KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

# NATIONAL SENIOR CERTIFICATE

## GRADE 12

## PHYSICAL SCIENCES P2 (CHEMISTRY)

## MARKING GUIDELINE

## PREPARATORY EXAMINATION

## SEPTEMBER 2022

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**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)

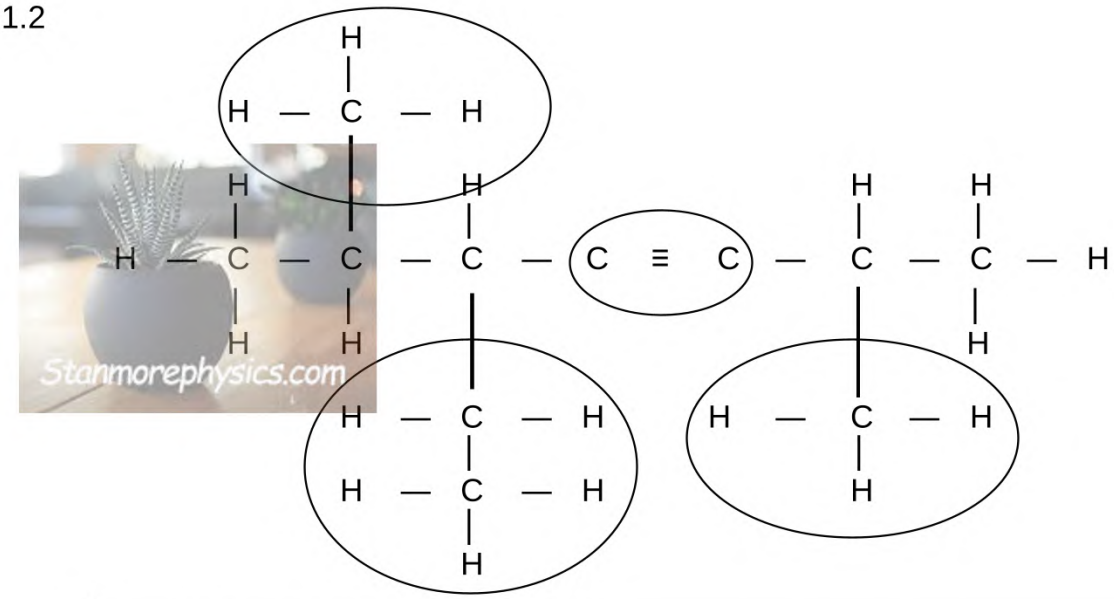
**[20]**

## 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)

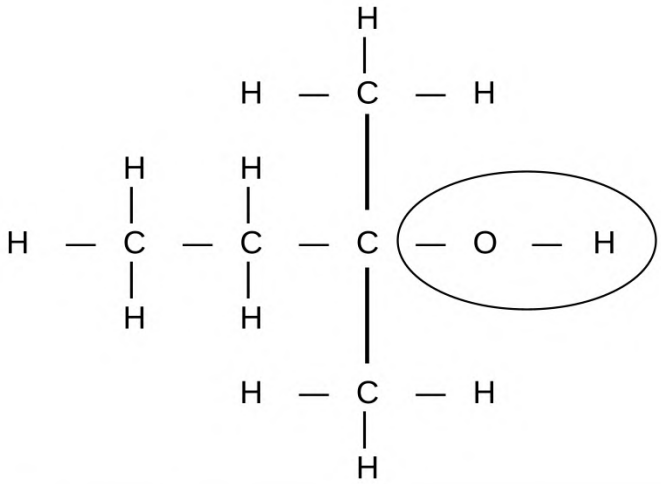
2.2.2 Pentanal/2-methylbutanal/3-methylbutanal/2,2-dimethylpropanal ✓✓ (2)
(functional group –anal ✓
Everything correct ✓)
(If wrong functional group 0/2)

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]**

## 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)

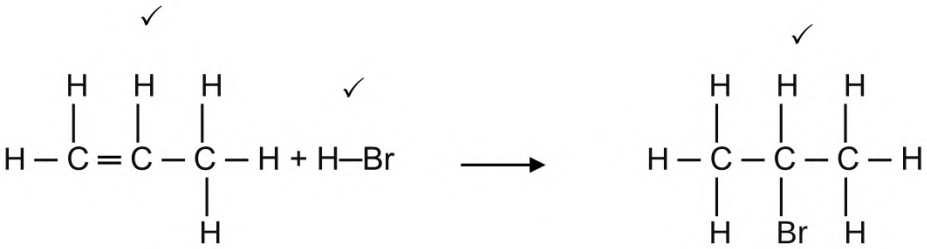
4.2 Hydrohalogenation/hydrobromination ✓ (1)

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)

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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

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

(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

Either ✓

$= \frac{V}{V_m}$ ✓

$= \frac{0,12}{24,04}$ ✓

Either ✓

= 4,99 x $10^{-3}$ 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 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]**

## QUESTION 6

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

**Notes**

**IF:** Forward reaction equals reverse reaction. ½ (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 | 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 ($mol \cdot dm^{-3}$) | 0,04 | $\frac{x - 0,2}{5}$ | 0,08 | 0,08 | Divide by 5 ✓ |

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

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

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

| |
|---|
| No $K_c$ expression, correct substitution. 7/8 |
| Wrong $K_c$ expression 6/8 |

$n(O_2) = nM$

$= \underline{(0,3)\ (32)}$ ✓

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

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**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 $^{6}/_{8}$ |

$n(O_2) = nM$

$= \underline{(0,3)\ (32)}$ ✓

$= 9,60\ g$✓ (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:** |
|---|---|
| $n(OH^-) = n(H^+)$ ✓<br>= cV ✓<br>= (0,1)(0,03) ✓<br>= 0,003 mol ✓ | • Mol ratio: $n(OH^-) = n(H^+)$<br>• n = cV ( entire eq)<br>• Substitution of 0,1<br>• Substitution of 0,03.<br>• Final answer: 0,003 mol. |
| **OPTION 2**<br>$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$<br>$\frac{0,1 \times 30}{cb \times 20} = \frac{1}{1}$ ✓<br>$cb = 0,15 \text{ mol} \cdot dm^{-3}$<br>↓<br>n = cV ✓<br>= (0,15)(0,02) ✓<br>= 0,003 mols✓ | **Marking guidelines:**<br>• Mol ratio<br>• Formula: n = cV<br>• Substitution of (0,15)(0,02)<br>• Final answer: 0,03 mol<br> |

(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**

$n(OH^-)$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 $cm^3$

$VBa(OH)_2$ 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]**

## 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 <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

**<u>Notes</u>**

- $Cu \leftarrow Cu^{2+} + 2e^-$ $(2/2)$ $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(1/2)$
  $Cu^{2+} + 2e^- \leftarrow Cu$ $(0/2)$ $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(0/2)$
- 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 **<u>OPTION 1</u>**

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




**<u>OPTION 2</u>** (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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