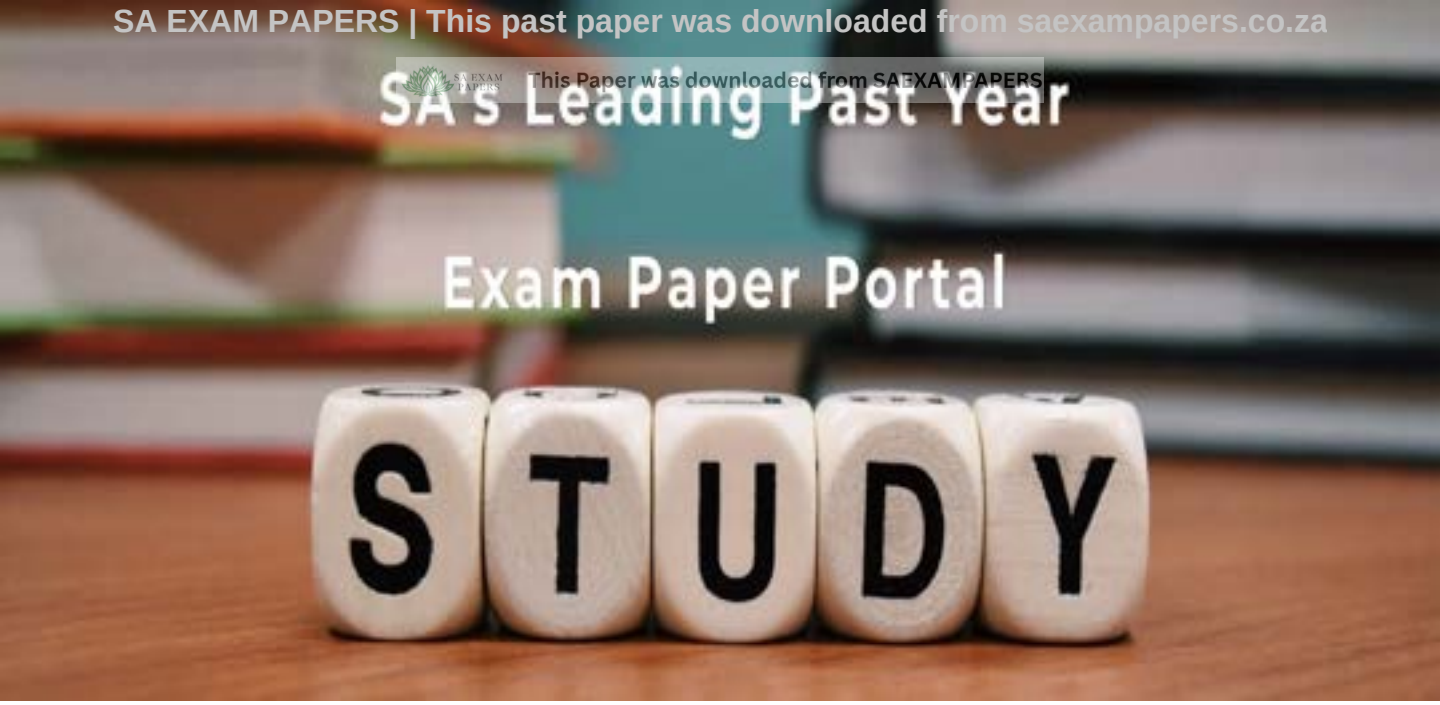


education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

PROVINCIAL ASSESSMENT

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

JUNE 2025

Marks: 150

Time: 3 hours

This question paper consists of 17 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

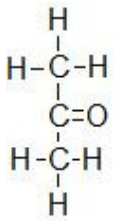
Read the following instructions carefully before answering the questions.

1. Write your name on the ANSWER BOOK.
2. This question paper consists of EIGHT questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on the 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, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. Give brief motivations, discussions, etc. where required.
7. You may use a non-programmable calculator.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. 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. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Study the structural formula of a ketone below:



Which ONE of the following is a structural isomer of the ketone shown above?

A Propan-2-one

B Propanone

C Propanal

D Propane (2)

1.2 Consider the organic compound $CH_3CH(OH)CH_2CH_3$, the IUPAC name of the CHAIN isomer of this compound is:

A Butan-2-ol

B Butan-3-ol

C 2-Methylpropan-2-ol

D 2-Methylpropanal (2)

1.3 Which ONE of the following combinations are the three compounds arranged in order of decreasing (highest to lowest) vapour pressure?

A	$CH_3CH_2CH_3$	CH_3CH_2COOH	$CHOOCH_2CH_3$
B	$CH_3CH_2CH_3$	$CHOOCH_2CH_3$	CH_3CH_2COOH
C	$CHOOCH_2CH_3$	CH_3CH_2COOH	$CH_3CH_2CH_3$
D	CH_3CH_2COOH	$CHOOCH_2CH_3$	$CH_3CH_2CH_3$

(2)

1.4 Consider the ELIMINATION reaction below:

$$C_8H_{18} \rightarrow \mathbf{X} + C_4H_{10}$$

The name of the organic product **X** is:

A Butane

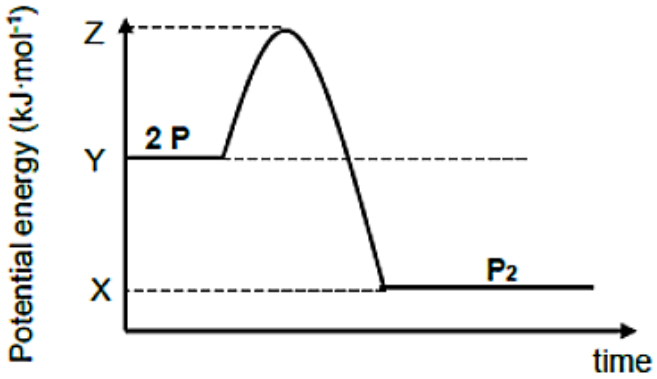
B Butan-2-ol

C But-2-ene

D But-2-yne (2)

1.5 Consider the potential energy graph for the hypothetical reaction:

$$\mathbf{2P \rightarrow P_2}$$



The heat of the reaction (ΔH) is represented by:

A Z – Y

B X – Y

C Y – X

D Y – Z (2)

1.6 Which ONE of the following is a product in ALL neutralisation reactions?

A Hydronium ion

B Hydrogen oxide

C Hydroxide ion

D Hydroxyl group (2)

1.7 Chromate ions and dichromate ions are in equilibrium with each other in an aqueous solution according to the following balanced equation:

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$
yellow orange

Which ONE of the following reagents should be added to change the colour of the solution to yellow?

A HNO_3

B $HC\ell$

C NaOH

D CH_3COOH (2)

1.8 Consider the following reaction:

$$CH_3NH_2(aq) + H_2O(\ell) \rightarrow CH_3NH_3^+(aq) + OH^-(aq)$$

The CH_3NH_2 acts as a/an …

A proton donor.

B proton acceptor.

C oxidising agent.

D reducing agent. (2)

1.9 The yield in a certain reversible reaction at equilibrium at temperature **T** and pressure **P** is 40%.

A certain catalyst is added to the reaction mixture at the start of the reaction and the reaction reaches equilibrium at the same temperature **T** and pressure **P**.

What effect will the addition of a catalyst have on the yield and rate of reaction?

	Yield	**Reaction rate**
A	Remains 40%	Higher
B	Remains 40%	Remains the same
C	Higher than 40%	Higher
D	Higher than 40%	Remains the same

(2)

1.10 The pH of a 0,5 mol·dm^{-3} HNO_3 is:

A 0,2

B 0,0301

C 0,3

D 0,03 (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 Define the term *molecular formula*. (2)

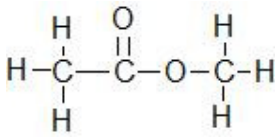
2.2 The IUPAC name of a haloalkane is 2-chloro-3,4-dimethylhexane.

2.2.1 Write down the molecular formular of this compound. (1)

2.2.2 Draw the structural formula of this compound. (2)

2.2.3 Is this compound a PRIMARY, SECONDARY or TERTIARY haloalkane. Give a reason for the answer. (3)

2.3 Study the structural formulae for compounds **A** and **B** given below:

A	B
	CH_3-CH_2-COOH

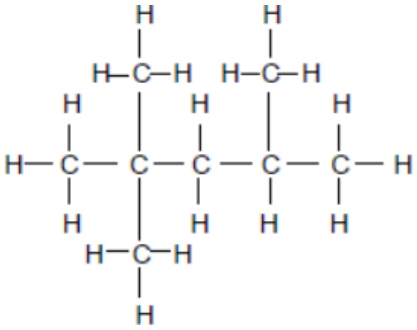
Compounds **A** and **B** are isomers.

2.3.1 Write down the NAME of the functional group of the homologous series to which compound **B** belongs. (1)

2.3.2 What TYPE of isomers are these compounds?
Give a reason for the choice. (3)

2.3.3 Write down the IUPAC name of compound **A**. (2)

2.4 Study the structural formula of the compound below:



Write down the:

2.4.1 IUPAC name (3)

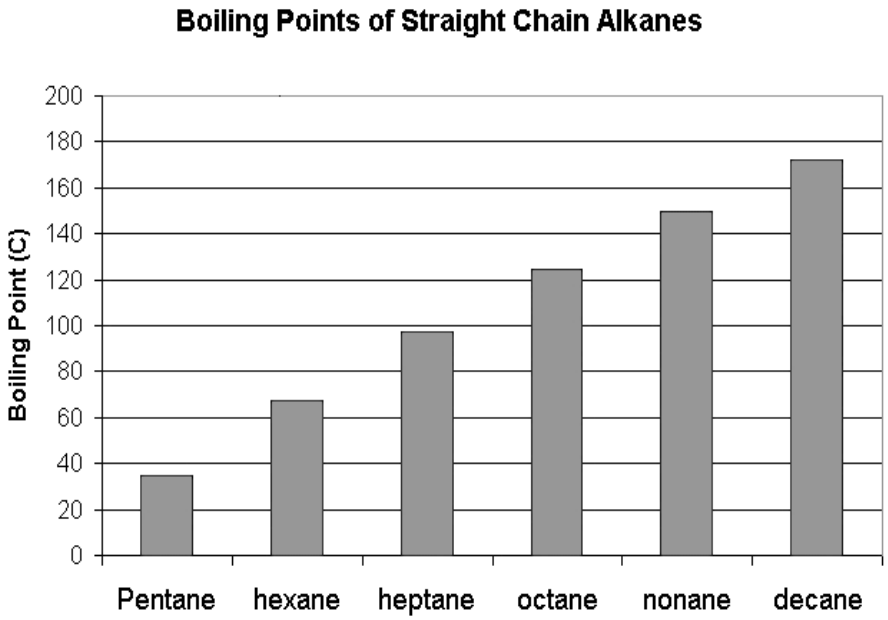
2.4.2 General formula of the homologous series to which it belongs (1)

2.4.3 Balanced chemical equation for the complete combustion in excess oxygen (3)

[21]

QUESTION 3 (Start on a new page.)

Learners investigated one of the factors that affect the boiling point of straight chain alkanes. They recorded their results in the graph shown below:



3.1 For this investigation, write down:

3.1.1 An investigative question (2)

3.1.2 Controlled variable (1)

3.2 Is the above investigation a fair comparison? YES or NO.
Give a reason for the answer. (2)

3.3 Define *vapour pressure*. (2)

3.4 Consider PENTANE and HEXANE, which compound has a higher vapour pressure? Explain the answer, refer to MOLECULAR STRUCTURE, STRENGTH of INTEMOLECULAR FORCES and ENERGY. (4)

3.5 Two compounds BUTAN-1-OL and BUTANOIC ACID have different boiling points.

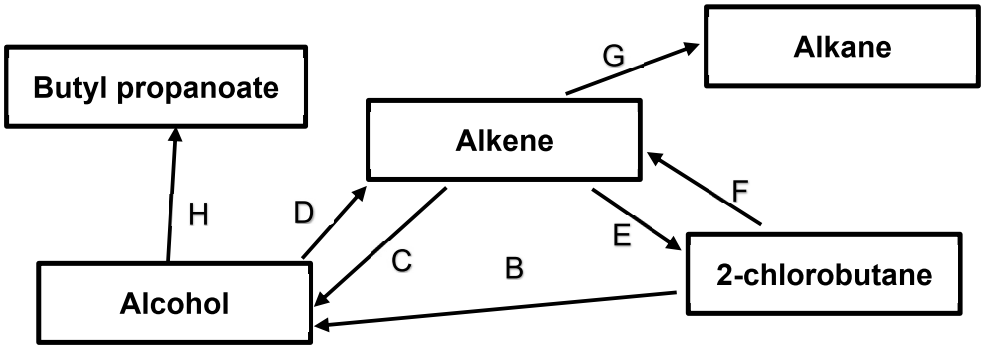
3.5.1 Which compound has a lower boiling point? (1)

3.5.2 Explain the answer to QUESTION 3.5.1 by referring to TYPE and STRENGTH of INTERMOLECULAR FORCES. (3)
[15]

QUESTION 4 (Start on a new page.)

Study the flow diagram below.

Letters **B** to **H** represent different organic reactions:



4.1 Name the TYPE of reaction represented by letter:

4.1.1 **C** (1)

4.1.2 **B** (1)

4.1.3 **F** (1)

4.2 What TYPE of alcohol is produced in reaction **C**?
Choose from PRIMARY, SECONDARY or TERTIARY. (1)

4.3 Reaction **D** is dehydration of an alcohol. What is meant by "dehydration of alcohols"? (1)

4.4 Using STRUCTURAL FORMULAE write down a balanced chemical reaction for reaction **E.** (4)

4.5 Reaction **H** represents a reaction between an alcohol and a carboxylic acid in the presence of a catalyst.

Write down the:

4.5.1 FORMULA of the catalyst (1)

4.5.2 Balanced chemical reaction using CONDENSED formulae (5)

4.5.3 Name of the carboxylic acid that was used as a reactant in this reaction (2)

4.6 Write down TWO reaction conditions for reaction **F**. (2)

4.7 Consider reaction **G**:

4.7.1 Besides platinum (Pt) used as a catalyst, write down the NAME or FORMULA of another catalyst that could be used (1)

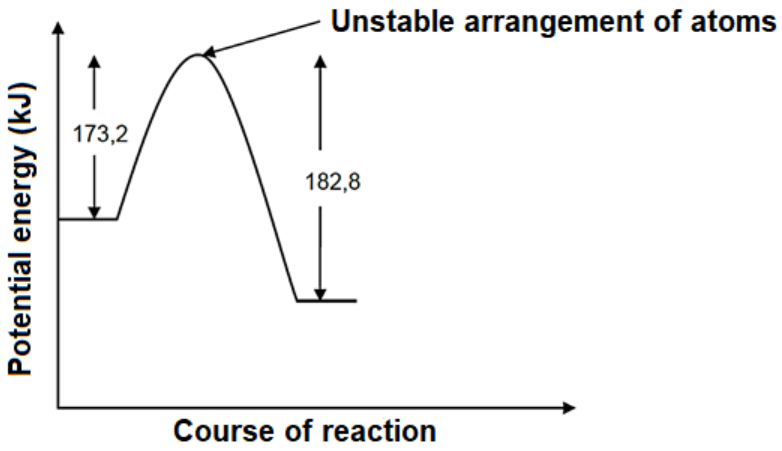
4.7.2 Write down the molecular formula of the alkane formed (1)
[21]

QUESTION 5 (Start on a new page.)

The reactions involving iodine are commonly used to investigate rates of reaction. One reaction involves hydrogen and iodine to form hydrogen iodide.

$$H_2(g) + I_2(g) \rightarrow 2HI(g)$$

5.1 The potential energy diagram for the reaction between hydrogen and iodine, is shown below:



5.1.1 Write down the term used for "unstable arrangement of atoms". (1)

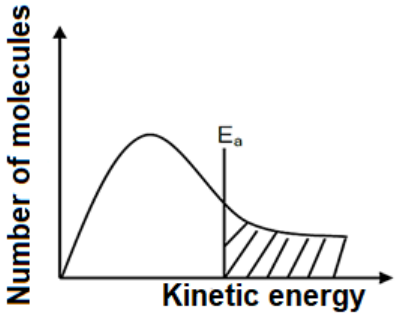
5.1.2 Calculate the enthalpy change, ΔH, in kJ, for the forward reaction. (1)

5.1.3 Is the above reaction EXOTHERMIC or ENDOTHERMIC?
Give a reason for the answer. (2)

5.1.4 Platinum can be used as a catalyst for this reaction. What effect would platinum have on the activation energy of this reaction?

Write down only INCREASE, DECREASE or REMAIN THE SAME. (1)

5.2 The graph below shows the distribution of the kinetic energy of reactant molecules in the gas mixture at 536 K.



5.2.1 Redraw the graph in your ANSWER SHEET and label it **X**. Add a second curve to the graph to show the distribution of the kinetic energy at 673 K and label it **Y**. (3)

5.2.2 Compare the reaction rate at 673 K with that at 536 K. Write down only LOWER THAN, HIGHER THAN or EQUAL TO. (1)
[9]

QUESTION 6 (Start on a new page.)

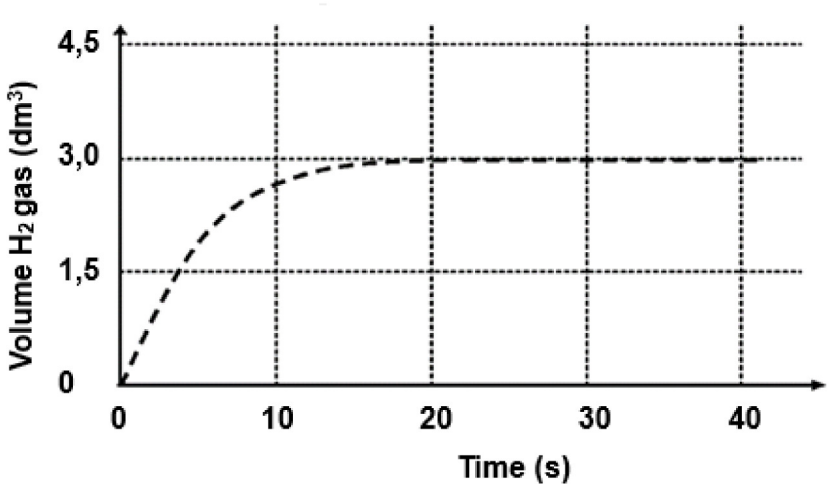
A group of learners perform a series of experiments to test the effect of certain factors on reaction rate when magnesium metal is added to EXCESS hydrochloric acid

$$Mg(s) + 2HC\ell(aq) \rightarrow 2MgC\ell_2(aq) + H_2(g) \qquad \Delta H < 0$$

The table below summarises the reaction conditions and results of the experiment:

EXPERIMENT	STATE OF MAGNESIUM	MASS OF MAGNESIUM (g)	TEMPERATURE (^{0}C)
1	Ribbon	6,0	25
2	Ribbon	6,0	15
3	Fine powder	4,5	25

The results of experiment **1** were collected and plotted on the graph below:



6.1 Define *reaction rate*. (2)

6.2 What volume of hydrogen gas was collected in experiment **1** after 40s? (1)

6.3 Calculate the average rate of reaction (in $dm^3 \cdot s^{-1}$) for experiment **1** over first 20s. (3)

6.4 How will the rate of reaction be affected if a higher concentration of $HC\ell$ (aq) is used. Choose from INCREASES, DECREASE or REMAINS THE SAME. Explain the answer in terms of collision theory. (4)

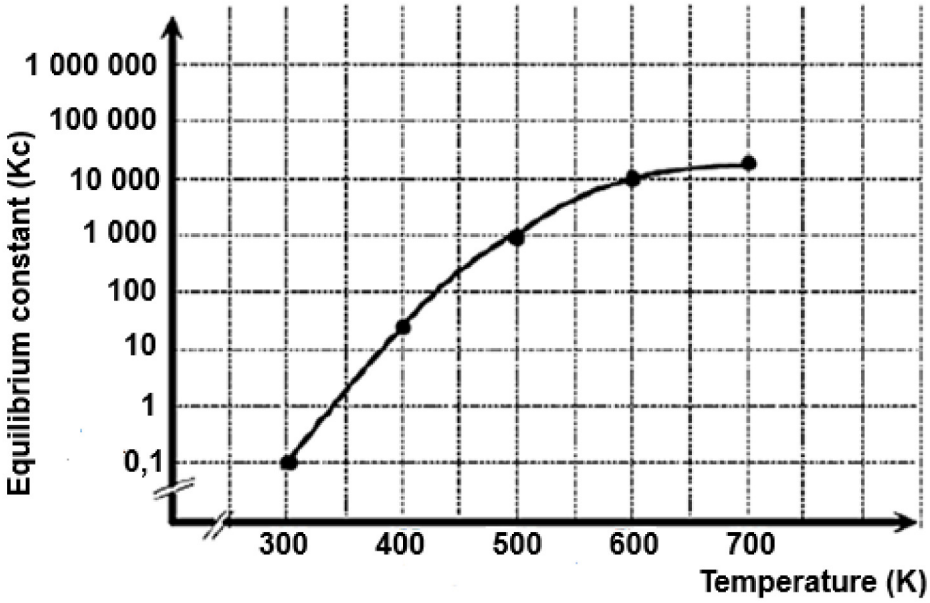
6.5 Redraw the above graph of experiment **1** in the ANSWER SHEET and on the same system of axes sketch the graphs that will be obtained for experiment **2** and **3**. Clearly label the graphs for each experiment. (4)

[14]

QUESTION 7 (Start on a new page.)

7.1 The graph below shows the effect of a temperature change on the value K_C for the following reaction taking place in a closed container:

$$N_2O_4\,(g) \leftrightarrows 2NO_2\,(g)$$



7.1.1 What effect does an increase in temperature have on the amount of NO_2 formed? (1)

7.1.2 Which reaction was favoured due to an increase in temperature? Write only FORWARD or REVERSE (1)

7.1.3 State Le Chatelier's Principle. (2)

7.1.4 Using Le Chatelier's Principle, explain whether the forward reaction is EXOTHERMIC or ENDOTHERMIC (4)

7.1.5 Write down TWO factors, other than temperature, that can be used to increase the rate of the forward reaction at 500 K. (2)

7.2 Consider the hypothetical reaction that takes place between **A_2** and **B** in a closed container:

$$A_2(g) + 2B(g) \leftrightarrow 2AB(aq) \qquad \Delta H > 0$$

Colourless Dark red

X mol of gas **A_2** and 2,0 mol of gas **B** are sealed in a 1,0 dm^3 container. After a few minutes equilibrium is reached, and the contents of the container turns light red.

At equilibrium it is found that 0,40 mol of gas **AB** is present in the container. The value of K_C is 0,50.

7.2.1 Determine **X**, the quantity (in mol) of gas **A_2** that was originally sealed in the container. (8)

[18]

QUESTION 8 (Start on a new page.)

Two groups of grade 12 learners were given separate experiments to conduct using a strong base (sodium hydroxide) and weak acids (oxalic acid and ethanoic acid) respectively.

8.1 **GROUP 1**

Learners were asked to determine the percentage purity of a sample of oxalic acid ($H_2C_2O_4$). To do this, they followed the procedure below:

i. Prepared a standard solution of sodium hydroxide by diluting 50,0 cm^3 of NaOH solution of concentration 0,63 $mol.dm^{-3}$ to a volume of 1,00 dm^3
ii. Prepared a solution of oxalic acid by dissolving 0,25 g of the IMPURE SAMPLE in 75 cm^3
iii. Titrate the oxalic acid solution against the standard NaOH solution. The titration required 40,02 cm^3 of the NaOH solution to neutralize ALL the oxalic acid solution in STEP (ii) above.

The equation for the reaction is:

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

8.1.1 Define a *standard solution*. (2)

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

8.1.3 Calculate the percentage purity of the oxalic acid sample. (7)

8.2 **GROUP 2**

Learners were required to find the concentration and percentage of ethanoic acid in household vinegar. To do this they used the following procedure:

i. Diluted vinegar sample by placing 25 cm^3 household vinegar in a 250 cm^3 volumetric flask and adding water up to the 250 cm^3 mark.
ii. Titrate the diluted vinegar sample with a solution of NaOH of concentration 0,2 $mol.dm^{-3}$.

8.2.1 Calculate the pH of the NaOH solution. (4)

In the titration, 15 cm^3 of the diluted vinegar sample needed 30,25 cm^3 of the sodium hydroxide solution for the endpoint to be reached.

$$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$$

8.2.2 Define *endpoint.* (2)

8.2.3 Calculate the concentration of diluted vinegar solution (in ethanoic acid). (4)

8.2.4 If 1 cm^3 vinegar has a mass of 1 g, calculate the percentage ethanoic acid by mass, present in the vinegar. (5)

8.3 Sodium ethanoate, CH_3COONa, undergoes hydrolysis.

8.3.1 Define “hydrolysis of salt”. (2)

8.3.2 How will the pH of the water be affected by the hydrolysis reaction? (choose from INCREASES, DECREASES or REMAINS THE SAME)

Write a balanced chemical equation that will explain the answer. (3)
[32]

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
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* $E^\theta_{cell} = E^\theta_{oxidisingagent} - E^\theta_{reducingagent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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