EXAMINATION	NATIONAL SENIOR CERTIFICATE
GRADE	12
DATE	MAY/JUNE 2025
SUBJECT	PHYSICAL SCIENCES
PAPER	2
MARK TOTAL	150
DURATION (HOURS)	3
NUMBER OF PAGES	20

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SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE

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INSTRUCTIONS AND INFORMATION

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

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

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

4. Leave **ONE** line between two sub questions, for example between **QUESTION 2.1** and **QUESTION 2.2**.

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. You are advised to use the attached **DATA SHEETS**.

8. Show **ALL** formulae and substitutions in **ALL** calculations.

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

10. Give brief motivations, discussions, *et cetera* where required.

11. Write neatly and legibly, in **BLUE** ink only.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A−D) next to the question numbers (1.1 to1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Consider the compound with molecular formula C_5H_{12}. How many STRUCTURAL ISOMERS does the compound have?

A 2

B 3

C 4

D 5 (2)

1.2 In which one of the following options are the three compounds arranged in order of increasing (lowest to highest) boiling points?

A	CH_3CH_2COOH	$CH_3CH_2CH_2CH_2CH_3$	$CH_3CH_2CH_2CH_2OH$
B	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH_2CH_2CH_3$	CH_3CH_2COOH
C	$CH_3CH_2CH_2CH_2CH_3$	$CH_3CH_2CH_2CH_2OH$	CH_3CH_2COOH
D	$CH_3CH_2CH_2CH_2CH_3$	CH_3CH_2COOH	$CH_3CH_2CH_2CH_2OH$

(2)

1.3 2-chlorobutane is heated in the presence of concentrated NaOH. The type of reaction that will take place can best be described as:

A Elimination

B Addition

C Substitution

D Oxidation (2)

1.4 The average rate of the formation of CO_2 in the following balanced reaction is 0,5 $mol.min^{-1}$.

$$\mathbf{CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)}$$

The average rate of consumption (disappearance) of HCℓ for this same reaction is:

A 2 $mol{\cdot}min^{-1}$

B 1 $mol{\cdot}min^{-1}$

C 0,5 $mol{\cdot}min^{-1}$

D 0,25 $mol{\cdot}min^{-1}$ (2)

1.5 Methanol (CH_3OH) is synthesised from carbon monoxide (CO) and hydrogen gas (H_2) according to the balanced equation below:

$$\mathbf{CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H < 0}$$

Which one of the following changes will NOT affect the value of the equilibrium constant (K_c) and will decrease the YIELD of CH_3OH?

A Increase in temperature.

B Decrease in temperature.

C Increase in pressure.

D Decrease in pressure. (2)

1.6 Which one of the following statements regarding the equilibrium reaction given below is TRUE?

$$\mathbf{2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g) \qquad \Delta H < 0}$$

A Chemical equilibrium is reached when the forward reaction stops, and the product and reactants remain constant.

B Chemical equilibrium is reached when the concentration of the product is equal to the concentrations of the reactants.

C Chemical equilibrium is reached when K_c is zero and the concentrations of the product and reactants remain constant.

D Chemical equilibrium is reached when the concentrations of the product and reactants remain constant. (2)

1.7 Which one of the following pairs is NOT a conjugate acid-base pair?

A NH_4^+ and NH_3

B H_3O^+ and OH^-

C H_2S and HS^-

D HSO_3^- and SO_3^{2-} (2)

1.8 Which one of the following is CORRECT regarding a strong acid? The stronger the acid, …

A the more concentrated it is.

B the less concentrated it is.

C the higher the pH.

D the weaker the conjugate base. (2)

1.9 Which ONE of the following combinations CORRECTLY shows the products formed during the electrolysis of a CONCENTRATED sodium chloride solution?

	CATHODE	**ANODE**
A	Hydrogen	Sodium
B	Hydrogen	Chlorine
C	Chlorine	Sodium
D	Chlorine	Hydrogen

(2)

1.10 Which ONE of the following reactions, when used in a galvanic cell, will get a positive reading on the voltmeter?

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

B $Co^{2+}(aq) + Sn^{2+}(aq) \rightarrow Co(s) + Sn^{4+}(aq)$

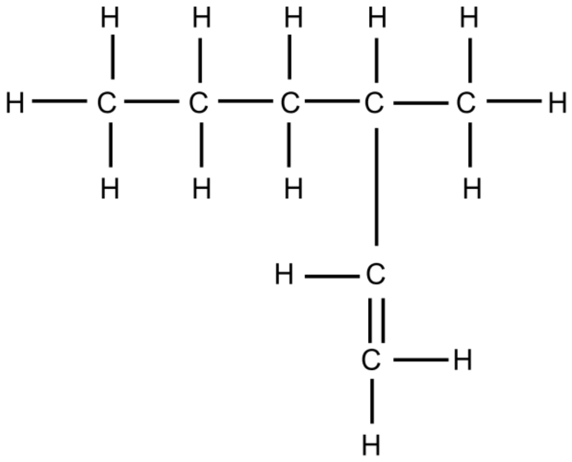
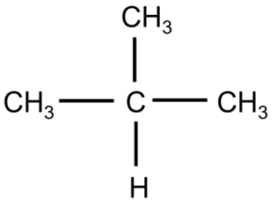
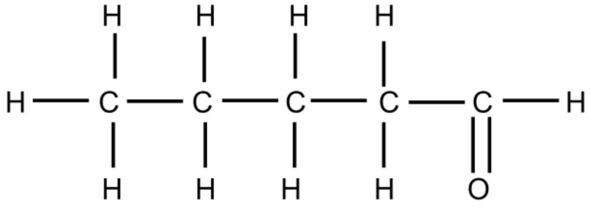
C $Mg^{2+}(aq) + Zn(s) \rightarrow Mg(s) + Zn^{2+}(aq)$

D $3Ni^{2+}(aq) + Fe(s) \rightarrow 3Ni(s) + 2Fe^{3+}(aq)$ (2)

[20]

QUESTION 2 [START ON A NEW PAGE]

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

A	
B	C_8H_{18}
C	 $\mathrm{CH_3 - \overset{CH_3}{\underset{H}{C}} - CH_3}$
D	$CH_3(CH_2)_2(CH)_2CH_2F$
E	Propanoic acid
F	

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

2.2 Write down the:

2.2.1 NAME of the functional group of compound **A**. (1)

2.2.2 STRUCTURAL FORMULA of the functional group of compound **E**. (1)

2.3 Define *homologous series*. (2)

2.4 For compound **B,** write down**:**

2.4.1 The homologous series to which it belongs (1)

2.4.2 A balanced equation, using molecular formula, for its complete combustion. (3)

2.5 For compound **D**, write down the:

2.5.1 STRUCTURAL FORMULA of this compound. (2)

2.5.2 IUPAC name of this compound. (3)

2.6 Write down the:

2.6.1 IUPAC name of a CHAIN ISOMER of compound **C**. (2)

2.6.2 STRUCTURAL formula of the FUNCTIONAL ISOMER of compound **F**. (2)

2.6.3 IUPAC name of the functional isomer in QUESTION 2.6.2. (2)

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QUESTION 3 [START ON A NEW PAGE]

Consider the various organic compounds and their boiling points given in the table below. No boiling points were given for compounds **B** and **F**.

Compound	Organic compound	Boiling point (ºC)
A	Pentanoic acid	187
B	2-methylbutane	**X**
C	$CH_3CH_2CH_2CH_2CH_2OH$	138
D	$CH_3CH_2CH_2COOCH_3$	102
E	1-bromo-4-methylpentane	154
F	Pentane	**Y**
G	Pentan-2-ol	119

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

3.2 Which compound will have the LOWEST vapour pressure? Write down only the LETTER of the compound. (1)

3.3 Consider compound **D**.

3.3.1 What is the STRONGEST INTERMOLECULAR FORCE that occurs between molecules of compound **D**? (1)

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

3.3.2 Fully explain the difference in boiling points of these two compounds. (4)

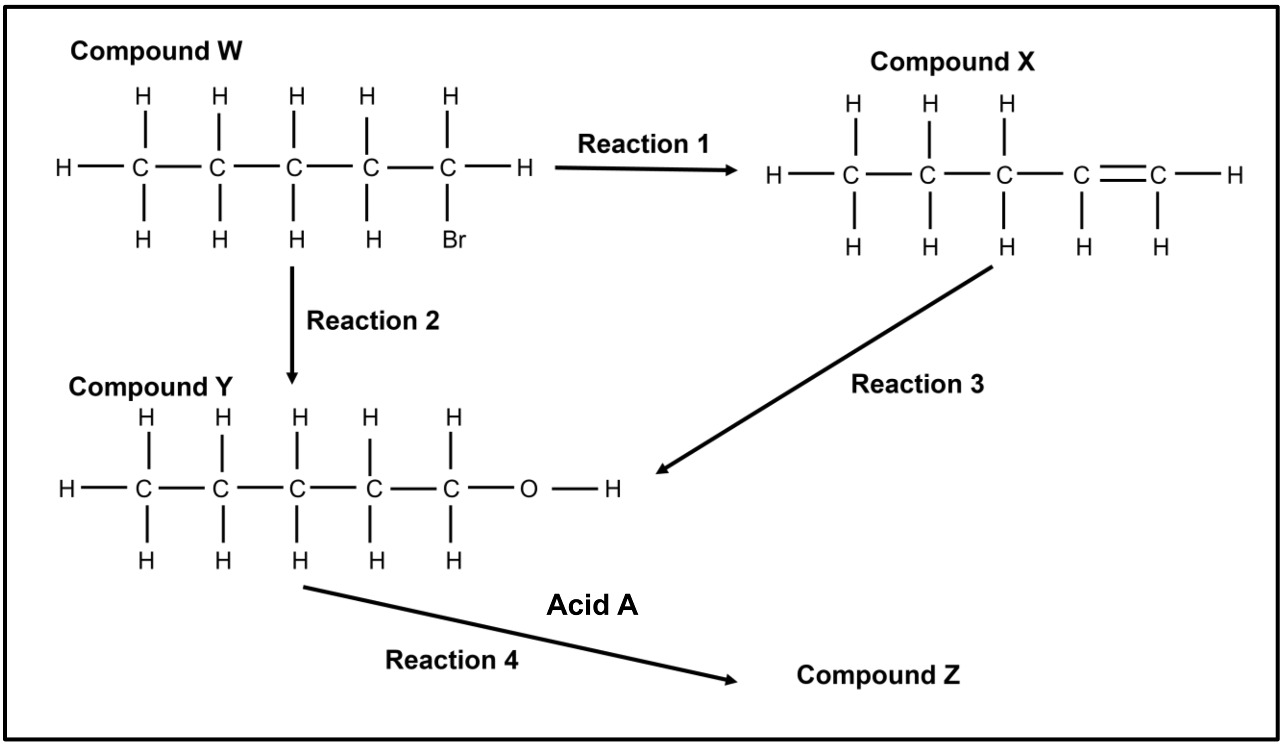
3.4 Which compound, **B** or **F**, has the LOWEST boiling point? (1)

3.5 Refer to the structure of the compounds to explain your answer to QUESTION 3.4. (3)

[12]

QUESTION 4 [START ON A NEW PAGE]

Study the flow diagram below, which represents various organic reactions, and answer the questions that follow:



4.1 For reaction **1**, write down the:

4.1.1 SPECIFIC type of reaction. (1)

4.1.2 TWO reaction conditions for this reaction. (2)

4.2 Consider compound **X**.

4.2.1 Write down the IUPAC name of compound **X**. (2)

4.2.2 Using CONDENSED FORMULAE, write down a balanced equation for the reaction that takes place when compound **X** mentioned in QUESTION 4.2.1 reacts with hydrogen gas (H_2). (3)

4.3 Write down the name for the GENERAL type of reaction represented by reaction **2**. (1)

4.4 Consider reaction **3**. This reaction takes place in the presence of steam and an acid. What is the GENERAL name for this reaction? (1)

4.5 Reaction **4** takes place when compound **Y** reacts with propanoic acid in the presence of acid **A**. Compound **Z** is formed as a major product.

4.5.1 Write down the CHEMICAL NAME of the acid **A**. (1)

4.5.2 Give two reasons why acid **A** is used. (2)

4.5.3 Using STRUCTURAL FORMULAE write down the equation for this reaction. (3)

4.5.4 Write down the IUPAC name of compound **Z**. (2)

[18]

QUESTION 5 [START ON A NEW PAGE]

Methanol (CH_3OH) and hydrochloric acid ($HC\ell$) react according to the following balanced equation:

$$CH_3OH(aq) + HC\ell(aq) \rightarrow CH_3C\ell(aq) + H_2O(\ell)$$

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

The rate of the reaction between methanol and hydrochloric acid is investigated. The concentration of $HC\ell(aq)$ was measured at different time intervals. The following results were obtained:

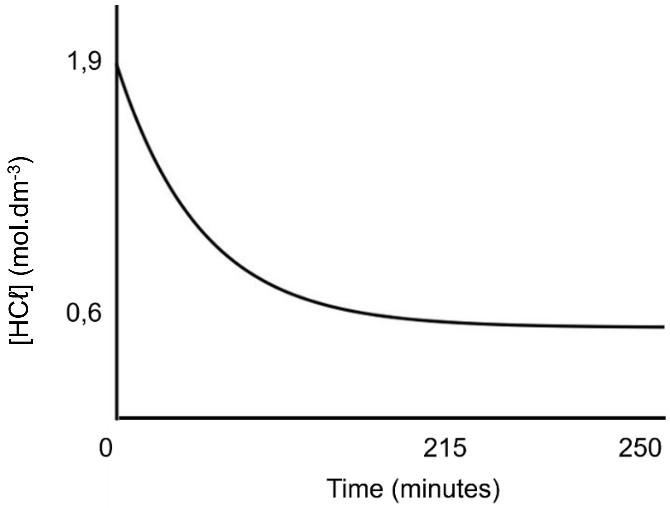
Time (minutes)	$[HC\ell]$ (mol.dm^{-3})
0	1,90
15	1,45
55	1,10
100	0,85
215	0,60
250	0,60

5.2 Calculate the AVERAGE RATE of the reaction during the first 15 minutes in mol·dm^{-3}·min^{-1}. (3)

5.3 Use the COLLISION THEORY to explain why the reaction rate decreases with time. Assume that the temperature remains constant. (3)

5.4 Calculate the mass of $CH_3C\ell(aq)$ in the flask at the 215th minute. The volume of the reagents remains 60 cm^3 during the reaction. (5)

5.5 The SKETCH GRAPH below (only relevant values were used) represents the data in the table. Study the graph and answer the questions.



How will the gradient of the graph change in the following cases? Choose from STEEPER, LESS STEEP or REMAIN THE SAME.

5.5.1 If the temperature was increased? (2)

5.5.2 If the volume of the HCℓ was increased? (2)

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QUESTION 6 [START ON A NEW PAGE]

6.1 A small amount of cobalt chloride powder is dissolved in ethanol resulting in a blue solution. When a few drops of water are carefully added to the blue solution, the colour changes to light pink. The following equilibrium represented by a balanced chemical equation has been established:

$$\underset{\textbf{blue}}{\mathbf{CoC\ell_4^{2-}(aq)}} + \mathbf{6H_2O(\ell)} \rightleftharpoons \underset{\textbf{pink}}{\mathbf{Co(H_2O)_6^{2+}(aq)}} + \mathbf{4C\ell^-(aq)}$$

To investigate some of the factors which affect this equilibrium, the following experiments are performed.

EXPERIMENT 1: A small quantity of concentrated HCℓ is added to the solution.

EXPERIMENT 2: The beaker with the solution is cooled and the solution becomes more pink.

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

6.1.2 What colour change was observed after experiment **1** was performed? (1)

6.1.3 Explain your answer to QUESTION 6.1.2 in terms of how the RATES of the forward and reverse reactions are affected. (2)

6.1.4 From the results of experiment **2**, is the heat of the reaction (∆H) NEGATIVE or POSITIVE? (1)

6.1.5 Use Le Chatelier's Principle to explain the answer to QUESTION 6.1.4. (3)

6.2 When nitrogen monoxide (NO) reacts with oxygen in a closed container, nitrogen dioxide (NO_2) is formed. Consider the balanced equation for the reaction.

$$\mathbf{2NO\ (g) + O_2\ (g) \rightleftharpoons 2NO_2\ (g)}$$

Initially 3,375 mol of NO was inserted in the 0,75 dm^3 flask. When equilibrium was reached at temperature **T**, the concentration of NO_2 was 1,5 $mol{\cdot}dm^{-3}$ and the K_c value 0,125. Calculate the number of OXYGEN ATOMS that were initially inserted in the flask. (7)

[16]

QUESTION 7 [START ON A NEW PAGE]

7.1 Hydrogen sulphate ions (HSO_4^-) react with water according to the following balanced equation:

$$HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons SO_4^{2-}(aq) + H_3O^+(aq) \qquad Ka = 1,3 \times 10^{-2}$$

7.1.1 Define the term *ampholyte*. (2)

7.1.2 Write down the FORMULAE of the TWO ampholytic substances in the equation above. (2)

7.1.3 Explain what the K_a value for this reaction indicates about HSO_4^-. (2)

7.1.4 The concentration of the hydronium ions (H_3O^+) in a 0,5 mol·dm^{-3} solution of HSO_4^- at 25 ºC is 1,8 x 10^{-4} mol·dm^{-3}. Calculate the concentration of the hydroxide ions (OH^-). (3)

7.2 A learner prepares a standard solution with concentration 0,5 mol·dm^{-3} of hydrofluoric acid (HF) to titrate against a sodium hydroxide (NaOH) solution. The balanced chemical equation for the reaction is shown below:

$$HF(aq) + NaOH(aq) \rightarrow NaF(aq) + H_2O(\ell)$$

He/she titrates 0,025 dm^3 of the standard HF solution against the NaOH solution with unknown concentration. 0,083 dm^3 of the NaOH solution neutralises the HF solution.

7.2.1 Calculate the number of moles of HF used. (2)

7.2.2 Calculate the concentration of the NaOH solution. (3)

7.2.3 The learner uses phenolphthalein as an indicator for this reaction. Explain, with the aid of the relevant HYDROLYSIS reaction, why he uses phenolphthalein. (3)

7.3 When sulphuric acid (H_2SO_4) reacts with IMPURE calcium fluoride (CaF_2), a solid, hydrogen fluoride is formed according to the following balanced equation.

$$CaF_2(s) + H_2SO_4(aq) \rightarrow 2HF(g) + CaSO_4(s)$$

0,32 moles of IMPURE CaF_2 yields 0,56 moles of pure HF. What is the percentage purity of the CaF_2? (4)

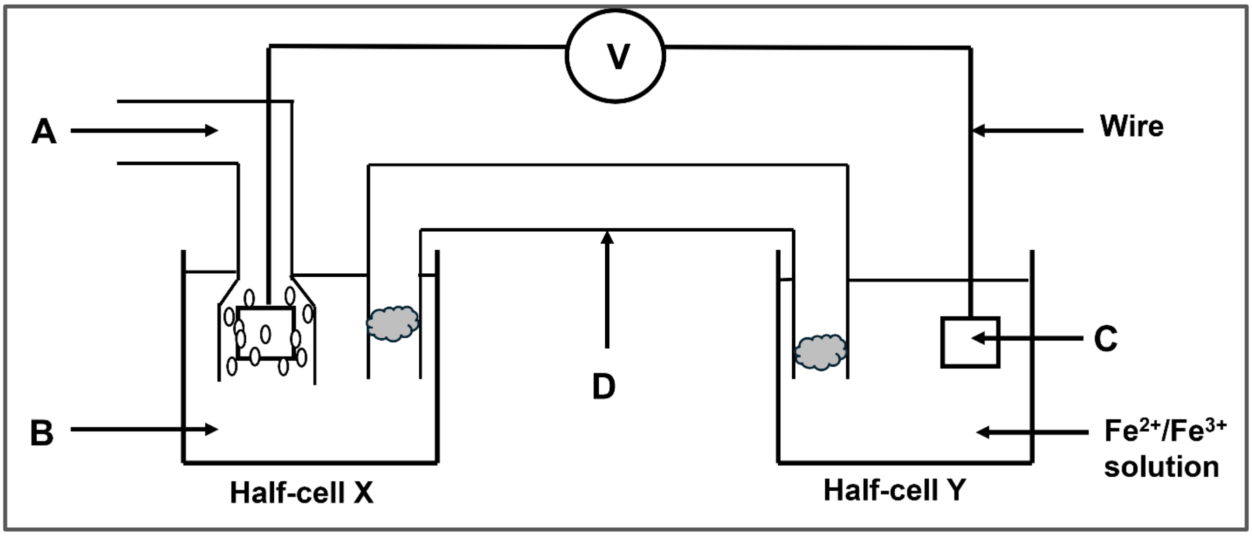
[21]

QUESTION 8 [START ON A NEW PAGE]

Chlorine gas ($C\ell_2$) and iron(II) (Fe^{2+}) ions react in an aqueous solution as follows:

$$\mathbf{C\ell_2(g) + 2Fe^{2+}(aq) \rightarrow 2C\ell^{-}(aq) + 2Fe^{3+}(aq)}$$

The diagram below shows a galvanic cell used to determine the cell potential (E^{θ}_{cell}) for the above reaction under standard conditions.



8.1 Write down the CHEMICAL FORMULAE of the substances **A**, **B** and **C**. (3)

8.2 Write down the name of component **D**. (1)

8.3 State the energy conversion that takes place in this cell. (1)

8.4 Write down the cell notation for this cell. (2)

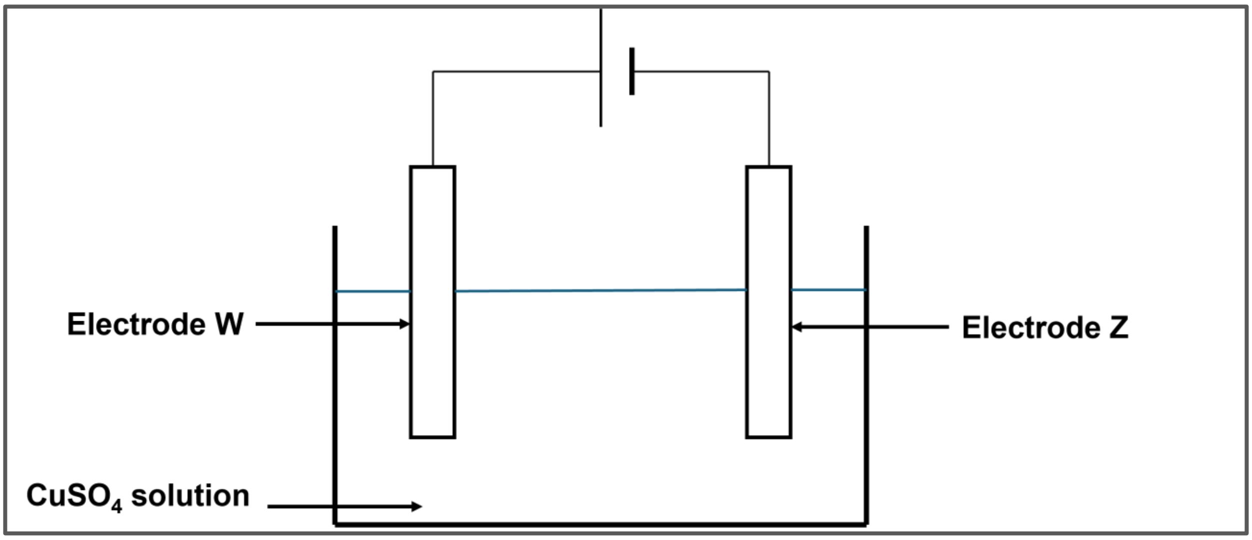
8.5 Calculate the initial cell potential (E^{θ}_{cell}) of this cell. (4)

8.6 Iron(III)hydroxide ($Fe(OH)_3$) is far less soluble than iron(II)hydroxide ($Fe(OH)_2$). Make use of Le Chatelier's Principle to explain how the emf of the cell will be affected if some sodium hydroxide (NaOH) is added to the Fe^{2+}/Fe^{3+} half-cell. (3)

[14]

QUESTION 9 [START ON A NEW PAGE]

The simplified diagram below represents an electrolytic cell used to purify copper. One of the electrodes will be made of pure copper, while the other electrode will consist of the impure copper with impurities such as silver and platinum.



9.1 Define the term *electrolyte*. (2)

9.2 Which electrode, **W** or **Z**, consists of the impure copper? (1)

9.3 Write down the half-reaction that takes place at electrode **Z**. (2)

9.4 During purification, metals such as silver (Ag) and platinum (Pt) form sludge (mud) at the bottom of the container. Refer to the relative strengths of REDUCING AGENTS to explain why these two metals (Ag and Pt) do not form ions during the purification process. (3)

9.5 54 040 C of charge (pure copper) is deposited on the electrode in 1 hour. Calculate the current required to realise this. (3)

[11]

GRAND TOTAL: [150]

DATA SHEET FOR PHYSICAL SCIENCES
INLIGTINGSBLAD VIR FISIESE WETENSKAPPE
PAPER 2 (CHEMISTRY)
VRAESTEL 2 (CHEMIE)

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

NAME / *NAME*	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 'n elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro se 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 $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^{+}]$
$K_w = [H_3O^{+}][OH^{-}] = 1 \times 10^{-14}$ at 298K	
$E^{\theta}_{cell/sel} = E^{\theta}_{cathode/katode} - E^{\theta}_{anode}$ Or/ of $E^{\theta}_{cell/sel} = E^{\theta}_{reduction/reduksie} - E^{\theta}_{oxidaton/oksidasie}$ Or/ of $E^{\theta}_{cell/sel} = E^{\theta}_{oxidising\ agent/\ oksideermiddel} - E^{\theta}_{reducing\ agent/\ reduseermiddel}$	

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)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3.0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1.5 22 Ti 48	1.6 23 V 51	1.6 24 Cr 52	1.5 25 Mn 55	1.8 26 Fe 56	1.8 27 Co 59	1.8 28 Ni 59	1.9 29 Cu 63,5	1.6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2.0 33 As 75	2.4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1.4 40 Zr 91	41 Nb 92	1.8 42 Mo 96	1.9 43 Tc	2.2 44 Ru 101	2.2 45 Rh 103	2.2 46 Pd 106	1.9 47 Ag 108	1.7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2.1 52 Te 128	2.5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1.6 72 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1.8 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 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 oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*

TABLE 4B: STANDARD REDUCTION POTENTIALS / *TABEL 4B: STANDAARD REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*