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)

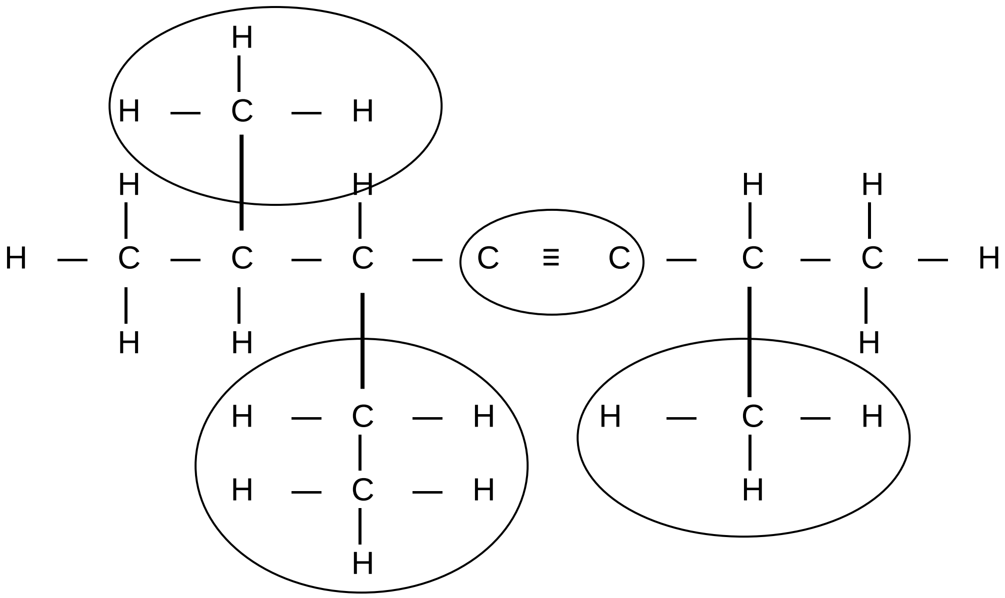
1.9 C ✓✓ (2)

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

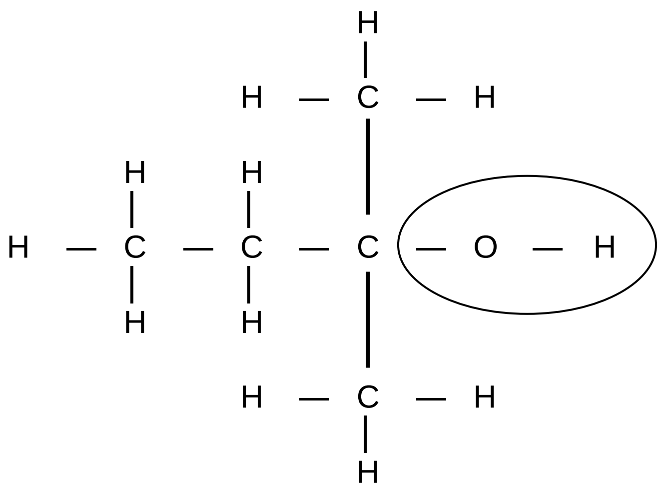
2.2.1 Organic compounds having the <u>same molecular formula</u>✓, but <u>different functional groups</u>✓ (underlined words must be in correct contexts) (2)

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



<u>Marking criteria:</u>

- 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)

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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)

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QUESTION 4

4.1 Hydrogenation. ✓ (1)

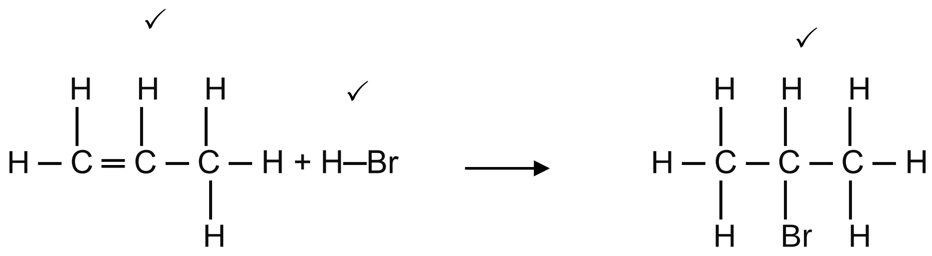
4.2 Hydrohalogenation/hydrobromination ✓ (1)

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)

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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

$$\text{average rate} = \frac{\Delta V}{\Delta t}$$
$$= \frac{(104 - 64)\ \checkmark}{(60 - 30)\ \checkmark}$$
$$= 1{,}33\ \checkmark\ (\ cm^3.s^{-1}\ )$$
(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 **<u>Marking criteria:</u>**

- 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✓
- <u>Correct substitution of 24 with n Mg</u> 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 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)

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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	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. $\frac{7}{8}$

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 ✓

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

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

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

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

$n(O_2)$ = nM
= <u>(0,3) (32)</u> ✓
= 9,60 g✓ (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✓

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 $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ $\frac{0{,}1 \times 30}{cb \times 20} = \frac{1}{1}$ ✓ $cb = 0{,}15\ mol \cdot dm^{-3}$ ↓ 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)

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
= $(0,1)(16 \times 10^{-3})$
= $1,6 \times 10^{-3}$ mols ✓

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

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

c $(Ba(OH)_2)$ = $\frac{n}{V}$ ✓

c $(Ba(OH)_2)$ = $\frac{0,0007}{0,004}$ ✓
= 0,175 $mol.dm^{-3}$. ✓ (7)

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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

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

(2)

8.5

	Notes
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ $0{,}03$✓ $= E^{\theta}_{reduction} - (0{,}77)$ ✓ $E^{\theta}_{reduction} = 0{,}80V$ X is Ag✓	• 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: $\frac{3}{4}$

(4)

[14]

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

- $Cu \leftarrow Cu^{2+} + 2e^{-}$ ($\frac{2}{2}$) $Cu^{2+} + 2e^{-} \rightleftharpoons Cu$ ($\frac{1}{2}$)
  $Cu^{2+} + 2e^{-} \leftarrow Cu$ ($\frac{0}{2}$) $Cu^{2+} + 2e^{-} \rightleftharpoons Cu$ ($\frac{0}{2}$)
- 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