Western Cape Government
Education

METRO CENTRAL EDUCATION DISTRICT

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2025

MARKS	:	**150**
TIME	:	**3 hours**
DATE	:	**25 SEPTEMBER 2025**

This question paper consists of 15 pages and 4 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your Name and Surname on the first page of your ANSWER BOOK.
2. This question paper consists of **9 QUESTIONS**. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW PAGE of your RULED A4 PAPER. Use BOTH sides of the page to avoid wasting paper.
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 or 2.1.1 and 2.1.2
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**. In multi-step calculations, intermediate steps, round of to four 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) on your RULED A4 PAPER, for example 1.11 D.

1.1 Consider the condensed structural formula:

$$CH_3COCH_3$$

Identify the name of the functional group in this formula.

A. Formyl group

B. Carboxyl group

C. Ketone

D. Carbonyl group (2)

1.2 An organic compound **is incorrectly** named as 4,5-dibromo-2-ethylhexane.

The CORRECT IUPAC name for this compound is:

A. 2,3-dibromo-5-ethylhexane

B. 2,3-dibromo-5-methylheptane

C. 5,6-dibromo-3-methylheptane

D. 5,6-dibromo-3,3-dimethylhexane (2)

1.3 Learners investigate the boiling points of the first five straight chain CARBOXYLIC ACIDS. Which of the following factors CANNOT be used explain the increase in boiling points as the number of carbon atoms increases?

A. Increase in chain length

B. Increase in surface area

C. Increase in strength of hydrogen bonds

D. Increase in molecular mass (2)

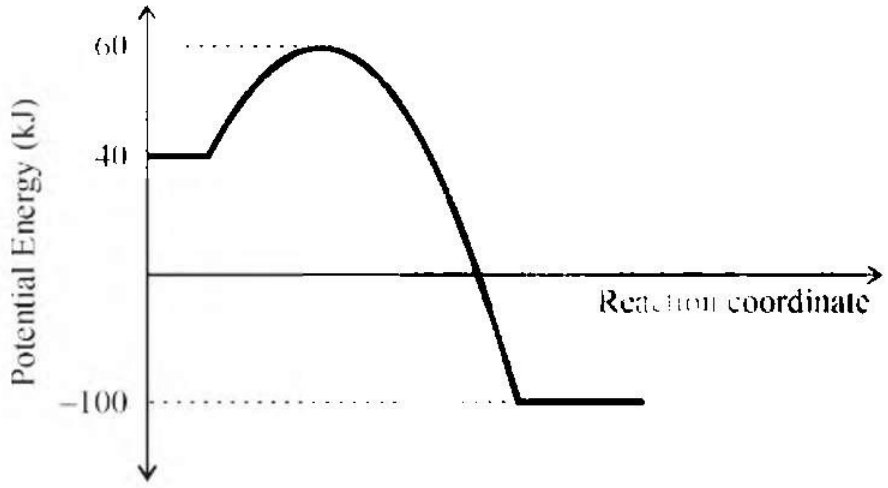
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1.4 An alkane reacts with Br_2 in a laboratory. Which of the following shows the correct combination of the REACTION CONDITION, the TYPE OF REACTION and the MAIN PRODUCT of the reaction?

	REACTION CONDITIONS	**TYPE OF REACTION**	**MAIN PRODUCT**
A	Conc. NaOH	Elimination	Haloalkane
B	Sunlight	Substitution	Alcohol
C	Conc. H_2SO_4	Elimination	Alkene
D	UV light	Substitution	Haloalkane

(2)

1.5 What is the HEAT OF THE REACTION (ΔH) and ACTIVATION ENERGY for the reverse reaction?



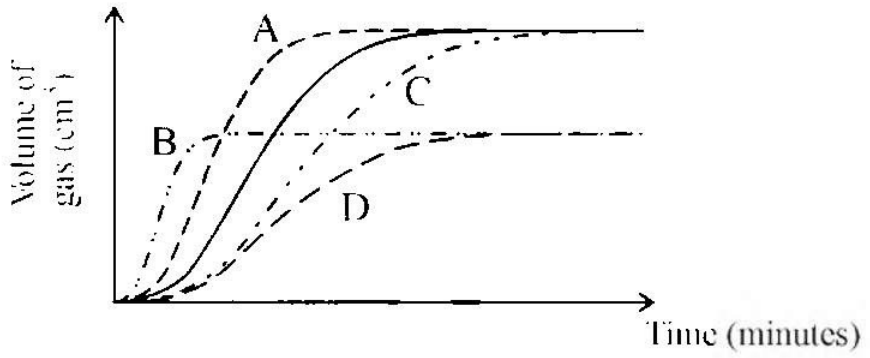
	HEAT OF REACTION (ΔH IN KJ)	**ACTIVATION ENERGY (KJ)**
A	140	60
B	-140	20
C	-140	-140
D	140	160

(2)

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1.6 In an experiment, a 10 g lump of zinc and a 5 g lump of zinc are added to separate flasks containing the same volume of excess sulphuric acid. The solid line in the graph shows the volume of gas given off when the 10 g lump of zinc is used.

Which dotted line is obtained when 5 g lump of zinc is used?



A. Curve A

B. Curve B

C. Curve C

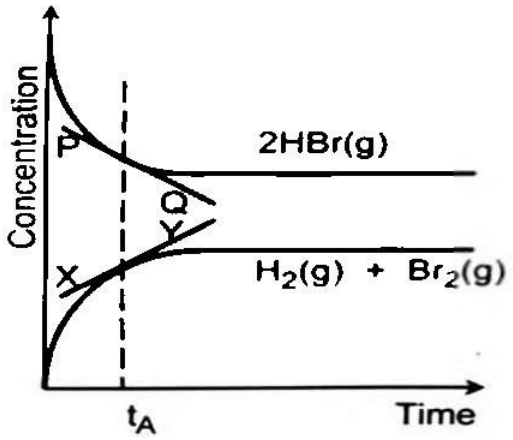
D. Curve D (2)

1.7 A solution of ethanoic acid (acetic acid) is titrated against a standard sodium hydroxide solution. Which of the following indicators would be the most suitable for this titration?

	INDICATOR	**pH RANGE OF THE INDICATOR**
A	Phenolphthalein	8,3 – 10
B	Methyl orange	3,1 – 4,4
C	Bromothymol blue	6,0 – 7,6
D	Universal indicator	Change colour over a wide range of pH values

(2)

1.8 The graph below refers to the equation: **$2HBr\,(g) \rightleftharpoons H_2\,(g) + Br_2\,(g)$**
Which ONE of the following statements is INCORRECT at time t_A?



A. The slope of PQ represents the rate at which the concentration of 2HBr(g) decreases.

B. The slope of XY represents the rate at which the concentration of H_2 (g) and Br_2 (g) increase.

C The rate at which the concentration of 2HBr(g) decreases is not equal to the rate at which the concentration of H_2(g) and Br_2(g) increases.

D The slopes of PQ and XY are not affected by temperature changes. (2)

1.9 According to the Table of Standard Reduction Potentials, Sn is a stronger reducing agent than:

A. Ag

B. Zn

C. Ni

D. Mn (2)

1.10 During the electrolysis of concentrated sodium chloride solution:

A. Sodium hydroxide forms at the anode.

B. Hydrogen forms at the positive electrode.

C. Sodium forms at the cathode.

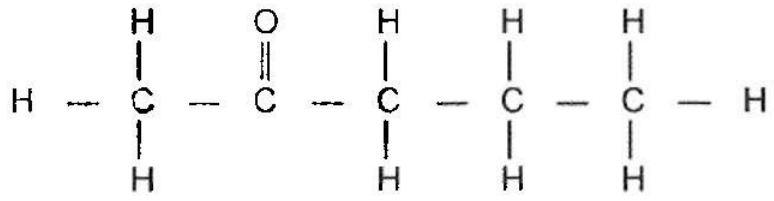
D. Chlorine gas forms at the positive electrode. (2)

[20]

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QUESTION 2 (Start on a NEW page)

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

A	5-ethyl-2,6-dimethylhept-3-yne	**B**	$CH_3CH_2CH_3$
C	$C_5H_{10}O$	**D**	$C_5H_{12}O$
E			
F	C_4H_9OH		

Use the information in the table (where applicable) to answer the questions that follow.

2.1 Write down the letter(s) representing:

2.1.1 An unsaturated hydrocarbon (1)

2.1.2 A compound that it used as a fuel (1)

2.2 For compound **A**, write down the:

2.2.1 General formula of the homologous series to which it belongs (1)

2.2.2 Structural formula (3)

2.3 Compound **C** is a functional isomer of compound **E**.
Write down the IUPAC name of compound **C** (2)

2.4 Compound **D** is a tertiary alcohol whereas compound **F** is a secondary alcohol.
Write down the:

2.4.1 IUPAC name of compound **F** (2)

2.4.2 Structural formula of compound **D** (2)

2.5 Write down the balanced equation using MOLECULAR FORMULAE for the complete combustion of compound **B**. (3)

[15]

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QUESTION 3 (Start on a NEW page)

The table below shows the boiling points of some organic compounds.

ORGANIC COMPOUND		BOILING POINT (°C)
A	Ethanol	79
B	Propan-1-ol	97
C	Butan-1-ol	117
D	Pentan-1-ol	138
E	Pentane	X
F	Pentanoic acid	Y

3.1 Define the term *boiling point* (2)

3.2 Refer to compounds **A** to **D**. When comparing their boiling points, write down:

3.2.1 The independent variable. (1)

3.2.2 One control variable. (1)

3.3 Fully explain the increase in boiling point from compound **A** to **D** by referring to the TYPE, STRENGTH and ENERGY of the intermolecular forces. (3)

3.4 Refer to compounds **D** and **E**. Is it fair to compare their boiling point? Write down YES or NO. Explain the answer. (2)

3.5 Which compound, **D** or **E**, has a higher boiling point? Explain the answer by referring to the TYPE, STRENGTH and ENERGY of the intermolecular forces. (3)

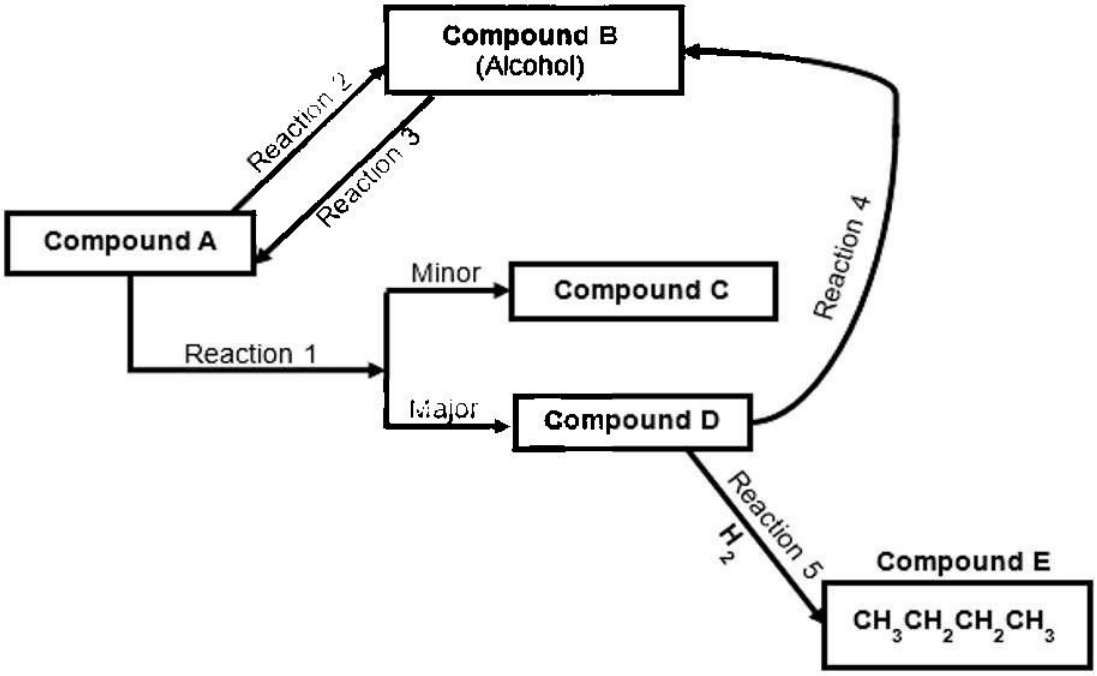
3.6 Compound **B** reacts with another compound to form the product compound **Z**, the *functional isomer* of compound **F**. Which compound **F** or **Z** will have the higher vapour pressure. Give a reason for the answer. (2)

[14]

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QUESTION 4 (Start on a NEW page)

In the flow diagram below, a ***secondary*** **bromoalkane,** compound **A,** is used as a starting reactant to form different organic compounds under different reaction conditions. Use the diagram below to answer the questions that follow.



It is given that Reaction **1** and Reaction **2** both use sodium hydroxide (NaOH) as a reagent.

4.1 Write down the structural formula of compound **A** (2)

4.2 In **Reaction 1** concentrated NaOH is used. Write down:

4.2.1 The type of reaction. (1)

4.2.2 The STRUCTURAL FORMULA of compound **C**. (2)

4.3 In **Reaction 2** dilute NaOH is used. Write down the balanced chemical equation using CONDENSED STRUCTURAL FORMULAE.
No reaction condition is required. (3)

4.4 State TWO reaction conditions for **Reaction 3**. (2)

4.5 Write down the TYPE of addition reaction represented by **Reaction 4**. (1)

4.6 Consider **Reaction 5**. Write down:

4.6.1 ONE reaction condition. (1)

4.6.2 The *general formula* of the homologous series to which the PRODUCT belongs. (1)
[13]

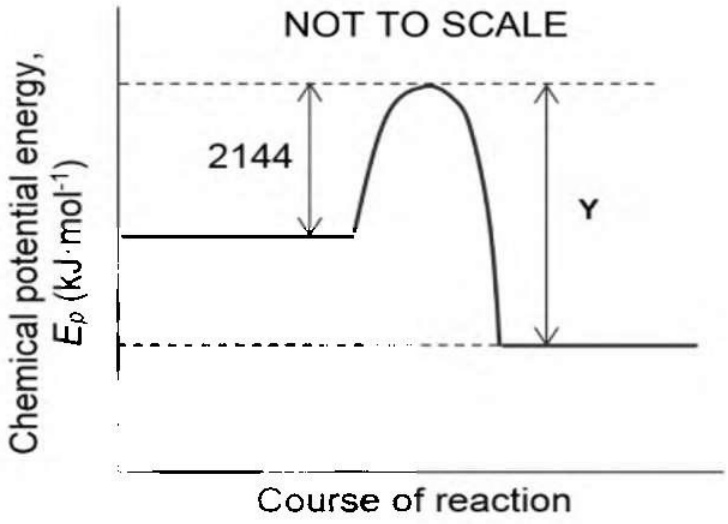
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QUESTION 5 (Start on a NEW page)

5.1 The decomposition of hydrogen peroxide is given below:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g) \quad \ldots\ldots\ldots\ldots \quad \Delta H = -203\ kJ\cdot mol^{-1}$$

The energy-profile graph for the decomposition of H_2O_2 is shown below:



5.1.1 Define the term *activated complex*. (2)

5.1.2 Calculate the energy released, **Y.** (2)

5.1.3 Manganese dioxide (MnO_2) can be used as a catalyst in the decomposition of hydrogen peroxide.
Redraw the above graph and on the same system of axes draw the curve that will be obtained for the catalysed reaction and label the catalysed activated complex as **C.** (2)

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5.2 Four experiments, **P**, **Q**, **R** and **S**, are carried out to investigate factors that affect the rate of decomposition of hydrogen peroxide, $H_2O_2(\ell)$.

Identical samples of hydrogen peroxide are used in each experiment.

The conditions used in each experiment are summarised in the table below.

EXPERIMENT	TEMPERATURE (^{0}C)	CONDITIONS
P	20	Without catalyst
Q	20	With MnO_2 catalyst
R	40	Without catalyst
S	40	With MnO_2 catalyst

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

5.2.2 Compare EXPERIMENTS **P** and **R**.

Which experiment **P** or **R**, will have the higher reaction rate?
Use the collision theory to explain the answer. (3)

5.3 The decomposition of hydrogen peroxide is given below:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g) \quad \ldots\ldots\ldots\ldots \quad \Delta H = -203 \text{ kJ·mol}^{-1}$$

During EXPERIMENT **S**, the following results for the decomposition of hydrogen peroxide are obtained:

TIME (s)	H_2O_2 CONCENTRATION (mol·dm^{-3})
0	0,0100
100	0,008
200	**X**
300	0,0053
400	0,0043

5.3.1 The rate of reaction during the first 200 s is $1,73 \times 10^{-5}$ mol·dm^{-3}· s^{-1}.

Calculate the concentration, **X**, of H_2O_2. (4)

5.3.2 Calculate the volume of oxygen produced within the first 300 s if 25 cm^3 of hydrogen peroxide decomposes in this time interval.

Take the molar gas volume as 25,7 dm^3 ·mol^{-1} (6)

[21]

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QUESTION 6 (Start on a NEW page)

The hypothetical reaction represented by the balanced equation below reaches *chemical equilibrium* in a closed container at temperature T °C.

$$Q_2(g) + RS_3(g) \rightleftharpoons 2QS(g) + RS(s)$$

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

6.2 Initially 0,6 moles of $Q_2(g)$, 0,6 moles of $RS_3(g)$, 0,4 moles of QS(g) and 0,4 moles of RS(s) were mixed and sealed in a 500 cm^3 flask.

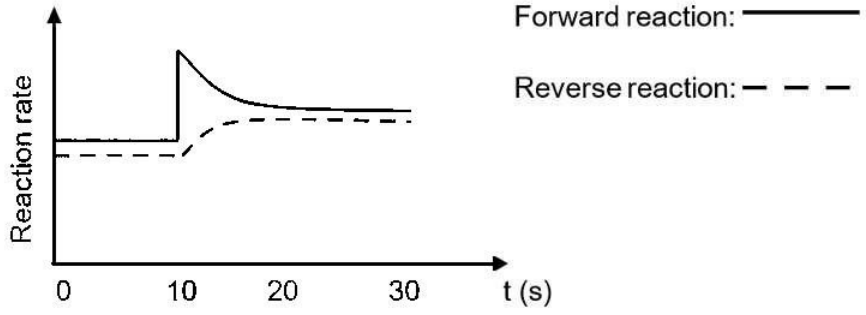
If the equilibrium constant (K_c) for this reaction at temperature T °C is 0,04, Calculate to THREE decimal places, the CHANGE IN THE NUMBER OF MOLES of Q_2. (7)

The temperature is now increased causing the amount of Q_2 in the container to decrease.

6.3 What is the sign of ΔH for the forward reaction?
Write down POSITIVE or NEGATIVE. Fully explain the answer. (3)

Further changes are made to the above equilibrium mixture.

The graph below shows how reaction rate changes with time.



6.4 Write down the disturbance responsible for the change observed at t = 10 s. (1)

6.5 Fully explain the change in reaction rate of both the forward and the reverse reactions from t = 10 s to t = 20 s. (3)

6.6 A suitable catalyst is now added to the reaction mixture at t = 30 s.
Redraw the above graph from 20 s to 30 s. On the same system of axes draw the change(s) in the graph, if any, from 30 s onwards. (2)

[18]

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QUESTION 7 (Start on a NEW page.)

7.1 Consider the following acid-base reactions, **X** and **Y**.

X: $H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+$

Y: $HSO_4^- + H_2O \rightleftharpoons SO_4^{2-} + H_3O^+$

7.1.1 Define the term *acid* according to the Arrhenius theory. (2)

7.1.2 Write down the NAME or FORMULAE of the substance that acts as an ampholyte. (1)

7.1.3 Write down the FORMULAE of the conjugate acid in reaction **X**. (1)

7.1.4 Calculate the pH of a 0,3 $mol \cdot dm^{-3}$ sulphuric acid solution. (3)

7.2 A solution is made by dissolving $Na_2CO_3(s)$ in water.

7.2.1 Will the solution of Na_2CO_3 have a pH EQUAL to 7, LESS THAN 7 or GREATER THAN 7? (1)

7.2.2 Write down a balanced chemical equation to explain the answer to QUESTION 7.2.1 (2)

7.3 An IMPURE sample of sodium carbonate ($Na_2CO_3(s)$) with a mass of 5 g is added to a 100 cm^3 volume of sulphuric acid of a pH of 0,2. After the reaction is complete, the EXCESS H_2SO_4 is titrated with 0,1 $mol \cdot dm^{-3}$ NaOH of volume 50 cm^3.

The following reactions take place during the above process:

Reaction 1: $H_2SO_4(aq) + Na_2CO_3(s) \rightarrow Na_2SO_4(aq) + CO_2(g) + H_2O(\ell)$

Reaction 2: $H_2SO_4(aq) + 2NaOH(s) \rightarrow Na_2SO_4(aq) + H_2O(\ell)$

7.3.1 Calculate the initial concentration of the sulphuric acid solution. (3)

7.3.2 Calculate the percentage purity of the Na_2CO_3 sample (7)

[20]

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QUESTION 8 (Start on a NEW page.)

The following reaction takes place in a galvanic cell under standard conditions.

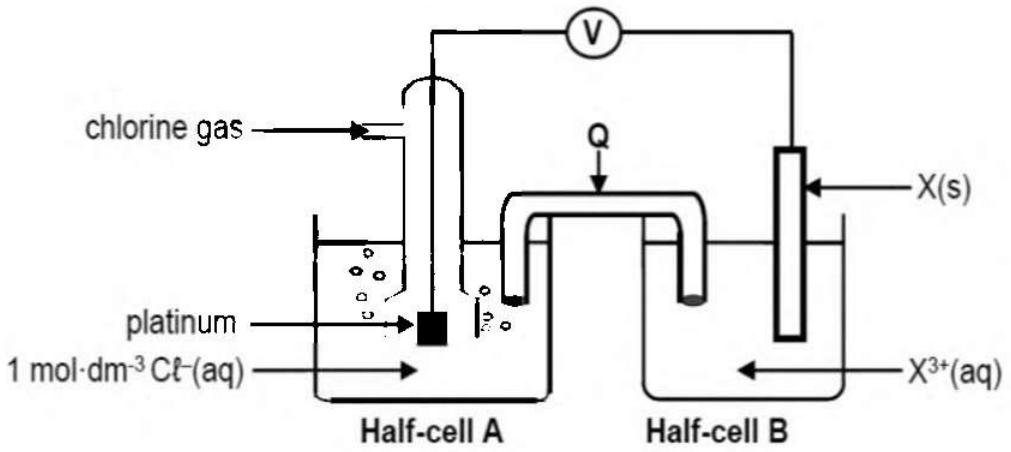
$$Mg(s) + X^{3+}(aq) \rightarrow Mg^{2+}(aq) + X(s)$$

8.1 Write down the energy conversion that takes place in this cell. (1)

8.2 Write down the half reaction taking place at the ANODE. (2)

8.3 Explain in terms of CHANGES IN OXIDATION NUMBERS, why $X^{3+}(aq)$ is the oxidising agent. (1)

The Mg half-cell is replaced with a chlorine half-cell as shown in the diagram below. The electrochemical cell below also functions under standard conditions.



8.4 Give a reason why platinum is used as the electrode in half-cell **A**. (1)

8.5 Besides concentration, state TWO other standard conditions for the above electrochemical cell. (2)

8.6 Write down the cell notation for the above electrochemical cell. (3)

8.7 The initial emf of this cell is 2,10 V. Using a suitable calculation, determine the NAME or FORMULA of metal **X**. (5)

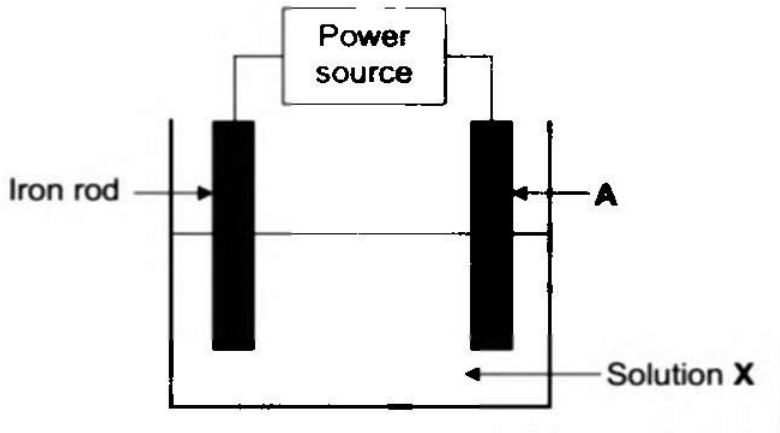
8.8 What will be the effect on the cell potential when a small amount of silver nitrate solution, $AgNO_3$ (aq), is added to half-cell **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer.
(HINT: Silver chloride is an insoluble salt.) (3)

[18]

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QUESTION 9 (Start on a NEW page.)

The diagram below shows an electrolytic cell that is used to electroplate an iron rod with **copper.** Solution **X** is made up of an UNKNOWN **nitrate.**



Solution X is an electrolyte.

9.1 Explain the term *electrolyte*. (2)

9.2 Write down the **FORMULA** of solution **X**. (1)

9.3 Which electrode (**A** or **iron rod**) is the cathode?
Give a reason for the answer. (2)

9.4 Write down the half reaction that takes place at electrode **A.** (2)

Electrode **A** is now replaced by a silver rod without making any other changes to the cell. After a while, TWO metallic ions are found to be present in the solution.

9.5 Name the TWO metallic ions present in the solution. (2)

9.6 Refer to the relative strength of oxidising agents to explain which ONE of the two ions will preferably be involved in the plating process. (2)

[11]

TOTAL 150 MARKS

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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 Molêregasvolume by STD	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature Standaardtemperatuur	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\,agent} - E^\theta_{reducing\,agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{q_e}$ where n is the number of electrons/ *waar n die aantal elektrone is*

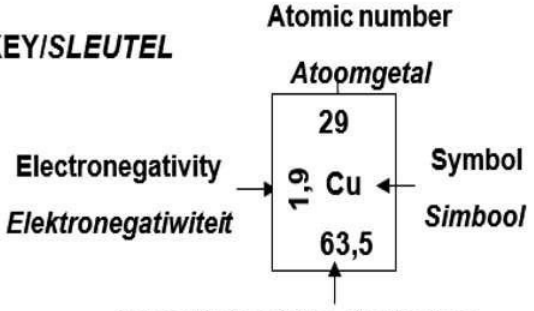
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS

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)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**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*



Please Turn Over

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TABLE 4A: STANDARD REDUCTION POTENTIALS

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

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TABLE 4B: STANDARD REDUCTION POTENTIALS

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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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