HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 2 - Chemistry

JUNE 2022
TIME: 2 HRS

Total 100

SECTION A: Question 1

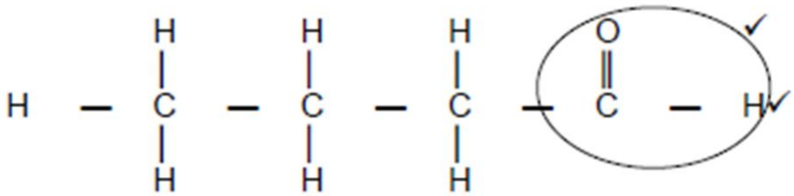
1.1 A
1.2 C √√
1.3 C
1.4 A
1.5 C

[10]

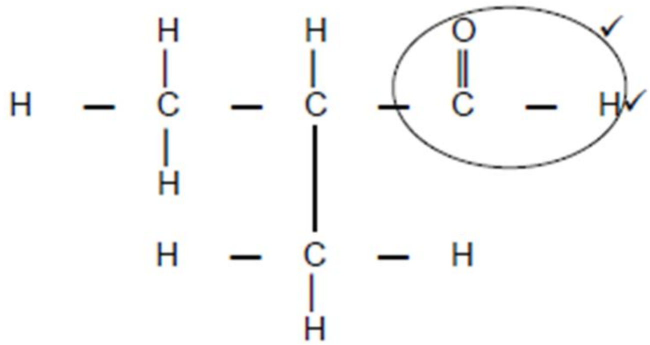
SECTION B: Question 2

2.1.1	2,4-dimethyl✓ hexane✓	(2)
2.1.2	ethyl√ butanoate√	(2)
2.1.3	$C_nH_{2n+1}X$ √	(1)
2.2	Unsaturated✓. Contains a multiple bond/triple bond between carbon atoms in the carbon chain. ✓	(2)
2.3	pentan-2-ol✓✓ OR pentan-3-ol✓✓	(2)
2.4.1	Compounds with same molecular formula but different functional groups. ✓✓	(2)

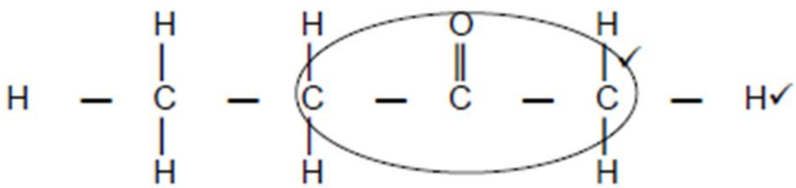
2.4.2



OR



OR



- Whole structure correct: 2/2
- Only functional group correct 1/2
- More than one functional group 0/2

(2)

2.4.3 **POSITIVE MARKING FROM Q5.4.2**

butan-2-one✓✓ OR butanal✓✓ OR 2 - Methylpropanal (2)

QUESTION 3

3.1 Boiling point is the temperature at which the vapour pressure of a substance is equal to atmospheric pressure. ✓✓ (2)

3.2

```
      O
      ‖
    - C - H        ✓
```
(1)

3.3 The strength of van der Waals London (induced dipole) forces increases with molecular size / chain length. ✓ As a result the intermolecular forces (London) are stronger for the molecules with a higher number of carbon atoms. ✓ This means that more energy will be required to separate the molecules, ✓ and hence the boiling point will be higher for those molecules with a higher number of carbon atoms. (3)

3.4.1 C ✓ (1)

3.4.2 B ✓.
Aldehydes have dipole-dipole IMF ✓which are stronger than London forces in the alkanes ✓ but weaker than hydrogen bonding in the alcohols ✓ thus the curve for aldehydes will be between the alkanes and the alcohols. (4)

3.5 butanal ✓ (1)

3.6 pentan-1✓-ol ✓ (2)

[14]

QUESTION 4

4.1.1 combustion / oxidation ✓ (1)

4.1.2 C_8H_{18} ✓✓ **(2 or 0)** (2)

4.1.3

<table>
<tr>
<td rowspan="2"><u>OPTION 1/OPSIE 1</u>
$V(CO_2) = 8 \times V_B$
$= 8(50)$
$= 400\ cm^3$
$V(H_2O) = \frac{18}{2} V_B$ ✓
$= 9(50)$
$= 450\ cm^3$
Total volume gas formed/
Totale volume gas gevorm
$= 400 + 450$ ✓
$= 850\ cm^3$ ✓</td>
<td><u>Marking criteria/Nasienkriteria</u>
• Use volume ratio/Gebruik volume verhouding:
$V(CO_2) : V(B) = 2 : 1$ and/en
$V(H_2O) : V(B) = 9 : 1$ ✓
• Add/Tel bymekaar: $V(CO_2)$ and/en $V(H_2O)$ ✓
• Final answer/Finale antwoord: $850\ cm^3$ ✓</td>
</tr>
<tr>
<td><u>OPTION 2/OPSIE 2</u>
2 mol C_xH_Y .... 16 + 18 = 34 mol gas ✓

50 mol C_xH_Y .... 25 x 34 ✓ mol gas

Total moles gas formed/Totale volume gas gevorm = $850\ cm^3$ ✓</td>
</tr>
</table>

(3)

OR

$2C_8H_{18} \rightarrow 16CO_2 + 18H_2O$

$50\ cm^3 \div 2 \times 16$ | $50\ cm^3 \div 2 \times 18$ ✓ both

$= 400\ cm^3$ ✓m | $= 450\ cm$

$V_T = 400 + 450$

$V_T = 850\ cm^3 / 0{,}85\ dm^3$ ✓

(3)

4.2.1.1 Substitution (hydrolysis) ✓ (1)

4.2.1.2 Esterification ✓ (1)

4.2.1.3 Elimination (dehydrohalogenation) ✓ (1)

4.2.1.4 Addition (hydration) ✓ (1)

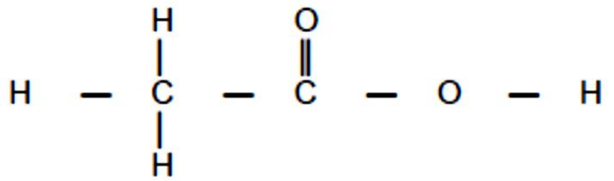
4.2.2.1 Heat under reflux ✓ concentrated strong base/KOH/ NaOH ✓ (2)

4.2.2.2 propene / prop-1-ene ✓ (1)

4.2.3 water / H_2O / NaOH / KOH ✓ (1)

4.2.4.1 The carbon to which the hydroxyl (OH) group is bonded to, is bonded to ONE other carbon atom. ✓✓ (2)

4.2.4.2



- Whole structure correct: 2/2
- Only functional group correct 1/2
- More than one functional group 0/2

(2)

[18]

Question 5

5.1.1 Number of particles / Fraction of particles with given E_k ✓ (1)

5.1.2 activation energy ✓ (1)

5.1.3 Increase ✓ (1)

5.2.1 Change in concentration/mass/amount ✓ of reactants/products per unit time. ✓

OR

Rate of change in concentration/mass/amount of reactants/products ✓✓ (2)

5.2.2 Sulphuric Acid / H_2SO_4 ✓ (1)

5.2.3.1

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

$$= \frac{1,8816}{22,04} \checkmark$$

$$= 0,084 \text{ mol}$$

$\therefore$ n Zn = 0,084 mol ✓

Mass = n x RM

= 0,084 x 65 ✓

= 5,46g

Mass remaining = 8, 46 – ✓ 5,46

= 3 g ✓

(5)

OR

5.2.3] Zn + [H₂SO₄ — whited out] → $ZnSO_4$ + H_2

8,46 g — 1,8816 dm^3

(2) 0,084 mol ÷ 1 × 1 ✓m

= 0,084 mol

(3) m = n.M

= 0,084(65) ✓

= 5,46 g

∴ left over = 8,46 − 5,46 ✓

= 3 g ✓

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

$= \frac{8,46}{65}$ ✓

= 0,1302 mol

OR

∴ $n_{leftover}$ = 0,1302 − 0,084 ✓

= 0,0462 mol

m = n.M

= 0,0462 (65)

= 3 g ✓

(1) $n = \frac{V}{V_m}$

$= \frac{1,8816}{22,4}$ ✓

= 0,084 mol

(5)

5.2.3.2) Rate $= \frac{\Delta m}{\Delta t} = \frac{5,46}{60}$ ✓ CA **OR** $\frac{8,46 - 3}{0 - 60}$ (2)

= 0,09 g.s^{-1} ✓

5

5.2.3.2 ***Positive marking from 4.3.1*** (2)

Rate = $\frac{5,46}{60}$ ✓ = 0,09 g.s^{-1} ✓ (0,091)

5.2.4 Experiment I✓ (1)

5.2.5
- Increase in concentration increases the number of particles per unit volume.✓
- increase in number of collisions per unit time.
- increase in number of effective collisions per unit time.✓
- increase in reaction rate.✓

OR

- Decrease in concentration decreases the number of particles per unt volume.✓
- Decreases in number of collisions per unit time.
- Decreases in number of effective collisions per unit time.✓
- Decreases in reaction rate.✓

(3)
[17]

QUESTION 6

6.1 The stage in a chemical reaction when the <u>rate of forward reaction equals the rate of reverse reaction</u>. ✓✓ **(2 or 0)**
Die stadium in 'n chemiese reaksie waar die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ***(2 of 0)***

OR/*OF*
The stage in a chemical reaction when the <u>concentrations of reactants</u> and <u>products remain constant.</u> **(2 or 0)**
Die stadium in 'n chemiese reaksie waar die konsentrasies van die reaktanse en produkte konstant bly. ***(2 of 0)*** (2)

6.2 **<u>CALCULATIONS USING NUMBER OF MOLES</u>**
<u>BEREKENINGE WAT AANTAL MOL GEBRUIK</u>

<u>Marking criteria/*Nasienkriteria*</u>

- Substitute/*Vervang* 18 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- $\Delta n(CO_2) = \Delta n(C)$ = <u>0,225</u> mol. ✓
- <u>Use</u> mole ratio/Gebruik $n(C) : n(H_2O) : n(CO_2) : n(H_2)$ = ! : 2 : 1 : 2 ✓
- Equilibrium/*Ewewig* $n(H_2O)$ = initial/*aanvaklike* $n(H_2O)$ - $\Delta n(H_2O)$
  Equilibrium/*Ewewig* $n(H_2)$ = initial/*aanvanklike* $n(H_2)$ + $\Delta n(H_2)$
  Equilibrium/*Ewewig* $n(CO_2)$ = initial/*aanvanklike* $n(CO_2)$ + $\Delta n(CO_2)$ } ✓
- Divide equilibrium moles of H_2O, H_2 AND/*EN* CO_2 by/*deur* 2 dm^3. ✓
- Correct K_c expression (<u>formulae in square brackets</u>). ✓
  Korrekte K_c uitdrukking (<u>formules in vierkantige hakies</u>).
- Substitution of concentrations into correct K_c expression. ✓
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,00948 ✓
  Range/*Gebied*: 0,00948 to/*tot* 0,01 (9,48 x 10^{-3} to/*tot* 1 x 10^{-2})

<u>OPTION 1/*OPSIE 1*</u>

$n(H_2O)_{initial/aanvanklik} = \frac{m}{M} = \frac{36}{18}$ ✓ = 2 mol

	H_2O	H_2	CO_2	
Initial amount (moles) *Aanvangs hoeveelheid (mol)*	2			
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,45	0,45	0,225 ✓	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	1,55	0,45	0,225	✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,775	0,225	0,1125	Divide by/ Deel deur 2 dm^3 ✓

$K_c = \frac{[H_2]^2[CO_2]}{[H_2O]^2}$ ✓

$= \frac{[0,225]^2[0,1125]}{[0,775]^2}$ ✓

= 0,00948 ✓

(9,48x10^{-3}/0,01)

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

- Substitute/*Vervang* 18 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Divide initial/*Deel aanvanklike* n(H_2O) AND Δn(CO_2) by/*deur* 2 dm^3.✓
- Δn(CO_2) = Δn(C) = 0,225 mol OR/*OF* Δc(CO_2) = 0,1125 mol·dm^{-3}. ✓
- Use mole ratio/*Gebruik molverhouding* n(H_2O) : n(CO_2) : n(H_2) = 2 : 1 : 2 ✓
- Equilibrium/*Ewewig* c(H_2O) = initial/*aanvanklike* c(H_2O) - Δc(H_2O)
  Equilibrium/*Ewewig* c(H_2) = initial/*aanvanklike* c(H_2) + Δc(H_2)
  Equilibrium/*Ewewig* c(CO_2) = initial/*aanvanklike* c(CO_2) + Δc(CO_2) ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,00948 ✓
  Range/*Gebied*: 0,00948 – 0,01)

OPTION 2/*OPSIE 2*

$n(H_2O)_{initial/aanvanklik} = \frac{m}{M} = \frac{36}{18}$ ✓ = 2 mol

	H_2O	H_2	CO_2	
Initial concentration (mol·dm^{-3}) Aanvangskonsentrasie (mol·dm^{-3})	1			Divide by/ *Deel deur* 2 dm^3 ✓
Change (mol·dm^{-3}) ✓ *Verandering (mol·dm^{-3})*	0,225	0,225	0,1125 ✓	ratio ✓ *verhouding*
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,775	0,225	0,1125	

$K_c = \frac{[H_2]^2[CO_2]}{[H_2O]^2}$ ✓

$= \frac{[0,225]^2[0,1125]}{[0,775]^2}$ ✓

$= 0,00948$ ✓

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

(8)

6.3.1 Steam is used up./Amount of steam decreases./Concentration of steam decreases./Reactants are used up. ✓
Water word opgebruik./Hoeveelheid stoom neem af./Konsentrasie van stoom neem af./Reaktanse word opgebruik. (1)

6.3.2 Catalyst was added./*Katalisator is bygevoeg.* ✓ (1)

6.3.3 Temperature was increased. ✓ (1)

6.3.4 Endothermic/*Endotermies* ✓ (1)

6.3.5
- The forward reaction is favoured./*Die voorwaartse reaksie word bevoordeel.* ✓
- Increase in temperature favours the endothermic reaction. ✓ *Toename in temperatuur bevoordeel die endotermiese reaksie.* (2)

[16]

QUESTION 7

7.1.1 It ionises incompletely/partially in water ✓ to produce a low concentration of hydronium ions. ✓ (2)

7.1.2 INCREASES ✓ (1)

Common ion has been added, $(COO)_2{}^{2-}$, therefore reverse reaction is favoured and $[H_3O^+]$ decreases, therefore pH increases.

7.2

At the end of the reaction,

$n(H^+) = cV$

$= (0,0461) \times 0,075$ ✓

$= 3,4575 \times 10^{-3}$ mol

$n(H^+)$initial $= cV$ ✓

$= (0,1) \times (0,05)$ ✓

$= 5 \times 10^{-3}$

$n(H^+)$reacted with NaOH $= 5 \times 10^{-3} - 3,4575 \times 10^{-3}$ ✓✓

$n(NaOH) = 1,5425 \times 10^{-3}$ mol

$c(NaOH) = \frac{n}{V}$

$= \frac{1,5425}{0,025}$ ✓

$= 0,0617$ mol.dm^{-3}. ✓

(7)

OR

7.2) ~~Excess~~ HCl + NaOH →

Given

① $n = c \cdot V$

$= 0,1 (0,05)$ ✓

$= 0,005$ mol

② Excess

$[HCl] = [H_3O^+]$ ✓

$= 0,0461\ mol.dm^{-3}$

③ $n_{excess} = c \cdot V$ ✓

$= 0,0461 (0,075)$ ← excess is in total volume

$= 0,00346$ mol

④ Reacted/needed n = Given − excess

$= 0,005 - 0,00346$ ✓

$= 0,0015425 / 1,5425 \times 10^{-3}$

⑤ $1,5425 \times 10^{-3} \div 1 \times 1$ ✓ M only if subtract shown

$= 1,5425 \times 10^{-3}$ mol

$c = n/V$ ✓

$= \frac{1,5425 \times 10^{-3}}{0,025}$ ✓

$= 6,17 \times 10^{-2}\ mol.dm^{-3}$

or $0,06\ mol.dm^{-3}$

(7)

[10]

Total 100