DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS
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**PROVINSIALE VOORBEREIDENDE EKSAMEN/
PROVINCIAL PREPARATORY EXAMINATION**

GRAAD/GRADE 12

FISIESE WETENSKAPPE/PHYSICAL SCIENCES

VRAESTEL/PAPER 2

CHEMIE/CHEMISTRY

SEPTEMBER 2025

PUNTE/MARKS: 150

TYD/TIME: 3 uur/hours

**Hierdie vraestel bestaan uit 15 bladsye, 'n grafiekblad en 4 gegewensblaaie./
This question paper consists of 15 pages, a graph sheet and 4 data sheets.**

INSTRUCTIONS AND INFORMATION

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

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

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

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

5. Leave ONE line between two subquestions, 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 correct 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 Which of the following reactants is used to prepare ethyl propanoate?

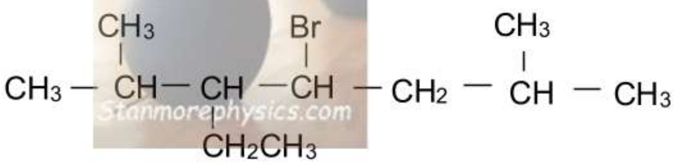
A Ethane and propanoic acid

B Propanol and ethanoic acid

C Ethanol and propanoic acid

D Ethene and propanol (2)

1.2 The structural formula of an organic compound is given below.



The IUPAC name of this compound is ...

A 4-bromo-3-ethyl-5,6-dimethylheptane.

B 4- bromo-5-ethyl-2,6-dimethylheptane.

C 3-ethyl-4-bromo-2,6-dimethylheptane.

D 4- bromo-3-ethyl-2,6-dimethylheptane. (2)

1.3 Which ONE of the following reaction types may be used to prepare ethene from pentane?

A Addition

B Cracking

C Substitution

D Hydrolysis (2)

1.4 Which ONE of the following combinations of values of activation energy (E_A) and heat of reaction (ΔH) CANNOT be obtained for any reaction?

	E_A ($kJ \cdot mol^{-1}$)	ΔH ($kJ \cdot mol^{-1}$)
A	60	-120
B	60	+120
C	120	+60
D	120	-60

(2)

1.5 Consider the following reaction that reaches equilibrium in a beaker:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$

A few drops of concentrated $HC\ell(aq)$ are now added to the beaker.

Which ONE of the following combinations correctly identifies the DISTURBANCE ON THE SYSTEM and the SYSTEM'S RESPONSE to the disturbance?

	DISTURBANCE IN THE SYSTEM	SYSTEM'S RESPONSE
A	$[H^+]$ increases	Forward reaction favoured
B	$[H^+]$ decreases	Reverse reaction favoured
C	$[CrO_4^{2-}]$ increases	Forward reaction favoured
D	$[CrO_4^{2-}]$ decreases	Reverse reaction favoured

(2)

1.6 Which ONE of the descriptions below is TRUE for a chemical reaction in equilibrium?

	CONCENTRATIONS OF REACTANTS AND PRODUCTS	RATES OF FORWARD AND REVERSE REACTIONS
A	Remain constant	Equal
B	Remain constant	Not equal
C	Equal	Equal
D	Not equal	Not equal

(2)

1.7 The pH of a solution of H_3PO_4 is 4,5. Which ONE of the following relations is CORRECT for the H_3PO_4 solution?

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

B $[H_3O^+] > [H^-]$

C $[H_3O^+] < [OH^-]$

D $[OH^-] < [H_3O^+]$ (2)

1.8 When sulphuric acid is titrated with ammonia, ammonium sulphate ($(NH_4)_2SO_4$) is produced. Which ONE of the combinations is correct for the indicator used in this titration and the pH of $(NH_4)_2SO_4$?

	INDICATOR	**pH**
A	Methyl orange	pH < 7
B	Phenolphthalein	pH > 7
C	Phenolphthalein	pH < 7
D	Bromothymol blue	pH = 7

(2)

1.9 Which ONE of the following is a NON-SPONTANEOUS redox reaction? Refer to the Table of Standard Reduction Potentials (Table 4A or 4B).

A $Zn(s) + 2HCℓ(aq) \rightarrow ZnCℓ_2(aq) + H_2(g)$

B $Cu(s) + FeCℓ_2(aq) \rightarrow CuCℓ_2(aq) + Fe(s)$

C $2AgNO_3(aq) + Cu(s) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

D $2Aℓ(s) + 3Ni(NO_3)_2(aq) \rightarrow 2Aℓ(NO_3)_3(aq) + 3Ni(s)$ (2)

1.10 The following characteristics may be used to describe an electrochemical cell:

I The chemical reaction is spontaneous
II The reaction requires energy from an electrical source.
III The anode is the positive electrode of the cell.

Which ONE of the following combinations are specific to an electrolytic cell?

A Only **I**

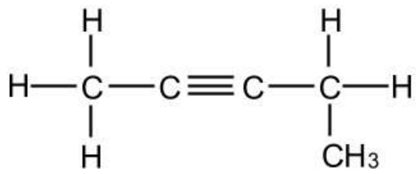
B Only **II**

C **I** and **III**

D **II** and **III** (2)
[20]

QUESTION 2 (Start on a new page.)

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

A	$CH_3(CH_2)_4CO_2H$	**D**	4-methylpentan-1-ol
B		**E**	
C	C_3H_6O	**F**	$(CH_3)_2CC(C_2H_5)CH_2CH_3$

Write down the:

2.1 LETTER of the compound that represents an aldehyde (1)

2.2 STRUCTURAL FORMULA of the functional group of compound **A** (1)

2.3 LETTERS of the compounds that represent unsaturated hydrocarbons (2)

2.4 STRUCTURAL FORMULA of compound **D** (3)

2.5 General formula for compound **E** (1)

2.6 IUPAC NAMES of the TWO compounds represented by **C** (2)

2.7 LETTER of the compound that represents an ester (1)

2.8 LETTER of the compound that has a hydroxyl group as a functional group (1)

2.9 NAME of the functional group of the ketones (1)

2.10 IUPAC NAME of compound **B** (2)
[15]

QUESTION 3 (Start on a new page.)

An investigation was carried out to determine the various factors affecting the boiling point of different alcohols **A** to **C**, shown in the table below:

A	$CH_3CH(OH)CH_3$
B	$CH_3CH_2CH(OH)CH_3$
C	$CH_3CH_2CH_2CH_2CH(OH)CH_3$

3.1 Which ONE of the compounds (**A**, **B** or **C**) has the highest boiling point?

Explain the answer. (3)

3.2 Write down the type of alcohol represented by compound **A**. Choose from PRIMARY, SECONDARY or TERTIARY.

Give a reason for the answer. (2)

Consider compounds **D** to **G**, shown in the table below.

	COMPOUND	**MOLECULAR MASS ($g.mol^{-1}$)**
D	$CH_3CH_2CH_2CH_2CH_3$	72
E	$CH_3CH_2CH_2CH_2OH$	74
F	CH_3CH_2COOH	74
G	CH_3CH_2OOCH	74

3.3 Which ONE of compounds **E**, **F** or **G** has the lowest vapour pressure?

Fully explain the answer. (4)

3.4 Compounds **F** and **G** are isomers. Identify the type of isomerism they represent.

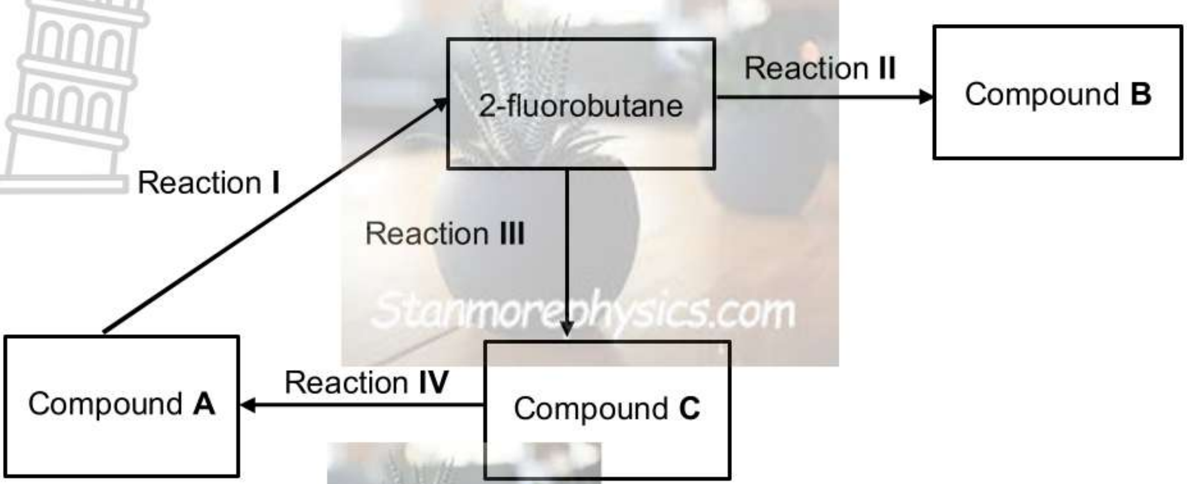
Give a reason for the answer. (2)

3.5 Write down a balanced equation, using MOLECULAR FORMULAE, for the combustion of compound **D** in excess oxygen. (3)

[14]

QUESTION 4 (Start on a new page.)

Study the flow diagram of various organic reactions and answer the questions that follow:



4.1 For Reaction **I**, write down the:

4.1.1 NAME of the substitution reaction (1)

4.1.2 STRUCTURAL FORMULA for compound **A** (2)

4.2 Compound **B** is formed in the presence of water. Write down the:

4.2.1 NAME of the substitution reaction (1)

4.2.2 IUPAC NAME of organic compound **B** (2)

4.3 Reaction **III** is an elimination reaction. Write down the:

4.3.1 NAME of the elimination reaction (1)

4.3.2 ONE reaction condition (1)

4.3.3 IUPAC NAME of the organic product formed (2)

4.3.4 Balanced equation for the above reaction using CONDENSED STRUCTURAL FORMULAE. (3)

4.4 Reaction **IV** takes place in the presence of a catalyst. Write down the:

4.4.1 Name of the catalyst (1)

4.4.2 Type of reaction (1)

4.5 In another reaction, the position isomer of compound **B** reacts with methanoic acid in the presence of a catalyst.

Write down the:

4.5.1 Name of this reaction (1)

4.5.2 Balanced equation using STRUCTURAL FORMULAE (5)
[21]

QUESTION 5 (Start on a new page.)

10 g of aluminium powder reacts with a limiting amount of sulphuric acid according to the following balanced equation:

$$2A\ell(s) + 3H_2SO_4(\ell) \rightarrow A\ell_2(SO_4)_3(aq) + 3H_2(g)$$

Aluminium is in excess.

The rate of the reaction between aluminium powder and sulphuric acid is investigated at 20 °C. Hydrogen gas is collected in a syringe, and the volume of hydrogen gas is measured at different time intervals.
The following results were obtained:

TIME (minutes)	H_2 VOLUME (dm^3)
0	0
2	1,2
4	2,4
6	3,6
8	4,2
10	4,5
12	4,5

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

5.2 Calculate the average reaction rate, in $dm^3 \cdot min^{-1}$, during the first 10 minutes. (2)

5.3 Use the data in the table to draw a graph of the volume of hydrogen gas collected versus time on the attached GRAPH SHEET. (3)

5.4 Use the collision theory to explain the change in the reaction rate over time. Assume that the temperature remains constant. (3)

5.5 Calculate the mass of aluminium powder that was left at the end of the reaction. The molar gas volume at this temperature is 24 $dm^3.mol^{-1}$ (6)

5.6 A change in reaction conditions will affect the sketch drawn on the GRAPH SHEET in QUESTION 5.3.

On the same GRAPH SHEET sketch graphs for the following changes:

5.6.1 The temperature is increased to 40 °C. Label this graph **B** (2)

5.6.2 10 g aluminium granules are used. Label this graph **C** (2)

[20]

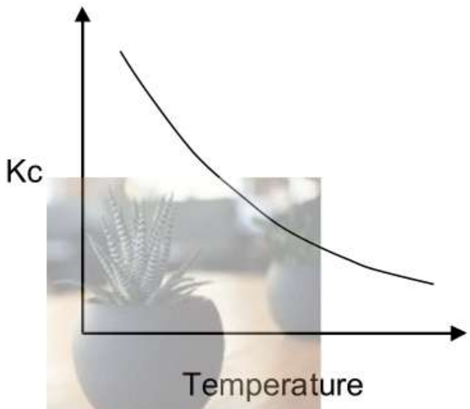
QUESTION 6 (Start on a new page.)

Consider the following balanced equation for a reversible reaction in a closed system below:

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$

6.1 Define the term *dynamic equilibrium*. (2)

The sketch graph below shows the relationship between the value of the equilibrium constant (Kc) and the temperature for this reaction.



6.2 Write down the sign of the heat of reaction (ΔH) for the above reaction. Choose from POSITIVE or NEGATIVE.

Explain the answer. (3)

6.3 The pressure on the system is decreased at constant temperature.

Use Le Chatelier's principle to explain how this change affects the yield of NO(g). (3)

6.4 1,4 mol of ammonia gas (NH_3) and 0,8 mol of oxygen gas (O_2) are placed in a 250 cm^3 container at 1 000 kPa and allowed to reach equilibrium at 800 °C. At this temperature and pressure, the amount of water vapour present is 12,6 g.

6.4.1 Calculate the value of the equilibrium constant (Kc) (7)

6.4.2 More ammonia gas is now added to the equilibrium mixture. How will this change affect the yield of NO(g)?

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

[16]

QUESTION 7 (Start on a new page.)

7.1 Hydrogen iodide (HI) reacts with water according to the following balanced equation:

$$HI(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + I^-(aq)$$

The Ka value for HI is 3,2 x 10^9 at 25 °C.

7.1.1 Is hydrogen iodide a weak or a strong acid? Give a reason for the answer. (2)

7.1.2 Write down the formulae for the TWO bases in the reaction above. (2)

7.2 60 cm^3 of a hydrogen iodide (HI) solution reacts with an unknown quantity of magnesium hydroxide ($Mg(OH)_2$) according to the following balanced equation:

Reaction **1**: $2HI(aq) + Mg(OH)_2(s) \rightleftharpoons 2H_2O(\ell) + MgI_2(aq)$

The EXCESS hydrogen Iodide is then neutralised with 18 cm^3 NaOH with a concentration of 0,3 $mol.dm^{-3}$ according to the following balanced equation:

Reaction **2**: $HI(aq) + NaOH(aq) \rightarrow NaI(aq) + H_2O(\ell)$

7.2.1 Calculate the pH of the excess hydrogen iodide. (5)

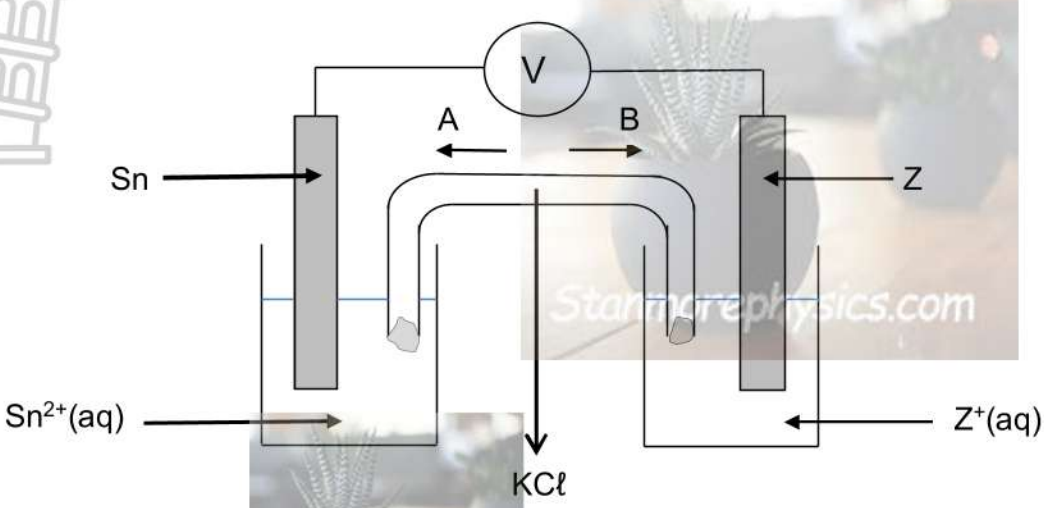
7.2.2 Calculate the initial mass of magnesium hydroxide used in Reaction **1** if the initial concentration of hydrogen iodide was 0,4 $mol.dm^{-3}$. (6)

7.2.3 Bromothymol blue is used as an indicator. Explain why it is the most suitable indicator by referring to the pH at the equivalence point. (2)

[17]

QUESTION 8 (Start on a new page.)

The diagram below represents an electrochemical cell operating under standard conditions, featuring tin (Sn) and an unknown metal, **Z**.



8.1 It is found that the mass of electrode **Z** increases whilst the cell is functioning.

For this cell, write down:

8.1.1 The electrode that acts as the ANODE. Choose from **Sn** or **Z**.

Give a reason for the answer. (2)

8.1.2 How will the concentration of Sn^{2+} change while the cell is in operation?

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

8.1.3 The reduction half-reaction (2)

8.1.4 In which direction (**A** or **B**) will CATIONS move in the salt bridge? (1)

8.1.5 The cell notation (3)

8.2 The initial emf of this cell is 0,94 V. Identify metal **Z** by means of a calculation. (5)

A stronger reducing agent is now used with the same oxidising agent under the same conditions.

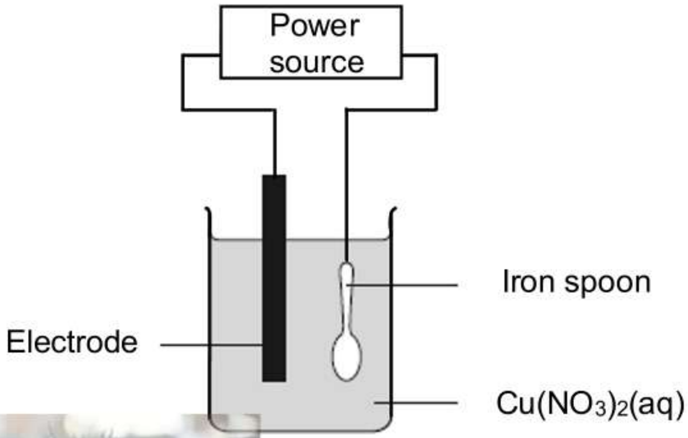
8.3 How will this affect the initial emf of the cell?

Choose from INCREASES, DECREASES or NO EFFECT. (1)

[15]

QUESTION 9 (Start on a new page.)

The diagram below represents the cell used for electroplating an iron spoon with copper.



9.1 Define the term *electrolyte*. (2)

9.2 What type of power source is used to drive the reaction in this cell? Choose from AC or DC.

Give a reason for the answer. (2)

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

9.4 Write down a half-reaction that takes place at the ANODE. (2)

9.5 Write down ONE observation that can be made after the cell has been operating for some time. (1)

9.6 Name the metal that is labelled 'Electrode'. (1)

9.7 How will the concentration of the copper (II) nitrate solution change while the cell is in operation?
Choose from INCREASES, DECREASES or REMAINS THE SAME.

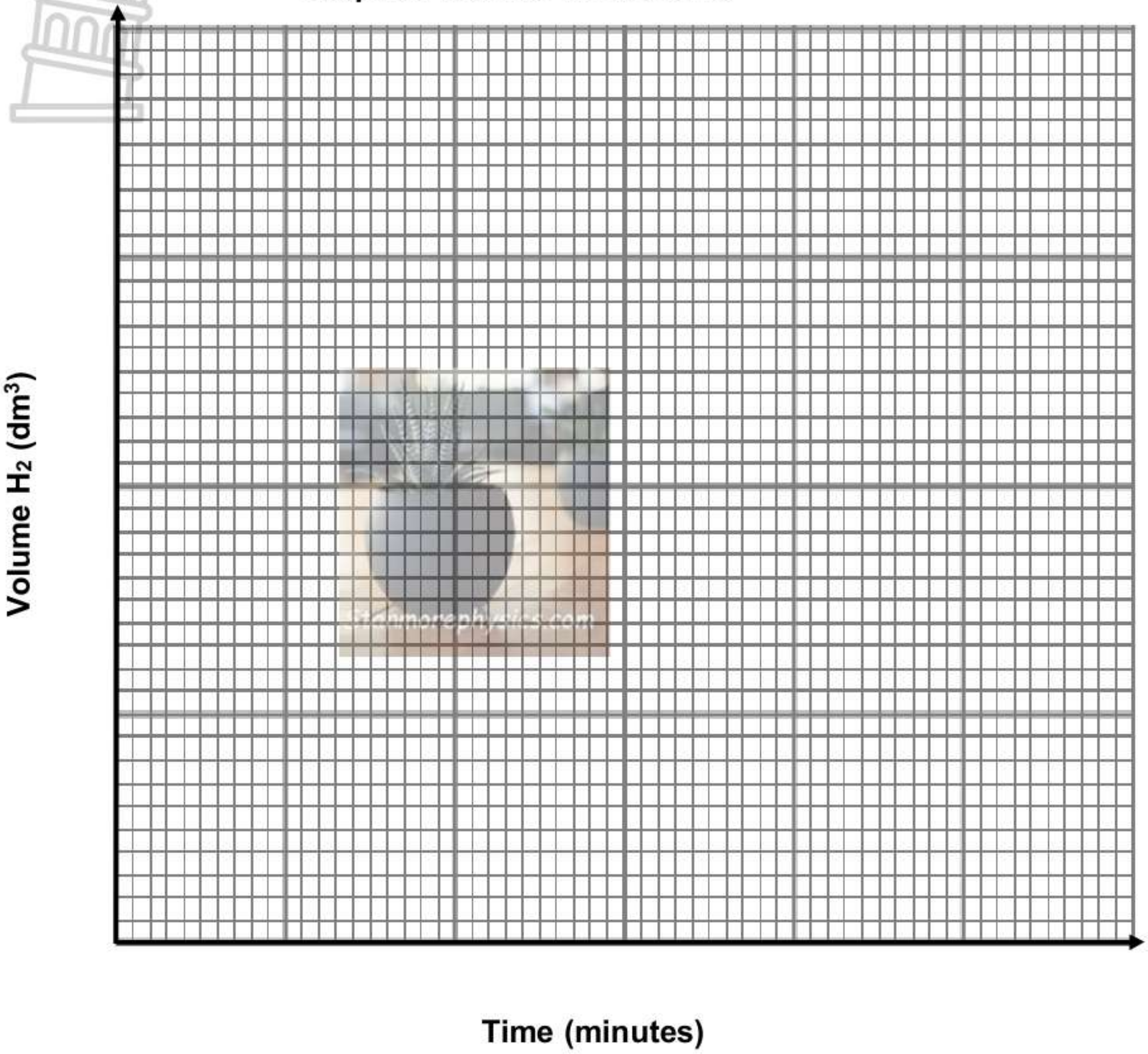
Give a reason for the answer. (2)
[12]

TOTAL: 150

QUESTION 5.3

Hand in this GRAPH SHEET with your ANSWER BOOK.

Graph of volume versus time



INFORMATION 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 gas volume 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

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*	29
Electronegativity / *Elektronegatiwiteit*	1,9
Symbol / *Simbool*	Cu
Approximate relative atomic mass / *Benaderde relatiewe atoommassa*	63,5

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)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 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	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 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

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

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

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

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

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

DEPARTMENT OF EDUCATION
DEPARTEMENT VAN ONDERWYS
LEFAPHA LA THUTO
ISEBE LEZEMFUNDO

PROVINCIAL PREPARATORY EXAMINATION/
PROVINSIALE VOORBEREIDENDE EKSAMEN

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY
FISIESE WETENSKAPPE: CHEMIE

PAPER/*VRAESTEL* 2

SEPTEMBER 2025

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

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

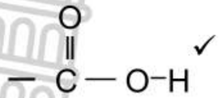
QUESTION 1/*VRAAG 1*

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

QUESTION 2/VRAAG 2

2.1 C ✓ (1)

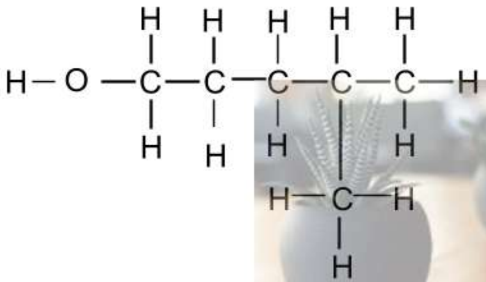
2.2



(1)

2.3 E✓ and F✓ (2)

2.4



Marking criteria/*Nasienriglyn*

- methyl substituent on carbon 4✓
  metielsubstituent op koolstof 4
- OH group on carbon 1✓
  OH groep op koolstof 1
- Whole structure correct✓
  Hele struktuur korrek

IF/*INDIEN*: H-atom/bond omitted/
H-atoom/binding uitgelaat. -1

(3)

2.5 C_nH_{2n-2}✓ (1)

2.6 Propanal✓/*propanaal* and /Propan-2-one / 2-propanoon✓ (2)

2.7 B ✓ (1)

2.8 D ✓ (1)

2.9 Carbonyl group ✓/*karbonielgroep* (1)

2.10 Propyl✓ ethanoate ✓/*propieletanoaat* (2)

[15]

QUESTION 3/VRAAG 3

3.1

Marking Guidelines/Nasienriglyne
• Compound C/*Verbinding*   • Compare strengths of IMF/*Vergelyk die sterkte van IMK*   • Compare energy needed to overcome/break IMF/*Vergelyk die energie nodig om kragte te oorkom/breek*

C✓ 2-hexanol/hexan-2-ol/2-heksanol/heksan – 2-ol

- C has stronger intermolecular forces than A and B. ✓/ C has more London forces than A and B.
- More energy is needed to overcome the IMF in C✓

- *C het sterker intermolekulêre kragte as A en B./ C het meer Londonkragte as A en B*
- *Meer energie is dus nodig om die IMK in C te oorkom*

(3)

3.2 Secondary ✓/*Sekondêr*
The C-atom to which the hydroxyl group /OH-group is attached to two other C-atoms. ✓
Die C-atoom waaraan die hidroksielgroep verbind is, is aan twee ander C-atome verbind. (2)

3.3

Marking Guidelines/Nasienriglyn
• Compound F/*Verbinding F*   • Compare structures/*Vergelyk strukture* (Mention the sites of H-bonds/ *verwys na setels met H-bindings*)   • Compare strengths of IMF/*Vergelyk die sterkte van IMK*   • Compare energy needed to overcome/break IMF/*Vergelyk die energie nodig om kragte te oorkom/breek*

F/propanoic acid✓/*propanoësuur*

- The carboxylic acid (F) has 2 sites for hydrogen bonds in comparison to the single hydrogen bond in alcohol (E) and the dipole-dipole forces in ester (G)✓
- The double hydrogen bond in carboxylic acid (F) is stronger than the intermolecular forces in alcohol (E) and that in ester (G)✓
- Carboxylic acids (F) require more energy to break the intermolecular forces than other compounds.✓

- *Die karboksielsuur (F) het 2 setels vir waterstofbindings in vergelyking met die enkele waterstofbinding in alkohol (E) en die dipool-dipoolkragte in ester (G).*
- *Dubbelle waterstofbinding in karboksielsuur (F) is 'n sterker intermolekulêre krag as in alkohol (E) en as in ester (G)..*
- *Karboksielsure (F) vereis meer energie om intermolekulêre kragte te oorkom as ander verbindings.*

(4)

3.4 Functional (isomerism) ✓/*Funksionele (isomerie)*
These compounds have the same molecular formula but <u>different functional groups</u>. ✓
Hierdie verbindings het dieselfde molekulêre formule, maar verskillende funksionele groepe ✓ (2)

3.5 $C_5H_{12} + 8O_2$ ✓ $\rightarrow$ $5CO_2 + 6H_2O$ ✓ (Bal)✓

<u>Marking criteria/*Nasienriglyne*</u>

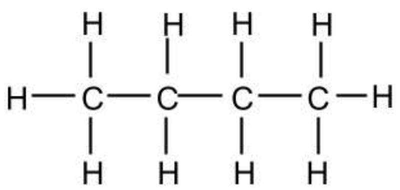
Reactants✓
Products✓
Balancing✓

(3)
[14]

QUESTION 4/VRAAG 4

4.1
4.1.1 Halogenation/fluorination ✓
Halogenering/fluorinering (1)

4.1
4.1.2



<u>Marking criteria/*Nasienriglyn*</u>
- 4 carbon atoms✓
  4 koolstogatome
- Whole structure correct✓
  Hele struktuur korrek

(2)

4.2
4.2.1 Hydrolysis✓/*Hidroliese* (1)

4.2.2 2-Butanol or Butan-2-ol ✓✓/*2-Butanol of Butan -2- ol* (2)
ACCEPT FOR 1 MARK: butanol

4.3
4.3.1 Dehydrohalogenation/Dehydrofluorination ✓
Dehidrohalogenering/Dehidrofluorinering (1)

4.3.2 Heat/Hitte ✓ **OR/*OF***
Concentrated strong base/*gekonsentreerde sterk basis* (1)

4.3.3 2-Butene/*2-Buteen* but-2-ene✓✓ (2)
ACCEPT FOR 1 MARK: butene

4.3.4 $CH_3CHFCH_2CH_3$ + conc.NaOH $\rightarrow$ $CH_3CHCHCH_3$✓ + NaF + H_2O ✓ (3)

4.4

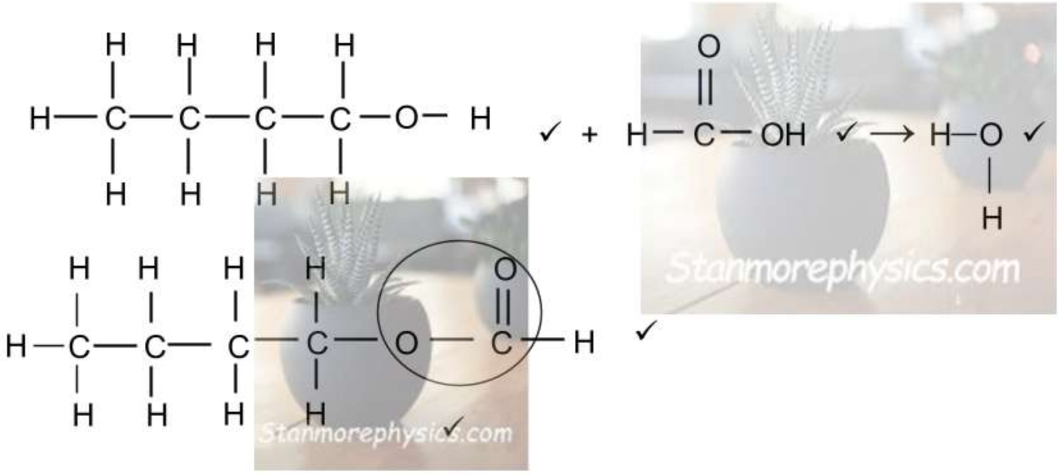
4.4.1 Platinum/Palladium/Nickel/pt/pd ✓ (1)

4.4.2 Addition/Hydrogenation✓
Addisie/Hidrogenering (1)

4.5

4.5.1 Esterification or condensation✓
Esterifikasie/verestering of kondensasie (1)

4.5.2



(5)
[21]

QUESTION 5/VRAAG 5

5.1

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

ANY ONE

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

ENIGE EEN

- *Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.*
- *Verandering in hoeveelheid/getal mol/volum/massa van produkte of reaktanse per (eenheid) tyd.*
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per eenheids tyd.*
- *Tempo van verandering in konsentrasie/hoeveelheid/getal mol/volume/ massa.* (2)

5.2

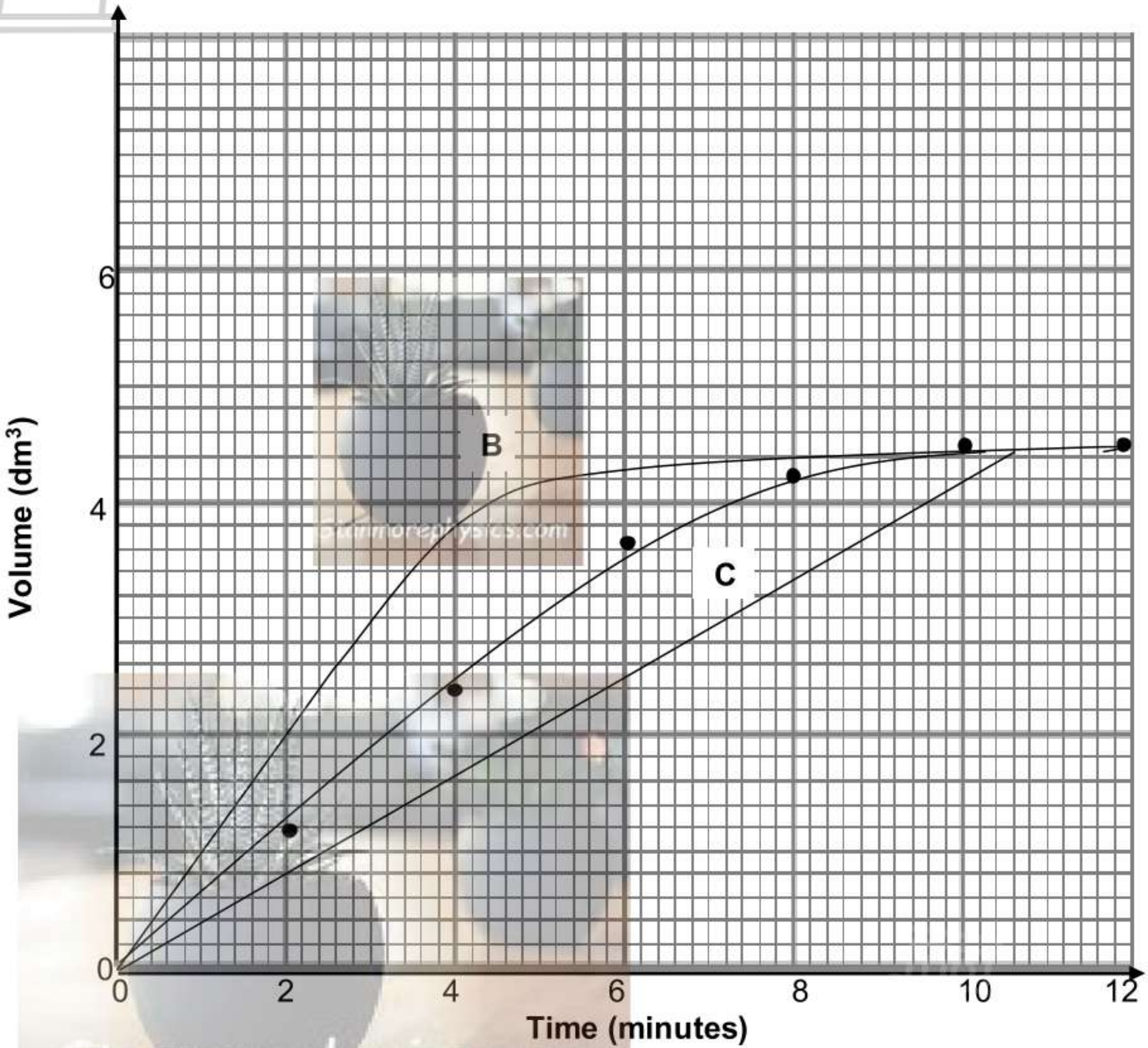
$$\text{rate/}\textit{tempo} = \frac{\Delta V}{\Delta t}$$

$$= \frac{4,5 - 0}{10-0} \checkmark$$

$$= 0,45 \checkmark \ (dm^3.min^{-1})$$ (2)

5.3

Graph of volume versus time



RUBRIC FOR THE GRAPH/*RUBRIEK VAN GRAFIEK*	
Use of correct scale for X & Y-axes/*Gebruik van korrekte skaal vir X & Y-asse*	1 mark
All the points plotted correctly/*Alle punte korrek geplot*	1 mark
Shape of graph/*Vorm van grafiek*	1 mark

(3)

5.4 As time goes

- There are fewer particles (that can react)✓/*Daar is minder partikels (wat kan reageer).*
- This leads to less effective collisions per unit time✓/*Dit lei tot minder effektiewe botsings per tydseenheid.*
- Reaction rate decrease✓/*Die reaksietempo neem af.* (3)

5.5

$n(H_2) = \frac{V}{V_m}$ ✓

$= \frac{4,5}{24}$ ✓

$= 0,1875$ mol

$n(A\ell) = (0,1875)\frac{2}{3}$ ✓

$= 0,125$ mol

$m(A\ell)$ react $= nM$

$= (0,125)(27)$ ✓

$= 3,375$ g

$m(A\ell)$excess $= m_i - m_f$

$= 10 - 3,375$ ✓

$= 6,625$ g ✓ (6)

5.6

5.6.1 On graph paper
Graph **B** ✓✓/*Grafiek* ***B*** (2)

5.6.2 On graph paper
Graph **C** ✓✓/*Grafiek* ***C*** (2)

Marking criteria/Nasienriglyn

Graph **B** has a greater gradient ✓
The start and end of graph stays the same✓
Grafiek ***B*** *het 'n groter gradiënt*
Die begin en einde van grafiek bly dieselfde

Graph **C** has a smaller gradient✓
The start and end of graph stays the same✓
Grafiek ***C*** *het 'n kleiner gradiënt*
Die begin en einde van grafiek bly dieselfde

[20]

QUESTION 6/VRAAG 6

6.1 (The stage in a chemical reaction when) <u>the rate of forward reaction equals the rate of reverse reaction</u>./Both forward and reverse reactions take place at the same rate. ✓✓ **(2 or/*of* 0)**
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie./Beide voor- en terugwaartse reaksies vind teen dieselfde tempo plaas.

OR/*OF*

The stage in a chemical reaction when <u>the concentrations of reactants and products remain constant</u>. ✓✓ **(2 or/*of* 0)**
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly. (2)

6.2 Negative ✓
- As the temperature increases, the Kc value decreases✓
- The reverse reaction is favoured. ✓

Negatief
- *Hoe hoër die temperatuur hoe laer die Kc waarde*
- *Die terugwaartse reaksie is bevoordeel* (3)

6.3 Increase✓
- Decrease in pressure favours the reaction that forms more moles✓
- The forward reaction is favoured ✓

Verhoog
- *Verlaging in druk bevoordeel die reaksie wat meeste mol vorm*
- *Die voorwaartse reaksie word bevoordeel* (3)

6.4 **<u>OPTION 1/*OPSIE 1*</u>**

6.4.1 CALCULATIONS USING MOLES

<u>Marking guidelines/*Nasienriglyne*:</u>

(a) $n(H_2O)$ at equilibrium = 0,7 mol✓
(b) Using ratio ✓/Gebruik van verhouding
(c) $n(NH_3)$ at equilibrium = initial $n(NH_3)$ - used $n(NH_3)$ ✓
 $n(O_2)$ at equilibrium = initial $n(O_2)$ - used $n(O_2)$
(d) Division of equilibrium moles by 0,25 to get equilibrium concentration✓
(e) Correct K_c expression*)* ✓*/Korrekte Kc uitdrukking*
(f) Substitution of concentrations into the K_c expression✓
(g) Final answer/*Finale antwoord* : 66,1✓ **RANGE: 59,565- 63,8**

$$n(H_2O) = \frac{m}{M} = \frac{12,6}{18} = 0,7 \text{ mol } ✓\textbf{(a)}$$

	$NH_3(g)$	$O_2(g)$	$NO(g)$	H_2O	
Molar ratio *Molêre verhouding*	4	5	4	6	
Initial mol *Aanvanklike mol*(mol)	1,4	0,8	-	-	
Change in mol. *Verandering in mol*(mol)	0,47	0,583	0,47	0,7	**(b)** ✓
Equilibrium amount (mol) *Ewewig hoeveelheid(mol)*	0,93	0,217 **(c)** ✓	0,47	0,7 **(a)**	
Equilibrium concentration *Konsentrasie by ewewig* (mol·dm^{-3})	3,72	0,868	1,88	2,8 ✓	÷ 0,25**(d)**

$$K_c = \frac{[NO]^4[H_2O]^6}{[NH_3]^4\,[O_2]^5} ✓\textbf{(e)}$$

$$= \frac{(1,88)^4 \times (2,8)^6}{[3,72]^4 \times [0,868]^5} ✓\textbf{(f)}$$

$$= 63,798 ✓\ \textbf{(g)}$$

(7)

OPTION 2/*OPSIE 2*
CALCULATIONS USING CONCENTRATION

Option 2/*Opsie 2:*

(a) $c(H_2O)$ at equilibrium = 2,8 mol·dm^{-3}✓
(b) Using ratio ✓/Gebruik van verhouding
(c) $c(NH_3)$ at equilibrium = initial $c(NH_3)$ - used $c(NH_3)$
$c(O_2)$ at equilibrium = initial $c(O_2)$ - used $c(O_2)$
(d) Division of equilibrium moles by 0,25 to get the initial concentration✓
(e) Correct K_c expression) ✓/*Korrekte Kc uitdrukking*
(f) Substitution of concentrations into the K_c expression✓
(g) Final answer/*Finale antwoord* : 66.1✓

$c(H_2O) = \frac{m}{MV} = \frac{12,6}{18 \times 0,25} = 2,8$ mol **(a)** ✓

	$NH_3(g)$	$O_2(g)$	NO(g)	H_2O
Molar ratio *Molêre verhouding*	4	5	4	6
Initial concentration *Aanvanklike konsentrasie(mol.dm^{-3})*	5,6	3,2 ✓**(d)**	-	-
Change in concentration. *Verandering in konsentraise (mol.dm^{-3})*	1,87	2,33	1,87	2,8
Equilibrium concentration *Konsentrasie by ewewig* (mol·dm^{-3})	3,73	0,87 ✓**(c)**	1,87	2,8 **(a)**

(b) ✓

$$K_c = \frac{[NO]^4[H_2O]^6}{[NH_3]^4 \times [O_2]^5} \checkmark \textbf{(e)}$$

$$= \frac{(1,87)^4 \times (2,8)^6}{[3,73]^4 \times [0,87]^5} \checkmark \textbf{(f)}$$

$$= 61,0777 \checkmark \textbf{(g)}$$

(7)

6.4.2 Increase✓ (1)

[16]

QUESTION 7/*VRAAG 7*

7.1.1 Strong acid. ✓The Ka value is very high.✓
Sterk suur. Die Ka waarde is baie groot. (2)

7.1.2 H_2O ✓ and I^- ✓ (2)

7.2

7.2.1 n(NaOH) = cV

= (0,018)(0,3) ✓

= $5,4 \times 10^{-3}$ mol

n(HI)excess = n(NaOH) = $5,4 \times 10^{-3}$ mol ✓

$$c(HI) = \frac{n}{V}$$

$$= \frac{5,4 \times 10^{-3}}{0,06} ✓$$

$$= 0,09 \text{ mol·dm}^{-3}$$

pH = -log $[H_3O^+]$✓

= -log [0,09]

= 1,045 ✓ (5)

7.2.2 **POSITIVE MARKING FROM QUESTION 7.2.1**

$n(HI)_{initial}$ = cV ✓

= (0,4)(0,06) ✓

= 0,024 mol

$n(HI)_{reacted} = n_{(initial)} - n_{(excess)}$

= 0,024 - $5,4 \times 10^{-3}$ ✓

= 0,0186 mol

$$n\ Mg(OH)_2\ _{reacted} = \frac{0,0186}{2} ✓$$

= $9,3 \times 10^{-3}$ mol

m = nM

= $(9,3 \times 10^{-3})(58)$ ✓

= 0,54 g ✓ (6)

7.2.3 This is a reaction between a strong acid and a strong base✓ and bromothymol blue changes colour (at the equivalence point) with a pH = 7✓
Dit is 'n reaksie tussen 'n sterk suur en 'n sterk basis en broomtimol blou verander van kleur by ekwivalensie punt met 'n pH = 7 (2)

[17]

QUESTION 8/VRAAG 8

8.1

8.1.1 Sn✓
Sn undergoes oxidation/ Mass decreases✓
Sn ondergaan oksidasie./ massa neem af (2)

8.1.2 INCREASES✓ (1)

8.1.3 $Z^+ + e^- \rightarrow Z$ ✓✓ (2)
ACCEPT: $Ag^+ + e^- \rightarrow Ag$✓✓

8.1.4 B ✓ (1)

8.1.5 $Sn(s) \mid Sn^{2+}(aq)$ ✓ ∥ ✓ $Z^+(aq) \mid Z(s)$✓

NOTE: Ignore phases/***NOTA:*** *Ignoreer fases* (3)

8.2 $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓
$0,94$ ✓ $= E_{cathode} - (-0,14)$✓
$E_{cathode} = 0,8\ V$✓

Metal = Ag/silver ✓ (5)

8.3 INCREASE/*TOENEEM* ✓ (1)
[15]

QUESTION 9/VRAAG 9

9.1 **ANYONE/*ENIGE EEN:***
A solution that conducts electricity (through the movement of ions). ✓✓
'n Oplossing wat elektrisiteit gelei (deur die beweging van ione). **(2 or/*of* 0)**
OR/*OF*
A substance that conducts electricity through the movement of ions.
'n Stof wat elektrisiteit gelei deur die beweging van ione. **(2 or/*of* 0)**
OR/*OF*
A solution/melt that consists of ions.
'n Oplossing/gesmelte stof wat ione bevat. **(2 or/*of* 0)** (2)

9.2 DC✓/*GS*
ANYONE/*ENIGE EEN:*

- To keep the polarity of the electrodes the same. ✓
  Om die polariteit van die elektrodes dieselfde te hou.
- To prevent the anode and cathode from swopping.
  Om te verhoed dat die anode en katode omruil.
- DC provides a one-way flow of electrons ensuring that the same chemical reaction occurs all the time at the electrodes.
  GS verskaf *'n eenrigting vloei van elektrone en verseker dat dieselfde chemiese reaksie altyd by die elektrodes plaasvind.*
- If you use AC the polarity of the electrodes will keep changing.
  Wanneer jy WS gebruik word hou die polariteit van die elektrodes aan om te verander.
- Pure copper deposited on only one electrode.
  Suiwer koper slaan slegs op een elektrode neer. (2)

9.3 Reduction is the gain of electrons ✓ ✓ **(2 or/*of* 0)**
Reduksie is die wins aan elektrone (2)

9.4 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓ ✓ (2)

9.5 ANYONE/ENIGE EEN
The anode errodes✓/*Die anode errodeer*
The cathode increase in mass/copper cover the spoon.✓/*Die katode se massa vermeerder/koper bedek teelepel.* (1)

9.6 Copper✓/*koper* (1)

9.7 Remains the same✓/*Bly dieselfde*

The rate of reduction is equal to the rate of oxidation.✓
Die tempo van reduksie is gelyk aan die tempo van oksidasie. (2)
[12]

GRAND TOTAL/*GROOTTOTAAL*: 150