education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

SEPTEMBER 2023

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

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 following organic condensed structures is 2,3-dimethylpentane?

A $(CH_3)_3CCH(CH_3)_2$

B $(CH_3)_2CHCH_2CH(CH_3)_2$

C $CH_3CH_2C(CH_3)_2CH_2CH_3$

D $(CH_3)_2CHCH(CH_3)CH_2CH_3$ (2)

1.2 The boiling points of branched alkanes are lower than those of straight chain alkanes containing the same number of carbon atoms because branched alkane chains have …

A larger molecular mass.

B longer chain lengths.

C smaller effective molecular surface areas.

D more electrons. (2)

1.3 Consider the reaction given below.

$$CH_3(CH_2)_4CH_3 \rightarrow CH_3CHCH_2 + H_2 + \mathbf{Z}$$

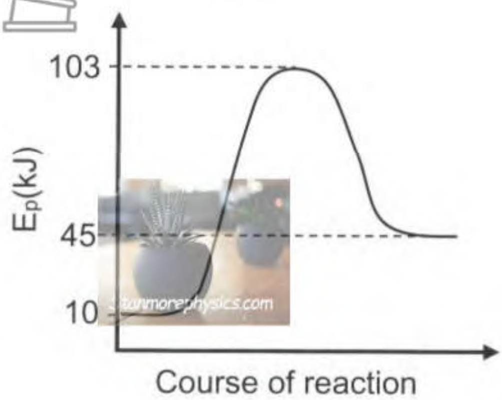
Which ONE of the following combinations correctly identifies the type of reaction that takes place and the IUPAC name of product **Z**?

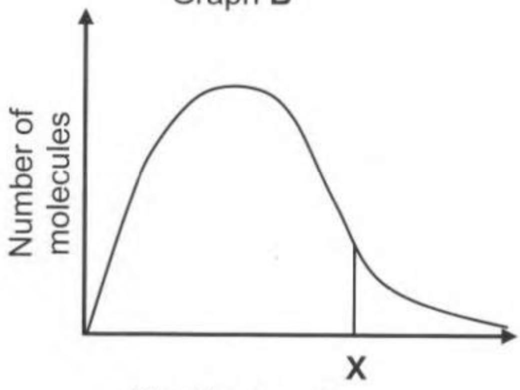
	TYPE OF REACTION	Z
A	Addition	Propane
B	Addition	Propene
C	Elimination	Propane
D	Elimination	Propene

(2)

1.4 Consider the graphs **A** and **B** below. Graph **A** shows the potential energy curve for the same reaction.

Graph **B** shows the distribution of molecular energy. **X** represents the minimum kinetic energy needed for a reaction to take place.





Which of the following will be the correct value for **X** in graph **B**?

A 103 kJ

B 93 kJ

C 35 kJ

D 10 kJ (2)

1.5 Consider the following hypothetical reaction taking place in a container that has a fixed volume:

$$A_3(g) + B_3(g) \rightleftharpoons 3AB(g) \qquad \Delta H < 0$$

The temperature of the system is doubled. Which ONE of the following combinations correctly indicates the change in the NUMBER OF MOLES of $A_3(g)$ and the TOTAL MASS in the container?

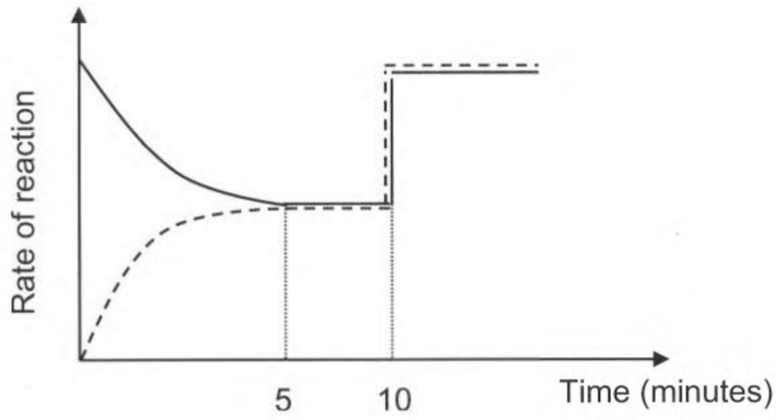
	NUMBER OF MOLES OF $A_3(g)$	**TOTAL MASS IN CONTAINER**
A	Decreases	Increases
B	Increases	Decreases
C	Increases	Remains constant
D	Decreases	Remains constant

(2)

1.6 The following reversible reaction reaches equilibrium in a closed container:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H < 0$$

The equilibrium was first established after 5 minutes. (The broken line on the graph represents the reverse reaction.)



What possible change could have been made to the reaction conditions at t = 10 minutes?

A The concentration of H_2 increases

B The temperature was increased

C The temperature was decreased

D The external pressure on the reaction mixture was increased. (2)

1.7 Chlorine gas, $C\ell_2(g)$, is used to disinfect water in public swimming pools. $C\ell_2(g)$ reacts with water, $H_2O(\ell)$ according to the following balanced equation.

$$C\ell_2g) + H_2O(\ell), \rightarrow HOC\ell(aq) + HC\ell(aq)$$

The addition of $C\ell_2(g)$ changes the pH of water in the swimming pools.

Which ONE of the following substances must be added to public swimming pools periodically to increase the pH?

A Na_2CO_3

B $NH_4C\ell$

C H_2SO_4

D $KC\ell$ (2)

1.8 The following equations represent two hypothetical half-reactions.

Which ONE of the following substances from these hypothetical half-reactions will be the strongest oxidising agent?

$$X_2 + 2e^- \rightleftharpoons 2X^- \qquad +1{,}09\ V$$

$$Y^+ + e^- \rightleftharpoons Y \qquad -2{,}8\ V$$

A X^-

B X_2

C Y^+

D Y (2)

1.9 Which of the following combinations CORRECTLY shows the products formed during the electrolysis of concentrated sodium chloride?

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

(2)

1.10 Which ONE of the following equations is spontaneous?

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

B $Mg^{2+}(aq) + Cu(s) \rightarrow Cu^{2+}(aq) + Mg(s)$

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

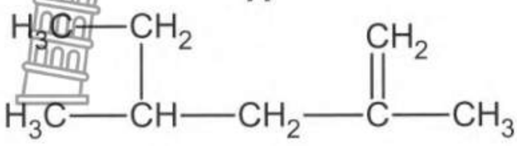
D $2Ag^+(aq) + Pb(s) \rightarrow Pb^{2+}(aq) + 2Ag(s)$ (2)

[20]

QUESTION 2 (Start on a new page.)

Compound **A** and **B** are hydrocarbons.

A



B

3-ethyl-2,5-dimethylheptane

2.1 Define the underlined term. (1)

2.2 Write down the:

2.2.1 IUPAC name of compound **A**. (3)

2.2.2 GENERAL FORMULA of the homologous series to which compound **A** belongs. (1)

2.2.3 The STRUCTURAL FORMULA of compound **B** (3)

2.2.4 NAME of the solution that can be used in the laboratory to test whether compound **A** and **B** are saturated or unsaturated. (1)

2.3 Consider the following compound: $CH_3CH_2CH_2CHO$

Write down the:

2.3.1 Homologous series to which this compound belongs? (1)

2.3.2 NAME of the functional group. (1)

2.3.3 IUPAC name of the CHAIN isomer for this compound. (2)

2.3.4 STRUCTURAL FORMULA of the FUNCTIONAL isomer for this compound. (2)

2.4 Consider the compound below:

$(CH_3)_2C(OH)CH_2CH_2CH_3$

2.4.1 Write down the IUPAC name of this compound. (2)

2.4.2 Is the compound a PRIMARY, SECONDARY OR TERTIARY alcohol. Give a reason for the answer. (2)

[19]

QUESTION 3 (Start on a new page.)

Four compounds (**A** to **D**) are used to investigate factors affecting the melting points. The results obtained are shown in the table below.

	COMPOUNDS	**MELTING POINT (°C)**
A	Propane	-188
B	Butane	-138
C	Butanal	-96,9
D	Butan-1-ol	-89,8

3.1 Define the term *melting point*. (2)

3.2 The melting points of compounds **A** and **B** are compared.

3.2.1 Write down the independent variable for this investigation. (1)

3.2.2 Explain the difference in the melting points of these two compounds. (3)

3.3 Which ONE of the compounds **B**, **C** or **D** has the lowest vapour pressure?

Explain the answer (2)

3.4 The melting points of compounds **C** and **D** are now compared.

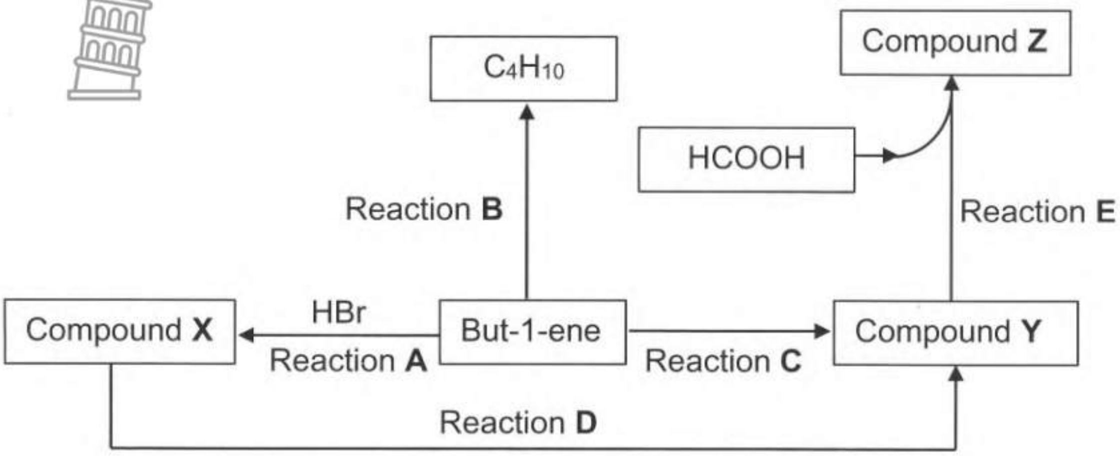
3.4.1 Which variable must be kept constant in this experiment? (1)

3.4.2 Refer to the TYPES of intermolecular forces to explain the difference in melting points between compound **C** and **D**. (4)

[13]

QUESTION 4 (Start on a new page.)

Study the flow diagram of organic reactions below and answer the questions that follow. The letters **X**, **Y** and **Z** represent organic compounds and letters **A** to **E** represent organic reactions.



4.1 Write down the type of addition reactions that take place in:

4.1.1 Reaction **A** (1)

4.1.2 Reaction **B** (1)

4.1.3 Reaction **C** (1)

4.2 For reaction **D**, write down:

4.2.1 The type of reaction that takes place. (1)

4.2.2 TWO reaction conditions necessary for the reaction to occur. (2)

4.2.3 The INORGANIC product that is formed. (1)

4.3 Give the FORMULA of the catalyst required for reaction **B** (1)

4.4 Write down a balanced chemical equation using CONDENSED STRUCTURAL FORMULAE for reaction **A**. Compound **X** is the main product. (3)

4.5 To which homologous series does compound **Y** belong? (1)

4.6 For reaction **E**, write down the:

4.6.1 NAME of the type of reaction (1)

4.6.2 IUPAC name of compound **Z**. (2)
[15]

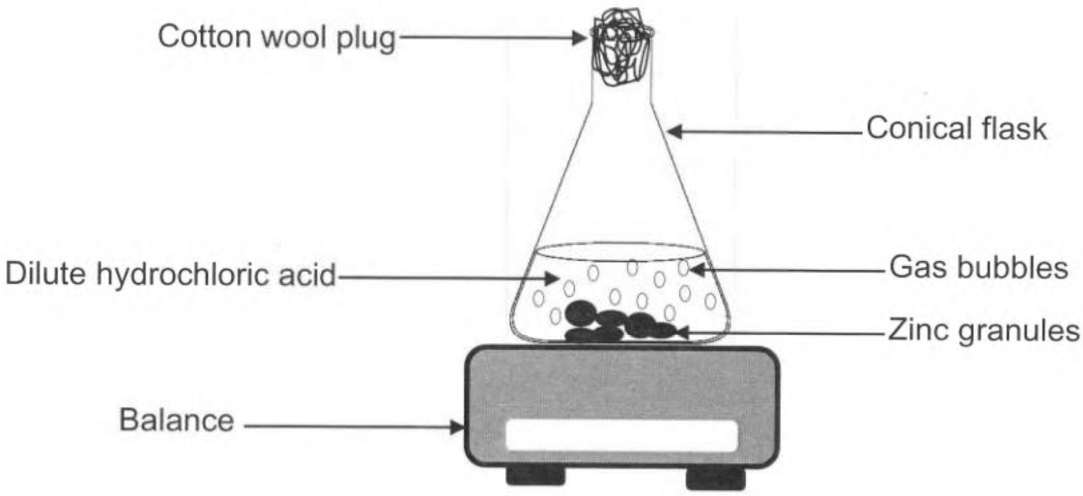
QUESTION 5 (Start on a new page.)

The reaction between zinc, Zn(s), with EXCESS dilute hydrochloric acid, HCℓ(aq), is used to investigate factors that affect the rate of a reaction.

The balanced equation for the reaction is:

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

The apparatus used is illustrated below.



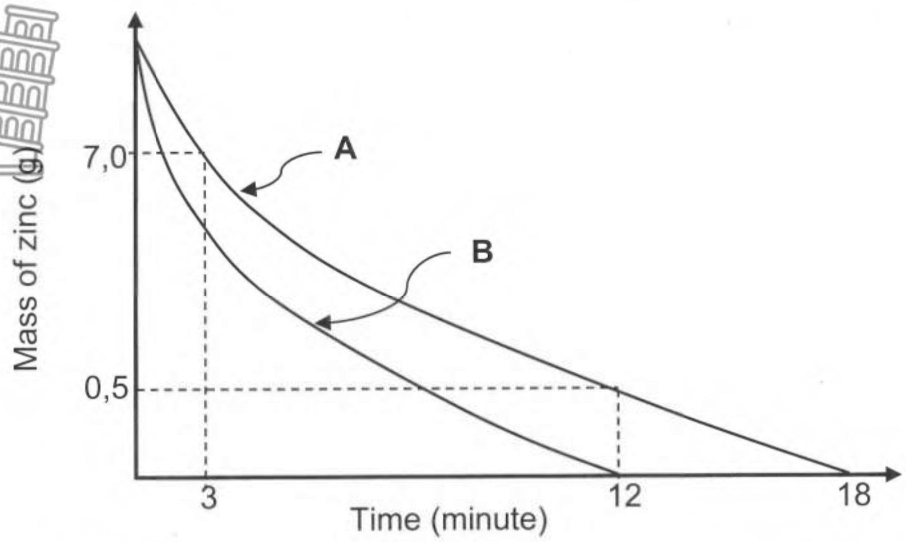
5.1 Define the term *reaction rate*. (2)

5.2 What is the function of the cotton plug? (1)

A summary of the conditions used in EXPERIMENT **1** and **2** is given in the table below.

EXPERIMENT	MASS (Zn)	VOLUME HCℓ (cm^3)	TEMPERATURE (°C)	STATE OF DIVISION
1	x	150	30	Granules
2	x	150	30	Powder

The change in mass of zinc is calculated and recorded in 3-minute intervals for both experiments. The results obtained are shown in the graph below (NOT drawn to scale).



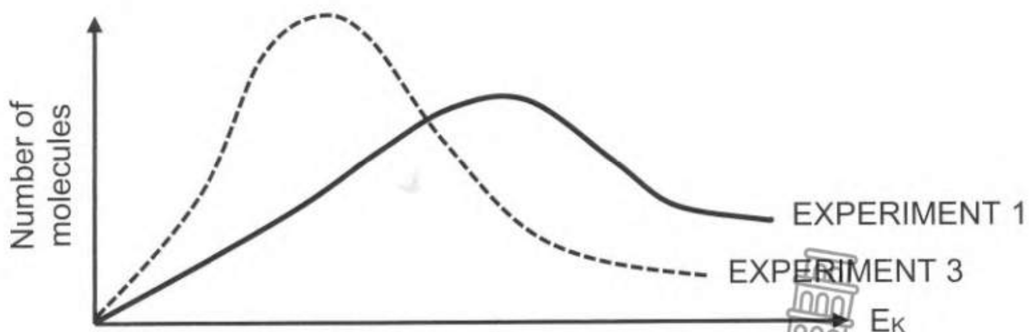
5.3 Use the information in the graph to answer the following questions:

5.3.1 Which graph **A** or **B** represents EXPERIMENT **2**? (1)

5.3.2 Calculate the number of moles of hydrochloric acid that reacted from t = 3 minutes to t = 12 minutes in the experiment that is represented by graph **A**. (4)

5.4 Calculate the initial mass of zinc used if the average rate of formation of hydrogen gas, in the experiment represented by graph **B**, is $2,5 \times 10^{-4}$ mol·s^{-1}. (5)

5.5 A third experiment (EXPERIMENT **3**) is carried out by changing only one condition in EXPERIMENT **1**. Two energy distribution curves for the reaction in EXPERIMENTS **1** and **3** are shown in the graph below.



5.5.1 What change was made to the reaction conditions in EXPERIMENT **1** to obtain the results of EXPERIMENT **3**? (1)

5.5.2 Use the collision theory to explain how the change mentioned in QUESTION 5.5.1 affects the reaction rate. (4)
[18]

QUESTION 6 (Start on a new page.)

A certain amount of sulphur and 0,3 mol oxygen gas are sealed in a container at 340°C. The reaction reaches EQUILIBRIUM according to the following balanced equation:

$$S(s) + O_2(g) \rightleftharpoons SO_2(g)$$

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

6.2 How will each of the following changes affect the yield of $SO_2(g)$?

Write down only INCREASES, DECREASES or REMAINS THE SAME.

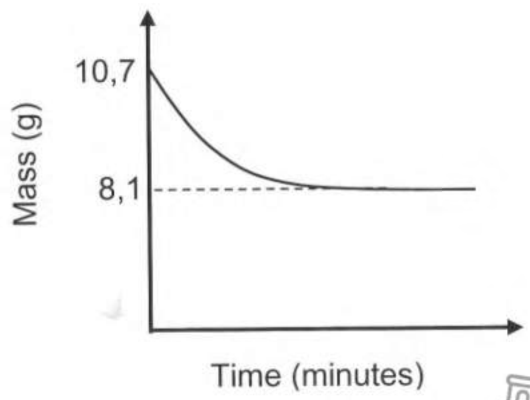
6.2.1 More Sulphur is added to the container. (1)

6.2.2 The pressure is increased by decreasing the volume of the container at constant temperature. (1)

6.3 It is found that the equilibrium constant (K_c) increases when the temperature is increased. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Fully explain the answer. (3)

6.4 How will the addition of a catalyst Influence the equilibrium constant (K_c) of this reaction? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

6.5 The graph below, not drawn to scale, shows how the amount of S(s) in the container changes with time at 340 °C.



6.5.1 Equilibrium is reached at 340 °C. Calculate the equilibrium constant, K_c, at this temperature. The volume of the container is 500 cm^3. (9)

6.5.2 Determine the K_c value for the reverse reaction. (2)
[19]

QUESTION 7 (Start on a new page.)

7.1 The dissociation constant of some substances is given in the table below:

Name of substance	Formula	Ka (298 K)
Hydrogen sulphate ion	HSO_4^-	$1,2 \times 10^{-2}$
Ammonium ion	NH_4^+	$5,6 \times 10^{-10}$
Hydrocyanic acid	HCN	$4,9 \times 10^{-10}$

7.1.1 Write down the NAME or FORMULA of the substance that has the highest tendency to dissociate. Give a reason for the answer. (2)

7.1.2 Write down the FORMULAE of the conjugate bases of hydrogen sulphate ion and hydrocyanic acid. (2)

7.2 To determine the percentage purity of a sample of oxalic acid ($H_2C_2O_4$). The three steps below are followed:

Step 1: A standard solution of sodium hydroxide, NaOH(aq), is prepared by adding 50 cm^3 of NaOH(aq) of concentration 0,63 $mol \cdot dm^{-3}$ in 950 cm^3 of water.

Step 2: An impure sample of oxalic acid solution, $H_2C_2O_4$(aq), is prepared by dissolving 0,25 g in 75 cm^3 of water.

Step 3: The $H_2C_2O_4$(aq) solution is titrated with the standard NaOH(aq).

During the titration, 40 cm^3 of the NaOH(aq) is needed to neutralise 50 cm^3 of the impure $H_2C_2O_4$(aq).

The equation for the reaction is:

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

7.2.1 Define the *endpoint of a titration*. (2)

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

7.2.3 Calculate the percentage purity of the oxalic acid sample. (6)

7.3 Sodium ethanoate solid, $CH_3COONa(s)$, undergoes hydrolysis in solution.

7.3.1 Define the term *hydrolysis*. (2)

7.3.2 How will the pH of the solution be affected by the hydrolysis of $CH_3COONa(s)$? Choose from INCREASES, DECREASES or REMAINS THE SAME. Use a balanced equation to explain the answer. (4)

[21]

QUESTION 8 (Start on a new page.)

The reaction between magnesium and copper(II)nitrate is used to set up an electrochemical cell under standard conditions. A balanced equation of the rection is given below:

$$Mg(s) + Cu(NO_3)_2(aq) \rightarrow Mg(NO_3)_2(aq) + Cu(s)$$

8.1 Write down the

8.1.1 Type of electrochemical cell (1)

8.1.2 Cell notation of this cell (3)

8.1.3 NAME of the reducing agent (1)

8.1.4 Standard conditions for this electrochemical cell (2)

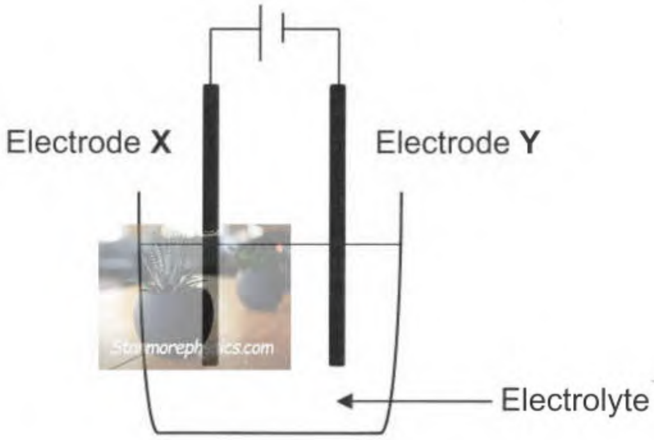
8.2 Calculate the initial emf of this cell. (4)

8.3 How will the concentration of Mg^{2+} ions be affected when the cell is functioning? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

8.4 This cell is connected to a light bulb. In theory the bulb should light up, but in practice it does not. Give TWO possible reasons for this observation. (2)
[14]

QUESTION 9 (Start on a new page.)

The diagram below shows an electrochemical cell used in the refining of copper.



9.1 Define the term *electrolyte*. (2)

9.2 Write down the formula of the cation in the electrolyte of the above electrochemical cell. (1)

9.3 When an electric current passes through the electrolyte the mass of the electrodes changes.

9.3.1 Does the mass of electrode **X** increase or decrease? (1)

9.3.2 Write down the relevant half reaction to support the answer in QUESTION 9.3.1 (2)

9.4 During the process illustrated by the above cell, a total of 2,259 x 10^{24} electrons is transferred. Calculate the mass by which the cathode change. (5)

[11]

TOTAL [150]

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* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$n = \frac{Q}{e}$	$n = \frac{Q}{q_e}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*

Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
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 POTENSTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↑

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↓

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

TABLE 4B: STANDARD REDUCTION POTENSTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents/*Toenemende sterkte van oksideermiddels*

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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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
$Cr_2O_7^{2-} + 14H^+ + 4e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7\ H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5\ e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 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

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels*