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✓✓✓

<u>**Marking criteria*:***</u>

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

(3)

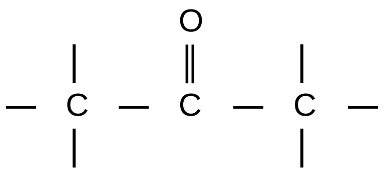
2.1.2 2,3 – dibromo – 5 – methylheptane✓✓

<u>**Marking criteria*:***</u>

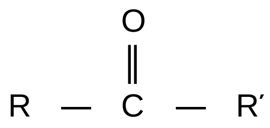
- correct stem and substituents i.e. dibromo, methyl and heptane✓
- IUPAC name completely correct including numbering, sequence and hyphen ✓

(2)

2.2.1



ACCEPT



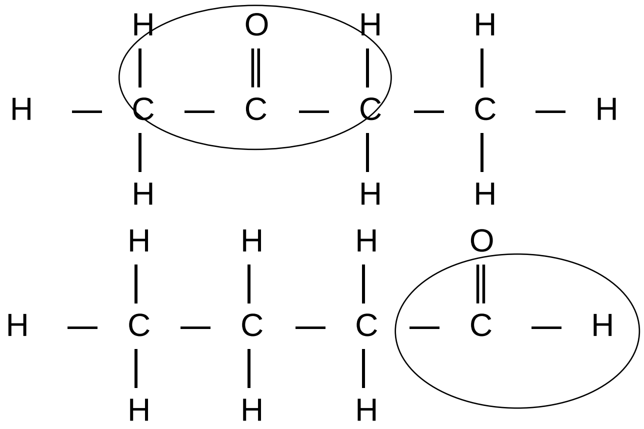
✓✓

(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 pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓

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✓ At the boiling point(149°C), the vapour pressure equals the atmospheric pressure. ✓ (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. ✓

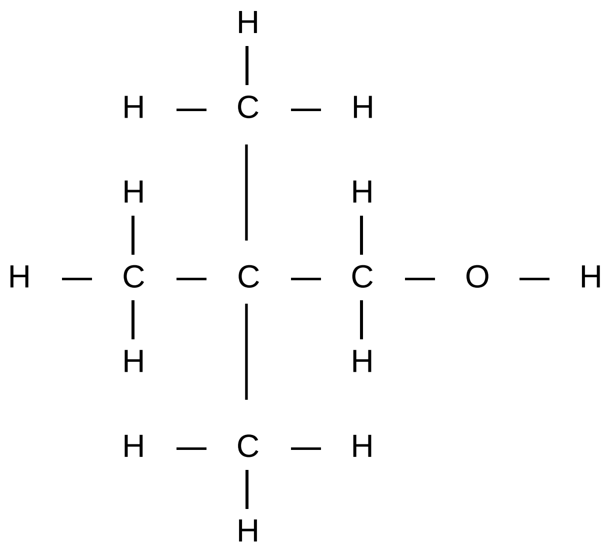
P has the lowest boiling point ✓ and therefore has the shortest carbon chain/most number of branches/smallest surface area over which the intermolecular forces act. ✓
Weakest/least intermolecular forces/Van der Waals forces/London forces✓
Least energy needed to overcome the intermolecular forces✓

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)

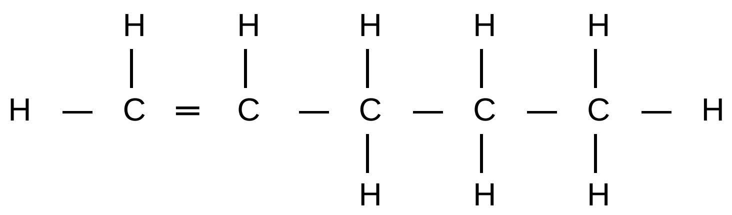
3.7.2 At 100 kPa, the vapour pressure corresponds to the atmospheric pressure✓
T represents the highest boiling point. ✓✓ (3)
[18]

QUESTION 4: DO NOT MARK

4.1.1 Hydrogenation✓ (1)

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

4.2.1



<u>Marking criteria:</u>
• 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 $C_5H_{11}Br + NaOH \rightarrow C_5H_{10} + NaBr + H_2O$ 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)

5.3

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

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

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

$$= 1,1\ dm^3.min^{-1} \checkmark$$

(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: $n = \frac{V}{V_m}$ ✓ to calculate $n(CO_2)$produced
- Correct substitution ($\frac{5,8}{25,7}$) in the above formula ✓
- Ratio: $n(CaCO_3)$ used equals $n(CO_2)$ produced ✓
- Substitution of $n(CaCO_3)$ to get n✓
- Use $n = \frac{m}{M}$ 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✓

$n(CO_2)$produced $= \frac{V}{V_m}$ ✓

$= \frac{5,8}{25,7}$ ✓

= 0,22568 mol

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

= 0,22568 mol ✓

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

$0,22568 = \frac{m}{100}$ ✓

$m(CaCO_3)$ = 22,57 g

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

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

$= \frac{22,57}{100}$ = 0,2257 mol

Use the ratio

reaction I ✓

All of the $CaCO_3$ reacted. ✓

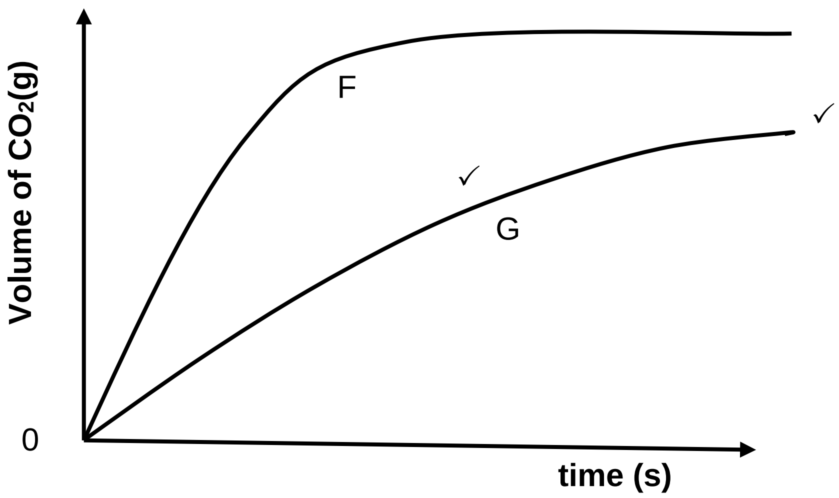
OR

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	✓

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

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

$$= 11,25 \checkmark$$

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. ✓✓ (2)

7.1.2 HCO_3^- + H_2O ⇌ CO_3^{2-} + H_3O^+ LHS✓ RHS✓ Balancing✓
OR
HCO_3^- + H_2O ⇌ H_2CO_3 + OH^- (3)

7.2.1

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

pH = - log[H_3O^+] ✓
= - log(2x0,15) ✓
= 0,52✓

(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✓

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

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

$$pH = -\log[H_3O^+]$$
$$\underline{12{,}96} \underline{=} \underline{-\log[H_3O^+]} ✓$$
$$[H_3O^+] = 1{,}096 \times 10^{-3} \text{ mol.dm}^{-3}$$
$$[H_3O^+][OH^-] = 1 \times 10^{-14}$$
$$\underline{(1{,}096 \times 10^{-3})[OH^-]} \underline{=} \underline{1 \times 10^{-14}} ✓$$
$$[OH^-] = 0{,}091 \text{ mol.dm}^{-3}$$
$$n(OH^-)_{excess} = cV$$
$$= (0{,}091) \frac{(50 + X)}{1000}$$
$$n(OH^-)_{excess} = n(OH^-)_{TOTAL} - n(H^+) \text{ from } H_2SO_4$$

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

(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: $^{3}/_{4}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓
$0,03$ ✓ $= 0,80$ ✓ $- E^{\theta}_{oxidation}$
$E^{\theta}_{oxidation} = 0,77\ V$ ✓

(4)

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

Notes
- **Ignore phases**
- $Fe^{2+} \leftarrow Fe^{3+} + e^{-}$ ($^{0}/_{2}$) $Fe^{3+} + e^{-} \rightleftharpoons Fe^{2+}$ ($^{0}/_{2}$)

  $Fe^{2+} \rightleftharpoons Fe^{3+} + e^{-}$ ($^{1}/_{2}$) $Fe^{3+} + e^{-} \leftarrow Fe^{2+}$ ($^{2}/_{2}$)
- Ignore if charge on electron omitted.

  If a charge of an ion is omitted eg. $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$ Max: ($^{0}/_{2}$)

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. $Cu + 2\,e^- \leftarrow Cu$ 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: $n = \frac{m}{M}$ ✓
- 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✓

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

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

$$n(e) = 2\left(\frac{5{,}33}{63{,}5}\right) ✓$$

$$= 0{,}168 \text{ mols}$$

$n(e) = n = nN_A$

$= \underline{0{,}168 \times 6{,}02 \times 10^{23}}$ ✓
$= 1{,}011 \times 10^{23}$
$Q = ne$
$= \underline{(1{,}011 \times 10^{23})(1{,}6 \times 10^{-19})}$ ✓
$= 16\ 176$ C

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

9.5 Zn^{2+} is a weaker oxidising agent than Cu^{2+}✓ and will not be reduced. ✓ (2)

OR

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

[15]
TOTAL: 150

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