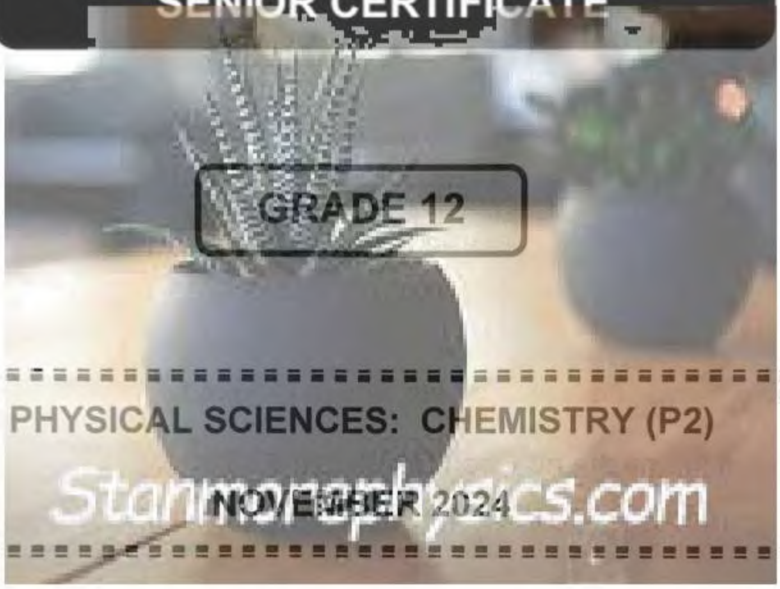
basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE



GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 17 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 Which ONE of the following compounds has hydrogen bonds between its molecules?

A CH_3CH_2CHO

B CH_3COOCH_3

C $CH_3CH_2CH_2OH$

D CH_3COCH_3 (2)

1.2 Which ONE of the following is a CORRECT GENERAL FORMULA for the carboxylic acids?

A $C_nH_{2n+1}O_2$

B $C_nH_{2n}O_{2n}$

C $C_nH_{2n}O_2$

D $C_nH_nO_2$ (2)

1.3 Study the reactions below.

Reaction **1**: $CH_3CH_2CHOHCH_3 \xrightarrow[\text{conc.}]{H_2SO_4}$ Compound **P** (major product) + H_2O

Reaction **2**: Compound **P** $\xrightarrow{\text{hydrogenation}}$ Compound **Q**

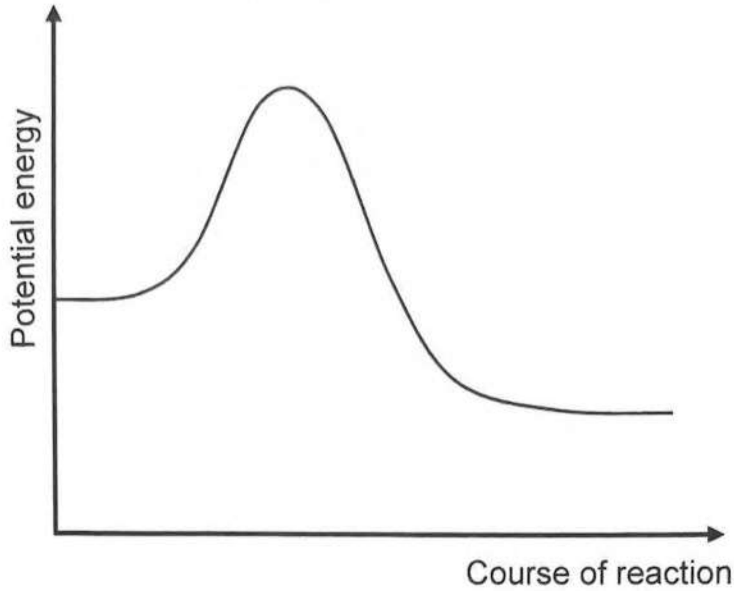
Which ONE of the following combinations is the CORRECT IUPAC names of compounds **P** and **Q**?

	COMPOUND P	COMPOUND Q
A	But-1-ene	Butane
B	But-2-ene	Butane
C	But-1-ene	Butan-2-ol
D	But-2-ene	Butan-2-ol

(2)

1.4 The potential energy diagram below is for the following hypothetical chemical reaction:

$$X + Y \rightleftharpoons Z$$



Which ONE of the following combinations of values for the heat of the reaction and the activation energies can be obtained for this reaction?

	$\Delta H_{(forward)}$ ($kJ \cdot mol^{-1}$)	$E_{A(forward)}$ ($kJ \cdot mol^{-1}$)	$E_{A(reverse)}$ ($kJ \cdot mol^{-1}$)
A	-400	300	100
B	-200	300	100
C	+400	100	300
D	-200	100	300

(2)

1.5 Initially, an equal number of moles of hydrogen gas, $H_2(g)$, and iodine gas, $I_2(g)$, are mixed in a closed container. The reaction reaches equilibrium at a constant temperature according to the balanced equation.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the following is ALWAYS TRUE at equilibrium?

A $[H_2] = [I_2]$

B $[HI] = [I_2]$

C $[HI] = 2[H_2]$

D $[H_2] = [I_2] = [HI]$ (2)

1.6 Consider the following reaction at equilibrium:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -188\ kJ \cdot mol^{-1}$$

Which ONE of the changes to the reaction conditions below will increase the yield of $SO_3(g)$?

A The addition of $O_2(g)$

B The addition of a catalyst

C An increase in temperature

D An increase in the volume of the container at a constant temperature (2)

1.7 The table below shows the ionisation constants, K_a, for two acids at 25 °C.

ACID	K_a
Butanoic acid	$1,5 \times 10^{-5}$
Ethanoic acid	$1,8 \times 10^{-5}$

Consider the following statements for these two acids when they have equal concentration at 25 °C:

(i) Both are weak acids.
(ii) Butanoic acid is a stronger acid than ethanoic acid.
(iii) The butanoic acid solution has a lower concentration of hydronium ion, $H_3O^+(aq)$, than the ethanoic acid solution.

Which of the above statements are TRUE?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii) (2)

1.8 Which ONE of the following pairs of acids and bases, all of the same concentration, react to give the highest pH at the equivalence point in a titration at 25 °C?

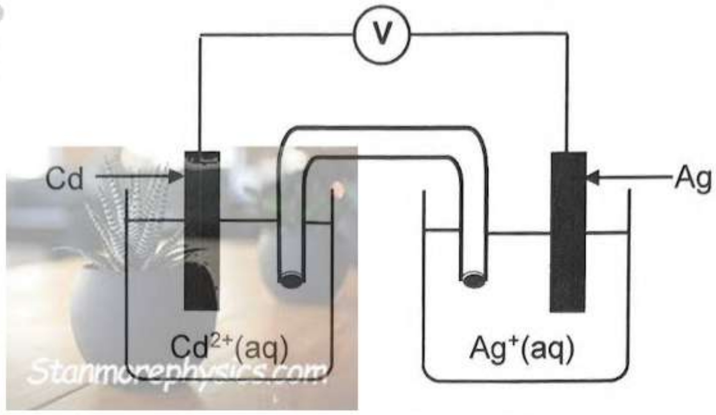
A $HC\ell$ and NH_3

B $HC\ell$ and NaOH

C HNO_3 and KOH

D CH_3COOH and NaOH (2)

1.9 A standard galvanic cell is set up, as shown below.

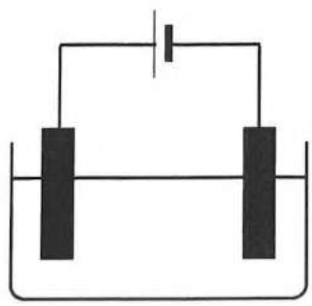


Which ONE of the following combinations of the metal used as cathode and the electron flow direction is CORRECT?

	METAL USED AS CATHODE	ELECTRON FLOW DIRECTION
A	Cd	Cd to Ag
B	Ag	Cd to Ag
C	Cd	Ag to Cd
D	Ag	Ag to Cd

(2)

1.10 An electrolytic cell is set up to electroplate an iron rod with nickel, as shown in the diagram below.



Consider the following statements:

(i) The iron rod is the negative electrode.
(ii) The metal ions in the solution undergo reduction.
(iii) The anode is pure nickel.

Which of the above statements are TRUE?

A (i) and (ii) only

B (i) and (iii) only

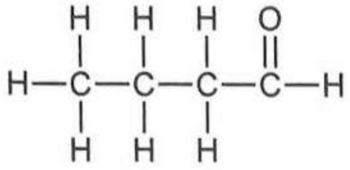
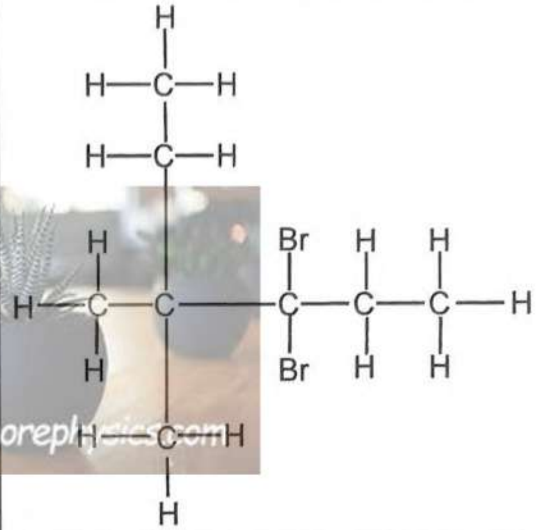
C (ii) and (iii) only

D (i), (ii) and (iii)

(2)
[20]

QUESTION 2 (Start on a new page.)

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

A		**B**	
C	Butanone	**D**	$C_4H_{10}O$
E	$CH_3C(CH_3)_2CCCH_3$	**F**	$CH_3COO(CH_2)_2CH_3$
G	$C_4H_8O_2$	**H**	$CH_3C(CH_3)_2CH_2CH_3$

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

2.1.1 An alcohol (1)

2.1.2 A compound with a formyl group (1)

2.1.3 An unsaturated compound (1)

2.2 Write down the IUPAC name of compound:

2.2.1 **B** (3)

2.2.2 **E** (3)

2.3 Two different compounds in the above table are functional isomers.

2.3.1 Define the term *functional isomer*. (2)

2.3.2 Write down the LETTERS that represent these functional isomers. (1)

2.4 Compound **F** is formed when a carboxylic acid reacts with another organic compound, **X**, in the presence of a catalyst.

Write down the:

2.4.1 NAME or FORMULA of the catalyst (1)

2.4.2 Type of reaction (1)

2.4.3 STRUCTURAL FORMULA of compound **F** (2)

2.4.4 IUPAC name of compound **X** (2)
[18]

QUESTION 3 (Start on a new page.)

The vapour pressures of different organic compounds are determined at 20 °C. The vapour pressures of compounds **A**, **B** and **C** are NOT shown in the table.

COMPOUND	IUPAC NAME	MOLAR MASS ($g\cdot mol^{-1}$)	VAPOUR PRESSURE (kPa) AT 20 °C
A	Pentane	72	
B	2-methylbutane	72	
C	2,2-dimethylpropane	72	
D	Propanoic acid	74	0,32
E	Butanal	72	12,2

3.1 Define the term *vapour pressure.* (2)

3.2 The vapour pressures of compounds **A**, **B** and **C** are given in random order below.

79 kPa	146 kPa	58 kPa

3.2.1 Write down the vapour pressure of compound **C**. (1)

3.2.2 Fully explain your answer to QUESTION 3.2.1. (3)

3.3 Compounds **D** and **E** are compared.

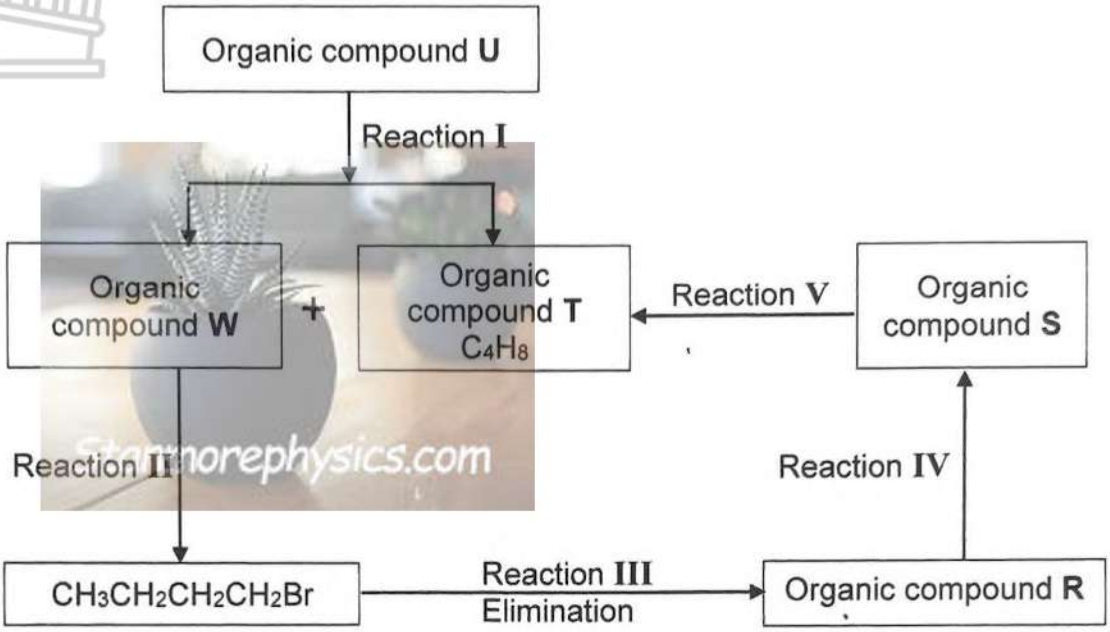
3.3.1 Which compound has the lower boiling point? (1)

3.3.2 Fully explain the difference in the vapour pressures between compounds **D** and **E**. (4)
[11]

QUESTION 4 (Start on a new page.)

Study the flow diagram below.

Reaction **I** is a CRACKING REACTION forming two organic compounds, **W** and **T**, as the ONLY products.



4.1 Define the term *cracking reaction*. (2)

4.2 Is the product in reaction **II** a PRIMARY, SECONDARY or TERTIARY haloalkane? Give a reason for the answer. (2)

4.3 Write down the:

4.3.1 STRUCTURAL FORMULA of compound **W** (3)

4.3.2 MOLECULAR formula of compound **U** (1)

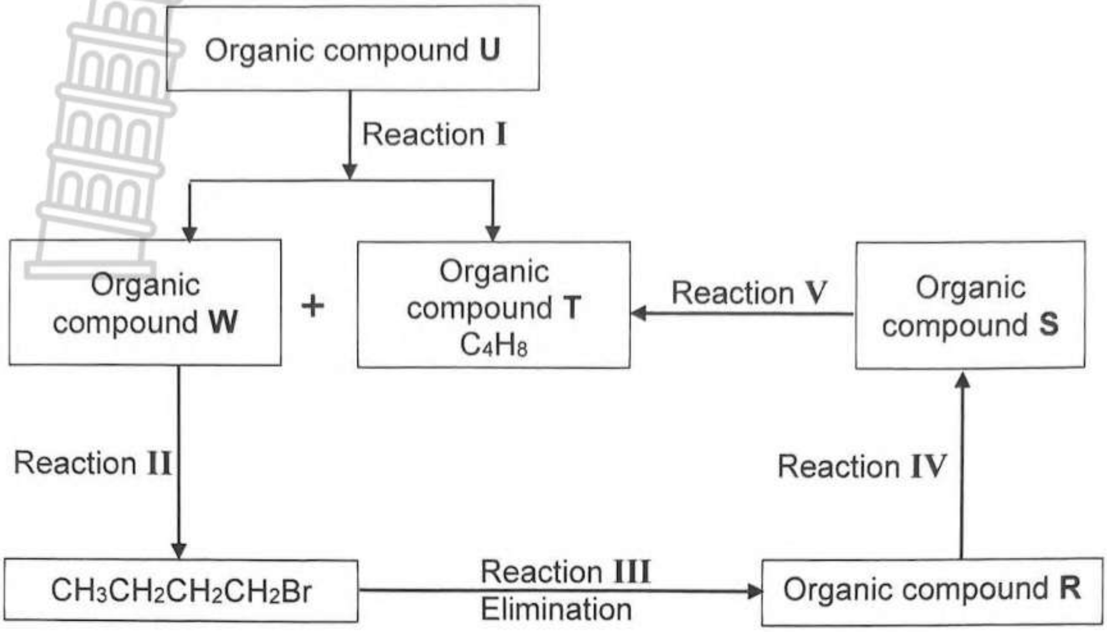
4.4 For reaction **II**, write down:

4.4.1 The NAME or FORMULA of the inorganic reactant (1)

4.4.2 The type of reaction (Choose from SUBSTITUTION, ADDITION or ELIMINATION.) (1)

4.4.3 ONE reaction condition (1)

The flow diagram on page 9 is redrawn below for easy reference.



4.5 Write down the TYPE of elimination in reaction **III**. (1)

4.6 Compounds **R** and **T** are positional isomers.

The inorganic reagents shown below are available for reactions **IV** and **V**.

Br_2	H_2SO_4(conc.)	NaOH(conc.)	HBr	H_2

Write down:

4.6.1 The balanced equation for reaction **IV**, using STRUCTURAL FORMULAE and the correct inorganic reagent shown above (5)

4.6.2 The balanced equation for reaction **V**, using STRUCTURAL formulae and the correct reagent shown above (3)

4.6.3 The IUPAC name of compound **T** (2)

[22]

QUESTION 5 (Start on a new page.)

5.1 The reaction between pure aluminium, Aℓ(s), and EXCESS hydrochloric acid, HCℓ(aq), is used to investigate the factors that affect the rate of a reaction.

The balanced equation for the reaction is:

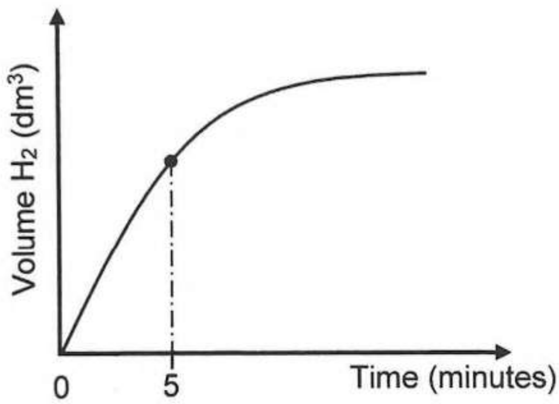
$$2A\ell(s) + 6HC\ell(aq) \rightarrow 2A\ell C\ell_3(aq) + 3H_2(g)$$

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

EXPERIMENT I

In this experiment, 1 mol·dm^{-3} HCℓ solution reacts with a 0,5 g Aℓ strip from an aluminium roll at room temperature.

The graph of volume H_2(g) versus time for this experiment, not drawn to scale, is shown below.



5.1.2 For the time interval t = 0 to t = 5 minutes, the average reaction rate for the formation of H_2(g) is 0,033 dm^3·min^{-1}.

Calculate the mass of Aℓ present in the container at t = 5 minutes. Take the molar gas volume as 24,5 dm^3·mol^{-1}. (6)

Assume that the concentration of the HCℓ(aq) stays constant for the duration of the reaction.

5.1.3 Use the collision theory to explain the change in the reaction rate from t = 0 to t = 5 minutes. (4)

EXPERIMENT II

Experiment I is repeated using a 2 mol·dm^{-3} HCℓ solution.

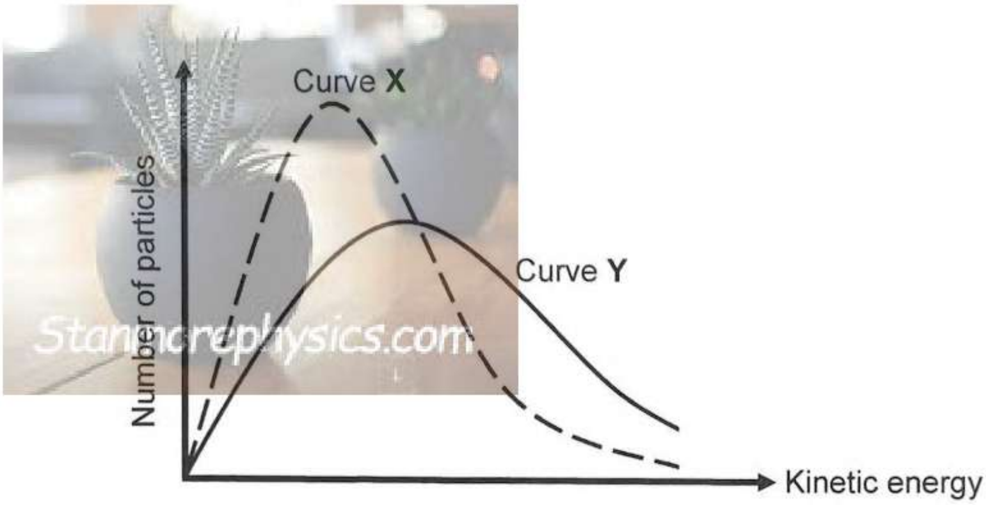
5.1.4 Redraw the above graph (NO numerical values need to be shown) in your ANSWER BOOK and label the curve **A**. On the same set of axes, draw the curve that will be obtained for Experiment II. Label this as curve **B**. (2)

EXPERIMENT III

Experiment I is repeated using 0,5 g pure powdered Aℓ.

5.1.5 How will the volume of $H_2(g)$ produced in Experiment III compare to that in Experiment I? Choose from GREATER THAN, LESS THAN or EQUAL TO. (1)

5.2 Curve **X** is the Maxwell Boltzmann distribution curve for a reaction under a set of reaction conditions. A change was made to one of the reaction conditions to obtain curve **Y**.



5.2.1 What change was made to obtain curve **Y**? (1)

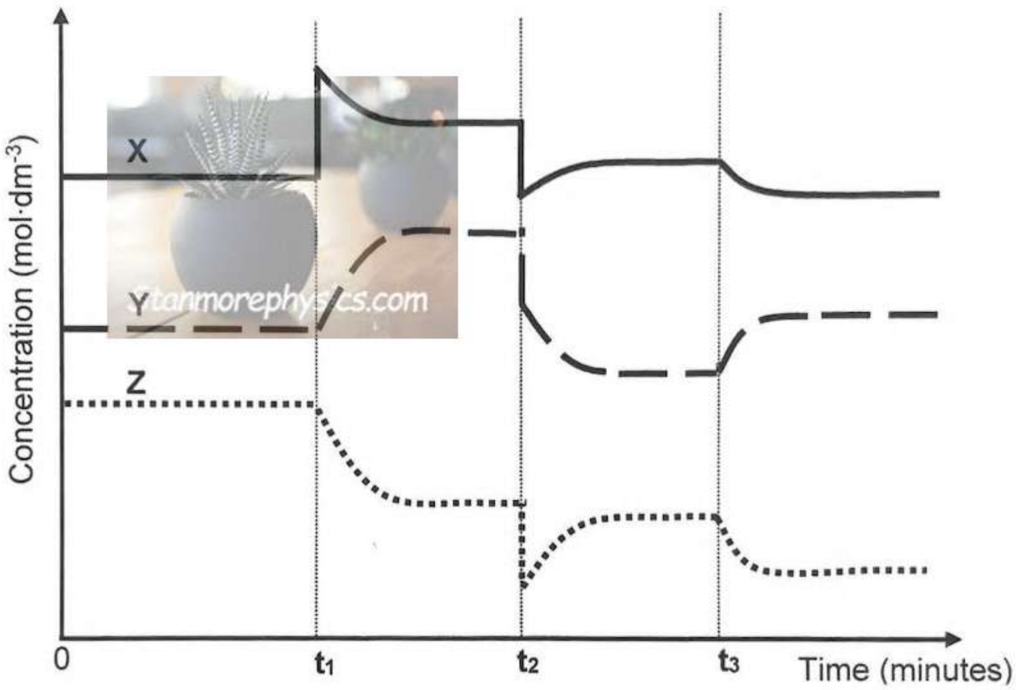
5.2.2 Give a reason for the answer to QUESTION 5.2.1. (1)
[17]

QUESTION 6 (Start on a new page.)

6.1 The reaction of carbon monoxide gas, $CO(g)$, with oxygen gas, $O_2(g)$, is investigated. The reaction reaches equilibrium in a closed container at constant temperature T °C, according to the balanced equation:

$$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g) \quad \Delta H < 0$$

Changes to the conditions of equilibrium are made at different times. The graph shows the results obtained. **X**, **Y** and **Z** represent the gases in the above reaction.



6.1.1 Define the term *chemical equilibrium*. (2)

Use the graph to answer the questions below.

6.1.2 At t_1, oxygen, $O_2(g)$, was added to the container. Write down the letter that represents $O_2(g)$. Choose from **X**, **Y** or **Z**. (1)

6.1.3 At t_2, the pressure is adjusted by changing the volume of the container. Was the pressure INCREASED or DECREASED? (1)

6.1.4 Give a reason for the answer to QUESTION 6.1.3. (1)

6.1.5 Write down the NAME or FORMULA of the gas that is represented by the letter **Z.** (1)

6.1.6 Give a reason for the answer to QUESTION 6.1.5. (1)

6.1.7 What change in temperature is made at t_3? Choose between INCREASED or DECREASED. (1)

6.1.8 Use Le Chatelier's principle to explain the answer to QUESTION 6.1.7. (3)

6.2 Carbon monoxide gas, $CO(g)$, reacts with water vapour, $H_2O(g)$, at T °C. The reaction reaches chemical equilibrium according to the balanced equation:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

Initially, 0,6 moles of $CO(g)$, 0,6 moles of $H_2O(g)$, 0,1 moles of carbon dioxide gas, $CO_2(g)$, and 0,1 moles of hydrogen gas, $H_2(g)$, were mixed and sealed in a 2 dm^3 flask.

If the equilibrium constant, K_c, for this reaction at T °C is 4, calculate the mass of $CO(g)$ present in the flask at equilibrium. (9)

[20]

QUESTION 7 (Start on a new page.)

Hydrated potassium carbonate, $K_2CO_3 \cdot \mathbf{x}H_2O$, is a WEAK BASE. A solution is prepared by dissolving some of this solid in water.

7.1 Define the term *weak base.* (2)

7.2 Write down the formula of the conjugate acid of the carbonate ion, $CO_3^{2-}(aq)$. (1)

A hydrochloric acid solution, $HC\ell(aq)$, of concentration 0,1 mol·dm^{-3} is titrated with the prepared potassium carbonate solution, $K_2CO_3(aq)$, of unknown concentration.

The balanced equation for the reaction is:

$$K_2CO_3(aq) + 2HC\ell(aq) \rightarrow 2KC\ell(aq) + CO_2(g) + H_2O(\ell)$$

The results of the titration are given below.

	VOLUME OF $HC\ell(aq)$ USED (cm^3)	**$K_2CO_3(aq)$ IN BURETTE**		**VOLUME OF $K_2CO_3(aq)$ USED (cm^3)**
		INITIAL BURETTE READING (cm^3)	**FINAL BURETTE READING (cm^3)**	
Run 1	25	6,5	**p**	20,05
Run 2	25	**q**	48,3	20,15

7.3 Determine the value of:

7.3.1 **p** (1)

7.3.2 **q** (1)

7.4 METHYL ORANGE is used as the indicator. Explain why methyl orange is the most suitable indicator for this titration by referring to the pH at the equivalence point. (2)

7.5 Calculate the concentration of the K_2CO_3 solution. (5)

The above K_2CO_3 solution used in the titration, was prepared by completely dissolving 6,525 g of the hydrated potassium carbonate, $K_2CO_3 \cdot \mathbf{x}H_2O$, in 600 cm^3 water.

7.6 Calculate the value of **x** in the formula $K_2CO_3 \cdot \mathbf{x}H_2O$. (5)
[17]

QUESTION 8 (Start on a new page.)

8.1 Dilute hydrochloric acid, $HC\ell(aq)$, reacts with magnesium, Mg(s), at 25 °C according to the following balanced equation:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

8.1.1 Use oxidation numbers for EACH of the reactants and explain why this reaction is a redox reaction. (2)

8.1.2 Write down the FORMULA of the oxidising agent in this reaction. (1)

It is observed that dilute hydrochloric acid does not react with copper, Cu(s), at 25 °C.

8.1.3 Explain this observation by referring to the relative strengths of the reducing agents. (2)

8.1.4 Will dilute nitric acid, $HNO_3(aq)$, react with copper, Cu(s), at 25 °C? Choose from YES or NO.

Explain the answer in terms of the relative strengths of the oxidising agents. (3)

8.2 A galvanic cell is represented by the following cell notation:

$$Pb(s) \mid Pb^{2+}(aq) \parallel Fe^{3+}(aq), Fe^{2+}(aq) \mid Pt(s)$$

8.2.1 Write down the balanced net ionic equation for this cell. (3)

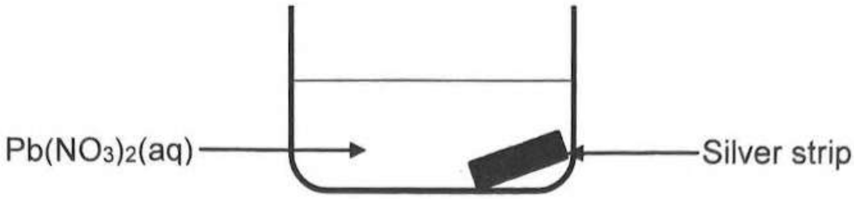
A stronger reducing agent is now used with the same oxidising agent under the same conditions.

8.2.2 How will this affect the initial emf of the cell? Choose from INCREASES, DECREASES or NO EFFECT. (1)

[12]

QUESTION 9 (Start on a new page.)

9.1 A strip of silver is added to a 1 mol·dm^{-3} solution of $Pb(NO_3)_2$ at 25 °C.

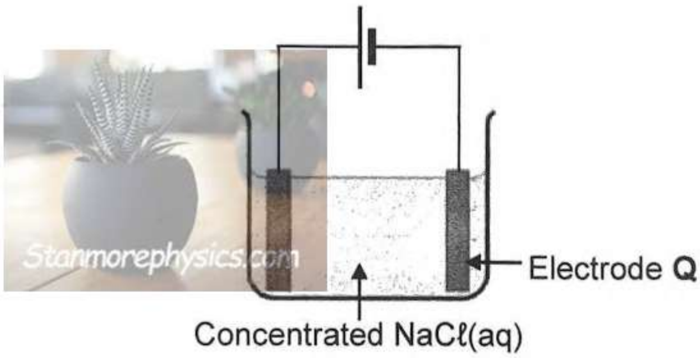


Consider the reaction below.

$$2Ag(s) + Pb^{2+}(aq) \rightarrow 2Ag^{+}(s) + Pb(s)$$

By means of a calculation, determine whether this reaction is SPONTANEOUS or NON-SPONTANEOUS. (5)

9.2 The simplified diagram below represents an electrolytic cell. The electrodes are made of carbon.



9.2.1 Define an *electrolyte*. (2)

9.2.2 Write down the PREDOMINANT oxidation half-reaction that takes place in this cell. (2)

9.2.3 Write down the NAMES or FORMULAE of the products formed at electrode **Q**. (2)

9.2.4 Explain the answer to QUESTION 9.2.3 by referring to the relative strengths of the oxidising agents involved. (2)
[13]

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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{q_e}$ where n is the number of electrons/ *waar n die aantal elektrone is*

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

KEY/*SLEUTEL*

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

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	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 140	Pr 141	Nd 144	Pm	Sm 150	Eu 152	Gd 157	Tb 159	Dy 163	Ho 165	Er 167	Tm 169	Yb 173	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* ↑

Half-reactions/*Halfreaksies*			$E^\ominus$ (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

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

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

Half-reactions/*Halfreaksies*			$E^{\ominus}$(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

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

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

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)

NOVEMBER 2024

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 28 pages.
Hierdie nasienriglyne bestaan uit 28 bladsye.

QUESTION 1/*VRAAG 1*

1.1 C ✓✓ (2)

1.2 C ✓✓ (2)

1.3 B ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 A ✓✓ (2)

1.7 B ✓✓ (2)

1.8 D ✓✓ (2)

1.9 B ✓✓ (2)

1.10 D ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1
2.1.1 D ✓ (1)

2.1.2 A ✓ (1)

2.1.3 E ✓ (1)

2.2
2.2.1

<u>Marking criteria:</u>
- Correct stem, i.e. <u>hexane</u>. ✓
- Correct substituents (bromo and methyl) identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

<u>Nasienkriteria:</u>
- *Korrekte stam d.i. <u>heksaan</u>.* ✓
- *Korrekte substituente (bromo en metiel) geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

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

2.2.2

<u>Marking criteria:</u>

- Correct stem, i.e. <u>pentyne</u>. ✓
- Substituent (dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

<u>Nasienkriteria:</u>

- *Korrekte stam, d.i. pentyn.* ✓
- *Substituente (dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

4,4-dimethylpent-2-yne/4,4-dimethyl-2-pentyne ✓✓✓
4,4-dimetielpent-2-yn/4,4-dimetiel-2-pentyn (3)

2.3

2.3.1

<u>Marking criteria/*Nasienkriteria*</u>
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.*

Compounds with the <u>same molecular formula</u>, ✓ but <u>different functional groups/homologous series.</u>✓

Verbindings met <u>dieselfde molekulêre formule</u>, maar <u>verskillende funksionele groepe/homoloë reekse.</u> (2)

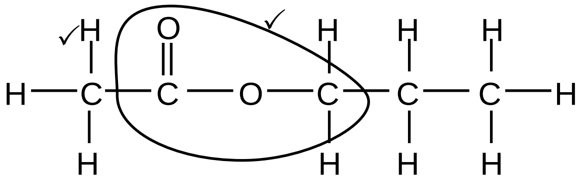
2.3.2 A and/*en* C ✓ (1)

2.4

2.4.1 H_2SO_4/Sulphuric acid/*Swaelsuur* ✓ (1)

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

2.4.3



<u>Marking criteria:</u>
- Functional group correct. ✓
- Whole structural formula correct. ✓

<u>Nasienkriteria:</u>
- *Funksionele groep korrek.* ✓
- *Hele struktuurformule korrek.* ✓

(2)

2.4.4

<u>Marking criteria:</u>	***<u>Nasienkriteria:</u>***
• Correct chain length and functional group, i.e Propanol. ✓ • Everything else correct: IUPAC name completely correct including numbering. ✓	• *Korrekte kettinglengte en funksionele groep, d.i. Propanol.*✓ • *Alles verder reg: IUPAC-naam heeltemal korrek nommering ingesluit.* ✓

Propan-1-ol/1-propanol ✓✓

<u>NOTE/*AANTEKENING:*</u>
Propanol ✓

(2)
[18]

QUESTION 3/*VRAAG 3*

3.1

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 pressure exerted by a vapour at equilibrium with its liquid in a closed system.✓✓
Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem. (2)

3.2

3.2.1 146 (kPa) ✓

Accept/*Aanvaar*:
146 000 Pa (1)

3.2.2

Marking criteria:
- Compare structures. ✓
- Compare the strength of intermolecular forces. ✓
- Compare the energy required to overcome intermolecular forces. ✓

Nasienkriteria:
- *Vergelyk strukture.* ✓
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓

Accept/*Aanvaar*:
Abbreviation IMF in explanations./*Afkorting IMK in verduidelikings*.

Comparing compound C/2,2-dimethylpropane with compounds A/pentane and B/2-methylbutane
- **Structure:**
  Compound C is more branched than compounds A and B/Shorter chain length/most compact most spherical/smallest surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Compound C has weaker/less intermolecular forces/Van der Waals forces/London forces than A and B. ✓
- **Energy:**
  Lesser energy needed to overcome or break intermolecular forces/Van der Waals force in compound C than A and B. ✓

Vergelyk verbinding C/2,2-dimetielpropaan met verbindings A/pentaan en B/2-metielbutaan
- ***Struktuur:***
  Verbinding C is meer vertak as verbindings A en B/Korter kettinglengte/meer kompak/meer sferies/kleiner oppervlak (waaroor intermolekulêre kragte werk).
- ***Intermolekulêre kragte:***
  Verbinding C het swakker/minder intermolekulêre kragte/Van der Waals-kragte/London-kragte as vebindings A en B.
- ***Energie:***
  Minder energie benodig om intermolekulêre kragte/Van der Waals-kragte/ London-kragte van verbinding C te oorkom/breek as in verbinding A en B. (3)

3.3

3.3.1 E/butanal/*butanaal* ✓ (1)

3.3.2

Marking criteria:

- Strongest intermolecular forces in compound D: Hydrogen bond. ✓
- Strongest intermolecular forces in compound E: Dipole-dipole forces. ✓
- Compare the strength of intermolecular forces. ✓
- Compare the energy required to overcome intermolecular forces. ✓

Nasienkriteria:

- *Sterkste intermolekulêre kragte in verbinding D: Waterstofbinding.* ✓
- *Sterkste intermolekulêre kragte in verbinding E: Dipool-dipoolkragte.* ✓
- *Vergelyk die sterkte van die intermolekulêre kragte.* ✓
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓

Accept/*Aanvaar*:
Abbreviation IMF in explanations./*Afkorting IMK in verduidelikings*.

- Compound D/Propanoic acid has hydrogen bonding (dipole-dipole and London forces) between molecules. ✓
- Compound E/Butanal has dipole-dipole forces (and London forces) between molecules. ✓
- Intermolecular forces between molecules of compound D/propanoic acid are stronger than intermolecular forces between molecules of compound E/butanal. ✓
- More energy is needed to overcome/break intermolecular forces between molecules of compound D/propanoic acid than in compound E/butanal ✓

OR

- Compound D/Propanoic acid has hydrogen bonding (dipole-dipole and London forces) between molecules.
- Compound E/Butanal has dipole-dipole forces (and London forces) between molecules.
- Intermolecular forces between molecules of compound E/butanal are weaker than intermolecular forces between compound D/propanoic acid
- Lesser energy is needed to overcome/break intermolecular forces between molecules of compound E/butanal than in compound D/propanoic acid

- *Verbinding D/propanoësuur het watertofbinding (dipool-dipool en London-kragte) tussen die molekules.*
- *Verbinding E/butanaal het dipool-dipoolkragte (en London-kragte) tussen die molekules.*
- *Intermolekulêre kragte tussen die molekules van verbinding D/ propanoësuur is sterker as die intermolekulêre kragte tussen molekules van verbinding E/butanaal.*
- *Meer energie word benodig om die intermolekulêre kragte tussen die molekules van verbinding D/propanoësuur te oorkom/breek.*

OF

- *Verbinding D/propanoësuur het watertofbinding (dipool-dipool en London-kragte) tussen die molekules.*
- *Verbinding E/butanaal het dipool-dipookragtel (en London-kragte) tussen die molekules.*
- *Intermolekulere kragte tussen die molekules van verbinding E/ butanaal is swakker as die intermolekulêre kragte tussen verbinding D/propanoësuur.*
- *Minder energie word benodig om die intermolekulêre kragte tussen die molekules van verbinding D/butanaal te oorkom/breek.*

(4)
[11]

QUESTION 4/*VRAAG 4*

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.*

The chemical process/reaction in which longer chain hydrocarbon/alkane molecules/are broken down to shorter (more useful) molecules. ✓✓

Die chemiese proses/reaksie waarin langer kettingkoolwaterstof/alkaan-molekule afgebreek word in korter (meer bruikbare) molekules. (2)

4.2 Primary/*Primêre* ✓

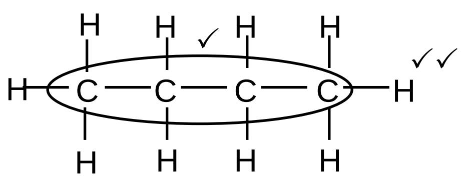
The halogen/bromine/functional group (-X) is bonded to a C atom that is bonded to one other C atom. ✓
Die halogeen/broom/funksionele groep (-X) is gebind aan 'n C-atoom wat aan een ander C-atoom gebind is/ 'n premêre C-atoom.

OR/*OF*
The functional group (—C—) is bonded to one other C atom.
(C bonded to Br/X)

Die funksionele groep (—C—) is gebind aan een ander C-atoom.
(C bonded to Br/X)

Accept/*Aanvaar*:
The Br/bromine (atom)/X/halogen is bonded to first /last/ terminal C-atom.
Die Br/broom (atoom)/X/halogeen is gebind/verbind aan die eerste/laaste C-atoom. (2)

4.3
4.3.1



Marking criteria*:*   • Correct stem, i.e. 4 C atoms. ✓   • Whole structural formula correct. ✓✓   ***Nasienkriteria:***   • *Korrekte stam, d.w.s. 4 C-atome.* ✓   • *Hele struktuur korrek.* ✓✓

(3)

POSITIVE MARKING FROM QUESTION 4.3.1
POSITIEWE NASIEN VAN VRAAG 4.3.1

4.3.2 C_8H_{18} ✓ (1)

4.4
4.4.1 Br_2/Bromine/*Broom* ✓ (1)

4.4.2 Substitution / *Substitusie* ✓ (1)

4.4.3 UV/(Sun)light/Heat/*(Son)lig/Hitte* ✓ (1)

4.5 Dehydrohalogenation/Dehydrobromination ✓
Dehidrohalogenering/Dehidrohalogenasie/Dehidrobrominering (1)

4.6

4.6.1

<u>Marking criteria:</u>

<u>Reaction IV</u>

- Functional group of alkene on first C atom. ✓
- Whole structural formula of alkene correct. ✓
- HBr. ✓
- Functional group of haloalkane correct. ✓
- Whole structural formula of haloalkane correct (halogen on second/first C-atom). ✓

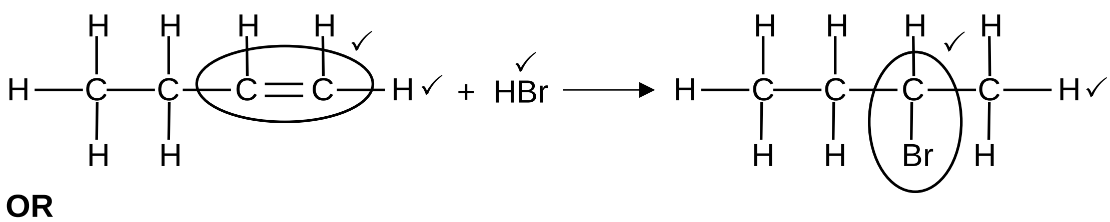
<u>Nasienkriteria:</u>

- *Funksionele groep van alkeen op die eerste C-atoom.* ✓
- *Hele struktuurformule van alkeen korrek.* ✓
- *HBr.* ✓
- *Funksionele groep van haloalkaan korrek.* ✓
- *Hele struktuurformule van haloalkaan korrek (halogeen op die tweede/eerste C-atoom).* ✓

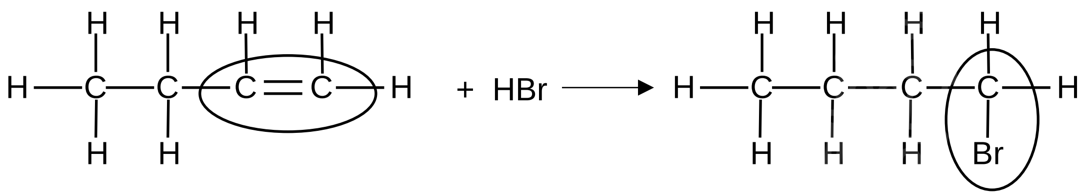
IF/*INDIEN*

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

<u>Note/*Aantekening*</u>:
For extra product or reactant, deduct 1 mark.
Vir ekstra produk of reaktans, trek 1 punt af.



OR



(5)

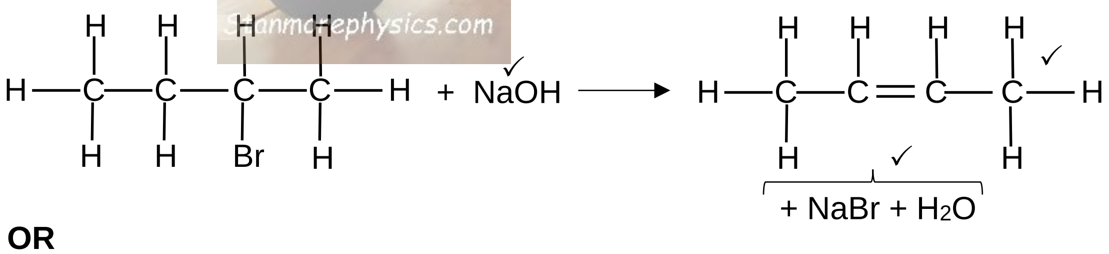
4.6.2

Marking criteria*:*
- NaOH. ✓
- Whole structural formula of alkene correct (functional group on second/ first C atom). ✓
- NaBr + H_2O ✓

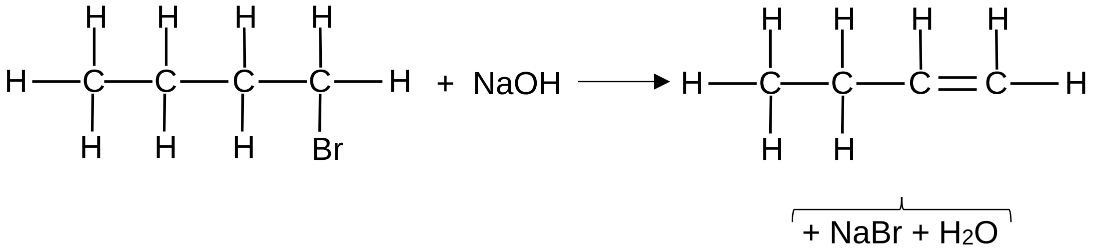
Nasienkriteria:
- *NaOH.* ✓
- *Hele struktuurformule van van alkeen korrek (funksionele groep op de tweede/ eerste C-atoom).* ✓
- *NaBr +* H_2O ✓

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*

Note/*Aantekening*:
For extra product or reactant, deduct 1 mark.
Vir ekstra produk of reaktans, trek 1 punt af.



OR



(3)

4.6.3 But-2-ene/2-butene/but-1-ene/1-butene/*But-2-een/2-buteen/but-1-een/ 1-buteen* ✓✓

Butene/*Buteen*: deduct 1 mark/*trek een punt af*. (2)

[22]

QUESTION 5/*VRAAG 5*

5.1

5.1.1

> **NOTE/*LET WEL***
> Give the mark for per unit time only if in context of reaction rate.
> *Gee die punt vir per eenheid tyd 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 0)**

ENIGE EEN:

- *Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.*
- *Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.*
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.*
- *Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa.* ***(2 of 0)*** (2)

5.1.2

Marking criteria	***Nasienkriteria:***
(a) Substitute 0,033 and 5 in rate formula. ✓ (b) Substitute 24,5 in $\frac{V}{V_m}$ ✓ (c) USE mol ratio: $n(A\ell) : n(H_2) = 2 : 3$ ✓ (d) Substitute 27 g·mol^{-1} in $\frac{m}{M}$ ✓ (e) Subtract $m(A\ell)_{t=5}$ from $m(A\ell)_{ini}$ / $n(A\ell)_{t=5}$ from $n(A\ell)_{ini}$ ✓ (f) Final correct answer: 0,38 g ✓ (0,379) Range: 0,365 – 0,42 g	(a) *Vervang* 0,033 *en* 5 *in tempoformule* ✓ (b) Vervang 24,5 in $\frac{V}{V_m}$ ✓ (c) *GEBRUIK molverhouding:* $n(A\ell) : n(H_2) = 2 : 3$ ✓ (d) *Vervang* 27 g in $\frac{m}{M}$ ✓ (e) *Trek* $m(A\ell)_{t=5}$ *van* $m(A\ell)_{begin}$ / $n(A\ell)_{t=5}$ *van* $n(A\ell)_{begin}$ ✓ (f) *Finale korrekte antwoord: 0,38 g* (0,379 g) ✓ *Gebied:* 0,365 – 0,42 g

$$\text{Rate/}\textit{Tempo} = \frac{\Delta V(H_2)}{\Delta t}$$

$$0{,}033 = \frac{\Delta V(H_2)}{5} \ ✓\text{(a)}$$

$$V(H_2) = 0{,}165\ dm^3$$

$$n(H_2) = \frac{V}{V_m}$$

$$= \frac{0{,}165}{24{,}5} \ ✓\text{(b)}$$

$$= 6{,}74 \times 10^{-3}\ \text{mol}\ (0{,}0067)$$

$$n(A\ell) = \frac{2}{3} n(H_2)$$

$$= \frac{2}{3}(6{,}74 \times 10^{-3})\ ✓\text{(c)}$$

$$= 4{,}49 \times 10^{-3}\ \text{mol}\ (0{,}00449)$$

OPTION 1/*OPSIE 1*:	**OPTION 2/*OPSIE 2*:**
$n(A\ell) = \frac{m}{M}$ $4{,}49 \times 10^{-3} = \frac{m(Al)}{27}$ ✓**(d)** $m(A\ell) = 0{,}12$ g (0,121) $\Delta m(A\ell) = 0{,}5 - 0{,}12$ ✓**(e)** $= 0{,}38$ g ✓**(f)**	$n(A\ell) = \frac{m}{M}$ $= \frac{0{,}5}{27}$ $= 0{,}0185$ mol $\Delta n(A\ell) = 0{,}0185 - 4{,}49 \times 10^{-3}$ ✓**(e)** $= 0{,}014$ mol $n(A\ell) = \frac{m}{M}$ $0{,}014 = \frac{m(Al)}{27}$ ✓**(d)** $m(A\ell) = 0{,}38$ g ✓**(f)**

(6)

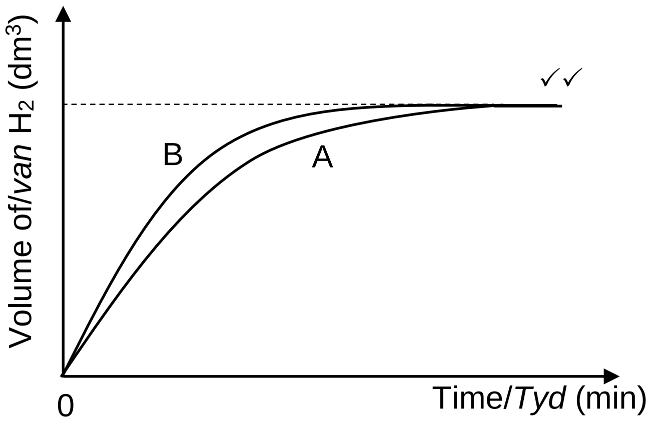
5.1.3

- The surface area/contact area/mass/size of aluminium decreases. ✓
- Less particles exposed. ✓
- Less effective collisions per unit time/second. ✓
  OR
  Lower frequency of effective collisions.
- Reaction rate decreases./Lower reaction rate./Reaction slows down. ✓

- *Die reaksieoppervlak/kontakoppervlak/massa/grootte van aluminium neem af.*
- *Minder deeltjies blootgestel.*
- *Minder effektiewe botsings per eenheid tyd/sekonde.*
  OF
  Laer frekwensie van effektiewe botsings.
- *Reaksietempo neem af./Laer reaksietempo./ Reaksie is stadiger .* (4)

5.1.4

Marking criteria:	***Nasienkriteria:***
• Curve B starts at the origin and ends at the same point as curve A. ✓ • Gradient of curve B steeper for the whole duration. ✓ **Note:** Graph not labelled: Max. $^1/_2$	• *Kurwe B begin by oorsprong en eindig by dieselfde punt as kurwe A.* ✓ • *Gradiënt van kurwe B steiler vir die volle duur.* ✓ ***Aantekening:*** *Grafiek nie benoem nie: Maks.* $^1/_2$



(2)

5.1.5 Equal to./*Gelyk aan.* ✓ (1)

5.2

5.2.1 An increase in temperature./*'n Toename in temperatuur.* ✓ (1)

5.2.2 Curve Y has a peak/maximum at a higher kinetic energy./Peak shifted to the right.
OR
The (average) kinetic energy (of the particles) increases./More particles with higher kinetic energy./Larger area with higher kinetic energy. ✓

Kurwe Y het 'n piek/maksimum by 'n hoër kinetiese energie./Piek het regs geskuif.
OF
Die (gemiddelde) kinetiese energie van die deeltjies het toegeneem./Meer deeltjies met 'n hoer kinetiese energie./Groter oppervlak met hoër kinetiese energie (1)

[17]

QUESTION 6/*VRAAG 6*

6.1
6.1.1 (The dynamic equilibrium when) the rate of the forward reaction equals the rate of the reverse reaction. ✓✓ (**2 or 0**)
(Die dinamiese ewewig wanneer) die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie.

OR/*OF*

The stage in a chemical reaction when the concentrations of the reactants and products remain constant.
Die stadium in 'n chemiese reaksie waar die konsentrasie van die reaktanse en produkte konstant bly. (2)

6.1.2 X ✓ (1)

6.1.3 Decreased/*Verlaag* ✓ (1)

6.1.4 The concentrations of (all) the gases decreased./The reverse reaction was favoured.✓
Die konsentrasies van die (al) die gasse verminder./Die terugwaartse reaksie is bevoordeel.
Accept/*Aanvaar*:
All concentrations decreased./*Al die kosentrasies het verminder.* (1)

6.1.5 CO(g)/carbon monoxide/*koolstofmonoksied.* ✓ (1)

6.1.6 The concentration of Z (CO) decreased with a decrease in the concentration of X (O_2). ✓
OR
The concentration of Z (CO) increased with an increase in the concentration of X (O_2).
OR
Z (CO) behaves like X (O_2)/Follows the same trend as X (O_2).
OR
Z (CO) and X(O_2) are both reactants/ Y(CO_2) is the product.
OR
The reverse reaction is favoured to increase the number of moles.

Die konsentrasie van Z (CO) neem af met 'n afname in die konsentrasie van X (O_2).
OF
Die konsentrasie van Z (CO) neem toe met 'n toename in die konsentrasie van X (O_2).
OF
Z (CO) tree dieselfde op as X (O_2)/volg dieselfde neiging as X (O_2).
OF
Z(CO) en X(O_2) is beide reaktanse/ Y(CO_2) is die produk.
OF
Die terugwaartse reaksie word bevoordeel om die hoeveelheid mol te verhoog. (1)

6.1.7 Decreased/*Verlaag* ✓ (1)

6.1.8
- Concentration of products/Y/CO_2 increases. ✓

  OR

  Concentration of reactant/Z/X/CO/O_2 decreases.

  OR

  The forward reaction is favoured.

- The forward reaction is exothermic. ✓
- A decrease in temperature favours the exothermic reaction. ✓

- *Konsentrasie van produkte/Y/CO_2 neem toe.* ✓

  OF

  Konsentrasie van reaktanse/Z/X/CO/O_2 neem af.

  OF

  Die voorwaartse reaksie word bevoordeel.

- *Die voorwaartse reaksie is eksotermies.* ✓
- *Afname in temperatuur bevoordeel die eksotermiese reaksie.* ✓ (3)

6.2

REACTANTS ARE USED/*REAKTANSE WORD GEBRUIK*

CALCULATIONS USING MOLES

BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:

(a) USING ratio: $n(H_2O) : n(CO) : n(H_2) : n(CO_2) = 1 : 1 : 1 : 1$ ✓
(b) $n(CO)_{eq} = n(CO)_{initial} - \Delta n(CO)$, $n(H_2O)_{eqm} = n(H_2O)_{initial} - \Delta n(H_2O)$,
$n(CO_2)_{eq} = n(CO_2)_{initial} + \Delta n(CO_2)$ AND $n(H_2)_{eqm} = n(H_2)_{initial} + \Delta n(H_2)$ ✓
(c) Divide n_{eq} by the volume 2 dm^3 ✓
(d) Correct K_c expression. ✓
(e) Substitute K_c value 4. ✓
(f) Substitute concentrations in K_c expression. ✓
(g) Substitute numerical values of x in $n(CO)_{initial} - \Delta n(CO)_{change}$ ✓
(h) Substitute of 28 in $n = \frac{m}{M}$ ✓
(i) Final answer: 6,44 g ✓
Range: 6,44 – 6,72 g

Nasienkriteria:

(a) *GEBRUIK verhouding: $n(H_2O) : n(CO) : n(H_2) : n(CO_2) = 1 : 1 : 1 : 1$* ✓
*(b) $n(CO)_{ewe} = n(CO)_{begin} - \Delta n(CO)$, $n(H_2O)_{ewe} = n(H_2O)_{begin} - \Delta n(H_2O)$,
$n(CO_2)_{ewe} = n(CO_2)_{begin} + \Delta n(CO_2)$ EN $n(H_2)_{ewe} = n(H_2)_{begin} + \Delta n(H_2)$* ✓
(c) Deel n_{ewe} deur 2 dm^3 ✓
(d) Korrekte K_c-uitdrukking. ✓
(e) *Vervang K_c-waarde 4.* ✓
(f) *Vervanging van konsentrasies in K_c-uitdrukking.* ✓
(g) Vervanging van nomeriese waarde van x in $n(CO)_{begin} - \Delta n(CO)$ ✓
(h) *Vervanging van 28 in $n = \frac{m}{M}$* ✓
(i) *Finale answer: 6,44 g* ✓
Gebied: 6,44 – 6,72 g

IF/*INDIEN*:
No table/calculation giving table values – do not award marks for criteria (a) and (b)
Geen tabel/berekening waarin tabelwaardes gegee is – geen punt vir riglyn (a) en (b).

(x change in amount/ *verandering in hoeveelheid.)*	CO	H_2O	CO_2	H_2
Initial amount (moles) *Aanvanklike hoeveelheid (mol)*	0,6	0,6	0,1	0, 1
Change in amount (moles) *Verandering in hoeveelheid* (mol)	x	x	x	x ✓ **(a)**
Equilibrium amount (moles) *Ewewigshoeveelheid* (mol) ✓ **(b)**	0,6 - x	0,6 - x	0,1 + x	0,1 + x
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie* ($mol·dm^{-3}$)	$\frac{0,6-x}{2}$	$\frac{0,6-x}{2}$	$\frac{0,1+x}{2}$	$\frac{0,1+x}{2}$ ✓ **(c)**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} \checkmark \textbf{(d)}$$

$$4 \checkmark \textbf{(e)} = \frac{\left(\frac{0,1+x}{2}\right)\left(\frac{0,1+x}{2}\right)}{\left(\frac{0,6-x}{2}\right)\left(\frac{0,6-x}{2}\right)} \checkmark \textbf{(f)}$$

x = 0,37

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.* $^6/_9$

Option 1:

$n(CO)_{eq} = 0,6 – 0,37$ ✓ **(g)**
= 0,23 mol

$$n(CO)_{eq} = \frac{m}{M}$$

$$0,23 = \frac{m}{28} \checkmark \textbf{(h)}$$

$m(CO)_{eq} = 6,44$ g ✓ **(i)**

Option 2:

$$[CO]_{eq} = \frac{0,6-x}{2}$$

$$= \frac{0,6-0,37}{2} \checkmark \textbf{(g)}$$

$= 0,115\ mol·dm^{-3}$

n = cV
= (0,115)(2)
= 0,23 mol

$$n(CO)_{eq} = \frac{m}{M}$$

$$0,23 = \frac{m}{28} \checkmark \textbf{(h)}$$

$m(CO)_{eq} = 6,44$ g ✓ **(i)**

(x equilibrium amount/ *ewewigshoeveelheid.)*	CO	H_2O	CO_2	H_2
Initial amount (moles) *Aanvanklike hoeveelheid (mol)*	0,6	0,6	0,1	0, 1
Change in amount (moles) *Verandering in hoeveelheid* (mol)	-x + 0,6	-x + 0,6	-x + 0,6	-x + 0,6
Equilibrium amount (moles) *Ewewigshoeveelheid* (mol) ✓ **(b)**	x	x	0,7 - x	0,7 - x
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie* ($mol \cdot dm^{-3}$)	$\frac{x}{2}$	$\frac{x}{2}$	$\frac{07 - x}{2}$	$\frac{0,7 - x}{2}$

✓ **(a)**

✓ **(c)**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} \checkmark \textbf{(d)}$$

$$4 \checkmark \textbf{(e)} = \frac{\left(\frac{0,7 - x}{2}\right)\left(\frac{0,7 - x}{2}\right)}{\left(\frac{x}{2}\right)\left(\frac{x}{2}\right)} \checkmark \textbf{(f)}$$

x = 0,23

$$n(CO)_{eq} = \frac{m}{M}$$

$$\checkmark \textbf{(g)}\ 0,23 = \frac{m}{28} \checkmark \textbf{(h)}$$

$$m(CO)_{eq} = 6,44 \text{ g} \checkmark \textbf{(i)}$$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria:

(a) **USING RATIO**: $[H_2O] : [CO] : [H_2] : [CO_2] = 1 : 1 : 1 : 1$ ✓
(b) Calculate $[CO]_{initial}$, $[H_2O]_{initial}$, $[CO_2]_{initial}$ AND $[H_2]_{initial}$ (divide initial moles by the volume of 2 dm^3) ✓
(c) $[CO]_{eq} = [CO]_{initial} - \Delta[CO]$ and $[H_2O]_{eq} = [H_2O]_{initial} - \Delta [H_2O]$ and $[CO_2]_{eq} = [CO_2]_{initial} + \Delta [CO_2]$ and $[H_2]_{eq} = [H_2]_{initial} + \Delta[H_2]$ ✓
(d) Correct K_c expression ✓
(e) Substitute $K_c = 4$ ✓
(f) Substitute K_c expression ✓
(g) Substitute numerical value of x in $c(CO)_{initial} - \Delta c(CO)$ ✓
(h) Substitute 28 in $n = \frac{m}{M}$ ✓
(i) ***CORRECT*** final answer; x = 6,72 g. ✓
Range: 6,44 – 6,72 g

Nasienkriteria:

(a) ***GEBRUIK*** *verhouding:* $[H_2O] : [CO] : [H_2] : [CO_2] = 1 : 1 : 1 : 1$ ✓
(b) *Bereken* $[CO]_{begin}$, $[H_2O]_{begin}$, $[CO_2]_{begin}$ *AND* $[H_2]_{begin}$ *(divide initial moles by the volume of 2* dm^3*)* ✓
(c) $[CO]_{ewe} = [CO]_{begin} - \Delta[CO]$ *en* $[H_2O]_{ewe} = [H_2O]_{begin} - \Delta [H_2O]$ *en* $[CO_2]_{eq} = [CO_2]_{begin} + \Delta[CO_2]$ *and* $[H_2]_{ewe} = [H_2]_{initial} + \Delta[H_2]$ ✓
(d) *Korrekte* K_c *uitdrukking (formules in vierkanthakies).* ✓
(e) *Vervang* $K_c = 4$ ✓
(f) *Vervanging van konsentrasies in* K_c*-uitdrukking.*
(g) *Vervanging van nomeriese waarde van x in* $c(CO)_{begin} - \Delta c(CO)$ ✓
(h) *Vervang 28 in* $n = \frac{m}{M}$ ✓
(i) ***Korrekte*** *final answer; x = 6,72 g.* ✓
Gebied: 6,44 – 6,72 g

(x change concentration/ *ewewigskonsentrasie.)*	CO	H_2O	H_2	CO_2
Initial concentration ($mol \cdot dm^{-3}$) Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)	0,3	0,3	0,05	0,05 ✓ **(b)**
Change ($mol \cdot dm^{-3}$) *Verandering ($mol \cdot dm^{-3}$)*	x	x	x	x ✓ **(a)**
Equilibrium concentration ($mol \cdot dm^{-3}$) Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	0,3 - x	0,3 - x	0,05 + x	0,05 + x ✓ **(c)**

$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]}$ ✓ **(d)**

✓ **(e)** $4 = \frac{(0,05 + x)(0,05 + x)}{(0,3 - x)(0,3 - x)}$ ✓ **(f)**

$x = 0,18\ (0,183)$

$[CO] = 0,3 – 0,18$ ✓ **(g)**

$= 0,12\ mol \cdot dm^{-3}$

$n(CO)_{eq} = cV$

$= (0,12)(2)$

$= 0,24\ mol$

$n(CO) = \frac{m}{M}$

$0,24 = \frac{m}{28}$ ✓ **(h)**

$m(CO)_{eqm} = 6,72\ g$ ✓ **(i)**

(x equilibrium concentration/ ewewigkonsentrasie*)*	CO	H_2O	H_2	CO_2
Initial concentration ($mol \cdot dm^{-3}$) Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)	0,3	0,3	0,05	0,05 ✓ **(b)**
Change ($mol \cdot dm^{-3}$) *Verandering ($mol \cdot dm^{-3}$)*	-x + 0,3	-x + 0,3	-x + 0,3	-x + 0,3 ✓ **(a)**
Equilibrium concentration ($mol \cdot dm^{-3}$) Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	x	x	0,35 - x	0,35 - x ✓ **(c)**

$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]}$ ✓ **(d)**

✓ **(e)** $4 = \frac{(0,35 - x)(0,35 - x)}{(x)(x)}$ ✓ **(f)**

$x = 0,12\ mol \cdot dm^{-3}$

$n(CO)_{eq} = cV$

$= (0,12)(2)$ ✓ **(g)**

$= 0,24\ mol$

$n(CO) = \frac{m}{M}$

$0,24 = \frac{m}{28}$ ✓ **(h)**

$m(CO)_{eqm} = 6,72\ g$ ✓ **(i)**

PRODUCTS ARE USED/*PRODUKTE WORD GEBRUIK*

CALCULATIONS USING MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:
(a) USING ratio: $n(H_2O) : n(CO) : n(H_2) : n(CO_2) = 1 : 1 : 1 : 1$ ✓
(b) $n(CO)_{eq} = n(CO)_{initial} + \Delta n(CO)$, $n(H_2O)_{eqm} = n(H_2O)_{initial} + \Delta n(H_2O)$, $n(CO_2)_{eq} = n(CO_2)_{initial} - \Delta n(CO_2)$ AND $n(H_2)_{eqm} = n(H_2)_{initial} - \Delta n(H_2)$ ✓
(c) Divide n_{eq} by the volume 2 dm^3 ✓
(d) Correct K_c expression. ✓
(e) Substitute K_c value 4. ✓
(f) Substitute concentrations in K_c expression. ✓
(g) Substitute numerical value of x in $n(CO)_{initial} + \Delta n(CO)_{change}$ ✓
(h) Substitute of 28 in $n = \frac{m}{M}$ ✓
(i) Finale answer: 6,44 g ✓
Range: 6,44 – 6,72 g

Nasienkriteria:
(a) *GEBRUIK verhouding:* $n(H_2O) : n(CO) : n(H_2) : n(CO_2) = 1 : 1 : 1 : 1$ ✓
(b) $n(CO)_{ewe} = n(CO)_{begin} + \Delta n(CO)$, $n(H_2O)_{ewe} = n(H_2O)_{begin} + \Delta n(H_2O)$, $n(CO_2)_{ewe} = n(CO_2)_{begin} - \Delta n(CO_2)$ *EN* $n(H_2)_{ewe} = n(H_2)_{begin} - \Delta n(H_2)$ ✓
(c) Deel n_{ewe} *deur 2* dm^3 ✓
(d) Korrekte K_c*-uitdrukking.* ✓
(e) *Vervang* K_c*-waarde 4.* ✓
(f) *Vervanging van konsentrasies in* K_c*-uitdrukking.* ✓
(g) Vervanging van nomeriese waarde van x in $n(CO)_{begin} + \Delta n(CO)$ ✓
(h) *Vervanging van 28 in* $n = \frac{m}{M}$ ✓
(i) *Finale answer: 6,44 g* ✓
Gebied: 6,44 – 6,72 g

(x change in amount/ *verandering in hoeveelheid.)*	CO	H_2O	CO_2	H_2
Initial amount (moles) *Aanvanklike hoeveelheid (mol)*	0,6	0,6	0,1	0, 1 ✓ **(a)**
Change in amount (moles) *Verandering in hoeveelheid* (mol)	x	x	x	x
Equilibrium amount (moles) *Ewewigshoeveelheid* (mol) ✓ **(b)**	0,6 + x	0,6 + x	0,1 - x	0,1 - x
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{0,6+x}{2}$	$\frac{0,6+x}{2}$	$\frac{0,1-x}{2}$	$\frac{0,1-x}{2}$

✓ **(c)**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} \checkmark \textbf{(d)}$$

$$4 \checkmark \textbf{(e)} = \frac{\left(\frac{0,1-x}{2}\right)\left(\frac{0,1-x}{2}\right)}{\left(\frac{0,6+x}{2}\right)\left(\frac{0,6+x}{2}\right)} \checkmark \textbf{(f)}$$

$x = -0,37$

$n(CO)_{eq} = 0,6 + (-0,37)$ ✓ **(g)**

$= 0,23$ mol

$$n(CO)_{eq} = \frac{m}{M}$$

$$0,23 = \frac{m}{28} \checkmark \textbf{(h)}$$

$m(CO)_{eq} = 6,44$ g ✓ **(i)**

(x equilibrium amount / *ewewigshoeveelheid.)*	CO	H_2O	CO_2	H_2
Initial amount (moles) *Aanvanklike hoeveelheid (mol)*	0,6	0,6	0,1	0, 1
Change in amount (moles) *Verandering in hoeveelheid* (mol)	-0,6 +x	-0,6 +x	-0,6 +x	-0,6 +x ✓ **(a)**
Equilibrium amount (moles) *Ewewigshoeveelheid* (mol) ✓ **(b)**	x	x	0,7 - x	0,7 - x
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{x}{2}$	$\frac{x}{2}$	$\frac{0,7-x}{2}$	$\frac{0,7-x}{2}$

✓ **(c)**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]} \checkmark \textbf{(d)}$$

$$4 \checkmark \textbf{(e)} = \frac{\left(\frac{0,7-x}{2}\right)\left(\frac{0,7-x}{2}\right)}{\left(\frac{x}{2}\right)\left(\frac{x}{2}\right)} \checkmark \textbf{(f)}$$

$x = 0,23$

$$n(CO)_{eq} = \frac{m}{M}$$

$$\checkmark \textbf{(g)}\ 0,23 = \frac{m}{28} \checkmark \textbf{(h)}$$

$m(CO)_{eq} = 6,44$ g ✓ **(i)**

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria:
(a) **USING RATIO**: $[H_2O] : [CO] : [H_2] : [CO_2] = 1 : 1 : 1 : 1$ ✓
(b) Calculate $[CO]_{initial}$, $[H_2O]_{initial}$, $[CO_2]_{initial}$ AND $[H_2]_{initial}$ (divide initial moles by the volume of 2 dm^3) ✓
(c) $[CO]_{eq} = [CO]_{initial} + \Delta[CO]$ and $[H_2O]_{eq} = [H_2O]_{initial} + \Delta[H_2O]$ and $[CO_2]_{eq} = [CO_2]_{initial} - \Delta[CO_2]$ and $[H_2]_{eq} = [H_2]_{initial} - \Delta[H_2]$ ✓
(d) Correct Kc expression ✓
(e) Substitute $K_c = 4$ ✓
(f) Substitute K_c expression ✓
(g) Substitute numerical value of x in $c(CO)_{initial} + \Delta c(CO)$ ✓
(h) Substitute 28 in $n = \frac{m}{M}$ ✓
(i) ***CORRECT*** final answer; x = 6,72 g. ✓
Range: 6,44 – 6,72 g

Nasienkriteria:
(a) ***GEBRUIK** verhouding: $[H_2O] : [CO] : [H_2] : [CO_2] = 1 : 1 : 1 : 1$* ✓
(b) *Bereken $[CO]_{begin}$, $[H_2O]_{begin}$, $[CO_2]_{begin}$ AND $[H_2]_{begin}$ (divide initial moles by the volume of 2 dm^3)* ✓
(c) *$[CO]_{ewe} = [CO]_{begin} + \Delta[CO]$ en $[H_2O]_{ewe} = [H_2O]_{begin} + \Delta[H_2O]$ en $[CO_2]_{ewe} = [CO_2]_{begin} - \Delta[CO_2]$ and $[H_2]_{ewe} = [H_2]_{initial} - \Delta[H_2]$* ✓
(d) *Korrekte K_c uitdrukking (formules in vierkanthakies).* ✓
(e) *Vervang $K_c = 4$* ✓
(f) *Vervanging van konsentrasies in K_c-uitdrukking.* ✓
(g) *Vervanging van nomeriese waarde van x in $c(CO)_{begin} - \Delta c(CO)$* ✓
(h) *Vervang 28 in $n = \frac{m}{M}$* ✓
(i) ***Korrekte** final answer; x = 6,72 g.* ✓
Gebied: 6,44 – 6,72 g

(x change in concentration/ *verandering in konsentrasie.)*	CO	H_2O	H_2	CO_2
Initial concentration ($mol{\cdot}dm^{-3}$) Aanvanklike konsentrasie ($mol{\cdot}dm^{-3}$)	0,3	0,3	0,05	0,05 ✓ **(b)**
Change ($mol{\cdot}dm^{-3}$) *Verandering ($mol{\cdot}dm^{-3}$)*	X	x	x	x ✓ **(a)**
Equilibrium concentration ($mol{\cdot}dm^{-3}$) Ewewigskonsentrasie ($mol{\cdot}dm^{-3}$)	0,3 + x	0,3 + x	0,05 - x	0,05 - x ✓ **(c)**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]}$$ ✓ **(d)**

✓ **(e)**
$$4 = \frac{(0,05 - x)(0,05 - x)}{(0,3 + x)(0,3 + x)}$$ ✓ **(f)**

x = - 0,18 (0,183)

[CO] = 0,3 +(– 0,18) ✓ **(g)**
= 0,12 $mol{\cdot}dm^{-3}$

$n(CO)_{eq} = cV$
= (0,12)(2)
= 0,24 mol

$n(CO) = \frac{m}{M}$

$0,24 = \frac{m}{28}$ ✓ **(h)**

$m(CO)_{eq}$ = 6,72 g ✓ **(i)**

(x equilibrium concentration/ *ewewigkonsentrasie*)	CO	H_2O	H_2	CO_2	
Initial concentration ($mol \cdot dm^{-3}$) Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)	0,3	0,3	0,05	0,05	✓ **(b)**
Change ($mol \cdot dm^{-3}$) *Verandering* ($mol \cdot dm^{-3}$)	-0,3 +x	-0,3 +x	-0,3 +x	-0,3 +x	✓ **(a)**
Equilibrium concentration ($mol \cdot dm^{-3}$) Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	X	x	0,35 - x	0,35 - x	

✓ **(c)**

$$K_c = \frac{[CO_2][H_2]}{[CO][H_2O]}$$ ✓ **(d)**

✓ **(e)** $$4 = \frac{(0{,}35 - x)(0{,}35 - x)}{(x)(x)}$$ ✓ **(f)**

$x = 0{,}117\ mol \cdot dm^{-3}$

$n(CO)_{eq} = cV$
$= (0{,}117)(2)$ ✓ **(g)**
$= 0{,}233\ mol$

$$n(CO) = \frac{m}{M}$$

$$0{,}233 = \frac{m}{28}$$ ✓ **(h)**

$m(CO)_{eq} = 6{,}53\ g$ ✓ **(i)**

(9)
[20]

QUESTION 7/*VRAAG 7*

7.1 Weak bases dissociate/ionise incompletely/partially in water ✓ to form a low concentration of hydroxide/OH^- ions ✓
Swak basisse dissosieer/ioniseer onvolledig/gedeeltelik in water om 'n lae konsentrasie hidroksied/OH^--ione te vorm. (2)

7.2 HCO_3^-(aq) ✓ (1)

7.3

7.3.1 26,55 (cm^3) ✓ (1)

7.3.2 28,15 (cm^3) ✓ (1)

7.4

- The titration's equivalence point/colour change is in pH range less than 7./ Solution is acidic/ The reaction of strong acid and weak base has equivalence point at pH less than 7. ✓
Die titrasie se ekwivalente punte/kleurverandering is in pH gebied minder as 7./ Oplossing is suur/ Die reaksie van 'n sterk suur met 'n swak basis het 'n ekwivalente punt laer as pH 7.

- The end point of this titration is within the pH range in which methyl orange/indicator changes colour./Methyl orange changes colour at a pH less than 7. ✓
Die endpunt van hierdie titrasie is binne die pH-gebied waarin metieloranje/indicator kleur verander./ Metieloranje verander van kleur by 'n pH minder as 7.

(2)

7.5

Marking criteria (a) Any formula: $\frac{V_a \times c_a}{V_b \times c_b} = \frac{n_a}{n_b}$ **OR** n = cV ✓ (b) Substitute: 0,1 mol·dm^{-3} & 25 x 10^{-3} dm^3 (25 cm^3) ✓ (c) Substitute average volume 20,1 x 10^{-3} dm^3 (20,1 cm^3)✓ (d) Use ratio: *n(K_2CO_3) = $\frac{1}{2}$n(HCℓ)* ✓ (e) Final answer: 0,0625 mol·dm^{-3} ✓ Range: 0,06 to 0,0625 mol·dm^{-3} **Note:** If 20,05 or 20,15 is used: deduct 1 mark	***Nasienkriteria:*** *(a) Enige formule:* $\frac{V_a \times c_a}{V_b \times c_b} = \frac{n_a}{n_b}$ ***OF*** *n = cV* ✓ *(b) Vervang:* 0,1 mol·dm^{-3} & 25 x 10^{-3} dm^3 (25 cm^3) ✓ *(c) Vervang gemiddelde volume* 20,1 x 10^{-3} dm^3 (20,1 cm^3) ✓ *(d) Gebruik verhouding:* *n(K_2CO_3) = $\frac{1}{2}$n(HCℓ)* ✓ *(e) Finale antwoord:* 0,0625 mol·dm^{-3} ✓ *Gebied: 0,06 tot 0,0625 mol·dm^{-3}* ***Aantekening:*** *Indien 20,05 of 20,15 gebruik word: trek een punt af*
OPTION 1/*OPSIE 1*: $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ ✓ **(a)** ✓ **(b)** $\frac{\boxed{0,1 \times 25}}{c_b \times \boxed{20,1}} = \frac{2}{1}$ ✓ **(d)** ✓ **(c)** [K_2CO_3] = 0,0622 mol·dm^{-3} (0,06) ✓ **(e)**	**OPTION 2/*OPSIE 2*:** n(HCℓ) = cV ✓ **(a)** = $\boxed{(0,1)(25 \times 10^{-3})}$ ✓ **(b)** = 2,5 x 10^{-3} mol n(K_2CO_3) = $\frac{1}{2}$ n(HCℓ) ✓ **(d)** = $\frac{2,5 \times 10^{-3}}{2}$ = 1,25 x 10^{-3} mol n(K_2CO_3) = cV 1,25 x 10^{-3} = c$\boxed{(20,1 \times 10^{-3})}$ ✓ **(c)** c (K_2CO_3) = 0,0622 mol·dm^{-3} (0,06) ✓ **(e)**

(5)

7.6 **POSITIVE MARKING FROM QUESTION 7.5/**
POSITIEWE NASIEN VANAF VRAAG 7.5

Marking criteria

(a) Any formula: $n = \frac{m}{M}$ **OR** $c = \frac{m}{MV}$ **OR** $n = cV$ ✓

(b) Substitute: 600 cm^3 **OR** 0,6 dm^3 in $n = cV$ ✓

(c) Substitute: 6,525 in formula $n = \frac{m}{M}$ OR $c = \frac{m}{MV}$ ✓

(d) Substitute: 138 & 18 in $n = \frac{m}{M}$ ✓

(e) Final answer: x = 2 ✓

Nasienkriteria:

*(a) Enige formule: $n = \frac{m}{M}$ **OF** $c = \frac{m}{MV}$ **OF** $n = cV$✓*

*(b) Vervang: 600 cm^3 **OF** 0,6 dm^3 in $n = cV$ ✓*

(c) Vervang: 6,525 in formule $n = \frac{m}{M}$ OF $c = \frac{m}{MV}$ ✓

(d) Vervang: 138 & 18 in $n = \frac{m}{M}$ ✓

(e) Finale antwoord: x = 2 ✓

OPTION 1/*OPSIE 1*:

$$c = \frac{m}{MV} \checkmark \textbf{(a)}$$

$$0,0622 = \frac{6,525 \checkmark \textbf{(c)}}{M(0,6) \checkmark \textbf{(b)}}$$

$$M = 174,84 \text{ g·mol}^{-1}$$

$K_2CO_3·xH_2O$ = 174,84

$2(39) + 12 + (3)(16) + x(18)$ ✓ **(d)** = 174,84

x = 2 ✓ **(e)**

OPTION 2/*OPSIE 2:*

$n(K_2CO_3)$ in 600 cm^3 = (0,0622)(0,6) ✓ **(b)**
= 0,0373 mol

$n(K_2CO_3 \cdot xH_2O) = \frac{m}{M}$ ✓ **(a)**

$0,0373 = \frac{6,525}{138+18x}$ ✓ **(c)** ✓ **(d)**

x = 2 ✓ **(e)**

OR

OPTION 3/*OPSIE 3:*

$n(HC\ell) = cV$ ✓ **(a)**
$= (0,1)(2,5 \times 10^{-2})$
$= 2,5 \times 10^{-3}$ mol

$n(K_2CO_3) = \frac{1}{2} n(HC\ell)$
$= \frac{2,5 \times 10^{-3}}{2}$
$= 1,25 \times 10^{-3}$ mol

$n(K_2CO_3)$ in 20 cm^3 = $1,25 \times 10^{-3}$ mol
$n(K_2CO_3)$ in 600 cm^3
$= \frac{(1,250 \times 10^{-2})(600)}{20}$ ✓ **(b)**
= 0,0375 mol

$n(K_2CO_3) = \frac{m}{M}$
$0,0373 = \frac{m}{138}$
m = 5,147 g

$m(H_2O) = 6,525 - 5,147$ ✓ **(c)**
= 1,378 g

$n(H_2O) = \frac{m}{M}$
$= \frac{1,378}{18}$
= 0,0766 mol

✓ **(d)** Both/*Beide*

$n(K_2CO_3):n(H_2O)$
0,0373 : 0,0766
x = 2 ✓ **(e)**

(5)
[17]

QUESTION 8/*VRAAG 8*

8.1

8.1.1 The oxidation number of H changes from +1 to 0 ✓**AND** the oxidation number of Mg changes from 0 to +2. ✓
Die oksidasiegetal van H verander van +1 na 0 ***EN*** *Die oksidasiegetal van Mg verander van 0 na +2.*

***OR*/OF**
$Mg^0 \rightarrow Mg^{2+}$ Oxidation number increases./*Oksidasiegetal neem toe.*
$H^+ \rightarrow H_2^0$ Oxidation number decreases./Oksidasiegetal neem af. (2)

8.1.2 H^+/HCℓ ✓ (1)

8.1.3 Cu/copper is a weaker reducing agent ✓ than hydrogen/H_2 ✓ (and will not reduce H^+/hydrogen ion to H_2).
OR
Cu/copper is too weak a reducing agent ✓ to reduce H^+/hydrogen ion (to H_2). ✓

Cu/koper is 'n swakker reduseermiddel as H_2 (*en sal nie* H^+*/waterstofione na* H_2 *te reduseer).*
OF
Cu/koper is te 'n swak reduseermiddel om H^+*/waterstofione (na* H_2*) te reduseer.* (2)

8.1.4 Yes/*Ja*✓
NO_3^-/Nitrate ion/Nitric acid is a stronger oxidising agent ✓ than Cu^{2+}/copper (II) ion ✓ (therefore Cu/copper will be oxidised to Cu^{2+} /copper (II) ion).

NO_3^-/Nitrate ioon/Salpetersuur is 'n sterker oksideermiddel as Cu^{2+}/ koper(II)ioon (daarom sal Cu/koper geoksideer word na Cu^{2+}/koper(II)ion). (3)

8.2

8.2.1

<u>Marking criteria/*Nasienkriteria:*</u>
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* ⇌ and phases/*en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

$Pb(s) + 2Fe^{3+}(aq)$ ✓ $\rightarrow Pb^{2+}(aq) + 2Fe^{2+}(aq)$ ✓ Bal. ✓
OR/*OF:*
$Pb + 2Fe^{3+} \rightarrow Pb^{2+} + 2Fe^{2+}$ Bal. (3)

8.2.2 Increases/*Toeneem* ✓ (1)
[12]

QUESTION 9/*VRAAG 9*

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. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $\frac{3}{4}$

9.1 **OPTION 1/*OPSIE 1***

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓

$= -0,13$ ✓ $- (0,80)$ ✓

$= -0,93$ V ✓

∴ non-spontaneous/*nie-spontaan* ✓

OPTION 2/*OPSIE 2*

$Pb^{2+} + 2e^- \rightarrow Pb$ $\quad E^{\theta} = -0,13$ V ✓

$2Ag \rightarrow 2Ag^+ + 2e^-$ $\quad E^{\theta} = -0,80$ V ✓

(both half-reactions) ✓

$Pb^{2+} + 2Ag \rightarrow Pb + 2Ag^+$ $\quad E^{\theta} = -0,93$ V ✓

∴ non-spontaneous/*nie-spontaan* ✓ (5)

9.2.1 **ANY ONE*:* (2 or 0)**

- A substance of which the (aqueous) solution contains ions. ✓✓
- A substance that dissolves in water to give a solution that conducts electricity.
- A substance that forms ions in water / when melted.
- A solution/substance that conducts electricity through the movement of ions.

ENIGE EEN: (2 of 0)

- *'n Stof waarvan die oplossing in water ione bevat.*
- *'n Stof wat in water oplos om 'n oplossing te vorm wat elektrisiteit gelei.*
- *'n Stof wat ione in water vorm/ wanneer dit gesmelt word.*
- *'n Oplossing/stof wat elektrisiteit gelei deur die beweging van ione.* (2)

9.2.2 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓

Note/*Aantekening:*
- $C\ell_2 + 2e^- \leftarrow 2C\ell^-$ $(\frac{2}{2})$
  $2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ $(\frac{1}{2})$
  $C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $(\frac{0}{2})$
  $2C\ell^- \leftarrow C\ell_2 + 2e^-$ $(\frac{0}{2})$
- 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:* $2C\ell \rightarrow C\ell_2 + 2e^-$ Max/*Maks:* $\frac{1}{2}$

(2)

9.2.3 Hydroxide ions/OH^-/Sodium hydroxide/NaOH ✓
Hidroksiedione/Natriumhidroksied

Hydrogen/H_2 ✓
Waterstof (2)

9.2.4 Water/H_2O is a stronger oxidising agent ✓ (than Na^+/sodium ion) and water/H_2O will be reduced. ✓
Water/H_2O is 'n sterker oksideermiddel (as Na^+/natrium-ioon) en water/H_2O sal gereduseer word.
OR/*OF*
Na^+/sodium ion is a weaker oxidising agent than water/H_2O and water/H_2O will be reduced.
Na^+/natrium-ioon is 'n swakker oksideermiddel as water/H_2O en water/H_2O sal gereduseer word. (2)

[13]

TOTAL/*TOTAAL*: 150