KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2023

MARKING GUIDELINES

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: methyl and pentene✓ • IUPAC name completely correct including numbering, sequence and hyphen ✓

(2)

2.3 A series of organic compounds that can be described by the same general formula ✓✓

OR

A series of organic compounds in which one member differs from the next by a -CH_2 group.✓✓

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

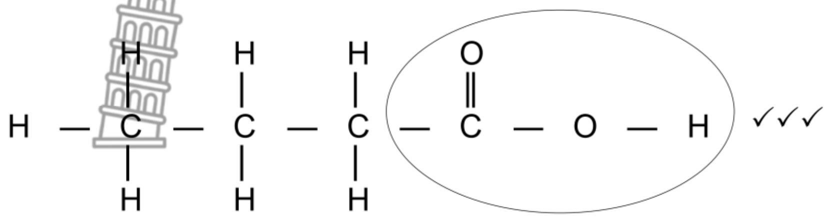
(2)

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

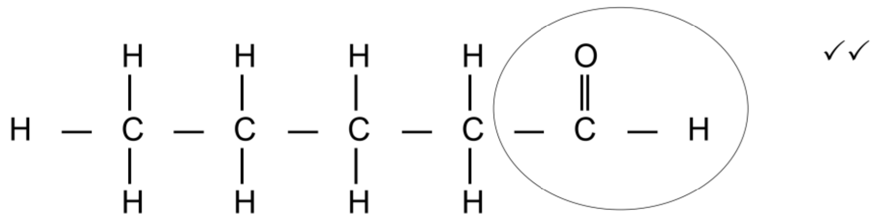


(3)

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

2.6 Compounds with same molecular formula✓but different functional groups. ✓ (2)

2.7



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

(2)

ACCEPT structures for: 2-methylbutanal, 3-methylbutanal and 2,2-dimethylpropanal.

[18]

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 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 For ethanoic acid:
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.✓

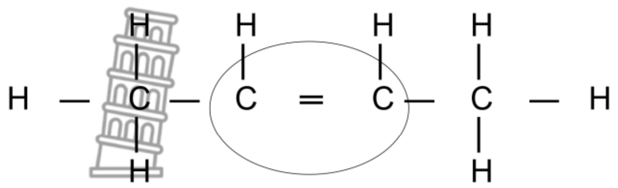
C ✓
Both the carboxylic acid/ethanoic acid/A and alcohol/propan-1-ol/B have strongest intermolecular forces resulting in lowest vapour pressures. ✓
Butane/D has weakest intermolecular forces resulting in the highest vapour pressure. ✓
2-propanone/propanone/C has intermolecular forces stronger than Butane/D,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

(4)
[15]

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: chloro and butane✓
> - 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 **<u>Marking criteria</u>*:***

- Formula: $n = \frac{V}{V_m}$ ✓ to calculate $n(O_2)$produced
- Correct substitution ($\frac{0,116}{22,4}$) 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: $C = \frac{n}{V}$✓ to calculate C required
- Correct substitution into the formula: $c = \frac{n}{V}$ ✓
- Final answer = 0,15 $mol \cdot dm^{-3}$ ✓

5.5 **<u>OPTION 1</u>:**

$$n(O_2)\text{produced} = \frac{V}{V_m} \checkmark$$

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

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

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

$$c = \frac{n}{V} \checkmark$$

$$c = \frac{0,029642}{0,2} \checkmark$$

$= 0,15 \text{ mol·dm}^{-3}$ ✓ Range: 0,1482 to 0,15

<u>OPTION 2:</u>

$$n(O_2)\text{produced} = \frac{V}{V_m} \checkmark$$

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

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

	$2H_2O_2$	$2H_2O$	O_2
R	2	2	1
I	0,04✓		0
C	-0,010358✓(Ratio)		$+5,179 \times 10^{-3}$✓
END	0,029642✓✓		$5,179 \times 10^{-3}$

$$c = \frac{n}{V} \checkmark$$

$$c = \frac{0,029642}{0,2} \checkmark$$

$= 0,15 \text{ mol·dm}^{-3}$ ✓ Range: 0,1482 to 0,15 (9)

[16]

QUESTION 6

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

Notes
IF: Forward reaction equals reverse reaction. $\frac{1}{2}$ (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 ($mol \cdot dm^{-3}$)	0,625	0,625	0,375	0,375	Divide by 2 ✓

$$K_c = \frac{[SO_3]\ [NO]}{[NO_2][SO_2]} \checkmark$$

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

$$= 0,36 \checkmark$$

No K_c expression, correct substitution: Max $\frac{6}{7}$
Round brackets used for Kc expression: Max 6/7

Wrong K_c expression: Max $\frac{5}{7}$

(7)

6.2.1 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. ✓✓

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

$\underline{(0{,}018)[OH^-] = 1 \times 10^{-14}}$✓

$[OH^-] = 5.56 \times 10^{-13}$ 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 $n(H_2SO4)$) ✓
- 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.

$pH = -\log[H_3O^+]$

$\underline{12{,}56 = -\log[H_3O^+]}$ ✓

$[H_3O^+] = 2{,}75 \times 10^{-13}\ mol{\cdot}dm^{-3}$

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

$2{,}75 \times 10^{-13}[OH^-] = 1 \times 10^{-14}$ ✓

$[OH^-] = 0{,}0363\ mol{\cdot}dm^{-3}$

OR $14 - pH = -\log[OH^-]$

$\underline{14 - 12{,}56}$ ✓ $\underline{= -\log[OH^-]}$ ✓

$[OH^-] = 0{,}0363\ mol{\cdot}dm^{-3}$

$n(OH^-)excess = cV$

$n(OH^-) = \frac{(0{,}0363)(37)}{1000}$ ✓ **OR** $(0{,}0363)(0{,}037)$

$= 1{,}3431 \times 10^{-3}$ mols

$n(OH^-)$reacted with $H_2SO_4 = 2n(H_2SO_4)$

$= cV$

$n(OH^-)$in 25 cm^3 $= \frac{(2)(0{,}1)(12)}{1000}$ ✓ **OR** $(2)(0{,}1)(0{,}012)$

$= 2{,}4 \times 10^{-3}$ mols

OR

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

$n(NaOH) = 2 \times 0{,}0012 = 0{,}0024$ moles

Initial $n(NaOH) = 0{,}0024 + 0{,}0013 = 0{,}0037$ moles

$m(NaOH) = n(total)M$

$= \underline{(2{,}4 \times 10^{-3} + 1{,}3431 \times 10^{-3})}$ ✓✓ (40) ✓

$= 0{,}149$ (g)✓

OR

$m(NaOH) = n(total)M$

$= \underline{(0{,}0024 + 0{,}0013)}$ ✓ (40) ✓

$= 0{,}144$ (g)✓

(8)

[18]

QUESTION 8

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

8.2 $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓
$= 0,00$ ✓ $- (-0,27)$ ✓
$= 0,27 V$ ✓

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: $\frac{3}{4}$

(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 $Ni \rightarrow Ni^{2+} + 2e^-$ ✓✓ (Ignore phases)

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

(2)

8.4. Increases✓
H^+ ions are reduced to H_2✓
Concentration of H^+ ions decreases✓ (3)

8.5 No effect✓ (1)
[15]

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. $Cu + 2e^- \leftarrow Cu$ 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 which the Cu^{2+} is reduced at the cathode ✓ (2)

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: $n = \frac{m}{M}$ to calculate number of moles of Cu. ✓
- Ratio of number of mols 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✓

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

$: \ n = \frac{1{,}72}{63{,}5}$ ✓

$n(e) = 2(\frac{1{,}72}{63{,}5})$✓

$= 0{,}054$ mol

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

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

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

(6)
[17]
TOTAL: 150