



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA



NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

FEBRUARY/MARCH 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages, 4 data sheets and 1 graph sheet.

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 TEN questions. Answer QUESTION 5.3 on the attached GRAPH PAPER. 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. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
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 number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following is the general formula of alkynes?

- A C_nH_{2n}
- B $C_{2n}H_{2n}$
- C C_nH_{2n-2}
- D C_nH_{2n+2} (2)

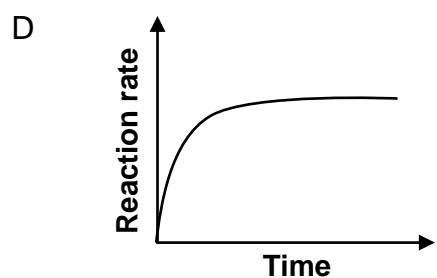
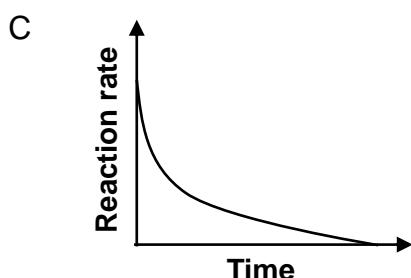
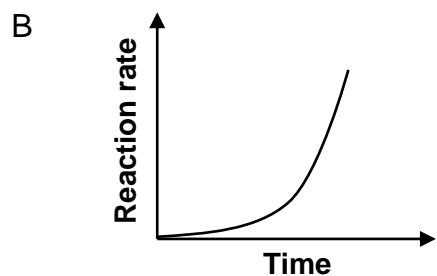
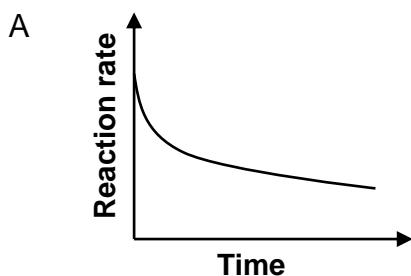
1.2 The type of reaction that takes place when a carboxylic acid and an alcohol react in the presence of an acid:

- A Addition
- B Hydrolysis
- C Substitution
- D Esterification (2)

1.3 Which ONE of the following isomers has the LOWEST boiling point?

- A $CH_3CH_2CH_2CH_2CH_2CH_3$
- B $CH_3CH_2C(CH_3)_2CH_3$
- C $CH_3CH(CH_3)CH_2CH_2CH_3$
- D $CH_3CH_2CH(CH_3)CH_2CH_3$ (2)

- 1.4 Which ONE of the reaction rate versus time graphs below best represents the reaction between magnesium and EXCESS dilute hydrochloric acid?



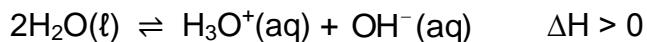
(2)

- 1.5 Which ONE of the following will NOT affect the equilibrium position of reversible chemical reactions?

- A Temperature
- B Catalyst
- C Pressure
- D Concentration

(2)

- 1.6 The following equilibrium exists in pure water at 25 °C.



At this temperature, the pH = 7 and $K_w = 1 \times 10^{-14}$.

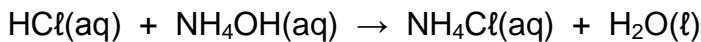
The temperature of the water is now increased to 90 °C.

Which ONE of the following is TRUE at the new temperature?

- A pH = 7
- B $[\text{H}_3\text{O}^+] = [\text{OH}^-]$
- C $[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$
- D $[\text{H}_3\text{O}^+] = 10^{-7} \text{ mol}\cdot\text{dm}^{-3}$

(2)

- 1.7 A hydrochloric acid solution is titrated against an ammonia solution. The balanced equation for the reaction is:



Which ONE of the following gives the pH of the solution at the end point and the reason for this pH?

	pH	REASON
A	3	$\text{H}_3\text{O}^+(\text{aq})$ is formed during the ionisation of HCl(aq) .
B	5	$\text{H}_3\text{O}^+(\text{aq})$ is formed during hydrolysis of $\text{NH}_4^+(\text{aq})$.
C	7	Neutralisation takes place at the end point.
D	9	$\text{OH}^-(\text{aq})$ is formed during hydrolysis of $\text{NH}_4^+(\text{aq})$.

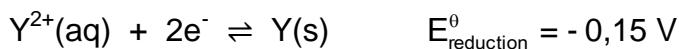
(2)

- 1.8 A decrease in the oxidation number of an atom during a chemical reaction is known as ...

- A redox.
- B oxidation.
- C reduction.
- D electrolysis.

(2)

1.9 The two half-reactions below are used to construct a galvanic cell.



Which ONE of the statements below is CORRECT when the cell is in operation?

- A $X^+(aq)$ is reduced.
- B $Y(s)$ is reduced.
- C $X(s) | X^+(aq)$ is the negative electrode.
- D Electrons flow from $X(s)$ to $Y(s)$ in the external circuit. (2)

1.10 Which ONE of the following is CORRECT for the industrial preparation of sulphuric acid?

	PROCESS	CATALYST
A	Ostwald	Platinum
B	Haber	Iron
C	Contact	Iron
D	Contact	Vanadium pentoxide

(2)
[20]

QUESTION 2 (Start on a new page.)

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

A	<pre> H O H H H—C—C—C—C—H H H H—C—H H </pre>	B	<pre> H H H O = H—C—C—C—C—H H H H </pre>
C	Butan-1-ol	D	Butan-2-one
E	<pre> H CH₃ CH₂ H H H H H—C—C—C—C—C—C—H H CH₂ H H OH H H CH₃ </pre>		

2.1 Write down the LETTER that represents EACH of the following:

- 2.1.1 A tertiary alcohol (1)
- 2.1.2 An aldehyde (1)
- 2.1.3 A ketone (1)
- 2.1.4 A functional isomer of compound **B** (1)

2.2 Write down the IUPAC name of:

- 2.2.1 Compound **B** (1)
- 2.2.2 Compound **E** (4)

2.3 Define *positional isomers*.



(2)

2.4 Write down the STRUCTURAL FORMULA of:

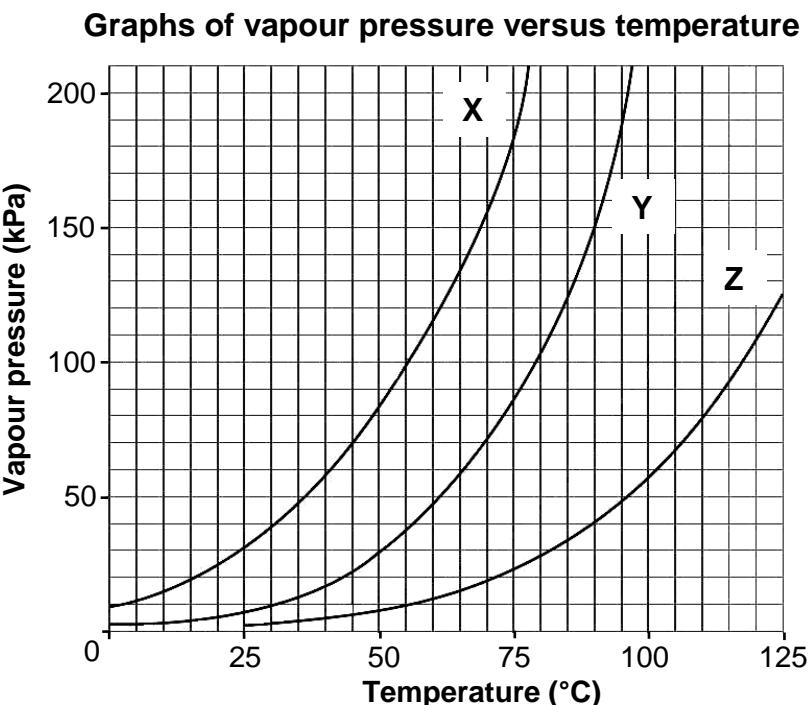
- 2.4.1 A positional isomer of compound **C** (2)
- 2.4.2 Compound **D** (2)
- 2.4.3 The organic acid that will react with compound **C** to form butyl propanoate (2)

[17]

QUESTION 3 (Start on a new page.)

Study the vapour pressure versus temperature graphs for three organic compounds, **X**, **Y** and **Z**, below which belong to different homologous series.

Atmospheric pressure is 100 kPa.



- 3.1 Write down the vapour pressure of compound **Y** at 90 °C. (1)
- 3.2 The graphs can be used to determine the boiling points of the three compounds.
- 3.2.1 Define *boiling point*. (2)
- 3.2.2 Determine the boiling point of compound **X**. (1)
- 3.3 The homologous series to which the three compounds of similar molecular masses belong, were identified in random order as:
alcohol; carboxylic acid; ketone
- 3.3.1 Which compound (**X**, **Y** or **Z**) is the carboxylic acid? (1)
- 3.3.2 Explain the answer to QUESTION 3.3.1 by referring to the type of intermolecular forces in compounds of each of the homologous series above. (4)
- 3.3.3 Compound **X** has three carbon atoms per molecule. Write down the IUPAC name of compound **X**. (1)
[10]

QUESTION 4 (Start on a new page.)

Consider the incomplete equations for reactions **I** to **IV** below. **P**, **Q**, **R** and **S** are organic compounds.

I	Q + Br ₂ → 2-bromobutane + HBr
II	n P → $\left[\text{CH}_2 - \text{CH}_2 \right]_n$
III	R $\xrightarrow{\text{heat}}$ 2 P + Q
IV	2-bromobutane + KOH (in ethanol) $\xrightarrow{\text{heat}}$ S + T + H ₂ O

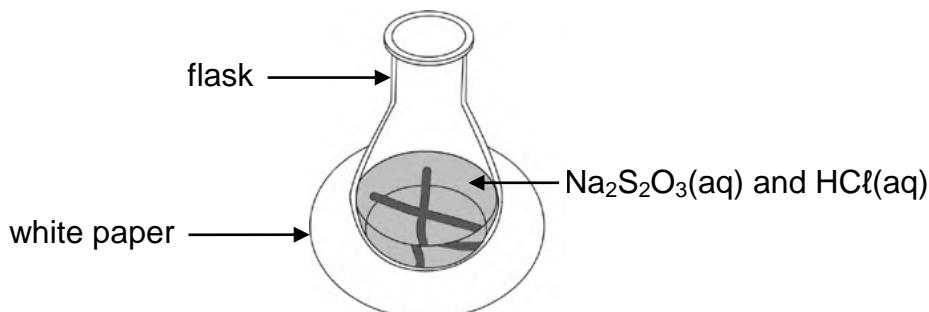
- 4.1 Define a *cracking reaction*. (2)
- 4.2 Write down the reaction number (**I**, **II**, **III** or **IV**) that represents EACH of the following:
- 4.2.1 A cracking reaction (1)
 - 4.2.2 An addition reaction (1)
 - 4.2.3 A substitution reaction (1)
- 4.3 Write down:
- 4.3.1 ONE reaction condition for reaction **I** (1)
 - 4.3.2 The compound (**P**, **Q**, **R** or **S**) that represents an unsaturated hydrocarbon (1)
 - 4.3.3 The IUPAC name of compound **P** (1)
 - 4.3.4 The molecular formula of compound **R** (2)
 - 4.3.5 The structural formula of compound **Q** (2)
 - 4.3.6 The structural formula of compound **S** (2)
- [14]

QUESTION 5 (Start on a new page.)**ANSWER QUESTION 5.3 ON THE ATTACHED GRAPH PAPER.**

Learners use the reaction between sodium thiosulphate and hydrochloric acid to investigate one of the factors that affects reaction rate. The balanced equation for the reaction is:



The diagram below shows the experimental setup.



In the first experiment, 50 cm^3 of the sodium thiosulphate solution is added to 100 cm^3 of a $2 \text{ mol}\cdot\text{dm}^{-3}$ dilute hydrochloric acid solution in a flask that is placed over a cross drawn on a sheet of white paper. The hydrochloric acid is in EXCESS.

The time taken for the cross to become invisible, when viewed from the top, is recorded.

The experiment is then repeated four times with different volumes of the sodium thiosulphate solution. The results obtained are shown in the table below.

EXPERIMENT	VOLUME OF $\text{Na}_2\text{S}_2\text{O}_3 (\text{cm}^3)$	VOLUME OF $\text{H}_2\text{O} (\text{cm}^3)$	TIME (s)	AVERAGE RATE ($\frac{1}{\text{time}}$) ($\times 10^{-2} \text{ s}^{-1}$)
1	50	0	22,7	4,4
2	40	10	28,6	3,5
3	30	20	38,5	2,6
4	20	30	58,8	1,7
5	10	40	111,1	0,9

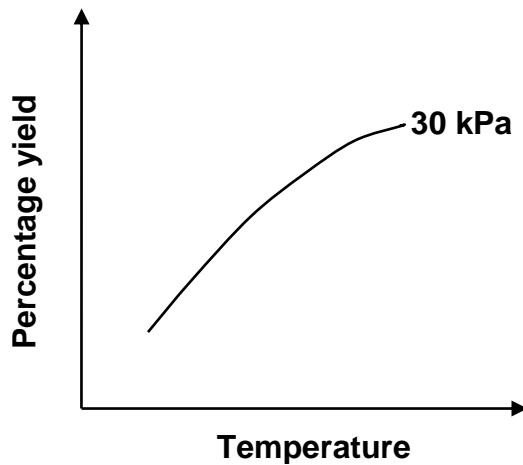
- 5.1 Define *reaction rate*. (2)
- 5.2 How does the concentration of the sodium thiosulphate solution used in experiment 2 compare to that used in experiment 5? Choose from MORE THAN, LESS THAN or EQUAL TO. (1)

- 5.3 Draw a graph of average reaction rate versus volume of sodium thiosulphate used on the attached GRAPH SHEET.
(ATTACH THIS GRAPH SHEET TO YOUR ANSWER BOOK.) (3)
- 5.4 Use the information in the graph to answer the following questions.
- 5.4.1 Determine the volume of dilute sodium thiosulphate solution that needs to react in order for the cross to become invisible in 40 seconds.
- USE DOTTED LINES ON THE GRAPH TO SHOW HOW YOU ARRIVED AT THE ANSWER. (3)
- 5.4.2 Write down a conclusion for this investigation. (2)
- 5.5 Use the collision theory to explain the effect of an increase in concentration on reaction rate. (3)
- 5.6 The mass of sulphur produced in experiment 1 is 1,62 g. Calculate the mass of the sodium thiosulphate used in experiment 1. (4) [18]

QUESTION 6 (Start on a new page.)

- 6.1 A reversible gaseous reaction is allowed to reach equilibrium in a closed container at different temperatures and pressures.

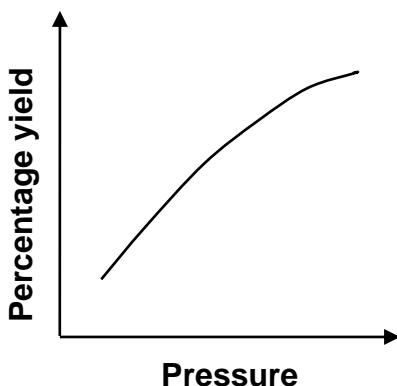
The graph below shows the percentage yield for this reaction at 30 kPa as the temperature is increased.



Use the information in the graph above to answer the following questions.

- 6.1.1 State Le Chatelier's principle. (2)
- 6.1.2 The heat of reaction (ΔH) for the forward reaction is POSITIVE. Use Le Chatelier's principle to explain this statement. (3)

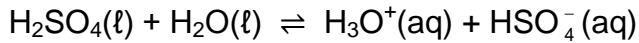
The graph below show the percentage yield for this reaction as pressure changes at constant temperature.



- 6.1.3 Explain the effect of an increase in pressure on the equilibrium position of a reaction. (2)
- 6.1.4 Which ONE of the following equations (**I**, **II** or **III**) represents the equilibrium above?
- I:** $2A(g) + 3B(g) \rightleftharpoons 3C(g)$
- II:** $A(g) + B(g) \rightleftharpoons 3C(g)$
- III:** $A(g) + B(g) \rightleftharpoons 2C(g)$ (2)
- 6.2 A mixture of 0,2 moles of hydrogen chloride (HCl) and 0,11 moles of oxygen gas (O_2) is sealed in a 200 cm^3 flask at a certain temperature. The reaction reaches equilibrium according to the balanced equation below:
- $$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(g)$$
- It is found that 1,825 g of hydrogen chloride is present at equilibrium.
- Calculate the equilibrium constant, K_c , for this reaction at this temperature. (9)
[18]

QUESTION 7 (Start on a new page.)

- 7.1 The balanced equation below represents the first step in the ionisation of sulphuric acid (H_2SO_4) in water:

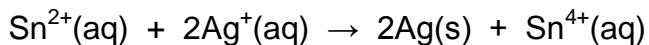


- 7.1.1 Write down the FORMULAE of the TWO bases in the equation above. (2)
- 7.1.2 Is sulphuric acid a STRONG or a WEAK acid? Give a reason for the answer. (2)
- 7.2 Learners use the reaction of a $0,15 \text{ mol}\cdot\text{dm}^{-3}$ sulphuric acid solution with a sodium hydroxide solution in two different experiments. The balanced equation for the reaction is:
- $$\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + \text{H}_2\text{O}(\ell)$$
- 7.2.1 They use 24 cm^3 of $\text{H}_2\text{SO}_4(\text{aq})$ in a titration to neutralise 26 cm^3 of $\text{NaOH}(\text{aq})$.
Calculate the concentration of the $\text{NaOH}(\text{aq})$. (5)
- 7.2.2 In another experiment, 30 cm^3 of the $\text{H}_2\text{SO}_4(\text{aq})$ is added to 20 cm^3 of a $0,28 \text{ mol}\cdot\text{dm}^{-3}$ NaOH solution in a beaker.
Calculate the pH of the final solution. (8)

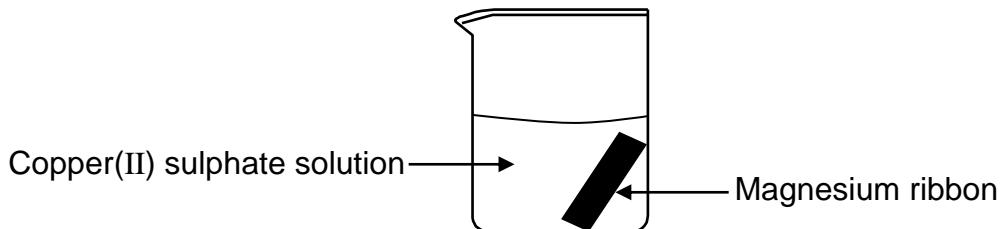
[17]

QUESTION 8 (Start on a new page.)

- 8.1 A group of learners use the redox reaction below to construct an electrochemical cell.



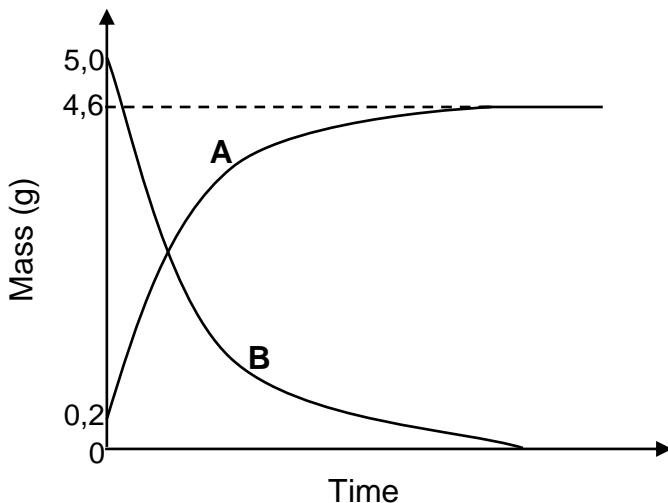
- 8.1.1 Define a *reducing agent* in terms of *electron transfer*. (2)
- 8.1.2 Name a substance that should be used as electrode in the anode half-cell. (1)
- 8.1.3 Write down the NAME or FORMULA of the reducing agent. (1)
- 8.1.4 Write down the cell notation of the cell. (3)
- 8.1.5 Calculate the initial emf of this cell under standard conditions. (4)
- 8.2 In a separate experiment, the learners place magnesium ribbon in a beaker containing a blue solution of copper(II) sulphate. After a while the solution becomes colourless.



- 8.2.1 State ONE observable change in the beaker, besides a colour change of the solution, that the learners can make. (1)
- 8.2.2 Refer to the relative strengths of oxidising agents or reducing agents to explain why the solution becomes colourless. (3)
- [15]**

QUESTION 9 (Start on a new page.)

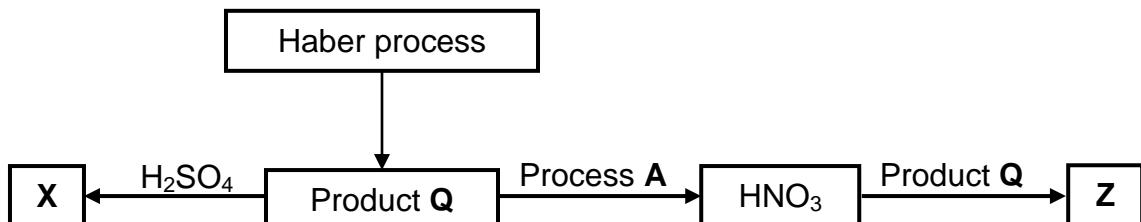
The graph below represents the changes in mass that occur at electrode A and electrode B in an electrolytic cell during the purification of copper.



- 9.1 Define *electrolysis*. (2)
- 9.2 Which graph, A or B, represents the change in mass of the anode during electrolysis? (1)
- 9.3 Write down the equation of the half-reaction which takes place at the cathode of this cell. (2)
- 9.4 Use the information in the graph and calculate the percentage purity of the impure copper. (4)
[9]

QUESTION 10 (Start on a new page.)

- 10.1 The diagram below shows processes involved in the production of fertiliser X and fertiliser Z.



Write down the:

- 10.1.1 Balanced equation for the formation of product Q (3)
- 10.1.2 FORMULA of fertiliser X (1)
- 10.1.3 NAME of process A (1)
- 10.1.4 NAME of fertiliser Z (1)
- 10.2 A 10 kg bag of NPK fertiliser is labelled 6 : 1 : 5 (22).
- 10.2.1 What is the meaning of NPK? (1)
- 10.2.2 What is the meaning of (22) on the label? (1)
- 10.2.3 Calculate the mass of potassium in the bag. (4)
[12]

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

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at/by 298 K	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta / E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$	
or/of	
$E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta / E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$	
or/of	
$E_{\text{cell}}^\theta = E_{\text{oxidisingagent}}^\theta - E_{\text{reducingagent}}^\theta / E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$	

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)	
2,1 H 1																	2 He 4	
1,0 Li 7	1,5 Be 9		4														10 Ne 20	
0,9 Na 23	1,2 Mg 24		12														18 Ar 40	
0,8 K 39	1,0 Ca 40	20	1,3 Sc 45	21	22	23	24	25	26	27	28	29	30	31	32	33	36 Kr 84	
0,8 Rb 86	1,0 Sr 88	38	1,2 Y 89	39	40	41	42	43	44	45	46	47	48	49	50	51	52 Xe 131	
0,7 Cs 133	0,9 Ba 137	56	1,6 La 139	57	72	73	74	75	76	77	78	79	80	81	82	83	86 Rn	
0,7 Fr	0,9 Ra 226	88	1,6 Ac	89														
					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

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
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 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
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 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 oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reducerende vermoë

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

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reducerende vermoë*

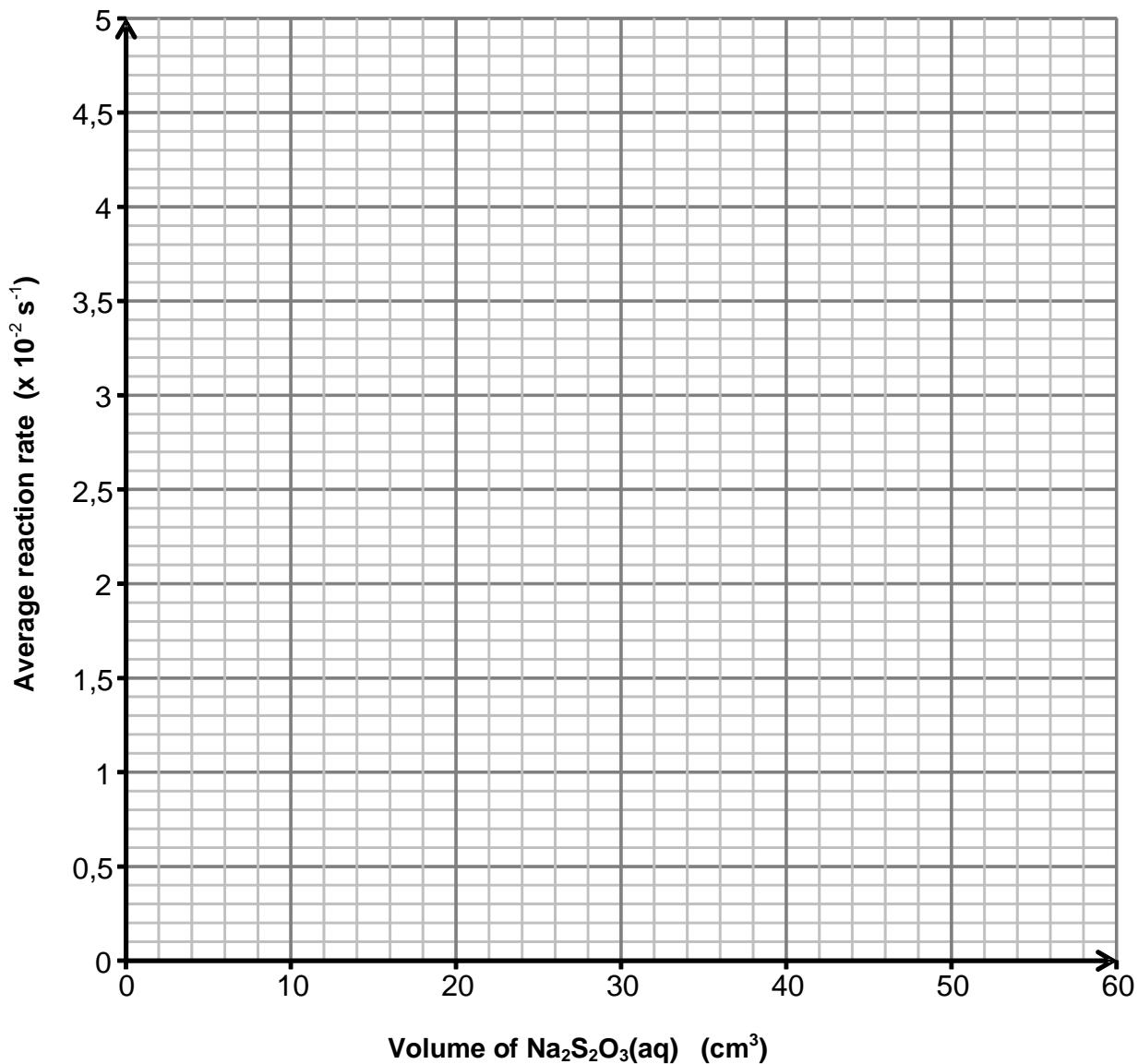
Half-reactions/ <i>Halfreaksies</i>	E^θ (V)
$\text{Li}^+ + \text{e}^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + \text{e}^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + \text{e}^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2,36
$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3\text{e}^- \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Hg}(\ell)$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3\text{e}^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-$	+2,87

CENTRE NUMBER:							
EXAMINATION NUMBER:							

QUESTION 5.3

Hand in this GRAPH SHEET with your ANSWER BOOK.

Graph of reaction rate versus volume





basic education



Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE NASIONALE SENIOR SERTIFIKAAT

GRADE/GRAAD 12

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

FEBRUARY/MARCH/FEBRUARIE/MAART 2018

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

These marking guidelines consist of 15 pages.
Hierdie nasienriglyne bestaan uit 15 bladsye.

QUESTION 1/VRAAG 1

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

QUESTION 2/VRAAG 2

- 2.1
2.1.1 A ✓ (1)
2.1.2 B ✓ (1)
2.1.3 D ✓ (1)
2.1.4 D ✓ (1)
- 2.2
2.2.1 Butanal/Butanaal ✓ (1)
2.2.2 5-ethyl-6,6-dimethyloctan-3-ol/5-etiel-6,6-dimetieloktan-3-ol

OR/OF

5-ethyl-6,6-dimethyl-3-octanol/5-etiel-6,6-dimetiel-3-oktanol

Marking criteria/Nasienriglyne:

- Stem, i.e. octan./Stam d.i. oktan. ✓
- Correct functional group, i.e. –ol./Korrekte funksionele groep d.i. –ol. ✓
- Two methyl groups and one ethyl group.
Twee metielgroepe en een etielgroep. ✓
- Correct numbering of substituents and functional group ✓
Korrekte nommering van substituente en funksionele groep.

IF/INDIEN:

Any error e.g. hyphens omitted and/or incorrect sequence:

Enige fout bv. koppeltekens weggelaat en/of verkeerde volgorde:

Max./Maks. 3/4

(4)

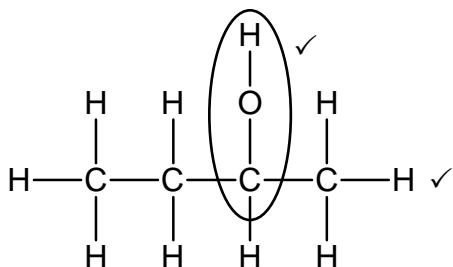
- 2.3 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups on parent chain. ✓

Verbindings met dieselfde molekuläre formule, maar verskillende posisies van die syketting/substituente/funksionele groepes op die stamketting.

(2)

2.4

2.4.1



Marking criteria/Nasienriglyne:

- Whole structure correct:

Hele struktuur korrek:

2/
2

- Only functional group correct:/Slegs funksionele groep korrek: Max/Maks.: 1/2

IF/INDIEN:

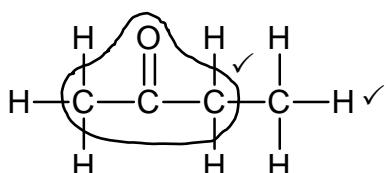
More than one functional group:

Meer as een funksionele groep:

0/
2

(2)

2.4.2



Marking criteria/Nasienriglyne:

- Whole structure correct:

Hele struktuur korrek:

2/
2

- Only functional group correct:/Slegs funksionele groep korrek: Max/Maks.: 1/2

IF/INDIEN:

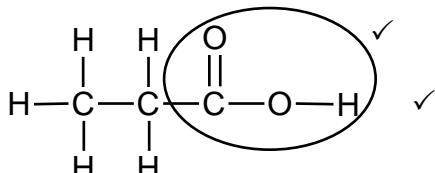
More than one functional group:

Meer as een funksionele groep:

0/
2

(2)

2.4.3



Marking criteria/Nasienriglyne:

- Whole structure correct:

Hele struktuur korrek:

2/
2

- Only functional group correct:/Slegs funksionele groep korrek: Max/Maks.: 1/2

IF/INDIEN:

More than one functional group:

Meer as een funksionele groep:

0/
2

(2)

[17]

QUESTION 3/VRAAG 3

3.1 150 kPa ✓ (1)

3.2

3.2.1 The temperature at which the vapour pressure equals atmospheric/external pressure. ✓✓ (2 or 0)

Die temperatuur waar die dampdruk gelyk is aan atmosferiese/eksterne druk. (2)

3.2.2 55 °C ✓ (1)

3.3

3.3.1 Z ✓ (1)

3.3.2 • Carboxylic acids have, in addition to London forces and dipole-dipole forces, two sites for hydrogen bonding between molecules. ✓

Karboksielsure het, in toevoeging tot Londonkragte en dipool-dipoolkragte, twee punte vir waterstofbinding tussen molekule.
OR/OF

Carboxylic acids can form dimers due to strong hydrogen bonding between molecules.

Karboksielsure kan dimere vorm as gevolg van sterk waterstofbindings tussen molekule.

• Alcohols have, in addition to London forces and dipole-dipole forces, one site for hydrogen bonding between molecules. ✓

Alkohole het, in toevoeging tot Londonkragte en dipool-dipoolkragte, een punt vir waterstofbinding tussen molekule.

• Ketones has, in addition to London forces, dipole-dipole forces between molecules. ✓

Ketone het, in toevoeging tot Londonkragte, dipool-dipoolkragte tussen molekule.

• Intermolecular forces in carboxylic acids is the strongest./Most energy needed to overcome/break intermolecular forces in ethanoic acid. ✓

Intermolekulêre kragte in karboksielsure is die sterkste./Die meeste energie word benodig om intermolekulêre kragte in karboksielsure te oorkom/breek. (4)

3.3.3 Propanone/Propanoon ✓

OR/OF

Propan-2-one/Propan-2-oon

OR/OF

2-propanone/2-propanoon

(1)

[10]

QUESTION 4/VRAAG 4

- 4.1 The chemical process in which longer chain hydrocarbon molecules are broken down ✓ to shorter more useful molecules. ✓

Die chemiese proses waarin langer ketting koolwaterstofmolekule afgebreek word in korter meer bruikbare molekule.

(2)

4.2

- 4.2.1 III ✓

(1)

- 4.2.2 II ✓

(1)

- 4.2.3 I ✓

(1)

4.3

- 4.3.1 Heat/Light /UV light ✓
Hitte/Lig/UV Lig



(1)

- 4.3.2 P or/of S ✓

(1)

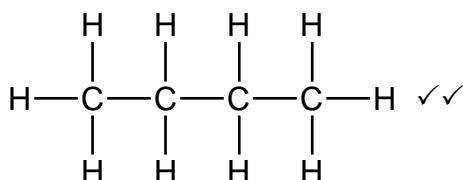
- 4.3.3 Ethene/Eteen ✓

(1)

- 4.3.4 C₈H₁₈ ✓✓ (Correct Structural formula/Korrekte struktuurformule: ½)

(2)

4.3.5

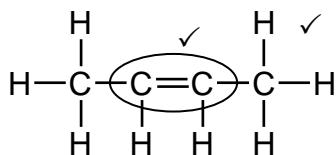


Marking criteria/Nasienriglyne:

- Whole structure correct:
Hele struktuur korrek: $\frac{2}{2}$
- 4 C atoms in chain:/4 C-atome in ketting: *Max/Maks.:* $\frac{1}{2}$
- Correct condensed formula/Korrekte gekondenseerde formule: $\frac{1}{2}$

(2)

4.3.6



Marking criteria/Nasienriglyne:

- Whole structure of alkene/haloalkane correct:
Hele struktuur van alkeen/haloalkaan korrek: $\frac{2}{2}$
- Only functional group correct/Slegs funksionele groep korrek: $\frac{1}{2}$
- Correct condensed structure/Korrekte gekondenseerde struktuur:
 $\text{CH}_3\text{CH}=\text{CHCH}_3$ $\frac{1}{2}$

(2)

[14]

QUESTION 5/VRAAG 5

5.1

ONLY ANY ONE OF/SLEGS ENIGE EEN VAN:

- Change in concentration ✓ of a reactant/product per unit time. ✓
Verandering in konsentrasie van reaktanse/produkte per eenheidtyd.
- Rate of change in concentration. ✓✓
Tempo van verandering in konsentrasie.
- Change in amount/number of moles/volume/mass of products/reactants per (unit) time./Verandering in hoeveelheid/getal mol/volume/massa van produkte/reaktanse per (eenheid)tyd.
- Amount/number of moles/volume/mass of products formed OR reactants used per (unit) time./Hoeveelheid/getal mol/volume/massa van produkte gevorm OF reaktanse gebruik per (eenheid)tyd.

(2)

5.2

More than/Groter as ✓

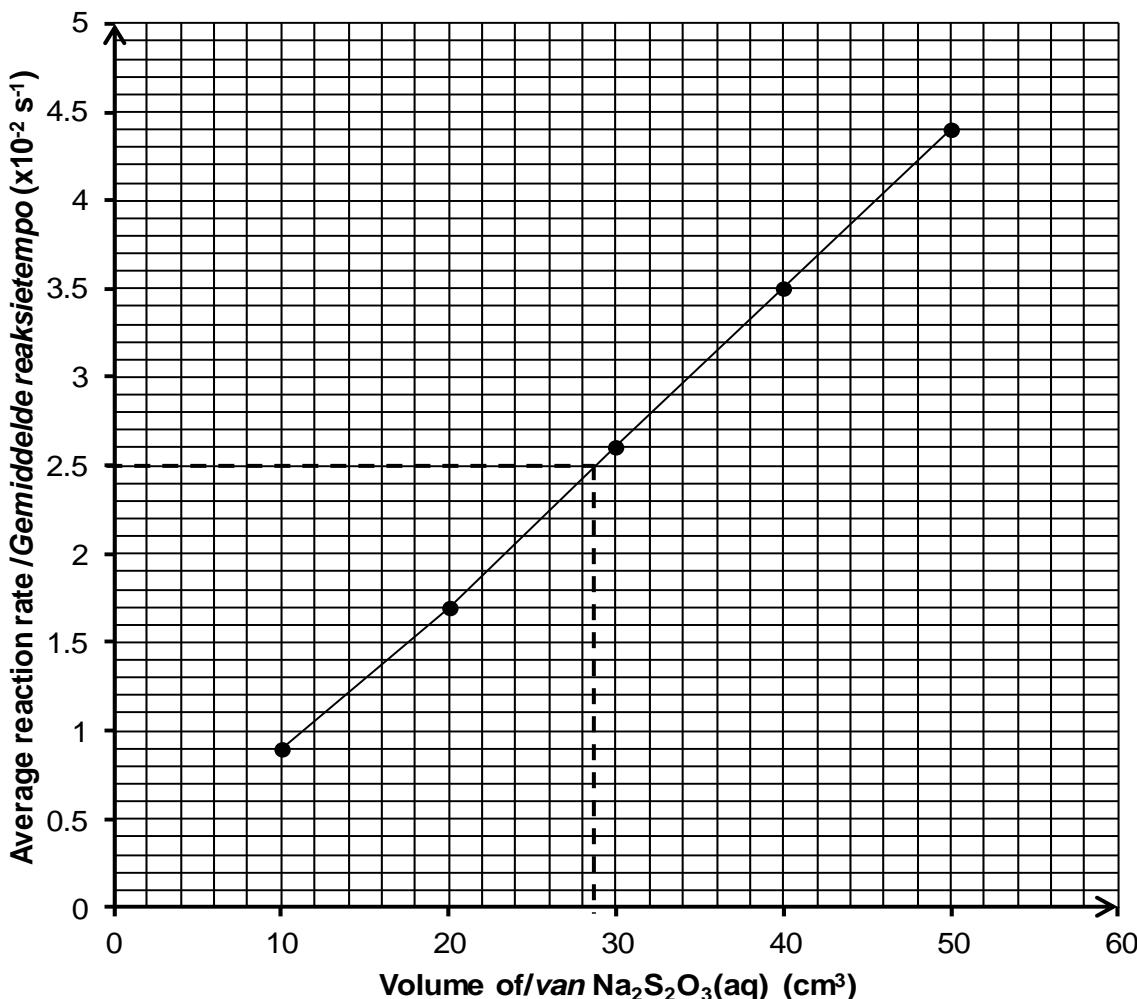
Accept/Aanvaar

Equal to/Gelyk aan

(1)

5.3

Graph of average reaction rate versus volume of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$
Grafiek van gemiddelde reaksietempo teenoor volume $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$

**Marking criteria/Nasienriglyne:**

Any 3 points correctly plotted./Enige 3 punte korrek gestip. ✓

All (5) points correctly plotted./Alle (5) punte korrek gestip. ✓

Straight line drawn./Reguitlyn getrek. ✓

(3)

5.4

5.4.1

Marking criteria/Nasienriglyne:

y axis/y-as: $2,5 \times 10^{-2} \text{ s}^{-1}$ ✓

Dotted line drawn from the y-axis to the x-axis as shown. ✓

Stippellyn getrek van y-as na x-as soos getoon.

$V = 28 \text{ to } 30 \text{ cm}^3$ ✓

(3)

5.4.2

Criteria for conclusion/Riglyne vir gevolgtrekking:

Dependent and independent variables correctly identified.

Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.

✓

Relationship between the independent and dependent variables correctly stated./Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.

✓

Examples/Voorbeelde:

- Reaction rate of reaction increases with an increase in concentration/volume of sodium thiosulphate.
Reaksietempo neem toe met 'n toename in konsentrasie/volume van natriumtiosultaat.
- Reaction rate decreases with a decrease in concentration/volume of sodium thiosulphate.
Reaksietempo neem af met 'n afname in konsentrasie/volume van natriumtiosultaat.
- Reaction rate is (directly) proportional to concentration/volume of sodium thiosulphate.
Reaksietempo is (direk) eweredig aan konsentrasie/volume van natriumtiosultaat.

(2)

5.5

- More($\text{Na}_2\text{S}_2\text{O}_3$) particles per unit volume. ✓
Meer $\text{Na}_2\text{S}_2\text{O}_3$ -deeltjies per eenheid volume.
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.
- Increase in reaction rate./Toename in reaksietempo. ✓

(3)

5.6

OPTION 1/OPSIE 1

$$\begin{aligned} n(\text{S})_{\text{produced/gevorm}} &= \frac{m}{M} \\ &= \frac{1,62}{32} \checkmark \\ &= 0,0506 \text{ mol} \end{aligned}$$

$$n(\text{Na}_2\text{S}_2\text{O}_3) = n(\text{S}) = 0,0506 \text{ mol} \checkmark$$

$$\begin{aligned} n(\text{Na}_2\text{S}_2\text{O}_3) &= \frac{m}{M} \\ 0,0506 &= \frac{m}{158} \checkmark \end{aligned}$$

$$\therefore m(\text{Na}_2\text{S}_2\text{O}_3) = 7,99 \text{ g} \checkmark$$

[Range/Gebied: 7,90 to 8,06]

Marking criteria/Nasienriglyne:

- Substitute/Vervang 32 in $n = \frac{m}{M}$ ✓
- Use ratio/Gebruik verhouding:
 $\text{Na}_2\text{S}_2\text{O}_3 : \text{S} = 1 : 1$ ✓
- Substitute/Vervang 158 in $n = \frac{m}{M}$ ✓
- Final answer/Finale antwoord:
7,90 to/tot 8,06 g ✓

OPTION 2/OPSIE 2

$$\begin{aligned} 158 \text{ g} \checkmark \text{ Na}_2\text{S}_2\text{O}_3 &\longrightarrow 32 \text{ g} \checkmark \text{ S} \\ \therefore x &\longrightarrow 1,62 \text{ g S} \checkmark \\ x &= \frac{158 \times 1,62}{32} = 7,99 \text{ g} \checkmark \end{aligned}$$

[Range/Gebied: 7,90 to 8,06]

(4)

[18]

QUESTION 6/VRAAG 6

6.1

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

Wanneer die ewewig in 'n geslotte sisteem versteur word, stel die sisteem 'n nuwe ewewig in deur die reaksie wat die versteuring teenwerk, te bevoordeel.

(2)

6.1.2

- Percentage yield increases with an increase in temperature. ✓
Persentasie opbrengs verhoog met toename in temperatuur.
- Forward reaction is favoured. ✓
Voorwaartse reaksie word bevoordeel.
- Increase in temperature favours an endothermic reaction. ✓
Toename in temperatuur bevoordeel die endotermiese reaksie.

(3)

6.1.3

- When the pressure increases, the reaction that leads to a decrease in the number of moles will be favoured. ✓✓

Wanneer die druk verhoog, word die reaksie wat tot 'n afname in die aantal mol lei, bevoordeel.

Accept/Aanvaar

When the pressure increases, the yield increases ✓ because the equilibrium position shifts to the right. ✓

Wanneer die druk toeneem, neem die opbrengs toe omdat die ewewigsposisie na regs skuif.

(2)

6.1.4

I ✓✓

(2)

6.2

Mark allocation/Puntetoekenning

- Substitution of/Vervanging van $36,5 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$. ✓
- Change/Verandering $n(\text{HCl}) = \text{initial/aanvanklik} - \text{equilibrium/ewewig}$. ✓
- USING ratio/GEBRUIK verhouding: $4 : 1 : 2 : 2$ ✓
- Equilibrium: $n(\text{O}_2) \& n(\text{H}_2\text{O}) \& n(\text{Cl}_2) = \text{initial} \pm \text{change}$ ✓
Ewewig: : $n(\text{O}_2) \& n(\text{H}_2\text{O}) \& n(\text{Cl}_2) = \text{aanvanklik} \pm \text{verandering}$
- Divide by volume/Gedeel deur volume ($0,2 \text{ dm}^3$) ✓
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules tussen vierkantjie).
- Substitution of reactant concentrations/Vervanging van reaktanskonsentrasies. ✓
- Substitution of product concentrations./Vervanging van produk-konsentrasies. ✓
- Final answer/Finale antwoord: $13,966 \text{ to/tot } 18,72$ ✓
Range/Gebied: $13,966 \text{ to/tot } 18,72$

OPTION 1/OPSIE 1

	HCl	O ₂	Cl ₂	H ₂ O	
Initial quantity/Aanvangs-hoeveelheid (mol)	0,2	0,11	0	0	
Change/Verandering (mol)	0,15 ✓	0,0375	0,075	0,075	ratio ✓ verhouding ✓
Quantity at equilibrium Hoeveelheid by ewewig (mol)	$\frac{1,825}{36,5} = 0,05 \checkmark$	0,0725	0,075	0,075	
Equilibrium concentration/Ewewigskonsentrasie (mol·dm ⁻³)	0,25	0,3625	0,375	0,375	Divide by 0,2✓ Deel deur 0,2
$K_c = \frac{[Cl_2]^2[H_2O]^2}{[HCl]^4[O_2]} \checkmark = \frac{(0,375)^2(0,375)^2}{(0,25)^4(0,3625)} \checkmark = 13,97 \checkmark$					
No K _c expression, correct substitution/Geen K _c -uitdrukking, korrekte vervanging: Max./Maks. 8/9					
Wrong K _c expression/Verkeerde K _c -uitdrukking: Max./Maks. 5/9					

(9)

OPTION 2/OPSIE 2:

$$n(HCl)_{\text{equilibrium/ewewig}} = \frac{m}{M} = \frac{1,825}{36,5} \checkmark = 0,05 \text{ mol}$$

$$n(HCl)_{\text{reacted/reageer}} = 0,2 - 0,05 = 0,15 \text{ mol} \checkmark$$

$$\left. \begin{array}{l} n(O_2)_{\text{reacted/reageer}} = \frac{1}{4}n(HCl)_{\text{reacted/reageer}} = \frac{1}{4} \times 0,15 = 0,0375 \text{ mol} \\ n(Cl_2)_{\text{formed/gevorm}} = \frac{1}{2}n(HCl)_{\text{reacted/reageer}} = \frac{1}{2} \times 0,15 = 0,075 \text{ mol} \\ n(H_2O)_{\text{formed/gevorm}} = \frac{1}{2}n(HCl)_{\text{reacted/reageer}} = \frac{1}{2} \times 0,15 = 0,075 \text{ mol} \end{array} \right\} \text{Using ratio } \checkmark$$

$$\left. \begin{array}{l} n(O_2)_{\text{equilibrium/ewewig}} = 0,11 - 0,0375 = 0,0725 \text{ mol} \\ n(Cl_2)_{\text{equilibrium/ewewig}} = n(H_2O)_{\text{equilibrium/ewewig}} = 0,075 \text{ mol} \end{array} \right\} \checkmark$$

$$\left. \begin{array}{l} c(O_2)_{\text{equilibrium/ewewig}} = \frac{n}{V} = \frac{0,0375}{0,2} = 0,3625 \text{ mol} \cdot \text{dm}^{-3} \\ c(Cl_2)_{\text{equilibrium/ewewig}} = c(H_2O)_{\text{equilibrium/ewewig}} = \frac{n}{V} = \frac{0,075}{0,2} = 0,375 \text{ mol} \cdot \text{dm}^{-3} \end{array} \right\} \text{Divide by/deel deur } 0,2 \checkmark$$

$$K_c = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]} \checkmark = \frac{(0,375)^2(0,375)^2}{(0,25)^4(0,3625)} \checkmark = 13,97 \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie:

Max./Maks. 8/9

Wrong K_c expression/Verkeerde K_c-uitdrukking:

Max./Maks. 5/9

(9)

CALCULATIONS USING CONCENTRATIONS

BEREKENINGE WAT KONSENTRASIES GEBRUIK

Mark allocation/Puntetoekenning

- Substitution of/Vervanging van $36,5 \text{ g} \cdot \text{mol}^{-1}$ $n = \frac{m}{M}$. ✓
- Initial concentration of reactants/Aanvanklike konsentrasie van reaktanse:
 $c(\text{HCl}) = 1,0$ & $c(\text{O}_2) = 0,55 \text{ mol} \cdot \text{dm}^{-3}$ ✓
- Change: $c(\text{HCl}) = 0,75 \text{ mol} \cdot \text{dm}^{-3}$ (initial – equilibrium) ✓
Verandering: $c(\text{HCl}) = 0,75 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik – ewewig)
- USING ratio/GEBRUIK verhouding: $4 : 1 : 2 : 2$ ✓
- Equilibrium/Ewewig: $c(\text{H}_2\text{O}) = c(\text{Cl}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (initial+change) and $c(\text{O}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (initial – change) ✓
Ewewig: $c(\text{H}_2\text{O}) = c(\text{Cl}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik + verandering) en $c(\text{O}_2) = 0,0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik – verandering)
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules tussen vierkanteklammes).
- Substitution of reactant concentrations./Vervanging van reaktanskonsentrasies. ✓
- Substitution of product concentrations./Vervanging van produkonsentrasies. ✓
- Final answer/Finale antwoord: 13,97 ✓
Range/Gebied: 13,966 to/tot 18,72

OPTION 3/OPSIE 3

$$\begin{aligned} n(\text{HCl})_{\text{equilibrium/ewewig}} &= \frac{m}{M} \\ &= \frac{1,825}{36,5} \checkmark \\ &= 0,05 \text{ mol} \end{aligned}$$

	HCl	O ₂	H ₂ O	Cl ₂	
Initial concentration/ Aanvangskonsentrasie (mol·dm ⁻³)	1,0 ✓	0,55	0	0	Divide by 0,2 ✓ Deel deur 0,2
Change in concentration Verandering in konsentrasie (mol·dm ⁻³)	0,75 ✓	0,1875	0,375	0,375	ratio ✓ verhouding
Equilibrium concentration Ewewigkonsentrasie (mol·dm ⁻³)	0,25	0,3625	0,375	0,375	✓

$$K_c = \frac{[\text{Cl}_2]^2 [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 [\text{O}_2]} \checkmark = \frac{(0,375)^2 (0,375)^2 \checkmark}{(0,25)^4 (0,3625)} \checkmark = 13,97 \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie:
Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{9}$

(9)
[18]

QUESTION 7/VRAAG 7

7.1

- 7.1.1 H_2O ✓
 HSO_4^- ✓

(2)

7.1.2 Strong/Sterk ✓

Completely ionised (in water)./Volledig geïoniseer (in water). ✓

(2)

7.2

7.2.1 Marking Criteria/Nasienriglyne

- Formula/Formule: $\frac{c_a \times V_a}{c_a \times V_b} = \frac{n_a}{n_b} / c = \frac{n}{V}$ ✓
- Substitute/Vervang $0,15 \times 24$ OR/OR $0,15 \times 0,024$ ✓
- Use/Gebruik 26 cm^3 OR/OR $0,026 \text{ dm}^3$ ✓
- Use mole ratio/Gebruik molverhouding: $1:2$ ✓
- Final answer/Finale antwoord: $0,28 \text{ mol} \cdot \text{dm}^{-3}$ ✓ $(0,2769\dots \text{ mol} \cdot \text{dm}^{-3})$

OPTION 1/OPSIE 1

$$\begin{aligned} \frac{c_a \times V_a}{c_a \times V_b} &= \frac{n_a}{n_b} \quad \checkmark \\ \frac{0,15 \times 24}{c_b \times 26} &= \frac{1}{2} \quad \checkmark \\ c(\text{NaOH}) &= 0,28 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned} n(\text{H}_2\text{SO}_4) &= cV \quad \checkmark \\ &= (0,15)(0,024) \quad \checkmark \\ &= 3,6 \times 10^{-3} \text{ mol} \\ n(\text{NaOH}) &= 2(3,6 \times 10^{-3}) \quad \checkmark \\ &= 7,2 \times 10^{-3} \text{ mol} \\ c &= \frac{n}{V} \\ &= \frac{7,2 \times 10^{-3}}{0,026} \quad \checkmark \\ &= 0,28 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark \end{aligned}$$

(5)



7.2.2

Marking Criteria/Nasienriglyne

- Calculate/Bereken $n(\text{NaOH})$: $0,02 \times 0,28 \checkmark$
- Calculate/Bereken $n(\text{H}_2\text{SO}_4)$: $0,03 \times 0,15 \checkmark$
- Use ratios/Gebruik molverhouding: $n(\text{H}_2\text{SO}_4) = \frac{1}{2}n(\text{NaOH}) \checkmark$
- $n(\text{H}_2\text{SO}_4)_{\text{excess}} = n(\text{H}_2\text{SO}_4)_{\text{initial}} - n(\text{H}_2\text{SO}_4)_{\text{used}} = 0,0045 - 0,0028 \checkmark$
- Substitute/Vervang $0,05 \text{ dm}^3$ in $c = \frac{n}{V} \checkmark$
- Substitution/Vervang $2 \times 0,034$ in $2[\text{H}_3\text{O}^+] \checkmark$
- Formula/Formule: $-\log[\text{H}_3\text{O}^+] \text{ OR/OF } \text{Substitute/Vervang: } -\log(0,068) \checkmark$
- Final answer: 1,10 to/tot 1,167 \checkmark

OPTION 1/OPTION 1

$$\begin{aligned} n(\text{NaOH}) &= cV \\ &= 0,02 \times 0,28 \checkmark \\ &= 0,0056 \text{ mol} \\ n(\text{H}_2\text{SO}_4) &= 0,03 \times 0,15 \checkmark \\ &= 0,0045 \text{ mol} \\ n(\text{H}_2\text{SO}_4)_{\text{used}} &= \frac{1}{2}n(\text{NaOH}) \checkmark \\ &= 0,0028 \\ n(\text{H}_2\text{SO}_4)_{\text{excess}} &= 0,0045 - 0,0028 \checkmark \\ &= 0,0017 \text{ mol} \\ [\text{H}_2\text{SO}_4] &= \frac{n}{V} = \frac{0,0017}{0,05} \checkmark \\ &= 0,034 \text{ mol} \cdot \text{dm}^{-3} \\ [\text{H}_3\text{O}^+] &= 2[\text{H}_2\text{SO}_4] \\ &= 2 \times 0,034 \checkmark \\ &= 0,068 \text{ mol} \cdot \text{dm}^{-3} \\ \text{pH} &= -\log[\text{H}_3\text{O}^+] \text{ OR/OF } -\log(0,068) \checkmark \\ &= 1,17 \checkmark \quad (1,167) \end{aligned}$$

OPTION 2/OPTION 2

$$\begin{aligned} n(\text{NaOH}) &= cV \\ &= 0,02 \times 0,28 \checkmark \\ &= 0,0056 \text{ mol} \\ n(\text{H}_2\text{SO}_4) &= 0,03 \times 0,15 \checkmark \\ &= 0,0045 \text{ mol} \\ n(\text{H}_3\text{O}^+) &= 2n(\text{H}_2\text{SO}_4) \checkmark \\ &= 2 \times 0,0045 \\ &= 0,009 \text{ mol} \\ n(\text{H}_3\text{O}^+)_{\text{excess}} &= 0,009 - 0,0045 \checkmark \\ &= 0,0034 \text{ mol} \\ c(\text{H}_3\text{O}^+) &= \frac{n}{V} \\ &= \frac{0,0034}{0,05} \checkmark \\ &= 0,068 \text{ mol} \cdot \text{dm}^{-3} \\ \text{pH} &= -\log[\text{H}_3\text{O}^+] \text{ OR/OF } -\log(0,068) \checkmark \\ &= 1,17 \checkmark \quad (1,167) \end{aligned}$$

(8)
[17]

QUESTION 8/VRAAG 8

8.1

- 8.1.1 A substance that loses/donates electrons./'n Stof wat elektrone verloor/skenk.
 ✓✓ (2 or 0) (2)

8.1.2 Platinum/Pt ✓ (1)

8.1.3 $\text{Sn}^{2+}(\text{aq})/\text{tin(II)}$ ions/tin(II)-ione ✓ (1)

8.1.4 $\text{Pt} | \text{Sn}^{2+}(\text{aq}) , \text{Sn}^{4+}(\text{aq}) || \text{Ag}^+(\text{aq}) | \text{Ag(s)}$

OR/OF

$\text{Pt} | \text{Sn}^{2+}(1 \text{ mol}\cdot\text{dm}^{-3}), \text{Sn}^{4+}(1 \text{ mol}\cdot\text{dm}^{-3}) || \text{Ag}^+(1 \text{ mol}\cdot\text{dm}^{-3}) | \text{Ag(s)}$

ACCEPT/AANVAAR

$\text{Pt} | \text{Sn}^{2+} | \text{Sn}^{4+} || \text{Ag}^+ | \text{Ag}$ (3)

8.1.5

OPTION 1/OPSIE 1

$$\begin{aligned} E_{\text{cell}}^{\circ} &= E_{\text{reduction}}^{\circ} - E_{\text{oxidation}}^{\circ} \checkmark \\ &= +0,80 \checkmark - (+0,15) \checkmark \\ &= 0,65 \text{ V} \checkmark \end{aligned}$$

Notes/Aantekeninge

- Accept any other correct formula from the data sheet./Aanvaar enige ander korrekte formule vanaf gegewensblad.
- Any other formula using unconventional abbreviations, e.g. $E_{\text{cell}}^{\circ} = E_{\text{OA}}^{\circ} - E_{\text{RA}}^{\circ}$ followed by correct substitutions:/Enige ander formule wat onkonvensionele afkortings gebruik bv. $E_{\text{sel}}^{\circ} = E_{\text{OM}}^{\circ} - E_{\text{RM}}^{\circ}$ gevvolg deur korrekte vervangings: Max/Maks: $\frac{3}{4}$

OPTION 2/OPSIE 2

$\text{Ag}^+(\text{aq}) + \text{e}^- \rightarrow \text{Ag(s)}$	0,80 V ✓
$\text{Sn}^{2+}(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + 2\text{e}^-$	-0,15 V ✓
$2\text{Ag}^+(\text{aq}) + \text{Sn}^{2+}(\text{aq}) \rightarrow \text{Sn}^{4+}(\text{aq}) + 2\text{Ag(s)}$	0,65 V ✓

(4)

8.2

- 8.2.1 Magnesium becomes smaller./Brown solid forms/Mg disappears/eaten away/Mg changes colour. ✓
Magnesium word kleiner./Bruin vaste stof vorm/Mg verdwyn/weggevrete/Mg verander van kleur. (1)

- 8.2.2 Cu^{2+} is a stronger oxidising agent ✓ (than Mg^{2+}) and will be reduced to ✓
 Cu . ✓
 Cu^{2+} is 'n sterker oksideermiddel (as Mg^{2+}) en sal na Cu gereduseer word.

OR/OF

Mg is a stronger reducing agent ✓ (than Cu) and will reduce Cu^{2+} to Cu.
Mg is 'n sterker reduseermiddel (as Cu) en sal Cu^{2+} na Cu reduseer.

(3)

[15]

QUESTION 9/VRAAG 9

9.1 The chemical process in which electrical energy is converted to chemical energy. ✓✓

'n Chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.

OR/OF

The use of electrical energy to produce a chemical change.

Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.

(2)

9.2 B ✓

(1)

9.3 $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}$ ✓✓

(2)

Marking criteria/Nasienriglyne

- $\text{Cu} \leftarrow \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$ (2/2) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}$ (1/2)
- $\text{Cu} \rightleftharpoons \text{Cu}^{2+}(\text{aq}) + 2\text{e}^-$ (0/2) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \leftarrow \text{Cu}$ (0/2)
- Ignore if charge omitted on electron./Ignoreer indien lading op elektron wegelaat word.
- If charge (+) omitted on Cu^{2+} /Indien lading (+) wegelaat op Cu^{2+} .
Max./Maks: 1/2

9.4 % purity/suiwerheid =
$$\frac{\text{m}(\text{Cu})}{\text{m}(\text{Cu})_{\text{impure/onsuiwer}}} \times 100$$

$$= \frac{4,4}{5} \times 100 \checkmark$$

$$= 88\% \checkmark$$

(4)

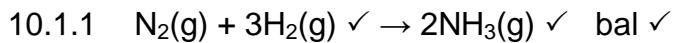
Marking criteria/Nasienriglyne:

- Substitute/Vervang 4,4 ✓
- Substitute/Vervang 5 ✓
- x 100 ✓
- Final answer/Finale antwoord: 88% ✓

[9]

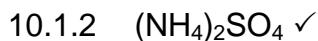
QUESTION 10/VRAAG 10

10.1

**Notes/Aanteikeninge:**

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse ✓ Produkte ✓ Balansering ✓
- Ignore if phases are omitted/*Ignoreer indien fases uitgelaat word*
- Ignore/*Ignoreer* ⇔
- Marking rule/*Nasienreël* 3.9

(3)



(1)

10.1.3 Ostwald process/*Ostwaldproses* ✓

(1)

10.1.4 Ammonium nitrate/*Ammoniumnitraat* ✓

(1)

10.2

10.2.1 The ratio of nitrogen (N), phosphorous (P) and potassium (K) in a certain fertiliser.✓*Die verhouding van stikstof (N), fosfor (P) en kalium (K) in 'n sekere kunsmis.***Accept/Aanvaar :**nitrogen, phosphorous and potassium/stikstof, fosfor en kalium.

(1)

10.2.2 Percentage fertiliser in the bag./*Persentasie kunsmis in die sak.* ✓

(1)

10.2.3

OPTION 1/OPSIE 1:

$$\begin{aligned} \% K &= \frac{5}{12} \times 22\% \checkmark \\ &= 9,17\% \\ \therefore m(N) &= \frac{9,17}{100} \times 10 \text{ kg } \checkmark \\ &= 0,92 \text{ kg } \checkmark \end{aligned}$$

OPTION 2/OPSIE 2:

$$\begin{aligned} m(\text{nutrients/voedingstowwe}) &: \\ \frac{22}{100} \times 10 &= 2,2 \text{ kg} \\ \downarrow \\ \therefore m(K) &= \frac{5}{12} \times (2,2) \checkmark \\ &= 0,92 \text{ kg } \checkmark \end{aligned}$$

(4)

[12]

TOTAL/TOTAAL: 150