education
MPUMALANGA PROVINCE
REPUBLIC OF SOUTH AFRICA

# NATIONAL SENIOR CERTIFICATE

## GRADE 12

## PHYSICAL SCIENCES: CHEMISTRY P2



## SEPTEMBER 2024

**MARKS: 150**

**TIME: 3 ure**

**This question paper consists of 16 pages and 4 data sheets.**

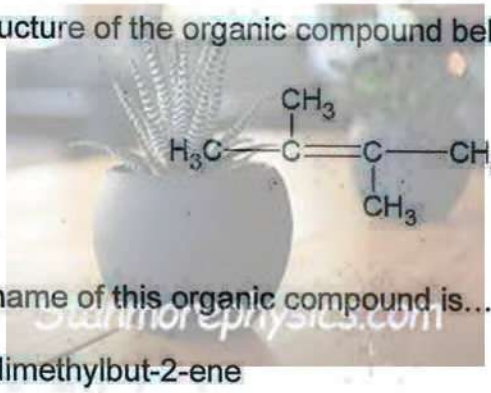
## INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a MINIMUM of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK, for example, 1.11 E.

1.1 Study the structure of the organic compound below.




The IUPAC name of this organic compound is...

A 2,3-dimethylbut-2-ene

B 2,2-dimethylbut-2-ene

C 1,1,2-trimethylprop-1-ene

D 1,1,2,2-trimethylethene (2)

1.2 Which ONE of the following organic reactions will take place when exposed to light.

A $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$

B $CH_3CH_3 \rightarrow CH_2CH_2 + H_2$

C $CH_2CH_2 + C\ell_2 \rightarrow CH_2C\ell CH_2C\ell$

D $CH_3CH_3 + C\ell_2 \rightarrow CH_3CH_2C\ell + HC\ell$ (2)

1.3 Consider the reaction given below.

$$CH_3(CH_2)_3CH_3 \rightarrow CH_3CHCH_2 + \mathbf{X}$$

Which ONE of the following combinations correctly identifies the type of reaction that takes place and the IUPAC name of product **X**?

| | TYPE OF REACTION | Product X |
|---|---|---|
| A | Elimination | Ethane |
| B | Elimination | Ethene |
| C | Addition | Ethane |
| D | Addition | Ethene |

(2)

1.4 Which ONE of the following isomers has the lowest boiling point?

A $CH_3CH_2CH_2CH_2CH_2CH_3$

B $CH_3CH_2C(CH_3)_2CH_3$

C $CH_3CH(CH_3)CH_2CH_2CH_3$

D $CH_3CH_2CH(CH_3)CH_2CH_3$ (2)

1.5 A potential energy diagram can be used to show the activation energy ($E_A$) and the heat of reaction ($\Delta H$) of a reaction.

Which ONE of the following combinations of values of $E_A$ and $\Delta H$ CANNOT be obtained for any reaction?

| | $E_A$ (kJ·mol$^{-1}$) | $\Delta H$ (kJ·mol$^{-1}$) |
|---|---|---|
| A | 50 | -100 |
| B | 50 | +100 |
| C | 100 | +50 |
| D | 100 | -50 |

(2)

1.6 The reaction represented by the balanced equation below reaches equilibrium in a closed container at 400 K and standard pressure.

$$4HC\ell(g) + O_2(g) \rightleftharpoons 2C\ell_2(g) + 2H_2O\ (g) \qquad \Delta H > 0$$

Which ONE of the following is CORRECT when the temperature is changed to 350 K?

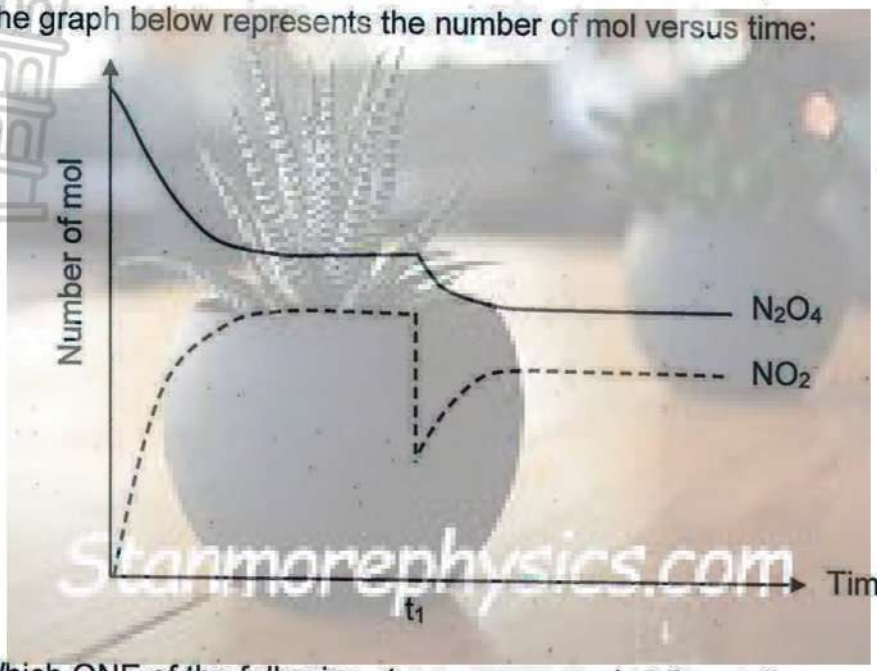
| | YIELD OF $O_2(g)$ | RATE OF FORWARD REACTION | EQUILIBRIUM CONSTANT |
|---|---|---|---|
| A | Decreases | Increases | Remains the same |
| B | Increases | Decreases | Decreases |
| C | Decreases | Increases | Increases |
| D | Increases | Decreases | Remains the same |

(2)

1.7 The following reversible reaction reached equilibrium in a closed container:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H > 0$$

The graph below represents the number of mol versus time:




Which ONE of the following stresses occurred at time $t_1$?

A $NO_2$ was removed from the system

B $N_2O_4$ was removed from the system

C The temperature was decreased

D The pressure was increased (2)

1.8 Ammonium sulphate is dissolved in water at 25 °C. Which ONE of the following options gives the best description of the solution?

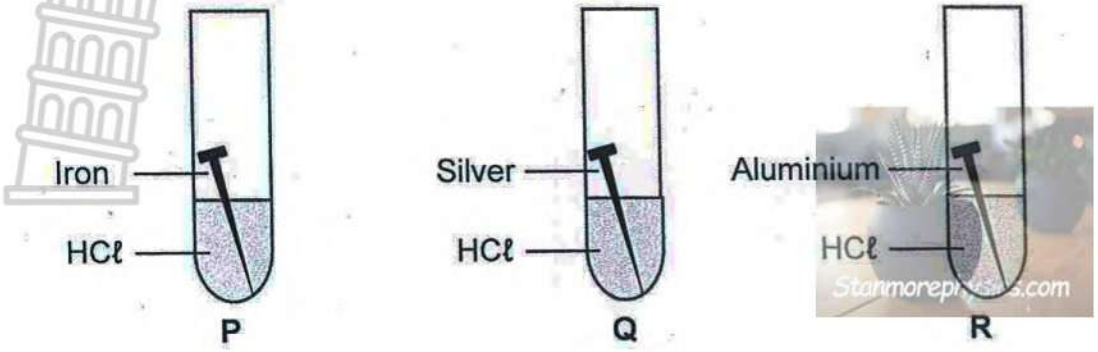
A $[OH^-] = 10^{-7}$ mol·dm$^{-3}$

B $[OH^-] = [H_3O^+]$

C $[OH^-] > [H_3O^+]$

D pH < 7 (2)

1.9 Three nails made of different metals are placed in separate test tubes, **P**, **Q** and **R**. Each of the test tubes contain 1 mol·dm$^{-3}$ hydrochloric acid (HCℓ) at 25 °C




In which tubes will hydrogen gas be produced?

A **P** and **Q** only

B **P** and **R** only

C **Q** and **R** only

D **P**, **Q** and **R** (2)

1.10 Which ONE of the following represents the oxidation half-reaction in the electrolysis of concentrated sodium chloride solution?

A $Na(s) \rightarrow Na^+(aq) + e^-$

B $2Cl^-(aq) \rightarrow 2Cl_2(g) + 2e^-$

C $2H_2O \rightarrow O_2(g) + 4H^+ + 4e^-$

D $2H_2O + 2e^- \rightarrow H_2(g) + 2OH^-$ (2)

**[20]**

**QUESTION 2 (Start on a new page.)**

2.1 Study the organic compound below:

$$CH_3COOCH_3$$

For this compound, write down the:

2.1.1 IUPAC name (2)

2.1.2 Structural formula for the functional group (1)

2.1.3 IUPAC name of the alcohol used in the preparation of this compound. (1)

2.1.4 Define the term *functional isomer* (2)

2.1.5 Structural formula of this compound's functional isomer (2)

2.2 The IUPAC name of an organic compound is:

**2,4-dimethylhexan-3-one**

For this compound, write down the:

2.2.1 Homologous series to which it belongs (1)

2.2.2 Structural formula (3)

2.2.3 Structural formula of its positional isomer (2)

2.3 Study the following chemical reaction:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(g)$$

2.3.1 Name the type of reaction represented above. (1)

2.3.2 Write down the IUPAC name of the gas that reacted with oxygen in the reaction above. (1)

2.3.3 60,2 g of the gas named in QUESTION 2.3.2 reacts completely with an excess of oxygen gas. All the carbon dioxide that is formed during the reaction is bubbled through a solution of calcium hydroxide to form calcium carbonate as a product. As shown in the reaction below.

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O$$

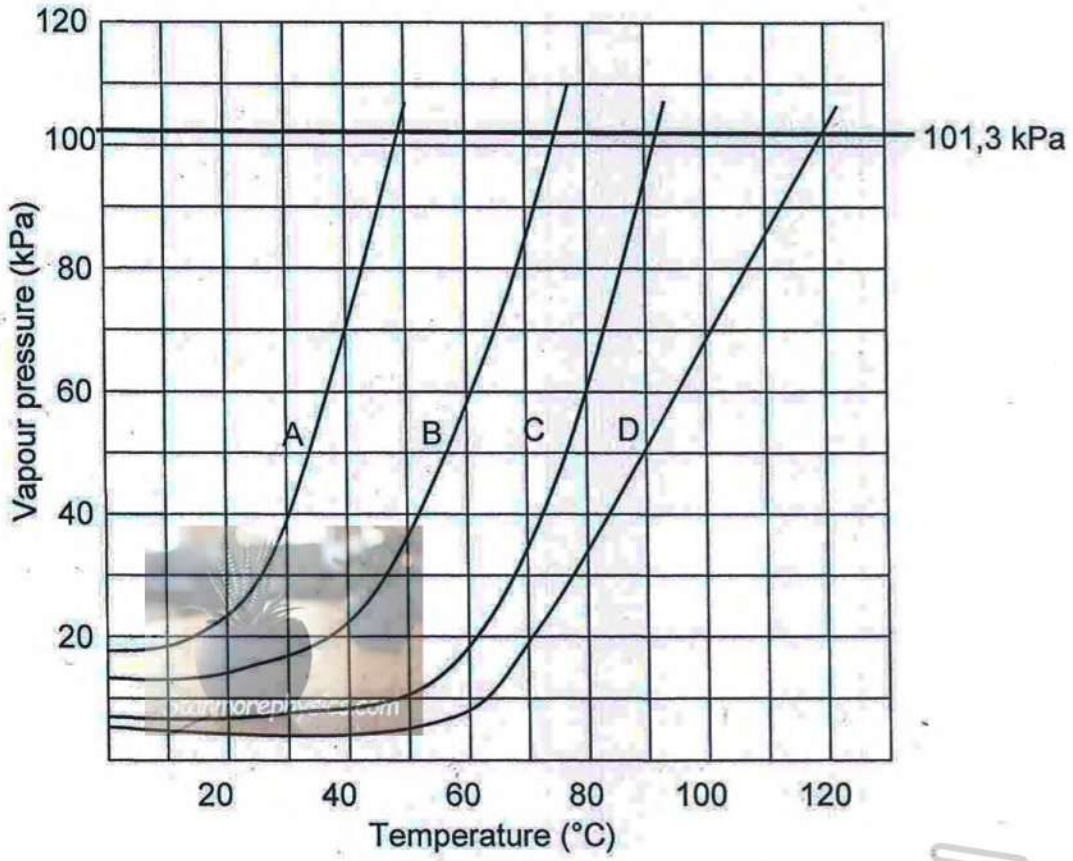
Calculate the mass of calcium carbonate that will form. (5)

**[21]**

**QUESTION 3 (Start on a new page.)**

The graph below shows how the vapour pressure of different organic molecules change as the temperature changes. The line at 101,3 kPa, on the graph, indicates the external atmospheric pressure.

The vapour pressure of four different organic substances, which are similar in molecular mass, versus temperature are indicated. The four curves (**A**, **B**, **C** and **D**) represent organic compounds belonging to the following homologous series. A STRAIGHT CHAIN ALKANE, a BRANCHED ALKANE, a PRIMARY ALCOHOL and an ALDEHYDE.




3.1 Define the term *vapour pressure.* (2)

3.2 The vapour pressure of compounds **A** and **B** are compared.

3.2.1 Write down the independent variable for this investigation. (1)

3.2.2 Explain the difference in the vapour pressure of these two compounds. (4)

3.3 Write down the boiling point of compound **D** (1)

3.4 Which ONE of the compounds **C** or **D** is the alcohol?

Give a reason for the answer (2)

3.5 The vapour pressure of compounds **C** and **D** are now compared.

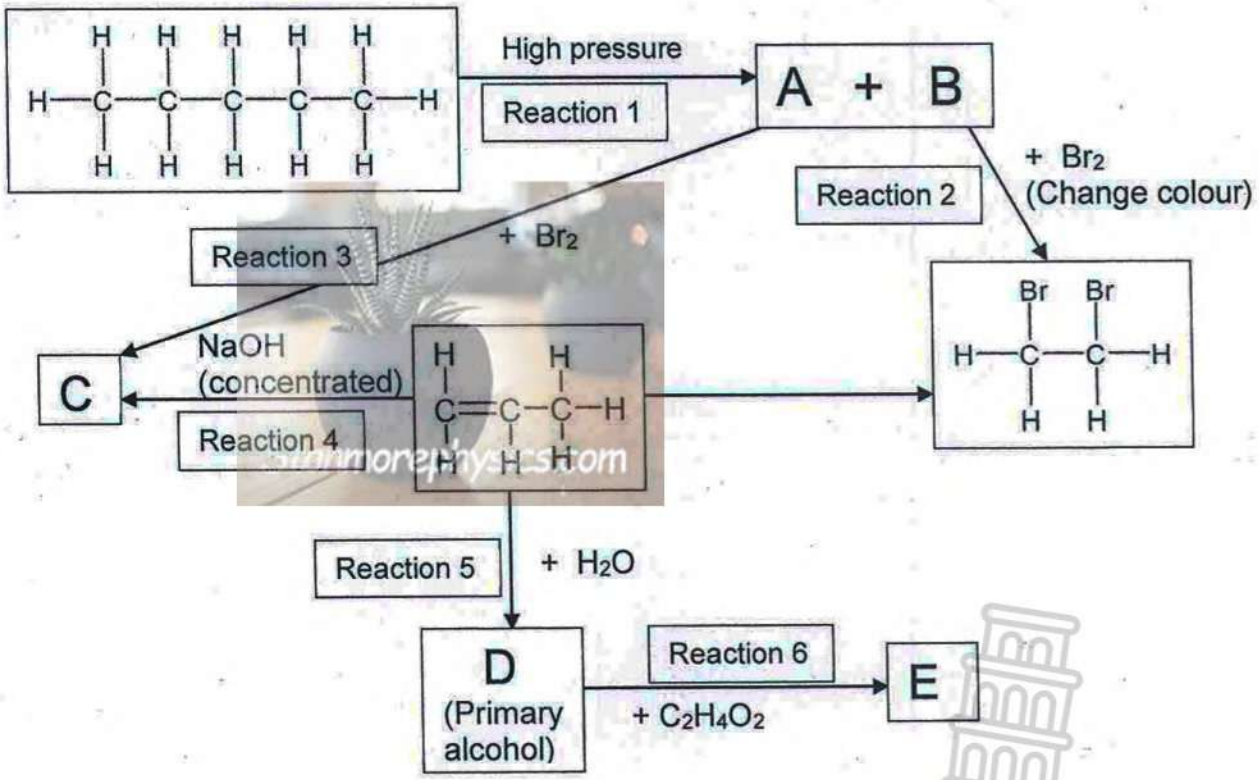
3.5.1 Which variable must be kept constant in this experiment? (1)

3.5.2 Refer to the TYPES of intermolecular forces to explain the difference in vapour pressure between compound **C** and **D**. (3)

**[14]**

**QUESTION 4 (Start on a new page.)**

Study the flow diagram of organic reactions below and answer the questions that follow. The letters **A**, **B**, **C**, **D** and **E** represent organic compounds.




4.1 For reaction **1** write down:

4.1.1 The type of reaction that takes place (1)

4.1.2 The structural formula for compound **B** (2)

4.2 For reaction **2**:

4.2.1 Write down the type of reaction that takes place. (1)

4.2.2 Explain the colour change as indicated in this reaction. (2)

4.3 For reaction **3** write down:

4.3.1 The type of reaction that takes place (1)

4.3.2 The NAME or FORMULA of the inorganic product for reaction **3** (1)

4.4 Write down a balanced chemical equation using CONDENSED STRUCTURAL FORMULAE for reaction **4**. (2)

4.5 Define the term *primary alcohol* (2)

4.6 Write down a balanced chemical equation using STRUCTURAL FORMULAE for reaction **6**. (3)
**[15]**

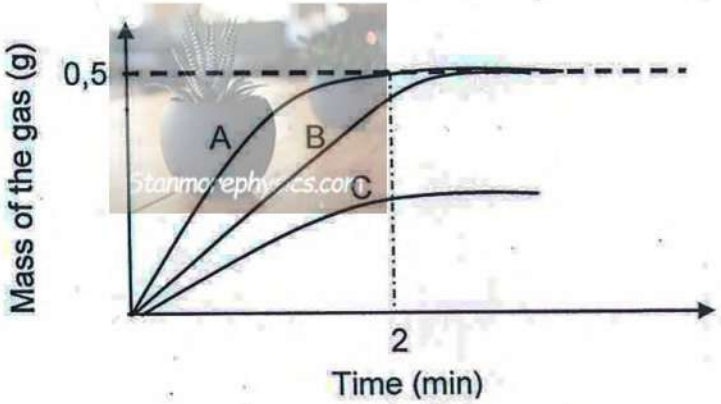
**QUESTION 5 (Start on a new page.)**

Learners use the reaction of a sodium thiosulphate solution with dilute hydrochloric acid to investigate several factors that affect the rate of a chemical reaction. The balanced equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow 2NaC\ell(aq) + SO_2(g) + S(s) + H_2O(\ell)$$

Three investigations (**A**, **B** and **C**) are carried out.

The graph below shows the results of three investigations in which the same concentration of diluted hydrochloric acid (HCℓ) reacts with 1,3 g impure sodium thiosulphate ($Na_2S_2O_3$). Details of the experiment are given in the table below.




| | Investigation 1 | Investigation 2 | Investigation 3 |
|---|---|---|---|
| Volume of (HCℓ) ($cm^3$) | 60 | 15 | 60 |
| Temperature (°C) | 40 | 20 | 40 |
| Catalyst added | No | No | Yes |

5.1 Match each curve **(A,B,C)** to its corresponding investigation **(1,2,3)** in the table. (3)

5.2 Use the information given on the graph and table to determine the rate of reaction of investigation **A** in ($mol \cdot s^{-1}$) (4)

5.3 Write down the factor that remains constant in all three investigations. (1)

5.4 A catalyst is used in investigation 3. State the effect that a catalyst has on each of the following. Write only INCREASE, DECREASE or REMAIN THE SAME.

5.4.1 Concentration of the products. (1)

5.4.2 Heat of the reaction. (1)

5.5 Use the collision theory to explain the difference in rate of reaction between investigation **A** and **B**. (4)

5.6 Sketch the Maxwell-Boltzman distribution curve for **Investigation 1**. Label this curve as **1**. On the same set of axis, draw the curve that will be obtained for **Investigation 3**. (4)
**[18]**

**QUESTION 6 (Start on a new page.)**

Carbon monoxide gas, CO(g), and oxygen gas, $O_2(g)$, are sealed in a 2 $dm^3$ container and allowed to react to form carbon dioxide, $CO_2(g)$. The reversible reaction reaches equilibrium at 600 K according to the following balanced equation:

$$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$$

6.1 Explain what is meant by the term *reversible* reaction. (1)

6.2 How will each of the following changes affect the yield of $CO_2(g)$?

Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.2.1 A catalyst is added to the reaction mixture. (1)

6.2.2 The pressure is lowered by increasing the volume of the container at constant temperature. (1)

6.2.3 Explain the answer in QUESTION 6.2.2 using Le Chateliers' principle. (2)

6.3 Initially, 0,35 mol of CO(g) and an unknown amount of $O_2(g)$ were placed in the container. At equilibrium, the number of particles CO(g) present is $9,03 \times 10^{22}$ . The equilibrium constant $K_c$ for the reaction is 51 at 600 K

Calculate the initial mass of $O_2(g)$, in grams, sealed in the container. (9)

6.4 The equilibrium constant ($K_c$) at 400 K for the reaction above is 45. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer fully. (3)
**[17]**

**QUESTION 7 (Start on a new page.)**

7.1 The hydrogens carbonate ion ($HCO_3^-$) can act as an ampholyte.

7.1.1 Explain what is meant by the underlined term. (2)

7.1.2 Consider the following reaction:

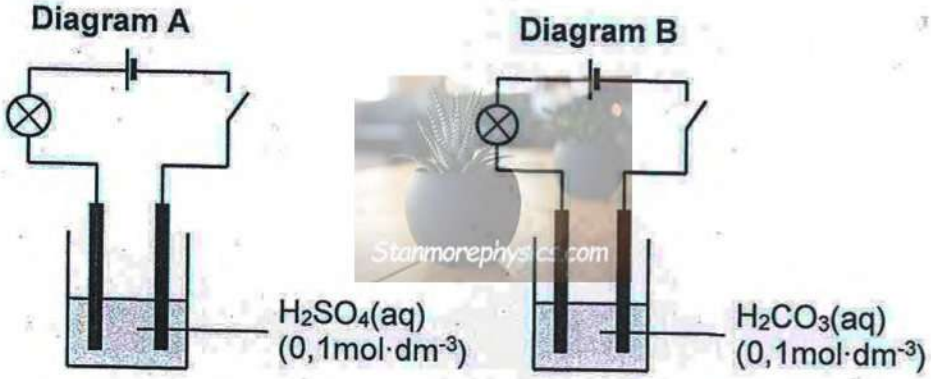
$$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$$

Is the $HCO_3^-$ ion in this reaction acting as a Brønsted-Lowry acid or a base? Give a reason for the answer. (2)

7.1.3 Write down the FORMULA of the substance which forms a conjugate acid base pair with the $HCO_3^-$ ion. (1)

7.2 Two identical electrolytic cells are set up as follows to determine the conductivity of sulphuric acid ($H_2SO_4$) and carbonic acid ($H_2CO_3$)

The concentration of both solutions is 0,1 mol·dm$^{-3}$




Which diagram's bulb will burn the brightest? Give a reason for the answer by referring to the acids. (2)

7.3 The concentration of the sulphuric acid ($H_2SO_4$) in a solution is $0,25 \times 10^{-3}$ mol·dm$^{-3}$. Calculate the pH of the solution. (3)

7.4 $Na_2CO_3$ is a salt that forms when NaOH reacts with $H_2CO_3$. This salt reacts with water.

7.4.1 Write down one word for the underlined part. (1)

7.4.2 Is the aqeous solution of sodium carbonate ($Na_2CO_3$), ACIDIC, BASIC, or NEUTRAL? (1)

7.5 A standard solution was prepared by adding an unknown amount of $Ba(OH)_2$ to 250 $cm^3$ water. $Ba(OH)_2$ now reacts with $HC\ell(aq)$ according to the following balanced equation.

$$Ba(OH)_2(aq) + 2HC\ell(aq) \rightarrow BaC\ell_2(aq) + 2H_2O(\ell)$$

25 $cm^3$ of the standard solution of $Ba(OH)_2$ reacts with 100 $cm^3$ of the diluted $HC\ell$ which has a concentration of 0,15 $mol \cdot dm^{-3}$.

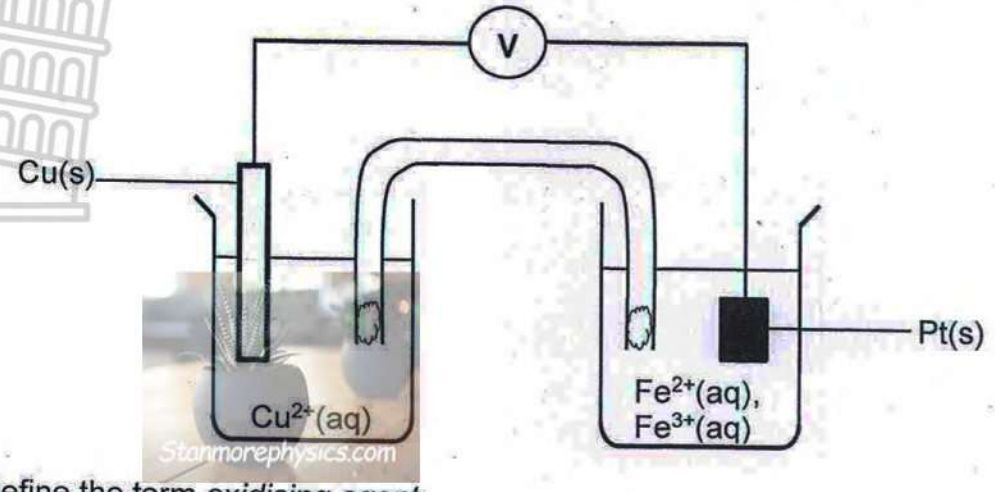
The EXCESS $Ba(OH)_2$ is neutralised by adding 50 $cm^3$ of a 0,05 $mol \cdot dm^{-3}$ $H_2SO_4$. The reaction is as follows:

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(aq) + 2H_2O(\ell)$$

Calculate the initial mass of $Ba(OH)_2$ used to prepare the standard solution. (8)
**[20]**

**QUESTION 8 (Start on a new page.)**

The electrochemical cell illustrated below was set up under standard conditions.




8.1 Define the term *oxidising agent*. (2)

8.2 Identify the oxidising agent in the cell above. (1)

8.3 Write down the:

8.3.1 Cell notation of this cell. (3)

8.3.2 Oxidation half-reaction that takes place. (2)

8.4 Iron(II)chloride solution, $FeC\ell_2$ is added to the $Fe^{3+}/Fe^{2+}$-half cell.

8.4.1 How will the reading on the voltmeter on the voltmeter be affected? (Choose from INCREASES, DECREASES or REMAINS THE SAME). (1)

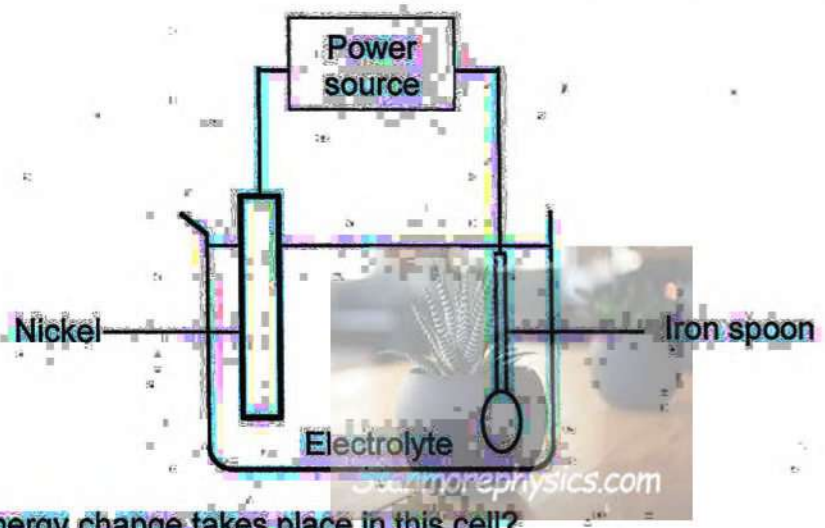
8.4.2 Use Le Chatelier's principle to explain the answer to QUESTION 8.4.1. (2)

8.5 The $Fe^{3+}|Fe^{2+}$ half-cell is now replaced by a $Sn^{4+}|Sn^{2+}$-half-cell. It is found that the direction of the electron flow changes.

Fully explain why there is a change in direction of electron flow by referring to the relative strengths of the reducing agents involved. (3)
**[14]**

**QUESTION 9 (Start on a new page.)**

The diagram below shown a simplified cell used to electroplate an iron spoon with nickel.




9.1 What energy change takes place in this cell? (1)

9.2 Write down the:

9.2.1 NAME or FORMULA of a substance that can be used as an electrolyte in this cell. (1)

9.2.2 NAME or FORMULA of the substance which is oxidised. (1)

9.2.3 Half-reaction that takes place at the cathode. (2)

9.3 How will the concentration of the electrolyte change during electroplating? Choose from INCREASE, DECREASE or STAY THE SAME.

Give a reason for the answer. (2)

9.4 Calculate the number of electrons transferred if 2,5 g of nickel is plated on the spoon. (4)
**[11]**

**TOTAL [150]**

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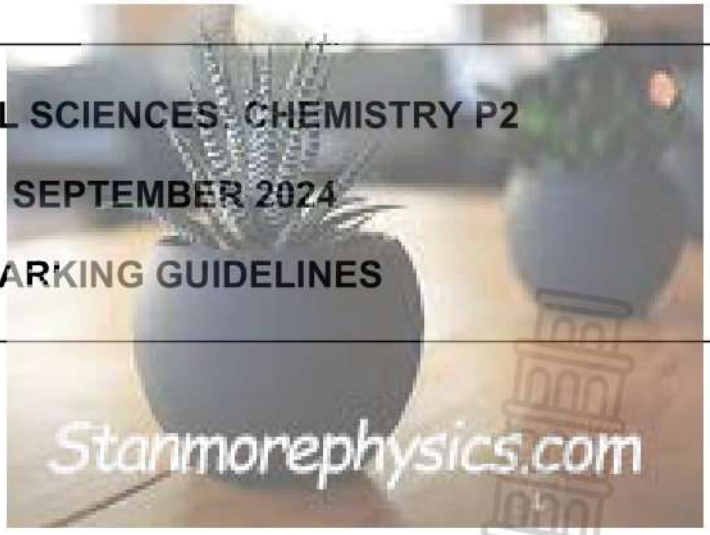
# NATIONAL SENIOR CERTIFICATE

## GRADE 12

## PHYSICAL SCIENCES: CHEMISTRY P2

## SEPTEMBER 2024

## MARKING GUIDELINES




**MARKS/PUNTE: 150**

**This memorandum consists of 13 pages.**
**Hierdie memorandum bestaan uit 13 bladsye.**

## QUESTION 1 / VRAAG 1

1.1 A ✓✓

1.2 D ✓✓

1.3 A ✓✓

1.4 B ✓✓

1.5 B ✓✓

1.6 B ✓✓

1.7 A ✓✓

1.8 D ✓✓

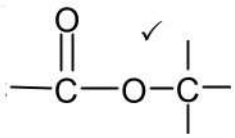
1.9 B ✓✓

1.10 B ✓✓ **[20]**

## QUESTION 2 / VRAAG 2

2.1.1 methyl ✓ethanoate ✓ / metielethanoeaat (2)

2.1.2

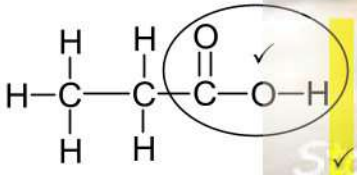


(1)

2.1.3 methanol/*metanol* ✓ (1)

2.1.4 Organic compound with the same molecular formula, but different functional groups on the parent chain✓✓/ *Organiese verbinding met dieselfde molekulêre formule, maar verskillende funksionele groepe op die stamketting*. **(2/0)** (2)

2.1.5



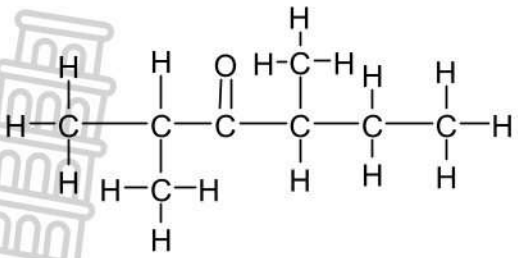
**Marking Criteria /*Nasienkriteria:***

- Functional group/ *Funksionele groep* ✓
- Whole structure correct /*Hele struktuur korrek* ✓

(2)

2.2.1 Ketone / ketoon ✓ (1)

2.2.2

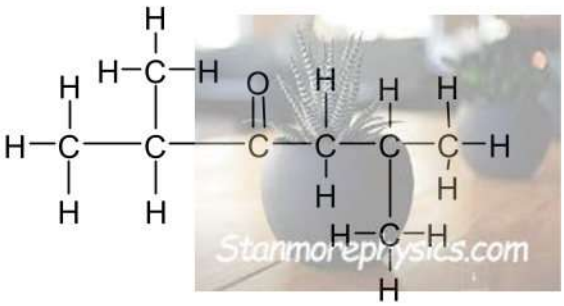


**Marking criteria:**
- Correct functional group. ✓
- All side chains (methyl) on 2 and 4 ✓
- Whole structure correct. ✓

***Nasienkriteria:***
- *Korrekte funksionele groep.* ✓
- *Alle substituente (metiel) op 2 en 4* ✓
- *Res van die ketting korrek.* ✓

(3)

2.2.3




**Marking criteria:**
- Correct functional group on carbon **2** OR **3**. ✓
- All side chains (methyl) on **2** and **5** OR **2** and **2** OR **3** and **5** OR **5** and **5.**✓

  **Note**: *The position of the functional group or side chain(s) or both can be changed.*

***Nasienkriteria:***
- *Korrekte funksionele groep op koolstof **2** OF **3**.* ✓
- *Alle substituente (metiel) op **2** en **5** OF* **2** en **2** OF **3** en **5** OF **5** en **5** ✓.

  **Nota:** *Die posisie van die funksionele groep of substituente of beide kan verander word.*

(2)

2.3.1 Combustion/oxidation Verbranding/ ✓ (1)

2.3.2 Butane / *butaan* ✓ (1)

2.3.3 **Marking criteria:**

(a) Substitution of 58 in the formula n = $\frac{m}{M}$ ✓
(b) Use of mol ratio 2:8 ($2C_4H_{10}$ : $8CO_2$)✓
(c) Use of mol ratio 1:1 ($CO_2$ : $CaCO_3$) ✓
(d) Substitution of 100 in the formula n = $\frac{m}{M}$ ✓
(e) Final answer (415,17 g) ✓

***Nasienkriteria:***

(a) Vervang 58 in die formule n = $\frac{m}{M}$ ✓
(b) Gebruik van verhouding 2:8 ($2C_4H_{10}$ : $8CO_2$)✓
(c) Gebruik van verhouding 1:1 ($CO_2$ : $CaCO_3$) ✓
(d) Vervang 100 in die formule n = $\frac{m}{M}$ ✓
(e) Finale antwoord (415,17 g) ✓

$n = \frac{m}{M}$
$= \frac{60,2}{58}$ ✓ (a)
$= 1,0379$ mol

$nCO_2 = \frac{8}{2} nC_4H_{10}$
$= \frac{(1,0379)(8)}{2}$ ✓(b)
$= 4,1517$ mol

$n(CaCO_3) = nCO_2$
$= 4,1517$ mol ✓ (c)

$n = \frac{m}{M}$
$4,1517 = \frac{m}{100}$ ✓ (d) m=415,17 g ✓(e)

(5)
**[21]**

## QUESTION 3 / VRAAG 3

3.1

**Marking criteria/*Nasienriglyne***
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark/*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The pressure exerted by a vapour at equilibrium with its liquid in a closed system ✓✓
*Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslote sisteem.* (2)

3.2.1 Type of organic compound/surface area/chain length
*Tipe organiese verbinding/oppervlakarea/ketting lengte* ✓ (1)

3.2.2

**Marking criteria:**
- Compare the structures of the compounds A and B
- Compare the strength of intermolecular forces
- Compare the energy required to overcome intermolecular forces
- Conclusion

***Nasienkriteria:***
- *Vergelyk die struktuur van die verbindings A en B*
- Vergelyk die sterkte van intermolekulêre kragte
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom*
- *Gevolgtrekking*

- **A** is the branched/more spherical alkane **and B** is the straight chain alkane / *A is die vertakte/meer sferiese alkaan **en B** is die reguitketting alkaan*✓
- **A** will have weaker London/intermolecular forces than **B** / ***A** het swakker London kragte as **B***✓
- Less energy is needed to overcome the London forces of **A**/ *Minder energie word benodig om die Londonkragte/intermolekulêre kragte van **B** te oorkom* ✓
- **A** will have the lower boiling point or higher vapour pressure. / ***A** het laer kookpunt of die hoogste dampdruk.*✓

**OR**

- **B** is the straight chain alkane and **A** is the branched/more spherical alkane / ***B** is die reguitketting alkaan*✓en ***A** is die vertakte/meer sferiese alkaan*
- **B** will have stronger London/intermolecular forces than **A** / **B** *het sterker London kragte as **A***✓
- More energy is needed to overcome the London forces of **B**/ *Meer energie word benodig om die Londonkragte/intermolekulêre van **B** te oorkom* ✓
- B will have the higher boiling point or lower vapour pressure. / **B** *het die hoër kookpunt of 'n laer dampdruk.*✓ (4)

3.3 118-120 (°C) ✓ (1)

3.4 D ✓
D has the lowest vapour pressure/highest boiling point/the strongest intermolecular forces/ *D het die laagste dampdruk/die hoogste kookpunt.*✓ (2)

3.5.1 Molecular mass / Molekulêre massa ✓ ACCEPT: Number of C atoms (1)

3.5.2

**Marking criteria:**
- Identify the type of intermolecular forces for C and D
- Compare the strength of intermolecular forces
- Compare the energy required to overcome intermolecular forces

***Nasienkriteria:***
- *Identifiseer die tiepe intermolekulêre kragte vir C en D*
- Vergelyk die sterkte van intermolekulêre kragte
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom*

- C have dipole-dipole forces / *C het dipool-dipool kragte* ✓
**and** D has hydrogen bonds / ***en** D het waterstofbindings.* ✓
- Hydrogen bonds are stronger than Dipole-dipole forces/the intermolecular forces in D are stronger/C has weaker intermolecular forces / *Waterstofbindings is sterker as dipool-dipool kragte/die intermolekulêre kragte van D is sterker*. ✓

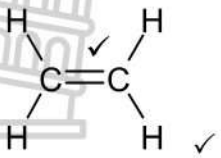
OR

- More energy is needed to overcome the intermolecular forces of D/less energy is needed to overcome the forces in C / *Meer energie word benodig om die intermolekulêre kragte van D te oorkom.* (3)

**[14]**

**QUESTION 4/ *VRAAG 4***

4.1.1 Cracking/Elimination / *Kraking/Eliminasie* ✓ (1)

4.1.2  ✓

**Marking Criteria/ *Nasienkriteria***
- Functional group/ *Funksionele groep* ✓
- Whole structure correct/ *Hele struktuur korrek* ✓

(2)

4.2.1 Addition/ halogenation / *Addisie / Halogenering*✓ (1)

4.2.2 B/ ethene is unsaturated/has multiple bonds✓, The colour change will be from orange brown to colourless/ $Br_2$ decolourises✓
*B/ eteen is onversadig, die kleur verander van rooi-bruin na kleurloos/ $Br_2$ word kleurloos* (2)

4.3.1 Substitution/halogenation/bromination / *Substitusie/ halogenering/brominasie* ✓ (1)

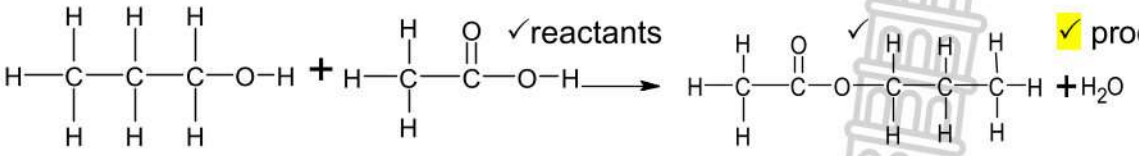
4.3.2 HBr/ hydrogen bromide/ waterstofbromied ✓ (1)

4.4 $CH_3CHBrCH_3 + NaOH \rightarrow CH_2CHCH_3$ ✓ + $NaBr + H_2O$ **REMOVE: Refer to Table 1**

**NOTE/LET WEL**
- Penalise only once for the use of structural formulae or molecular formulae
- *Penaliseer slegs een keer vir die gebruik van struktuurformules of molekulêre formule*

(2)

4.5 Primary alcohol is when the –OH group is attached/bonded to a carbon that is attached/bonded to one other carbon.
*'n Primêre alkohol is waar die –OH groep gebind is aan 'n koolstof wat slegs met een ander koolstof gebind is.*✓✓ (2)

4.6 


(3)
**[15]**

**QUESTION 5/ *VRAAG 5***

5.1 A – 3 ✓
B – 1 ✓
C – 2 ✓ (3)

5.2

**Marking criteria:**
(a) Substitute 64 in formula n = $\frac{m}{M}$
(b) Substitution of 0,0078
(c) Substitution of (2x60)
(d) Final answer 6,5104 x $10^{-5}$ / 0,000065

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

$= \frac{0,5}{64✓(a)}$

= 0,0078 mol

tempo = $\frac{\Delta n}{\Delta t}$

$= \frac{0,0078✓(b)-0}{(2)(60)✓(c)}$

= 6,5104 x $10^{-5}$ (mol·$s^{-1}$) / 0,000065 (mol·$s^{-1}$)(d)✓ (4)

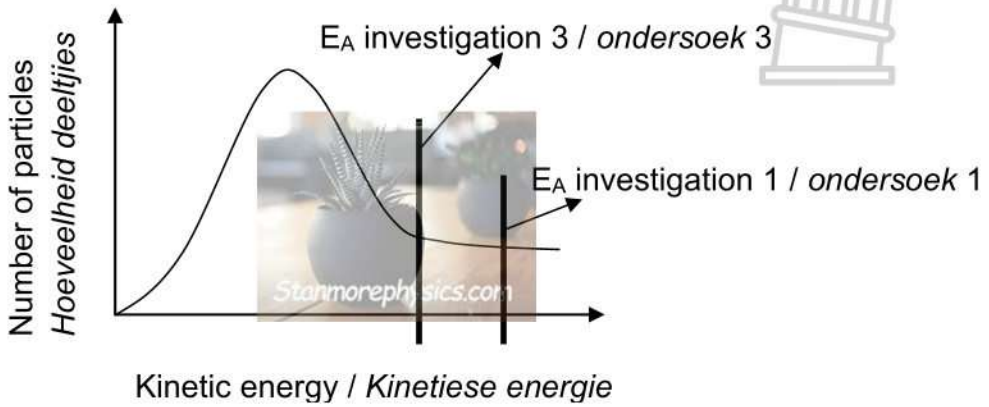
5.3 Concentration of HCℓ / *Konsentrasie van HCℓ* ✓ (1)

5.4.1 Remain the same / *Bly dieselfde* ✓ (1)

5.4.2 Remain the same / *Bly dieselfde* ✓ (1)

5.5
- A catalyst was added to Investigation 3 / *'n Katalisator is by ondersoek 3 gevoeg.*✓
- A catalyst lowers the activation energy/provides an alternative route with a lower activation energy / *'n Katalisator verlaag die aktiverings enegie* ✓
- More particles have enough $E_k$ to overcome the $E_A$ / *Meer deeltjies het genoeg $E_k$ om die $E_A$ te oorkom.* ✓
- More effective collisions per second/ per unit time take place/frequency of effective collisions increases/ *Meer effektiewe botsings per sekonde sal plaasvind.* ✓ (4)

5.6



**Marking criteria:**
- Labelling of x and y axes ✓
- Shape of the graph ✓
- $E_A$ for investigation 1 and 3 correctly indicated ✓✓

***Nasienkriteria:***
- *Benoem x – en y – asse korrek*
- *Vorm van grafiek korrek*
- *$E_A$ vir ondersoek 1 en 3 reg benoem*

(4)
**[18]**

## QUESTION 6 / *VRAAG 6*

6.1 A reaction is reversible when products can be converted back to reactants (and vice versa). ✓
*'n Reaksie is omkeerbaar wanneer produkte terug na reaktanse, en omgekeerd, omgeskakel kan word.* (1)

6.2.1 Remains the same / *Bly dieselfde* ✓ (1)

6.2.2 Decreases / *Afneem* ✓ (1)

6.2.3
- A decrease in the pressure favours the reaction that produces the higher number of moles/number of molecules/volume of gas ✓
  *'n Afname in druk bevoordeel die reaksie wat die groter aantal mol/aantal molekules/ volume gas lewer.*
- The reverse reaction was favoured ✓
  *Die terugwaartse reaksie is bevoordeel.* (2)

6.3 **Marking criteria / Nasienkriteria:**
a. Subsitute $9,03 \times 10^{22}$ in formula $n = \frac{N}{N_A}$ ✓
   *Vervang* $9,03 \times 10^{22}$ *in formule* $n = \frac{N}{N_A}$
b. Use mol ratio / *Gebruik mol verhouding* : CO: $O_2$ : $CO_2$ = 2:1:2 ✓
c. $n(CO_2)_{change} = n(CO_2)_{equilibrium}$/ $n(CO_2)_{verandering} = n(CO_2)_{ewewig}$ ✓
d. Divide and multiply by the volume (2)/ *Deel en vermenigvuldig deur die volume (2)* ✓
e. Correct $K_c$ expression / *Korrekte $K_c$ uitdrukking* ✓
f. Substitution of equilibrium concentrations into $K_c$ expressions/ *Vervanging van ewewigskonsentrasies in $K_c$-uitdrukking*✓
g. Substitution of $K_c$ value/*Vervanging van ewewigskonsentrasie in $K_c$-uitdrukking* ✓
h. $nO_{2(initial)}$ / $nO_{2(aanvanklik)} = nO_{2(equilibrium/ewewig)} + nO_{2\ (reacted/\ reageer)}$ ✓
i. Final answer / Finale antwoord (5,4 g) *Range (5,40 – 5,47)*✓

$$n = \frac{N}{N_A}$$
$$= \frac{9{,}03 \times 10^{22}\checkmark(a)}{6{,}02 \times 10^{23}}$$
$$= 0{,}15 \text{ mol}$$

| | CO(g) | $O_2$(g) | $CO_2$(g) |
|---|---|---|---|
| Initial mol<br>Aanvanklike mol | 0,35 | m = 0,169 × 32<br>= 5,4 g ✓(i) | 0 |
| Change in mol<br>Verandering in mol | -0,2 | -0,1 | +0,2 |
| Equilibrium mol<br>Ewewigs mol | 0,15 | 0,069<br>✓(h) | 0,2<br>✓(c) |
| Equilibrium concentration<br>Ewewigskonstante | 0,075 | 0,0348 | 0,1 |

Ratio ✓(b)

Divide and multiply by/*deel en vermenigvuldig deur 2*✓(d)

$$K_c = \frac{[CO_2]^2}{[CO]^2[O_2]}\checkmark(e)$$
$$51\checkmark(g) = \frac{(0{,}1)^2}{(0{,}075)^2[O_2]}\checkmark(f)$$
$$[O_2] = 0{,}0348 \text{ mol·d}m^{-3}$$

(9)

6.4 Endothermic/ *Endotermies*✓

- The $K_c$ value decreases, thus the reverse reaction is favoured. ✓
- If temperature decrease the exothermic reaction will be favoured✓

- *Die $K_c$ waarde verlaag met 'n verlaging in temperatuur, dus word die terugwaartse reaksie bevoordeel.*
- *As die temperatuur verlaag word die eksotermiese reaksie bevoordeel* (3)

**[17]**

## QUESTION 7 / VRAAG 7

7.1.1 *A substance that can act as either acid or base* ✓✓
*'n Stof wat as óf 'n suur óf 'n basis kan reageer* (2)

7.1.2 Acid/*Suur*✓
It donates a proton/$H^+$/*Was 'n protonskenker* ✓ (2)

7.1.3 $CO_3^{2-}$ ✓ (1)

7.2 A ✓
$H_2SO_4$ ionises completely in water to form a high concentration ($H_3O^+$) ions. OR
$H_2CO_3$ ionises incompletely in water to form a low concentration ($H_3O^+$) ions ✓
*$H_2SO_4$ ioniseer volledig in water en vorm 'n hoë konsentrasie ($H_3O^+$) ione.OF*
*$H_2CO_3$ ioniseer onvolledig in water en vorm 'n lae konsentrasie ($H_3O^+$) ione* (2)

7.3
$$[H_3O^+] = 2[H_2SO_4]$$
$$= 2(0{,}25 \times 10^{-3})$$
$$= 0{,}5 \times 10^{-3}\ mol \cdot dm^{-3}$$

$pH = -\log[H_3O^+]$ ✓
$= -\log(0{,}5 \times 10^{-3})$ ✓
$= 3{,}301$ ✓ (3)

7.4.1 Hydrolysis / *Hidrolise* ✓ (1)

7.4.2 Basic or alkaline/*Basis of alkalies* ✓ (1)

7.5

**Marking criteria / Nasienkriteria:**

a. Substitution of $(0{,}15 \times 0{,}1)$ in formula (n = c x v) to calculate n(HCℓ) ✓
*Vervanging van $(0{,}15 \times 0{,}1)$ in formula (n = c x v) om n(HCℓ) te bereken*
b. Use mole ratio/*Gebruik molverhouding:* $n(Ba(OH)_2)_{reacted}$:n HCℓ = 1:2 ✓
c. Substitution of $(0{,}05 \times 0{,}05)$ in formula $(n = c \times v)$ to calculate $n(H_2SO_4)$ ✓
*Vervanging van $(0{,}05 \times 0{,}05)$ in formula $(n = c \times v)$ om $n(H_2SO_4)$ te bereken.*
d. Use mol ratio/ *Gebruik molverhouding* $n(BaOH)_{2(excess)}$:$H_2SO_4$ = 1:1✓
e. $n(Ba(OH)_2)_{initial/aanvanklik} = n(Ba(OH)_2)_{reacted/gereageer} + n(Ba(OH)_2)_{excess/oormaat}$ ✓
f. Substitute 0,025 $dm^3$ to calculate $c(Ba(OH)_2)_{initial}$ ✓
*Vervang 0,025 $dm^3$ om $c(Ba(OH)_2)_{aanvanklik}$ te bereken*
g. Substitute $c(Ba(OH)_2)_{initial}$ and 171g·mol$^{-1}$ in $c = \frac{m}{MV}$ ✓
*Vervang $c(Ba(OH)_2)_{aanvanklik}$ en* 171g·mol$^{-1}$ in $c = \frac{m}{MV}$
h. Final answer / *Finale antwoord* (17,1 g)✓

$n(HCl) = cV$
$= (0,15)(0,1)$✓(a)
$= 0,015$ mol

$n\left(Ba(OH)_{2(reacted)}\right) = ½n(HCl)$
$= ½(0,015)$
$= 0,0075$mol ✓(b)

$n(H_2SO_4) = cV$
$= (0,05)(0,05)$✓(c)
$= 0,0025$ mol

$n\left(Ba(OH)_{2(excess)}\right) = n(H_2SO_4)$
$= 0,0025$mol ✓(d)

$nBa(OH)_{2(initial/aanvanklik)} = 0,0075 + 0,0025$✓ (e)
$= 0,01$ mol

| **OPTION 1/*OPSIE 1*** | **OPTION 2/*OPSIE 2*** |
|---|---|
| $c = \frac{n}{V}$<br>$= \frac{0,01}{0,025}$✓(f)<br>$= 0,4\ mol \cdot dm^{-3}$<br><br>$c = \frac{m}{MV}$<br>$0,4 = \frac{m}{(0,25)(171)}$✓(g)<br>$m = 17,1$ g✓(h) | mol in 250 $cm^3 = \frac{0,01 \times 250}{25}$<br>$= 0,1$ mol (f)✓<br><br>$n = \frac{m}{M}$<br>$0,1 = \frac{m}{171}$✓(g)<br>$= 17,1$ g ✓(h) |

(8)
**[20]**

## QUESTION 8 / VRAAG 8

8.1.1 A substance that is reduced/gains electrons/oxidation number decreases. ✓✓
'n Stof wat gereduseer word/elektrone opneem (2)

8.2 $Fe^{3+}$ /iron (III) ions/*yster(III)ione*✓ (1)

8.3.1 $Cu(s)/Cu^{2+}(aq)$ ✓ // $Fe^{3+}(aq),Fe^{2+}(aq)/Pt(s)$ ✓ ✓

**NOTE/LET WEL**
- If a phase separater (/) is used between $Fe^{3+}$ and $Fe^{2+}$ ($^2/_3$)
- *Indien 'n fasegrens (/) gebruik is tussen $Fe^{3+}$ en $Fe^{2+}$* ($^2/_3$)
- Ignore phases/ *ignoreer fases* (3)

8.3.2 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓✓ (Ignore phases) (2)

**Notes/*Aantekeninge***

| | |
|---|---|
| $Cu \rightleftharpoons Cu^{2+} + 2e^-$ ($^1/_2$) | $Cu^{2+} + 2e \leftarrow Cu$ ($^2/_2$) |
| $Cu^{2+} + 2e^- \rightleftharpoons Cu$ ($^0/_2$) | $Cu \leftarrow Cu^{2+} + 2e^-$ ($^0/_2$) |

8.4.1 Decrease/*Verlaag* ✓ (1)

8.4.2
- $[Fe^{2+}]$ increases/*neem toe* ✓
- Reverse reaction is favoured/*Terugwaartse reaksie word bevoordee l*✓ (2)

8.5 $Sn^{2+}$ is a stronger reducing agent ✓ than Cu✓
*$Sn^{2+}$ is 'n sterker reduseermiddel as Cu en dus sal $Cu^{2+}$/Cu ione gereduseer word/ $Sn^{2+}$ word geoksideer*
**OR**
Cu is a weaker reducing agent than $Sn^{2+}$ and therefore $Cu^{2+}$/Cu ions are reduced/ $Sn^{2+}$ is oxidised. ✓ (3)
**[14]**

## QUESTION 9 / VRAAG 9

9.1 Electrical energy to chemical energy/*Elektriese energie na chemiese energie* ✓ (1)

9.2.1 Nickel nitrate/*Nikkel nitraat*/$Ni(NO_3)_2$ /$Ni^{2+}$✓ (1)

9.2.2 Nickel/*Nikkel*/*Ni* ✓ (1)

9.2.3 $Ni^{2+} + 2e^- \rightarrow Ni$ ✓✓ (2)

9.3 Stays the same/ *Bly dieselfde* ✓

The rate of oxidation is equal to the rate of reduction/The rate at which Ni is oxidised is equal to the $Ni^{2+}$ is reduced../*Die tempo van oksidasie is gelyk aan die tempo van reduksie* ✓ (2)

9.4

**Marking criteria / Nasienkriteria:**

- Substitute 59 in formula/ *vervanging van 59 in formule* $n = \frac{m}{M}$ ✓
- Use mol ratio / *Gebruik mol verhouding* - $2e^-$: Ni : 2:1 ✓
- Substitute $6,02 \times 10^{23}$ in formula / *Vervang* $6,02 \times 10^{23}$ *in formule* $N = nN_A$ ✓
- Final answer / *Finale antwoord* ($5,102 \times 10^{22}$ electrons) ✓

$$n(Ni) = \frac{m}{M}$$
$$= \frac{2,5}{59}\checkmark$$
$$= 0,0423 \text{ mol}$$

$$n(e^-) = 2n(Ni)\checkmark$$
$$= 2(0,0423)$$
$$= 0,085 \text{ mol}$$

$$N = nN_A$$
$$= (0,085)(6,02 \times 10^{23})\checkmark$$
$$= 5,102 \times 10^{22} \text{ electrons } \checkmark$$

(4)
**[11]**

**GRAND TOTAL/*GROOTTOTAAL* [150]**

**Table 1**

**QUESTION 4**

Remove **Question 4.4**: Mark out of 13 and convert/scale to 15. Use the table below or formula: $\frac{\text{mark}}{13} \times 15$ e.g.


**Conversion Table**

| Mark Obtained | Converted Mark |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 5 |
| 5 | 6 |
| 6 | 7 |
| 7 | 8 |
| 8 | 9 |
| 9 | 10 |
| 10 | 12 |
| 11 | 13 |
| 12 | 14 |
| 13 | 15 |