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

JUNE 2025

PHYSICAL SCIENCES: (CHEMISTRY) P2

MARKS: 150

TIME: 3 hours

This question paper consists of 18 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.

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 compounds is an alkene?

A C_3H_8

B C_3H_6

C C_3H_4

D C_3H_6O (2)

1.2 Which ONE of the following is NOT correct about compounds that belong to the same homologous series?

A Similar chemical properties

B They have the same general formula

C They have the same functional group

D Similar physical properties (2)

1.3 Which ONE of the following can form a TERTIARY ALCOHOL?

A CH_3OH

B C_2H_5OH

C C_3H_7OH

D C_4H_9OH (2)

1.4 Consider the reaction below:

$$CH_3CH_2CHBrCH_3 + \text{conc. NaOH} \longrightarrow \underset{\text{(major product)}}{\text{Organic compound } \mathbf{Q}} + NaBr + H_2O$$

Which ONE of the following CORRECTLY gives the type of reaction and the name of organic compound **Q**?

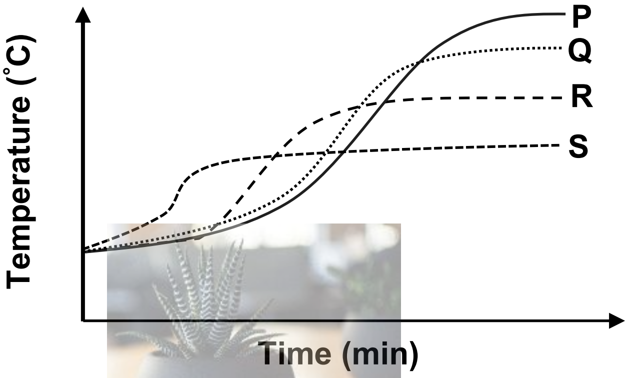
	TYPE OF REACTION	ORGANIC COMPOUND Q
A	Elimination	But-1-ene
B	Elimination	But-2-ene
C	Addition	But-1-ene
D	Addition	But-2-ene

(2)

1.5 Consider the four organic compounds below:

butan-1-ol, propanoic acid, 2-methylpropanal and butanal

The heating curves for the four organic compounds were obtained.



Which curve represents the heating curve of butanal?

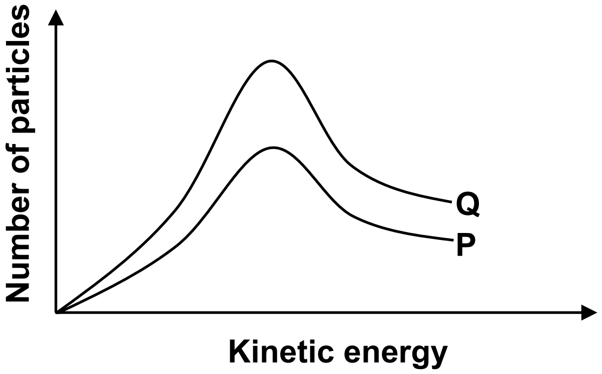
A Curve **P**

B Curve **Q**

C Curve **R**

D Curve **D** (2)

1.6 The Maxwell-Boltzmann energy distribution curve **P** for CO_2 gas under certain conditions. Curve **Q** was obtained after a change was made.



Which ONE of the following represents the change made to obtain curve **Q**?

A Increase in temperature

B Addition of a catalyst

C Increase in concentration

D Increase in surface area of CO_2 (2)

1.7 Consider the following reversible hypothetical reaction:

$$AB\ (aq) \rightleftharpoons A\ (aq) + B\ (g)$$

The heat of reactants (Hr) for the forward reaction is 25 kJ·mol^{-1} and activation energies (E_a) for the forward reaction and reverse reaction is 35 kJ·mol^{-1} and 45 kJ·mol^{-1} respectively.

The heat of the products (Hp) for the forward reaction is …

A 10 kJ·mol^{-1}.

B 15 kJ·mol^{-1}.

C 20 kJ·mol^{-1}.

D 35 kJ·mol^{-1}. (2)

1.8 Which ONE of the following acids, with the same concentration, will have the highest conductivity at a given temperature?

A H_2CO_3

B CH_3COOH

C HCℓ

D H_2SO_4 (2)

1.9 Consider the two-step ionisation of phosphoric acid:

(I) $H_3PO_4\ (aq) + H_2O\ (\ell) \rightleftharpoons H_2PO_4^-\ (aq) + H_3O^+\ (aq)$

(II) $H_2PO_4^-\ (aq) + H_2O\ (\ell) \rightleftharpoons HPO_4^{2-}(aq) + H_3O^+\ (aq)$

Consider the following statements regarding the two-step ionisation of H_3PO_4.

I $H_2PO_4^-$ act as an ampholyte

II HPO_4^{2-} is the conjugate acid of $H_2PO_4^-$

III $H_2PO_4^-$ can be considered as a diprotic acid

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

A **I** only

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

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

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

1.10 A specific indicator is colourless in an acidic solution and pink in an alkaline solution. The general equation for the indicator is:

$$HIn\ (aq) + H_2O\ (\ell) \rightleftharpoons In^-\ (aq) + H_3O^+\ (aq)$$

The indicator is added to a sodium hydroxide (NaOH) solution.

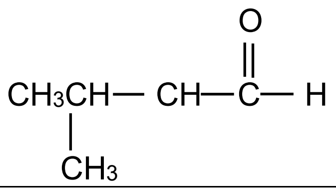
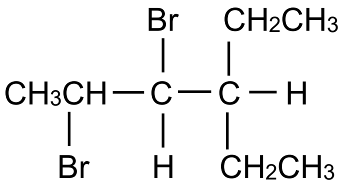
Which ONE of the following combinations are CORRECT regarding the colour of HIn and In⁻ and the shift in the equilibrium position?

	HIn	**In^-**	**SHIFT IN EQUILIBRIUM POSITION**
A	Pink	Colourless	Right
B	Colourless	Pink	Right
C	Pink	Colourless	Left
D	Colourless	Pink	Left

(2)
[20]

QUESTION 2 (Start on a new page.)

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

A	2-methylpentan-3-one	**B**	 $CH_3\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-CH-\overset{\displaystyle O}{\overset{\Vert}{C}}-H$
C	$CH_3C{\equiv}CCH(CH_3)CH_3$	**D**	 $CH_3\underset{\displaystyle Br}{\underset{\vert}{CH}}-\overset{\displaystyle Br}{\overset{\vert}{\underset{\displaystyle H}{\underset{\vert}{C}}}}-\overset{\displaystyle CH_2CH_3}{\overset{\vert}{\underset{\displaystyle CH_2CH_3}{\underset{\vert}{C}}}}-H$
E	Ethyl butanoate		

2.1 Define *functional group.* (2)

2.2 Write down the LETTER of the organic compound that represents the following:

2.2.1 Carbonyl group bonded to two carbon atoms (1)

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

2.2.3 Is an aldehyde (1)

2.3 Write down the IUPAC name of:

2.3.1 Compound **B** (2)

2.3.2 Compound **C** (2)

2.3.3 Compound **D** (3)

2.4 Write down the:

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

2.4.2 Name of the reaction that occurred to produce compound **E** (1)

2.4.3 STRUCTURAL FORMULA of the carboxylic acid needed to produce compound **E** (2)

2.5 An unknown organic compound (C**x**H**y**O**z**) with a molar mass of 74 g·mol^{-1} consists of 43,24% oxygen by mass.

2.5.1 Determine the MOLECULAR FORMULA of the organic compound. (3)

2.5.2 Draw TWO STRUCTURAL FORMULAE for the functional isomers that are represented by the molecular formula in QUESTION 2.5.1. (4)

[24]

QUESTION 3 (Start on a new page.)

Learners investigate the effect of structural differences on the boiling points of straight-chain PRIMARY ALCOHOLS. The data from the investigation are shown in the table below.

NUMBER OF CARBON ATOMS	BOILING POINTS OF THE ALCOHOLS (20 °C)
1	64
2	78
3	98
4	118

3.1 Define *boiling point.* (2)

3.2 Write down the controlled variable for this investigation. (1)

3.3 Explain the trend observed in the boiling points of the alcohols. (4)

3.4 Will the vapour pressure of the alcohols INCREASE, DECREASE or REMAIN THE SAME with an increase in the number of carbon atoms?

Give a reason for the answer. (2)

A PRIMARY ALCOHOL has a boiling point of 108 °C.

3.5 Give the IUPAC name of the primary alcohol with a boiling point of 108 °C. (2)

3.6 Fully explain the answer to QUESTION 3.5. (4)
[15]

QUESTION 4 (Start on a new page.)

4.1 Heptane undergoes cracking to produce a FIVE CARBON alkane **P** and organic compound **Q**, as shown below.

$$C_7H_{16} \longrightarrow \text{compound } \mathbf{P} + \text{compound } \mathbf{Q}$$

4.1.1 Define *cracking*. (2)

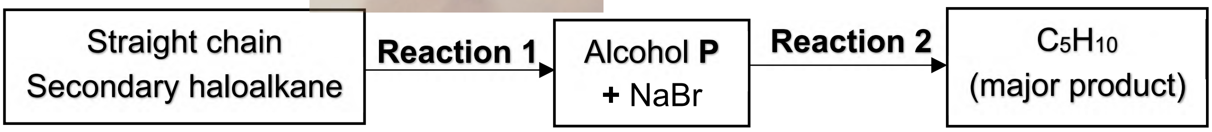
4.1.2 Write down the MOLECULAR FORMULA for compound **Q**. (2)

Compound **P** undergoes complete combustion.

4.1.3 Write down the most important use of alkanes. (1)

4.1.4 Using MOLECULAR FORMULAE, write down balanced equation for the complete combustion for COMPOUND **P**. (3)

4.2 Consider the flow diagram showing organic reactions given below.



Consider **REACTION 1**.

Write down:

4.2.1 The IUPAC name of the SECONDARY HALOALKANE (2)

4.2.2 The name of the reaction (1)

4.2.3 One reaction condition besides heat (1)

4.2.4 The STRUCTURAL FORMULA of alcohol **P** (2)

Consider **REACTION 2**.

Write down the:

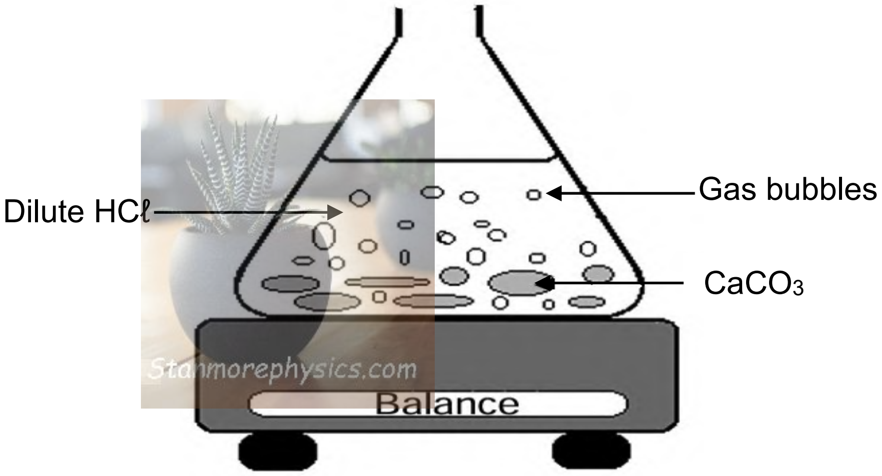
4.2.5 Name of the type of elimination reaction (1)

4.2.6 STRUCTURAL FORMULA for the product that was produced (2)
[17]

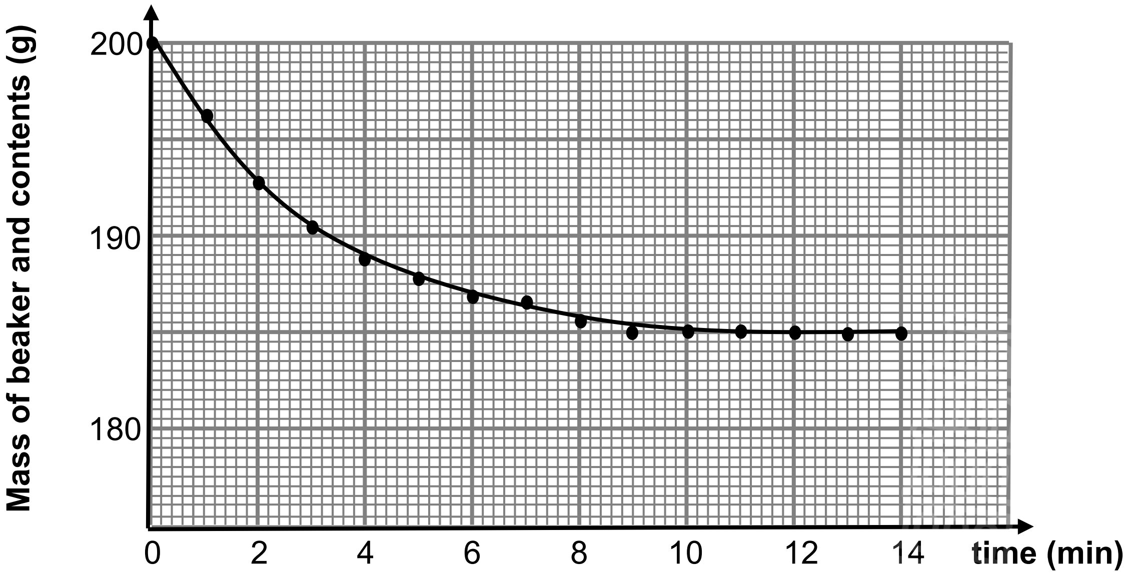
QUESTION 5 (Start on a new page.)

Calcium carbonate ($CaCO_3$) chunks are added to EXCESS dilute hydrochloric acid (HCℓ) solution in an Erlenmeyer flask that is placed on an electronic scale, as shown below. The balanced equation for the reaction that takes place is:

$$CaCO_3\,(s) + 2\,HC\ell\,(aq) \longrightarrow CaC\ell_2\,(aq) + H_2O\,(\ell) + CO_2\,(g) \qquad \Delta H < 0$$



The change in mass of the flask and its contents are recorded in 1-minute intervals. The results obtained are shown in the graph below.

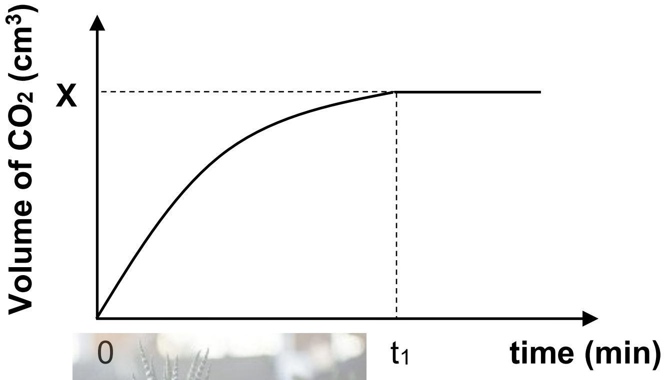


5.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer. (2)

5.2 Give a reason why the mass of the flask and its contents does not remain constant. (2)

5.3 Write down the reading on the scale balance on 4 minutes. (1)

5.4 The sketch graph below shows the change in volume of CO_2 gas produced for this experiment.



5.4.1 Write down the value of t_1. (1)

5.4.2 How does the rate at which the amount CO_2 is produced compared to the rate at which the amount $CaCO_3$ is consumed?

Choose from HIGHER THAN, SMALLER THAN or EQUAL TO.

Give a reason for the answer. (3)

Calculate the:

5.4.3 Value of **X**
Take the molar volume as 24 000 $cm^3 \cdot mol^{-1}$ (5)

5.4.4 Average rate in $g \cdot min^{-1}$ at which calcium carbonate was consumed after 11 minutes (4)

5.5 The experiment is repeated by increasing the temperature of the reaction mixture. The results of the two experiments are compared.

5.5.1 Write down a hypothesis for this comparison. (2)

5.5.2 How would reaction rate be affected by this change?

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

5.5.3 Explain the answer to QUESTION 5.5.2 by referring to the collision theory. (3)

[24]

QUESTION 6 (Start on a new page.)

6.1 Dinitrogen tetraoxide (N_2O_4) decomposes to nitrogen dioxide (NO_2) according to the balanced equation:

$$N_2O_4\,(g) \rightleftharpoons 2\,NO_2\,(g) \quad \Delta H > 0$$

The reaction is allowed to reach chemical equilibrium.

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

6.1.2 How would EACH of the following changes effect the concentration of NO_2 at equilibrium.

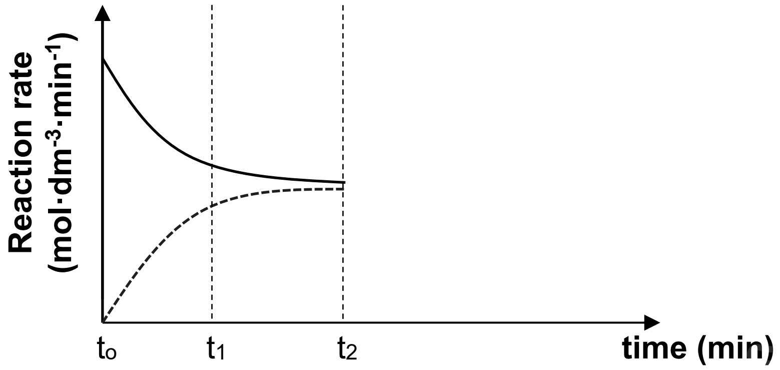
Choose from INCREASES, DECREASES or NO EFFECT.

(a) Addition of a suitable indicator (1)

(b) Increase in temperature (1)

(c) Increase in pressure by decreasing the volume.
Explain the answer by referring to Le Chatelier's principle. (4)

6.2 The reaction rate-time graph below shows the reaction until equilibrium.



6.2.1 Write down the reaction represented by the dashed line. (2)

6.2.2 The concentration of NO_2 was increased at t_2.

Redraw the graph above in the ANSWER BOOK on the same set of axes, sketch the complete graph showing the effect of the increase in the concentration of NO_2 after t_2. (2)

6.3 The table below shows the experimental data for the NO_2–N_2O_4 system at 25 ˚C.

INITIAL CONCENTRATIONS (mol·dm^{-3})		**EQUILIBRIUM CONCENTRATIONS (mol·dm^{-3})**	
[NO_2]	[N_2O_4]	[NO_2]	[N_2O_4]
0,05	0,446	0,0457	0,448

6.3.1 Calculate the equilibrium constant at 25 ˚C. (3)

6.3.2 Is there a HIGH YIELD or LOW YIELD of NO_2 at 25 ˚C.

Give a reason for the answer. (2)

When the initial concentration of NO_2 was changed to 0,03 mol·dm^{-3}, it is found that the equilibrium concentration of N_2O_4 is now 0,491 mol·dm^{-3} at 25 ˚C.

6.3.3 Calculate the percentage decomposition of N_2O_4 when the concentration of NO_2 was changed to 0,03 mol·dm^{-3} at 25 ˚C. (6)

[23]

QUESTION 7 (Start on a new page.)

7.1 The table below shows the ionisation constants, K_a values, for three acids at 25 °C.

NAME	FORMULA	K_a value
Methanoic acid	$HCOOH$	$1{,}8 \times 10^{-4}$
Ethanoic acid	CH_3COOH	$1{,}8 \times 10^{-5}$
Propanoic acid	CH_3CH_2COOH	$1{,}3 \times 10^{-5}$

7.1.1 Define an *acid* according to the Lowry-Brønsted theory. (2)

7.1.2 Write down the ionisation reaction for CH_3COOH. (2)

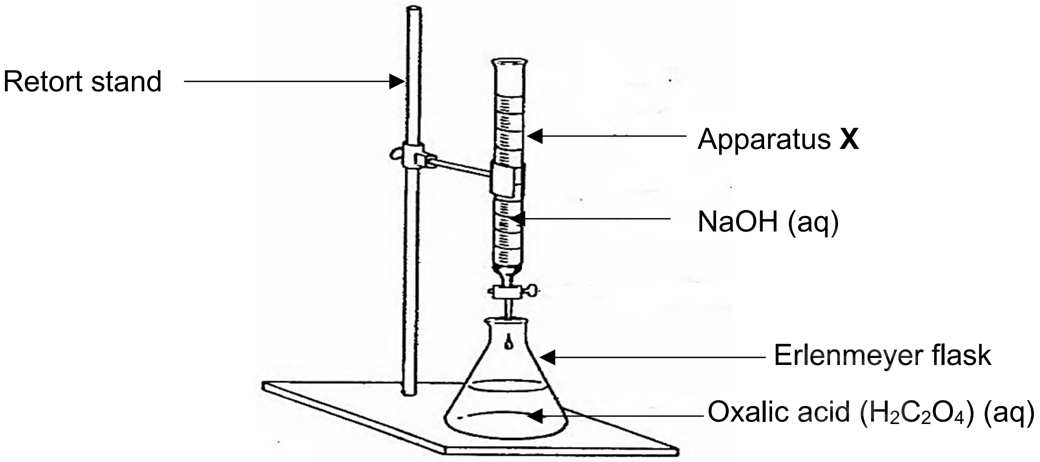
7.1.3 Are the above WEAK ACIDS or STRONG ACIDS?

Give a reason for the answer. (2)

7.1.4 Which ONE of the three acids, with equal concentrations, will have the lowest pH value?

Explain the answer. (3)

7.2 A group of learners used the set-up below to titrate sodium hydroxide (NaOH) against oxalic acid ($H_2C_2O_4$).



The balanced equation is:

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

7.2.1 Write down the name of apparatus **X**. (1)

7.2.2 Give a reason why the titration is carried out at least three times. (1)

7.2.3 At what pH range will a suitable indicator changes colour for this titration?

Choose from:

3,1– 4,4	6,0–7,6	8,3–10

(1)

7.2.4 Explain the answer to QUESTION 7.2.3 by referring to the relevant equation. (3)

7.3 The learners carried out another titration between hydrochloric acid (HCℓ) and sodium hydroxide (NaOH) with EQUAL concentration. They placed 25 cm^3 of hydrochloric acid with a concentration of 0,1 $mol{\cdot}dm^{-3}$ in the Erlenmeyer flask. The balanced equation is:

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

They over titrated the sodium hydroxide solution. The pH value at the end is 12,52.

Calculate the:

7.3.1 Initial number of moles of hydrochloric acid (3)

7.3.2 Concentration of the excess hydroxide ions (4)

7.3.3 Volume of sodium hydroxide titrated in cm^3 (5)

[27]

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* $c = \frac{m}{MV}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K

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

KEY/ *SLEUTEL*

Atoomgetal
Atomic number

29
1,9 Cu

Elektronegatiwiteit
Electronegativity

Simbools
Symbol

Benaderde relatiewe atoommassa
Approximate relative atomic mass

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

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NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

JUNE/*JUNIE* 2025

PHYSICAL SCIENCES: CHEMISTRY P2/ *FISIESE WETENSKAPPE: CHEMIE V2*

MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: **150**

This marking guideline consists of 15 pages./
Hierdie nasienriglyn bestaan uit 15 bladsye.

QUESTION/*VRAAG 1*

1.1	B ✓✓	(2)
1.2	D ✓✓	(2)
1.3	D ✓✓	(2)
1.4	B ✓✓	(2)
1.5	C ✓✓	(2)
1.6	C ✓✓	(2)
1.7	B ✓✓	(2)
1.8	D ✓✓	(2)
1.9	C ✓✓	(2)
1.10	B ✓✓	(2)
		[20]

QUESTION/*VRAAG 2*

2.1 A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds. ✓✓

'n Binding of 'n atoom of 'n groep atome wat die fisiese en chemiese eienskappe van 'n groep organiese verbindings bepaal. (2)

2.2 2.2.1 A ✓ (1)

2.2.2 C ✓ (1)

2.2.3 B ✓ (1)

2.3 2.3.1 3-methylbutanal ✓✓
3-metielbutanaal

Marking criteria/*Nasienkriteria*:
- Butanal / *butanaal* ✓
- Whole name correct / *Hele naam korrek* ✓

(2)

2.3.2 4-methylpent-2-yne ✓✓
4-metielpent-2-yn

Marking criteria/*Nasienkriteria*:
- Pent-2-yne / *pent-2-yn* ✓
- Whole name correct / *Hele naam korrek* ✓✓

OR/*OF*

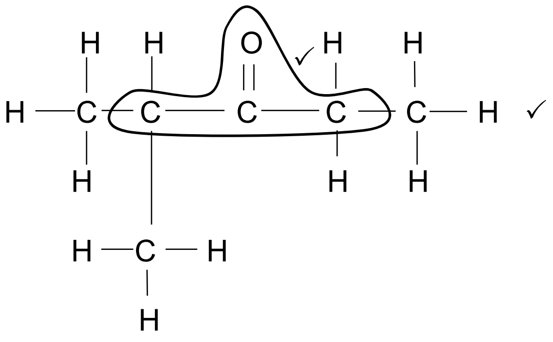
4-methyl-2-pentyne ✓✓
4-metiel-2-pentyn (2)

2.3.3 2,3-dibromo-4-ethylhexane ✓✓✓
2,3-dibromo-4-etielheksaan

Marking criteria/*Nasienkriteria*:
- Hexane / *heksaan* ✓
- dibromo and ethyl / *dibromo en etiel* ✓
- Whole name correct / *Hele naam korrek* ✓

(3)

2.4 2.4.1

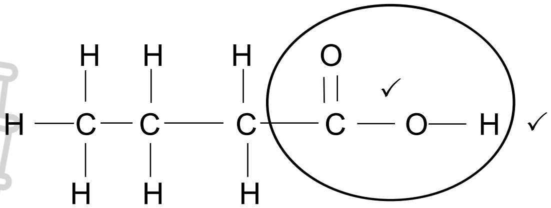


Markingcriteria /*Nasienkriteria*
- Correct functional group / *Funksionele groep korrek* ✓ 1/2
- Whole structure correct/ *Hele struktuur korrek* ✓2/2

(2)

2.4.2 Esterification / Condensation / *Esterifikasie / Kondensasie* ✓ (1)

2.4.3



Marking criteria/*Nasienkriteria*
- Correct functional group / *Funksionele groep korrek* ✓ 1/2
- Whole structure correct/ *Hele struktuur korrek* ✓2/2

(2)

2.5 2.5.1

$$43{,}24 = \frac{M}{74} \times 100 \checkmark$$

M = 31,9976

M = 32 g·mol^{-1}
M(O) = 16 g·mol^{-1}

$C\mathbf{x}H\mathbf{y}O_2$
Organic compound is either carboxylic acid or ester.
Organiese verbinding is 'n karboksiesuur of 'n ester.

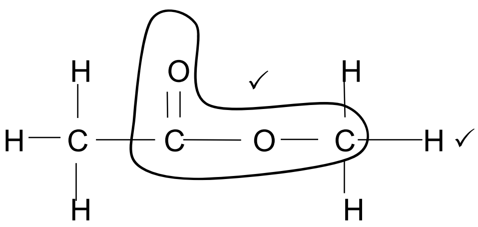
General formula / *Algemene formule*: $C_nH_{2n}O_2$

12 x n + 2 x n + 32 = 74 ✓

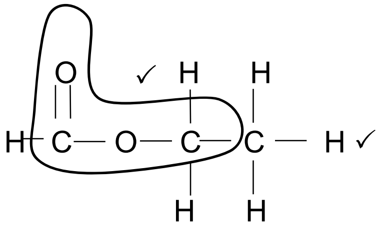
n = 3

$C_3H_6O_2$ ✓ (3)

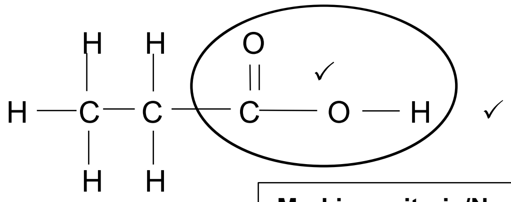
2.5.2



OR/ *OF*



AND/*EN*



Marking criteria/Nasienkriteria
- Correct functional group / *Funksionele groep korrek* ✓ 1/2
- Whole structure correct/ *Hele struktuur korrek* ✓ *2/2*

(4)
[24]

QUESTION/*VRAAG* 3

Marking criteria/ *Nasienkriteria*
If any of the underlined key words/ phrases in the **correct context** are omitted: - 1 mark per word/phrase.
*Indien enige van die sleutelwoorde/ frases in die **korrekte konteks** weggelaat word: - 1 punt per woord/frase.*

3.1 Boiling point is the temperature at which the vapour pressure of a substance /liquid equal the atmospheric pressure ✓✓

Kookpunt is die temperatuur waarteen die dampdruk van 'n stof/vloeistof gelyk aan die atmosferiesedruk is (2)

3.2 Same functional group / Same homologous series ✓
Dieselfde funksionele groep / Dieselfde homoloëreeks
Accept same type of intermolecular forces/*Aanvaar dieselfde tipe van intermolekulêre kragte* (1)

3.3 **Marking criteria**

- The boiling point increases down the table
- Chain length / molecular size increases down the table
- Increase in the strength of the London forces/Dispersion forces/Induced dipole forces / down the table
- Relate the strength of London forces /dispersion forces/induced dipole to energy involved

Nasienkriteria

- *Die kookpunt styg teen die tafel af*
- *Kettinglengte / molekulêre grootte neem teen die tabel af*
- *Toename in die sterkte van die Londonkragte /Dispersiekragte /Geïnduseerde dipoolkragte / teen die tabel af*
- *Verband hou met die sterkte van die Londonkragte/ verspreidingskrag/ geïnduseerde dipoolkragte met die energie betrokke*

- The trend shows an increase in the boiling point down the table ✓
- Increase in the surface area/chain length/molecular size down the table ✓
- Strength of London forces/dispersion forces/induced dipole forces / increases ✓
- More energy is needed to overcome intermolecular forces ✓

- *Die tendens toon 'n toename in die kookpunt teen die tabel af*
- *Toename in die oppervlakte/ketting lengte/molekulêre grootte teen die tabel af*
- *Sterkte van die Londonkragte/verspreidingskragte/geïnduseerde dipoolkragte neem toe*
- *Meer energie word benodig om die intermolekulêre kragte te oorkom* (4)

3.4 Decreases. ✓ The boiling point increases. ✓
Afneem. Die kookpunt neem toe. (2)

3.5 2-methylpropan-1-ol / 2-methyl-1-propanol ✓✓
2-metielpropan-1-ol/ 2-metiel-1-propanol

Marking criteria/*Nasienkriteria*:
- Propan-1-ol ✓
- Whole name correct / *Hele naam korrek* ✓

(2)

3.6 **Marking criteria**
- Compare the boiling point of the alcohol to the alcohol with 3-carbon atom alcohol
- Compare the surface area/chain length/molecular size of the alcohol to the alcohol with 3-carbon atoms
- Compare the boiling point of the alcohol to the alcohol with 4-carbon atoms
- Compare the surface area/chain length of the alcohol to the alcohol with 4-carbon atoms

- ***Nasienkriteria***
- *Vergelyk die kookpunt van die alkohol met die 3-koolstof atoom alkohol*
- *Vergelyk die oppervlakte/kettinglengte/molekulêre grootte van die alkohol met die 3-koolstof atoom alkohol*
- *Vergelyk die kookpunt van die alkohol met die 4-koolstof atoom alkohol*
- *Vergelyk die oppervlakte/kettinglengte van die alkohol met die 4-koolstof atoom alkohol*

- The boiling point of the unknown alcohol (2-methylpropan-1-ol) is higher than that of the alcohol with 3-carbon atoms (propan-1-ol) ✓
- Surface area / chain length / molecular size is greater than the alcohol with 3-carbon atoms (propan-1-ol) ✓
- The boiling point of the unknown alcohol (2-methylpropan-1-ol) is smaller than that of the straight chain alcohol with 4-carbon atoms (butan-1-ol) ✓
- Surface area / chain length is smaller than the straight chain alcohol with 4-carbon atoms (butan-1-ol) ✓

- *Die kookpunt van die onbekende alkohol (2-metielpropan-1-ol) is hoër as dié alkohol met 3-koolstofatome (propan-1-ol)*
- *Oppervlakte / kettinglengte / molekulêre grootte is grootter as die alkohol met 3-koolstof atome (propan-1-ol)*
- *Die kookpunt van die onbekende alkohol (2-metielpropan-1-ol) is laer as die reguitketting alkohol met 4-koolstofatome (butan-1-ol)*
- *Oppervlakte / kettinglengte is kleiner as die reguitketting alkohol met 4-koolstof atome (butan-1-ol)*

(4)
[15]

QUESTION/*VRAAG 4*

4.1 4.1.1 Breaking down of long chain hydrocarbon molecules into more useful shorter chains ✓✓ **(2 or 0)**
Die afbreek van lang kettingkoolwaterstof-molekules in meer bruikbare, molekule korter kettings ***(2 of 0)*** (2)

4.1.2 C_2H_4 ✓✓ (2)

4.1.3 Used as a fuel / *Word as 'n brandstof gebruik* ✓ (1)

4.1.4 $C_5H_{12} + 8\ O_2$ ✓ $\longrightarrow$ $5\ CO_2 + 6\ H_2O$ ✓ (✓ bal.)

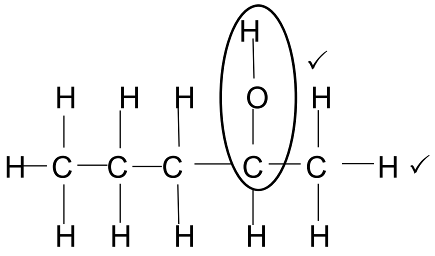
Reactants, ✓ products ✓and balancing ✓
Reaktanse, produkte en balansering (3)

4.2 4.2.1 2-bromopentane / *2-bromopentaan* ✓✓ (2)

4.2.2 Substitution/ Hydrolysis of haloalkanes / *Substitusie / Hydrolise van haloalkane* ✓ (1)

4.2.3 <u>Diluted strong base</u> / diluted NaOH ✓
<u>Verdunde sterk basis</u> / verdunde NaOH (1)

4.2.4

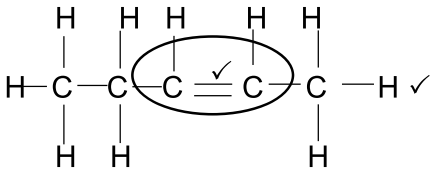


<u>Marking criteria/*Nasienkriteria*</u>
- Correct functional group / *Funksionele groep korrek* ✓ 1/2
- Whole structure correct/ *Hele struktuur korrek* ✓ *2/2*

(2)

4.2.5 Dehydration / *Dehidrasie / Dihidratering* ✓ (1)

4.2.6



<u>Marking criteria/Nasienkriteria</u>
- Correct functional group / *Funksionele groep korrek* ✓ 1/2
- Whole structure correct/ *Hele struktuur korrek* ✓ *2/2*

(2)
[17]

QUESTION/*VRAAG* 5

5.1 EXOTHERMIC / *EKSOTERMIES*. ✓ $\Delta H < 0$ ✓ (2)

5.2 Carbon dioxide (CO_2) gas escapes / *Koolstof dioksied (CO_2) gas ontsnap* ✓✓ (2)

5.3 189 g ✓ Accept/*Anvaar* (188,5 – 189) (1)

5.4 5.4.1 11 (minutes / *minute*) accept/ *aanvaar* 10 (minutes / *minute*) ✓ (1)

5.4.2 EQUAL TO ✓

The amount of $CaCO_3$ consumed is equal to the amount of CO_2 produced / the mol ratio of $CaCO_3$ to CO_2 is 1 : 1. ✓

The time taken for consumption and production is the same. ✓

GELYK AAN

Die hoeveelheid $CaCO_3$ verbruik is gelyk aan die hoeveelheid CO_2 vervaardig / die molverhouding van $CaCO_3$ tot CO_2 is 1 : 1.

Die tyd geneem vir die verbuik en vervaardiging is dieselfde. (3)

5.4.3

Marking criteria / *Nasienkriteria*

(a) Subtract / *Aftrek* 200 – 185
(b) Subst. into / *Vervanging in* $n = m/M$
(c) Formula / *Formule* $V = nV_m$
(d) Subst. into/ *Vervanging in* $V = nV_m$
(e) Final answer/ *Finale antwoord*

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

$$n = \frac{200 - 185 \checkmark \text{(a)}}{44} \checkmark \text{(b)}$$

$$n = 0{,}34 \text{ mol}$$

$V = nV_m$ ✓ (c)

$V = (0{,}34)(24000)$ ✓ (d)

$V = 8\ 160\ (cm^3)$ ✓ (e)

Range = 8160 – 8181,82 (5)

5.4.4 **Marking criteria/*Nasienkriteria***

(a) Use of mol ratio / *Gebruik van molverhouding* $CO_2 : CaCO_3$
(b) Subst. into/ *Vervanging in* n = m/M
(c) Subst. into rate equation/ *Vervanging in tempo vergelyking*
(d) Final answer / *Finale antwoord*

Positive marking from/*Positiewe nasien van 5.4.3*

$n(CO_2) = n(CaCO_3) = 0{,}34$ mol ✓ (a)

m = nM

m = (0,34)(100) ✓ (b)

m = 34 g

$$\text{rate/}\textit{tempo} = -\frac{\Delta m}{\Delta t}$$

$$\text{rate/}\textit{tempo} = -\frac{0 - 34}{11}$$ ✓ (c)

m = 3,09 $g{\cdot}min^{-1}$ ✓ (d) (4)

5.5 5.5.1

Marking criteria for hypothesis
- Statement regarding the correct independent and dependent variable
- Statement is measurable

Nasienkriteria vir hipotese
- *Stelling om die onafhanklike en afhanklike veranderlike is korrek*
- *Stelling is meetbaar*

A(n) decrease / increase in temperature will decrease / increase the reaction rate.
'n Afname/ toename in temperatuur sal die reaksietempo laat afneem/ toeneem. (2)

5.5.2 INCREASES / *TOENEEM* ✓ (1)

5.5.3
- Higher temperature means the average kinetic energy of the particles increases ✓
- More particles will have sufficient kinetic energy / more particles will have kinetic energy equal to or higher than the activation energy ✓
- More effective collisions per unit time / Frequency of the effective collisions increases ✓

- *Hoër temperatuur beteken die gemiddelde kinetiese energie van die deeltjies neem toe*
- *Meer deeltjies het genoeg kinetiese energie / meer deeltjies het kinetiese energie gelyk of hoër as die aktiveringsenergie*
- *Meer effektiewe botsings per tydseenheid / Frekwensie van die effektiewe botsings neem toe* (3)

[24]

QUESTION/*VRAAG* 6

6.1.1

> **Marking criteria/*Nasienkriteria***
> If any of the underlined key words/phrases in the **correct context** are omitted: - 1 mark per word/phrase.
> *Indien enige van die sleutelwoorde/frases in die **korrekte konteks** weggelaat word: - 1 punt per woord/frase.*

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose/cancel the disturbance. ✓✓

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

6.1.2 (a) NO EFFECT / *GEEN EFFEK* ✓ (1)

(b) INCREASES / *TOENEEM* ✓ (1)

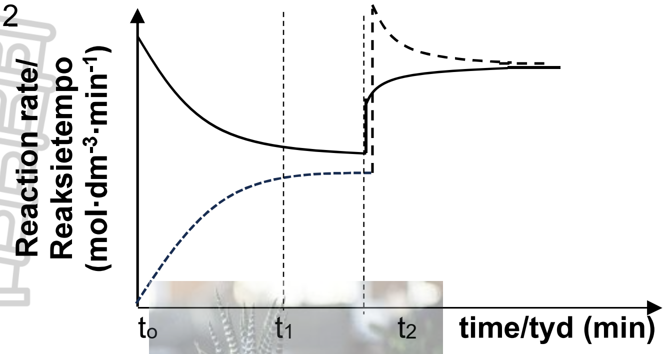
(c) DECREASES / *AFNEEM* ✓

- An increase in pressure favours the reaction that produces the least number of gaseous moles. ✓
- Mole ratio of reactants : products 1 : 2 ✓
- The reverse reaction is favoured / the equilibrium position shifted towards left. ✓

- *'n Toename in druk bevoordeel die reaksie wat die minste gasmol produseer.*
- *Die molverhouding reaktanse : produkte 1 : 2*
- *Die terugwaartse reaksie word bevoordeel / die ewewigsposisie verskuif links.* (4)

6.2 6.2.1 $2\,NO_2(g) \rightarrow N_2O_4(g)$ ✓✓ (2)

6.2.2



Marking criteria/
Nasienkriteria

Both graphs rates increases vertically and reached new equilibrium ✓

Increase in the reverse reaction rate is higher than the forward rate ✓

Beide grafieke se tempo neem vertikaal toe en bereik 'n nuwe ewewig

Toename in die tempo van die terugwaartse reaksie is hoër as die tempo van die voortwaartse reaksie

(2)

6.3 6.3.1

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} \checkmark$$

$$K_c = \frac{(0{,}0457)^2}{(0{,}448)} \checkmark$$

$$K_c = 4{,}66 \times 10^{-3} \checkmark$$ (3)

6.3.2 LOW YIELD. ✓ Kc is less than 1. ✓
LAE OPBRENGS. Kc is kleiner as 1. (2)

6.3.3 **POSITIVE MARKING FROM / *POSITIEWE NASIEN VANAF* 6.3.1**
MARKING CRITERIA

a. Subst. Kc value and correct N_2O_4 concentration into the correct Kc expression ✓
b. Determine the change in concentration of NO_2 ✓
c. Correct ratio N_2O_4 and NO_2 ✓
d. Determine the initial concentration N_2O_4 ✓
e. Subst. change in concentration and initial concentration of N_2O_4 in % change formula ✓
f. Final answer ✓

NASIENKRITERIA

a. *Vervang die Kc-waarde en korrekte N_2O_4 konsentrasie in die korrekte Kc-uitdrukking*
b. *Bepaal die verandering in die konsentrasie van NO_2*
c. *Korrekte verhouding tussen N_2O_4 en NO_2*
d. *Bepaal die aanvanklike konsentrasie van N_2O_4*
e. *Vervanging in verandering in konsentrasie en die aanvanklike konsentrasie van N_2O_4 in die % verandering formule*
f. *Finale antwoord*

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}$$

$$4,66 \times 10^{-3} = \frac{[NO_2]^2}{(0,491)}$$ (a) ✓

$[NO_2] = 0,0478\ mol·dm^{-3}$

	N_2O_4	2 NO_2 (g)
Initial conc/ *Aanvangskonsentrasie*	0,5 (d) ✓	0,03
Change in conc./ *Verandering in konsentrasie*	$8,9 \times 10^{-3}$	0,0178 (b) ✓
Equilibrium conc./ *Ewewigskonsentrasie*	0,491	0,0478

(c) ratio/ verhouding ✓

$$\% [N_2O_4] = \frac{8,9 \times 10^{-3}}{0,5} \times 100\ \%$$ (e) ✓

$\% [N_2O_4] = 1,78\ \%$ (f) ✓ (6)

[23]

QUESTION/*VRAAG* 7

7.1 7.1.1 An acid is <u>a proton (H^+) donor</u> ✓✓ **(2 or 0)**
'n Suur is <u>proton (H^+) skenker</u> ***<u>(2 of 0)</u>*** (2)

7.1.2 $CH_3COOH + H_2O$ ✓ $\rightleftharpoons CH_3COO^- + H_3O^+$ ✓
Ignore phases / *Ignoreer fases* (2)

7.1.3 Weak acid / *Swaksuur* ✓
K_a value is less than 1 / *K_a-waarde is kleiner as 1* ✓ (2)

7.1.4 *Methanoic acid* ✓

It has the larger K_a-value / Ionises to a greater extend / It is the stronger acid. ✓
The higher the concentration of the H_3O^+ the lower the pH-value. ✓

Metanoësuur
Dit is het die groter K_a-waarde / Ioniseer tot 'n groter mate / Dit is die sterker suur.
Hoe hoër die konsentrasie van H_3O^+ hoe kleiner is is die pH-waarde (3)

7.2 7.2.1 Burette / *Buret* ✓ (1)

7.2.2 To ensure <u>reliable results / accurate results</u> ✓
Om <u>betroubare resultate / akkurate resultate te verseker</u> (1)

7.2.3 8,3–10 ✓ (1)

7.2.4 $C_2O_4^{2-}$ + H_2O ✓ → $HC_2O_4^-$ + OH^- ✓

(reactants / *reaktanse* and / *en* products / *produkte*)

Excess OH^- is produced / *Oormaat OH^- is geproduseer* ✓ (3)

7.3 7.3.1 n = cV ✓

n = (0,1)(25 x 10^{-3}) ✓

n = 2,5 x 10^{-3} mol ✓ (3)

7.3.2

OPTION 1 **Marking criteria** (a) pH formula (b) Subst. into pH-formula (c) Subst. into $K_w = [H_3O^+][OH^-]$ (d) Final answer	**OPTION 2** **Marking criteria** (a) Formula pH + pOH = 14 (b) Subst. into pH + pOH =14 (c) Subst. into pOH formula (d) Final answer
OPSIE 1 ***Nasienkriteria*** *(a) pH-formule* *(b) Vervang in pH-formule* *(c) Vervang in $K_w = [H_3O^+][OH^-]$* *(d) Finale antwoord*	***OPSIE 2*** ***Nasienkriteria*** (a) *Formule pH +pOH = 14* (b) *Vervang in pH + pOH =14* (c) *Vervang in pOH-formule* (d) *Finale antwoord*
$pH = -\log[H_3O^+]$ ✓ (a) $12,52 = -\log[H_3O^+]$ ✓ (b) $[H_3O^+] = 3,02 \times 10^{-13}$ mol·dm^{-3} $K_w = [H_3O^+][OH^-]$ $1 \times 10^{-14} = (3,02 \times 10^{-13})[OH^-]$ ✓ (c) $[OH^-] = 0,033$ mol·dm^{-3} ✓ (d)	pH + pOH = 14 ✓ (a) 12,52 + pOH = 14 ✓ (b) pOH = 1,48 $pOH = -\log[OH^-]$ $1,48 = -\log[OH^-]$ ✓ (c) $[OH^-] = 0,033$ mol·dm^{-3} ✓ (d)

(4)

7.3.3 **POSITIVE MARKING FROM QUESTION 7.3.1 AND 7.3.2**
POSITIEWE NASIEN VAN VRAAG 7.3.1 EN 7.3.2

Marking criteria
(a) Subst. 0,033 and V into n = cV
(b) Subst. 0,033V, 0,1V and n equivalence point in
$n_{excess} = n_{Totaal} - n_{ep}$
(c) Subst. into V (total volume) = V (volume titrated) + V (acid)
(d) Subst. eq (2) into (1)
(e) Final answer

Nasienkritria
(a) Vervang 0,033 en V in n = cV
(b) Vervang 0,033V , 0,1V en 'n ekwivalente punt in
$n_{oormaat} = n_{totaal} - n_{ekw}$
(c) Vervang in V (totale volume) = V (volume getitreer) + V (suur)
(d) Vervang vergelyking (2) in (1)
(e) Finale antwoord

n (excess) = n (total) – n (equivalence point)
n (oormaat) = n (totaal) – n (ekwivalente punt)

cV (total volume) = cV(volume titrated) – n (equivalence point)
cV (totaal volume) = cV (volume getitreer) – n (ekwivalente punt)

0,033V (total volume) ✓ **(a)** = 0,1V (volume titrated) – $2,5 \times 10^{-3}$ …(1) ✓ **(b)**

V (total volume) = V (volume titrated) + V (acid)
V (totale volume) = V(getitreer) + V (suur)

V (total volume) = V (volume titrated) + 25 x 10^{-3} … (2) **(c)** ✓

Subst. equation (2) into (1) / *Vervang vergelyking (2) in (1)*

0,033 [Volume titrated + 25 x 10^{-3}] ✓ **(d)** = 0,1 Volume titrated – 2,5 x 10^{-3}

Volume titrated / *volume getitreer* = 0,050 dm^3

Volume titrated / *volume getitreer* = 50 cm^3 ✓ **(e)** (5)

[27]

TOTAL/*TOTAAL*: 150