH_3COOH	$1,8 \times 10^{-5}$
HNO_2	$4,6 \times 10^{-4}$
$H_2C_2O_4$	$6,0 \times 10^{-2}$

7.3.1 Define the term *electrolyte*. (1)

7.3.2 Which ONE of the above acids is the most effective electrolyte? Give a reason for the answer. (2)

7.4 An antacid tablet contains a mixture of $A\ell(OH)_3$ and $Mg(OH)_2$ only. This tablet is reacted with 50 cm^3 of a 0,5 $mol \cdot dm^{-3}$ $HC\ell$ solution. The balanced equations for the two reactions that take place are:

$$A\ell(OH)_3(s) + 3HC\ell(aq) \rightarrow A\ell C\ell_3(aq) + 3H_2O(\ell)$$

$$Mg(OH)_2(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + 2H_2O(\ell)$$

The resulting solution is completely neutralised by 26,5 cm^3 of a 0,378 $mol \cdot dm^{-3}$ NaOH solution. Stanmorephysics.com

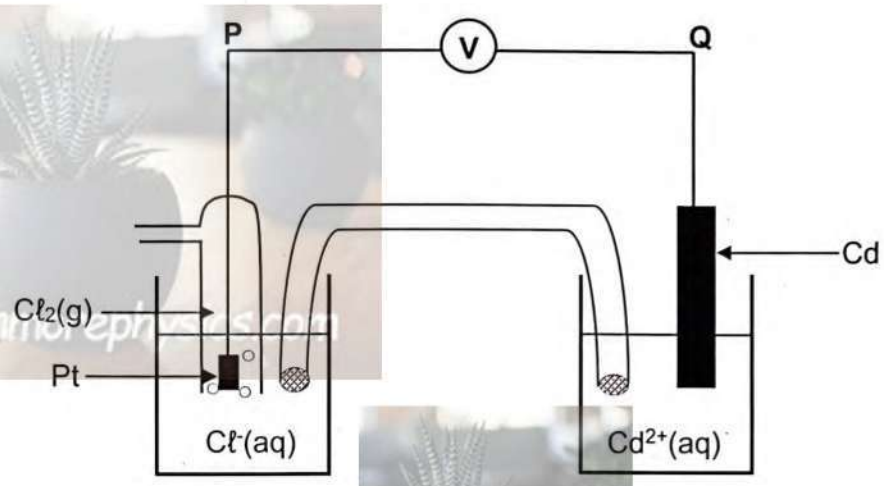
$$NaOH(aq) + HC\ell(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

7.4.1 Calculate the number of moles of hydroxide ions present in the tablet. (5)

7.4.2 If the tablet contains an equal number of moles of aluminium hydroxide and magnesium hydroxide, calculate the mass of $A\ell(OH)_3(s)$ in the tablet. (5)
[24]

QUESTION 8 (Start on a new page.)

A group of learners set up a standard galvanic cell, as shown below.



8.1 Define the term *galvanic cell.* (2)

8.2 For this cell, write down the:

8.2.1 Cell notation (3)

8.2.2 Direction of the electron flow. Choose from **P TO Q** or **Q TO P**. (1)

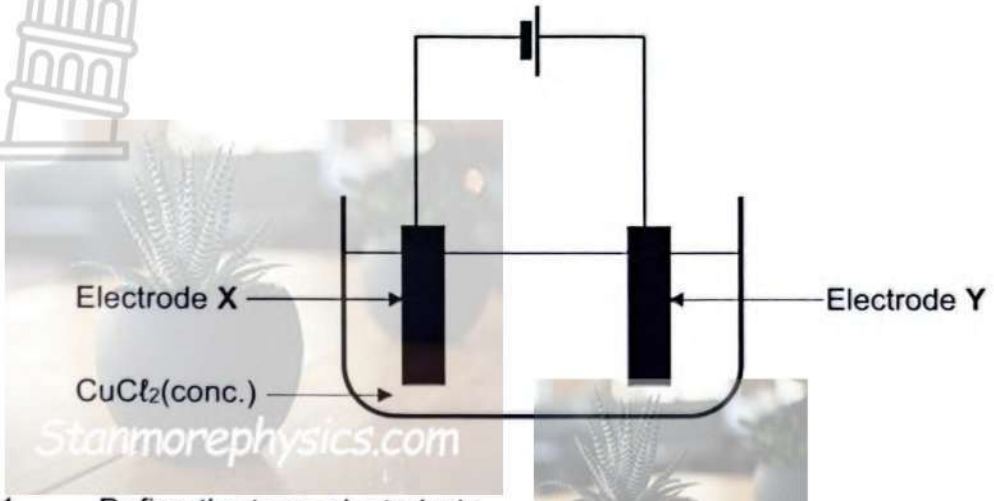
8.2.3 Reduction half-reaction (2)

8.3 How will the reading on the voltmeter be affected when the concentration of the chloride ions is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for the answer. (2)
[10]

QUESTION 9 (Start on a new page.)

An electrolytic cell is set up for the electrolysis of a concentrated copper(II) chloride solution, $CuC\ell_2$(conc.). **X** and **Y** are carbon electrodes.



9.1 Define the term *electrolysis*. (2)

9.2 Write down balanced equations for TWO reactions that will take place at the anode. (4)

9.3 Write down the NAME or FORMULA of the substance produced in higher amount at electrode **Y**. (1)

9.4 A solution of zinc iodide, ZnI_2, is added to the electrolyte of this cell. What product(s) will be formed at:

9.4.1 Electrode **X** (1)

9.4.2 Electrode **Y** (1)
[9]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
																	2 He 4
2,1 H 1																	
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr 87	0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit*

Symbol *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↑

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents /*Toenemende sterkte van oksideermiddels* ↓

↑ Increasing strength of reducing agents /*Toenemende sterkte van reduseermiddels*

Half-reactions/*Halfreaksies*			$E^{\ominus}$(V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	– 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/ NASIONALE SENIORSERTIFIKAAT-EKSAMEN

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

MAY/JUNE/*MEI/JUNIE* 2026

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 16 pages./
Hierdie nasienriglyne bestaan uit 16 bladsye.

QUESTION 1/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 C ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 D ✓✓ (2)

1.6 A ✓✓ (2)

1.7 A ✓✓ (2)

1.8 D ✓✓ (2)

1.9 B ✓✓ (2)

1.10 B ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains. ✓✓ **(2 or/*of* 0)**
A compound:
that has ONLY single bonds between C atoms.
that has no double OR triple bonds OR multiple bonds between C atoms.

Verbindings waarin daar geen meervoudige bindings tussen C-atome in hul koolwaterstofkettings is nie
Verbinding wat:
SLEGS enkelbindingsbevat tussen C-atome bevat.
geen dubbel- OF trippelbindings OF meervoudige bindings tussen C-atome nie. (2)

2.2.1 E ✓ (1)

2.2.2 D ✓ (1)

2.2.3 A and/*en* F ✓ (1)

2.3.1

Marking criteria:
- Correct stem, i.e. heptyne. ✓
- Substituent (methyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam, d.i. heptyn.* ✓
- *Substituente (metiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

4-methylhept-2-yne /4-methyl-2-heptyne ✓✓✓
4-metielhept-2-yn /4-metiel-2-heptyn (3)

2.3.2

Marking criteria:
- Correct stem, i.e. hexane. ✓
- All substituents (dibromo and dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Alle substituente (dibromo en dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

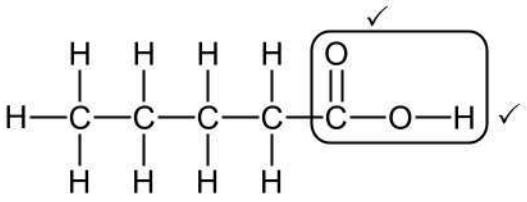
2,4-dibromo-3,5-dimethylhexane/*2,4-dibromo-3,5-dimetielheksaan* ✓✓✓ (3)

2.4.1

Marking criteria/*Nasienkriteria*
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 underlined phrases must be in the correct context. / *Die onderstreepte frases moet in die korrekte konteks wees.*

Compounds with the same molecular formula, but different functional groups. ✓✓
Verbindings met dieselfde molekulêre formule, maar verskillende funksionele groepe. (2)

2.4.2



Marking criteria:
- Functional group correct. ✓
- Whole structural formula correct. ✓

Nasienkriteria:
- *Funksionele groep korrek.* ✓
- *Hele struktuurformule korrek.* ✓

(2)

2.4.3

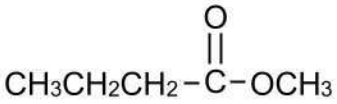
Marking criteria:
- Functional group correct. ✓
- Whole condensed structural formula correct. ✓

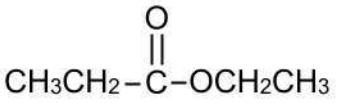
Nasienkriteria:
- *Funksionele groep korrek.* ✓
- *Hele gekondenseerde struktuurformule korrek.* ✓

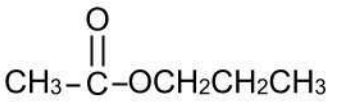
NOTE/*AANTEKENING:*
- Structural formulae used/*Struktuurformule gebruik.* Max./*Maks.* $^1/_2$
- Molecular formulae used/*Molekulêre formule gebruik.* Max./*Maks.* $^0/_2$
- Accept bonds on functional group in condensed structure/*Aanvaar bindings in funksionele groep.*

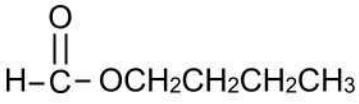
$CH_3CH_2CH_2\overset{\checkmark}{C}OOCH_3$ ✓
$CH_3CH_2COOCH_2CH_3$
$CH_3COOCH_2CH_2CH_3$
$HCOOCH_2CH_2CH_2CH_3$

OR/*OF*







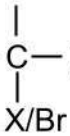


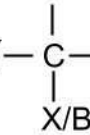
(2)

2.5 Secondary/*Sekondêre* ✓

The halogen (-X/-Br) is bonded to a C atom that is bonded to two other C atoms. ✓
Die halogeen (-X/-Br) is gebind aan 'n C-atoom wat gebind is aan twee ander C-atome

OR

The functional group () is bonded to two other C atoms.

Die funksionele groep ( *) is gebind aan twee ander C-atome.*

(2)

2.6 C_5H_{12} + $8O_2$ ✓ → $5CO_2$ + $6H_2O$ ✓ Bal. ✓

Ignore phases./*Ignoreer fases.*

Marking criteria/*Nasienkriteria:*
- Reactants ✓ Products ✓ Balancing: ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*

IF/*INDIEN*:
Structural formula for C_5H_{12} penalise 1 mark
Struktuur formule vir C_5H_{12} - penaliseer 1 punt.
Equal sign instead of arrow - penalise 1 mark.
Gelykaanteken ipv pyl – penaliseer 1 punt. (3)

[22]

QUESTION 3/*VRAAG 3*

3.1.1 II ✓ (1)

3.1.2 II ✓ (1)

3.1.3 I ✓ (1)

3.2.1

Marking criteria/*Nasienkriteria*
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 temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓
Die temperatuur waar die dampdruk van 'n stof gelyk is aan atmosferiese druk. (2)

3.2.2 A, B and C are straight chain primary alcohols ✓
A, B en C is reguitketting primêre alkohole (1)

3.2.3 London/dispersion/Van de Waals forces ✓
London/dispersie/Van de Waalskragte (1)

3.2.4 Increase in chain length ✓
Toename in kettinglengte (1)

3.2.5

Marking criteria:
- Name the TYPES of intermolecular forces. ✓✓
- Compare the strength of intermolecular forces. ✓

OR Compare the energy required to overcome intermolecular forces.
- Compare the boiling points ✓

Nasienkriteria:
- *Vergelyk die TIPE intermolekulêre kragte .*
- *Vergelyk die sterkte van intermolekulêre kragte.*

OF *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.*
- Vergelyk die kookpunt

- Between butan-1-ol molecules are hydrogen bonds (in addition to London and dipole-dipole forces). ✓
- Between butanal molecules are dipole-dipole forces (in addition to London forces). ✓
- Hydrogen bonds are stronger than dipole-dipole forces ✓/More energy needed to overcome/ break hydrogen bonds/ At given temperature less molecules will be in vapour phase.

OR

Dipole-dipole forces are weaker than hydrogen bonds /Less energy needed to overcome/ break dipole-dipole forces./ At given temperature more molecules will be in vapour phase.
- Butan-1-ol has a higher boiling point **OR** Butanal has lower boiling point ✓

- *Tussen die butan-1-ol molekules is waterstofbindings (asook London en dipool-dipoolkragte).*
- *Tussen die butanaal molekules is dipool-dipoolkragte (asook Londonkragte).*
- *Waterstofbindings is sterker as die dipool-dipoolkragte/ Meer energie is nodig om die waterstofbinding te oorkom/breek./ By 'n gegewe temperatuur is minder molekules in dampfase.*

OF

Dipool-dipoolkragte is swakker as die waterstofbinding./ Minder energie word benodig om die dipool-dipoolkragte te oorkom/ breek as die waterstofbindings. By 'n gegewe temperatuur is meer molekules in die dampfase.
- *Butan-1-ol het 'n hoër kookpunt **OF** Butanaal het 'n laer kookpunt*

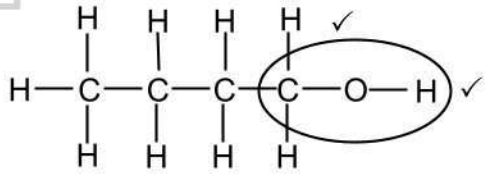
(4)
[12]

QUESTION 4/*VRAAG 4*

4.1.1 Substitution/halogenation/bromination ✓✓
Substitusie/halogenering/brominering (2)

4.1.2 Heat/sunlight/UV / *Hitte/sonlig* ✓ (1)

4.2.1



Marking criteria:
- Functional group correct. ✓
- Whole structural formula correct. ✓

Nasienkriteria:
- *Funksionele groep korrek.* ✓
- *Hele struktuurformule korrek.* ✓

(2)

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

4.2.3 Butyl ✓methanoate ✓ / *Butielmetanoaat* (2)

4.3 Substitution/Hydrolysis / *Substitusie/Hidrolise* ✓✓ (2)

4.4 Hydrogen bromide/HBr / Waterstofbromied ✓

ACCEPT/*AANVAAR*:
Sodium bromide AND sulphuric acid/NaBr + H_2SO_4
Natriumbromied EN swawelsuur (1)

4.5.1 Elimination / *Eliminasie* ✓ (1)

4.5.2 Concentrated strong base/NaOH/KOH/LiOH/ *Gekonstreerde sterk basis* ✓ (1)

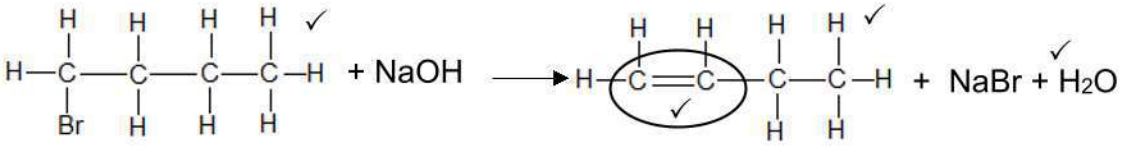
4.5.3 Concentrated sulphuric acid/H_2SO_4/ *Gekonsentreerde swawelsuur*/ ✓
Concentrated phosphoric acid/H_3PO_4 / *Gekonsentreerde fosforsuur* (1)

4.5.4

Marking criteria:
- Whole structural formula of bromoalkane correct (functional group on first C atom).✓
- Functional group of alkene correct. ✓
- Whole structural formula of alkene correct (functional group on first C atom). ✓
- *NaOH, NaBr + H_2O / LiOH, LiBr + H_2O / KOH, KBr + H_2O* ✓

Nasienkriteria:
- *Hele struktuurformule van van haloakaan korrek (funksionele groep op de eerste C-atoom).* ✓
- *Funksionele groep van alkeen korrek.*
- *Hele struktuurformule van van alkeen korrek (funksionele groep op de eerste C-atoom).* ✓
- *NaOH, NaBr + H_2O / LiOH, LiBr + H_2O / KOH, KBr + H_2O* ✓

IF/*INDIEN*
- Condensed, semi structural or molecular formula.
  Gekondenseerde, semi-struktuurformule of molekulêre formule. Max/*Maks*: $^1/_5$
- Marking rule 6.3.10/*Nasienreël 6.3.10*



(4)
[17]

QUESTION 5/*VRAAG 5*

5.1 A substance where the number of moles is stoichiometrically more than needed / A substance that is not first consumed completely /used up in a chemical reaction. ✓✓
Die stof waarvan die aantal mol stoichiometries meer is as wat benodig word. /Die stof wat nie eerste opgebruik is nie in 'n chemiese reaksie. (2)

5.2.1
- At t_3, the concentration of HNO_3 has decreased/Cu is being used up. ✓
- Less (HNO_3) particles per unit volume. ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓

- *By t_3, het die konsentrasie van HNO_3 afgeneem/Cu word opgebruik.*
- *Minder (HNO_3) deeltjies per eenheidsvolume.*
- *Minder effektiewe botsings per eenheidtyd/sekonde./ Laer frekwensie van effektiewe botsings.* (3)

5.2.2 Higher than / *Hoër as* ✓ (1)

5.2.3 Steeper gradient ✓
Steiler helling (1)

5.2.4

Marking criteria/*Nasienkriteria:*
- Substitute the volume and rate into rate formula. ✓
  Vervang volume en die tempo in tempo formule.
- Final correct answer/*Finale korrekte antwoord:* 85 s ✓

$$\text{Ave rate/}gem\ tempo = \frac{\Delta V(NO_2)}{\Delta t}$$

$$0,02 = \frac{1,7}{t_2} \checkmark$$

$$t_2 = 85\ (s) \checkmark$$

(2)

5.2.5

Marking criteria	***Nasienkriteria:***
(a) Formula $n = \frac{V}{V_m}$ or $n = cV$ ✓	(a) *Formule* $n = \frac{V}{V_m}$ *or* $n = CV$ ✓
(b) Substitute 12 and 0,04 in $n = cV$ ✓	(b) *Vervang 12 en 0,04 in* $n = cV$ ✓
(c) Substitute 25 in $n = \frac{V}{V_m}$ ✓	(c) *Vervang 25 in* $n = \frac{V}{V_m}$ ✓
(d) USE mol ratio: $n(HNO_3) : n(NO_2) = 4 : 2$ ✓	(d) *GEBRUIK molverhouding:* $n(HNO_3) : n(NO_2) = 4 : 2$ ✓
(e) Calculate excess moles $n(HNO_3)_{inital} - n(HNO_3)_{used}$/ $c(HNO_3)_{inital} - c(HNO_3)_{used}$. ✓	a) *Bereken oormaat* n $(HNO_3)_{aanvank} - n(HNO_3)_{gebruik}$ $c(HNO_3)_{aanvank} - c(HNO_3)_{gebruik}$. ✓
(f) Final correct answer: 4,5 mol·dm^{-3} ✓ Range: 4 to 4,5 mol·dm^{-3}	b) *Finale korrekte antwoord:* 4,5 mol·dm^{-3} ✓ *Gebied: 4 to 4,5 mol·dm^{-3}*

$$n(HNO_3)_{ini} = cV \checkmark$$
$$= (12)(0,02) \checkmark$$
$$= 0,24 \text{ mol}$$

$$n(NO_2)_{prod} = \frac{V}{V_m}$$
$$= \frac{1,92}{25} \checkmark$$
$$= 0,077 \text{ mol}$$

$$n(HNO_3)_{used} = \frac{4}{2} n(NO_2)$$
$$= \frac{4}{2}(0,077) \checkmark$$
$$= 0,15 \text{ mol}$$

$$n(HNO_3)_{excess} = 0,24 - 0,15 \checkmark$$
$$= 0,09 \text{ mol}$$

$$c(HNO_3)_{excess} = \frac{n}{V}$$
$$= \frac{0,09}{0,02}$$
$$= 4,32 \text{ mol·dm}^{-3}$$

$$c(H_3O^+) = c(HNO_3) = 4,32 \text{ mol·dm}^{-3} \checkmark$$

(6)

5.2.6 B ✓✓ (2)

5.3 (+)5 ✓✓ (2)
[19]

QUESTION 6/*VRAAG 6*

6.1

Marking criteria/*Nasienkriteria*
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.*

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk. (2)

6.2 Equilibrium is reached. / *Ewewig is bereik.* ✓ (1)

6.3 Decreased / *Verlaag* ✓
- Forward reaction is favoured/ Concentration of ICl_3/products increases/ Concentration of I_2 and Cl_2 /reactants decreases. ✓
- The reaction that produces a fewer number of moles/amount of gas (4 mole gas to 2 moles gas) is favoured/The reaction that decreases the pressure is favoured. ✓

- *Voorwaartse reaksie is bevoordeel/Konsentrasie van ICl_3/produkte verhoog /Konsentrasie van I_2 en Cl_2 /reaktanse verminder.*
- *Die reaksie wat 'n kleiner aantal mol/hoeveelheid gas (4 mol gas na 2 mol gas) produseer word bevoordeel./Die reaksie wat die druk verlaag word bevoordeel.* (3)

6.4 Decrease in temperature./*Verlaging van temperatuur.* ✓✓

IF/*INDIEN*:
Temperature/*Temperatuur* Max/*Maks:* $^1/_2$ (2)

6.5

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria:

(a) Initial concentrations. ✓
(b) **USE** ratio: $I_2(g)$: $3C\ell_2(g)$: $2IC\ell_3(g)$ ✓
(c) Equilibrium $[I_2]$ = initial $[I_2]$ - change in $[I_2]$
Equilibrium $[C\ell_2]$ = initial $[C\ell_2]$ - change in $[C\ell_2]$
Equilibrium $[IC\ell_3]$ = initial $[IC\ell_3]$ + change in $[IC\ell_3]$ ✓
(d) K_c expression ✓
(e) Substitute K_c value in K_c expression ✓
(f) Substitute concentrations in K_c expression ✓
(g) Calculate $n(I_2)$, substitute 2 dm^3 in n = cV ✓
(h) ***CORRECT*** final answer. ✓
Range: 1,34 – 1,42 mol

Nasienkriteria:

(a) *Aanvangskonsentrasie.* ✓
(b) ***GEBRUIK*** *verhouding:* $I_2(g)$: $3C\ell_2(g)$: $2IC\ell_3(g)$ ✓
(c) *Ewewig* $[I_2]$ = *initial* $[I_2]$ - *change in* $[I_2]$
Equilibrium $[C\ell_2]$ = *initial* $[C\ell_2]$ - *change in* $[C\ell_2]$
Equilibrium $[IC\ell_3]$ = *initial* $[IC\ell_3]$ + *change in* $[IC\ell_3]$ ✓
(d) K_c*-uitdrukking* ✓
(e) *Vervang* K_c *waarde in Kc -uitdrukking* ✓
(f) *Vervang konsentrasies in Kc - uitdrukking* ✓
(g) *Bereken* $n(I_2)$, *vervang 2* dm^3 *in n = cV* ✓
(h) ***KORREKTE*** *finale antwoord.* ✓
Gebied: *1,34 – 1,42 mol*

OPTION 1/*OPSIE 1*

	$I_2(g)$	$C\ell_2(g)$	$IC\ell_3(g)$	
Initial concentration ($mol \cdot dm^{-3}$) *Aanvangskonsentrasie* ($mol \cdot dm^{-3}$)	0,15 + x	0,36	0,05	✓**(a)**
Change in concentration ($mol \cdot dm^{-3}$) *Verandering in konsentrasie* ($mol \cdot dm^{-3}$)	0,02	0,06	0,04	✓**(b)**
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie* ($mol \cdot dm^{-3}$)	0,13 + x	0,3	0,09	✓**(c)**

$$K_c = \frac{[ICl_3]^2}{[I_2][Cl_2]^3}$$ ✓**(d)**

$$0,357 \overset{\checkmark(e)}{=} \frac{(0,09)^2}{\left(\frac{0,26 + x}{2}\right)(0,3)^3}$$ ✓**(f)**

$x = 0,7103\ mol \cdot dm^{-3}$

$n\ I_2(g) = cV$ ✓**(g)**
$= (0,7103)(2)$ ✓**(h)**
$= 1,4206\ mol$

No K_c expression, correct substitution/*Geen* K_c*-uitdrukking, korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_c expression/
Verkeerde K_c*-uitdrukking*: Max./*Maks.* $^5/_8$

OPTION 2/*OPSIE 2*

	$I_2(g)$	$C\ell_2(g)$	$IC\ell_3(g)$	
Initial moles (mol) *Aanvangsmol (mol·dm^{-3})*	0,3 + x	0,72	0,1	✓(a)
Change in moles (mol) *Verandering in mol (mol·dm^{-3})*	0,04	0,12	0,08	✓(b)
Equilibrium moles (mol) *Ewewigsmol (mol·dm^{-3})*	0,26 + x	0,6	0,18	✓(c)
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	$\frac{0,26 + x}{2}$	0,3	0,09	✓(g)

$$K_c = \frac{[ICl_3]^2}{[I_2][Cl_2]^3}$$ ✓(d)

$$0,357 \overset{\checkmark(e)}{=} \frac{(0,09)^2}{\left(\frac{0,26 + x}{2}\right)(0,3)^3}$$ ✓(f)

$x = 1,4206$ mol ✓(h)

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_c expression/
Verkeerde K_c-uitdrukking: Max./*Maks.* $^5/_8$

(8)
[16]

QUESTION 7/*VRAAG 7*

7.1.1
- Endothermic ✓
- Forward reaction is favoured. ✓/K_w increased with an increase in temperature.
- Increase in temperature favours endothermic reaction. ✓

- *Endotermies*
- *Voorwaartse reaksie word bevoordeel./K_w verhoog met 'n toename in temperatuur.*
- *Verhoging in temperatuur bevoordeel die endotermiese reaksie.* (3)

7.1.2

OPTION 1/*OPSIE 1*

$K_w = [H_3O^+][OH^-]$

$5,48 \times 10^{-14} = [H_3O^+]^2$ ✓

$[H_3O^+] = 2,34 \times 10^{-7}$

$pH = -\log[H_3O^+]$ ✓

$= -\log(2,34 \times 10^{-7})$ ✓

$= 6,63$ ✓

OPTION 2/*OPSIE 2*

$pH = -\log[H_3O^+]$ ✓

$= -\log\sqrt{5,48 \times 10^{-14}}$ ✓✓

$= 6,63$ ✓

(4)

7.2.1

Marking criteria/*Nasienkriteria:*
Products / *Produkte* ✓✓ one mark for each/*een punt vir elk*

Marking rule 6.3.10/*Nasienreël 6.3.10*
IF/*INDIEN*:
Ignore/*Ignoreer* ⇌ and phases/*en fases*
Equal sign instead of ⇌ ignore/ Gelykaanteken ipv ⇌ ignoreer

$HCO_3^-(aq) + H_2O(\ell) \rightarrow H_2CO_3(aq)$ ✓ $+ OH^-(aq)$ ✓ (2)

7.2.2

Marking criteria/*Nasienkriteria:*
Products / *Produkte* ✓✓ one mark for each/*een punt vir elk*

Marking rule 6.3.10/*Nasienreël 6.3.10*
IF/*INDIEN*:
Ignore/*Ignoreer* ⇌ and phases/*en fases*
Equal sign instead of ⇌ ignore/ Gelykaanteken ipv ⇌ ignoreer

$HCO_3^-(aq) + H_2O(\ell) \rightarrow CO_3^{2-}(aq)$ ✓ $+ H_3O^+(aq)$ ✓ (2)

NOTE:
If Q7.2.1 and 7.2.2 are swapped around, then 2/4 max.
LET WEL:
Indien V7.2.1 en 7.2.2 omgeruil word, dan 2/4 maks.

7.3.1 **ANY ONE**:

- A substance whose (aqueous) solution contains ions. ✓
- Substance that dissolves in water to give a solution that conducts electricity.
- A substance that forms ions in water / when melted.

ENIGE EEN:

- *'n Stof waarvan die (waterige) oplossing ione bevat.* ✓
- *'n Stof wat in water oplos om 'n oplossing te vorm wat elektrisiteit gelei.*
- *'n Stof wat ione in water vorm / wanneer gesmelt word.* (1)

7.3.2 $H_2C_2O_4$ ✓
Highest K_a value/Strongest acid/Highest concentration of ions formed. ✓
Hoogste K_a waarde/Sterkste suur./*Hoogste konsentrasie ione vorm.* (2)

7.4.1

Marking criteria	***Nasienkriteria:***
(a) Substitute: 0,5 mol·dm^{-3} & 0,05 dm^3 in n = cV ✓	*(a) Vervang: 0,5 mol·dm^{-3} & 0,05 dm^3 in n = cV ✓*
(b) Substitute: 0,378 mol·dm^{-3} & 0,0265 dm^3 in n = cV ✓	*(b) Vervang: 0,378 mol·dm^{-3} & 0,0265 dm^3 in n = cV ✓*
(c) USE ratio: n(HCℓ) = n(NaOH)✓	*(c) GEBRUIK verhouding ratio: n(HCℓ) = n(NaOH) ✓*
(d) nHCℓ = $n_{ini} - n_{excess}$ ✓	*(d) nHCℓ = $n_{aanvanklik} - n_{oormaat}$ ✓*
(e) Final answer: 0,015 mol ✓ Range: 0,01498 to 0,02 mol	*(e) Finale antwoord: 0,015 mol ✓ Gebied: 0,01498 tot 0,02 mol*

nHCℓ = cV
= (0,5)(0,05) ✓(a)
= 0,025 mol

nNaOH in titrate = cV
= (0,378)(0,0265) ✓(b)
= 1 x 10^{-2} mol

nHCℓ = nNaOH ✓(c)
= 1 x 10^{-2} mol

nHCℓ reacted with nOH$^-$ in tablet = 0,025 - 1 x 10^{-2} ✓(d)
= 0,015 mol

nOH$^-$ = nHCℓ
= 0,015 mol ✓(e)

(5)

7.4.2 **POSITIVE MARKING FROM QUESTION 7.4.1/**
POSITIEWE NASIEN VANAF VRAAG 7.4.1

Marking criteria	***Nasienkriteria:***
(a) 5 parts of nOH$^-$ ions in tablet ✓	*(a) 5 dele van nOH$^-$ ione in tablet ✓*
(b) 3 parts from nAℓ(OH)$_3$ ✓	*(b) 3 dele van nAℓ(OH)$_3$ ✓*
(c) Use ratio nAℓ(OH)$_3$:nOH$^-$ ✓	*(c) Gebruik verhouding nAℓ(OH)$_3$:nOH$^-$ ✓*
(d) Substitute: nAℓ(OH)$_3$ and 78 in $n = \frac{m}{M}$ ✓	*(d) Vervang: nAℓ(OH)$_3$ en 78 in $n = \frac{m}{M}$ ✓*
(e) Final answer = 0,234 g ✓	*(e) Finale antwoord = 0,234 g ✓*

OPTION 1/*OPSIE 1*

nOH$^-$ = 3x + 2x ✓(a) = 0,015 mol

nOH$^-$ from/van Aℓ(OH)$_3$
$= \frac{3x}{5x}$ ✓(b) x 0,015
= 9 x 10^{-3} mol

nAℓ(OH)$_3$ $= \frac{9 \times 10^{-3}}{3}$ ✓(c)
= 3 x 10^{-3} mol Aℓ(OH)$_3$

nAℓ(OH)$_3$ $= \frac{m}{M}$

3 x 10^{-3} $= \frac{m}{78}$ ✓(d)

m = 0,234 g ✓(e)

OPTION 2/*OPSIE 2*

$\frac{3}{5}$ ✓(b) x 0,015 OH$^-$ = nAℓ(OH)$_3$
✓(a) = 9 x 10^{-3}

nAℓ(OH)$_3$ $= \frac{9 \times 10^{-3}}{3}$ ✓(c)
= 3 x 10^{-3} mol Aℓ(OH)$_3$

nAℓ(OH)$_3$ $= \frac{m}{M}$

3 x 10^{-3} $= \frac{m}{78}$ ✓(d)

m = 0,234 g ✓(e)

(5)
[24]

QUESTION 8/*VRAAG 8*

8.1 A cell in which chemical energy is converted to electrical energy. ✓✓
'n Sel waarin chemiese energie omgeskakel word na elektriese energie. (2)

8.2.1 $Cd(s) \mid Cd^{2+}(aq) \parallel C\ell_2(g) \mid C\ell^-(aq) \mid Pt(s)$ ✓ ✓ ✓

OR/OF
$Cd(s) \mid Cd^{2+}\ (1\ mol{\cdot}dm^{-3}) \parallel C\ell_2(g) \mid C\ell^-(1\ mol{\cdot}dm^{-3}) \mid Pt\ (s)$

OR/OF
$Cd \mid Cd^{2+} \parallel C\ell_2 \mid C\ell^- \mid Pt$ (3)

8.2.2 Q to/*na* P ✓ (1)

8.2.3

Marking criteria/*Nasienkriteria:*

- $C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-(aq)$ $(\frac{1}{2})$ $2C\ell^-(aq) \leftarrow C\ell_2(g) + 2e^-$ $(\frac{2}{2})$
- $C\ell_2(g) + 2e^- \leftarrow 2C\ell^-(aq)$ $(\frac{0}{2})$ $2C\ell^-(aq) \rightleftharpoons C\ell_2(g) + 2e^-$ $(\frac{0}{2})$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on $C\ell^-$/*Indien lading (-) weggelaat op* $C\ell^-$.
  Example/*Voorbeeld:* $C\ell_2 + 2e^- \rightarrow 2C\ell$ Max./*Maks:* $\frac{1}{2}$
- Ignore phases/*Ignoreer fases.*

$C\ell_2(g) + 2e^- \rightarrow 2C\ell^-(aq)$ ✓✓ (2)

8.3 Decreases. /*Verminder.* ✓
Reverse reaction is favoured. / *Terugwaartse reaksie is bevoordeel.* ✓ (2)
[10]

QUESTION 9/*VRAAG 9*

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

Die chemiese proses waar elektriese energie omgeskakel word in chemiese energie.
OF
Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring. (2)

9.2 $2H_2O \rightarrow O_2(g) + 4H^+ + 4e^-$ ✓✓

$2C\ell^- \rightarrow C\ell_2(g) + 2e^-$ ✓✓ (4)

9.3 $C\ell_2$/Chlorine/*Chloor* ✓ (1)

9.4.1 Copper / Cu / *Koper* ✓ (1)

9.4.2 Iodine / I_2 / *Jodium* ✓ (1)
[9]

TOTAL/*TOTAAL*: 150