

education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE



GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

SEPTEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets

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INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two 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. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a MINIMUM of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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QUESTION 1 : MULTIPLE-CHOICE QUESTIONS

Four 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 number (1.1 – 1.10) in the ANSWER BOOK, for example, 1.11 E.

1.1 Which ONE of the homologous series below contains a formyl group?

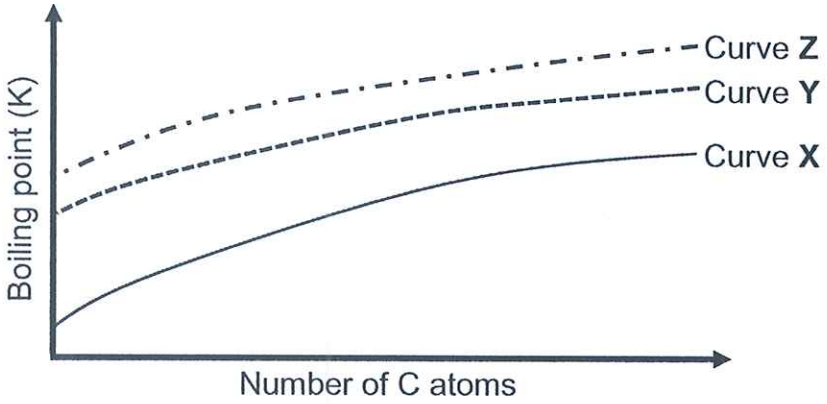
A Esters

B Carboxylic acid

C Aldehydes

D Ketones (2)

1.2 The relationship between the chain length of straight chain organic molecules of carboxylic acids, aldehydes, and primary alcohols and boiling points is investigated. Curves **X**, **Y** and **Z** are obtained.



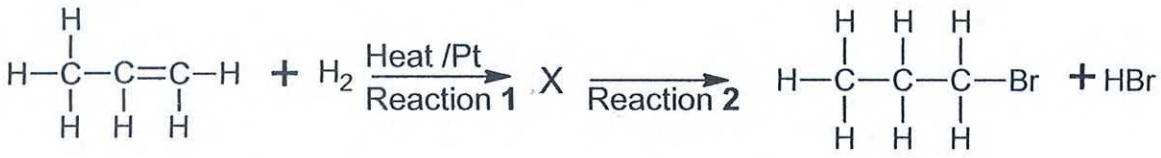
Which ONE of the following CORRECTLY identifies the homologous series against the chain length of the organic molecules

	Curve **X**	Curve **Y**	Curve **Z**
A	Carboxylic acids	Alcohols	Aldehydes
B	Alcohols	Carboxylic acids	Aldehydes
C	Carboxylic acids	Aldehydes	Alcohols
D	Aldehydes	Alcohols	Carboxylic acids

(2)

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1.3 Consider the reaction **1** and **2** below. Compound **X** is an organic compound.



What type of reaction is REACTION 2?

A Halogenation

B Hydrolysis

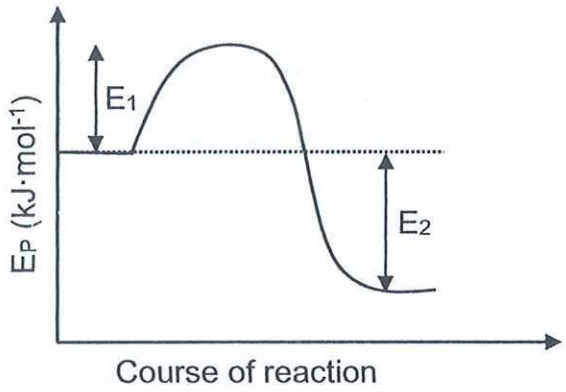
C Hydration

D Hydrohalogenation

(2)

1.4 Consider the potential energy diagram for a reversible hypothetical reaction represented by the balanced equation below.

$$X_2(g) \rightleftharpoons 2X(g)$$



The sum of (E_1 + E_2) is equal to the …

A energy of the activated complex.

B activation energy for the reverse reaction.

C activation energy for the forward reaction.

D ΔH for the forward reaction. (2)

1.5 Consider the chemical reaction represented by the balanced equation below:

$$Zn(s) + 2HC\ell(aq) \rightarrow ZnC\ell_2(aq) + H_2(g)$$

Which ONE of the following changes will DECREASE the rate of production of $H_2(g)$?

A Decrease in pressure

B Increase in volume of $HC\ell(aq)$

C Increase in concentration of $HC\ell(aq)$

D Decrease in temperature (2)

1.6 One of the stages in the industrial preparation of iron from its ore is represented by the equilibrium equation below:

$$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(s) + 3CO_2(g)$$

Which ONE of the following changes will favour the forward reaction?



A Fe is removed

B CO_2 is removed.

C CO is removed

D A suitable catalyst is added (2)

1.7 The table below shows pH ranges of some indicators.

INDICATORS	pH RANGES
Methyl orange	3,1 – 4,4
Methyl red	4,2 – 6,2
Bromothymol blue	6,0 – 7,8
Phenolphthalein	8,3 – 10,0

The indicator best suited for the titration of ethanoic acid against a solution of sodium hydroxide, is ...

A Methyl orange

B Methyl red

C Bromothymol blue

D Phenolphthalein (2)

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1.8 Sulphuric acid, $H_2SO_4(aq)$ ionises in water according to the following balanced equation:

$$H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons HSO_4^-(aq) + H_3O^+(aq)$$

Which ONE is the correct conjugate acid-base pair for this reaction:

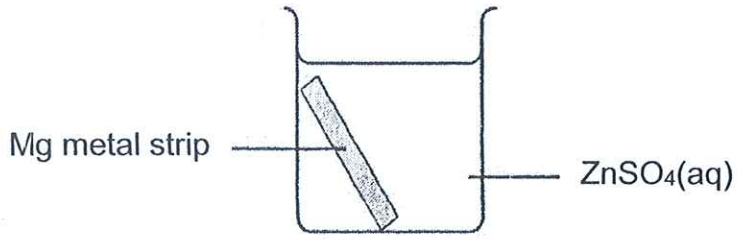
A H_2SO_4 and H_2O

B H_2SO_4 and H_3O^+

C H_2SO_4 and HSO_4^-

D HSO_4^- and H_3O^+ (2)

1.9 A strip of magnesium metal is placed in a zinc sulphate ($ZnSO_4$) solution.



The reaction that takes place is represented by the balanced equation below:

$$Mg(s) + ZnSO_4(aq) \rightarrow MgSO_4(g) + Zn(s)$$

Which ONE of the following statements is correct?

A Zn is the oxidising agent.

B Mg is the reducing agent.

C Mg is reduced.

D Zn is oxidised. (2)

1.10 A solution of copper (II) chloride ($CuC\ell_2$) must be stored in a metal container. Which ONE of the following metals should the container be made of?

A Ag

B Zn

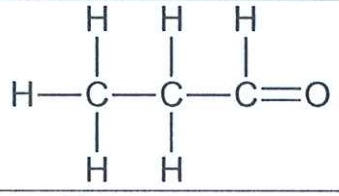
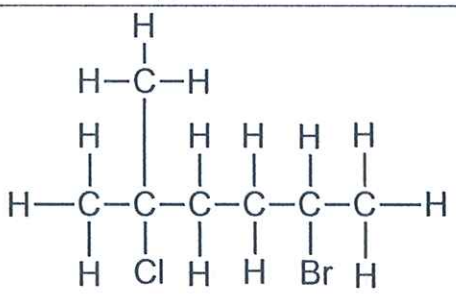
C Mg

D Fe (2)

[20]

QUESTION 2 (Start on a new page)

Consider the following six organic compounds represented by letters **A** to **F**.

A	$CH_3CH(CH_3)COCH(CH)_3CH_2CH_3$	**B**	2,2-dimethylpentan-3-ol
C		**D**	C_5H_{10} 
E		**F**	CH_3COOH

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

2.2 Write down the:

2.2.1 STRUCTURAL FORMULA of the FUNCTIONAL GROUP of compound **A** (1)

2.2.2 LETTER that represents a carboxylic acid (1)

2.2.3 IUPAC name of compound **E** (3)

2.2.4 IUPAC name for the FUNCTIONAL ISOMER of compound **C** (1)

2.2.5 Homologous series to which Compound **A** belong (1)

2.2.6 Draw the STRUCTURAL FORMULA of compound **B** (3)

2.2.7 Is compound **B** a PRIMARY, SECONDARY or TERTIARY alcohol? (1)

2.3 Consider compound **D**.

2.3.1 Is the compound SATURATED or UNSATURATED? Give a reason for the answer. (2)

2.3.2 Write down the NAME of a solution that can be used to test whether the compound is saturated or unsaturated. (1)

2.3.3 Write down the general formula of a saturated hydrocarbon (1)
[17]

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QUESTION 3 (Start on a new page)

The boiling points of FIVE organic compounds, represented by the letters **A** to **E**, are given in the table below.

	COMPOUNDS	BOILING POINT (°C)
A	Ethane	– 88,6
B	Butane	– 1
C	Methylpropane	– 11,7
D	Pentan-1-ol	97
E	Butanoic acid	163,5

3.1 An unknown STRAIGHT CHAIN ALKANE has a boiling point of -42 °C. Write down the NAME of this alkane using the information in the table above. (1)

3.2 Compounds **B** and **C** are structural isomers

3.2.1 Define the term *structural isomer*. (2)

3.2.2 What type of structural isomers are compound **B** and **C**? (1)

3.2.3 Explain why Compound **B** has a higher boiling point than Compound **C**. (3)

3.3 Compounds **D** and **E** have the same molecular mass but different vapour pressure.

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

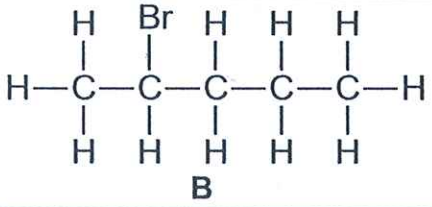
3.3.2 Which compound, **D** or **E**, has the higher vapour pressure? (1)

3.3.3 Fully explain the answer in QUESTION 3.3.2. (4)
[14]

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QUESTION 4 (Start on a new page)

4.1 Consider the following organic reactions **I** to **V** involving organic compounds.

I	**A** + HBr ⟶  **B**
II	**B** + concentrated NaOH → **C** (main product) + NaBr + **D**
III	**A** + **D** $\xrightarrow[H_3PO_4]{\text{Dilute}}$ **E**
IV	$C_5H_{12} \xrightarrow[\text{high pressure}]{600\ ^\circ C} C_3H_6$ + **F**

Write down the:

4.1.1 Name of the types of reactions represented by reaction **I** to **IV**. (4)

4.1.2 The IUPAC name of compound **B**. (2)

4.1.3 Homologous series to which compound **C** belong? (1)

4.1.4 Name or formula of the INORGANIC product **D** of reaction **II** (1)

4.1.5 STRUCTURAL FORMULA of compound **E** (2)

4.1.6 NAME and MOLECULAR FORMULA of compound **F** (2)

4.2 A group of learners in a school laboratory are preparing an ester using methanol and ethanoic acid. The balanced chemical equation for this reaction is given below:

$$CH_4O + C_2H_4O_2 \xrightarrow{H_2SO_4(conc)} C_3H_6O_2 + H_2O$$

4.2.1 Write down the IUPAC name of the ester formed. (2)

4.2.2 Give ONE function of the concentrated sulphuric acid in this reaction. (1)

4.2.3 When impure methanol completely reacts with excess ethanoic acid, 68,88 g $C_3H_6O_2$ is produced The percentage purity of methanol is 60%, calculate the mass of the impure methanol. (5)

[20]

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QUESTION 5 (Start on a new page.)

A group of learners use the reaction of the decomposition of hydrogen peroxide to investigate one of the factors that affect the rate of a chemical reaction. The balanced equation for the reaction is given below.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

The learners collect the oxygen gas by the downward displacement of water. Four experiments are carried out.

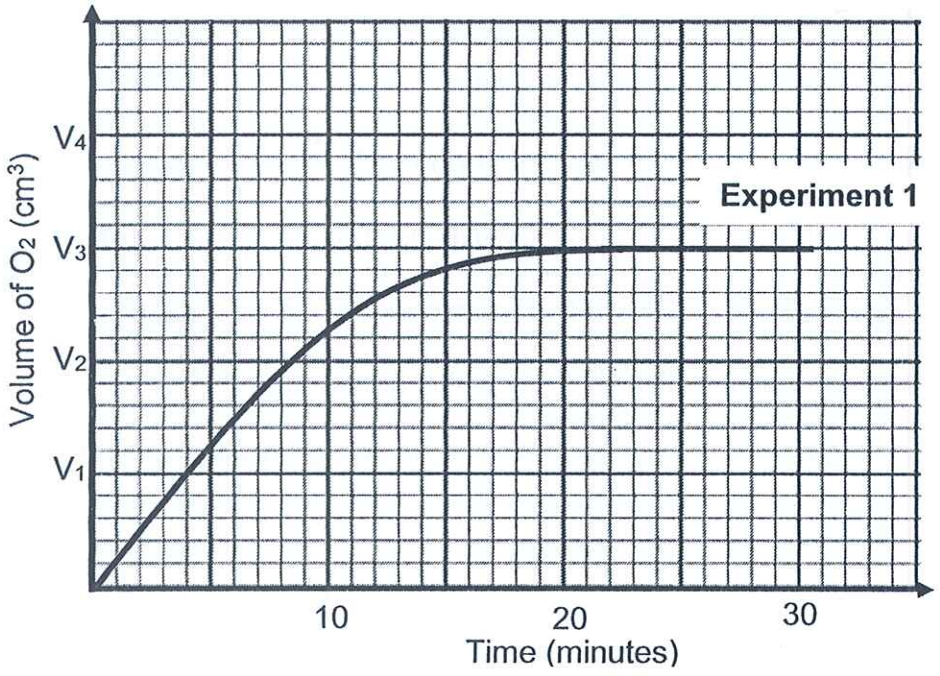
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5.1 Define the term *reaction rate*. (2)

The reaction conditions for each experiment **1** and **2** are summarised in the table below:

	Volume of H_2O_2 (cm^3)	**Concentration of H_2O_2 ($mol \cdot dm^{-3}$)**	**Temperature (°C)**
Experiment 1	40	x	25
Experiment 2	40	x	40

The results of experiment **1** are shown in the graph below.



5.2 For this investigation write down the dependent variable. (1)

5.3 What can be deduced from the graph regarding the RATE OF THE REACTION during the time interval:

5.3.1 10 minutes to 17 minutes (1)

5.3.2 20 minutes to 30 minutes (1)

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5.4 The average rate of the production of oxygen gas in experiment **1** is 10 $cm^3 \cdot min^{-1}$. Use the information on the graph to calculate the initial concentration of the hydrogen peroxide (H_2O_2) used. Take the molar gas volume at 25 °C as 24 000 cm^3. (5)

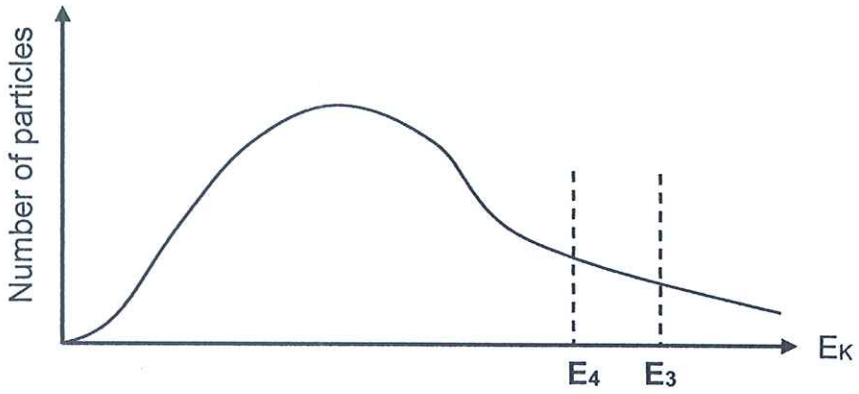
5.5 Copy the graph of EXPERIMENT **1** in your answer book. On the same set of axes, draw the graph for EXPERIMENT **2**. Assume this reaction goes to completion. (2)

5.6 In another Investigation, EXPERIMENT **1** is repeated under the same conditions, but MnO_2 is added to the reaction mixture.

The reaction conditions for each experiment **3** and **4** are summarised in the table below:

	Volume of H_2O_2 (cm^3)	**Temperature (°C)**	**MnO_2**
Experiment 3	40	25	absent
Experiment 4	40	25	present

The Maxwell-Boltzmann distribution curve for the hydrogen peroxide molecules in EXPERIMENT **3** is shown below. **E_3** and **E_4** represent the activation energy for experiment **3** and **4** respectively.



5.6.1 What is the function of MnO_2 in EXPERIMENT **4**? (1)

5.6.2 Use the collision theory to explain the effects of the MnO_2 on the reaction rate in EXPERIMENT 4. (3)
[16]

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QUESTION 6 (Start on a new page)

10 g of hydrogen gas and 355 g of chlorine gas are heated together in a sealed 500 cm^3 container. A chemical equilibrium is reached at 450 °C. The balanced equation for the reaction is:

$$H_2(g) + C\ell_2(g) \rightleftharpoons 2HC\ell(g)$$

The equilibrium constant K_c for this reaction at 450 °C is 64.

6.1 Calculate the mass of chlorine gas present at equilibrium. (9)

The reaction is now carried out at a lower temperature. It is found that the K_c value increases.

6.2 Is the heat of the reaction (ΔH) POSITIVE or NEGATIVE? Use Le Chatelier's principle to explain the answer (4)

6.3 The pressure of the container is increased without affecting the temperature. How would the following be affected?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The yield of $HC\ell$ (1)

6.3.2 The K_c value (1)

[15]

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QUESTION 7 (Start on a new page)

7.1 A laboratory technician prepares the following two dilute sulphuric acid solutions:

Solution **A**: 0,20 mol·dm^{-3} H_2SO_4

Solution **B**: 0,30 mol·dm^{-3} H_2SO_4

7.1.1 Explain the meaning of the term *dilute acid* (2)

7.1.2 Give a reason why sulphuric acid is classified as a *strong acid*. (2)

7.1.3 Sulphuric acid ionises in water according to the following equation:

$$H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons HSO_4^-(aq) + H_3O^+(aq)$$

Write down the conjugate base of sulphuric acid (1)

7.1.4 Calculate the pH of solution **A** at 25 °C. (3)

7.2 A few crystals of sodium carbonate (Na_2CO_3) are added to water in a test tube.

7.2.1 Is the solution in the test tube ACIDIC, BASIC or NEUTRAL? (1)

7.2.2 Use a balanced ionic equation to explain the answer in QUESTION 7.2.1. (3)

7.3 7,6 g of impure commercial washing soda ($Na_2CO_3 \cdot 10H_2O$) is dissolved in 500 cm^3 of water. 25 cm^3 of this solution is titrated with a standard HCℓ solution of concentration 0,1 mol·dm^{-3}.

$$Na_2CO_3 \cdot 10H_2O(aq) \cdot + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + H_2O(\ell) + CO_2(g)$$

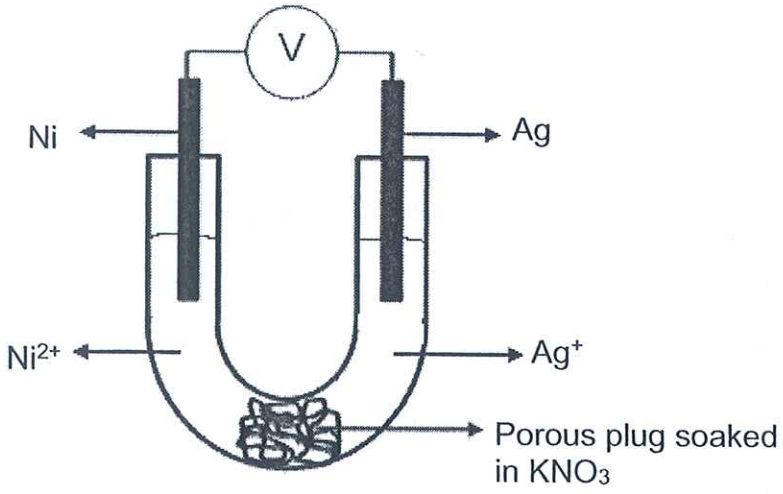
Calculate the mass of pure $Na_2CO_3 \cdot 10H_2O$ in commercial washing soda, if 24,8 cm^3 of the HCℓ solution was needed to reach the equivalence point in the titration. (6)

[18]

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QUESTION 8 (Start on a new page)

The diagram represents a galvanic cell labeled **A,**



8.1 State TWO standard conditions under which this cell functions. (2)

8.2 Write down TWO functions of the porous plug. (2)

8.3 In which direction (from **Ni to Ag** or from **Ag to Ni)** do electrons flow in the external circuit? (1)

8.4 Write down the balanced equation for the overall (net) reaction for this cell. (3)

8.5 If 0,4 moles of electrons flow to the cathode, what will be the decrease in mass of the anode be? (3)

8.6 A SECOND galvanic cell **B** is constructed using Mg(s)/ $Mg(NO_3)_2$(aq) and Ag(s)/$AgNO_3$(aq) half-cells

Without any calculations, determine which ONE of the TWO galvanic cells (**A or B**) will result in the highest initial potential difference when it is operational under standard conditions.

Explain your answer by referring to the relative strengths of the reducing agents. (4)

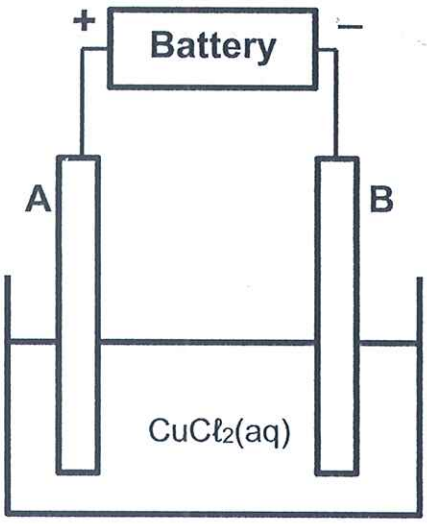
[15]

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QUESTION 9 (Start on a new page.)

The sketch below shows a cell used in the purification of copper.



9.1 Define the term *electrolysis* (2)

9.2 Which electrode **A** or **B** represents the impure copper? (1)

9.3 Which electrode **A** or **B** will increase in mass? (1)

9.4 Write down the equation for the reaction that takes place at the cathode. (3)

9.5 "The colour of the electrolyte remains unchanged." When the cell is in operation, is this statement TRUE or FALSE? Explain the answer. (2)

The two electrodes **A** and **B** are now replaced with carbon rods.

9.6 Write down TWO reasons why carbon is used as electrodes. (2)

9.7 At which electrode (**A** or **B**) will chlorine gas form when the cell is in operation?

Write down a half-reaction to show the formation of chlorine gas. (3)

9.8 State whether the concentration of the electrolyte will INCREASE, DECREASE or REMAIN THE SAME when carbon rods are used. (1)

[15]

TOTAL: 150

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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
Avogadro's constant	N_A	$6{,}023 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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* $E^\theta_{cell} = E^\theta_{oxidisingagent} - E^\theta_{reducingagent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit*

Symbol *Simbool*

29 Cu 63,5

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 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 oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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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)
$Li^+ + e^-$	$\rightleftharpoons$	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
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	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
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

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