Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2023

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKS: 150

TIME: 3 hours

Font size 18

This question paper consists of 31 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 an example 1.11 E.

1.1 Which ONE of the following has the STRONGEST intermolecular forces?

A CH_3COCH_3

B CH_3CH_2CHO

C $CH_3CH_2CH_2OH$

D CH_3CH_2COOH (2)

1.2 Consider the reaction below:

$$C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$$

What TYPE of reaction is represented by the above equation?

A Hydration

B Halogenation

C Hydrogenation

D Hydrohalogenation (2)

1.3 The name of the functional group of aldehydes is …

A formyl.

B carbonyl.

C hydroxyl.

D carboxyl. (2)

1.4 Compound **Q** undergoes a cracking reaction to produce organic compound **P** and ethene, C_2H_4 as shown below.

Compound **Q** → Compound **P** + C_2H_4

Compound **P** further undergoes a combustion reaction according to the balanced equation.

P + $8\ O_2 \rightarrow 5\ CO_2 + 6\ H_2O$

The IUPAC name of compound **Q** is …

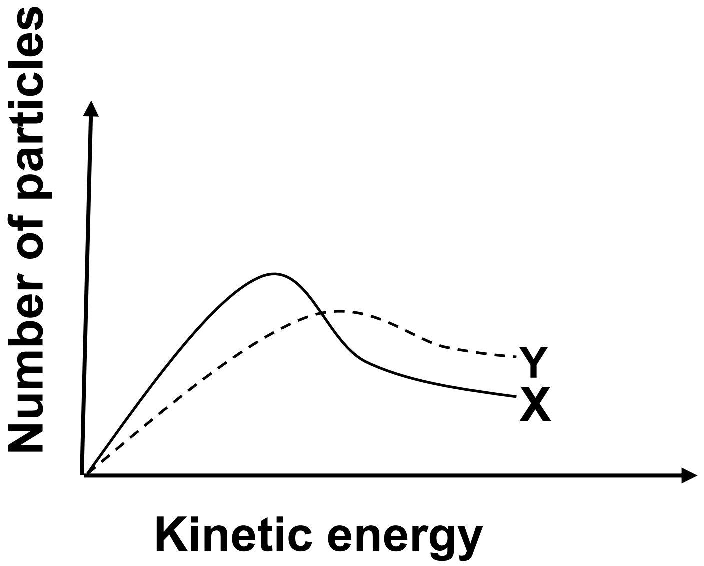
A butane.

B pentane.

C hexane.

D heptane. (2)

1.5 The Maxwell-Boltzmann distribution curve **X** represents the number of molecules against kinetic energy for a certain reaction. Curve **Y** was obtained when one of the reaction conditions was changed.



Which ONE of the following factors was changed to obtain curve **Y**?

A Pressure

B Temperature

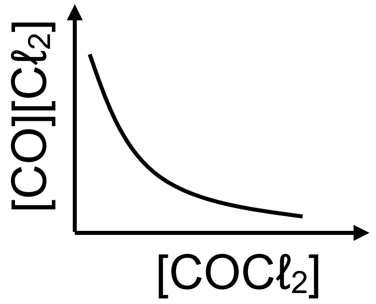
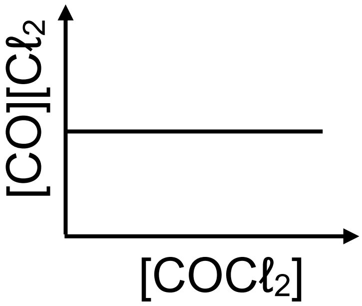
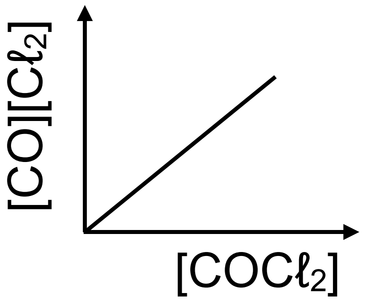
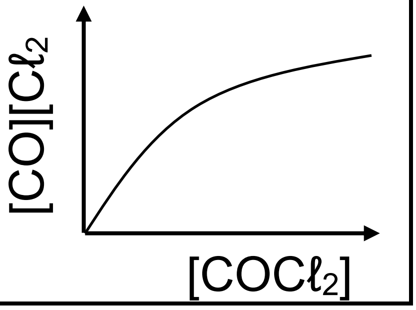
C Concentration

D Addition of a catalyst (2)

1.6 The following decomposition reaction is allowed to reach equilibrium:

$$COC\ell_2\ (g) \rightleftharpoons CO\ (g) + C\ell_2\ (g)$$

Which ONE of the following graphs of $[CO][C\ell_2]$ versus $[COC\ell_2]$ is CORRECT at equilibrium?

A		B	
C		D	

(2)

1.7 Which ONE of the salts below can be produced by the reaction of a strong base with a weak acid?

A Na_2SO_4

B $NH_4C\ell$

C $NaC\ell$

D $KHCO_3$ (2)

1.8 The reaction represented by the equation below reaches equilibrium.

$CH_3COOH (aq) + H_2O (\ell) \rightleftharpoons CH_3COO^- (aq) + H_3O^+ (aq)$

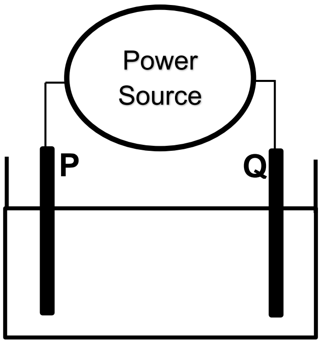
A few drops of a concentrated solution of CH_3COONa (aq) are added to the equilibrium mixture.

Which ONE of the following regarding the pH and the equilibrium position is CORRECT as the reaction approaches a new equilibrium?

	pH	**Equilibrium position shifts towards the:**
A	Increases	Left
B	Decreases	Right
C	Increases	Right
D	Decreases	Left

(2)

1.9 The simplified diagram below represents an electrolytic cell that is used in the purification of copper (Cu).



Electrode **P** is the CATHODE of the cell.

Which ONE of the following combinations regarding electrode **P** is correct?

	Reaction taking place at electrode P	**Terminal to which electrode P is connected**
A	Oxidation	Positive
B	Oxidation	Negative
C	Reduction	Positive
D	Reduction	Negative

(2)

1.10 Consider the following hypothetical spontaneous reactions:

$$Q^{2+} + R \rightarrow R^{2+} + Q$$

$$P^{2+} + Q \rightarrow P + Q^{2+}$$

Which ONE of the following lists the oxidising agents in order of increasing strength?

A Q^{2+}, R^{2+}, P^{2+}

B R^{2+}, Q^{2+}, P^{2+}

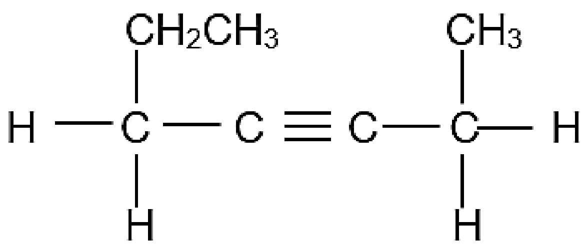
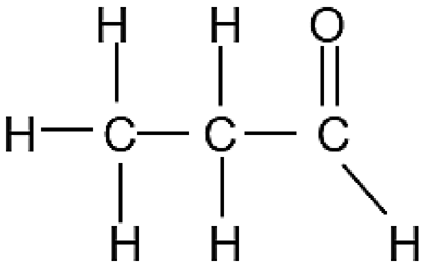
C P^{2+}, Q^{2+}, R^{2+}

D P^{2+}, R^{2+}, Q^{2+} (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 Consider the organic compounds **A** to **F** below.

A 2-methylpent-2-ene	**B** $(CH_3)_3COH$
C 2,3-dimethylpentanoic acid	**D** 
E 	**F** CH_3CH_2Br

2.1 Write down the LETTER of the compound that:

2.1.1 Is an alkyne (1)

2.1.2 Is a haloalkane (1)

2.1.3 Has the general formula $C_nH_{2n+2}O$ (1)

2.2 Is compound **A** SATURATED or UNSATURATED?

Give a reason for your answer. (2)

2.3 Write down the:

2.3.1 Structural formula of compound **C** (2)

2.3.2 IUPAC name of compound **D** (2)

2.4 Is compound **B** a PRIMARY, SECONDARY OR TERTIARY alcohol?

Give a reason for your answer. (2)

2.5 Write down the IUPAC name of a CHAIN isomer of compound **B**. (2)

2.6 Compound **E** has a functional isomer.

2.6.1 What are *functional isomers*? (2)

2.6.2 Write down the CONDENSED STRUCTURAL formula of the functional isomer of compound **E** (2)

[17]

QUESTION 3 (Start on a new page.)

Compounds **A** to **C** are used to investigate a factor that influences boiling point of organic compounds. The table below shows the results obtained.

	Compound	**Boiling point (˚C)**
A	Propan-1-ol	97
B	Butan-1-ol	117,7
C	Pentan-1-ol	138

3.1 Define *boiling point.* (2)

3.2 For this investigation, write down the:

3.2.1 Independent variable (1)

3.2.2 Controlled variable (1)

3.3 Name the intermolecular force that is responsible for the observed trend in boiling points. (1)

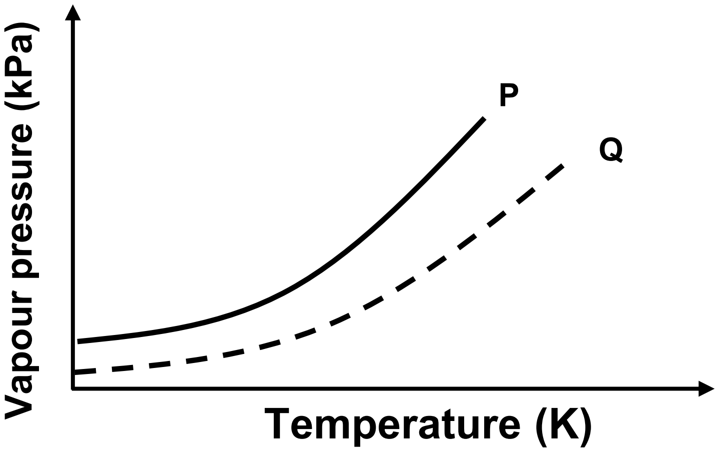
3.4 The boiling points of three branched alcohols are given below.

108 ˚C	129 ˚C	149 ˚C

Which ONE of the three temperatures is most likely to be the boiling point of 2-methylbutan-1-ol? (1)

3.5 Fully explain your answer to QUESTION 3.4. (4)

3.6 The graphs below represent the relationship between vapour pressure and temperature for propan-1-ol and propanal.



3.6.1 Define *vapour pressure.* (2)

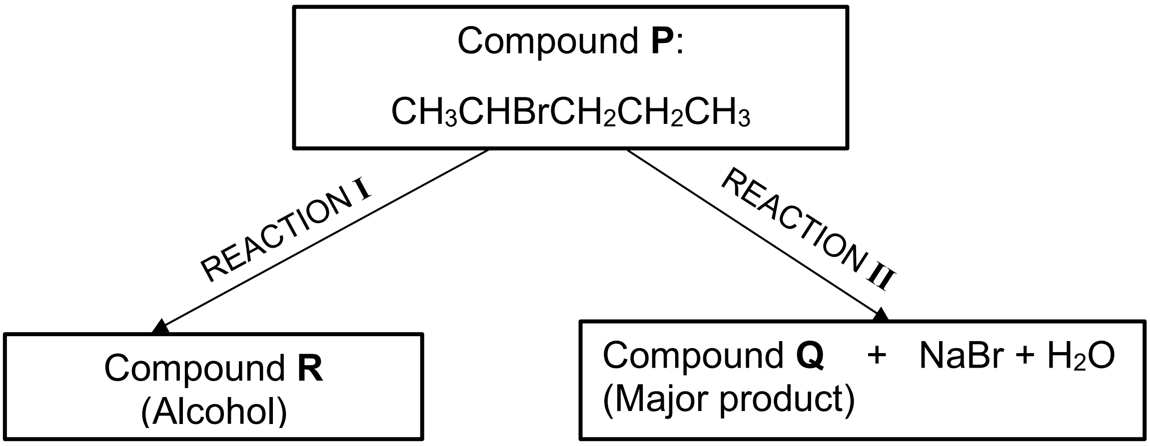
3.6.2 Which curve, **P** or **Q**, represents the graph for propan-1-ol? (1)

3.6.3 Explain your answer to QUESTION 3.6.2 by referring to the TYPE of intermolecular forces. (4)

[17]

QUESTION 4 (Start on a new page.)

4.1 The flow diagram below shows how compound **P** can be converted to organic compounds **Q** and **R.**



For reaction **I** write down the:

4.1.1 Name of the type of substitution reaction (1)

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

For reaction **II** write down:

4.1.3 One reaction condition other than heat (1)

4.1.4 The structural formula of compound **Q** (2)

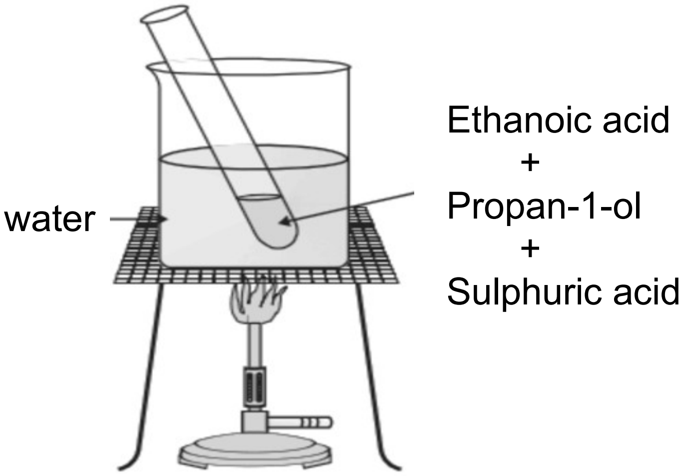
Compound **R** can be converted to compound **Q**.

For the conversion of compound **R** to compound **Q** write down the:

4.1.5 Formula or name of the inorganic reagent needed (1)

4.1.6 Type of reaction (1)

4.2 A mixture of ethanoic acid (CH_3COOH) and propan-1-ol ($CH_3CH_2CH_2OH$) is heated in the presence of concentrated sulphuric acid (H_2SO_4) in a water bath as shown below.



4.2.1 Write down the name of the reaction that takes place. (1)

4.2.2 Give a reason why the reaction mixture is heated in a water bath. (1)

4.2.3 Write down the structural formula and IUPAC name of the product formed. (4)

[14]

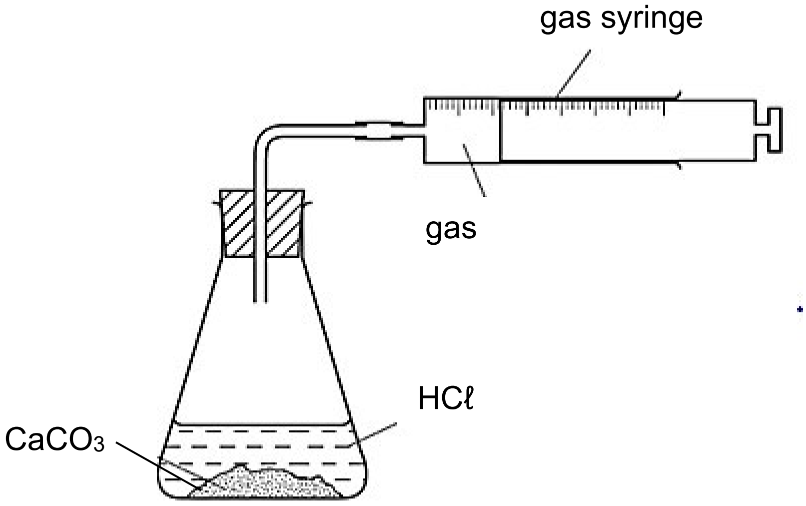
QUESTION 5 (Start on a new page.)

A group of learners investigate the relationship between reaction rate and concentration. They used the reaction between calcium carbonate powder, $CaCO_3$ (s) and EXCESS hydrochloric acid solution, $HC\ell$ (aq), at 25 °C.

The balanced equation for this reaction is:

$$CaCO_3 (s) + 2 HC\ell (aq) \rightarrow CaC\ell_2 (aq) + H_2O (\ell) + CO_2 (g) \quad \Delta H < 0$$

The apparatus used is illustrated below.



The table below shows the reaction conditions for Experiments **1** and **2**.

EXPERIMENT	**CONCENTRATION OF HCℓ (mol.dm^{-3})**	**VOLUME OF HCℓ (cm^3)**	**TIME TAKEN BY THE REACTION TO REACH COMPLETION (minutes)**
1	0,9	50	5,28
2	1,2	50	Y

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

5.2 Name the apparatus needed for this investigation that is not shown in the sketch above. (1)

5.3 Give a reason why the temperature of the reaction mixtures does not remain constant during the reactions. (1)

5.4 Will time **Y** for experiment **2** be LONGER or SHORTER than 5,28 minutes? (1)

5.5 Explain your answer to QUESTION 5.4 by referring to the collision theory. (2)

5.6 In experiment **1,** exactly 250 cm^3 of CO_2 is produced in 5,28 minutes.

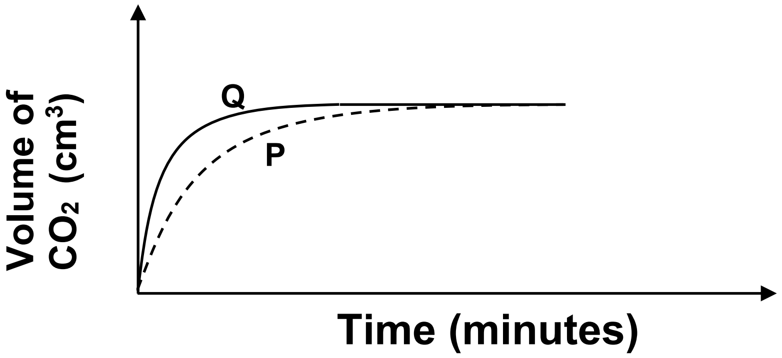
5.6.1 Calculate the average rate of production of CO_2 in $cm^3 \cdot min^{-1}$ (3)

Shortly after the reaction in experiment **1** is completed, the flask is sealed tightly and it is found that 100 cm^3 of CO_2 has escaped out of the flask.

5.6.2 Calculate of mass of CO_2 remaining in the flask after the flask is sealed. Take the molar volume of CO_2 at 25 ˚C to be 25 000 $cm^3 \cdot mol^{-1}$. (4)

5.7 In **experiment 3** the learners now add 50 cm^3 of EXCESS ethanoic acid ($C_2H_4O_2$) solution with a concentration of 0,9 $mol \cdot dm^{-3}$ to $CaCO_3$ powder at 25 °C and compare the results to those of experiment **1**.

The graph of volume of CO_2 against time for the two experiments is shown below.



5.7.1 Which graph **P** or **Q** represents the results of experiment **3**? (1)

5.7.2 Explain your answer to QUESTION 5.7.1. (2)

5.7.3 How does the amount of $CaCO_3$ used in experiment **1** compare to the amount of $CaCO_3$ used in experiment **3**?

Choose from LARGER THAN,
SMALLER THAN or EQUAL TO.

Give a reason for your answer. (2)

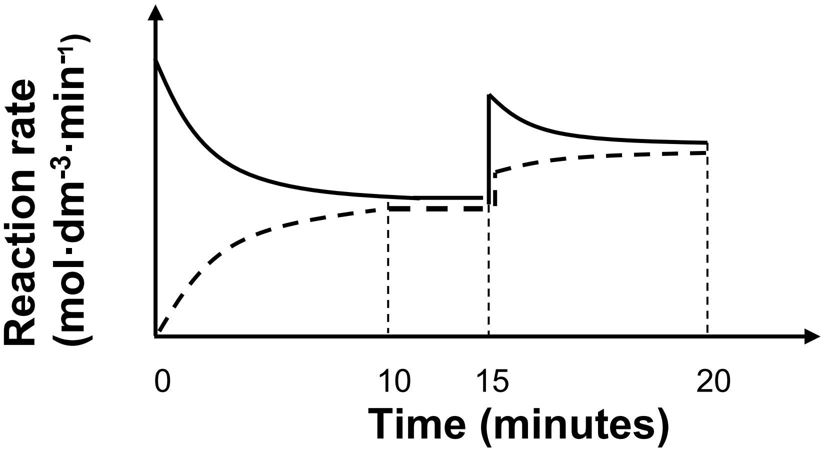
[19]

QUESTION 6 (Start on a new page.)

6.1 Sulphur trioxide (SO_3) gas is injected into an empty container which is then sealed. The following reaction takes place inside the container:

$$2\,SO_3\,(g) \rightleftharpoons 2\,SO_2\,(g) + O_2\,(g)$$

The graph below shows the changes in the reaction rates against time for the first 20 minutes.



6.1.1 Write down the meaning of the double arrow "⇌" in the equation. (1)

6.1.2 What is represented by the horizontal section of the graph between t = 10 minutes and t = 15 minutes (1)

At **t** = 15 minutes the temperature of the reaction mixture in the container was changed.

6.1.3 Was the container COOLED or HEATED at **t** = 15 minutes? (1)

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

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

After 20 minutes the pressure inside the reaction container is increased by decreasing the volume at constant temperature.

6.1.6 Redraw the graph below and indicate the effect that the increase in pressure will have on the reaction rate up until a new equilibrium is established.

GRAPH OF RATE VERSUS TIME

Time (minutes) (2)

6.2 Carbon (C) and carbon dioxide (CO_2) are mixed in an empty 2 dm^3 container which is then sealed.

The following balanced equation represents the reaction that reaches equilibrium in the container at 700 °C.

$$C\ (s) + CO_2\ (g) \rightleftharpoons 2\ CO\ (g)$$

At equilibrium, it is found that the concentration of CO_2 is 0,05 $mol.dm^{-3}$ and 0,4 moles of C (s) are present. The equilibrium constant for this reaction at 700 °C is 0,05.

Calculate the percentage of carbon that has reacted. (8)

[16]

QUESTION 7 (Start on a new page.)

7.1 Consider the ionisation of oxalic acid, $H_2C_2O_4$ (aq), represented by the following balanced equation:

$$H_2C_2O_4\,(aq) + H_2O\,(\ell) \rightleftharpoons HC_2O_4^-\,(aq) + H_3O^+\,(aq)$$

The concentration of EACH of the substances found in 0,1 mol·dm^{-3} solution of $H_2C_2O_4$ at equilibrium is given in the table below.

Substances	$H_2C_2O_4$	$HC_2O_4^-$	H_3O^+
Concentration (mol·dm^{-3})	0,046	0,054	0,054

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

7.1.2 Write down the formula of a base in the above reaction other than H_2O. (1)

7.1.3 Is oxalic acid ($H_2C_2O_4$) a STRONG or a WEAK acid? (1)

7.1.4 Explain your answer to QUESTION 7.1.3 by referring to the data in the table. (2)

7.2 A concentrated sodium hydroxide solution, NaOH(aq), is diluted with water to one tenth of its original concentration.

Exactly 35 cm^3 of the dilute sodium hydroxide solution is mixed with 25 cm^3 of hydrochloric acid solution, HCℓ (aq) of concentration 0,1 $mol·dm^{-3}$ in a flask.

A neutralisation reaction occurs in the flask according to the balanced equation:

$$HCℓ\ (aq) + NaOH\ (aq) \rightarrow NaCℓ\ (aq) + H_2O\ (ℓ)$$

7.2.1 Calculate the initial number of moles of HCℓ in the flask. (3)

The pH of the final solution is 12.

Calculate the CONCENTRATION of the:

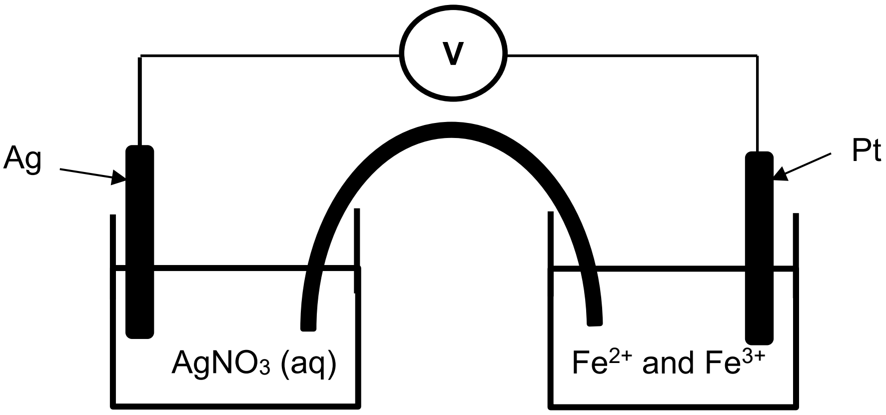
7.2.2 Hydroxide ions (OH^-) in the final solution (4)

7.2.3 Concentrated sodium hydroxide (NaOH) (6)

[19]

QUESTION 8 (Start on a new page.)

A galvanic cell is set up under standard conditions. One half cell consists of a silver plate, Ag, in an aqueous solution of $AgNO_3$, while the other half cell consists of an inert platinum plate in an aqueous solution containing, Fe^{2+} and Fe^{3+}, as shown in the simplified diagram below.



8.1 Write down the energy change that takes place when this cell is in operation. (2)

8.2 For this galvanic cell, write down the:

8.2.1 Oxidation half-reaction (2)

8.2.2 Cell notation (3)

8.2.3 TWO standard conditions for the Fe^{2+}, Fe^{3+} half cell (2)

8.3 Calculate the initial emf of this cell. (4)

8.4 What would happen to the emf calculated in QUESTION 8.3, if a solution of NaCℓ were to be used as a salt bridge in the cell under standard conditions?

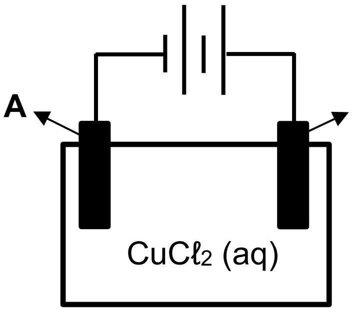
Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

8.5 Explain your answer to QUESTION 8.4. (2)

[16]

QUESTION 9 (Start on a new page.)

The electrolytic cell shown below is used for the electrolysis of $CuC\ell_2$ solution.



A and **B** are carbon electrodes.

9.1 Define *electrolysis.* (2)

9.2 Is the process of electrolysis EXOTHERMIC of ENDOTHERMIC? (1)

9.3 Write down the half reaction that occurs at electrode **B**.

0,369 g of Cu is deposited on the cathode in 27 minutes. (2)

9.4 Calculate the electrical current used during this process. (7)

[12]

TOTAL: 150

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DATA FOR PHYSICAL SCIENCES GRADE 12 PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12 VRAESTEL 2 (CHEMIE)

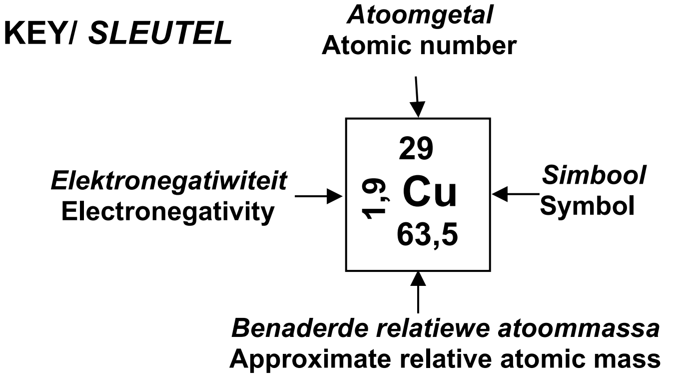
TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

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
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$		
$q = I\Delta t$ $n = \frac{Q}{e}$ or/of $n = \frac{Q}{q_e}$		

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



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

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

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