Hillcrest High School

PHYSICAL SCIENCE P2

Trials 2023 MEMO

Grade 12

MARKS: 150

TIME: 3 Hours

EXAMINER: Mrs J. Knox-Whitehead

MODERATOR: Ms N. Badenhorst

<u>SECTION A:</u> QUESTION 1 (Multiple-choice)

1.1 D ✓✓

1.2 D

1.3 A

1.4 D

1.5 A

1.6 D

1.7 D

1.8 C

1.9 B

1.10 A

[20]

QUESTION/*VRAAG* 2

2.1 2.1.1 Ester/*Ester* ✓ (1)

2.1.2 Methyl ✓propanoate✓/ *Metiel✓propanoaat✓* (2)

2.1.3 carboxylic acid ✓ (1)

2.2 2.2.1 catalyst / dehydrating agent / speeds up the reaction ✓ (1)

2.2.2 propanoic acid ✓ (1)

2.3 2.3.1 *Functional group* is a bond or an atom or a group of atoms ✓ that determines the physical and chemical properties of a group of organic compounds. ✓ (2)

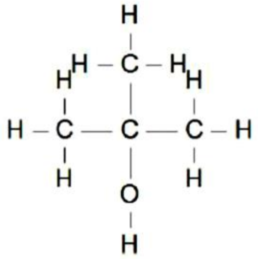
2.3.2 carboxyl group ✓ (1)

2.3.3 CH_3COOH ✓ (1)

2.4 2.4.1 positional isomers ✓ (1)

2.4.2 D ✓ (1)

2.4.3



Marking criteria / *Nasienkriteria*
• methyl and alcohol both on 2nd C ✓/ *metiel en alkohol beide op 2de C* • main chain / *hoofketting*: 3 C ✓

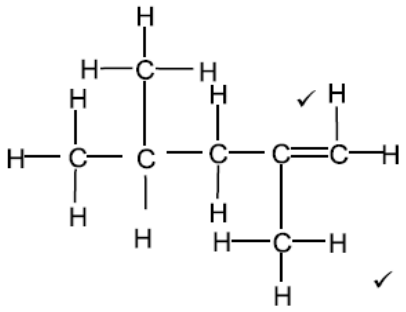
(2)

2.5 2.5.1 2-bromo-5,5-dimethylhexane

(2)

Marking criteria/*Nasienkriteria*
- Correct stem i.e. hexane ✓/ *Korrekte stam d.w.s. heksaan*✓
- All substituents: bromo and dimethyl ✓ do not accept methyl only

2.5.2



Marking criteria/*Nasienkriteria*
- Whole structure correct / *Hele struktuur korrek* 2/2
- Only functional group correct / *Slegs funksionele groep korrek* 1/2
- Additional functional groups / *Addisionele funksionele groepe* 0/2

(2)

[18]

QUESTION 3

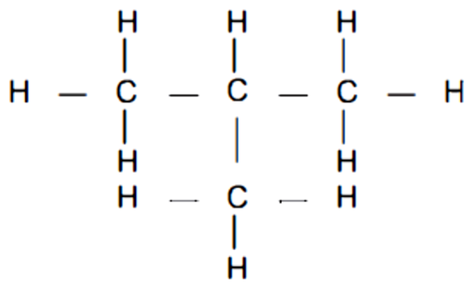
3.1.1 Melting point is <u>the temperature</u> at which <u>the solid and liquid phases of a substance are at equilibrium</u>. ✓✓ (2)

3.1.2 Compound X is branched / has a smaller surface area than compound Y which has a straight chain / is unbranched / has a bigger surface area. ✓

Van der Waal's London forces are stronger in molecules that have a bigger surface area. ✓

More energy is required to overcome the intermolecular forces in compound Y. ✓ (3)

3.1.3



Marking criteria:
- 3 carbons in the longest chain✓
- substituent methyl on the second carbon and everything else correct✓

(2)

3.1.4 Y (1)

3.2.1 Butanoic acid ✓
The compounds must be of comparable molecular mass OR butanoic acid has the same m ecular mass as pentan – 1 - ol✓

OR

Pentanoic acid ✓
The compounds must be of comparable chain length OR pentanoic acid has the same chain le gth as pentan – 1 - ol✓ (2)

3.2.2 Boiling point (1)

3.2.3 GREATER THAN✓ (1)

3.2.4 The carboxylic acid has 2 sites for hydrogen bonding while the alcohol has only 1 site for hydrogen bonding. ✓
The intermolecular forces will therefore be stronger between the molecules of the carboxylic acid. ✓
More energy will therefore be required to overcome the intermolecular forces between the molecules of the acid. ✓ (3)

[15]

QUESTION 4

4.1.1 **I**: Addition, Hydrohalogenation ✓

II: Elimination - Deydrohalogenation ✓

III: Addition - Hydration

IV: Cracking✓

(4)

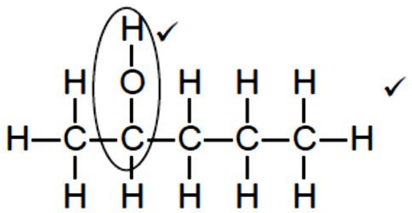
4.1.2 2-bromo✓pentane✓ (2)

4.1.3 alkene ✓ (1)

4.1.4 H_2O ✓ (1)

4.1.5 heat under reflux ✓ (1)

4.1.6



Marking criteria / *Nasienriglyne*
• Only functional group correct / *Slegs funksionele groep korrek* ✓
• Whole structure correct / *Hele struktuur korrek* ✓

(2)

4.1.7 ethane ✓ (1)

4.2.1 CH_4 + 2 O_2 ✓ LHS → CO_2 + 2 H_2O ✓ RHS ✓ balancing (3)

4.2.2 Given: m = 68,88 g

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

$= \frac{68,88}{44}$ ✓

= 1,565 mol

Used: n = 1,565 ÷1x1✓

= 1,565 mol

m = n x M

= 1,565 x 16 ✓

= 25,05 g

$$\% \text{ Purity} = \frac{\text{pure mass}}{\text{total mass}} \times 100$$

$$60 = \frac{25{,}05}{x} \times 100 \checkmark$$

$x = \underline{41{,}75 \text{ g}}$ ✓ (5)

[20]

QUESTION 5

5.1.1 **The minimum energy needed for a reaction to take place.** ✓✓ (2)

5.1.2 **Endothermic**✓ energy is absorbed / energy of products is higher than energy of reactants ✓ (2)

5.1.3

$1250 - E_P(C) = 800$✓
$E_P(C) = 1250 - 800$
$= 450$ KJ✓

$E_{reactants} = 1250 - 800$
$= 450$ kJ

(2)

5.1.4

$EP(B) = 1250 - 520$
$= 730$ KJ✓

$\therefore \Delta H = E_P(P) - E_P(R)$
$= 730 - 450$
$= 280$ KJ✓

Hproducts = 1250 – 520
= 730

ΔH = Hproducts – H reactants
= 730 – 450
= 280 kJ

(2)

5.2.1 Rate of reaction ✓ (1)

5.2.2 X ✓ (1)

5.2.3 The granules have larger particle size than the powder therefore less surface area exposed to react. ✓

Therefore less effective collisions per unit time. ✓

Therefore it took a longer time to produce the 100cm^3 of H_2. ✓
(must refer back to graph) (3)

NO MARKS for discussing the effects of Concentration change, which did not relate to the question.

5.2.4 $N = \frac{V}{V_m}$

$= \frac{0,1}{24,04}$ ✓

$= 0,00415973$ mol

But: $n(Zn) : n(H_2) = 1:1$ ✓

$n(Zn) = n(H_2) = 0,00415973$ mol

$m(Zn) = nM$

$= (0,00415973)(65)$ ✓

$= 0,27$ g ✓

(4)

[17]

QUESTION 6 / *VRAAG 6*

6.1

Marking criteria:

- Calculate number of moles of H_2 and $C\ell_2$ ✓
- Use mole ratio 1:1:2 ✓
- Moles at equilibrium ✓
- Divide equilibrium moles by Volume (0,5) ✓
- Correct K_c expression (formulae in square brackets) ✓
- Substitute 64 as K_c value ✓
- Substitution of equilibrium concentrations into Kc expression. ✓
- Substitute moles of $C\ell_2$ and in correct formula. ✓
- Final answer: 71 g ✓

Nasienkriteria:

- *Bereken die aantal mol van H_2 en $C\ell_2$* ✓
- *Gebruik verhouding 1:1:2* ✓
- *Mol by ewewig* ✓
- *Deel mol by ewewig met volume (0,5)* ✓
- *Korrekte Kc - uitdrukking (formules in vierkanthakies)* ✓
- *Vervang 64 as K_c-waarde* ✓
- *Vervanging van ewewigskonsentrasies in K_c -uitdrukking.* ✓
- *Vervang mol van $C\ell_2$ en 71 $g \cdot mol^{-1}$ in korrekte formule* ✓
- *Finale antwoord: 71 g* ✓

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

$= \frac{10}{2}$ $= \frac{355}{71}$

$= 5 \text{ mol } H_2$ $= 5 \text{ mol } Cl_2$

	$H_2(g)$	$Cℓ_2$ (g)	HCℓ(g)	
Initial quantity (mol) Aanvangshoeveelheid (mol)	5	✓ 5	0	
Change (mol) Verandering (mol)	x	x	2x	Ratio ✓
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	5 – x	5 – x	2x ✓	
Equilibrium concentration ($mol·dm^{-3}$) Ewewigskonsentrasie ($mol·dm^{-3}$)	$\frac{5-x}{0,5}$	$\frac{5-x}{0,5}$	$\frac{2x}{0,5}$ ✓	

$K_c = \frac{[HCl]^2}{[H_2][Cl_2]}$ ✓

$64 ✓ = \frac{(\frac{2x}{0,5})^2}{(\frac{5-x}{0,5})(\frac{5-x}{0,5})}$ ✓

$x = 4$

No Kc expression, correct substitution/*Geen Kc-uitdrukking, korrekte substitusie*: Max./Maks. 8/9

Wrong Kc expres[sion/*Verkeerde Kc uitdrukking*: Max./Maks. 6/9

$n(Cl_2)_{equilibrium/ewewig} = 5 - 4$

$= 1$ ✓

$m_{Cl_2} = nM$

$= (1)(71)$

$= 71 \text{ g}$ ✓

(9)

6.2 Negative ✓

- Decrease in temperature favours the exothermic reaction ✓
- The forward reaction is favoured ✓ (3)

6.3.1 Increases ✓ (1)

6.3.2 Remains the same (1)

[14]

QUESTION 7

7.1.1 A strong acid ionises completely in water to form a high concentration of H_3O^+ ions.✓✓ (2)

7.1.2 Solution **I.** ✓

- $HCℓ$ is a stronger acid than CH_3COOH / $HCℓ$ has a higher K_a ✓ (than CH_3COOH)
- $HCℓ$ will produce a higher concentration of H_3O^+ ✓ (than CH_3COOH)

OR

- CH_3COOH is a weaker acid than $HCℓ$ / CH_3COOH has a lower K_a (than $HCℓ$)
- CH_3COOH will produce a lower concentration of H_3O^+ (than $HCℓ$)

(3)

7.2.1
$n = cV$ ✓
$= 1 \times 10 / 1\,000$ ✓
$= 0{,}01$ mol ✓
(3)

7.2.2

Marking criteria	Marking criteria
• Formula $pH = -\log[H_3O^+]$ ✓ • pH value substituted into formula ✓ • Substitution in K_w formula ✓ • Substitution into $n = cV$ ✓ • Final answer ✓ ***Nasienkriteria*** • *Formule $pH = -\log[H_3O^+]$* • *pH-waarde vervang in formule* • *Vervanging in K_w formule* • *Vervanging in $n = cV$* • *Finale antwoord*	• Formula $pOH + pH = 14$ ✓ • pH value substituted into formula ✓ • Substitution in pOH formula ✓ • Substitution into $n = cV$ ✓ • Final answer ✓ ***Nasienkriteria*** • *Formule $pOH + pH = 14$* • *pH-waarde vervang in formule* • *Vervanging in pOH formule* • *Vervanging in $n = cV$* • *Finale antwoord*

OPTION 1 / *OPSIE 1*	**OPTION 2 / *OPSIE 2***
$pH = -\log[H_3O^+]$ ✓ 13 ✓ $= -\log[H_3O^+]$ $[H_3O^+] = 1 \times 10^{-13}\ mol \cdot dm^{-3}$ $K_w = [OH^-][H_3O^+] = 1 \times 10^{-14}$ $[OH^-][H_3O^+] = 1 \times 10^{-14}$ $[OH^-](1 \times 10^{-13}) = 1 \times 10^{-14}$ ✓ $[OH^-] = 0{,}1\ mol \cdot dm^{-3}$ $[NaOH] = 0{,}1\ mol \cdot dm^{-3}$	$pOH + pH = 14$ ✓ $pOH + 13$ ✓ $= 14$ $pOH = 1$ $pOH = -\log[OH^-]$ $1 = -\log[OH^-]$ ✓ $[OH^-] = 0{,}1\ mol \cdot dm^{-3}$ $[NaOH] = 0{,}1\ mol \cdot dm^{-3}$
$c = \frac{n}{V}$ **OR/*OF*** $0{,}1 = \frac{0{,}01}{V}$ ✓ (From 7.2.1 / *Vanaf 7.2.1*) $V = 0{,}1$ ✓ (dm^3)	$c_1V_1 = c_2V_2$ $(1)(10) = (0{,}1)V_2$ ✓ $V_2 = 100\ cm^3$ $V = 0{,}1$ ✓ (dm^3)

(5)

7.2.3] $2NaOH + H_2C_2O_4 \rightarrow$

Given

$n = c.V$ From 7.2.1
$= 0{,}1(0{,}1)$
$= 0{,}01$ mol

$n = c.V$
$= 0{,}012(0{,}09)$ ✓
$= 0{,}00108$ mol

needed
$0{,}00108 \text{ mol} \div 1 \times 2$ ✓m
$= 0{,}00216$ mol

From 7.2.1 / 7.2.2

mol excess $= 0{,}01 - 0{,}00216$ ✓ (or)
$= 0{,}00784$ mol

$V = \frac{n}{c}$
$= \frac{0{,}00784}{0{,}1}$ ✓
$= 0{,}0784$ ✓A
$\approx 0{,}08$ / $7{,}84 \times 10^{-2}$ dm^3

Volume used

$V = \frac{n}{c}$
$= \frac{0{,}00216}{0{,}1}$ ✓
$= 0{,}0216$ dm^3

$V_{excess} = 0{,}1 - 0{,}0216$ ✓
$= 0{,}08$ dm^3 ✓

(5)

(or)

$\frac{C_aV_a}{C_bV_b} = \frac{n_a}{n_b}$ ✓

$\frac{0{,}09(0{,}012)}{0{,}1(V_b)}$ ✓ $= \frac{1}{2}$ ✓

$V_b = 0{,}0216$ dm^3

7.3.1] Basic ✓ (1)

7.3.2] $Na_2CO_3 + H_2O$ ✓ $\rightarrow 2Na^+ + HCO_3^-$ ✓ $+ OH^-$ ✓

$CO_3^{2-} + H_2O$ ✓ $\rightarrow HCO_3^-$ ✓ $+ OH^-$ ✓ (3)

7.3.1 basic (1)

7.3.2

$CO_3^{2-} + H_2O$ ✓→ $OH^- + HCO_3^-$ ✓ Balancing ✓

Marking criteria / *Nasienkriteria*:		
• Reactants ✓ *Reaktanse*	Products ✓ *Produkte*	Balancing ✓ *Balansering*
• Ignore phases / *Ignoreer fases.*		

(3)

[22]

QUESTION 8 / *VRAAG 8*

8.1 Concentration/*Konsentrasie*: 1 mol·dm^{-3} ✓
Temperature/*Temperatuur*: 25 °C ✓ (2)

8.2 Ni to Ag ✓ (1)

8.3 $Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$ ✓ balancing ✓

Marking criteria / *Nasienkriteria*:		
• Reactants ✓ *Reaktanse*	Products ✓ *Produkte*	Balancing ✓ *Balansering*

(3)

8.4 n(anode) = ½n(cathode)
n(anode) = ½(0,4)
= 0,2 mol✓

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

$0,2 = \frac{m}{59}$✓

$m_{decrease/afname} = 11,8$ g✓ (3)

8.5.1 $E^\theta_{cell} = E^\theta_{cathode/reduction/oxidising\ agent} - E^\theta_{anode/oxidation/reducing\ agent}$ ✓
= 0,80 ✓– (-0,27) ✓
= 1,07 V ✓ (4)

8.5.2 Equilibrium ✓ (1)

[14]

QUESTION 9

9.1.1 A substance of which the aqueous solution contains ions. OR: a substance that dissolves in water to give a solution that conducts electricity. ✓✓ (2)

9.1.2 Cathode ✓ (1)

9.1.3 $Cu^{2+}_{(aq)} + 2e^{-} \rightarrow Cu_{(s)}$ ✓✓ (2)

9.2 Positive✓ (1)

9.3 Cu^{2+} Is a stronger oxidising agent than Zn^{2+} ✓and therefore the Zn^{2+} will not be reduced (will stay in solution). ✓ (2)

9.4 gas bubbles (1)

[9]

Total 150