KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

NATIONAL SENIOR CERTIFICATE



PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2023

MARKING GUIDELINES

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MARKS: 150

This marking guideline document consists of 13 pages.

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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)

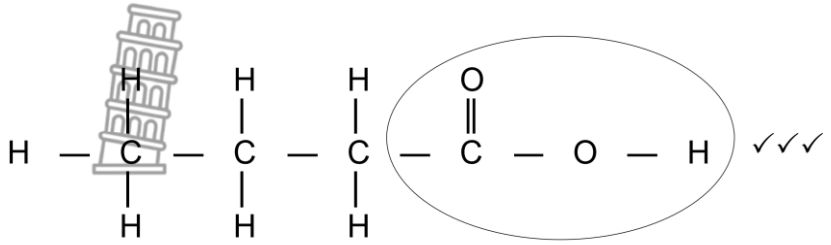
2.4 C_nH_{2n-2}✓ (1)

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2.5.1 Esterification/ester formation✓ (1)

2.5.2 Sulphuric acid/H_2SO_4✓ (1)

2.5.3

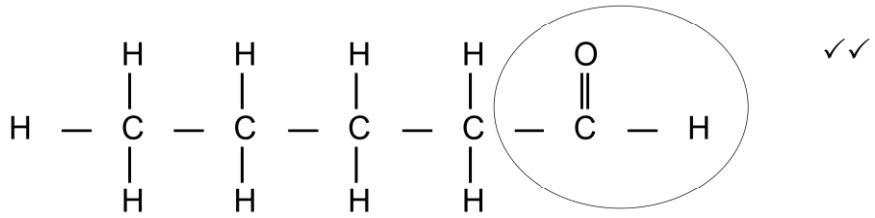


✓✓✓ (3)

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. ✓

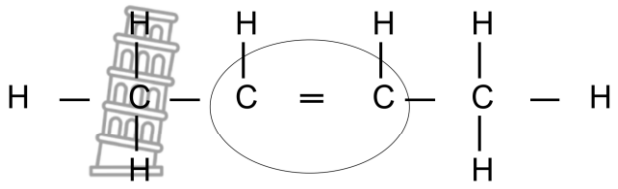
(4)
[15]

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QUESTION 4

4.1.1 Dehydrohalogenation / Dehydrobromination✓ (1)

4.1.2



Marking criteria:
- Functional group correctly drawn✓ ½
- Whole structure correct ✓ 2/2

(2)

4.1.3 $C_4H_9Br + NaOH \rightarrow C_4H_8 + NaBr + H_2O$ (any strong base)
LHS✓ RHS✓ BAL✓

NOTE: If structural formulae used, max 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 **Marking criteria:**

- 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·dm^{-3} ✓

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5.5 **OPTION 1:**

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

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

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

$c = \frac{n}{V}$ ✓

$c = \frac{0,029642}{0,2}$ ✓

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

OPTION 2:

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

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

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

$c = \frac{n}{V}$ ✓

$c = \frac{0,029642}{0,2}$ ✓

= 0,15 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. 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 ($mol \cdot dm^{-3}$)	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 6/7
Round brackets used for Kc expression: Max 6/7

Wrong K_c expression: Max 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 Increase concentration of reactants✓ (by adding more) OR decrease concentration of products (by removing some) (1)
[16]

QUESTION 7

7.1.1 Ionises completely in water ✓to form a high concentration of H_3O^+ ions.✓
ACCEPT: Ionises completely in water ✓✓ (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 $Kw = [H_3O^+][OH] = 1 \times 10^{-14}$✓
$(0,018)[OH^-] = 1 \times 10^{-14}$✓
$[OH^-] = 5.56 \times 10^{-13}$ 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 **Marking criteria:**

- 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

NOTE: If the calculation is done using a table, mark within the table using the criteria above.

pH = - log$[H_3O^+]$

12,56 = - log$[H_3O^+]$ ✓

$[H_3O^+]$ = 2,75 x 10^{-13} mol·dm^{-3}

$[H_3O^+][OH^-]$ = 1 x 10^{-14}

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

$[OH^-]$ = 0,0363 mol·dm^{-3}

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

14 – 12,56 ✓= -log$[OH^-]$✓

$[OH^-]$ = 0,0363 mol·dm^{-3}

$n(OH^-)_{excess}$ = cV

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

= 1,3431 x 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 x 10^{-3} mols

OR

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

n(NaOH) = 2 x 0,0012 = 0,0024 moles

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

m(NaOH) = n(total)M

= (2,4 x 10^{-3} + 1,3431 x 10^{-3}) ✓✓ (40) ✓

= 0,149 (g)✓

OR

m(NaOH) = n(total)M

= (0,0024 + 0,0013) ✓ (40) ✓

= 0,144 (g)✓

(8)

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[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. $E°_{cell} = E°_{OA} - E°_{RA}$ 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 $Ni \rightarrow Ni^{2+} + 2\ e^{-}$ ✓✓ (Ignore phases)

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

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

(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

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