KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARKING GUIDELINES

SEPTEMBER 2023

MARKS: 150

This marking guideline document consists of 13 pages.

QUESTION 1

1.1   B ✓✓   (2)

1.2   D ✓✓   (2)

1.3   A ✓✓   (2)

1.4   A ✓✓   (2)

1.5   D ✓✓   (2)

1.6   C ✓✓   (2)

1.7   A ✓✓   (2)

1.8   C ✓✓   (2)

1.9   B ✓✓   (2)

1.10   B ✓✓   (2)
                                                                          [20]

QUESTION 2

2.1
2.1.1   C ✓   D ✓ (accept E)   (2)

2.1.2   F ✓   (1)

2.1.3   D or E ✓   (1)

2.2   2 – methylpent – 1 – ene ✓✓

> **Marking criteria:**
> • correct stem and substituents: <u>methyl and pentene</u> ✓
> • IUPAC name completely correct including numbering, sequence and hyphen ✓   (2)

2.3   A series of organic compounds that can be <u>described by the same general formula</u> ✓✓
                                    OR
        A series of organic compounds in <u>which one member differs from the next by a -CH_2 group.</u> ✓✓
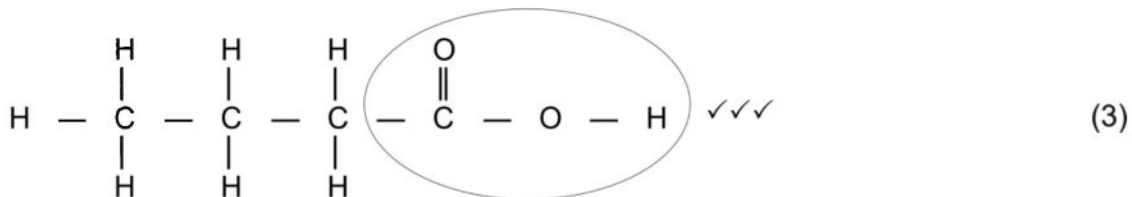
> **Marking criteria:**
> If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark.   (2)

2.4 C_nH_{2n-2} ✓   (1)

2.5.1   Esterification/ester formation✓   (1)

2.5.2   Sulphuric acid/H_2SO_4✓   (1)

2.5.3

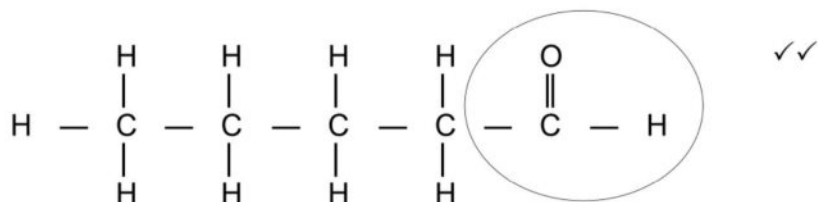✓✓✓   (3)

Marking criteria:
- Functional group correctly drawn✓
- 4 carbons ✓
- Whole structure correctly drawn✓

2.6   Compounds with <u>same molecular formula</u>✓ but <u>different functional groups</u>. ✓   (2)

2.7

✓✓

Marking criteria:
- Functional group correctly drawn✓ $\frac{1}{2}$
- Whole structure correct ✓ $\frac{2}{2}$
                                                                            (2)

<u>ACCEPT</u> structures for: 2-methylbutanal, 3-methylbutanal
and 2,2-dimethylpropanal.

                                                                    [18]

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 Vapour pressure is temperature dependent✓ (1)

3.3.1 Vapour pressure ✓ (1)

3.3.2 Molecular mass✓ OR Temperature. Accept: straight chain✓ (1)

3.4 D; C; B; A ✓✓ **(2 OR ZERO)** (2)

3.5 1,6 (kPa)✓ (1)

3.6 <u>For ethanoic acid:</u>
Strongest intermolecular forces between the molecules (Hydrogen bonds).✓
Most energy required to overcome the intermolecular forces.✓
Lowest vapour pressure✓ (3)

3.7

Marking criteria:
• Correct answer (C)
• Compare strengths of IMFs of A and B, and relate to vapour pressure✓
• Compare strengths of IMFs of D, and relate to vapour pressure✓
• Compare strengths of IMFs of C with A, B and D.✓

C
Both the carboxylic acid/ethanoic acid/A and alcohol/propan-1-ol/B have strongest intermolecular forces resulting in lowest vapour pressures. ✓
Butane/D has weakest intermolecular forces resulting in the highest vapour pressure.✓
2-propanone/propanone/C has intermolecular forces stronger than Butane/D, but weaker than carboxylic acid/ethanoic acid/A and alcohol/propan-1-ol/B. ✓
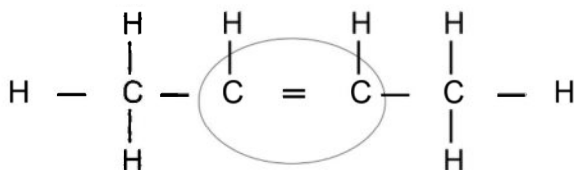
(4)

[15]

SA EXAM PAPERS

QUESTION 4

4.1.1   Dehydrohalogenation / Dehydrobromination✓   (1)

4.1.2

Marking criteria:
• Functional group correctly drawn✓ $\frac{1}{2}$
• Whole structure correct ✓ $\frac{2}{2}$

(2)

4.1.3 C_4H_9Br + NaOH → C_4H_8 + NaBr + H_2O (any strong base)
LHS✓   RHS✓   BAL✓
NOTE: If structural formulae used, max $\frac{2}{3}$ (3)

4.2   2 - chlorobutane✓✓

Marking criteria:
• correct stem and substituents: <u>chloro and butane</u>✓
• IUPAC name completely correct including numbering, sequence and hyphen ✓

(2)

4.3.1   Hydrolysis✓ or substitution   (1)

4.3.2   butan – 2 - ol✓✓ OR 2-butanol

Marking criteria:
• correct stem and substituents: butanol✓
• IUPAC name completely correct including numbering, sequence and hyphen ✓

(2)

4.4.1   Elimination ✓or dehydration   (1)

4.4.2   Water/H_2O✓   (1)

4.5.1   Hydrogenation✓   (1)

4.5.2   Platinum/Pt **OR** Nickel/Ni **OR** Palladium/Pd ✓   (1)
    [15]

QUESTION 5

5.1   7 (minutes) ✓   (1)

5.2   Decreases ✓   (1)

5.3   0,1 g ✓   (1)

5.4   Gradient of the graph decreases as the reaction progresses. ✓
        Rate of the reaction decreases. ✓
        Concentration of H_2O_2 decreases as the reaction progresses / Amount of
        reacting molecules decreases in the same volume. ✓
        Number of effective collisions per unit time decreases. ✓   (4)

5.5   **Marking criteria:**

- Formula: $n = \dfrac{V}{V_m}$ ✓ to calculate $n(O_2)$ produced

- Correct substitution ($\dfrac{0,116}{22,4}$) in the above formula / Award mark for
  answer ($5,179 \times 10^{-3}$ if substitution is not shown) ✓
- Ratio: $n(H_2O_2)$ used equals $2n(O_2)$ produced ✓

- Use $n = cV$ to calculate $n(H_2O_2)$ initial ✓

- $n(H_2O_2)$ when reaction stops = $n(H_2O_2)$initial - $n(H_2O_2)$used/reacted ✓✓

- Formula: $C = \dfrac{n}{V}$ ✓ to calculate C required

- Correct substitution into the formula: $c = \dfrac{n}{V}$ ✓

- Final answer = 0,15 mol·dm⁻³ ✓

SA EXAM PAPERS

5.5 **OPTION 1:**

$n(O_2)$produced $= \dfrac{V}{V_m}$ ✓

$\left. \begin{array}{l} = \dfrac{0,116}{22,4} \\[3mm] = 5,179 \times 10^{-3} \text{ mol} \end{array} \right\}$ Any one ✓

$n(H_2O_2)$ used $= 2n(O_2)$ produced ✓

$= 2(5,179 \times 10^{-3})$

$= 0,010358$ mol

$n(H_2O_2)$ initial $= cV$

$= (0,2)(0,2)$ ✓

$= 0,04$ mol

$n(H_2O_2)$ when reaction stops $= n(H_2O_2)$initial $-$ $n(H_2O_2)$used/reacted

$= 0,04 - 0,010358$ ✓✓

$= 0,029642$ mol

$c = \dfrac{n}{V}$ ✓

$c = \dfrac{0,029642}{0,2}$ ✓

$= 0,15$ mol·dm⁻³ ✓   Range: 0,1482 to 0,15

OPTION 2:

$n(O_2)$produced $= \dfrac{V}{V_m}$ ✓

$= \dfrac{0,116}{22,4}$

$= 5,179 \times 10^{-3}$ mol

	$2H_2O_2$	$2H_2O$	O_2
R	2	2	1
I	0,04✓		0
C	-0,010358✓(Ratio)		+5,179 x 10⁻³✓
END	0,029642✓✓		5,179 x 10⁻³

$c = \dfrac{n}{V}$ ✓

$c = \dfrac{0,029642}{0,2}$ ✓

$= 0,15$ mol·dm⁻³ ✓   Range: 0,1482 to 0,15   (9)

[16]

SA EXAM
PAPERS

QUESTION 6

6.1.1   When the <u>rate of forward reaction equals the rate of reverse reaction</u>. ✓✓
         OR when the amounts of reactants and products remain constant.

         <u>**Notes**</u>
         IF: Forward reaction equals reverse reaction.   ½   (2)

6.1.2

Marking criteria:
• $n(SO_3)$ equilibrium = 0,75✓
•   Using the correct mol ratio✓
•   Calculating the quantity(mol) at equilibrium of all three substances ✓
•   Divide number of moles at equilibrium by 2 dm^3✓
• K_c expression✓
•   Correct substitution of equilibrium concentrations into K_c expression ✓
•   Kc = 0,36✓

	NO_2	SO_2	SO_3	NO	
Ratio	1	1	1	1	
Initial quantity (mol)	2	2	0	0	
Change (mol)	0,75	0,75	0,75	0,75	Using ratio ✓
Quantity at equilibrium (mol)	1,25	1.25	0,75 ✓	0,75	✓
Equilibrium concentration (mol·dm^{-3})	0,625	0,625	0,375	0,375	Divide by 2 ✓

$$K_c = \frac{[SO_3]\,[NO]}{[NO_2][SO_2]} \quad ✓$$

$$\therefore \; = \frac{(0,375)(0,375)}{(0,625)(0,625)} ✓$$

$$= 0,36 \; ✓$$

No K_c expression, correct substitution: Max ⁶⁄₇
Round brackets used for Kc expression: Max 6/7
Wrong K_c expression: Max ⁵⁄₇

                                                        (7)

6.2.1   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. ✓✓

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

                                                        (2)

6.2.2   Decreased✓
Green implies forward reaction/ reaction that produces a larger number of molecules is favoured. ✓
According to LCP a decrease in pressure favours the reaction that produces a larger number of gas molecules / gas moles✓   (3)

6.2.3   Increases. ✓   (1)

6.2.4   <u>Increase concentration of reactants</u>✓ (by adding more) OR <u>decrease concentration of products</u> (by removing some)   (1)
   [16]

QUESTION 7

7.1.1   <u>Ionises completely in water</u> ✓to form a <u>high concentration of H_3O^+ ions.</u>✓

ACCEPT: <u>Ionises completely in water</u> ✓✓ (for 2023 Prep Exams).   (2)

7.1.2   No✓
Does not ionise completely✓/ ionises partially/0,018 mol.dm⁻³ is less than 0,10 mol·dm⁻³   (2)

7.1.3 $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$✓

$(0,018)[OH^-] = 1 \times 10^{-14}$✓

$[OH^-] = 5.56 \times 10^{-13}$ mol·dm⁻³✓   (3)

7.2.1   Contains a small amount (number of moles) of acid in proportion to the volume of water / in a given volume of water. ✓✓   (2)

7.2.2   SMALLER THAN✓   (1)

7.2.3   **<u>Marking criteria</u>**:
   • Substitute in the formula $pH = -\log[H_3O^+]/[H_3O^+][OH^-] = 1 \times 10^{-14}/$
     $pOH = -\log[OH^-]/pH + pOH = 14$ to calculate $c(OH^-)$excess ✓✓
   • Substitute in the formula $n = cV$ to calculate $n(OH^-)$ in excess ✓
   • Calculation of moles of OH^- reacted with H_2SO_4. (ratio as well as $r \cdot H_2SO_4$)) ✓
   • Addition of excess moles to moles reacted of NaOH (total number of moles of NaOH)✓✓
   • Substitution of molar mass (40) to calculate mass of NaOH✓
   • Final answer 0,144 g. ✓

   RANGE: 0,144 g TO 0,149 g

   <u>**NOTE:**</u> If the calculation is done using a table, mark within the table using the criteria above.

$$pH = -\log[H_3O^+]$$
$$12,56 = -\log[H_3O^+] \checkmark$$
$$[H_3O^+] = 2,75 \times 10^{-13} \text{ mol·dm}^{-3}$$
$$\underline{[H_3O^+][OH^-] = 1 \times 10^{-14}}$$
$$2,75 \times 10^{-13}[OH^-] = 1 \times 10^{-14}\checkmark$$
$$[OH^-] = 0,0363 \text{ mol·dm}^{-3}$$

OR $14 - pH = -\log[OH^-]$
$$14 - 12,56 \checkmark = -\log[OH^-]\checkmark$$
$$[OH^-] = 0,0363 \text{ mol·dm}^{-3}$$

$$n(OH^-)\text{excess} = cV$$
$$n(OH^-) = \frac{(0,0363)(37)}{1000} \checkmark \quad \textbf{OR} \quad \boxed{(0,0363)(0,037)}$$
$$= 1,3431 \times 10^{-3} \text{ mols}$$

$$n(OH^-)\text{reacted with } H_2SO_4 = 2n(H_2SO_4)$$
$$= cV$$
$$n(OH^-)\text{in 25 cm}^3 = \frac{(2)(0,1)(12)}{1000} \checkmark \quad \textbf{OR} \quad \boxed{(2)(0,1)(0,012)}$$
$$= 2,4 \times 10^{-3} \text{ mols}$$

OR

$$n(H_2SO_4) = cxV = 0,1 \times 0,012 = 0,0012$$

$$n(NaOH) = 2 \times 0,0012 = 0,0024 \text{ moles}$$
$$\text{Initial } n(NaOH) = 0,0024 + 0,0013 = 0,0037 \text{ moles}$$

$$m(NaOH) = n(\text{total})M$$
$$= \underline{(2,4 \times 10^{-3} + 1,3431 \times 10^{-3})} \checkmark\checkmark (40) \checkmark$$
$$= 0,149 \text{ (g)}\checkmark$$

OR

$$m(NaOH) = n(\text{total})M$$
$$= \underline{(0,0024 + 0,0013)} \checkmark (40) \checkmark$$
$$= 0,144 \text{ (g)}\checkmark$$

(8)

[18]

QUESTION 8

8.1 Pressure of 101,3 kPa / 1 atm✓
Concentration of electrolytes: 1 mol·dm⁻³✓ (2)

8.2 $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓

$= 0,00$ ✓ $- (-0,27)$ ✓

$= 0,27V$ ✓

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

(4)

8.3.1 From chemical to electrical✓ (1)

8.3.2 Maintain electrical neutrality (of the electrolytes)✓
Complete the circuit (any ONE) (1)

8.3.3 Towards the nickel half cell✓ (1)

8.3.4 Ni → Ni²⁺ + 2 e⁻ ✓✓ (Ignore phases)

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

(2)

8.4. Increases✓
H⁺ ions are reduced to H₂✓
Concentration of H⁺ ions decreases✓ (3)

8.5 No effect✓ (1)

[15]

SA EXAM PAPERS

QUESTION 9

9.1   • The chemical process in which electrical energy is converted to chemical energy. ✓✓ (2 or 0) **OR**
       • The use of electrical energy to produce a chemical change **OR**
       • The process during which an electric current passes through a solution/molten ionic compound.

(2)

9.2   T ✓ Reduction takes place (at the cathode) / It is the negative electrode / R is the electrode that is impure Cu.✓
       ACCEPT: So that the Cu forms on pure Cu.

(2)

9.3 $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ ✓✓
       Ignore phases

┌──┐
│ **Notes**   │
│   • $Cu \leftarrow Cu^{2+} + 2e^-$ $(\frac{0}{2})$ $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(\frac{0}{2})$ │
│ $Cu^{2+} + 2e^- \leftarrow Cu$ $(\frac{2}{2})$ $Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(\frac{1}{2})$ │
│   • Ignore if charge on electron omitted.   │
│   • If a charge of an ion is omitted eg. $Cu + 2 e^- \leftarrow Cu$ Max: $(\frac{1}{2})$ │
└──┘

(2)

9.4   REMAINS THE SAME✓
       The rate at which Cu is oxidised to Cu^{2+} at the anode is equal to the rate at   (2)
       which the Cu^{2+} is reduced at the cathode ✓

9.5   No✓
       Zn^{2+} is a weaker oxidising agent than Cu^{2+}✓ and will not be reduced. ✓   (3)

9.6 **Marking criteria:**

- Substitute in the formula: $n = \dfrac{m}{M}$ to calculate number of moles of Cu. ✓
- Ratio of number of moles of e to number of moles of Cu: 2 : 1 ✓
- Substitute in the formula $N = nN_A$ to calculate number of electrons ✓
- Substitute in $Q = nq_e$ to calculate total charge ✓
- Substitute in $Q = I\Delta t$ ✓
- Final answer 2,89 A ✓

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

$: n = \dfrac{1,72}{63,5}$ ✓

$n(e) = 2(\dfrac{1,72}{63,5})$ ✓

$= 0,054$ mol

$N(e) = nN_A$
$= 0,054 \times 6,02 \times 10^{23}$ ✓
$= 3,2508 \times 10^{22}$

$Q = Nq_e$
$= (3,2508 \times 10^{22})(1,6 \times 10^{-19})$ ✓
$= 5201,28$ C

$Q = I\Delta t$
$5201,28 = I(1800)$ ✓
$I = 2,89$ A ✓

(6)

[17]

TOTAL: **150**

SA EXAM PAPERS