KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKING GUIDELINE

PREPARATORY EXAMINATION

SEPTEMBER 2022

MARKS: 150

This marking guideline consists of 13 pages.

QUESTION 1

1.1   C ✓✓   (2)

1.2   B ✓✓   (2)

1.3   D ✓✓   (2)

1.4   A ✓✓   (2)

1.5   B ✓✓   (2)

1.6   D ✓✓   (2)

1.7   D ✓✓   (2)
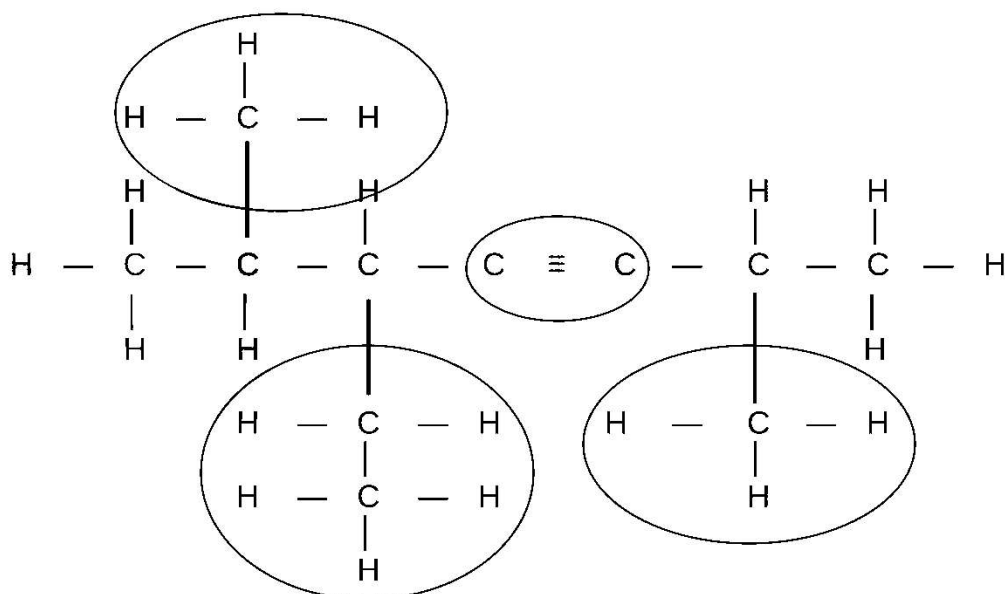
1.8   A ✓✓ (accept C)   (2)

1.9   C ✓✓   (2)

1.10   D ✓✓   (2)
                                                                              [20]

QUESTION 2

2.1
2.1.1 C_nH_{2n-2} ✓   (1)

2.1.2

Marking criteria:
• functional group✓
• All the substituents(2 methyl groups and 1 ethyl group) correct ✓
• Whole structure correct✓ $^3/_3$

                                                                              (3)
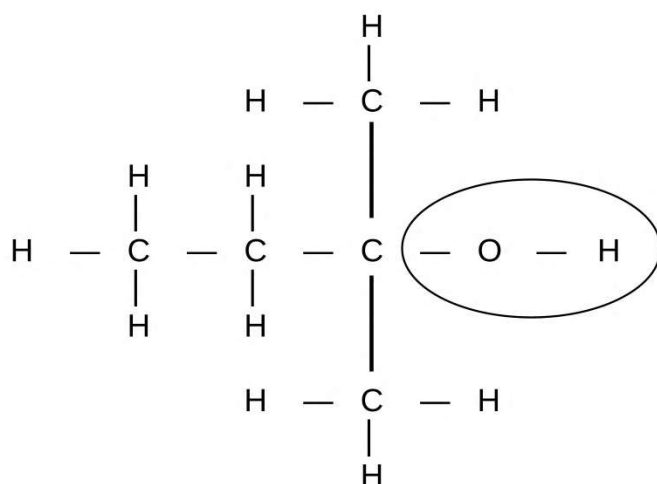
2.2

2.2.1 Organic compounds having the <u>same molecular formula</u>✓, but <u>different functional groups</u>✓ (underlined words must be in correct contexts) (2)

2.2.2 Pentanal/2-methylbutanal/3-methylbutanal/2,2-dimethylpropanal ✓✓ (2)
(functional group –anal ✓
Everything correct ✓)
(If wrong functional group 0/2)

2.3

2.3.1 hydroxyl✓ (1)

2.3.2

| **Marking criteria:** |
| • Only functional group correct: Max: $\frac{1}{2}$ |
| • Whole structure correct: $\frac{2}{2}$ |

(2)

2.4

2.4.1 esterification ✓ (1)

2.4.2 butyl✓ propanoate✓ (2)

[14]

QUESTION 3

3.1   The temperature at which the vapour pressure equals atmospheric (external) pressure. ✓✓ (2 or 0)
(2)

3.2   YES. ✓
P, Q and R are straight chain primary alcohols/only ONE independent variable. ✓
(2)

3.3   Boiling point increases ✓ with increase in chain length/molecular mass. ✓
(2)

3.4
- Intermolecular forces/Van der Waals forces/London forces/dispersion forces increase (becomes stronger) with increase in chain length✓
- More energy needed to <u>overcome/break intermolecular forces as chain length increases.</u> ✓
(2)

3.5   REMAINS UNCHANGED✓
(1)

3.6   P✓
<u>Any One</u>
P has the lowest boiling point ✓   **OR**
P has the weakest intermolecular forces✓
(2)

3.7   LESS THAN✓
- Intermolecular forces between molecules of alcohols are hydrogen bonding (in addition to London forces/dispersion forces). ✓
- Intermolecular forces between molecules of C_6H_{14} are only London forces/dispersion forces. ✓
- London forces/dispersion forces are weaker than hydrogen bonding / Intermolecular forces in C_6H_{14} are weaker/ Intermolecular forces in Q are stronger. ✓
- Less energy needed to overcome/break intermolecular forces in C_6H_{14}/ more energy needed to overcome Intermolecular forces in Q.✓
(5)

[16]

QUESTION 4

4.1   Hydrogenation. ✓   (1)

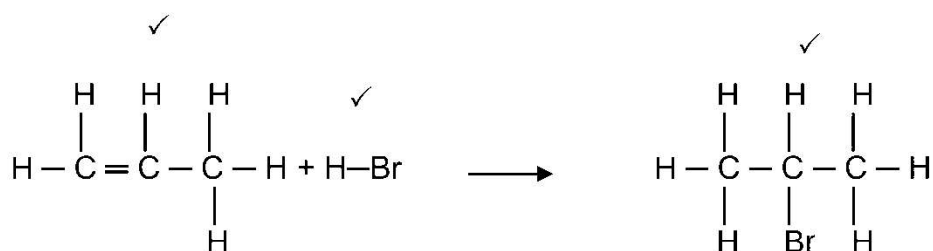4.2   Hydrohalogenation/hydrobromination ✓   (1)

4.3   I✓   (1)

4.4.1   Strong bases✓   (1)

4.4.2   Reaction IV, base is dilute✓
            Reaction III base is concentrated (in ethanol). ✓   (2)

4.5

                                                      (3)

4.6   hydrolysis ✓   (1)

4.7 $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$
          reactants ✓   products ✓   balancing ✓

                                                      (3)

4.8   dehydration✓   (1)

4.9   ethene ✓✓✓   (3)

                                                                        [17]

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

$$\text{average rate} = \frac{\Delta V}{\Delta t}$$
$$= \frac{(104 - 64)}{(60 - 30)} \quad \checkmark \;\; \checkmark$$
$$= 1{,}33 \; \checkmark \; \left(\; cm^3.s^{-1} \; \right) \quad\quad (3)$$

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: $n = \dfrac{V}{V_m}$ ✓
- Correct substitution ($\dfrac{0{,}12}{24{,}04}$) 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 $\quad = n(H_2)$produced in EXP II

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

$$= \frac{0,12}{24,04} \checkmark \qquad\qquad \text{Either} \checkmark$$

Either $\checkmark$

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

$n(Mg)$used in EXP I $\quad = n(H_2)$produced in EXP I

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

$$= \frac{0,102}{24,04} \checkmark$$

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

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

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

$m(Mg) \qquad\qquad = nM \checkmark$

$$= \underline{(0,75 \times 10^{-3})(24)} \checkmark$$

$$= 0,018 \text{ g} \checkmark$$

OPTION 2

nH_2 still to be produced $= nMg \checkmark$

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

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

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

$m = n \times M \checkmark$

$$= \underline{7,49 \times 10^{-4} \times 24} \checkmark$$

$$= 0,018g \checkmark$$

(8)

[19]

QUESTION 6

6.1   The <u>rate of forward reaction equals the rate of reverse reaction</u>. ✓✓

Notes

IF: Forward reaction equals reverse reaction. $\frac{1}{2}$ (2)

6.2   Reactants and products are ALL in the same phase. ✓   (1)

6.3
Marking criteria:
• $n(Cl_2)$ equilibrium = 0,4✓
• Using the correct mol ratio✓
• Calculating the quantity(mol) at equilibrium of all three substances ✓
• Divide number of moles at equilibrium by 5 dm^3✓
• K_c expression✓
• Correct substitution of equilibrium concentrations into K_c expression ✓
• Substitute $n(O_2)$ initial and $M(O_2)$ into m = nM✓
• Final answer 9,60 g ✓

OPTION 1

	HCl	O$_2$	H$_2$O	Cl$_2$	
Ratio	4	1	2	2	
Initial quantity (mol)	1	x	0	0	Using ratio ✓
Change (mol)	0,8	0,2	0,4	0,4	
Quantity at equilibrium (mol)	1 - 0,8	x – 0,2	0 + 0,4 ✓	0,4✓	
Equilibrium concentration (mol·dm^{-3})	0,04	$\dfrac{x-0,2}{5}$	0,08	0,08	Divide by 5 ✓

$$K_c = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]} \checkmark$$

No K_c expression, correct substitution. $\frac{7}{8}$
Wrong K_c expression $\frac{6}{8}$

$$\therefore 800 = \frac{(0,08)^2(0,08)^2}{(0,04)^4\left(\dfrac{x-0,2}{5}\right)} \checkmark$$

$$x = 0,3 \text{ mols}$$

$$
\begin{aligned}
n(O_2) &= nM \\
&= \underline{(0,3)\,(32)} \checkmark \\
&= 9,60 \text{ g}\checkmark \text{ (range 9,595312 to 9,60)}
\end{aligned}
$$

(8)

OPTION 2

	HCℓ	O_2	H_2O	$Cℓ_2$	
Ratio	4	1	2	2	
Initial quantity (mol)	1	0,3	0	0	
Change (mol)	0,8	0,2	0,4	0,4	Using ratio ✓
Quantity at equilibrium (mol)	1 - 0,8	0,1	0 + 0,4 ✓	0,4 ✓	
Equilibrium concentration (mol·dm⁻³)	0,04	$[O_2]$	0,08	0,08	Divide by 5 ✓

$$K_c = \frac{[H_2O]^2[Cℓ_2]^2}{[HCℓ]^4[O_2]} \quad ✓$$

$$\therefore 800 = \frac{(0,08)^2(0,08)^2}{(0,04)^4[O_2]} \quad ✓$$

$$[O_2] = 0,02 \text{ mol·dm}^{-3}$$

No K_c expression, correct substitution. $\frac{7}{8}$
Wrong K_c expression $\frac{6}{8}$

$$n(O_2) = nM$$
$$= \underline{(0,3)\ (32)} \quad ✓$$
$$= 9,60 \text{ g} ✓ \text{ (range 9,595312 to 9,60)}$$

6.4   When <u>the equilibrium in a closed system</u> is disturbed, the system will <u>re-instate a new equilibrium</u> by favouring the reaction that will oppose the disturbance. ✓✓
Note: Underlined phrases must be in correct context   (2)

6.5.1   Remains the same. ✓   (1)

6.5.2   Increases. ✓   (1)

6.6   An increase in pressure favours the reaction that produces a fewer number of moles. ✓
The forward reaction is favoured. ✓   (2)

6.7.1   Negative   (1)

6.7.2   ***Option 1***

- When the temperature increases the reverse reaction is favoured. ✓
- An increase in temperature favours the endothermic reaction. ✓
- Forward reaction is exothermic. ✓

Option 2

- Kc decreases with an increase in temperature. ✓
- Reverse reaction is favoured/concentration of reactants increases/concentration of products decreases/yield decreases. ✓
- Increase in temperature favours the endothermic reaction. ✓   (3)
                                                                                                                        [21]

QUESTION 7

7.1.1   A substance that acts as an acid and as a base. ✓✓   (2)

7.1.2 HSO_4^- /hydrogen sulphate ion✓   (1)

7.2.1   **Marking guidelines:**

- Formula: $pH = -\log [H_3O^+]$ ✓
- Substitution: 0,1✓
- Final answer: 1✓

$$
\begin{aligned}
pH &= -\log [H_3O^+] \checkmark \\
&= -\log 0,1 \checkmark \\
&= 1 \checkmark
\end{aligned}
$$

                                                                        (3)

7.2.2   EQUAL TO 7 ✓   (1)

7.2.3

OPTION 1/OPSIE 1	**Marking guidelines:**
$n(OH^-) = n(H^+)$ ✓ $\qquad = cV$ ✓ $\qquad = (0,1)(0,03)$ ✓ $\qquad = 0,003$ mol ✓	• Mol ratio: $n(OH^-) = n(H^+)$ • $n = cV$ (entire eq) • Substitution of 0,1 • Substitution of 0,03. • Final answer: 0,003 mol.
OPTION 2	**Marking guidelines:**
$\dfrac{c_a \times V_a}{c_b \times V_b} = \dfrac{n_a}{n_b}$ $\dfrac{0,1 \times 30}{cb \times 20} = \dfrac{1}{1}$ ✓ $cb = 0,15 \ mol \cdot dm^{-3}$ $n = cV$ ✓ $\qquad = (0,15)(0,02)$ ✓ $\qquad = 0,003$ mols✓	• Mol ratio • Formula: $n = cV$ • Substitution of (0,15)(0,02) • Final answer: 0,03 mol

                                                                                 (4)

7.2.4   **Marking criteria:**

- Calculate number of moles of hydroxide ions in 250 cm^3.✓
- Calculate number of moles of hydroxide ions in Ba(OH)$_2$. ✓
- Calculate number of moles NaOH = 0,02 ✓
- Mol ratio: number of moles of Ba(OH)$_2$: number of moles of OH$^-$.✓
- Formulae: n = cV ✓
- Substitute in the above formula. ✓
- Final answer: 0,175 mol.dm^{-3}. ✓

OPTION 1

$$n(OH^-)\text{ in 250 cm}^3 = \frac{(0,003)(250)}{20} ✓$$
$$= 0,0375 \text{ mols}$$

$$n(OH^-)\text{ in Ba(OH)}_2 = n(OH^-)_{TOTAL} - n(OH^-)NaOH$$
$$= \underline{0,0375} ✓ \underline{0,02} ✓$$
$$= 0,0175 \text{ mols}$$

$$n(Ba(OH)_2) = ½ n(OH^-)$$
$$= ½ (0,0175) ✓$$
$$= 0,00875 \text{ mols}$$

$$c (Ba(OH)_2) = \frac{n}{V} ✓$$

$$c (Ba(OH)_2) = \frac{0,00875}{0,05} ✓$$

$$= 0,175 \text{ mol.dm}^{-3}. ✓$$

OPTION 2

$$V(NaOH)\text{ in 20 cm}^3 = \frac{4}{5} \times 20$$
$$= 16 \text{ cm}^3$$

$$VBa(OH)_2\text{ in 20 cm}^3 = 20 - 16$$
$$= 4 \text{ cm}^3$$

$$n(OH^-)\text{ from NaOH} = cV$$
$$= (0,1)(16 \times 10^{-3})$$
$$= 1,6 \times 10^{-3} \text{ mols} ✓$$

$$n(OH^-)\text{ from Ba(OH)}_2 = \underline{3 \times 10^{-3}} ✓ \underline{1,6 \times 10^{-3}} ✓$$
$$= 1,4 \times 10^{-3} \text{ mols}$$

$$n(Ba(OH)_2) = ½ n(OH^-)$$
$$= ½ (1,4 \times 10^{-3}) ✓$$
$$= 0,7 \times 10^{-3} \text{ mols}$$

$$c (Ba(OH)_2) = \frac{n}{V} ✓$$

$$c (Ba(OH)_2) = \frac{0,0007}{0,004} ✓$$

$$= 0,175 \text{ mol.dm}^{-3}. ✓$$

(7)
[18]

QUESTION 8

8.1 Voltaic/galvanic cell.✓ (1)

8.2 Temperature: 25 °C/298 K. ✓
Concentration of electrolytes: 1 mol.dm^{-3}. ✓ (2)

8.3 spontaneous. ✓ No external energy is required ✓
Accept: cell potential is positive / cell is a galvanic cell. ✓ (2)

8.4.1 Pt(s)/ Fe^{2+}(aq)(1 mol.dm^{-3}), Fe^{3+}(aq)(1 mol.dm^{-3}) // X$^+$(aq)(1 mol.dm^{-3})/X(s) (3)

Accept: Pt/Fe^{2+}, Fe^{3+}//X$^+$/X (MINUS 1 MARK FOR ANY ERROR)

8.4.2 X$^+$(aq) + e$^-$ → X(s) ✓✓ **Ignore phases**

Notes
• X ← X$^+$+ e$^-$ $\left(\frac{2}{2}\right)$ X$^+$+ e$^-$ ⇌ X $\left(\frac{1}{2}\right)$
X ⇌ X$^+$ + e$^-$ $\left(\frac{0}{2}\right)$ X$^+$+ e$^-$ ← X $\left(\frac{0}{2}\right)$
• Ignore if charge on electron omitted.
If a charge of an ion is omitted eg. X + e$^-$ → X Max: $\left(\frac{1}{2}\right)$

(2)

8.5

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓	**Notes**
$0{,}03$✓ $= E^{\theta}_{reduction} - (0{,}77)$ ✓	• Accept any other correct formula from the data sheet.
$E^{\theta}_{reduction} = 0{,}80\,V$	• Any other formula using unconventional abbreviations, e.g. E°$_{cell}$ = E°$_{OA}$ - E°$_{RA}$
X is Ag✓	followed by correct substitutions Max:$\frac{3}{4}$

(4)

[14]

QUESTION 9

9.1   A <u>substance that forms free</u> (positive and negative) <u>ions when melted or dissolved.</u> ✓✓

OR

A <u>solution that conducts electricity.</u> ✓✓

OR

A liquid/solution/dissolved substance that conducts electricity through the movement of ions. ✓✓   (2)

9.2   Electrode P ✓   (1)

9.3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓
Ignore phases

Notes
• $Cu \leftarrow Cu^{2+} + 2e^-$ $(\frac{2}{2})$ $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(\frac{1}{2})$
$Cu^{2+} + 2e^- \leftarrow Cu$ $(\frac{0}{2})$ $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(\frac{0}{2})$
• Ignore if charge on electron omitted.
• If a charge of an ion is omitted eg. $Cu + 2e^- \leftarrow Cu$ Max: $(\frac{1}{2})$

(2)

9.4   Increases. ✓
Reduction takes place at electrode P. ✓   (2)

9.5
9.5.1   Zinc ions(Zn^{2+})✓ and Copper ions(Cu^{2+})✓   (2)

9.5.2   **OPTION 1**

Cu^{2+} ions is a stronger oxidising agent than Zn^{2+} ions✓ Cu^{2+} will be reduced to Cu.✓

OPTION 2   (2)

Zn^{2+} ions are a weaker oxidising agent than Cu^{2+} ions✓ Zn^{2+} will therefore not be reduced to Zn. ✓

[11]

TOTAL: 150