Province of the EASTERN CAPE EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Department van Onderwys
Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2024

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 19 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 subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, et cetera where required.

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

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following homologous series contains a hydroxyl group that is bonded to a saturated carbon atom?

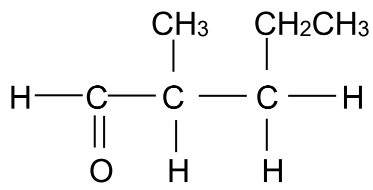
A Ketones

B Aldehydes

C Alcohols

D Esters (2)

1.2 Consider the compound shown below:



The CORRECT IUPAC name of the above compound is:

A 3-ethyl-2-methylpropanal

B 2-methyl-3-ethylpropanal

C 2-methylpentanal

D 4-methylpentanal (2)

1.3 Consider the reaction:

$$C_3H_6 + C\ell_2 \rightarrow C_3H_6C\ell_2$$

The name of the reaction is …

A hydration

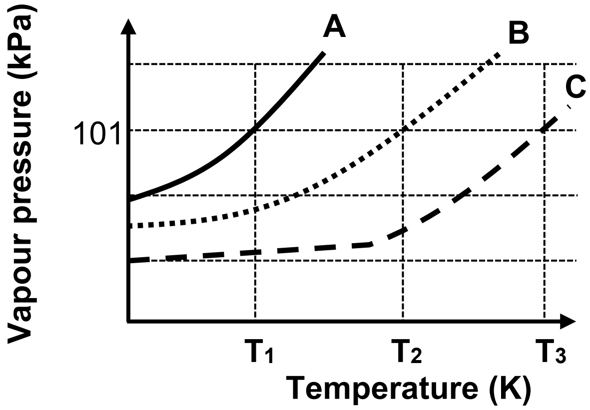
B halogenation

C hydrogenation

D hydrolysis (2)

1.4 Consider the vapour pressure against temperature curves for THREE CHAIN ISOMERS under standard atmospheric pressure.

VAPOUR PRESSURE VERSUS TEMPERATURE



Consider the statements regarding the curves for the THREE CHAIN ISOMERS.

I Compound **A** has the shortest chain length.

II The boiling point of compound **B** is T_2.

III Compound **C** is at a gaseous phase at T_2.

Which of the above statement(s) is/are true?

A **I** and **II** only

B **III** only

C **II** and **III** only

D **I** and **III** only (2)

1.5 Consider the synthesis reaction of ammonia, NH_3:

$$N_2\,(g) + 3\,H_2\,(g) \rightleftharpoons 2\,NH_3\,(g)$$

The rate at which N_2 (g) is consumed during the reaction is x mol·dm^{-3}·s^{-1}.

Which ONE of the following is the rate at which ammonia, NH_3 (g) is produced in mol·dm^{-3}·s^{-1} with respect to N_2 (g)?

A x

B $2x$

C $\frac{x}{2}$

D $3x$ (2)

1.6 Consider the following reaction at equilibrium:

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

The solution is currently **pink**.

Concentrated hydrochloric acid (HCℓ) is added to the equilibrium mixture.

Which ONE of the following combinations CORRECTLY describes the effect that the addition of concentrated hydrochloric acid (HCℓ) will have on the equilibrium constant, Kc and the colour change of the solution?

	Kc	**COLOUR CHANGE**
A	No Effect	Solutions turns pinker
B	No Effect	Solution turns blue
C	Increases	Solution turns blue
D	Decreases	Solution turns pinker

(2)

1.7 Which ONE of the following substances can be classified as a Lowry-Brønsted acid?

A Na_2CO_3

B KOH

C NH_4^+

D NaCℓ (2)

1.8 Consider the salt, CH_3COONa.

Which ONE of the following combinations CORRECTLY identifies the hydrolysis reaction and the pH of the salt?

	HYDROLYSIS	**pH**
A	$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$	Greater than 7
B	$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$	Less than 7
C	$Na^+ + H_2O \rightleftharpoons NaOH + H_2O$	Greater than 7
D	$CH_3COO^- + Na^+ \rightleftharpoons CH_3COONa$	Equal to 7

(2)

1.9 Consider the cell notation of a galvanic cell below:

$$A\ell \,|\, A\ell^{3+} \,||\, MnO_4^- , Mn^{2+} \,|\, Pt$$

Which ONE of the following reactions occurs at the cathode?

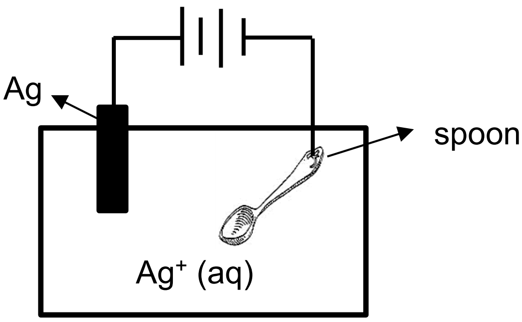
A $Mn^{2+} + 4\,H_2O \rightarrow MnO_4^- + 8\,H^+ + 5\,e^-$

B $MnO_4^- + 8\,H^+ + 5\,e^- \rightarrow Mn^{2+} + 4\,H_2O$

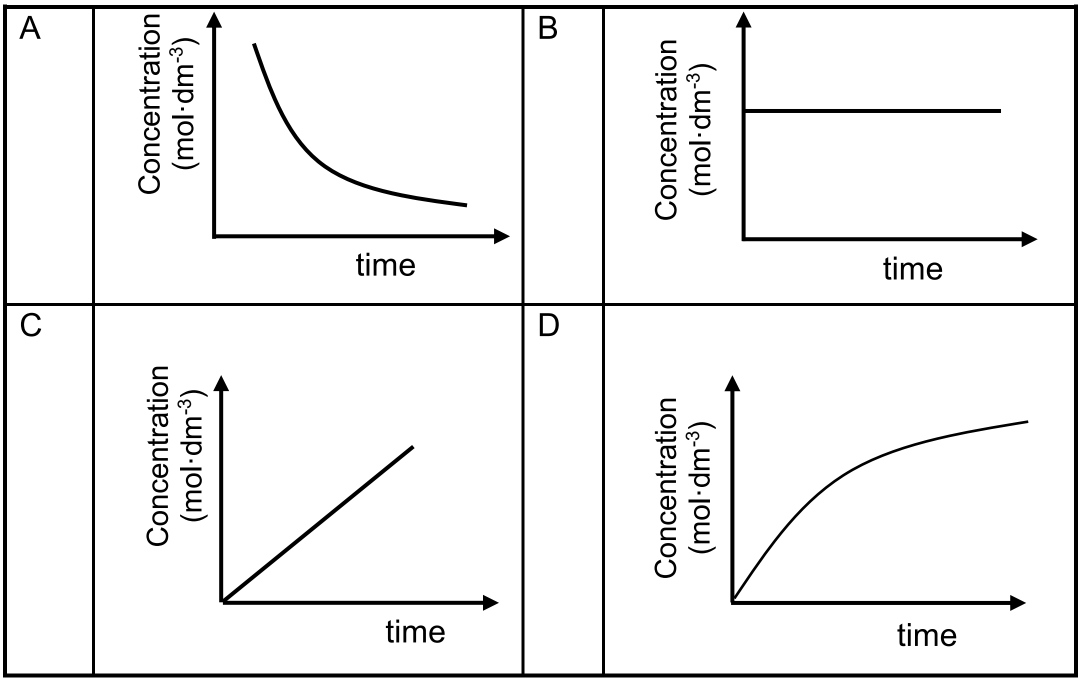
C $A\ell \rightarrow A\ell^{3+} + 3\,e^-$

D $A\ell^{3+} + 3\,e^- \rightarrow A\ell$ (2)

1.10 A spoon is plated with silver (Ag) during the process of electrolysis.



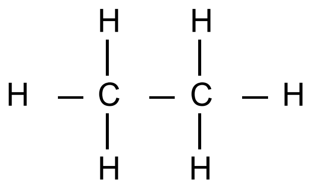
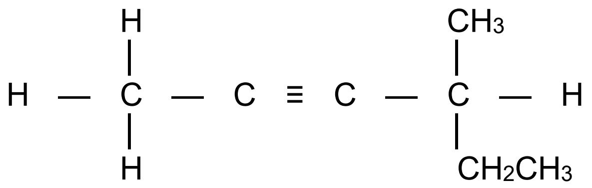
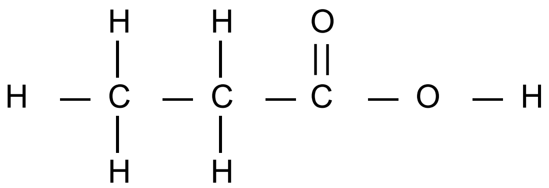
Which ONE of the following graphs BEST represents the concentration of the silver ions (Ag^+) in the electrolyte over time?



(2)
[20]

QUESTION 2 (Start on a new page.)

Consider the organic compounds **A–E** below.

A 3-methylbutanone	**B** $C_3H_7C\ell$
C 	**D** 
E 	

2.1 Define *functional group.* (2)

2.2 Write down the LETTER of a compound that:

2.2.1 Contains a carboxyl group (1)

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

2.2.3 Has an empirical formula of CH_2 (1)

2.3 How will the molecular mass of compound **E** compare to ethyl methanoate?

Choose from GREATER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (3)

2.4 Write down the:

2.4.1 STRUCTURAL FORMULA of compound **A** (2)

2.4.2 IUPAC name of compound **E** (2)

2.4.3 IUPAC name of compound **D** (3)

2.5 Compound **B** is a secondary haloalkane.

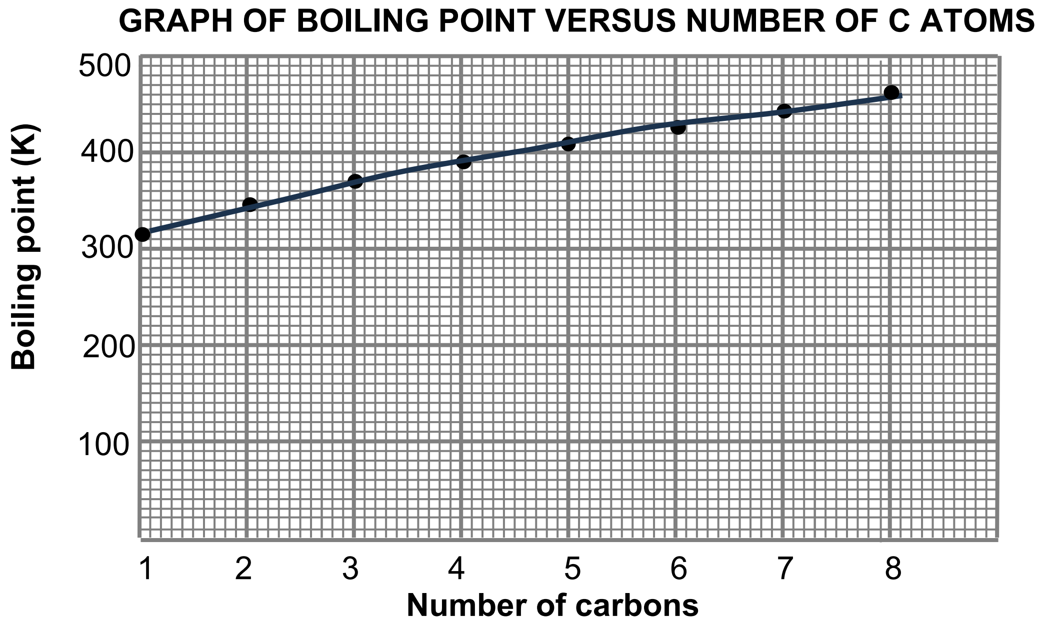
Draw the STRUCTURAL FORMULA of compound **B**. (2)

2.6 Using the MOLECULAR FORMULAE, write down the balanced equation for the complete combustion of compound **D**. (3)

[20]

QUESTION 3 (Start on a new page.)

3.1 The relationship between boiling point and the number of carbons in STRAIGHT CHAIN PRIMARY ALCOHOLS is investigated. The following curve is obtained:



3.1.1 Define *boiling point.* (2)

3.1.2 What is the structural similarity between the alcohols that make this a fair investigation? (1)

3.1.3 Which van der Waals force is responsible for the trend observed in this curve? (1)

3.1.4 Write down the IUPAC name of the alcohol with a boiling point of approximately 410 K. (2)

3.2 Another investigation is carried out to determine the effect of structural differences on the boiling point. The table below shows the different compounds and their respective molar mass that was used in this investigation.

COMPOUND		MOLAR MASS ($g{\cdot}mol^{-1}$)
A	Butanone	72
B	Butan-1-ol	74
C	Propanoic acid	74

3.2.1 Which compound **A**, **B** or **C** will have the highest boiling point? (1)

3.2.2 Fully explain the answer to QUESTION 3.2.1. (5)
[12]

QUESTION 4 (Start on a new page.)

4.1 Consider the three organic reactions, **I**, **II** and **III** below:

I	Pent-1-ene + HCℓ → Organic compound **P** (Major product)
II	Organic compound **P** + NaOH → secondary alcohol **Q** + NaCℓ
III	Organic compound **P** + NaOH → Organic compound **R** + NaCℓ + H_2O (Major product)

4.1.1 Is pent-1-ene SATURATED or UNSATURATED? Give a reason for the answer. (2)

Write down the type of reaction represented by:

4.1.2 Reaction **II** (1)

4.1.3 Reaction **III** (1)

Write down the:

4.1.4 STRUCTURAL FORMULA of compound **P**. (2)

4.1.5 IUPAC name of compound **Q**. (2)

4.1.6 Reactions **II** and **III** require the use of a strong base.

Write down the conditions that will prefer reaction **II** over reaction **III.** (2)

4.1.7 Pent-1-ene and organic compound **R** are isomers.

What type of isomer is pent-1-ene and organic compound **R**?

Choose from FUNCTIONAL, POSITIONAL or CHAIN. (2)

4.2 The flow diagram below shows the conversion of butan-1-ol to butane gas.

$$\boxed{\text{Butan-1-ol}} \xrightarrow{\text{Step 1}} \boxed{\text{Organic compound } \mathbf{X}} \xrightarrow{\text{Step 2}} \boxed{\text{Butane}}$$

The following chemicals are needed:

Concentrated H_2SO_4	Pt	H_2

Using CONDENSED STRUCTURAL FORMULAE, write down the balanced equation and indicate the chemicals used in each step in the preparation of butane gas from butan-1-ol. (6)

[18]

QUESTION 5 (Start on a new page.)

The reaction between EXCESS hydrochloric acid ($HCℓ$) with zinc (Zn) is used to investigate factors that influences the reaction rate. The balanced equation for this reaction is:

$$Zn\ (s) + 2\ HCℓ\ (aq) \rightarrow ZnCℓ_2\ (aq) + H_2\ (g) \qquad \Delta H < 0$$

Three experiments are carried out and one factor is changed in each experiment. The same volume of hydrochloric acid and the same mass of zinc granules are used in each experiment. The hydrochloric acid completely covers the zinc in each experiment.

The table below shows the reaction conditions.

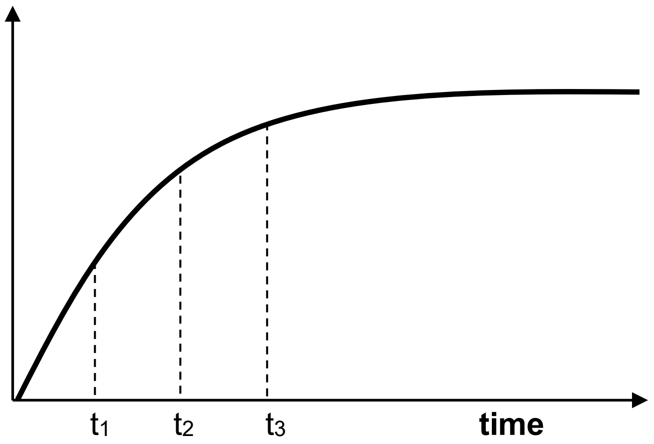
EXPERIMENT	CONCENTRATION OF HCℓ ($mol \cdot dm^{-3}$)	Cu (s) PRESENT
1	0,5	No
2	0,8	No
3	0,5	Yes

5.1 Define *reaction rate.* (2)

5.2 Write down an investigative question when comparing experiments **1** and **2.** (2)

5.3 The curve, not drawn to scale, is obtained for the volume of hydrogen gas, H_2 (g) produced over time for experiment **1**.

VOLUME OF HYDROGEN GAS VERSUS TIME



5.3.1 How does the rate at which hydrogen gas is produced between t_1–t_2 compare to that at t_2–t_3?

Write down only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

5.3.2 Redraw the graph in the ANSWER BOOK. Clearly label the curve as **A**.

On the same set of axes, sketch the curve that will be obtained for experiment **3**. Label this curve as **B**. (2)

5.4 The reaction in experiment **1** takes 58 s to reach completion and the average reaction rate at which hydrogen gas, H_2 is produced is 8,39 $cm^3 \cdot s^{-1}$.

Calculate the initial mass of zinc used in each experiment.

The molar volume for hydrogen gas (H_2) at 25 °C is 24 000 $cm^3 \cdot mol^{-1}$.

Experiment **4** is now conducted by increasing the temperature of the reaction mixture in experiment **1**. (5)

5.5 How will this change affect the reaction rate?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

5.6 Explain the answer to QUESTION 5.5 by referring to the collision theory. (3)
[16]

QUESTION 6 (Start on a new page.)

6.1 Consider the following hypothetical reaction at equilibrium:

$$A\ (g) \rightleftharpoons 2\ B\ (g)$$

The data in the table below shows the equilibrium concentrations of A (g) and B (g) at different temperatures:

Temperature (˚C)	A ($mol·dm^{-3}$)	B ($mol·dm^{-3}$)
200	0,0125	0,843
300	0,171	0,764

6.1.1 State Le Chaterlier's principle. (2)

6.1.2 Is the FORWARD or REVERSE reaction favoured at 200 ˚C?

Give a reason for the answer. (2)

How will the equilibrium concentration of **A** at 200 ˚C be affected by the following:

Choose from INCREASES, DECREASES or NO EFFECT

6.1.3 The pressure is increased. (1)

6.1.4 Addition of a suitable catalyst. (1)

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

6.1.6 Use Le Chatelier's principle and refer to the data in the table to explain the answer to QUESTION 6.1.5. (3)

6.2 Initially 1,05 moles of Bromine (Br_2) are sealed in an empty container. The following reaction occurs at 1 600 ˚C.

$$Br_2\ (g) \rightleftharpoons 2\ Br\ (g)$$

At equilibrium the concentration of Bromine (Br_2) is 2,074 $mol·dm^{-3}$. The equilibrium constant, Kc is $6,34 \times 10^{-4}$ at 1 600 ˚C.

Calculate the volume of the container. (7)

[17]

QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid, H_2SO_4 is a strong acid that ionises in two steps as represented by the equations below:

Step 1: $H_2SO_4\,(aq) + H_2O\,(\ell) \rightleftharpoons HSO_4^-\,(aq) + H_3O^+\,(aq)$

Step 2: $HSO_4^-\,(aq) + H_2O\,(\ell) \rightleftharpoons SO_4^{2-}\,(aq) + H_3O^+\,(aq)$

7.1.1 Explain what is meant by *strong acid.* (2)

7.1.2 Give a reason why sulphuric acid is referred to as a diprotic acid. (1)

7.1.3 Write down the conjugate base of H_3O^+. (1)

7.1.4 Write down the FORMULA of the substance that acts as an ampholyte during the ionisation of sulphuric acid. (2)

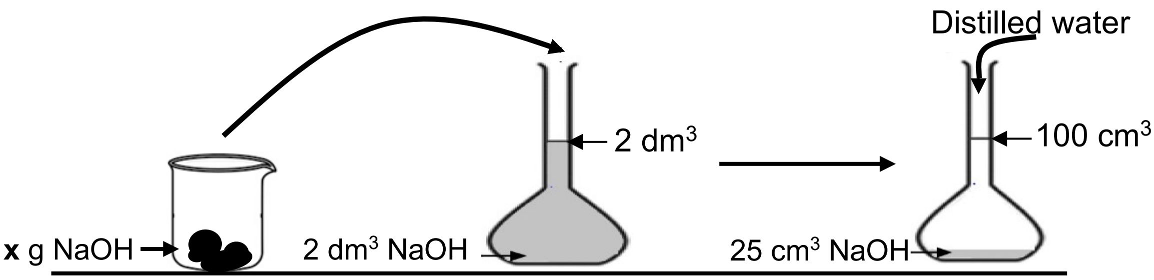
Sulphuric acid has a concentration of 0,1 mol·dm^{-3}.

7.1.5 Calculate the pH value after complete ionisation. (4)

7.2 1,2 g of anhydrous oxalic acid ($H_2C_2O_4$) is dissolved in water to make a 50 cm^3 solution.

7.2.1 Calculate the concentration of the oxalic acid, $H_2C_2O_4$. (3)

Learners dissolve **x** g of sodium hydroxide, NaOH to make a 2 dm^3 solution of sodium hydroxide, NaOH (aq). They transfer 25 cm^3 of the sodium hydroxide, NaOH solution to a volumetric flask and added distilled water to make a **diluted** 100 cm^3 solution.



They titrate 43,8 cm^3 of the **diluted** sodium hydroxide, NaOH solution against 25 cm^3 oxalic acid, $H_2C_2O_4$ prepared in QUESTION 7.2.1 to reach the endpoint.

The balanced equation is:

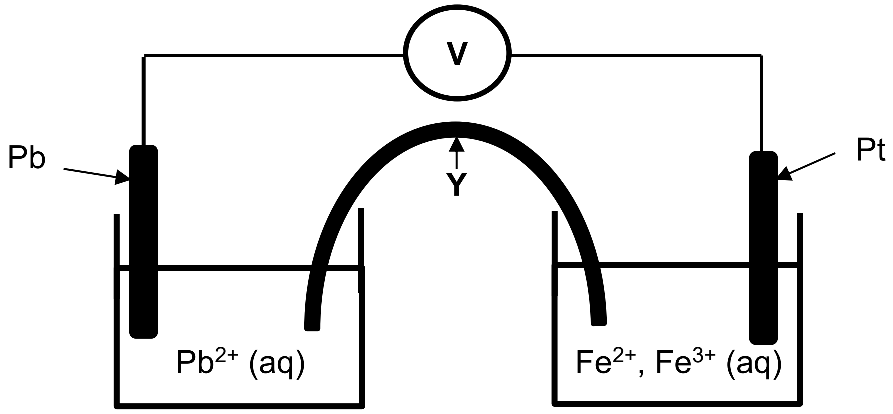
$$H_2C_2O_4\,(aq) + 2\,NaOH\,(aq) \rightarrow Na_2C_2O_4\,(aq) + 2\,H_2O\,(\ell)$$

7.2.2 Calculate the mass, **x** g of sodium hydroxide that was used to make the 2 dm^3 solution. (7)

[20]

QUESTION 8 (Start on a new page.)

A standard electrochemical cell is set up as shown below.



8.1 State the energy conversion that takes place in this cell. (2)

8.2 Component **Y** ensures that the cell is complete.

State ONE other function of component **Y**. (1)

8.3 Write down the reduction half reaction. (2)

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

8.5 How will the reading on the voltmeter be affected, if the:

Choose from INCREASES, DECREASES or REMAINS THE SAME

8.5.1 Initial concentration of Pb^{2+} is increased. (1)

8.5.2 Surface area of the Pt electrode is increased. (1)

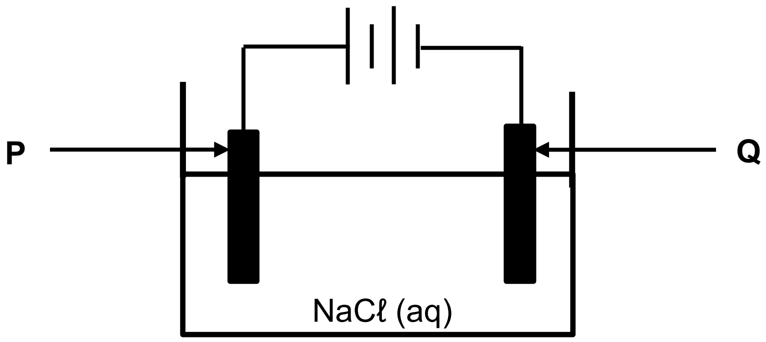
8.5.3 The $Pb | Pb^{2+}$ half-cell is replaced with $Zn | Zn^{2+}$. (1)

8.6 Explain the answer to QUESTION 8.5.3 by referring to the relative strength of the reducing agents. (2)

[14]

QUESTION 9 (Start on a new page.)

A few drops of phenolphthalein are added to concentrated sodium chloride (NaCℓ) solution. The solution remains colourless. Carbon electrodes **P** and **Q** that are connected to a battery is dipped into the solution as shown below.



9.1 Define *electrolysis.* (2)

9.2 Write down the name of the component that shows that the above cell is an electrolytic cell. (1)

9.3 Write down the NAME or FORMULA of the gas produced at electrode **Q**. (1)

9.4 Write down the half reaction that occurs on electrode **P**. (2)

9.5 Phenolphthalein is COLOURLESS in an acidic solution and PINK in an alkaline solution.

Write down the colour of the solution around electrode **Q** and formula of the substance responsible for the colour. (2)

9.6 An electrolytic cell is set-up for the purification of copper (Cu) ore that contains zinc (Zn) and platinum (Pt) impurities. After the purification of the impure copper was completed, $1,38 \times 10^{-2}$ mol of electrons were transferred. The initial mass of the cathode is 2 g.

9.6.1 Which metal, besides copper, will be oxidised?

Choose from zinc or platinum. (1)

9.6.2 Calculate the mass of the cathode after the purification. (4)
[13]

TOTAL: 150

NATIONAL SENIOR CERTIFICATE
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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 $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at /by 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*

KEY/ *SLEUTEL*

Elektronegatiwiteit / Electronegativity	*Atoomgetal* / Atomic number	*Simbool* / Symbol	*Benaderde relatiewe atoommassa* / Approximate relative atomic mass
1,9	29	Cu	63,5

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

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
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 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
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**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 POTENTIALS
TABEL 4B: STANDAARD REDUKSIEPOTENSIALE

Increasing oxidising ability/*Toenemende oksiderende vermoë* (increases down the table)

Increasing reducing ability/*Toenemende reduserende vermoë* (increases up the table)

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