Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2022

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 21 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME 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 sub questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. 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. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The name of the functional group of propanoic acid is ...

A formyl.

B carboxyl.

C carbonyl.

D hydroxyl. (2)

1.2 Which ONE of the following is the CORRECT name for the addition reaction of water to an alkene?

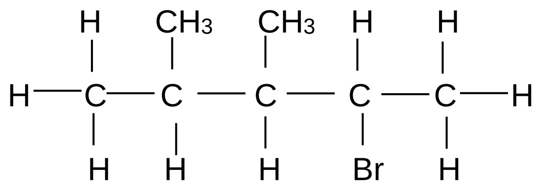
A hydration

B hydrolysis

C dehydration

D hydrohalogenation (2)

1.3 Consider the compound shown below:



The CORRECT IUPAC name of the above compound is:

A 4-bromo-2,3-dimethylpentane

B 2-bromo-3,4-dimethylpentane

C 2,3-dimethyl-4-bromopentane

D 3,4-dimethyl-2-bromopentane (2)

1.4 Which ONE of the following organic molecules will react rapidly with bromine water?

A CH_3CH_2OH

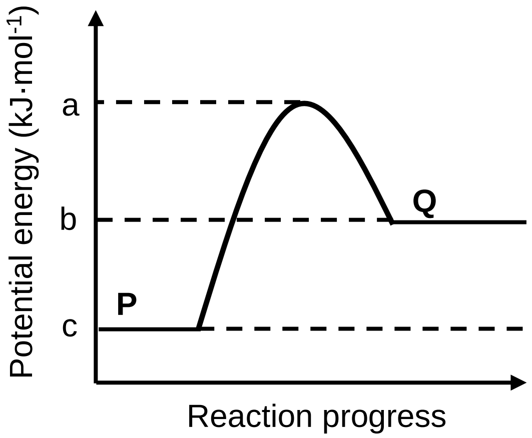
B CH_3CH_3

C CH_2CH_2

D $CH_3CH_2CH_3$ (2)

1.5 Consider the potential energy profile below for the following hypothetical reaction:

$$P \rightleftharpoons Q$$



Which ONE of the following combinations correctly indicates both the activation energy and the heat of reaction (ΔH) for the REVERSE REACTION?

	Activation energy ($kJ{\cdot}mol^{-1}$)	Heat of reaction (ΔH)
A	**a – b**	**b – c**
B	**b – a**	**a – c**
C	**a – b**	**c – b**
D	**b – c**	**a – b**

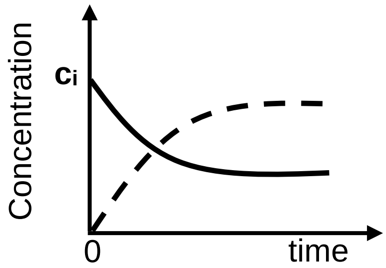
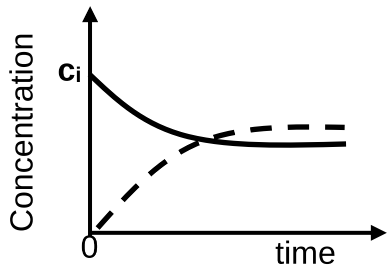
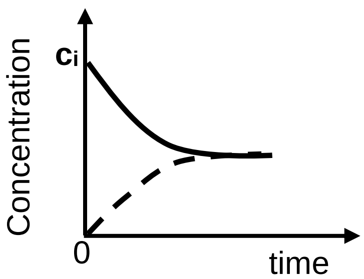
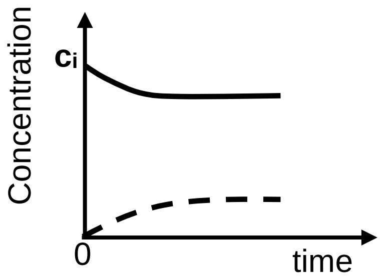
(2)

1.6 H_2S (g) decomposes according to the following balanced equation:

$$H_2S\ (g) \rightleftharpoons H_2\ (g) + S\ (s)$$

In each of four separate experiments, **A** to **D**, H_2S of initial concentration $\mathbf{c_i}$ is placed in identical empty flasks which are then sealed and heated. The graphs below display the results of the experiments **A** to **D**.

Which experiment has the largest K_c value?

A		B	
C		D	

(2)

1.7 The reaction below represents the general equation for the reaction of an acid-base indicator.

$$\underset{\text{yellow}}{HIn\ (aq)} + H_2O\ (\ell) \rightleftharpoons H_3O^+\ (aq) + \underset{\text{blue}}{In^-\ (aq)}$$

In which ONE of the following salt solutions will this indicator turn yellow?

A $KC\ell(aq)$

B $NH_4C\ell(aq)$

C $NaHCO_3(aq)$

D $CH_3COONa(aq)$ (2)

1.8 The function of a salt bridge in a galvanic cell is to …

A allow for the movements of protons.

B allow for the movements of electrons.

C provide a site for reduction to occur.

D ensure electrical neutrality of solutions. (2)

1.9 Which ONE the substances can act as an ampholyte in some reactions?

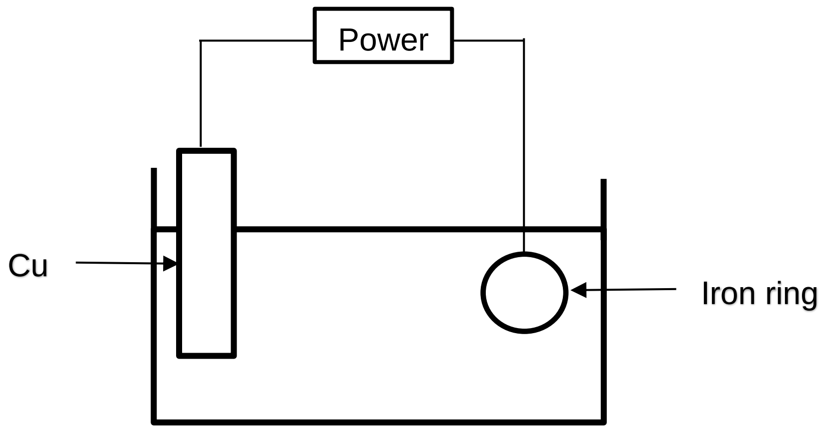
A CH_3COO^-

B HSO_4^-

C H_3O^+

D NH_4^+ (2)

1.10 The electrolytic cell below is used during the electroplating of an iron ring with copper.



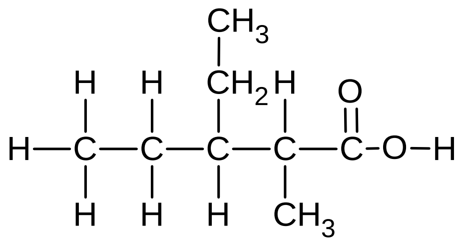
Which ONE of the following combinations is CORRECT about the ions in the electrolyte when the cell is operating?

	Concentration	Positive ions
A	Remain constant	Cu^{2+}
B	Remain constant	Fe^{2+}
C	Increases	Fe^{3+}
D	Increases	Cu^{2+}

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **D** in the table below represent four organic compounds that belong to different homologous series.

A 2-methylpropanal	**B** 
C $CH_3C \equiv CCH_2CH_3$	**D** Pentane

2.1 Define the term *homologous series.* (2)

2.2 Write down the:

2.2.1 Letter that represents a saturated hydrocarbon (1)

2.2.2 General formula of the homologous series to which compound **C** belongs (1)

2.2.3 Structural formula of compound **A** (2)

2.3 Write down the IUPAC name of compound **B**. (3)

2.4 Compound **D** has three structural isomers.

Write down the:

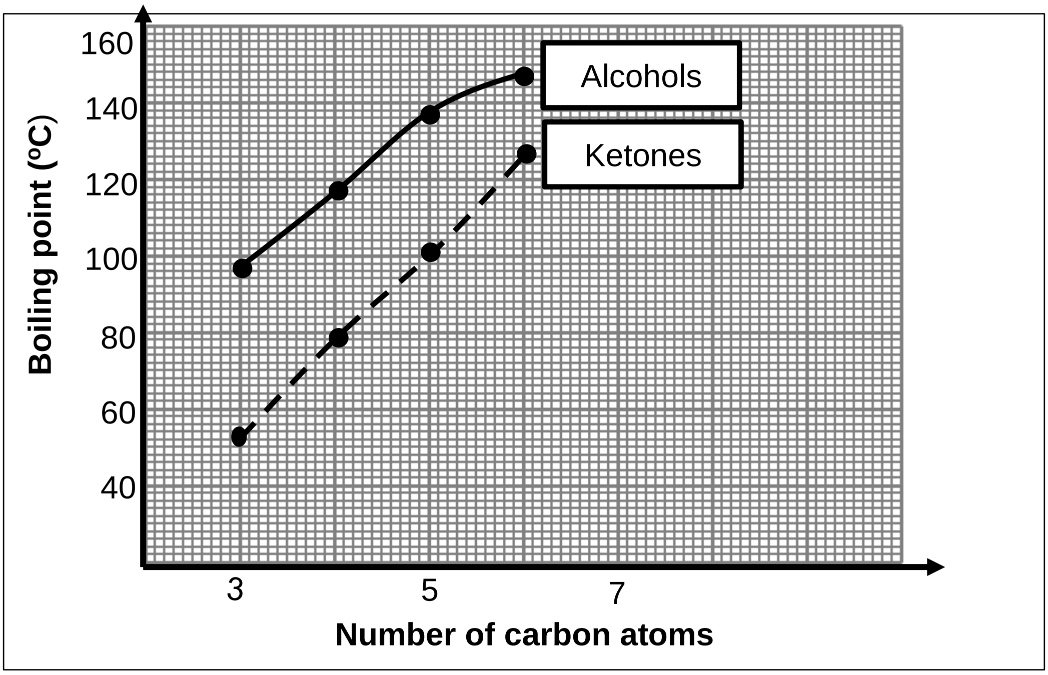
2.4.1 Structural formula of the isomer with the shortest chain (3)

2.4.2 Balanced equation for the combustion reaction of compound **D** in EXCESS oxygen using molecular formulae (3)

[15]

QUESTION 3 (Start on a new page.)

3.1 The graphs below show the boiling points of straight chain primary alcohols and straight chain ketones with different number of carbon atoms.



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

3.1.2 Explain why the boiling points of alcohols increase as the number of carbon atoms increase by referring to TYPE and STRENGTH of intermolecular forces only. (2)

3.1.3 Explain why the curve of the alcohols is higher than that of the ketones.

Refer to the TYPE and STRENGTH of intermolecular forces involved. (3)

The vapour pressure of the alcohol is compared to that of a ketone at the same temperature.

3.1.4 Why must the alcohol and ketone which are used for the comparison have the same number of carbon atoms? (1)

3.1.5 Which ONE will have a higher vapour pressure: ALCOHOL or KETONE?

Give a reason for the answer by referring to the data in the graph. (2)

3.2 The boiling points of propanoic acid and propan-1-ol are compared.

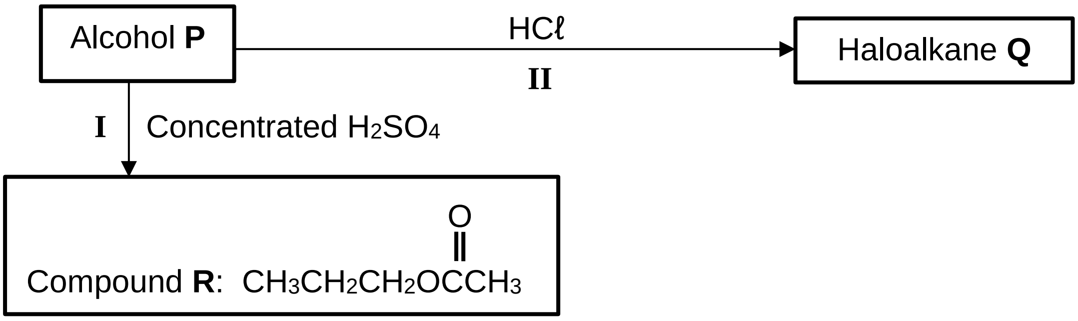
3.2.1 Which compound has the higher boiling point? (1)

3.2.2 Explain the answer to QUESTION 3.2.1 by referring to TYPE, STRENGTH of intermolecular forces and ENERGY. (3)

[14]

QUESTION 4 (Start on a new page.)

4.1 Compound **P** can be used to prepare organic compounds **R** and **Q** as shown in the flow diagram below.



In reaction **I,** alcohol **P** reacts with another organic compound in the presence of concentrated sulphuric acid.

4.1.1 Name the type of reaction represented by **I**. (1)

4.1.2 Besides the presence of a catalyst write down another reaction condition for reaction **I.** (1)

Write down the:

4.1.3 Structural formula of alcohol **P** (2)

4.1.4 IUPAC name of compound **R** (2)

4.1.5 IUPAC name of a straight chain FUNCTIONAL isomer of compound **R** (2)

For reaction **II** write down the:

4.1.6 Type of reaction taking place (1)

4.1.7 Formula of the inorganic product (1)

4.1.8 Condensed structural formula of compound **Q** (2)

4.2 A primary alcohol that contains 3 carbon atoms is converted to a secondary alcohol in a TWO step process as shown in the flow diagram below:

$$\boxed{\text{Primary alcohol}} \xrightarrow[\mathbf{P}]{\text{STEP 1}} \boxed{\text{Compound } \mathbf{Q}} \xrightarrow{\text{STEP 2}} \boxed{\text{Secondary alcohol}}$$

P is an inorganic reagent while compound **Q** is an organic compound.

Write down the:

4.2.1 Formula of reagent **P** (2)

4.2.2 One reaction condition for the reaction in STEP 2 (1)

4.2.3 A balanced equation for the reaction in STEP 2 by using structural formulae for the organic compounds. (5)

[20]

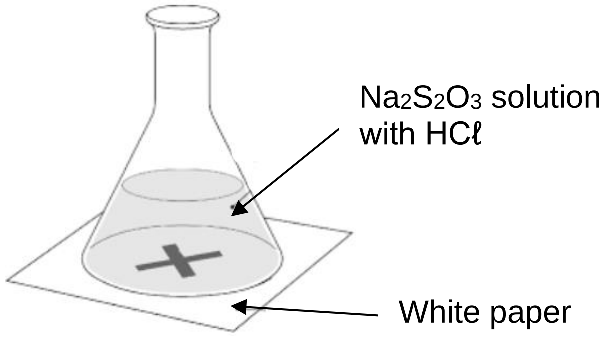
QUESTION 5 (Start on a new page.)

The reaction between sodium thiosulphate ($Na_2S_2O_3$) and EXCESS hydrochloric acid ($HCℓ$) is used to investigate the effect of concentration and temperature on the rate of reaction.

The balanced equation for this reaction is:

$$Na_2S_2O_3\ (aq) + 2\ HCℓ \rightarrow 2\ NaCℓ\ (aq) + S\ (s) + SO_2\ (g) + H_2O\ (ℓ)$$

An Erlenmeyer flask is placed on a white paper marked with a light cross on it. The time taken for the visibility of the cross (X) to disappear is measured. See the diagram below.



NOTE: The same volume of $Na_2S_2O_3$ solution was used for all three reactions.

The table below shows the reaction conditions.

Exp	Concentration of $Na_2S_2O_3$	Concentration of $HCℓ$ ($mol{\cdot}dm^{-3}$)	Temperature (°C)	Volume of $HCℓ$ (cm^3)
1	0,05	2	25	25
2	0,05	1	25	25
3	0,05	2	40	25

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

5.2 Write down the name of the independent variable for the comparison of experiment **1** and **2**. (1)

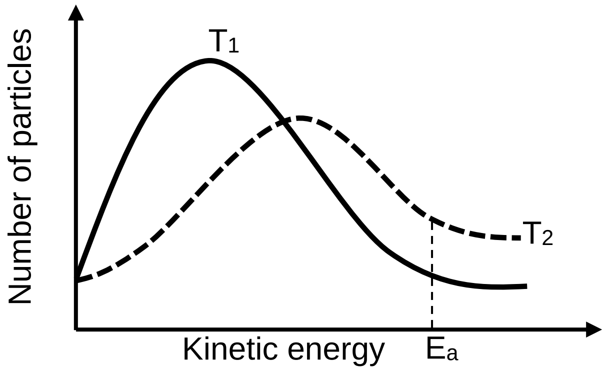
5.3 How will the amount of sulphur (S) formed in experiment **1** compare to the amount of sulphur (S) produced in experiment **2** at the completion of the reaction?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO.

Give a reason for the answer. (2)

5.4 Experiments **1** and **3** are now compared.

The Maxwell-Boltzmann energy distribution curves for Experiments **1** and **3** are shown below**.**



5.4.1 Which experiment **1** or **3** is represented by curve $\mathbf{T_2}$? (1)

5.4.2 Explain the answer to QUESTION 5.4.1 by referring to the collision theory. (3)

5.4.3 Sketch the curve of $\mathbf{T_2}$ ONLY in the answer book and indicate the effect that a catalyst would have on E_a**.**

Indicate the new activation energy as **X** on the graph. (2)

5.5 0,7118 g of $Na_2S_2O_3$ reacted completely with HCℓ in **experiment 1** in 34 s.

Calculate the rate at which HCℓ reacted in **experiment 1** in mol·s^{-1}. (5)

The volume of HCℓ used in **experiment 1** is now **doubled**. All other reaction conditions remain the same.

5.6 How would the reaction rate be affected by the change in volume?

Choose from INCREASES, DECREASES or REMAIN THE SAME. (1)
[17]

QUESTION 6 (Start on a new page.)

6.1 The following reversible reaction can be used to demonstrate how certain factors influence chemical equilibrium:

$$\underset{\text{Blue}}{CoC\ell_4^{2-}\ (aq)} + 6\ H_2O\ (\ell) \rightleftharpoons \underset{\text{Pink}}{Co(H_2O)_6^{2+}\ (aq)} + 4\ C\ell^-\ (aq)$$

6.1.1 Define the term *reversible reaction.* (2)

Initially, the solution is **BLUE**.

Write down either TURNS MORE BLUE or TURNS MORE PINK to describe what happens to the reaction mixture if some:

6.1.2 $CoC\ell_4^{2-}$ is added (1)

6.1.3 Concentrated $HC\ell$ is added (1)

The test tube containing the reaction mixture is placed in a hot water bath. It is observed that the solution becomes more blue.

6.1.4 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

6.1.5 Explain the answer to QUESTION 6.1.4 by referring to Le Chatelier's principle. (2)

6.2 $3{,}01 \times 10^{23}$ molecules of N_2O_4 are sealed into a 4 dm^3 container and then heated to 400 K.

The following balanced equation represents the reaction that reaches equilibrium in the container at 400 K.

$$N_2O_4\ (g) \rightleftharpoons 2\ NO_2\ (g)$$

At equilibrium, it is found that 0,4 mol of N_2O_4 have decomposed to NO_2

Calculate the equilibrium constant (K_c) at 400 K. (8)

[15]

QUESTION 7 (Start on a new page.)

7.1 The equations below show the reactions occurring in hydrochloric acid ($HC\ell$) and ethanoic acid (CH_3COOH) solutions. Both acids have a concentration of 1 mol·dm^{-3}, and are kept at a temperature of 25° C.

I: $HC\ell\ (aq) + H_2O\ (\ell) \rightleftharpoons C\ell^-\ (aq) + H_3O^+\ (aq)$ $K_a = 1{,}3 \times 10^6$

II: $CH_3COOH\ (aq) + H_2O\ (\ell) \rightleftharpoons CH_3COO^-\ (aq) + H_3O^+\ (aq)$ $K_a = 1{,}8 \times 10^{-5}$

7.1.1 Define an *acid* according to the Lowry-Brønsted theory. (2)

7.1.2 Write down ONE conjugate acid pair-base pair in reaction **I**. (2)

7.1.3 Which solution, **I** or **II**, will have the lower pH value?

Explain the answer. (3)

7.2 10 cm^3 of a 1 mol·dm^{-3} sodium hydroxide ($NaOH$) solution is diluted with water until its pH is 13.

7.2.1 Calculate the number of moles of NaOH in the 10 cm^3 of the initial solution. (3)

7.2.2 Calculate the volume of the diluted solution in dm^3. (5)

All of the diluted sodium hydroxide solution is poured into a burette. During a titration, 15 cm^3 of oxalic acid of concentration 0,09 mol·dm^{-3} is exactly neutralised by a certain volume of the diluted sodium hydroxide solution.

The balanced equation for the reaction is:

$$2\ NaOH\ (aq) + H_2C_2O_4\ (aq) \rightarrow Na_2C_2O_4\ (aq) + 2\ H_2O\ (\ell)$$

7.2.3 Calculate the volume of the diluted sodium hydroxide that is left in the burette after the titration. (5)

[20]

QUESTION 8 (Start on a new page.)

A galvanic cell is set up under standard conditions using half-cells **A** and **B** shown below.

Half-cell **A**: $Cu(s)/Cu^{2+}(aq)$ Half-cell **B**: $H_2O(\ell)$ /$O_2(g)$/ $H^+(aq)$

8.1 Define *oxidation* in terms of electron transfer. (2)

8.2 Write down the:

8.2.1 Initial concentration of the $H^+(aq)$ solution in half-cell **B** (1)

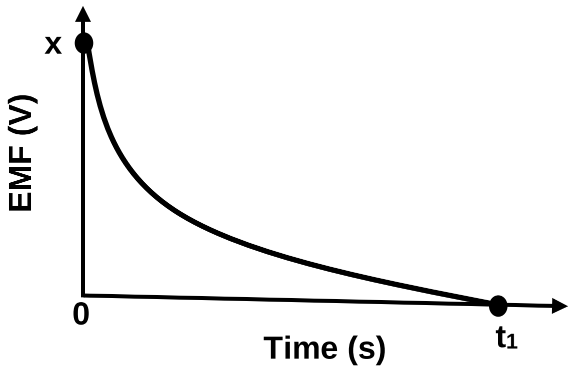
8.2.2 Name of the metal used as the electrode in half-cell **B** (1)

8.2.3 Formula of the reducing agent (1)

8.2.4 Reduction half reaction (2)

8.2.5 Balanced ionic equation for the overall cell reaction (3)

8.3 The graph below shows the EMF of this cell against time.



8.3.1 Calculate the value of **x** on the graph. (4)

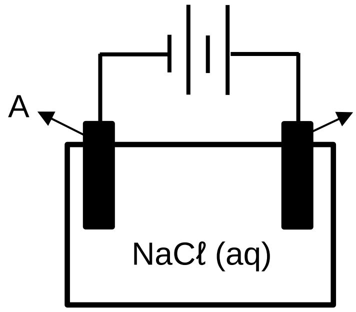
8.3.2 Explain the decrease in the EMF of the cell as time proceeds. (2)

8.3.3 What has happened to the reaction in the cell at time **t_1**? (1)

[17]

QUESTION 9 (Start on a new page.)

9.1 The diagram represents the apparatus used in the electrolysis of a concentrated NaCℓ solution. **A** and **B** are two carbon electrodes.



9.1.1 Define an *electrolytic cell.* (2)

9.1.2 Write down the half reaction that occurs at electrode **B**. (2)

Gas bubbles are observed at the cathode of the cell.

9.1.3 Write down the NAME or FORMULA of the gas formed at the cathode. (1)

9.1.4 Refer to the relative strengths of the oxidising agents to explain why the gas in QUESTION 9.1.3 and not Na, is formed at the cathode. (2)

9.2 An electrolytic cell is using an impure copper electrode consisting of 95% Cu and a pure copper electrode. Copper (II) chloride ($CuCℓ_2$) solution is used as the electrolyte.

9.2.1 Is the pure copper the ANODE or CATHODE? (1)

9.2.2 When all the copper in the impure copper electrode has been deposited on the copper electrode, it is found that 6 mol of electrons were transferred.

Calculate the initial mass of the IMPURE copper electrode. (4)
[12]

TOTAL: 150

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

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*

NAAM/*NAME*	SIMBOOL/*SYMBOL*	WAARDE/*VALUE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^{5}$ Pa
Molar gas volume at STP *Molêre gasvolume teen 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 se konstante	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$ or/of $n = \frac{N}{N_A}$ or/of $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1x10^{-14}$ at /by 298K
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$		

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

KEY/ *SLEUTEL*

Elektronegatiwiteit Electronegativity	*Atoomgetal* Atomic number	*Simbool* Symbol	*Benaderde relatiewe atoommassa* Approximate relative atomic mass
1,9	29	Cu	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 oxidising ability/*Toenemende oksiderende vermoë*

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

Increasing reducing ability/*Toenemende reduserende vermoë*

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

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