GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12
2026

PHYSICAL SCIENCES: CHEMISTRY

(PAPER 2)

PHYSICAL SCIENCES P2

C2842E

TIME: 3 hours

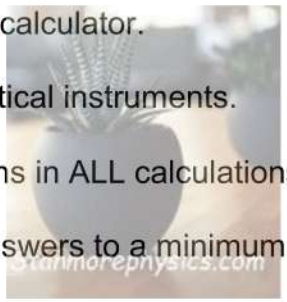
MARKS: 150

14 pages + 2 data sheets

X05

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in the question paper.
4. Leave ONE line open between subquestions, e.g., between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round-off your FINAL numerical answers to a minimum of TWO decimal places.
9. Provide brief discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. 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 Which of the following is an example of an unsaturated hydrocarbon?

A C_2HCl_3
B C_4H_8
C C_3H_8
D C_3H_7OH (2)

1.2 A compound with the molecular formula $C_6H_{12}O$ could be either of the following:

i. An ester
ii. A ketone
iii. An aldehyde

A (i) only
B (i) and (ii) only
C (ii) and (iii) only
D (i), (ii) and (iii) (2)

1.3 The equation below represents the cracking of a long hydrocarbon chain.

$$C_7H_{16} \rightarrow C_5H_{10} + X$$

Which of the following represents compound X?

A Ethanol
B Ethyne
C Ethene
D Ethane (2)

1.4 Give the IUPAC name of the organic compound below.

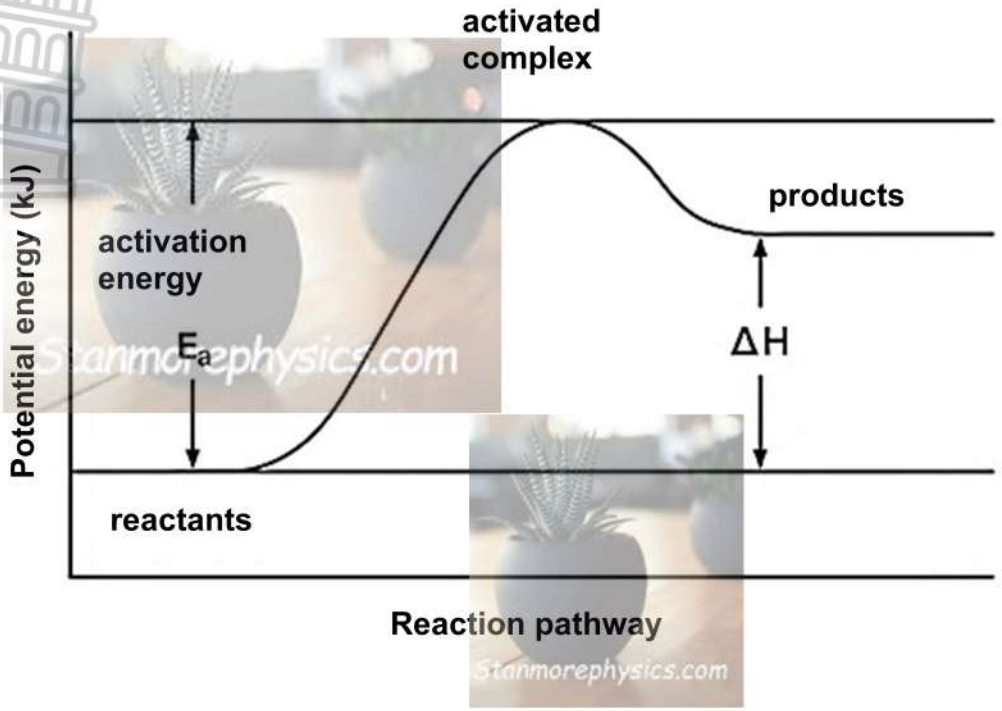
$CH_3CH_2CH(C_2H_5)CH(CH_3)CH(CH_3)CH_2CH_3$

A 4-ethyl-2,3-dimethylheptane
B 3-ethyl-4,5-dimethylheptane
C 4-ethyl-5,6-dimethylheptane
D 2,3-dimethyl-4-ethylheptane (2)

1.5 Which of the following compounds has the strongest Van der Waals forces?

A $CH_3(CH_2)_2CH_3$
B $CH_3COCH_2CH_3$
C $CH_3COOCH_2CH_3$
D $CH_3CH(OH)CH_2CH_3$ (2)

1.6 The diagram below shows the energy profile of an endothermic reaction.



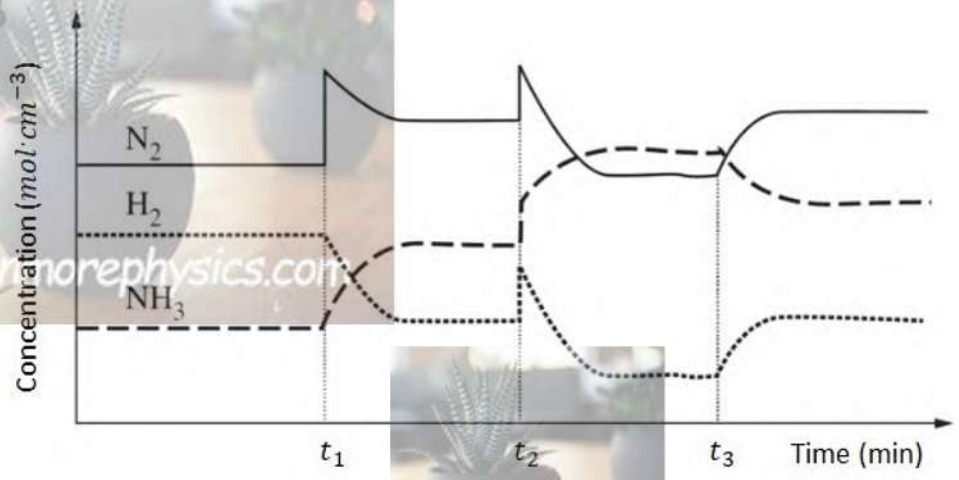
Which of the following correctly describes the effect of a CATALYST on the activation energy, and the enthalpy change for the reverse reaction?

	ACTIVATION ENERGY	ENTHALPY CHANGE
A	Increases	Positive
B	Decreases	Negative
C	Decreases	Remains unchanged
D	Increases	Remains unchanged

(2)

1.7 The graph below shows the concentrations of N_2, H_2, and NH_3 against time for the reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -93\ kJ \cdot mol^{-1}$$



Which is the CORRECT representation for each time in the graph?

	t_1	t_2	t_3
A	$[NH_3]$ is increased	Pressure is decreased	Temperature is decreased
B	$[N_2]$ is increased	Pressure is increased	Temperature is increased
C	$[NH_3]$ is decreased	Temperature is increased	Pressure is increased
D	$[N_2]$ is increased	Temperature is decreased	Pressure is decreased

(2)

1.8 The reaction between sodium and oxygen is:

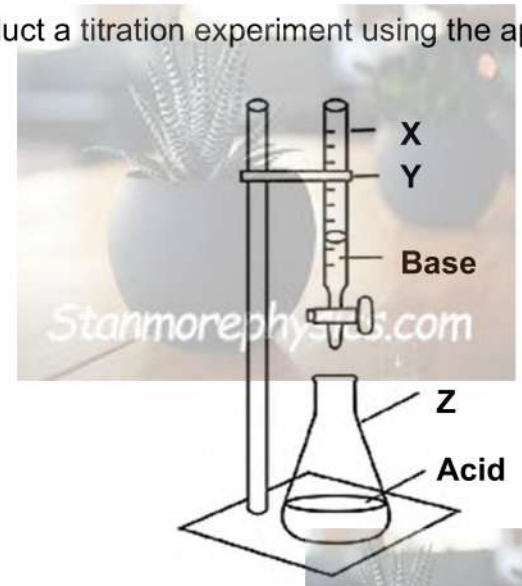
$$2Na(s) + O_2(g) \rightarrow 2Na_2O(s) \qquad \Delta H = -418{,}8\ kJ \cdot mol^{-1}$$

If the equilibrium concentration of $O_2(g)$ at 25°C is equal to Y $mol \cdot dm^{-3}$, the value of the equilibrium constant at this temperature will be equal to:

A	$\frac{1}{[Y]}$
B	$\frac{1}{[Y]^2}$
C	$[Y]^2$
D	Y

(2)

1.9 Learners conduct a titration experiment using the apparatus below.



The correct labels for **X**, **Y**, and **Z** are …

	X	Y	Z
A	Burette	Tripod stand	Beaker
B	Pipette	Tripod stand	Conical flask
C	Pipette	Retort stand	Beaker
D	Burette	Retort stand	Conical flask

(2)

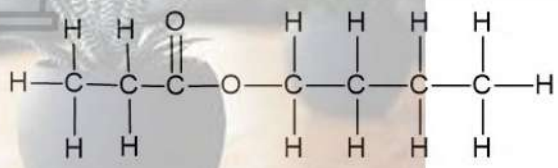
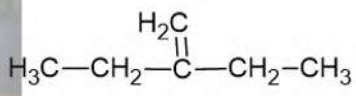
1.10 According to the Lowry-Brønsted theory, a base …

A is a proton donor.
B is a proton acceptor.
C produces hydroxide ions in an aqueous solution.
D produces hydrogen ions in an aqueous solution. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **H** in the table below represent organic compounds.

A	Propanoic acid	**B**	$CH_3CH(CH_3)CH_2CH_2COCH_3$
C		**D**	$CH_3CH_2CH_2CH_2CH_2COOH$
E	$CH_3CHBrCH_2CH_2CH(CH_3)CH_3$	**F**	$C_7H_{14}O$
G	$CH_3(CH_2)_4CH_3$	**H**	

2.1 Define the term *homologous series*. (2)

2.2 What is the name of the functional group of the homologous series to which compound **A** belongs? (1)

2.3 Using the table above, write down the letter that represents each of the following:

2.3.1 An aldehyde (1)

2.3.2 An ester (1)

2.3.3 An unsaturated hydrocarbon (1)

2.3.4 A chain isomer of 2,2-dimethylbutane (1)

2.4 Write down the IUPAC name of:

2.4.1 Compound **C** (2)

2.4.2 Compound **E** (2)

2.5 Compound **D** reacts with a primary alcohol containing four carbon atoms in the presence of a catalyst.

Write down the:

2.5.1 Name of the catalyst (1)

2.5.2 Type of reaction (1)

2.5.3 Name AND formula of the inorganic product that is formed (2)

2.6 Compounds **B** and **F** are isomers.

2.6.1 Define the term *structural isomers*. (2)

2.6.2 Identify the type of isomers. Write only CHAIN, POSITIONAL or FUNCTIONAL. (1)

2.6.3 Write down the structural formula of compound **F**. (2)

2.7 Write down the empirical formula of compound **G**. (2)

2.8 Give the general formula of compound **H**. (1)

2.9 Compound **G** undergoes complete combustion. Using molecular formulae, write down the balanced equation for this reaction. (3)

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QUESTION 3 (Start on a new page.)

The melting points of five organic compounds with known molar masses were determined during a practical investigation. The results are recorded in the table below.

	COMPOUND	MOLAR MASS ($g \cdot mol^{-1}$)	MELTING POINT ($^{\circ}C$)
P	$CH_3CH_2CH_3$	44	-188
Q	$CH_3CH_2CH_2CH_3$	58	-138
R	$CH_3CH_2CH_2CH_2CH_3$	72	-130
S	$CH_3CH(CH_3)CH_2CH_3$	72	-160
T	$CH_3C(CH_3)_2CH_3$	72	-16

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

3.2 For compounds **P, Q** and **R**, write down:

3.2.1 The dependent variable (1)

3.2.2 The controlled variable (1)

3.2.3 An investigative question (2)

3.2.4 An explanation for the trend of the melting points of these compounds. (3)

3.3 Consider compound **R** and compound **S**.

3.3.1 Which compound will have a higher boiling point? (1)

3.3.2 Which compound will have a lower vapour pressure? (1)

3.3.3 Explain the answer to QUESTION 3.3.1. (3)

3.4 Consider compound **T:**

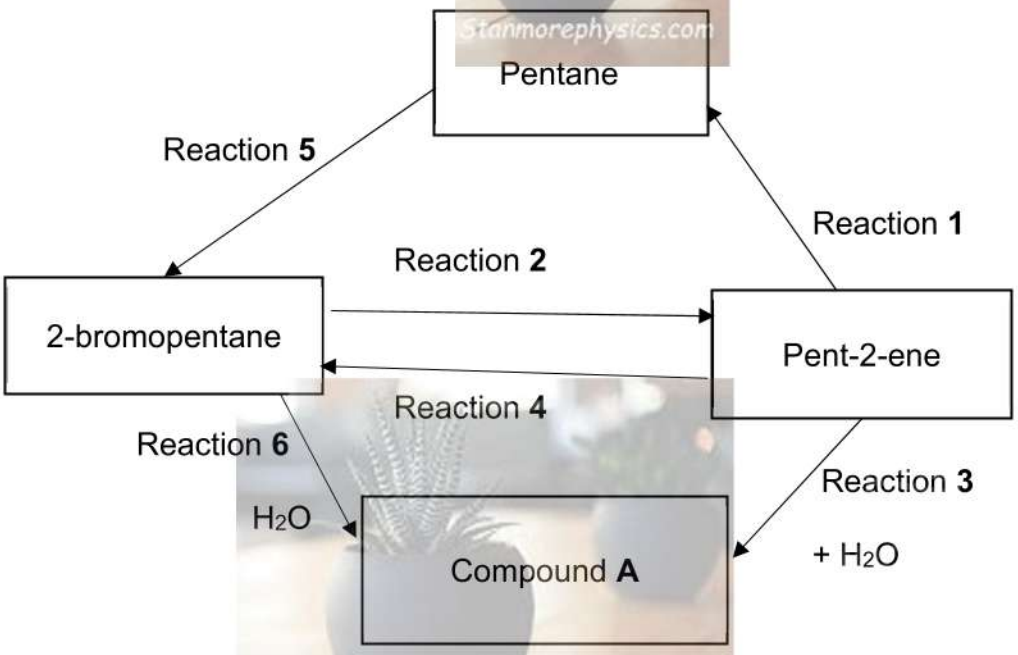
3.4.1 To which homologous series does this compound belong? (1)

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

[17]

QUESTION 4 (Start on a new page.)

The flow diagram below represents 6 different organic reactions undergone by various organic compounds.



4.1 Name the TYPE of addition reaction that takes place at:

4.1.1 Reaction **1** (1)

4.1.2 Reaction **3** (1)

4.1.3 Reaction **4** (1)

4.2 For reaction **2**, write down the:

4.2.1 Type of reaction that takes place (1)

4.2.2 Two reaction conditions required (2)

4.2.3 Balanced chemical equation using STRUCTURAL FORMULAE (5)

4.3 Consider reaction **3**.

4.3.1 To which homologous series does compound **A** belong? (1)

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

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

4.4 Write down a balanced chemical equation for reaction **4** using condensed structural formulae. (4)

4.5 Name the type of reaction represented by reaction **5**. (1)

4.6 Consider reaction **6**.

4.6.1 Identify the type of substitution reaction. (1)

4.6.2 Suggest an alternative reactant if water is not available. (1)

[23]

QUESTION 5 (Start on a new page.)

When chromium metal is added to hydrochloric acid, it undergoes a reaction that produces a characteristic green solution of chromium(III)chloride, as well as hydrogen gas.

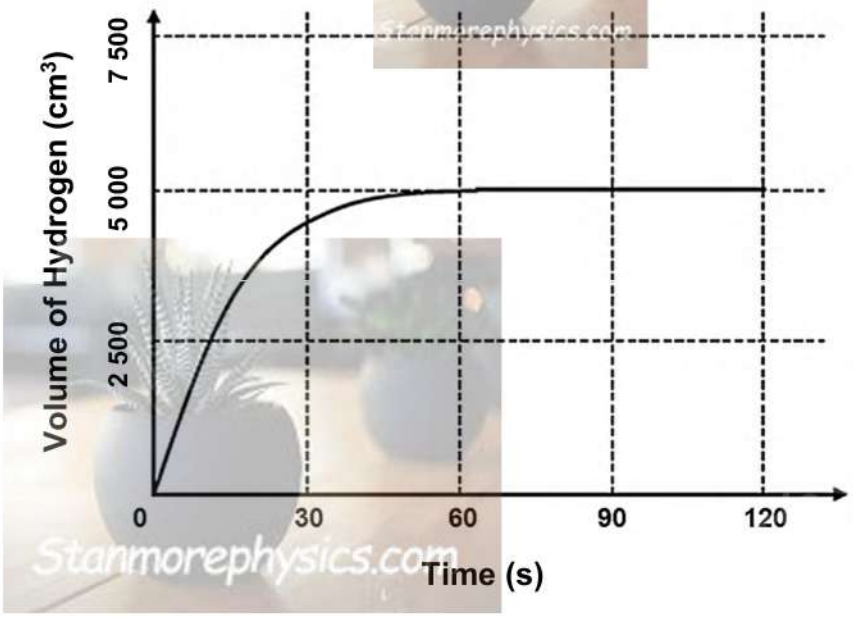
The balanced equation can be represented as follows:

$$2Cr(s) + 6HC\ell(aq) \rightarrow 2CrC\ell_3(aq) + 3H_2(g) \qquad \Delta H<0$$

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

5.2 Name TWO experimental methods that could be used to measure the rate of this reaction in a school laboratory. (2)

5.3 In the experiment, 8,67 g of powdered chromium metal was added to excess hydrochloric acid in a flask. The reaction produced hydrogen gas, which was collected at STP. The volume of hydrogen gas formed was measured at regular time intervals, and the results were used to plot the graph shown below.



5.3.1 Calculate the average rate (in $dm^3 \cdot s^{-1}$) of the above reaction for the first 60 s. (4)

5.3.2 Calculate the mass of hydrogen gas produced. (4)

5.3.3 Calculate the percentage yield of hydrogen gas in this reaction. (5)

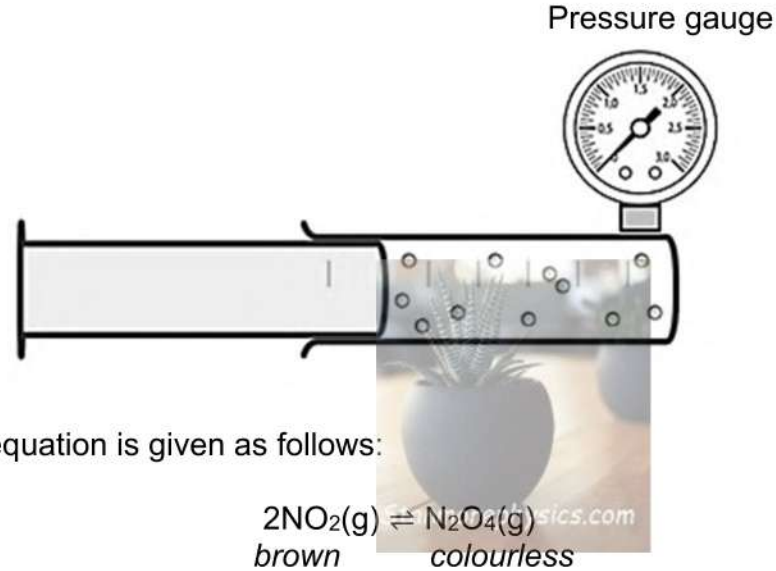
5.3.4 If a LUMP of chromium is used, how will this affect the rate of the reaction? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

5.3.5 Use the collision theory to fully explain the answer to QUESTION 5.3.4. (3)

[21]

QUESTION 6 (Start on a new page.)

The equilibrium mixture of nitrogen dioxide (NO_2), a brown gas with a sharp, pungent smell, and colourless dinitrogen tetroxide (N_2O_4) is investigated using a sealed industrial gas syringe. This colour change allows the progress of the equilibrium to be observed visually.



The balanced equation is given as follows:

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$
brown *colourless*

6.1 State *Le Chatelier's principle*. (2)

6.2 Is the system above OPEN or CLOSED? Give a reason for the answer. (2)

6.3 How will EACH of the following changes affect the concentration of $N_2O_4(g)$ at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The plunger is pressed to decrease the volume. (1)

6.3.2 A catalyst is added. (1)

6.4 The syringe is now placed into a water bath filled with ice cubes. The gas in the syringe starts to turn colourless.

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

6.4.2 Using Le Chatelier's principle, explain the answer to QUESTION 6.4.1. (3)

6.5 The sealed industrial gas syringe is removed from the water bath and allowed to reach equilibrium at 298 K. At equilibrium, the mixture contains 0,52 moles of NO_2 and 0,08 moles of N_2O_4. The volume of the syringe is 1 000 cm³.

The syringe is then placed in a hot water bath at 373 K. A new equilibrium is established at which point the mixture contains 8,28 g of N_2O_4.

Calculate the:

6.5.1 Number of moles of N_2O_4 at the new equilibrium (3)

6.5.2 Value of the equilibrium constant, K_c, at this temperature (7)

[20]

QUESTION 7 (Start on a new page.)

Hydrochloric acid ($HC\ell$) is a strong acid. It dissolves in water, as shown in the equation below:

$$HC\ell\,(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + C\ell^-(aq)$$

7.1 Explain what is meant by the term *strong acid*. (2)

7.2 Identify ONE conjugate acid-base pair. (2)

7.3 Hydrochloric acid is a monoprotic acid. Give a reason for this. (1)

7.4 A 150 cm^3 hydrochloric acid, HCℓ(aq), solution with a concentration of 0,8 $mol \cdot dm^{-3}$ is available for laboratory experiments.

7.4.1 Calculate the number of moles of hydrochloric acid in this solution. (3)

All of the 150 cm^3 hydrochloric acid solution, HCℓ(aq), is allowed to react with **X** g of calcium carbonate, $CaCO_3(s)$, according to the balanced chemical equation:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + 2H_2O(\ell) + CO_2(g)$$

The hydrochloric acid solution is found to be in excess.

The excess hydrochloric acid, HCℓ(aq), is neutralised by a 60 cm^3 sodium hydroxide, NaOH(aq), solution with a concentration of 0,5 $mol \cdot dm^{-3}$.

The neutralisation reaction is as shown below:

$$NaOH(aq) + HC\ell(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

7.4.2 Calculate the value of **X**. (7)

7.4.3 Will the salt that is formed in the neutralisation reaction undergo hydrolysis? Give a reason for the answer. (2)

7.4.4 Bromothymol blue is used as the indicator. Explain why it is the most suitable indicator for this titration by referring to the pH at the equivalence point. (2)

7.5 In aqueous solutions, the concentrations of hydronium ions and hydroxide ions determine the acidity or alkalinity of a solution.

Calculate the pH of potassium hydroxide, KOH(aq), solution with concentration of $2,5 \times 10^{-7}$ $mol \cdot dm^{-3}$ at a temperature of 298 K. (4)

[23]

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*

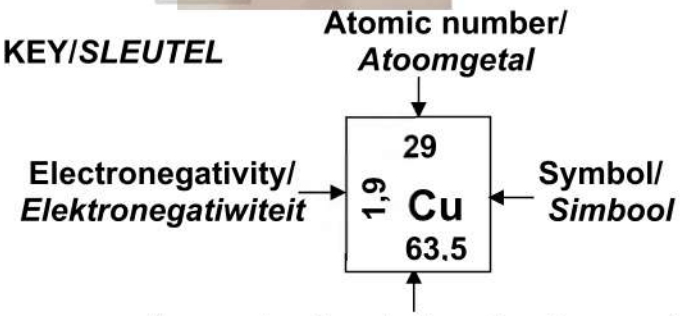
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$	$n = \frac{V}{V_M}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH = - log[H_3O^+]
K_w = [H_3O^+][OH^-] = 1×10^{-14} at/by 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/of $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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 H 1																	2 He 4
1,0 Li 3	1,5 Be 4											2,0 B 5	2,5 C 6	3,0 N 7	3,5 O 8	4,0 F 9	10 Ne 20
0,9 Na 11	1,2 Mg 12											1,5 Aℓ 13	1,8 Si 14	2,1 P 15	2,5 S 16	3,0 Cℓ 17	18 Ar 40
0,8 K 19	1,0 Ca 20	1,3 Sc 21	1,5 Ti 22	1,6 V 23	1,6 Cr 24	1,5 Mn 25	1,8 Fe 26	1,8 Co 27	1,8 Ni 28	1,9 Cu 29	1,6 Zn 30	1,6 Ga 31	1,8 Ge 32	2,0 As 33	2,4 Se 34	2,8 Br 35	36 Kr 84
0,8 Rb 37	1,0 Sr 38	1,2 Y 39	1,4 Zr 40	Nb 41	1,8 Mo 42	1,9 Tc 43	2,2 Ru 44	2,2 Rh 45	2,2 Pd 46	1,9 Ag 47	1,7 Cd 48	1,7 In 49	1,8 Sn 50	1,9 Sb 51	2,1 Te 52	2,5 I 53	54 Xe 131
0,7 Cs 55	0,9 Ba 56	La 57	1,6 Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	1,8 Tℓ 81	1,8 Pb 82	1,9 Bi 83	2,0 Po 84	2,5 At 85	86 Rn
0,7 Fr 87	0,9 Ra 88	Ac 89															

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*



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MARKING GUIDELINE
NASIENRIGLYNE

PHYSICAL SCIENCES: CHEMISTRY(P2)
FISIESE WETENSKAPPE: CHEMIE(V2)

13 pages/*bladsye*

QUESTION / *VRAAG* 1

1.1	B	✓✓	(2)
1.2	C	✓✓	(2)
1.3	D	✓✓	(2)
1.4	B	✓✓	(2)
1.5	D	✓✓	(2)
1.6	C	✓✓	(2)
1.7	B	✓✓	(2)
1.8	A	✓✓	(2)
1.9	D	✓✓	(2)
1.10	B	✓✓	(2)

[20]

QUESTION / *VRAAG* 2

2.1 Homologous series is a series of organic molecules/compounds that can be described by the same general formula, ✓✓
OR one member differs from the next with the CH_2 group. **(2 or 0)**

Homoloë reeks: 'n Reeks organiese verbindings/molekule wat deur dieselfde algemene formule beskryf kan word
OF *waarin die een lid van die volgende verskil met 'n CH_2-groep.* (2)

2.2 Carboxyl group / *Karboksielgroep* ✓

Do not accept carboxylic acid / *Moet nie karboksielsuur aanvaar nie* (1)

2.3 2.3.1 F ✓ (1)

2.3.2 C ✓ (1)

2.3.3 H ✓ (1)

2.3.4 G ✓ (1)

2.4 2.4.1 Butyl✓ propanoate ✓/ *Butielpropanoaat* (2)

2.4.2 2-bromo-5-methylhexane / *2-bromo-5-metielheksaan*

Marking criteria/*Nasienkriteria*:
- Correct stem and substituents / *Korrekte stam en substituente* ✓
- Everything correct / *heeltemal korrek* ✓ (2)

2.5 2.5.1 (Concentrated) sulphuric acid / *(gekonsentreerde) swawelsuur* ✓ (1)

2.5.2 Esterification **OR** condensation / *Esterifikasie **OF** kondensasie* ✓ (1)

2.5.3 Water ✓ and/*en* H_2O ✓ (2)

2.6 2.6.1 Organic compounds with the same molecular formula but different structural formulae. ✓✓ **(2 or 0)**

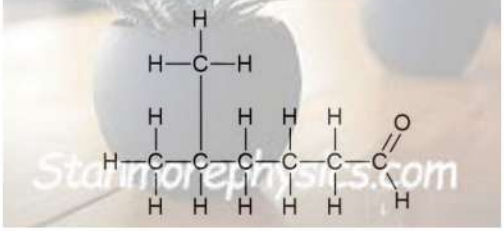
Struktuurisomeer: Organiese molekule met dieselfde molekulêre formule, maar verskillende struktuurformules. (2)

2.6.2 (1)

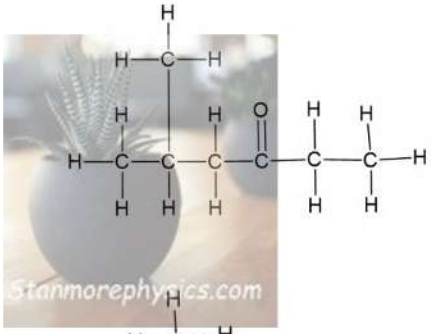
2.6.3 (2)

Marking criteria/*Nasienkriteria*:
- Functional group / *Funksionele groep* ✓
- Whole structure correct/*Hele struktuur korrek* ✓

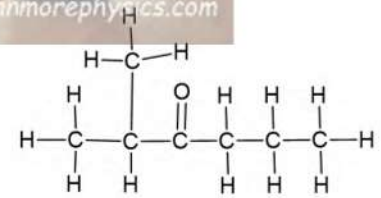
Functional isomers / *Funksionele isomeer* ✓



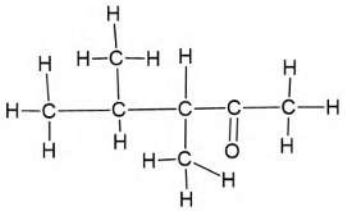
Positional isomer / *Posisionele isomeer*



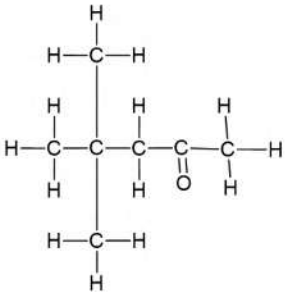
OR



Chain isomer / *Ketting isomeer*



OR



2.7 C_3H_7 ✓✓ (2)

2.8 C_nH_{2n} ✓ (1)

2.9 $2C_6H_{14} + \underset{\checkmark}{19\ O_2} \rightarrow \underset{\checkmark}{12\ CO_2} + 14\ H_2O$ ✓ balancing / *balanseer* (3)

[26]

QUESTION / *VRAAG* 3

3.1 **Marking criteria/*Nasienkriteria:***

If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark.

Indien enige een van die onderstreepte sleutelfrases in die korrekte konteks weggelaat word, trek 1 punt af.

The temperature at which the solid and liquid phases of a substance are at equilibrium. ✓✓

Die temperatuur waarby die vaste- en vloeistoffases van 'n stof in ewewig is. (2)

3.2 3.2.1 Melting point / *Smeltpunt* ✓ (1)

3.2.2 Straight chain alkane ✓ Accept: Homologous series
Reguitketting alkane *Aanvaar: Homoloë reeks* (1)

3.2.3 **Marking Criteria**: show the relationship between the dependent and independent variables. If the question has a yes or no answer – deduct one mark.

Example:
What is the relationship between the chain length/molecular mass/number of carbon atoms and the melting points of organic compounds (from the same homologous series)? ✓✓

(2)

***Nasienkriteria**: toon die verband tussen die afhanklike en onafhanklike veranderlike. Indien die vraag 'n ja of nee antwoord het – trek een punt af.*

Voorbeeld:
Wat is die verband tussen die kettinglengte/molekulêre massa/ getal koolstofatome en die smeltpunt van die organiese verbinding(van dieselfde homoloëreeks)?

3.2.4
- The melting point of organic compounds increases with an increase in the chain length/molecular mass/number of carbon atoms/longer chain length of organic compounds. ✓
- The intermolecular forces in R are stronger than in P and Q ✓
- More energy is required to overcome the intermolecular forces in R than in P and Q. ✓

- *Die smeltpunt van 'n organiese verbinding verhoog met 'n verhoging in die kettinglente/ molekulêre massa/ getal koolstofatome/langer kettinglengte in die organiese verbinding.*
- *Die intermolekulêrekragte in R is sterker as in P en Q*
- *Meer energie word benodig om die intermolekulêrekragte te oorkom in R as in P en Q.* (3)

3.3 3.3.1 R ✓ (1)

3.3.2 R ✓ (1)

3.3.3
- Compound R has a longer straight chain length/larger surface area as compared to the branched compound S. ✓
- Both have London forces but the intermolecular forces in compound R are stronger than in S. ✓
- More energy is needed to overcome/weaken the intermolecular forces in compound R. ✓

- *Verbinding R het 'n langer reguit kettinglengte/groter oppervlakarea in vergelyking met die vertakte verbinding S.*
- *Albei het London-kragte, maar die intermolekulêre kragte in verbinding R is sterker as in S.*
- *Meer energie is nodig om die intermolekulêre kragte in verbinding R te oorkom/verswak.* (3)

3.4 3.4.1 Alkane / *Alkaan* ✓ (1)

3.4.2 2,2-dimethylpropane / dimethylpropane ✓✓

2,2-dimetielpropaan / dimetielpropaan

Marking criteria/*Nasienkriteria*:
- Correct stem and substituents / *Korrekte stam en substituente* ✓
- Whole name correct / *Hele naam korrek* ✓ (2)

[17]

QUESTION / *VRAAG* 4

4.1 4.1.1 Hydrogenation / *Hydrogenering* ✓ (1)

4.1.2 Hydration / *hidrasie* ✓ (1)

4.1.3 Hydrohalogenation / *hydrohalogenering* ✓ (1)

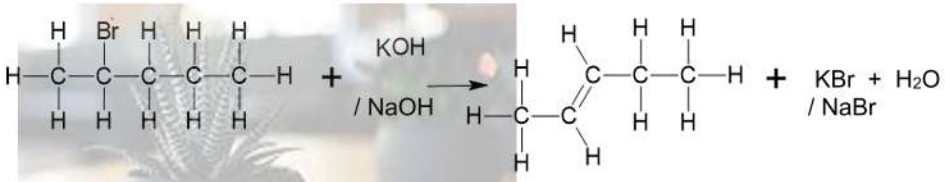
4.2 4.2.1 Elimination / dehydrohalogenation / dehydrobromination

Eliminasie / dehydrohalogenasie / dehydrobrominasie ✓ (1)

4.2.2 Concentrated strong base / NaOH(c) / KOH(c) / LiOH(c) ✓
Heat ✓ (under reflux)

Gekonsentreerde sterk basis / NaOH(c) / KOH(c) / LiOH(c)
Hitte (onder refluks) (2)

4.2.3



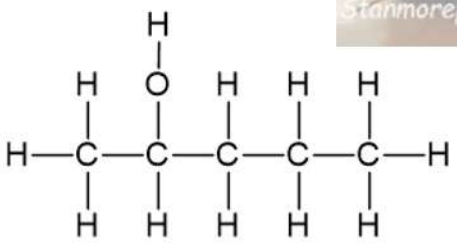
Marking criteria/*Nasienkriteria*:
- Correct structural formula of 2-bromopentane where the Br is on the correct carbon ✓and KOH / NaOH / LiOH ✓
- Functional group of alkene ✓
- Correct structural formula of pent-2-ene ✓ and KBr + H_2O ✓

- *Korrekte struktuurformule vir 2-bromopentaan waar die Br op die regte koolstof is en KOH* / NaOH / LiOH
- *Funskionele groep van alkeen*
- *Korrekte struktuurformule vir pent-2-een en KBr + H_2O*

(5)

4.3 4.3.1 Alcohol / *alkohol* ✓ (1)

4.3.2



Marking criteria/*Nasienkriteria*:
- Functional group / *Funksionele groep* ✓
- Whole structure correct / *Hele struktuur korrek* ✓

(2)

4.3.3 pentan-2-ol / *pentan-2-ol* ✓✓ **(2 or 0)** (2)

4.4

✓ ✓ ✓ ✓

$CH_3CHCHCH_2CH_3 + HBr \rightarrow CH_3CHBrCH_2CH_2CH_3$

Marking criteria for product/*Nasienkriteria vir produk*:
- Functional group / *Funksionele groep* ✓
- Whole formula correct/*Hele formule korrek* ✓

NOTE / *NOTA*
If structural formulae used – max ¾
indien struktuurformule – maks ¾
If molecular formula used – ¼ only for HBr
Indien molekulêre formule gebruik – slegs ¼ vir HBr

(4)

4.5 Substitution / *Substitusie* ✓ (1)

4.6 4.6.1 Hydrolysis / *Hidrolise* ✓ (1)

4.6.2 Diluted Strong base / NaOH(aq) ✓
Verdunde Sterk basis / NaOH(aq) (1)
[23]

QUESTION / *VRAAG* 5

5.1 The change in concentration of reactants or products per unit time. ✓✓ **(2 or 0)**
OR Rate of change in concentration of reactants or products

Die verandering in konsentrasie van reaktante of produkte per eenheid tyd.
OF *Tempo van verandering in konsentrasie van reaktante of produkte* (2)

5.2
- Measure the volume of hydrogen gas using a gas syringe/downward displacement of water. ✓
- Measure the decrease in mass on a scale/the rate of colour change of the solution. ✓
(accept any two reasonable answers – be it collecting gas or measuring the mass).

- *Meet die volume van die waterstofgas met die hulp van 'n gasspuit/afwaarste verplasing van water.*
- *Meet die afname aan massa op 'n skaal/die tempo van kleurverandeing van die oplossing.*
(aanvaar enige twee redelike antwoorde – wat hetsy gasversameling of die meting van die massa). (2)

5.3 5.3.1 $\text{Rate} = \frac{\Delta V}{\Delta t}$ ✓ for the conversion / *vir die omskakeling*

$= \frac{5 - (0) \checkmark}{60 - (0) \checkmark}$

$= 0{,}08$ ✓$(\text{dm}^3.\text{s}^{-1})$

Accept calculation done in cm^3 and then converted.
Aanvaar berekeininge wat in cm^3 gedoen word en dan omgeskakel word. (4)

5.3.2

Marking criteria:	***Nasienkriteria***
(a) Substituting 5 and 22,4 into n $= \frac{V}{V_M}$ ✓	(a) *Vervanging van 5 en 22,4 in* n $= \frac{V}{V_M}$ ✓
(b) Equation n= $\frac{m}{M}$ ✓	(b) *Vergelyking* n= $\frac{m}{M}$ ✓
(c) Substitution ✓	(c) *Vervanging* ✓
(d) Final answer m = 0,45 g (0,4464 g) ✓	(d) *Finale antwoord* m = 0,45 (0,4464) g ✓

$n = \frac{V}{V_M}$

$= \frac{5}{22,4}$ ✓ **(a)**

= 0,2232 mol

$n(H_2) = \frac{m}{M}$ ✓ **(b)**

$0,2232 = \frac{m}{2}$ ✓ **(c)**

m = 0,45 g ✓ **(d)** (4)

5.3.3

Marking criteria:
(a) n = 0,16673 mol ✓
(b) mole ratio Cr: H_2; 2:3; 0,16673: 0,25 ✓
(c) m = 0,5 g ✓
(d) substitution $\frac{0,45}{0,5}$ × 100 into percentage yield equation ✓
(e) Final answer: 90% ✓ (Range 89,25%-90%)
Nasienkriteria
(a) n = 0,16673 mol ✓
(b) m*olverhouding* Cr: H_2; 2:3; 0,16673: 0,25 ✓
(c) m = 0,5 g ✓
(d) *vervanging* $\frac{0,45}{0,5}$ × 100 *in persentasieopbrengs vergelyking* ✓
(e) *Finale antwoord:* 90% ✓ (*Gebied 89,25%-90%)*

OPTION 1 / *OPSIE 1*

$n = \frac{m}{M}$

$= \frac{8,67}{52}$ ✓ (a)

= 0,16673 mol

Mole ratio/*Molverhouding*

Cr : H_2

2 : 3 ✓ **(b)**

0,16673 : 0,25

$n(H_2) = \frac{m}{M}$

$0,25 = \frac{m}{2}$ ✓ **(c)**

m = 0,5 g

Percentage Yield / *Persentasie opbrengs*

$= \frac{\text{Actual yield/Werklike opbrengs}}{\text{Theoretical yield/Teoretiese opbrengs}} \times 100$

$= \frac{0,45}{0,5} \times 100$ ✓ **(d)**

= 90% ✓ **(e)** (Accept range/*Aanvaar reeks* 89,25%-90%)

OPTION 2 / *OPSIE 2*

$n = \frac{m}{M}$

$= \frac{8,67}{52}$ ✓ (a)

= 0,16673 mol

Mole ratio/*Molverhouding*

Cr : H_2

2 : 3 ✓ **(b)**

0,16673 : 0,25

from / *van* Q5.2.3 = 0,2232 mol✓ **(c)**

Percentage Yield / *Persentasie opbrengs*

$= \frac{\text{Actual yield/Werklike opbrengs}}{\text{Theoretical yield/Teoretiese opbrengs}} \times 100$

$= \frac{0,2232}{0,25} \times 100$ ✓ **(d)**

= 89,28% ✓ **(e)**

(5)

OPTION 3 / *OPSIE 3*

$n = \frac{m}{M}$

$= \frac{8,67}{52}$ ✓ (a)

= 0,16673 mol

Mole ratio / *Molverhouding*

Cr : H_2

2 : 3 ✓ **(b)**

0,16673 : 0,25

$n = \frac{V}{V_M}$

$V = 0,25(22,4)$ ✓ **(c)**

$= 5,6\ dm^3$

Percentage Yield / *Persentasie opbrengs*

$= \frac{\text{Actual yield/Werklike opbrengs}}{\text{Theoretical yield/Teoretiese opbrengs}} \times 100$

$= \frac{5}{5,6} \times 100$ ✓ **(d)**

= 89,29% ✓ **(e)**

5.3.4 DECREASES / *VERLAAG*✓ (1)

5.3.5
- As surface area decreases, the exposed area decreases, ✓ and
- fewer molecules will have sufficient energy ✓, less than or equal to the activation energy, / less particles with Ek ≥ Ea
- leading to less effective collisions per unit time / lower frequency of effective collisions ✓

- *Soos die oppervlak afneem, neem die blootgestelde area af,*
- *en minder molekules sal voldoende energie hê , minder as of gelyk aan die aktiveringsenergie, / minder deeltjies met Ek ≥ Ea*
- *wat lei tot minder effektiewe botsings per eenheid tyd / laer frekwensie van effektiewe botsings* (3)

[21]

QUESTION / *VRAAG* 6

6.1

Marking criteria/*Nasienkriteria*

If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark.

Indien enige een van die onderstreepte sleutelfrases in die korrekte konteks weggelaat word, trek 1 punt af.

When the equilibrium in a closed system is disturbed, the system will reinstate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓

Wanneer die ewewig in 'n geslote sisteem versteur word, stel die sisteem 'n nuwe ewewig in deur die reaksie wat die versteuring teenwerk, te bevoordeel. (2)

6.2 A CLOSED ✓ system is isolated from its surroundings/in a sealed gas syringe.✓

'n GESLOTE system is geïsoleer van die omgewing/ in 'n geseëlde gasspuit (2)

6.3 6.3.1 INCREASES / *VERHOOG*✓ (1)

6.3.2 REMAINS THE SAME / *BLY DIESELFDE*✓ (1)

6.4 6.4.1 EXOTHERMIC / *EKSOTERMIES*✓ (1)

6.4.2
- Placing the syringe in ice cubes will <u>decrease the temperature</u>. ✓
- The system will decrease the effect by <u>favouring an exothermic reaction</u>.✓
- The <u>forward reaction is favoured</u> because the syringe turns colourless.✓

- *As die gasspuit in ysblokkies geplaas word, <u>verlaag die temperatuur</u>.*
- *Die sisteem sal die effek teenwerk deur <u>die eksotermiese reaksie te bevoordeel</u>.*
- *Die <u>voorwaartse reaksie word</u> bevoordeel omdat die spuit kleurloos raak.* (3)

6.5 6.5.1 $n = \frac{m}{M}$ ✓

$= \frac{8,28}{92}$ ✓

$= 0,09$ mol ✓ (3)

6.5.2

Marking criteria:

(a) Initial quantities of all substances ✓
(b) Using the correct mol ratio ✓
(c) Calculating the quantity(mol) at equilibrium of NO_2 and N_2O_4 ✓
(d) Divide the number of moles at equilibrium by 1 dm^3 ✓
(e) Kc expression✓(no or wrong expression 6/7)
(f) Correct substitution of equilibrium concentrations into Kc expression ✓
(g) Final Answer $K_c = 0,36$ ✓

NOTE: If concentration table was used, the values will be the same, but the labels will differ.

Nasienkriteria:

(a) Aanvanklike hoeveelhede van alle stowwe
(b) Gebruik die korrekte mol verhouding
(c) Bereken die hoeveelheid(mol) by ewewig van NO_2 en N_2O_4
(d) Deel die aantal mol in ewewig deur 1 dm^3
(e) Kc uitdrukking(Verkeerde of geen Kc 6/7)
(f) Vervang ekwilibriumkonsentrasies in die K_c uitdrukking
(g) Finale antwoord $K_c = 0,36$

NOTA: Indien konsentrasie in tabel gebruik word, sal die waardes dieselfde bly, maar die byskrifte sal verskil.

	$2NO_2(g)$	$N_2O_4(g)$
Initial amount(mol) *Aanvanklike hoeveelheid(mol)*	0,52	0,08 ✓ **(a)**
Change(mol) *Verandering(mol)*	−0,02	+ 0,01 ✓**(b)**
Equilibrium amount(mol) *Ewewigshoeveelheid(mol)*	0,50	0,09 ✓**(c)**
Equilibrium concentration($mol \cdot dm^{-3}$) *Ewewigskonsentrasie*($mol \cdot dm^{-3}$)	$\frac{0,50}{1}$ = 0,50	$\frac{0,09}{1}$ = 0,09 ✓**(d)**

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓ **(e)**

$= \frac{(0,09)}{(0,50)^2}$ ✓ **(f)**

= 0,36 ✓ **(g)** (7)

[20]

QUESTION /*VRAAG 7*

7.1 Strong acids ionise completely in water to form a high concentration of H_3O^+ ions. ✓✓ **(2 or 0)**

'n Suur is 'n stof wat waterstofione (H^+)/hidroniumione (H_3O^+) vorm wanneer dit in water oplos. (2)

7.2 $HC\ell$; $C\ell^-$ ✓✓ **(2 or 0)**
OR/*OF*
H_2O : H_3O^+ (2)

7.3 Acids that release/donate ONLY ONE PROTON / H^+ ion✓

Sure wat NET EEN PROTON / H^+ ioon vrystel / skenk (1)

7.4 7.4.1 $c(HC\ell) = \frac{n}{V}$ ✓
n = (0,8) (0,15) ✓
n = 0,12 mol ✓ (3)

7.4.2

Marking criteria:

(a) Substituting (0,5)(0,06) into $c_{(NaOH)} = \frac{n}{V}$ ✓
(b) Using the correct mol ratio NaOH : HCℓ 1:1 ✓
(c) Calculating $n(HC\ell)_{reacted} = n_{initial} - n_{excess}$ by substituting ✓
(d) $n(HC\ell)_{reacted}$ = 0,09 mol ✓
(e) Mole Ratio $CaCO_3$: HCℓ1:2; 0,045 : 0,09✓
(f) Substituting 0,045 and 100 into $n=\frac{m}{M}$ ✓
(g) Final answer m = 4,5 g ✓

Nasienkriteria:

(a) Vervang (0,5)(0,06) in $c_{(NaOH)} = \frac{n}{V}$ ✓
(b) Gebruik die korrekte molverhouding NaOH : HCℓ 1:1 ✓
(c) Bereken $n_{(HC\ell)reacted} = n_{initial} - n_{excess}$ deur vervanging ✓
(d) $n(HC\ell)_{reacted}$ = 0,09 mol ✓
(e) molverhouding $CaCO_3$: HCℓ 1:2; 0,045 : 0,09
(f) Vervang 0,045 en 100 in $n = \frac{m}{M}$ ✓
(g) *Finale Antwoord m = 4,5 g ✓*

$c_{(NaOH)} = \frac{n}{V}$
$n_{(NaOH)}$ = (0,5)(0,06) ✓ **(a)**
$n_{(NaOH)}$ = 0,03 mol

Mole Ratio NaOH : HCℓ
1:1
0,03: 0,03 mol (in excess/*in oormaat*) ✓**(b)**

$n(HC\ell)_{reacted/gereageer} = n_{initial/aanvanklik} - n_{excess/oormaat}$
= 0,12 – 0,03 ✓**(c)**
= 0,09 mol

Mole Ratio
$CaCO_3$: HCℓ
1 : 2
0,045 ✓ **(e)** : 0,09 ✓ **(d)**

$n=\frac{m}{M}$
$0,045 = \frac{m}{100}$ ✓ **(f)**
m = 4,5 (g) ✓ **(g)** (7)

7.4.3 NO. ✓ It is a salt of a strong acid and a strong base. ✓

NEE. Dit is 'n sout van 'n sterk suur en 'n sterk basis. (2)

7.4.4
- The equivalence point is at pH of 7. ✓
- Bromothymol blue changes colour at a pH equal to 7. ✓ The endpoint of this titration is within the pH range (of 6 -7,6) in which bromothymol blue / indicator changes colour.

- *Die ekwivalensiepunt is by 'n pH van 7.*
- *Broomtimolblou verander van kleur by 'n pH gelyk aan 7. Die eindpunt van hierdie titrasie is binne die pH-gebied van (6 -7,6) waarin bromotimolblou / indikator van kleur verander.* (2)

7.5 **Marking criteria/*Nasienkriteria***

(a) Using the ratio of the base of KOH:OH^- / *Gebruik die verhouding van die KOH:OH^-* ✓
(b) Substitution/*Vervanging* $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ ✓
(c) Substituting/*Vervanging* $0,4 \times 10^{-7}$ into/*in* pH = -log $[H_3O^+]$ ✓
(d) Final answer/*Finale antwoord* pH = 7,3979 (7,40) ✓

OPTION 1/ *OPSIE 1*

$KOH \rightarrow K^+ + OH^-$
1 : 1 ✓**(a)**

$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$
$1 \times 10^{-14} = [H_3O^+][2,5 \times 10^{-7}]$ ✓ **(b)**
$[H_3O^+] = 0,4 \times 10^{-7}$ mol·dm^{-3}
pH = -log $[H_3O^+]$
= -log $(0,4 \times 10^{-7})$ ✓**(c)**
= 7,3979 (7,40) ✓**(d)**

OPTION 2/ *OPSIE 2*

$KOH \rightarrow K^+ + OH^-$
1 : 1 ✓**(a)**

pOH = - log$[OH^-]$
pOH = - log$(2,5 \times 10^{-7})$ ✓ **(b)**
= 6,60209

pOH + pH = 14
pH = 14 – 6,60209 ✓**(c)**
= 7,3979 ✓**(d)**

(4)

[23]

TOTAL: 150