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.

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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)

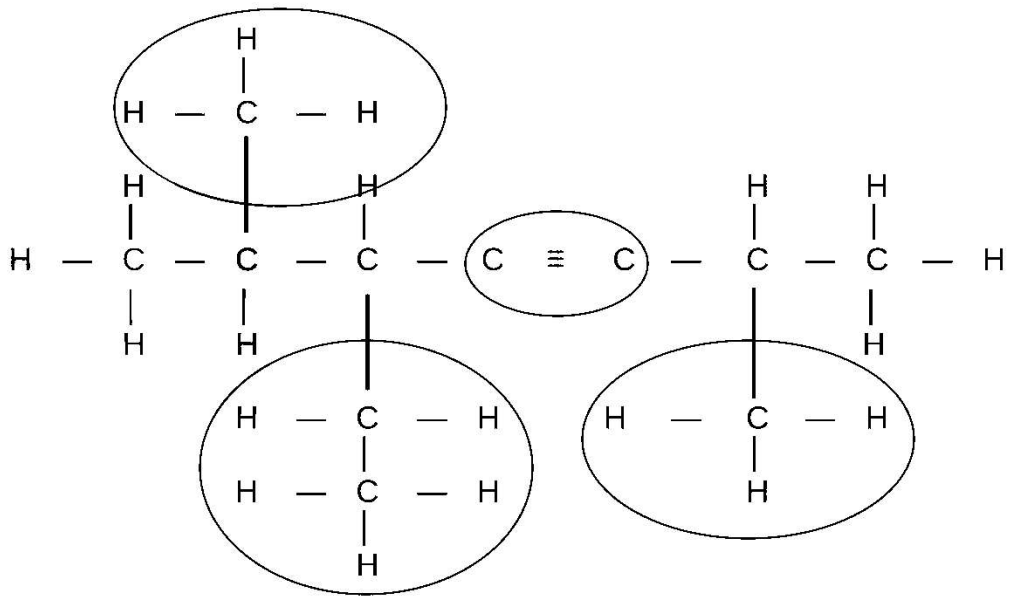
[20]

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

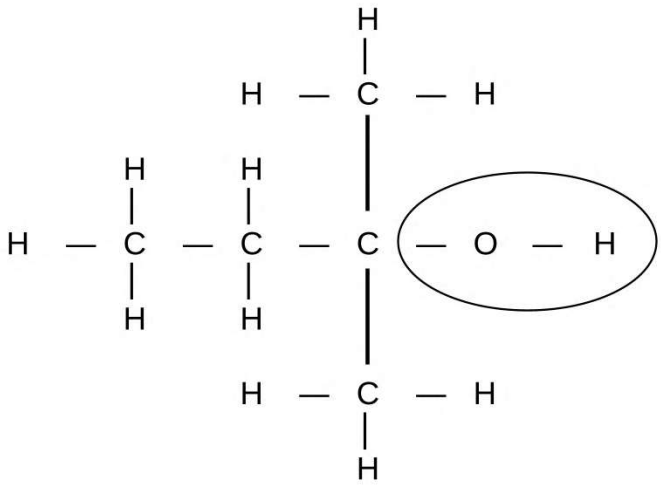
2.2.1 Organic compounds having the same molecular formula✓, but different functional groups✓ (underlined words must be in correct contexts) (2)

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]

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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]

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QUESTION 4

4.1 Hydrogenation. ✓ (1)

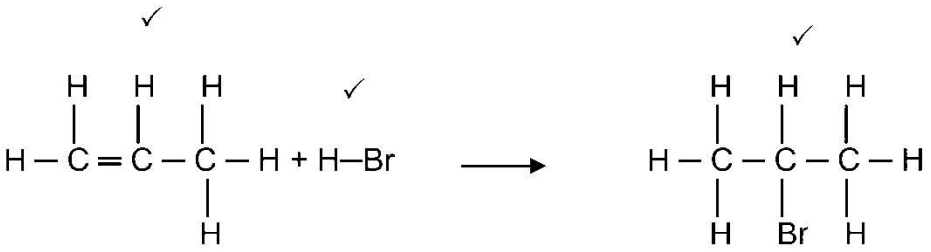
4.2 Hydrohalogenation/hydrobromination ✓ (1)

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]

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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

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

(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. ✓

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OPTION 1

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

$= \frac{V}{V_m}$ ✓

$= \frac{0,12}{24,04}$ ✓

= 4,99 x 10^{-3} mol

Either ✓

Either ✓

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

$= \frac{V}{V_m}$

$= \frac{0,102}{24,04}$ ✓

= 4,24 x 10^{-3} mol

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

= 0,75 x 10^{-3} mols

m(Mg) = nM ✓

= (0,75 x 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 x 10^{-4} x 24 ✓

= 0,018g ✓ (8)

[19]

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QUESTION 6

6.1 The rate of forward reaction equals the rate of reverse reaction. ✓✓

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:

- $n(C\ell_2)$ 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

	$HC\ell$	O_2	H_2O	$C\ell_2$
Ratio	4	1	2	2
Initial quantity (mol)	1	x	0	0
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 ($mol \cdot dm^{-3}$)	0,04	$\frac{x - 0,2}{5}$	0,08	0,08

Using ratio ✓

Divide by 5 ✓

$$K_c = \frac{[H_2O]^2[C\ell_2]^2}{[HC\ell]^4[O_2]} \checkmark$$

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

x = 0,3 mols

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

Wrong K_c expression $\frac{6}{8}$

$n(O_2)$ = nM

= (0,3) (32) ✓

= 9,60 g✓ (range 9,595312 to 9,60) (8)

OPTION 2

	$HC\ell$	O_2	H_2O	$C\ell_2$	
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 ($mol \cdot dm^{-3}$)	0,04	$[O_2]$	0,08	0,08	Divide by 5 ✓

$$K_c = \frac{[H_2O]^2[C\ell_2]^2}{[HC\ell]^4[O_2]} \quad ✓$$

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

$$[O_2] = 0,02\ mol \cdot dm^{-3}$$

No K_c expression, correct substitution. $^{7}/_{8}$
Wrong K_c expression $^{6}/_{8}$

$n(O_2)$ = nM
= (0,3) (32) ✓
= 9,60 g✓ (range 9,595312 to 9,60)

6.4 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium 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]

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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✓

pH	= - log $[H_3O^+]$ ✓
	= - log 0,1✓
	= 1✓

(3)

7.2.2 EQUAL TO 7 ✓ (1)

7.2.3

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

(4)

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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

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

= 0,0375 mols

$n(OH^-)$in $Ba(OH)_2$ = $n(OH^-)_{TOTAL}$ - $n(OH^-)$NaOH

= 0,0375 ✓ - 0,02 ✓

= 0,0175 mols

$n(Ba(OH)_2)$ = ½ $n(OH^-)$

= ½ (0,0175) ✓

= 0,00875 mols

c $(Ba(OH)_2)$ = $\frac{n}{V}$ ✓

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

= 0,175 $mol.dm^{-3}$. ✓

OPTION 2

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

= 16 cm^3

V$Ba(OH)_2$ in 20 cm^3 = 20 - 16

= 4 cm^3

$n(OH^-)$ from NaOH = cV

= (0,1)(16 x 10^{-3})

= 1,6 x 10^{-3} mols ✓

$n(OH^-)$ from $Ba(OH)_2$ = 3 x 10^{-3} ✓ - 1,6 x 10^{-3} ✓

= 1,4 x 10^{-3} mols

$n(Ba(OH)_2)$ = ½ $n(OH^-)$

= ½ (1,4 x 10^{-3}) ✓

= 0,7 x 10^{-3} mols

c $(Ba(OH)_2)$ = $\frac{n}{V}$ ✓

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

= 0,175 $mol.dm^{-3}$. ✓ (7)

[18]

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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 $X^+(aq) + e^- \rightarrow X(s)$ ✓✓ **Ignore phases**

Notes

- $X \leftarrow X^+ + e^-$ ($2/2$) $X^+ + e^- \rightleftharpoons X$ ($1/2$)
  $X \rightleftharpoons X^+ + e^-$ ($0/2$) $X^+ + e^- \leftarrow X$ ($0/2$)
- Ignore if charge on electron omitted.
  If a charge of an ion is omitted eg. $X + e^- \rightarrow X$ Max: ($1/2$)

(2)

8.5

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
$0,03$✓ $= E^\theta_{reduction} - (0,77)$ ✓
$E^\theta_{reduction} = 0,80V$

X is Ag✓

Notes

- Accept any other correct formula from the data sheet.
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions Max: $3/4$

(4)

[14]

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QUESTION 9

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

OR

A solution that conducts electricity. ✓✓

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

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

(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

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