Hillcrest High School

PHYSICAL SCIENCE P2

JUNE 2023

Grade 12

MARKS: 100

TIME: 2 Hours

EXAMINER: Mrs J. Knox-Whitehead

MODERATOR: Ms N. Badenhorst

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

1.1 C ✓✓

1.2 C

1.3 C

1.4 B

1.5 B **[10]**

QUESTION 2

2.1 Structural isomers are organic molecules with the same molecular formula but different structural formulae. ✓✓ (2)

2.2.1 S (1)

2.2.2 V (1)

2.2.3 S (1)

2.2.4 R (1)

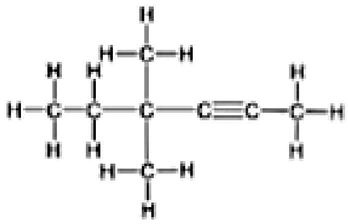
2.2.5 V (1)

2.3.1

2-bromo-5,5-dimethylhexane ✓ hexane ✓ for side chains

(2)

2.3.2

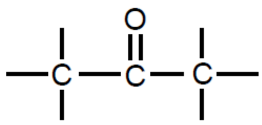


✓ triple bond correct

✓ for rest of molecule (2)

2.4.1 ketones (1)

2.4.2 (1)



2.5 ester (1)

QUESTION/*VRAAG* 3

3.1.1

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.*

a substance

The temperature at which the vapour pressure of (a liquid) equals the atmospheric pressure. ✓✓

Die temperatuur waarby die dampdruk van die vloeistof gelyk is aan die atmosferiese druk. (2)

3.1.2 As the number of C atoms increases:

- The surface area/chain length/molecular mass of the alcohols increases ✓
- The strength of London forces/induced dipole forces/dispersion forces increase. ✓

Soos die aantal C-atome toeneem:

- *Die oppervlak-area/kettinglengte/molekulêre massa van die alkohole verhoog.*
- *Die sterkte van die Londonkragte/geïnduseerde dipoolkragte/ verspreidingskragte verhoog*

OR/*OF*

As the number of C atoms decreases:

- The surface area/chain length/molecular mass of the alcohols decreases ✓
- The strength of London forces/induced dipole forces/dispersion forces decrease. ✓

Soos die aantal C-atome afneem:

- *Die oppervlak-area/kettinglengte/molekulêre massa van die alkohole verlaag.*
- *Die sterkte van die Londonkragte/geïnduseerde dipoolkragte/ verspreidingskragte verswak* (2)

Must say:

van der Waal's London

van der Waal's dipole-dipole

3.1.3

Marking criteria
- Identify the intermolecular forces in both compounds. ✓✓
- Compare the strength of the intermolecular forces. ✓

Nasienkriteria
- *Die intermolekulêre kragte korrek geïdentifiseer in beide verbindings*
- *Vergelyk die sterkte van die intermolekulêre kragte*

- Alcohols have both (London forces) and hydrogen bonds ✓
- Ketones have both (London forces) and dipole-dipole forces ✓
- Hydrogen bonds in the alcohols are stronger than the dipole-dipole forces in ketones ✓

- *Alkohole het beide (Londonkragte) en wa*
- *Ketone het beide (Londonkragte) en dipo*
- *Waterstofbindings in die alkohole is sterk in ketone*

Must say:

van der Waal's London

van der Waal's dipole-dipole

OR/*OF*

- Alcohols have both (London forces) and hydrogen bonds ✓
- Ketones have both (London forces) and dipole-dipole forces ✓
- the dipole-dipole forces in Ketones are weaker than the hydrogen bonds in the alcohols ✓

- *Alkohole het beide (Londonkragte) en waterstofbindings*
- *Ketone het beide (Londonkragte) en dipool-dippol kragte*
- *Die dipool-dipoolkragte in ketone is swakker as die waterstofbindings in die alkohole* (3)

3.1.4 Homologous series / functional group

(1)

3.1.5 Ketone ✓

Lower boiling point / *Laer kookpunt* ✓ (2)

[10]

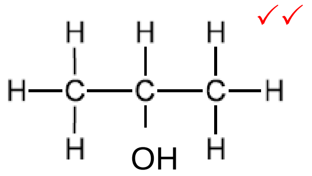
QUESTION/*VRAAG* 4

4.1 Elimination / Dehydration / *Eliminasie / Dehidrasie* ✓ (1)

4.1.2 water / H_2O (1)

4.2.1 H_2SO_4 / H_3PO_4 / sulfuric acid / phosphoric acid (not concentrated) (1)

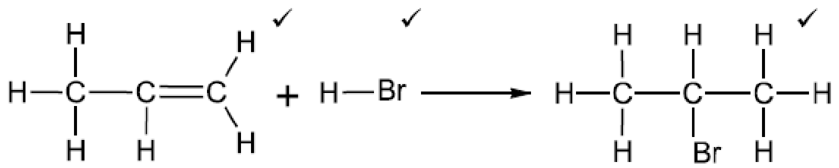
4.2.2



(2)

4.3 4.3.1
- No water / No H_2O ✓/ *Geen water* ✓
- (concentrated) strong acid as catalyst / *(gekonsentreerde) sterk*
- \+ Heated / UV light / sunlight ✓ (any 2) (2)

4.3.2



MARKING CRITERIA / *NASIENKRITERIA* (3)

• Whole structure of propene corrects – bromine must be on C 2 (rule of Markovnikov) / *Die hele struktuur van propeen korrek – broom moet op C 2 wees (reel van Markovnikov)* ✓	
Accept/*Aanvaar* HBr	Ignore/*Ignoreer*: ⇌
• **Condensed/semi-structural formulae/Gekondenseerde/ semi-struktuurformules** Max/*Maks*: $^2/_3$	
• **Molecular formula/*Molekulêre formule*** $^0/_3$	

Any additional reactant or products/*Enige addisionele reactant of produkte*: Max/*Maks*.: $^2/_3$	**Everything correct, *wrong balancing/Alles korrek, verkeerde balansering*** Max/*Maks*. $^2/_3$

4.4 4.4.1 Substitution / *Substitusie* ✓ (1)

4.4.2 Substitution / Hydrolysis / *Substitusie / Hidrolise* ✓ (1)

4.5 4.5.1
- Alkene dissolved in a non-polar solvent OR no water / *Alkeen opgelos in 'n nie-polêre oplosmiddel OF geen water* ✓
- (Catalyst) Pt / Pd / Ni / *(Katalisator) Pt / Pd / Ni* ✓ (1)
- \+ in a hydrogen atmosphere ✓ (any 1)

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QUESTION 5

5.1 Change in concentration✓ of reactants/products per unit time. ✓
Change in amount/number of moles/volume/mass✓ of reactants or products per unit time. ✓
Amount/number of moles/volume/mass✓ of products formed or reactants used per unit time. ✓ (2)

5.2

$$\text{average rate} = \frac{\Delta V}{\Delta t}$$

$$= \frac{(104 - 64)\ ✓}{(60 - 30)\ ✓}$$

$$= 1{,}33\ ✓\ (\ cm^3.s^{-1}\ )$$

(3)

5.3 **I**✓
The gradient / m / slope of graph I is less steep than II. ✓ or
Took a longer time for rection to reach completion. ✓ (2)

5.4 Catalyst✓ (1)

5.5
- A catalyst provides an alternate pathway of lower activation energy.✓
- More particles will have sufficient energy for an effective collision/ more molecules have kinetic energy equal to or greater than the activation energy.✓
- Number of effective collisions per unit time increases/frequency of effective collisions increases.✓ (3)

5.6 **Marking criteria*:***

- Ratio: n(Mg) initial equals n(H_2) final produced in reaction **II**. ✓
- Formula: $n = \frac{V}{V_m}$ ✓
- Correct substitution ($\frac{0{,}12}{24{,}04}$) in the above formula✓
- To calculate n(Mg) used(reacted) in reaction **I** in 150 s✓
- n(Mg)initial - n(Mg)used/reacted ✓
- Formula: m = nM✓
- Correct substitution of 24 with n Mg in the above formula. ✓
- Final answer = 0,018 g. ✓

OPTION 1

n(Mg)initial = n(H_2)produced in EXP II

$= \frac{V}{V_m}$ ✓

$= \frac{0,12}{24,04}$ ✓

Either ✓ Either ✓

$= 4,99 \times 10^{-3}$ mol

n(Mg)used in EXP I = n(H_2)produced in EXP I

$= \frac{V}{V_m}$

$= \frac{0,102}{24,04}$ ✓

$= 4,24 \times 10^{-3}$ mol

n(Mg) remaining $= 4,99 \times 10^{-3} - 4,24 \times 10^{-3}$ ✓

$= 0,75 \times 10^{-3}$ mols

m(Mg) = nM ✓

$= (0,75 \times 10^{-3})(24)$ ✓

= 0,018 g ✓

OPTION 2

nH_2 still to be produced = nMg ✓

$n = \frac{V}{V_m}$ ✓✓ ✓

$= \frac{0,12 - 0,102}{24,04}$ (1 mark for subtraction)

$= 7,49 \times 10^{-4}$ mol

m = n x M ✓

$= 7,49 \times 10^{-4} \times 24$ ✓

= 0,018g ✓ (8)

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QUESTION/*VRAAG* 6

6.1 6.1.1 Concentration of N_2 increases/*Konsentrasie van N_2 verhoog* ✓ (1)

6.1.2 Pressure increased/*Druk verhoog* ✓ (1)

6.1.3 Temperature increased/*Temperatuur verhoog* ✓ (1)

6.2 When <u>equilibrium</u> in a <u>closed system</u> is disturbed, the system will reinstate a <u>new equilibrium</u> by favouring the reaction that will <u>oppose</u> the disturbance. ✓✓ **(2 or 0)**

Wanneer die <u>ewewig</u> in 'n <u>geslote sisteem</u> versteur word, stel die sisteem 'n <u>nuwe ewewig</u> in deur die reaksie wat die versteuring <u>teenwerk</u>, te bevoordeel ✓✓**(2 of 0)** (2)

6.3 6.3.1 Decreases / *Verminder* ✓ (1)

6.3.2
- The pressure will decrease. ✓
- The system will favour the reaction that increases the number of gas molecules or number of particles. ✓
- Hence, the reverse reaction will be favoured. ✓

- Die druk sal verminder. ✓
- Die sisteem bevoordeel die reaksie wat die hoeveelheid gas molekule sal vermeerder. ✓
- Gevolglik, sal die terugwaartse reaksie bevoordeel word. ✓ (3)

6.4 **CALCULATION USING NUMBER OF MOLES/*BEREKENING MET DIE AANTAL MOL***

Mark allocation/*Puntetoekening*:

a. Use of/*gebruik van* n = $\frac{m}{M}$✓
b. n(NH_3) at equilibrium/*by ewewig* = 1,2 mol ✓
c. Using/*Gebruik* ratio/*verhouding* n(N_2): n(H_2) : n(NH_3) = 1:3:2 ✓
d. n(N_2) at equilibrium (initial – change)/*n(N_2) by ewewig (aanvanklik – verander)* ✓
e. n(H_2) at equilibrium (initial – change)/*n(H_2) by ewewig (aanvanklik – verander)* ✓
f. Divide by volume/*deel deur volume* ✓
g. K_c expression/*uitdrukking* ✓
h. Substitution into K_c expression/*Vervang in K_c uitdrukking* ✓
i. Final answer/*Finale antwoord*: 0,25 ✓

$n_{(NH_3)} = \frac{m}{M}$
$= \frac{20,4}{17}$ ✓ **a**
= 1,2mol ✓ **b**

OR/*OF*
give two marks in table for 1,2 mol/*gee twee punte in tabel vir 1,2 mol*

	N_2	H_2	NH_3	
Molar ratio/*Molêre verhouding*	1	3	2	
Initial moles/*Aanvanklike mol*	5	5	0	
Change in moles/*Verandering in mol*	0,6	1,8	1,2	✓Ratio/*Verhouding* **c**
Equilibrium moles/*Ewewig mol*	4,4✓ **d**	3,2✓ **e**	1,2	
Concentration at equilibrium/ *Konsentrasie by ewewig*	0,88	0,64	0,24	✓Divide by/ *Deel deur* 5 **f**

carry over

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ **g**
$= \frac{(0,24)^2}{(0,88)(0,64)^3}$ ✓ **h**
= 0,25✓ **i**

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CALCULATIONS USING NUMBER OF CONCENTRATIONS/ *BEREKENINGE MET BEHULP VAN KONSENTRASIES*

Mark allocation/*Puntetoekening*:

a. Use of/*gebruik van* c = $\frac{m}{MV}$ ✓
b. (NH_3) at equilibrium/*by ewewig* = 0,24 mol·dm^{-3} ✓
c. Using concentration ratio/*Gebruik konsentrasieverhouding* [N_2]: [H_2] : [NH_3] = 1:3:2 ✓
d. Divide by volume/V*erdeel volgens volume* ✓
e. Equilibrium concentration of N_2 (initial – change)/Ewewingskonsentrasie van N_2 (aanvanklik – verander)/ ✓
f. Equilibrium concentration of H_2 (initial – change)/Ewewingskonsentrasie van H_2 (aanvanklik – verander)/ ✓
g. K_c expression/*uitdrukking* ✓
h. Substitution into K_c expression/*Substitusie in K_c uitdrukking* ✓
i. Final answer/*Finale antwoord*: 0,25 ✓

	N_2	H_2	NH_3	
Molar ratio/*Molêre verhouding*	1	3	2	
Initial concentration/ *Aanvanklike konsentrasie*	1	1	0	
Change in concentration/ *Verandering in konsentrasie*	0,6	1,8	1,2	✓ Divide by/ *Verdeel deur 5* **d**
Equilibrium concentration/ *Ewewigskonsentrasie*	0,12	0,36	0,24 ✓ **b**	
Concentration at equilibrium/ *Konsentrasie by ewewig*	0,88✓ **e**	0,64✓ **f**	0,24✓ **a**	✓ Ratio/ *Verhouding* **c**

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ **g**

$= \frac{(0,24)^2}{(0,88)(0,64)^3}$ ✓ **h**

$= 0,25$ ✓ **i**

c $= \frac{m}{MV}$

$= \frac{20,4}{17 \times 5}$

$= 0,24$

(9)

QUESTION 7

7.1 An acid that ionises incompletely in water to form a low concentration of H_3O^+ ions. ✓✓ (2)

7.2 Less than ↓ ⊖ marking to 7.3 (1)

7.3 Oxalic acid is a weak acid therefore incomplete ionisation ✓ and concentration of ions will be < concentration of oxalic acid in solution. ✓ (2)

7.4 Basic/alkaline✓ (1)

7.5 Phenolphthalein (1)

7.6

For NaOH $(c\cdot V)_{dilute} = (c\cdot V)_{concentrated}$ $c_{dil} = \frac{(c\cdot V)_{Conc.}}{V_{dil}}$ $= \frac{(1,63)(0,05)}{(1)}$ ✓ $= 0,0825\ mol\cdot dm^{-3}$ $n(NaOH) = cV$ $= (0,0825)(0,04)$ ✓ $= 0,0033\ mol$ ✓	**But:** $n((COOH)_2): n(NaOH)=1:2$ $n((COOH)_2) = 2xn(NaOH)$ $= \frac{1}{2}(0,0033)$ ✓ $=0,00165\ mol$ ✓ $m(C_2H_2O_4) = nM$ $= (0,00165)(90)$ ✓ $= 0,1485\ g$ ✓ $\%\ purity = \frac{m(C_2H_2O_4)_{pure}}{m(C_2H_2O_4)_{impure}} \times 100$ $= \frac{0,1485}{0,25} \times 100$ ✓ $= 59,40\ \%$ ✓

(9)
[16]

7.6) $2NaOH + (COOH)_2 \rightarrow$

$C_1V_1 = C_2V_2$ ✓Formula

$1,63(0,05) = C_2(1)$ ✓sub

$\therefore C_2 = 0,0815\ mol.dm^{-3}$

Formula mark only at this point

$n = c.V$ ✓

$= 0,0815(0,04)$ ✓

$= 3,26 \times 10^{-3}\ mol$

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

$= \frac{0,25}{90}$ ✓

$= 2,7778 \times 10^{-3}\ mol$ ✓

Titration

$3,26 \times 10^{-3}\ mol \div 2 \times 1$ ✓m

$= 1,63 \times 10^{-3}\ mol$

Ⓞ $= \frac{1,63 \times 10^{-3}}{2,7778 \times 10^{-3}} \times 100$ ✓

$= 58,68\%$ ✓

$m = n.M$

$= 1,63 \times 10^{-3}(90)$ ✓

$= 0,1467\ g$ ✓

$\%\ Purity = \frac{0,1467}{0,25} \times 100$ ✓

$= 58,68\%$ ✓

2NaOH + $(COOH)_2$ →

$C_1V_1 = C_2V_2$ ✓Formula

$1,63(0,05) = C_2(1)$ ✓Sub

$\therefore C_2 = 0,0815\ mol.dm^{-3}$

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

$= \frac{0,25}{90}$ ✓

$= 0,00278\ mol$

$C_a = \frac{n}{V} = \frac{0,00278}{0,075}$ ✓

$= 0,03707\ mol.dm^{-3}$

Reacted $(COOH)_2$

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

m ✓ $\frac{1}{2} = \frac{C_a(0,075)}{0,0815(0,04)}$ ✓

$C_a = 0,02173\ mol.dm^{-3}$

$n = c.V$

$= 0,02173(0,075)$ ✓

$= 1,62975 \times 10^{-3}\ mol$ ✓

$\%Purity = \frac{1,62975 \times 10^{-3}}{0,00278} \times 100$

ans ✓

$\%\ purity = \frac{0,02173}{0,03707} \times 100$ ✓

$= 58,62\ \%$ ✓

or

$m = n.M$ ✓

$= 1,62975 \times 10^{-3}(90)$

$= 0,1467\ g$