Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2024

PHYSICAL SCIENCES: (CHEMISTRY) P2

MARKS: **150**

TIME: **3 hours**

This question paper consists of 19 pages, including 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and surname in the appropriate space on the ANSWER BOOK.
2. This question paper consists of SEVEN 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.

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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 The homologous series that contain a carbon-carbon triple bond is …

A alkanes.

B alkenes.

C alkynes.

D haloalkanes. (2)

1.2 Consider the following compounds:

Compounds	
A	Pentan-1-ol
B	Butan-1-ol
C	Pentanoic acid

Which ONE of the following correctly rank the above pure substances in the order of increasing strength of intermolecular forces?

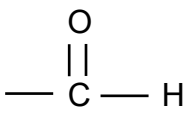
A Pentan-1-ol, butan-1-ol, pentanoic acid

B Pentanoic acid, butan-1-ol, pentan-1-ol

C Butan-1-ol, pentanoic acid, pentan-1-ol

D Butan-1-ol, pentan-1-ol, pentanoic acid (2)

1.3 Consider the structural formula:



Which ONE of the following compounds contains the above functional group?

A Propanal

B Propanone

C Propan-1-ol

D Propanoic acid (2)

1.4 2-methylpropan-1-ol can form two isomers. Which ONE of the following combinations CORRECTLY identifies the ISOMER and the TYPE OF ISOMER?

	NAME OF ISOMER	TYPE OF ISOMER
A	Butan-1-ol	Positional
B	2-methylpropan-2-ol	Chain
C	Butan-1-ol	Functional
D	2-methylpropan-2-ol	Positional

(2)

1.5 The conversion of CH_3CHCH_2 to $CH_3CH_2CH_3$ is known as …

A hydration.

B hydrogenation.

C halogenation.

D hydrohalogenation. (2)

1.6 Hydrochloric acid reacts with EXCESS zinc according to the balanced equation:

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

Which ONE of the following factors will influence the yield of H_2 (g) but not on the rate of production of H_2 (g)?

A Temperature

B Volume of $HC\ell$

C State of division of Zn

D Concentration of $HC\ell$ (2)

1.7 Carbonic acid, H_2CO_3, ionises in water in two steps. The first step of the ionisation is given by the equation:

$$H_2CO_3\,(aq) + H_2O\,(\ell) \rightleftharpoons HCO_3^-\,(aq) + H_3O^+\,(aq)$$

Which ONE of the following substances in the above reaction can act as an ampholyte?

A H_2CO_3 and H_2O

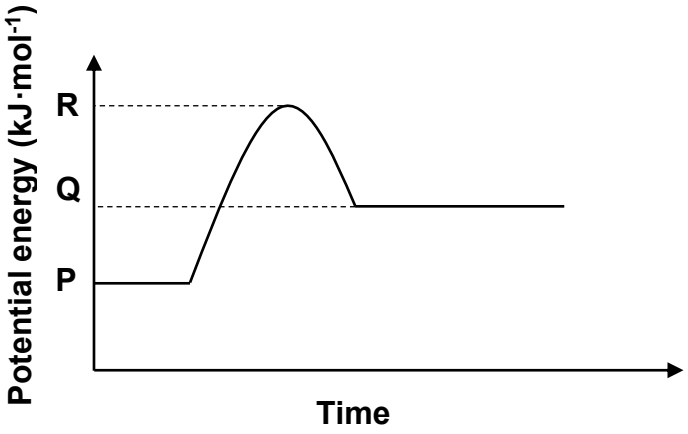
B HCO_3^- and H_3O^+

C H_2O and HCO_3^-

D H_2CO_3 and HCO_3^- (2)

1.8 The potential energy diagram for the following reversible hypothetical reaction is given:

$$2\,AB\,(g) \rightleftharpoons A_2\,(g) + Br_2\,(g)$$



Consider the following statements regarding the energy diagram.

I Δ H for the forward reaction is positive

II Catalyst would lower P–Q

III Reversible reaction is exothermic

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

A **I** only

B **I** and **II** only

C **I** and **III** only

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

1.9 Consider the following reversible reaction at equilibrium in a sealed container:

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

The volume inside the container is decreased while the temperature remains constant.

Which ONE of the following combinations are CORRECT regarding the amount of CO and the rate at which the new equilibrium is reached?

	AMOUNT OF CO	REACTION RATE
A	Higher	Lower
B	Lower	Higher
C	Higher	Higher
D	Lower	Lower

(2)

1.10 Consider two solutions of $Ba(OH)_2$ (aq) and KOH (aq) each with a concentration of 0,1 $mol \cdot dm^{-3}$.

Consider the following statements regarding the two solutions.

I Both KOH and $Ba(OH)_2$ can be regarded as Arrhenius bases

II $Ba(OH)_2$ will produce a higher concentration of OH^- than KOH when it dissociates

III Double the amount of HCℓ is needed to neutralise KOH than $Ba(OH)_2$

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

A **I** only

B **I** and **II** only

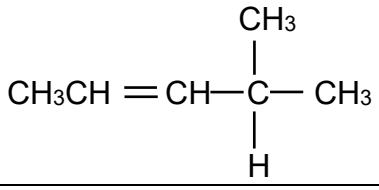
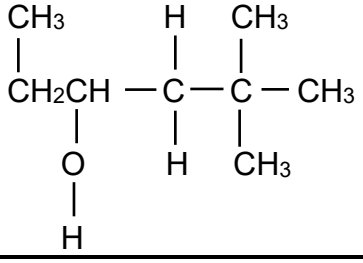
C **II** and **III** only

D **I** and **III** only

(2)
[20]

QUESTION 2 (Start on a new page.)

The table below shows organic molecules **A** to **E** from different homologous series.

A	$CH_3C\ell$	**B**	
C	Butanone	**D**	
E	$C_xH_yO_2$		

2.1 Define *homologous series.* (2)

2.2 Write down the LETTER that represents the following compounds:

2.2.1 Hydrocarbon (1)

2.2.2 Haloalkane (1)

2.2.3 Alkene (1)

2.2.4 The compound that contains the carbonyl group that is bonded to two saturated carbon atoms (1)

2.3 Is compound **D** a PRIMARY, SECONDARY OR TERTIARY ALCOHOL?
Give a reason for the answer. (2)

2.4 Write down the:

2.4.1 General formula for the homologous series to which compound **B** belong. (1)

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

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

2.5 Compound **C** has a functional isomer.

2.5.1 Define the term *functional isomer.* (2)

2.5.2 Draw the STRUCTURAL FORMULA of the functional isomer of compound **C**. (2)

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2.6 Compound **E** ($C_xH_yO_2$) reacts with alcohol **P** in the presence of concentrated sulphuric acid (H_2SO_4) to produce organic compound **Q** as shown by the incomplete equation below:

$$C_xH_yO_2 + \text{alcohol } \mathbf{P} \rightarrow \text{organic compound } \mathbf{Q} + H_2O$$

The percentage composition of compound **Q** is:

Organic compound **Q**		
Carbon	Hydrogen	Oxygen
58,82%	9,81%	31,37%

The molecular mass of the compound **Q** is EQUAL to the formula mass.

2.6.1 Write down the name of the type of reaction that occurred. (1)

2.6.2 Determine, by calculation, the molecular formula of organic compound **Q**. (5)

Compound **E** ($C_xH_yO_2$) has a molecular mass of 74 $g \cdot mol^{-1}$.

2.6.3 Determine the compound **E** ($C_xH_yO_2$) and write down its IUPAC name. (4)

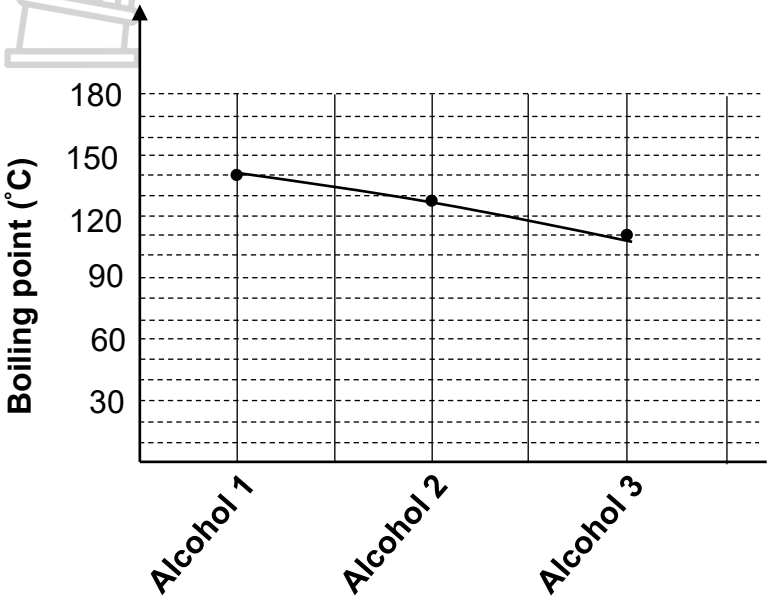
2.6.4 Determine the organic compound **Q** that was produced, write down its IUPAC name and STRUCTURAL FORMULA. (6)

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QUESTION 3 (Start on a new page.)

An investigation is carried out to determine the effect of branching on the boiling points of an organic compounds. Three PRIMARY ALCOHOLS that each contains 5 carbon atoms are used during this investigation.

Equal volumes of each alcohol are heated separately in a water bath.



3.1 Define *boiling point.* (2)

3.2 What property of alcohols requires them to be heated in a water bath? (1)

3.3 Write down the boiling point of alcohol **1**. (1)

3.4 Is this a fair investigation? Write only YES or NO.
Give a reason for the answer. (2)

3.5 Give the IUPAC name of alcohol **2**. (2)

3.6 Which alcohol has the shortest chain length?

Write down only ALCOHOL **1**, ALCOHOL **2** or ALCOHOL **3**. (1)

3.7 Fully explain the answer to QUESTION 3.6. (3)

3.8 A second investigation is carried out to determine the effect of intermolecular forces on the vapour pressure.

The table below summarises the results from two organic compounds.

	COMPOUND	VAPOUR PRESSURE AT 20 °C (kPa)
A	Butanone	9,47
B	Butan-1-ol	0,58

3.8.1 Define *vapour pressure.* (2)

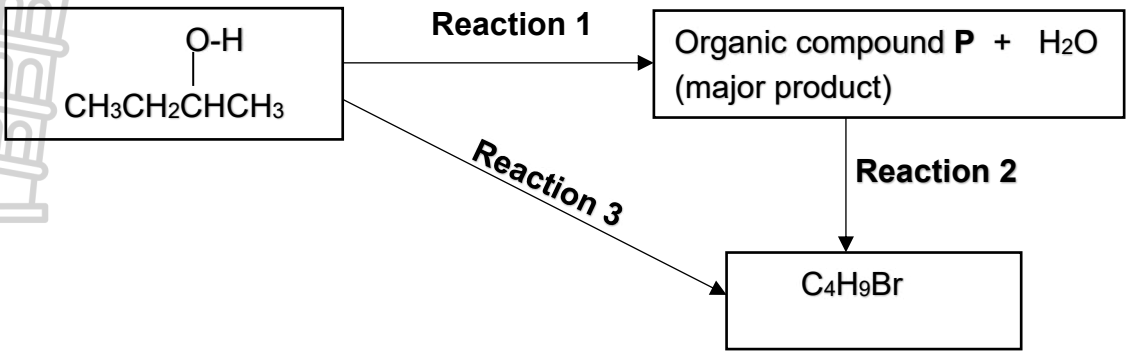
3.8.2 Explain the difference in vapour pressures by referring to the intermolecular forces involved. (4)

3.8.3 Will the vapour pressure of the above compounds INCREASE, DECREASE or REMAIN THE SAME at a higher temperature? (1)

[19]

QUESTION 4 (Start on a new page.)

4.1 Consider the flow diagram showing organic reactions given below.



Consider **REACTION 1**.

Write down the:

4.1.1 Name of the type of elimination reaction (1)

4.1.2 Name or formula of the inorganic reagent needed (1)

4.1.3 Balanced equation using STRUCTURAL FORMULAE for the organic compounds (4)

Consider **REACTION 2**.

Write down the:

4.1.4 Name the type of reaction taking place (1)

4.1.5 STRUCTURAL FORMULA and IUPAC name for the major product formed (4)

Consider **REACTION 3**.

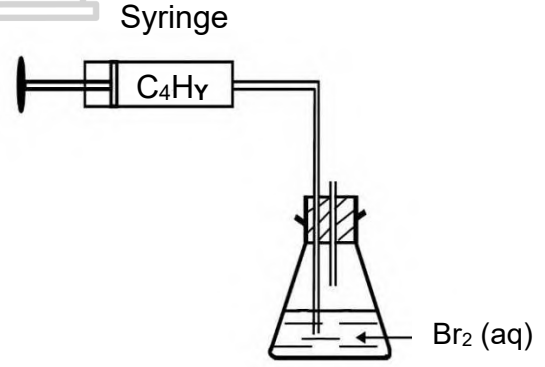
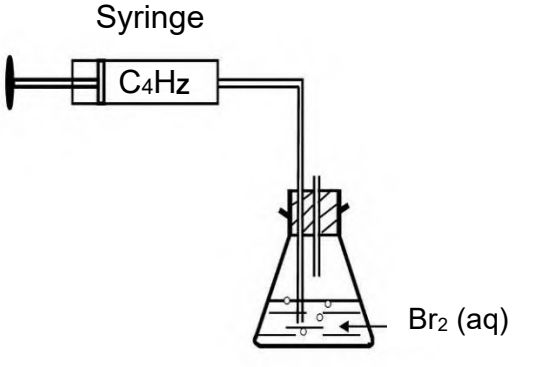
Write down the:

4.1.6 TWO reaction conditions needed (2)

4.2 Octane can be cracked according to the incomplete equation:

$$C_8H_{18} \rightarrow C_4H_Y + C_4H_Z$$

The two STRAIGHT CHAIN organic compounds, C_4H_Y and C_4H_Z, are now passed through bromine water (Br_2 (aq)) at room temperature in a darken room. The following observations are made:

EXPERIMENT 1	**EXPERIMENT 2**
	
When compound C_4H_Y is bubbled through the bromine water, no changes are observed.	When compound C_4H_Z is bubbled through the bromine water, the yellowish colour of the bromine water immediately turns colourless and bubbles are observed in the flask.

4.2.1 Define *cracking.* (2)

4.2.2 Give a reason why experiments **1** and **2** is carried out in a darken room. (1)

4.2.3 Which compound, C_4H_Y or C_4H_Z, is UNSATURATED?
Give a reason for the answer. (2)

Compound C_4H_Y undergoes the following reactions:

I	$C_4H_Y + C\ell_2 \xrightarrow{\text{UV-light}}$ Primary haloalkane $+ HC\ell$
II	Primary haloalkane + NaOH (conc) $\longrightarrow$ $C_4H_Z + NaC\ell + H_2O$

Write down the:

4.2.4 STRUCTURAL FORMULA for compound C_4H_Z (2)

4.2.5 Combustion reaction of compound C_4H_Y using MOLECULAR FORMULAE (3)

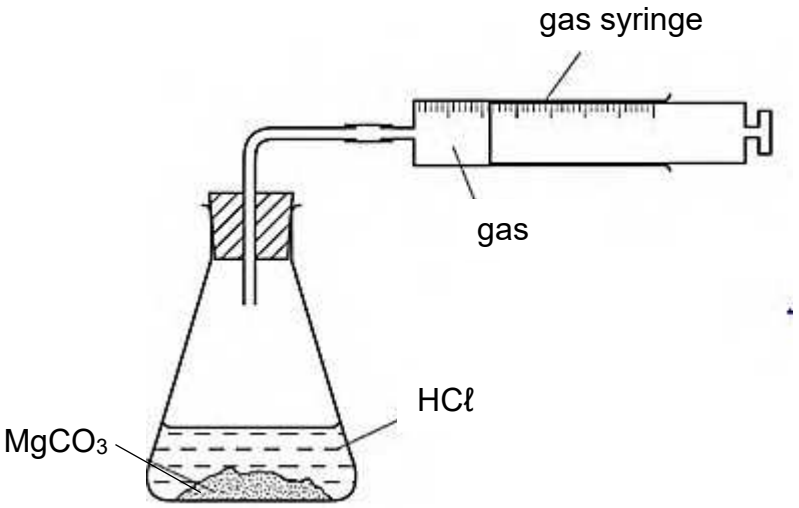
[23]

QUESTION 5 (Start on a new page.)

A group of learners use the reaction between magnesium carbonate ($MgCO_3$) and EXCESS hydrochloric acid ($HC\ell$) to investigate some of the factors that affect the reaction rate. The balanced equation for the reaction is:

$$MgCO_3\ (aq) + 2\ HC\ell\ (aq) \longrightarrow MgC\ell_2\ (aq) + H_2O\ (\ell) + CO_2\ (g)$$

The learners used the apparatus illustrated below.



The table below summarises the reaction conditions:

EXPERIMENT	REACTION CONDITIONS		
	CONCENTRATION OF $HC\ell$ ($mol \cdot dm^{-3}$)	STATE OF DIVISION OF $MgCO_3$	INITIAL TEMPERATURE (˚C)
1	0,9	Powder	25
2	0,9	Powder	30
3	0,9	Lumps	30

5.1 Define *reaction rate.* (2)

5.2 Write down the independent variable for the comparison between experiment **1** and **2.** (1)

5.3 Experiment **2** and **3** is now compared.

5.3.1 Which experiment, **2** or **3**, will have the highest reaction rate? (1)

5.3.2 Explain the answer to QUESTION 5.3.1 by referring to the collision theory. (3)

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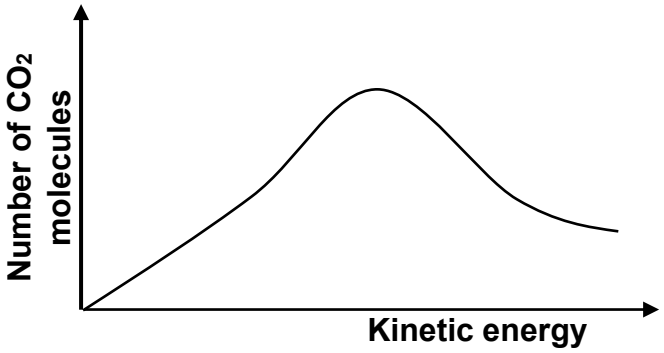
5.4 The learners measured the rate at which CO_2 was produced in experiment **2** and found it to be 0,25 $g \cdot min^{-1}$. It took 10,44 minutes to measure the time taken for the reaction to reach completion.

Calculate the:

5.4.1 Mass of $MgCO_3$ that was used (6)

5.4.2 Molar volume of CO_2 if 1,47 dm^3 of CO_2 was released (3)

5.5 The graph below represents Maxwell-Boltzmann distribution curve for $CO_2(g)$ produced experiment **1**.



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

On the same set of axes, sketch the curve that will be obtained for $CO_2(g)$ if the mass of $MgCO_3$ used is increased.
Label this curve as **B**. (2)
[18]

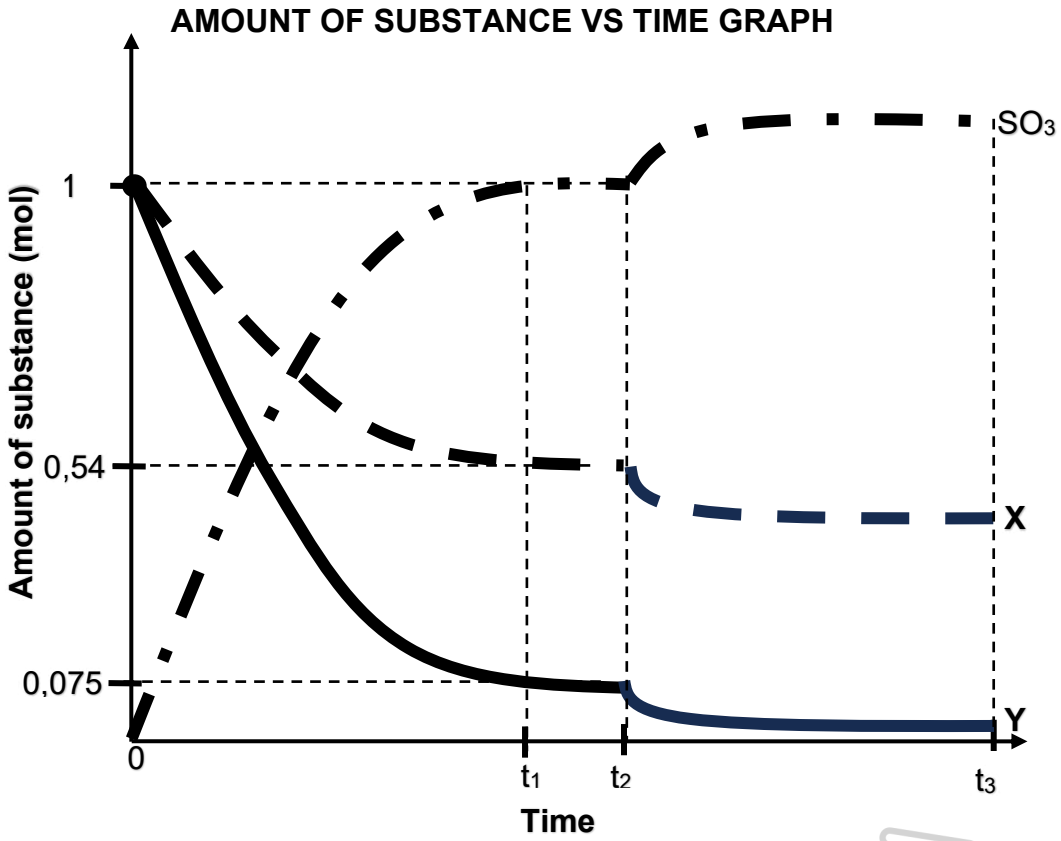
QUESTION 6 (Start on a new page.)

6.1 Initially 1 mol of sulphur dioxide SO_2 (g) and oxygen O_2 (g) are allowed to react in a sealed container according to the balanced equation:

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

The graph below shows the change in amounts of reactants and products over time.

Graph is NOT drawn to scale.



6.1.1 State Le Chatelier's principle in words. (2)

6.1.2 How will the rate of the forward reaction compare to the rate of the reverse reaction between t_1 and t_2?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO.

Give a reason for the answer. (2)

6.1.3 Which curve, **X** or **Y**, represent SO_2?

Give a reason for the answer. (2)

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The temperature of the reaction mixture was decreased at t_2.

6.1.4 Is the heat of the reaction (ΔH) POSITIVE or NEGATIVE for the forward reaction? (1)

6.1.5 Explain the answer to QUESTION 6.1.4 by referring to Le Chatelier's principle. (3)

6.2 2,5 mol of NOCℓ was initially placed in a 1,5 dm^3 sealed container at 400 ˚C. After the equilibrium was established, it was found that 28% of the NOCℓ dissociated according to the balanced equation:

$$2\ NOC\ell\ (g) \rightleftharpoons 2\ NO\ (g) + C\ell_2\ (g)$$

6.2.1 Calculate the equilibrium constant, Kc-value at 400 ˚C. (7)

6.2.2 More NOCℓ is added to the equilibrium mixture. How will this change affect the equilibrium constant, Kc?

Write down only INCREASES, DECREASES or REMAINS THE SAME.

Give a reason for your answer. (2)
[19]

QUESTION 7 (Start on a new page.)

7.1 The balanced equation below represents the first step of the ionisation reaction of sulphuric acid (H_2SO_4):

$$H_2SO_4\ (aq) + H_2O(\ell) \rightleftharpoons HSO_4^-\ (aq) + H_3O^+\ (aq)$$

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

Write down the:

7.1.2 FORMULAE of the TWO BASES in the above reaction (2)

7.1.3 Balanced chemical equation for the reaction between sulphuric acid (H_2SO_4) and potassium hydroxide (KOH) (3)

7.2 A standard solution of sodium hydroxide (NaOH) is prepared by dissolving 3,812 g to make a 100 cm^3 NaOH solution.

7.2.1 Calculate the concentration of sodium hydroxide (NaOH) solution. (3)

Household vinegar contains **x** % ethanoic acid (CH_3COOH) by mass. 25 cm^3 of vinegar reacts with 21,8 cm^3 sodium hydroxide (NaOH) solution prepared in QUESTION 7.2.1.

The balanced equation is:

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

7.2.2 Calculate the percentage mass of the ethanoic acid (value of **x**) found in the vinegar if 1 cm^3 of household vinegar has a mass of 1 g. (7)

[17]

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
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 298 K

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)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3.0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1.5 22 Ti 48	1.6 23 V 51	1.6 24 Cr 52	1.5 25 Mn 55	1.8 26 Fe 56	1.8 27 Co 59	1.8 28 Ni 59	1.9 29 Cu 63,5	1.6 30 Zn 65	1.6 31 Ga 70	1.8 32 Ge 73	2.0 33 As 75	2.4 34 Se 79	2.8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1.4 40 Zr 91	41 Nb 92	1.8 42 Mo 96	1.9 43 Tc	2.2 44 Ru 101	2.2 45 Rh 103	2.2 46 Pd 106	1.9 47 Ag 108	1.7 48 Cd 112	1.7 49 In 115	1.8 50 Sn 119	1.9 51 Sb 122	2.1 52 Te 128	2.5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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	1,8 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 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

KEY/ *SLEUTEL*

Atoomgetal

Atomic number

29

Elektronegatiwiteit → 1,9 Cu ← *Simbool*

Electronegativity — Symbol

Benaderde relatiewe atoommassa

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