FINAL

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

**NATIONAL
SENIOR CERTIFICATE**

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2024

MARKING GUIDELINES

MARKS: 150

These Marking Guidelines consist of 14 pages.

QUESTION 1

1.1   A ✓✓   (2)

1.2   A ✓✓   (2)

1.3   B ✓✓   (2)

1.4   D ✓✓   (2)

1.5   A ✓✓   (2)

1.6   B ✓✓   (2)

1.7   C ✓✓ **Do not mark**   (2)

1.8   B ✓✓   (2)

1.9   D ✓✓   (2)

1.10   C ✓✓   (2)
                                                                                                                [20]

QUESTION 2

2.1.1   5 – ethyl – 2,6 - dimethylhept – 3 – yne✓✓✓

Marking criteria:
• correct stem i.e. hept – 3 – yne ✓
• substituents correctly identified i.e. ethyl, dimethyl✓
• IUPAC name completely correct including numbering, sequence and hyphen ✓

                                                                                                                (3)

2.1.2   2,3 – dibromo – 5 – methylheptane✓✓

Marking criteria:
• correct stem and substituents i.e. dibromo, methyl and heptane✓
• IUPAC name completely correct including numbering, sequence and hyphen ✓

                                                                                                                (2)
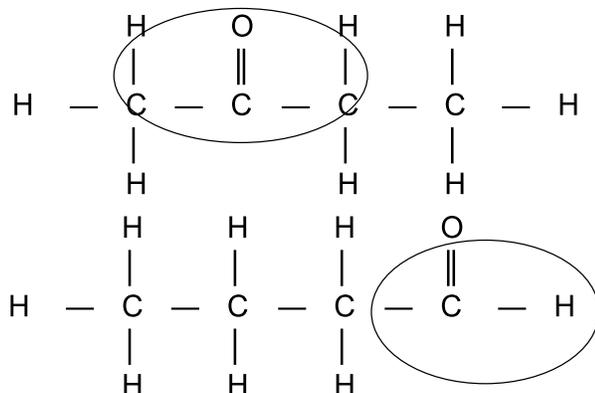
2.2.1

                                                                                                                (2)

2.2.2   alcohols✓ accept alkanols   (1)

2.2.3   A or E✓   (2)
         Has multiple bonds between atoms of carbon. ✓

2.3

Marking criteria:
• functional group of first isomer correctly drawn✓
• functional groupof second isomer correctly drawn✓
• Whole structure of first isomer correctly drawn✓
• Whole structure of second isomer correctly drawn ✓

(4)

2.4   Functional isomers✓   (1)
                                                                                         [15]

QUESTION 3

3.1   The <u>pressure exerted by a vapour</u> at <u>equilibrium with its liquid</u> in a <u>closed
         system.</u> ✓✓

Marking criteria:
If any one of the underlined key words/phrases in the correct context (vapour pressure) is omitted, deduct 1 mark.

(2)

3.2   100 kPa✓ <u>At the boiling point(149°C), the vapour pressure equals the
         atmospheric pressure.</u> ✓   (2)

3.3   P. ✓ P has a lower boiling point than R. ✓   (2)

3.4   Chain Length /branching/surface area ✓   (1)

3.5

> **Marking criteria:**
> - Relate boiling point with length of carbon chain/branching/number of side chains/surface area. ✓✓
> - Compare the strength of the intermolecular forces. ✓
> - Compare the energy required to overcome the intermolecular forces. ✓

P has the lowest boiling point ✓ and therefore has the shortest carbon chain/most number of branches/smallest surface area over which the intermolecular forces act. ✓
Weakest/least intermolecular forces/Van der Waals forces/London forces✓
Least energy needed to overcome the intermolecular forces✓

OR

Q has the highest boiling point ✓ and therefore has the longest carbon chain/least number of branches/largest surface area over which the intermolecular forces act. ✓
Strongest/most intermolecular forces/Van der Waals forces/London forces✓
Most energy needed to overcome the intermolecular forces✓

(4)

3.6
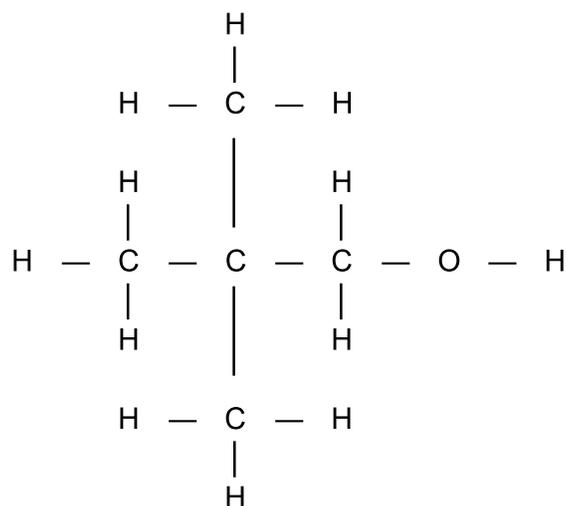
> **Marking criteria:**
> - Functional group on first carbon✓
> - 3 carbons in the longest chain ✓
> - 2 – methyl groups on the second carbon ✓

(3)

3.7.1　　149 (°C) ✓　　　　　　　　　　　　　　　　　　　　　　　　　　(1)

3.7.2　　At 100 kPa, the vapour pressure corresponds to the atmospheric pressure✓
　　　　　T represents　the highest boiling point. ✓✓　　　　　　　　　　　(3)
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[18]

QUESTION 4: DO NOT MARK

4.1.1　　Hydrogenation✓　　　　　　　　　　　　　　　　　　　　　　　(1)

4.1.2　　Requires a catalyst/Pt/Pd/Ni✓　　　　　　　　　　　　　　　　　(1)

4.2.1

```
        H       H       H       H       H
        |       |       |       |       |
  H  —  C  =  C  —  C  —  C  —  C  —  H
        |       |       |
        H       H       H
```

Marking criteria:
• double bond on first carbon✓
• Whole structure correct ✓

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　(2)

4.2.2　　substitution ✓
　　　　　hydrolysis✓　　　　　　　　　　　　　　　　　　　　　　　　(2)

4.2.3　　Dilute✓
　　　　　strong✓　　　　　　　　　　　　　　　　　　　　　　　　　(2)

4.3.1　　H_2O/water✓　　　　　　　　　　　　　　　　　　　　　　　(1)

4.3.2　　Sulphuric acid/H_2SO_4/phosphoric acid/H_3PO_4✓　　　　　　　(1)

4.3.3　　Hydration✓　　　　　　　　　　　　　　　　　　　　　　　　(1)

4.4.1　　Elimination/dehydrohalogenation✓　　　　　　　　　　　　　　(1)

4.4.2　　$C_5H_{11}Br$ + NaOH → C_5H_{10} + NaBr + H_2O　LHS✓　RHS✓　Bal✓　(3)
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[15]

QUESTION 5

5.1
- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass ✓ of products/reactants per (unit) time. ✓
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time. ✓✓
  - Rate of change in concentration/amount/number of moles/volume/ mass. ✓✓ (**2 or 0**)   (2)

5.2
- Reaction is exothermic/Temperature increases. ✓
- At a higher temperature particles move faster/have higher average kinetic energy.

  OR
- More molecules have enough/sufficient kinetic energy for an effective collision.

  OR
- More molecules have kinetic energy/Ek equal to or greater than the activation energy.
- More effective collisions per unit time/second. ✓

  OR
- Frequency of effective collisions increases.

  Reaction rate increases.
    (3)

✓ (bracket joining the three OR bullets in 5.2)

5.3

Marking criteria
• Equation✓
• Substitute $\dfrac{4-1,8}{3-1}$ in equation ✓
• Final answer: $1,1\ dm^3.min^{-1}$✓

$$rate \quad = \quad \frac{\text{change in volume of } CO_2(g)}{\Delta t} \quad ✓$$

$$= \quad \frac{4\ -\ 1,8}{3\ -\ 1} \quad ✓$$

$$= \quad 1,1\ dm^3.min^{-1}✓$$
  (3)

5.4   LESS THAN.✓

Less reactant particles per unit volume/lower concentration of HCl/Smaller surface of $CaCO_3$ ✓

Less effective collisions per unit time/Lower frequency of effective collisions.✓
  (3)

5.5   **Marking criteria*:*

- Formula: $n = \dfrac{V}{V_m}$ ✓ to calculate $n(CO_2)$ produced

- Correct substitution ($\dfrac{5,8}{25,7}$) in the above formula ✓

- Ratio: $n(CaCO_3)$ used equals $n(CO_2)$ produced ✓

- Substitution of $n(CaCO_3)$ to get n✓

- Use $n = \dfrac{m}{M}$ to calculate $m(CaCO_3)$initial ✓

- Final answer = reaction I ✓

Greater mass of impure $CaCO_3$ is required to produce the same volume of CO_2/22,57 g of impure $CaCO_3$ will produce less CO_2✓

$$n(CO_2)\text{produced} = \dfrac{V}{V_m} ✓$$

$$= \dfrac{5,8}{25,7} ✓$$

$$= 0,22568 \text{ mol}$$

$n(CaCO_3)$ used $= n(CO_2)$ produced✓

$= 0,22568$ mol ✓

We can also calculate number of moles of pure $CaCO_3$

$$n(CaCO_3) = \dfrac{m}{M}$$
$$= \dfrac{22,57}{100} = 0,2257 \text{ mol}$$

$$n(CaCO_3) = \dfrac{m}{M}$$

Use the ratio

$$0,22568 = \dfrac{m}{100} ✓$$

$$m(CaCO_3) = 22,57 \text{ g}$$

reaction I ✓

All of the $CaCO_3$ reacted. ✓

OR

Greater mass of impure $CaCO_3$ is required to produce the same volume of CO_2/22,57 g of impure $CaCO_3$ will produce less CO_2

(7)

5.6

Marking criteria:
• Gradient of G is smaller/less steep✓
• Curve G produces a smaller volume of CO_2(g) ✓
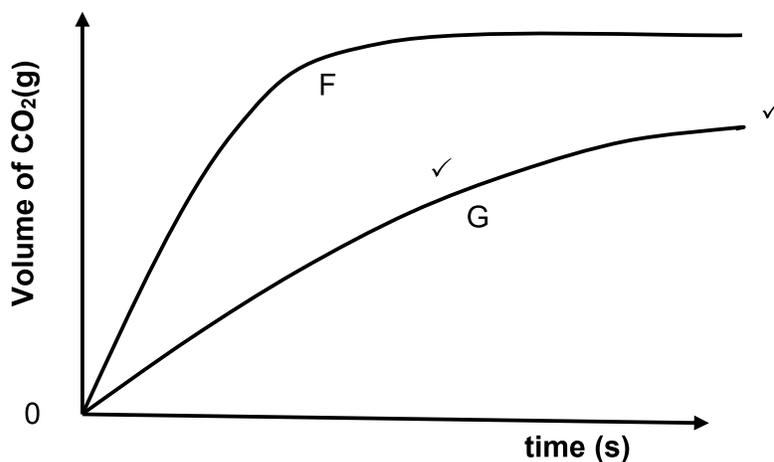
NB: If graphs are not labelled = 0/2

(2)
[20]

QUESTION 6

6.1   Double arrow in the equation. ✓   (1)

6.2

Marking criteria:
If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark.
The underlined phrase must be in the correct context.

When the <u>equilibrium in a closed system is disturbed</u>, the system will
<u>re-instate a new equilibrium</u> by favouring the reaction that will oppose the
disturbance. ✓✓

(2)

6.3   INCREASE. ✓
        According to Le Chatelier's Principle when the pressure increases, the
        reaction that leads to a decrease in the number of moles will be favoured. ✓
        In this case the forward reaction is favoured/equilibrium position shifts to the
        right.✓   (3)

6.4   EXOTHERMIC.✓
        Number of moles/mass of reactant decreased.✓
        Forward reaction favoured.✓
        A decrease in temperature favours the EXOTHERMIC REACTION.✓   (4)

6.5
Marking criteria:
• Initial quantities of all substances✓
• Quantity of SO_2 at equilibrium✓
• Using the correct mol ratio✓
• Calculating the quantity(mol) at equilibrium of O_2 and SO_3 substances ✓
• Divide number of moles at equilibrium by 2 dm^3✓
• K_c expression✓
• Correct substitution of equilibrium concentrations into K_c expression ✓

	SO_2	O_2	SO_3	
Initial quantity (mol)	0,6	0,5	0,4	✓
Change (mol)	0,2	0,1	0,2	✓
Quantity at equilibrium (mol)	0,4✓	0,4	0,6	✓
Equilibrium concentration (mol.dm^{-3})	0,2	0,2	0,3	✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$ ✓

$$\therefore \quad = \frac{[0,3]^2}{[0,2]^2[0,2]}$$ ✓

$$= 11,25$$ ✓

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

(8)

[18]

QUESTION 7

7.1.1   A substance that can act as an acid and a base. $\checkmark\checkmark$ (2)

7.1.2 HCO_3^- + H_2O $\rightleftharpoons$ CO_3^{2-} + H_3O^+ LHS$\checkmark$ RHS$\checkmark$ Balancing$\checkmark$
         OR
         HCO_3^- + H_2O $\rightleftharpoons$ H_2CO_3 + OH^- (3)

7.2.1

Marking criteria:
• Formula: pH = - log[H_3O^+]$\checkmark$
• Substitute c(H_3O^+) in the formula pH = - log[H_3O^+]$\checkmark$
• Final answer$\checkmark$

$$pH = - \log[H_3O^+] \quad \checkmark$$
$$ = - \log(2\times0,15) \quad \checkmark$$
$$ = 0,52\checkmark$$

                                                                    (3)

7.2.2

> **Marking criteria:**
> - Calculate $n(H^+)$ from H_2SO_4 ✓✓
> - Substitute for c and V in $n = cV$ to calculate $n(OH^-)$ from NaOH ✓
> - Substitute 12,96 into $pH = -\log[H_3O^+]$ to calculate $[H^+]$ ✓
> - Substitute $[H^+]$ in $[H_3O^+][OH^-] = 1 \times 10^{-14}$ to calculate $[OH^-]$ in excess ✓
> - Subtract $n(H^+)$ from $n(OH^-)_{TOTAL}$ and relate to $n(OH^-)_{EXCESS}$. Marks are awarded for substitution. LHS ✓ RHS ✓
> - Final answer ✓

$$n(H^+) \text{ from } H_2SO_4 = cV \times 2$$
$$= \underline{(0,15)(0,02) \times 2} \checkmark$$
$$= 0,006 \text{ mols} \checkmark$$

$$n(OH^-) \text{ from NaOH} = cV$$
$$= \underline{(0,25)(0,03)} \checkmark$$
$$= 0,0075 \text{ mols}$$

$$pH = -\log[H_3O^+]$$
$$\underline{12,96} = \underline{-\log[H_3O^+]} \checkmark$$
$$[H_3O^+] = 1,096 \times 10^{-3} \text{ mol.dm}^{-3}$$
$$[H_3O^+][OH^-] = 1 \times 10^{-14}$$
$$\underline{(1,096 \times 10^{-3})[OH^-]} = \underline{1 \times 10^{-14}} \checkmark$$
$$[OH^-] = 0,091 \text{ mol.dm}^{-3}$$
$$n(OH^-)_{excess} = cV$$
$$= (0,091) \frac{(50 + X)}{1000}$$

$$n(OH^-)_{excess} = n(OH^-)_{TOTAL} - n(H^+) \text{ from } H_2SO_4$$

$$(0,091)\frac{(50 + X)}{1000} \checkmark = (0,0075) + \frac{(0,1)(X)}{1000} - 0,006 \checkmark$$
$$X = 27,98 \text{ cm}^3 \checkmark$$

(8)

[16]

QUESTION 8
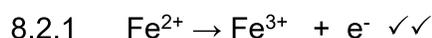
8.1

> **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: $\frac{3}{4}$

E^{θ}_{cell} $=$ $E^{\theta}_{reduction}$ $-$ $E^{\theta}_{oxidation}$ ✓

$0,03$ ✓ $=$ $0,80$ ✓ $-$ $E^{\theta}_{oxidation}$

$E^{\theta}_{oxidation}$ $=$ $0,77$ V ✓

(4)

8.2.1 $Fe^{2+} \rightarrow Fe^{3+} + e^-$ ✓✓   (2)

> **Notes**
> - **Ignore phases**
> - $Fe^{2+} \leftarrow Fe^{3+} + e^- \left(\frac{0}{2}\right)$ $Fe^{3+} + e^- \rightleftharpoons Fe^{2+} \quad \left(\frac{0}{2}\right)$
>
> $Fe^{2+} \rightleftharpoons Fe^{3+} + e^- \quad \left(\frac{1}{2}\right)$ $Fe^{3+} + e^- \leftarrow Fe^{2+} \quad \left(\frac{2}{2}\right)$
> - Ignore if charge on electron omitted.
>   If a charge of an ion is omitted eg. $Fe^{3+} + e^- \rightarrow Fe^{2+}$ Max: $\left(\frac{0}{2}\right)$

8.2.2   <u>$Pt(s)/Fe^{2+}(aq)(1\ mol·dm^{-3})/Fe^{3+}(aq)(1\ mol.dm^{-3})$</u> ✓ //✓<u>$Ag^+(aq)(1\ mol.dm^{-3})/Ag(s)$</u> ✓   (3)

NB: Award full marks even if the phases and concentrations are not shown

8.2.3   Temperature 25°C or 298 K ✓
        Concentration of electrolytes = 1 mol.dm^{-3} ✓   (2)

8.2.4   From chemical to electrical✓   (1)
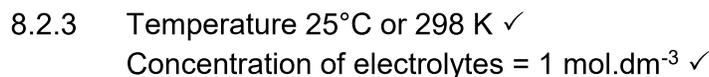
8.4.   INCREASES✓   (1)

[13]

QUESTION 9

9.1   A substance of which the aqueous solution contains ions/ A substance that dissolves in water to give a solution that conducts electricity/A solution/ dissolved substance that conducts an electric current through the movement of ions. ✓✓   (2)

9.2   M ✓
        $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ ✓✓
        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. $Cu + 2e^- \leftarrow Cu$ Max: $(^1/_2)$

                                                                                                                (3)

9.3   Cu/copper✓
        Copper is being plated on the metal M✓✓

                                                                                                                (3)

9.4   **Marking criteria:**
        - Calculate gain in mass of the bar i.e. 17,85 - 12,52 and substitute 63,5 in the formula: $n = \dfrac{m}{M}$ ✓
        - Substitute $6,02 \times 10^{23}$ ✓
        - Ratio of number of mols of e to number of moles of Cu: 2 : 1✓
        - Substitute in $Q = I\Delta t$, Calculate charge✓
        Final answer 3 hours✓

        : $n = \dfrac{m}{M}$

        : $n = \dfrac{17,85 - 12,52}{63,5}$ ✓

        $n(e) = 2(\dfrac{5,33}{63,5})$✓

        $= 0,168$ mols

        $n(e) = n = nN_A$

$$= \underline{0{,}168 \; x \; 6{,}02 \; x \; 10^{23}} \checkmark$$
$$= 1{,}011 \; x \; 10^{23}$$

$Q = ne$
$$= \underline{(1{,}011 \; x \; 10^{23})(1{,}6 \; x \; 10^{-19})} \checkmark$$
$$= 16\ 176 \text{ C}$$

$Q = I\Delta t$
$\underline{16\ 176} = 1{,}5(\Delta t)$
$\Delta t = 10\ 784 \text{ s}$ (5)
$X = 3 \text{ hr}\checkmark$

9.5 $\underline{Zn^{2+}}$ is a weaker oxidising agent $\underline{\text{than } Cu^{2+}}\checkmark$ and $\underline{\text{will not be reduced}}$. $\checkmark$ (2)

<div align="center">

OR

</div>

$\underline{Cu^{2+}}$ is a stronger oxidising agent $\underline{\text{than } Zn^{2+}}\checkmark$, $\underline{Cu^{2+} \text{ will be reduced to Cu}}.\checkmark$

                                                                     [15]
                                               TOTAL: **150**

NOTE:
The paper should be marked out 133 and then converted to 150.