

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE/
NATIONAL SENIOR CERTIFICATE**

GRADE 12

**PHYSICAL SCIENCES: CHEMISTRY (P2)
SEPTEMBER EXAMINATION 2021**

MARKS: 150

TIME: 3 hours

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



INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of TEN 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 subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following is an ALKANE?



(2)

1.2 Esters are formed by a reaction between two organic compounds, **X** and **Y**, each with a different functional group.

The functional groups of these compounds are:

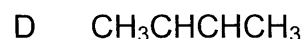
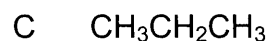
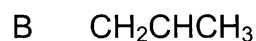
	Compound X	Compound Y
A	Hydroxyl group	Carboxyl group
B	Hydroxyl group	Carbonyl group
C	Hydroxide ion	Carboxyl group
D	Hydroxide ion	Carbonyl group

(2)

1.3 When butane is subjected to high temperatures and pressures, the following reaction takes place:



Which ONE of the following represents **Y**?



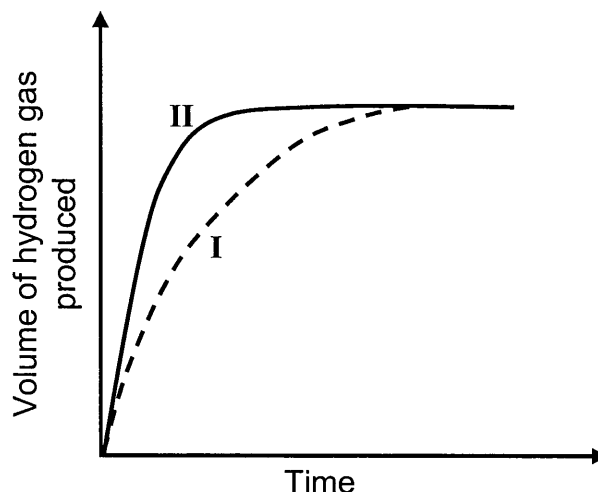
(2)



- 1.4 A hydrochloric acid solution, $\text{HCl}(\text{aq})$, of concentration $1 \text{ mol}\cdot\text{dm}^{-3}$ is added to EXCESS POWDERED magnesium at 25°C .

Curve I below represents the volume of hydrogen gas produced during the reaction.

Curve II was obtained at different conditions using the SAME VOLUME of hydrochloric acid solution.

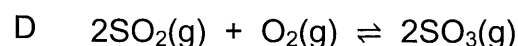
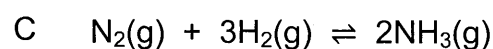
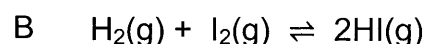
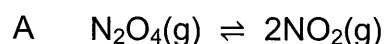


Which ONE of the following represents the conditions used to obtain curve II?

	STATE OF DIVISION OF Mg	CONCENTRATION OF ACID ($\text{mol}\cdot\text{dm}^{-3}$)	TEMPERATURE ($^\circ\text{C}$)
A	Ribbon	0,5	25
B	Ribbon	2	25
C	Powder	1	20
D	Powder	1	30

(2)

- 1.5 In which ONE of the following reactions at equilibrium will the YIELD of the product increase when the VOLUME of the container is increased at constant temperature?



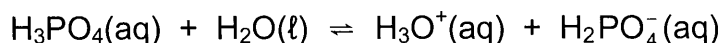
(2)



1.6 Which ONE of the following statements is TRUE for an EXOTHERMIC reaction?

- A More energy is absorbed than released.
- B More energy is released than absorbed.
- C Heat of reaction (ΔH) is positive.
- D Energy of the products is greater than the energy of the reactants. (2)

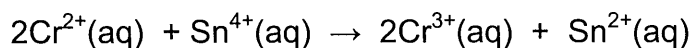
1.7 Consider the equation below.



Which ONE of the following is a conjugate acid-base pair?

- A $\text{H}_3\text{O}^+(\text{aq})$ and $\text{H}_2\text{O}(\ell)$
- B $\text{H}_3\text{PO}_4(\text{aq})$ and $\text{H}_2\text{O}(\ell)$
- C $\text{H}_3\text{PO}_4(\text{aq})$ and $\text{H}_3\text{O}^+(\text{aq})$
- D $\text{H}_3\text{O}^+(\text{aq})$ and $\text{H}_2\text{PO}_4^-(\text{aq})$ (2)

1.8 Consider the balanced equation for the reaction below:

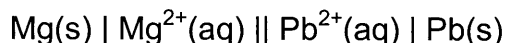


The OXIDISING AGENT is:

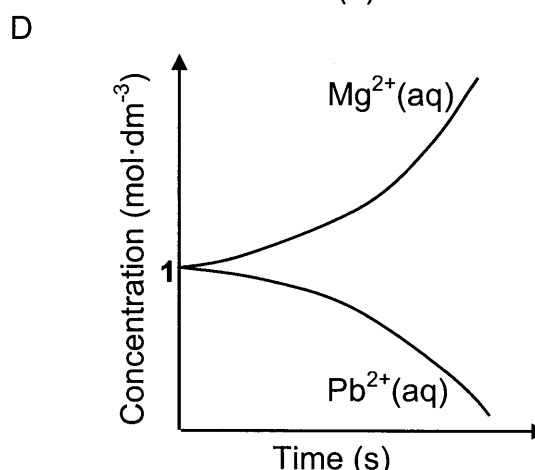
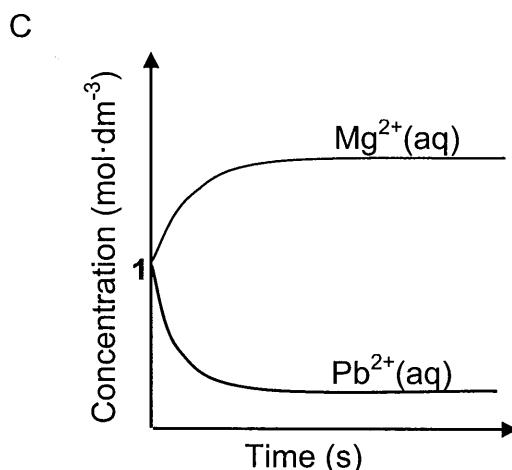
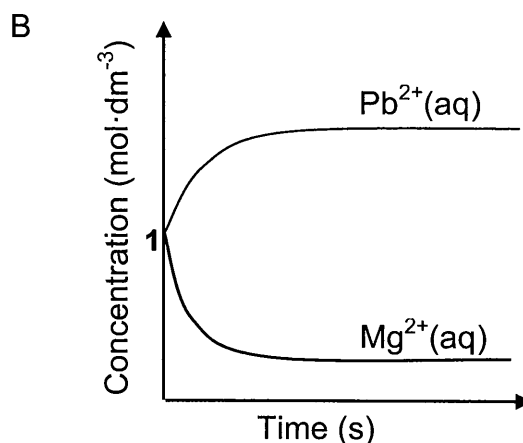
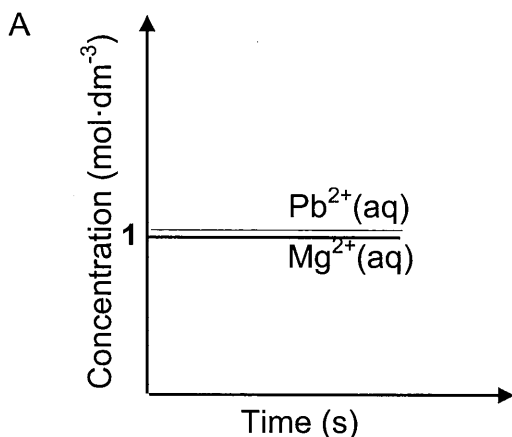
- A $\text{Cr}^{2+}(\text{aq})$
- B $\text{Cr}^{3+}(\text{aq})$
- C $\text{Sn}^{2+}(\text{aq})$
- D $\text{Sn}^{4+}(\text{aq})$ (2)



1.9 An electrochemical cell is set up at standard conditions. The cell notation for the cell is given below.



The cell is now connected in a circuit. Which ONE of the graphs below BEST represents the concentrations of the electrolytes after a long time?



(2)

1.10 Two 50 kg bags, containing fertilisers **R** and **S** respectively, are labelled as follows:

Fertiliser **R**: 3 : 1 : 5 (20)

Fertiliser **S**: 1 : 2 : 6 (20)

Identify the fertiliser(s) most suitable for healthy leaf growth and healthy root growth.

	LEAF GROWTH	ROOT GROWTH
A	R	R
B	S	R
C	R	S
D	S	S

(2)
[20]



QUESTION 2 (Start on a new page.)

The letters **A** to **E** in the table below represent five organic compounds.

A	$ \begin{array}{cccc} \text{H} & \text{Br} & \text{CH}_3 & \text{CH}_2\text{CH}_3 \\ & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} \\ & & & \\ \text{H} & \text{H} & \text{CH}_3 & \text{CH}_2\text{CH}_3 \end{array} $	B	C_xH_y
C	$ \begin{array}{ccccccc} \text{H} & \text{H} & \text{H} & \text{O} & \text{H} & & \\ & & & & & & \\ \text{H}-\text{C}- & \text{C}- & \text{C}- & \text{C}- & \text{C}-\text{H} & & \\ & & & & & & \\ \text{H} & \text{H} & \text{H} & & \text{H} & & \end{array} $	D	$\text{CH}_3(\text{CH}_2)_2\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$
E	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CHCH}_2$		

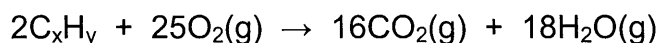
2.1 Write down the LETTER that represents EACH of the following:

- 2.1.1 A ketone (1)
- 2.1.2 A hydrocarbon (1)
- 2.1.3 An alkene (1)

2.2 Write down the:

- 2.2.1 IUPAC name of compound **A** (3)
- 2.2.2 STRUCTURAL FORMULA of compound **D** (2)
- 2.2.3 IUPAC name of the STRAIGHT CHAIN FUNCTIONAL ISOMER of compound **C** (2)

2.3 Compound **B** is a straight chain compound that undergoes the following exothermic reaction:



- 2.3.1 Besides being exothermic, what type of reaction is represented above? (1)
- 2.3.2 Determine the MOLECULAR FORMULA of compound **B**. (2)

The reaction above takes place in a closed container at a constant temperature higher than 100 °C and at constant pressure.

- 2.3.3 Calculate the TOTAL VOLUME of gas formed in the container when 50 cm³ of C_xH_y reacts completely with oxygen. (3)

[16]

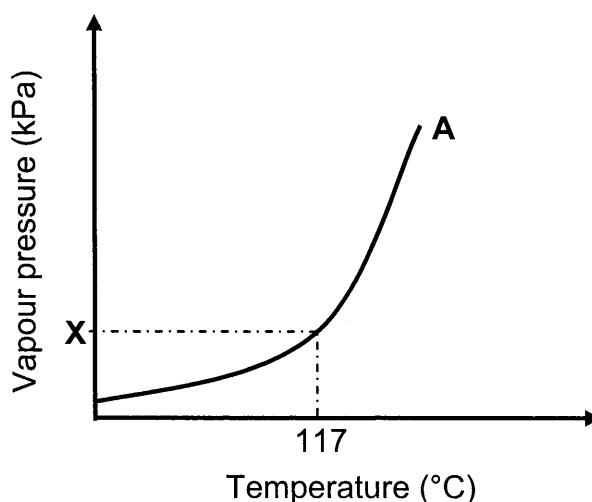


QUESTION 3 (Start on a new page.)

Compounds **A**, **B** and **C** are used to investigate a factor which influences the boiling points of organic compounds. The results of the investigation are given in the table below.

COMPOUND		BOILING POINT (°C)
A	Butan-1-ol	117
B	Butan-2-ol	100
C	2-methylpropan-2-ol	82

- 3.1 Is this a fair investigation? Choose from YES or NO. (1)
- 3.2 Give a reason for the answer to QUESTION 3.1. (1)
- 3.3 Fully explain the difference in the boiling points of compounds **B** and **C**. (3)
- 3.4 Define the term *positional isomer*. (2)
- 3.5 From compounds **A**, **B** and **C**, choose the letter(s) that represent(s) EACH of the following:
- 3.5.1 Positional isomers (1)
- 3.5.2 A tertiary alcohol
Give a reason for the answer. (2)
- 3.6 The graph below represents the relationship between vapour pressure and temperature for compound **A** (butan-1-ol).



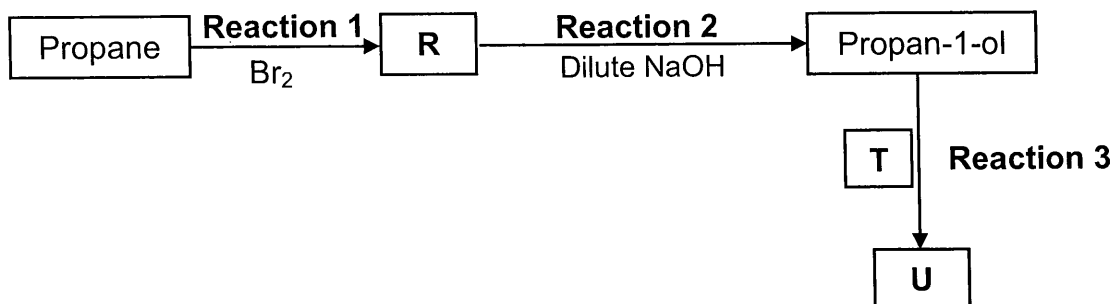
- 3.6.1 Write down the value of **X**. (1)
- 3.6.2 Redraw the graph above in the ANSWER BOOK. On the same set of axes, sketch the curve that will be obtained for compound **C**. Clearly label the curves **A** and **C**. Indicate the relevant boiling point for compound **C** on the graph. (2)

[13]

QUESTION 4 (Start on a new page.)

4.1 The flow diagram below shows various organic reactions using propane as starting reactant. **R**, **T** and **U** represent different organic compounds.

Compound **T** is a CARBOXYLIC ACID and compound **U** is a FUNCTIONAL ISOMER of pentanoic acid.



Write down the NAME of the type of reaction represented by:

4.1.1 Reaction 1 (1)

4.1.2 Reaction 2 (1)

Consider **reaction 1** and **reaction 2**.

4.1.3 Write down the IUPAC name of compound **R**. (2)

Reaction 3 takes place in the presence of a catalyst and heat.

Write down the:

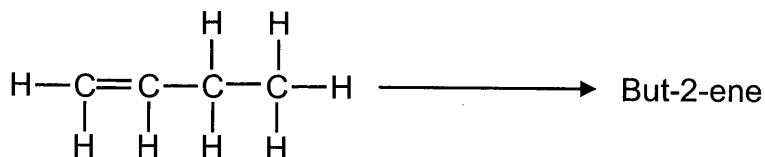
4.1.4 NAME or FORMULA of the catalyst (1)

4.1.5 IUPAC name of compound **T** (2)

4.1.6 STRUCTURAL FORMULA of compound **U** (2)



- 4.2 A laboratory technician wants to prepare but-2-ene using but-1-ene as starting reagent, as shown below.



The following chemicals are available in the laboratory:

concentrated H_2SO_4	H_2O	concentrated NaOH
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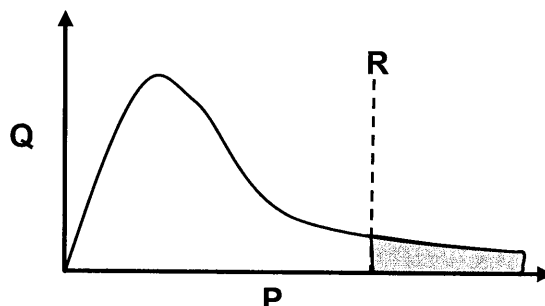
Select the chemicals required to design this preparation from the list above.

For EACH step of the preparation, write down the balanced equation, using STRUCTURAL FORMULAE for all organic compounds. Indicate the chemicals needed in each step.

(6)
[15]

QUESTION 5 (Start on a new page.)

- 5.1 Study the Maxwell-Boltzmann distribution curve for a certain reaction below.



P and **Q** are the labels of the axes. What quantity is represented by:

5.1.1 **P** (1)

5.1.2 **Q** (1)

- 5.2 Line **R** represents the minimum energy required for the reaction to take place.

5.2.1 Write down the term for the underlined phrase. (1)

5.2.2 How will the shaded area on the graph be affected when a catalyst is added? Choose from INCREASE, DECREASE or REMAINS THE SAME. (1)

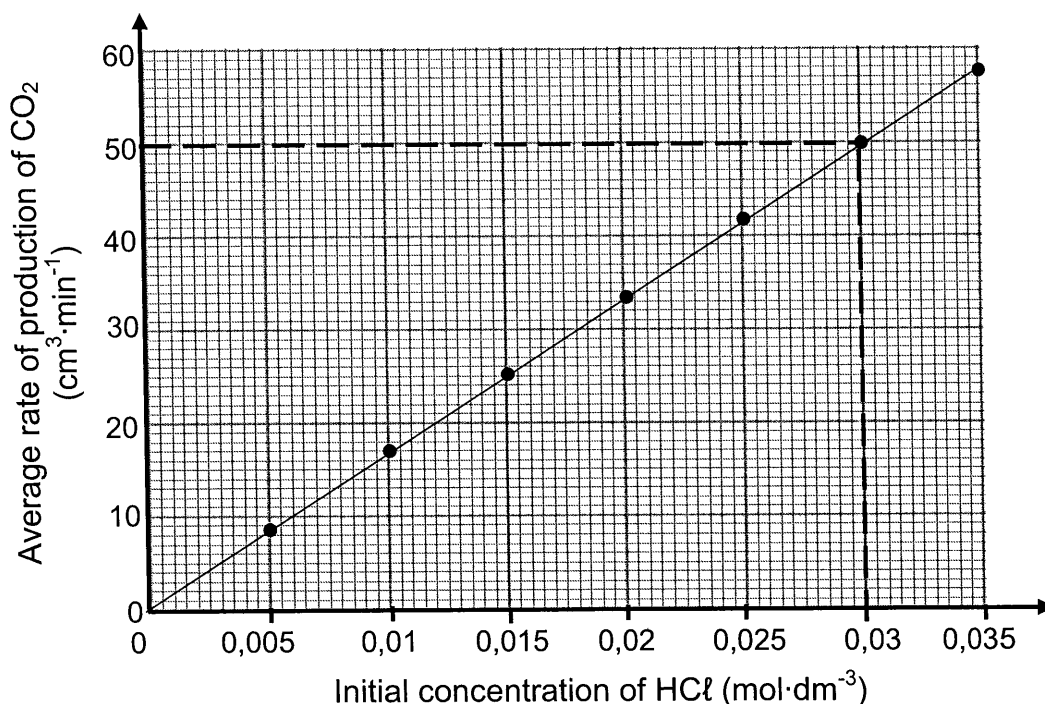
- 5.3 Use the collision theory to explain how a catalyst influences the rate of reaction. (4)



- 5.4 The reaction between POWDERED calcium carbonate, $\text{CaCO}_3(\text{s})$, and EXCESS hydrochloric acid, $\text{HCl}(\text{aq})$, is used to investigate reaction rate at $25\text{ }^\circ\text{C}$. The balanced equation for the reaction is:



Several experiments are conducted using the same mass of IMPURE calcium carbonate and different initial concentrations of dilute hydrochloric acid. The graph below represents the results obtained. Assume that the impurities do not react.



For this investigation, write down a:

5.4.1 Controlled variable (1)

5.4.2 Conclusion (2)

The $\text{CaCO}_3(\text{s})$ in 6 g of the impure sample reacts completely with $0,03\text{ mol}\cdot\text{dm}^{-3}$ $\text{HCl}(\text{aq})$ in 26 minutes.

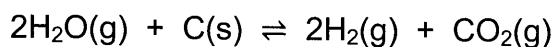
5.4.3 Use the information in the graph to calculate the percentage purity of the calcium carbonate. Assume that the molar gas volume at $25\text{ }^\circ\text{C}$ is $24\ 000\text{ cm}^3$.

(6)
[17]



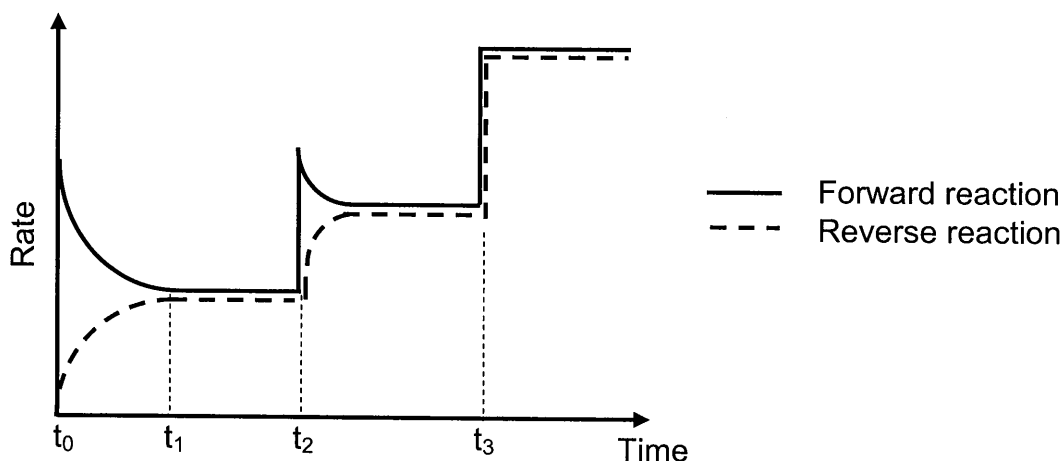
QUESTION 6 (Start on a new page.)

Steam, $\text{H}_2\text{O}(\text{g})$, reacts with hot carbon, $\text{C}(\text{s})$, at $1\,000\text{ }^\circ\text{C}$ according to the following balanced equation:



Initially, 36 g of steam and a certain amount of carbon were placed in a 2 dm^3 sealed container and allowed to react. At equilibrium it was found that the amount of carbon changed by 0,225 mol.

- 6.1 Define the term *dynamic equilibrium*. (2)
- 6.2 Calculate the equilibrium constant, K_c , for the reaction at $1\,000\text{ }^\circ\text{C}$. (8)
- 6.3 The graph shows how the rates of the forward and reverse reactions change with time.



- 6.3.1 Give a reason why the rate of the forward reaction decreases between t_0 and t_1 . (1)
- 6.3.2 What change was made to the equilibrium mixture at t_3 ? (1)

At time t_2 , the temperature of the system is increased.

- 6.3.3 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)
- 6.3.4 Refer to Le Chatelier's principle to explain the answer to QUESTION 6.3.3. (2)

[15]



QUESTION 7 (Start on a new page.)

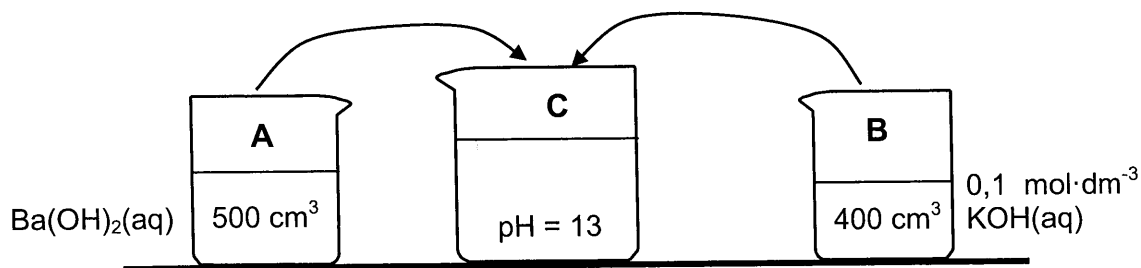
Two beakers, **A** and **B**, contain strong bases.

Beaker **A**: 500 cm³ of barium hydroxide, Ba(OH)₂(aq) of unknown concentration **X**

Beaker **B**: 400 cm³ of potassium hydroxide, KOH(aq) of concentration 0,1 mol·dm⁻³

- 7.1 Define a *base* according to the Arrhenius theory. (2)
- 7.2 Calculate the number of moles of hydroxide ions (OH⁻) in beaker **B**. (2)
- 7.3 The contents of beakers **A** and **B** are added together in beaker **C**. The solution in beaker **C** has a pH of 13.

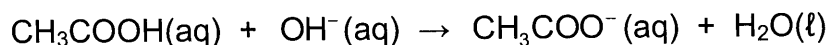
Assume that the volumes are additive and that the temperature of the solutions is 25 °C.



- 7.3.1 Calculate the concentration, **X**, of the Ba(OH)₂ in beaker **A**. (8)

The solution in beaker **C** is titrated with ethanoic acid. It was found that 15 cm³ of the solution neutralises 30 cm³ of the acid.

The balanced equation for the reaction is:

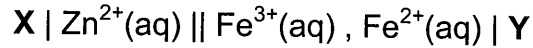


- 7.3.2 Is ethanoic acid, CH₃COOH(aq), a WEAK acid or a STRONG acid? (2)
Give a reason for the answer.
- 7.3.3 Calculate the concentration of the ethanoic acid. (4)

[18]

QUESTION 8 (Start on a new page.)

A galvanic cell at standard conditions is represented by the cell notation below. **X** and **Y** are unknown electrodes.

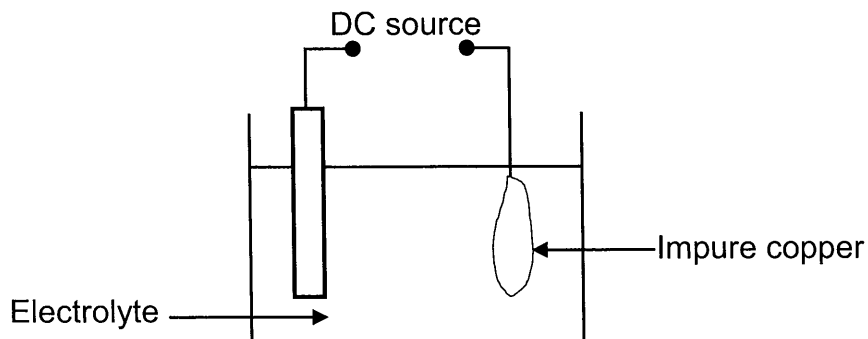


- 8.1 Write down the NAME or FORMULA of:
- 8.1.1 Electrode **X** (1)
 - 8.1.2 Electrode **Y** (1)
 - 8.1.3 The oxidising agent (1)
- 8.2 Write down:
- 8.2.1 ONE function of electrode **Y** (1)
 - 8.2.2 The half-reaction that takes place at electrode **Y** (2)
 - 8.2.3 The net (overall) equation for the cell reaction that takes place in this cell (3)
- 8.3 Calculate the initial emf of this cell. (4)
- 8.4 How will the initial emf of the cell be affected when the concentration of the iron(III) ions is changed to $0,6 \text{ mol}\cdot\text{dm}^{-3}$? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
- [14]**



QUESTION 9 (Start on a new page.)

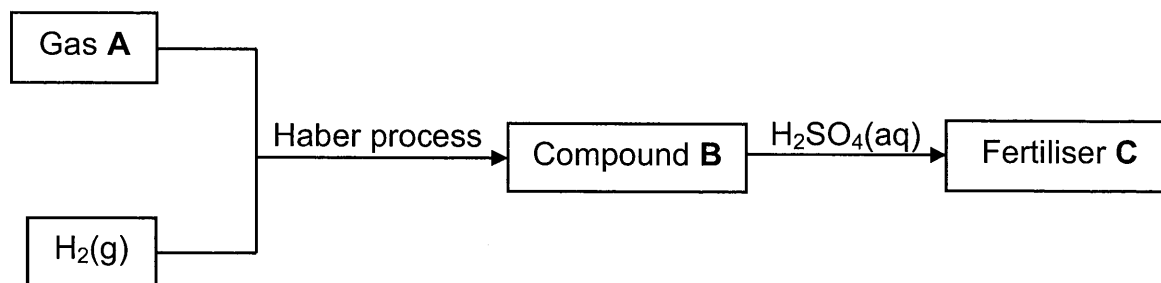
The simplified diagram below represents an electrochemical cell used for the purification of copper. The impure copper contains small amounts of silver (Ag) and zinc (Zn) as the only impurities.



- 9.1 Define the term *electrolysis*. (2)
- 9.2 Write down the NAME or FORMULA of TWO positive ions present in the electrolyte. (2)
- 9.3 Write down the half-reaction that takes place at the cathode. (2)
- 9.4 Refer to the Table of Standard Reduction Potentials and explain why the purified copper will NOT contain any zinc. (3)
- 9.5 Calculate the maximum mass of Cu formed if 0,6 moles of electrons are transferred. (3)
- [12]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows processes involved in the production of fertiliser **C**.



Write down the NAME or FORMULA of:

10.1.1 Gas **A** (1)

10.1.2 The catalyst used in the Haber process (1)

10.1.3 Compound **B** (1)

Write down the:

10.1.4 Name of the process used to produce gas **A** (1)

10.1.5 Balanced equation for the formation of fertiliser **C** (3)

10.2 A 40 kg bag of fertiliser contains 65% filler. The mass of the nutrients in the bag is shown in the table below.

NUTRIENTS	MASS (kg)
Nitrogen	x
Phosphorous	2x
Potassium	5



Calculate the NPK ratio of the fertiliser.

(3)
[10]

TOTAL: 150



**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESTE WETENSAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$
$K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14} \text{ at/by } 298 \text{ K}$	
$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta / E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$	
or/of	
$E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta / E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$	
or/of	
$E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta / E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$	



TABLE 4A: STANDARD REDUCTION POTENTIALS
 TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/Halfreaksies	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	- 2,36
$Na^+ + e^- \rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	- 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	- 2,93
$Li^+ + e^- \rightleftharpoons Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë



TABLE 4B: STANDARD REDUCTION POTENTIALS
 TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/Toenemende oksiderende vermoë

Half-reactions/Halfreaksies	E^{θ} (V)
$\text{Li}^+ + e^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + e^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + e^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2e^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2e^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2e^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + e^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	-2,36
$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2e^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2e^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3e^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2e^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + e^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2e^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2e^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2e^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2e^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3e^- \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2e^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + e^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2e^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4e^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4e^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + e^- \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2e^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + e^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + e^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}(\ell)$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3e^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2e^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2e^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + e^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{F}^-$	+2,87

Increasing reducing ability/Toenemende reduserende vermoë





basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

ERRATA/ERRATUM

NSC EXAMINATIONS: Preparatory Examinations 2021
NSS-EKSAMEN: Voorbereidende Eksamen 2021

SUBJECT/VAK: PHYSICAL SCIENCES/FISIESE WETENSKAPPE
PAPER/VRAESTEL: 2
DATE OF EXAMINATION: Monday 20 September 2021
DATUM VAN EKSAMEN: Maandag 20 September 2021
SESSION/SESSIE: 1 (09:00–12:00)

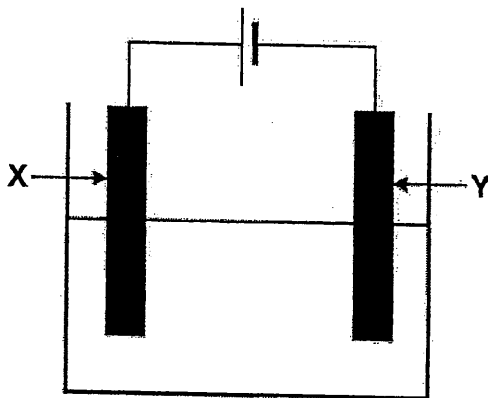
ATTENTION/AANDAG: CHIEF INVIGILATOR/HOOFD TOESIGHOUER

ENGLISH VERSION:

ERROR 1

Page	QUESTION	ERROR	CORRECTION
5	1.10	Incorrect question	Replace with the question below.

1.10 The electrolytic cell illustrated below is used to electroplate a nickel rod with copper.



Which ONE of the following is the correct representation of a suitable electrolyte and the nickel rod that should be used in the above cell to obtain the expected results?

	ELECTROLYTE	NICKEL ROD
A	$\text{NiSO}_4(\text{aq})$	X
B	$\text{CuSO}_4(\text{aq})$	X
C	$\text{NiSO}_4(\text{aq})$	Y
D	$\text{CuSO}_4(\text{aq})$	Y

(2)

ERROR 2

Page	QUESTION	ERROR	CORRECTION
15	10	Incorrect QUESTION 10	Replace QUESTION 10 with the entire question below.

QUESTION 10 (Start on a new page.)

Consider the Table of Standard Reduction Potentials below.

Half-reactions	E^θ (V)
$\text{Cr}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Sn}^{4+} + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0,52
$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0,80
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1,36

- 10.1 Define the term *reducing agent* in terms of electron transfer. (2)
- 10.2 From the above Table of Standard Reduction Potentials, write down the:
- 10.2.1 NAME or FORMULA of the strongest reducing agent (1)
- 10.2.2 Oxidation half-reaction with the lowest oxidation potential (2)
- 10.2.3 Reduction potential of the half-reaction in which $\text{Cr}^{2+}(\text{aq})$ acts as reducing agent (1)
- 10.3 A learner pours a copper(II) sulphate solution into a zinc container.
- 10.3.1 Is a zinc container suitable to store a copper(II) sulphate solution? Choose from YES or NO. (1)
- 10.3.2 Explain the answer to QUESTION 10.3.1 by referring to the above table. (3)
- [10]



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE/SENIOR SERTIFIKAAT
NATIONAL SENIOR CERTIFICATE/
NASIONALE SENIOR SERTIFIKAAT**

GRADE/GRAAD 12

**PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)**

SEPTEMBER 2021(2)

MARKING GUIDELINES/NASIENRIGLYNE

MARKS/PUNTE: 150

**This memorandum consists of 17 pages.
Hierdie memorandum bestaan uit 17 bladsye.**

QUESTION 1/VRAAG 1

- | | | |
|------|------|-------------|
| 1.1 | D ✓✓ | (2) |
| 1.2 | A ✓✓ | (2) |
| 1.3 | B ✓✓ | (2) |
| 1.4 | D ✓✓ | (2) |
| 1.5 | A ✓✓ | (2) |
| 1.6 | B ✓✓ | (2) |
| 1.7 | A ✓✓ | (2) |
| 1.8 | D ✓✓ | (2) |
| 1.9 | C ✓✓ | (2) |
| 1.10 | C ✓✓ | (2) |
| | | [20] |



QUESTION 2/VRAAG 2

2.1

2.1.1 C ✓ (1)

2.1.2 B/E ✓ (1)

2.1.3 E ✓ (1)

2.2

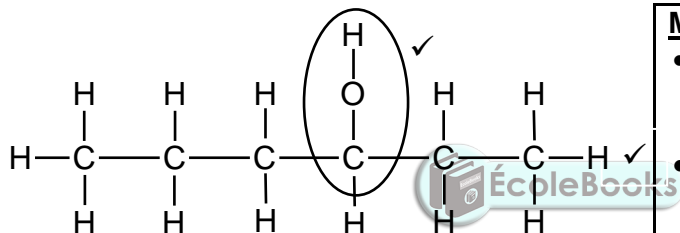
2.2.1 2-bromo-4-ethyl-3,3-dimethylhexane/2-broom-4-etiel-3,3-dimetielheksaan

Marking criteria/Nasienkriteria

- Correct stem i.e. hexane./Korrekte stam: heksaan. ✓
- All substituents (bromo, ethyl and dimethyl) correctly identified./Alle substituenten (broom, etiel en dimetiel) korrek geïdentifiseer. ✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used./Substituenten korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik. ✓

(3)

2.2.2

**Marking criteria/Nasienkriteria:**

- Six carbons in longest chain. Ses koolstowwe in die langste ketting. ✓
- Hydroxyl group on third carbon./Hidroksielgroep op tweede koolstof. ✓

Notes/Aantekeninge:

- One or more H atoms omitted/Een of meer H-atome uitgelaat: $\frac{1}{2}$
- Condensed or semi-structural formula./Gekondenseerde of semi-struktuurformule: $\frac{1}{2}$

(2)

2.2.3 Pentanal / Pentanaal ✓✓

Marking criteria/Nasienkriteria:

- Correct functional group i.e. -al/Korrekte funksionele groep d.i. -al. ✓
- Whole name correct/Hele naam korrek. ✓✓

(2)

2.3

2.3.1 Oxidation/combustion/oksidasie/verbranding ✓ (1)

2.3.2 C_8H_{18} ✓✓ (2 or/of 0) (2)

2.3.3

<p>OPTION 1/OPSIE 1</p> $V(\text{CO}_2) = 8 \times V_B$ $= 8(50)$ $= 400 \text{ cm}^3$ $V(\text{H}_2\text{O}) = \frac{18}{2} V_B$ $= 9(50)$ $= 450 \text{ cm}^3$ <p>Total volume gas formed/ Totale volume gas gevorm</p> $= 400 + 450$ $= 850 \text{ cm}^3$	<p>Marking criteria/Nasienkriteria</p> <ul style="list-style-type: none"> Use volume ratio/Gebruik volume verhouding: $V(\text{CO}_2) : V(\text{B}) = 2 : 1$ and/en $V(\text{H}_2\text{O}) : V(\text{B}) = 9 : 1$ ✓ Add/Tel bymekaar: $V(\text{CO}_2)$ and/en $V(\text{H}_2\text{O})$ ✓ Final answer/Finale antwoord: 850 cm^3 ✓
	<p>OPTION 2/OPSIE 2</p> $2 \text{ mol C}_x\text{H}_y \dots\dots\dots 16 + 18 = 34 \text{ mol gas}$ $50 \text{ mol C}_x\text{H}_y \dots\dots\dots 25 \times 34 \text{ mol gas}$ <p>Total moles gas formed/Totale volume gas gevorm = 850 cm^3 ✓</p>

(3)
[16]

QUESTION 3/VRAAG 3

3.1 No/Nee ✓

(1)

3.2 There is more than one independent variable. ✓
 Daar is meer as een onafhanklike veranderlike.

OR/OF

Positions of functional groups and branching/chain length differ.
 Posises van funksionele groepe en vertakking/kettinglengte verskil.

OR/OF

Compounds **A** and **B/C** are positional isomers and compounds **B** and **C** are chain isomers.
 Verbindings **A** en **B/C** is posisie-isomere en verbindings **B** en **C** is kettingisomere.

(1)

- 3.3
- B/butan-2-ol is less branched / less compact / less spherical/ has a longer chain length / has a larger surface area (over which intermolecular forces act). ✓
 - B/butan-2-ol has stronger / more intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓
 - More energy needed to overcome or break intermolecular forces / Van der Waals forces in B/butan-2-ol. ✓
 - B/butan-2-ol is minder vertak / minder kompak / minder sferies / het 'n langer kettinglengte / het 'n groter oppervlak (waaroor intermolekulêre kragte werk).
 - B/butan-2-ol het sterker / meer intermolekulêre kragte / Van der Waalskragte / London-kragte / dispersiekragte.
 - Meer energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / London-kragte te oorkom in B/butan-2-ol.

OR/OF

- C/2-methylpropan-2-ol is more branched / more compact / more spherical / has a smaller surface area (over which intermolecular forces act). ✓
- C/2-methylpropan-2-ol has weaker / less intermolecular forces / Van der Waals forces / London forces / dispersion forces. ✓
- Less energy needed to overcome or break intermolecular forces / Van der Waals forces in C/2-methylpropan-2-ol. ✓
- C/2-metielpropan-2-ol is meer vertak / meer kompak / meer sferies / het 'n kleiner oppervlak (waaroor intermolekulêre kragte werk).
- C/2-metielpropan-2-ol het swakker/minder intermolekulêre kragte / Van der Waalskragte / Londonkragte / dispersiekragte.
- Minder energie benodig om intermolekulêre kragte / Van der Waalskragte/ dispersiekragte / Londonkragte te oorkom in C/2-metielpropan-2-ol.

(3)

3.4

Marking criteria/Nasienkriteria

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.

Compounds with the same molecular formula, but different positions of the side chain/substituents/functional groups on parent chain. ✓✓

Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituente/funksionele groepe op die stamketting.

(2)

3.5

3.5.1 A & B ✓

(1)

3.5.2 C ✓

The C-atom bonded to the functional group/OH-group/hydroxyl (group) is bonded to three other C-atoms. ✓

Die C-atoom aan die funksionele groep/OH-groep/hidroksiel(groep) gebind is, is aan drie ander C-atome gebind.

OR/OF

The functional group/OH-group/hydroxyl (group) is bonded to a tertiary C-atom.

Die funksionele groep/OH-groep/hidroksiel(groep) is aan 'n tersiêre C-atoom gebind.

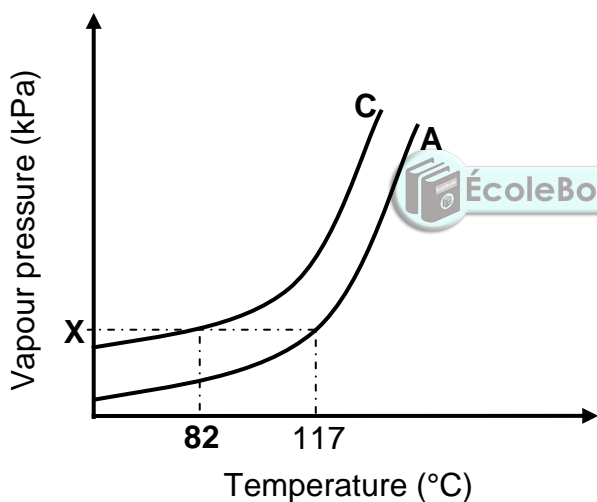
(2)

3.6

3.6.1 101,3 (kPa) / 1,013 x 10⁵ Pa / 1 atm / 760 mmHg ✓

(1)

3.6.2



Marking criteria/Nasienkriteria:

- Curve C is above A.
Kurwe C is bokant A. ✓
- Value 82 °C on curve C where vapour pressure is X/
101,3 kPa.
*Waarde 82 °C op kurwe C waar dampdruk gelyk is aan X/
101,3 kPa. ✓*

IF/INDIEN:

- Curves start at same point/*Indien kurwes by dieselfde punt begin:*
Max./Maks. $\frac{1}{2}$
- Straight line graph/*Reguitlyn grafiek.* Max./Maks. $\frac{1}{2}$

(2)

[13]



QUESTION 4/VRAAG 4

4.1

4.1.1 Substitution/halogenation/bromination ✓
Substitusie/halogenering/brominering (1)

4.1.2 Substitution/hydrolysis/*Substitusie/hidrolise* ✓ (1)

4.1.3 1-bromopropane/1-bromopropaan ✓✓

IF/INDIEN:Bromopropane/*bromopropaan* **OR/OF**

2-bromopropane/2-bromopropaan

Max./Maks. $\frac{1}{2}$

(2)

4.1.4 H_2SO_4 /(concentrated) sulphuric acid/(gekonsentreerde)

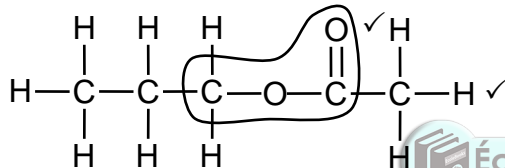
swaelsuur ✓

(1)

4.1.5 Ethanoic acid/Etanoësuur ✓✓

(2)

4.1.6

**Marking criteria/Nasienkriteria:**

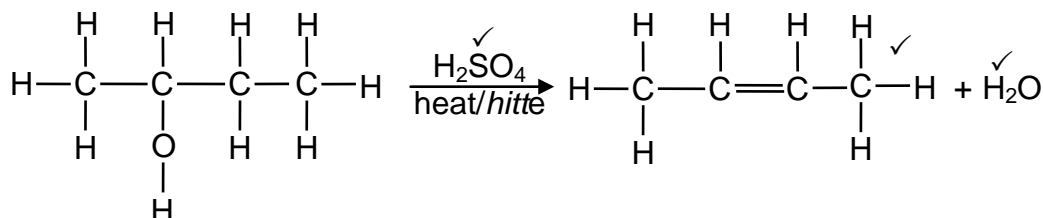
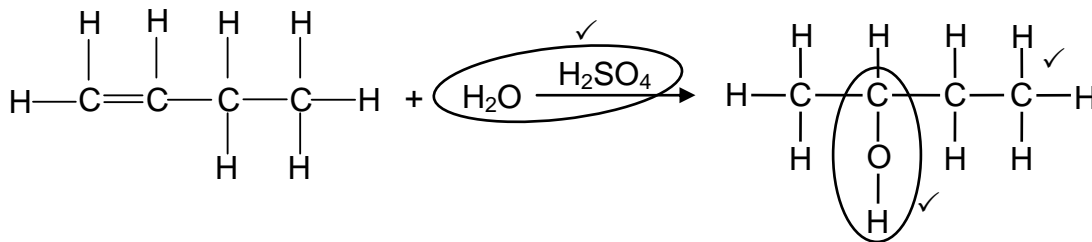
- Functional group correct. ✓
Funksionele groep korrek.
- Whole structure correct. ✓✓
Hele struktuur korrek.

Notes/Aantekeninge:

- One or more H atoms omitted: / *Een of meer H-atome uitgelaat:* $\frac{1}{2}$
- Condensed or semi-structural formula: / *Gekondenseerde of semi-struktuur-formule:* $\frac{1}{2}$

(2)

4.2



Notes/Aantekeninge:

- Condensed or semistructural formula: Max. $\frac{5}{6}$
Gekondenseerde of semistruktuurformule: Maks. $\frac{5}{6}$
- Molecular formula/Molekulêre formule: Max./Maks. $\frac{3}{6}$
- Marking rule 6.3.10/Nasienreël 6.3.10.
- Any additional reactants or products: Max. $\frac{5}{6}$
Enige addisionele reaktanse of produkte: Maks. $\frac{5}{6}$
- If arrow in equation omitted: Max. $\frac{5}{6}$
Indien pyltjie in vergelyking uitgelaat is: Maks. $\frac{5}{6}$

(6)
 [15]

QUESTION 5/VRAAG 5

5.1

5.1.1 Kinetic energy/*kinetiese energie* ✓ (1)5.1.2 Number of particles/molecules ✓
Aantal deeltjies/molekule (1)

5.2

5.2.1 Activation energy/*Aktiveringsenergie* ✓ (1)5.2.2 Increase/*Toeneem* ✓ (1)

5.3

- A catalyst provides an alternative pathway of lower activation energy. ✓
- More molecules have sufficient kinetic energy. ✓
- More effective collisions per unit time. /Frequency of effective collisions increases. ✓
- Increase reaction rate. ✓
- 'n Katalisator verskaf 'n alternatiewe roete van laer aktiveringsenergie.
- Meer molekule het voldoende kinetiese energie.
- Meer effektiewe botsings per eenheidtyd. /Frekwensie van effektiewe botsings neem toe.
- Verhoog reaksietempo. ✓



5.4

5.4.1 Temperature / Surface area / Amount or mass of CaCO_3 ✓
Temperatuur / Reaksie-oppervlak / Hoeveelheid of massa CaCO_3 (1)

5.4.2

Criteria for conclusion/Kriteria vir gevolgtrekking:Dependent (reaction rate) and independent (concentration) variables correctly identified. /*Afhanklike (reaksietempo) en onafhanklike (konsentrasie) veranderlikes korrek geïdentifiseer.* ✓Relationship between the independent and dependent variables correctly stated. /*Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.* ✓**Example/Voorbeeld:**Reaction rate is directly proportional to concentration.
*Reaksietempo is direk eweredig aan konsentrasie.***IF/INDIEN**Reaction rate increases with increase in concentration.
*Reaksietempo neem toe met toename in konsentrasie.***OR/OF**Reaksietempo is eweredig aan konsentrasie.
Reaction rate is proportional to concentration.Max./Maks. $\frac{1}{2}$

(2)

5.5

Marking criteria/Nasienkriteria:

- Substitute $50 \text{ cm}^3 \cdot \text{min}^{-1}$ and 26 minutes in $\text{rate} = \frac{\Delta V}{\Delta t}$ ✓
- Substitute/ Vervang $1\,300 \text{ cm}^3 / 1,3 \text{ dm}^3$ **OR/OF** $24\,000 \text{ cm}^3 \cdot \text{mol}^{-1} / 24 \text{ dm}^3 \cdot \text{mol}^{-1}$ in $n = \frac{V}{V_m}$ ✓
- Use ratio/Gebruik verhouding $n(\text{CO}_2) = n(\text{CaCO}_3) = 1:1$ ✓
- Substitute/ Vervang $100 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
- Calculate % purity/Bereken % suiwerheid = $\frac{m(\text{CaCO}_3)}{m(\text{Sample/ monster})} \times 100$ ✓
- Final answer/Finale antwoord: 90,33% ✓
 Range/Gebied: 83,33% to 90,33%



OPTION 1

$$\begin{aligned} \text{Rate/tempo} &= \frac{\Delta V}{\Delta t} \\ 50 &= \frac{\Delta V}{26} \checkmark \\ \Delta V &= 1\,300 \text{ cm}^3 \\ n(\text{CO}_2) &= \frac{1300}{24\,000} \checkmark \quad \text{OR} \quad \frac{1,3}{24} \\ &= 0,0542 \text{ mol} \\ n(\text{CaCO}_3) &= n(\text{CO}_2) \\ &= 0,0542 \text{ mol} \checkmark \\ m(\text{CaCO}_3) &= nM \\ &= 0,0542 \times 100 \checkmark \\ &= 5,42 \text{ g} \\ \% \text{ purity/suiwerheid} &= \frac{5,42}{6} \checkmark \times 100 \\ &= 90,33\% \checkmark \end{aligned}$$

OPTION 2:

$$\begin{aligned} \text{Rate/tempo} &= \frac{50}{24\,000} \checkmark \\ &= 0,00208 \text{ mol} \cdot \text{min}^{-1} \checkmark \\ n(\text{CO}_2) &= 0,00208 \times 26 \\ &= 0,0542 \text{ mol} \\ n(\text{CaCO}_3) &= n(\text{CO}_2) = 0,0542 \text{ mol} \checkmark \\ m(\text{CaCO}_3) &= nM \\ &= 0,0542(100) \checkmark \\ &= 5,42 \text{ g} \\ \% \text{ purity/suiwerheid} &= \frac{5,42}{6} \checkmark \times 100 \\ &= 90,33\% \checkmark \end{aligned}$$

(6)
[17]

QUESTION 6/VRAAG 6

6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓ (2 or 0)

Die stadium in 'n chemiese reaksie waar die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. (2 of 0)

OR/OF

The stage in a chemical reaction when the concentrations of reactants and products remain constant. (2 or 0)

Die stadium in 'n chemiese reaksie waar die konsentrasies van die reaktanse en produkte konstant bly. (2 of 0)

(2)

6.2 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT AANTAL MOL GEBRUIK

Marking criteria/Nasienkriteria

- Substitute/Vervang $18 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
- $\Delta n(\text{CO}_2) = \Delta n(\text{C}) = 0,225 \text{ mol}$. ✓
- Use mole ratio/Gebruik $n(\text{C}) : n(\text{H}_2\text{O}) : n(\text{CO}_2) : n(\text{H}_2) = 1 : 2 : 1 : 2$ ✓
- Equilibrium/Ewewig $n(\text{H}_2\text{O}) = \text{initial/aanvanklike } n(\text{H}_2\text{O}) - \Delta n(\text{H}_2\text{O})$ } ✓
- Equilibrium/Ewewig $n(\text{H}_2) = \text{initial/aanvanklike } n(\text{H}_2) + \Delta n(\text{H}_2)$ }
- Equilibrium/Ewewig $n(\text{CO}_2) = \text{initial/aanvanklike } n(\text{CO}_2) + \Delta n(\text{CO}_2)$ }
- Divide equilibrium moles of H_2O , H_2 AND/EN CO_2 by/deur 2 dm^3 . ✓
- Correct K_c expression (formulae in square brackets). ✓
 Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
 Vervanging van konsentrasies in korrekte K_c -uitdrukking.
- Final answer/Finale antwoord: 0,00948 ✓
 Range/Gebied: 0,00948 to/tot 0,01 ($9,48 \times 10^{-3}$ to/tot 1×10^{-2})

OPTION 1/OPSIE 1

$$n(\text{H}_2\text{O})_{\text{initial/aanvanklik}} = \frac{m}{M} = \frac{36}{18} = 2 \text{ mol}$$

	H_2O	H_2	CO_2
Initial amount (moles) <i>Aanvangs hoeveelheid (mol)</i>	2		
Change in amount (moles) <i>Verandering in hoeveelheid (mol)</i>	0,45	0,45	0,225 ✓
Equilibrium amount (moles) <i>hoeveelheid (mol)</i>	1,55	0,45	0,225 ✓
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	0,775	0,225	0,1125 ✓

ratio ✓
verhouding

Divide by/
Deel deur
 2 dm^3 ✓

$$K_c = \frac{[\text{H}_2]^2 [\text{CO}_2]}{[\text{H}_2\text{O}]^2}$$

$$= \frac{[0,225]^2 [0,1125]}{[0,775]^2}$$

$$= 0,00948 \text{ ✓}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{8}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

- Substitute/Vervang $18 \text{ g}\cdot\text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
- Divide initial/Deel aanvanklike $n(\text{H}_2\text{O})$ AND $\Delta n(\text{CO}_2)$ by/deur 2 dm^3 . ✓
- $\Delta n(\text{CO}_2) = \Delta n(\text{C}) = 0,225 \text{ mol}$ OR/OF $\Delta c(\text{CO}_2) = 0,1125 \text{ mol}\cdot\text{dm}^{-3}$. ✓
- Use mole ratio/Gebruik molverhouding $n(\text{H}_2\text{O}) : n(\text{CO}_2) : n(\text{H}_2) = 2 : 1 : 2$ ✓
- Equilibrium/Ewewig $c(\text{H}_2\text{O}) = \text{initial/aanvanklike } c(\text{H}_2\text{O}) - \Delta c(\text{H}_2\text{O})$ } ✓
 Equilibrium/Ewewig $c(\text{H}_2) = \text{initial/aanvanklike } c(\text{H}_2) + \Delta c(\text{H}_2)$ } ✓
 Equilibrium/Ewewig $c(\text{CO}_2) = \text{initial/aanvanklike } c(\text{CO}_2) + \Delta c(\text{CO}_2)$ }
- Correct K_c expression (formulae in square brackets). ✓
 Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
 Vervanging van konsentrasies in korrekte K_c -uitdrukking.
- Final answer/Finale antwoord: $0,00948$ ✓
 Range/Gebied: $0,00948 - 0,01$

OPTION 2/OPSIE 2

$n(\text{H}_2\text{O})_{\text{initial/aanvanklik}} = \frac{m}{M} = \frac{36}{18} = 2 \text{ mol}$

	H ₂ O	H ₂	CO ₂
Initial concentration (mol·dm ⁻³) Aanvangskonsentrasie (mol·dm ⁻³)	1		
Change (mol·dm ⁻³) Verandering (mol·dm ⁻³)	0,225	0,225	0,1125 ✓
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,775	0,225	0,1125

Divide by/Deel deur 2 dm^3 ✓
 ratio ✓
 verhouding

$K_c = \frac{[\text{H}_2]^2 [\text{CO}_2]}{[\text{H}_2\text{O}]^2}$ ✓
 $= \frac{[0,225]^2 [0,1125]}{[0,775]^2}$ ✓
 $= 0,00948$ ✓

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{5}{8}$


(8)

6.3

6.3.1 Steam is used up./Amount of steam decreases./Concentration of steam decreases./Reactants are used up. ✓
 Water word opgebruik./Hoeveelheid stoom neem af./Konsentrasie van stoom neem af./Reaktanse word opgebruik. (1)

6.3.2 Catalyst was added./Katalisator is bygevoeg. ✓ (1)

6.3.3 Endothermic/Endotermies ✓ (1)

6.3.4  The forward reaction is favoured./Die voorwaartse reaksie word bevoordeel. ✓
 Increase in temperature favours the endothermic reaction. ✓
 Toename in temperatuur bevoordeel die endotermiese reaksie. (2)

[15]

QUESTION 7/VRAAG 7

- 7.1 A base forms hydroxide ions (OH^-) in water/aqueous solution/ $\text{OH}^-(\text{aq})$. ✓✓
'n Basis vorm hidroksiedione (OH^-) in water/waterige oplossing/ $\text{OH}^-(\text{aq})$.

IF/INDIEN:

A base ionises to form hydroxide ions (OH^-). ✓

'n Basis ioniseer om hidroksiedione (OH^-) te vorm.

Max./Maks. $\frac{1}{2}$

(2)

- 7.2 $n(\text{KOH}) = cV$
 $= 0,1 \times 0,4$ ✓
 $= 0,04$ mol
 $n(\text{OH}^-) = n(\text{KOH}) = 0,04$ mol ✓



(2)

- 7.3
7.3.1

POSITIVE MARKING FROM Q7.2/POSITIEWE NASIEN VANAF V7.2**Marking criteria/Nasienkriteria**

- Use formula/Gebruik formule: $\text{pH} = -\log[\text{H}_3\text{O}^+]$
- Substitute/Vervang $\text{pH} = 13/\text{pOH} = 1$
- Substitute/Vervang 1×10^{-13} in K_w /Calculate/Bereken pOH
- Substitute/Vervang of $0,1 \times 0,9$
- Calculate/Bereken $n(\text{OH}^-) = n(\text{in C}) - n(\text{in B})$ ✓
- Use mol ratio/Gebruik molverhouding: $n(\text{Ba}(\text{OH})_2) : n(\text{OH}^-) = 1 : 2$. ✓
- Substitute/Vervang $0,5 \text{ dm}^3$. ✓
- Final answer/Finale antwoord: $0,05 \text{ mol} \cdot \text{dm}^{-3}$ ✓
Range/Gebied: $0,05$ to $0,06 \text{ mol} \cdot \text{dm}^{-3}$

OPTION 1/OPSIE 1

$$\begin{aligned} \text{pH} &= -\log[\text{H}_3\text{O}^+] \quad \text{OR/OF} \quad [\text{H}_3\text{O}^+] = 10^{-\text{pH}} \quad \checkmark \\ 13 \quad \checkmark &= -\log[\text{H}_3\text{O}^+] \quad \text{OR/OF} \quad [\text{H}_3\text{O}^+] = 10^{-13} \\ [\text{H}_3\text{O}^+] &= 1 \times 10^{-13} \text{ mol} \cdot \text{dm}^{-3} \\ \swarrow & \\ [\text{H}_3\text{O}^+][\text{OH}^-] &= 1 \times 10^{-14} \\ (1 \times 10^{-13}) [\text{OH}^-] &= 1 \times 10^{-14} \quad \checkmark \\ [\text{OH}^-] &= 0,1 \text{ mol} \cdot \text{dm}^{-3} \\ \downarrow & \\ n(\text{OH}^-) &= cV \\ &= 0,1 \times 0,9 \quad \checkmark \\ &= 0,09 \text{ mol} \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned} \text{pOH} &= 14 - 13 = 1 \quad \checkmark \\ \text{pOH} &= -\log[\text{OH}^-] \quad \checkmark \\ 1 \quad \checkmark &= -\log[\text{OH}^-] \\ [\text{OH}^-] &= 0,1 \text{ mol} \cdot \text{dm}^{-3} \\ \downarrow & \\ n(\text{OH}^-) &= cV \\ &= 0,1 \times 0,9 \quad \checkmark \\ &= 0,09 \text{ mol} \end{aligned}$$

$$n(\text{OH}^-) \text{ from/van } \text{Ba}(\text{OH})_2 \text{ in beaker/beker C} = 0,09 - 0,04 \quad \checkmark \\ = 0,05 \text{ mol}$$

$$\begin{aligned} n[\text{Ba}(\text{OH})_2] &= \frac{1}{2} n(\text{OH}^-) \\ &= \frac{1}{2} (0,05) \quad \checkmark \\ &= 0,025 \text{ mol} \end{aligned}$$

$$\begin{aligned} c[\text{Ba}(\text{OH})_2] &= \frac{n}{V} \\ &= \frac{0,025}{0,5} \quad \checkmark \end{aligned}$$

$$\therefore x = 0,05 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark$$

(8)

7.3.2 Weak (acid)/Swak (suur) ✓



Ionises/dissociates incompletely/partially. ✓
 Ioniseer/dissosieer onvolledig/gedeeltelik.

(2)

7.3.3 **POSITIVE MARKING FROM Q7.3.1/POSITIEWE NASIEN VANAF V7.3.1**

Marking criteria/Nasienkriteria

- Formula/Formule: $c = \frac{n}{V} / \frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓
- Substitution of/Vervanging van $0,1 \times 15 / 0,1 \times 0,015$ ✓ **OR/OF**
 Use/Gebruik $V_a = 30 \text{ cm}^3$
- Use mol ratio/Gebruik molverhouding 1 : 1 ✓
- Final answer/Finale antwoord: $0,05 \text{ mol} \cdot \text{dm}^{-3}$ ✓

OPTION 1/OPSIE 1

$$\begin{aligned}
 n(\text{OH}^-) &= cV \quad \checkmark \\
 &= 0,1 \times 0,015 \quad \checkmark \\
 &= 0,0015 \text{ mol} \\
 &\quad \swarrow \\
 n(\text{CH}_3\text{COOH}) &= n(\text{OH}^-) \\
 &= 0,0015 \text{ mol} \quad \checkmark \\
 &\quad \swarrow \\
 c &= \frac{n}{V} \\
 &= \frac{0,0015}{0,03} \\
 &= 0,05 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark
 \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}
 \frac{c_a \times V_a}{c_b \times V_b} &= \frac{n_a}{n_b} \quad \checkmark \\
 \frac{c_a \times 30}{0,1 \times 15} \quad \checkmark &= \frac{1}{1} \quad \checkmark \\
 c_a &= 0,05 \text{ mol} \cdot \text{dm}^{-3} \quad \checkmark
 \end{aligned}$$



(4)
[18]

QUESTION 8/VRAAG 8

8.1

8.1.1 Zinc/Zn ✓



(1)

8.1.2 Platinum/Pt /Carbon/C/Koolstof ✓

(1)

8.1.3 Iron(III) ions/Fe³⁺(aq)/Fe³⁺ ions/Yster(III)-ione/Fe³⁺-ione ✓

(1)

8.2

8.2.1 Conductor (to complete circuit). /Provides surface area for the reaction to take place. ✓

Geleier (om die stroombaan te voltooi./Verskaf oppervlak vir die reaksie om plaas te vind.

(1)

8.2.2 $Fe^{3+} + e^{-} \rightarrow Fe^{2+}$ ✓✓

Marking criteria/Nasienkriteria

- $Fe^{3+} + e^{-} \rightleftharpoons Fe^{2+}$ $\frac{1}{2}$ $Fe^{2+} \rightleftharpoons Fe^{3+} + e^{-}$ $\frac{0}{2}$
- $Fe^{2+} \leftarrow Fe^{3+} + e^{-}$ $\frac{2}{2}$ $Fe^{2+} \rightarrow Fe^{3+} + e^{-}$ $\frac{0}{2}$
- Ignore if charge omitted on electron. /Ignoreer indien lading weggelaat op elektron.
- If charge (+) omitted on Fe²⁺ and/or Fe³⁺ Indien lading (+) weggelaat op Fe²⁺ and/or Fe³⁺ Max./Maks: $\frac{1}{2}$ Example/Voorbeeld: $Fe^3 + e^{-} \rightarrow Fe^2$

(2)

8.2.3 $2Fe^{3+}(aq) + Zn \checkmark \rightarrow 2Fe^{2+}(aq) + Zn^{2+}(aq) \checkmark$ Bal ✓

Notes/Aantekeninge

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse ✓ Produkte ✓ Balansering ✓
- Ignore/Ignoreer → and phases / en fases
- Marking rule 6.3.10/Nasienreël 6.3.10

(3)

8.3

OPTION 1/OPSIE 1

$$E_{cell}^{\theta} = E_{reduction}^{\theta} - E_{oxidation}^{\theta} \checkmark$$

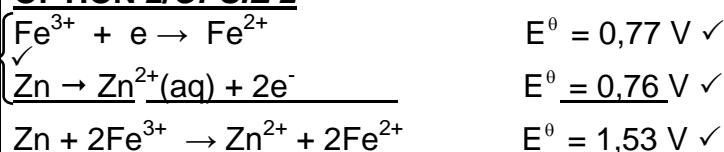
$$= 0,77 \checkmark - (-0,76) \checkmark$$

$$= 1,53 \text{ V} \checkmark$$

Notes/Aantekeninge

- Accept any other correct formula from the data sheet. /Aanvaar enige ander korrekte formule vanaf gegewensblad.
- Any other formula using unconventional abbreviations, e.g. $E^{\circ}_{cell} = E^{\circ}_{OA} - E^{\circ}_{RA}$ followed by correct substitutions. /Enige ander formule wat onkonvensionele afkortings gebruik bv. $E^{\circ}_{sel} = E^{\circ}_{OM} - E^{\circ}_{RM}$ gevolg deur korrekte vervangings: $\frac{3}{4}$

OPTION 2/OPSIE 2



(4)

8.4 Decreases/Verlaag ✓

(1)

[14]

QUESTION 9/VRAAG 9

9.1

Marking criteria/Nasienkriteria
 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.

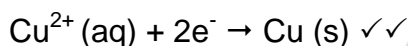
ANY ONE/ENIGE EEN:

- The chemical process in which electrical energy is converted to chemical energy. ✓✓
 Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.
- The use of electrical energy to produce a chemical change.
 Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.
- Decomposition of an ionic compound by means of electrical energy.
Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.
- The process during which an electric current passes through a solution/ionic liquid/molten ionic compound.
 Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg. (2)

9.2

Copper(II) ions/Cu²⁺/koper(II)-ione ✓
 Zinc(II) ions/Zn²⁺/sink(II)-ione ✓ (2)

9.3



Notes/Aantekeninge

Cu ²⁺ + 2e ⁻ ⇌ Cu (1/2)	Cu ← Cu ²⁺ + 2e ⁻ (2/2)
Cu ⇌ Cu ²⁺ + 2e ⁻ (0/2)	Cu ²⁺ + 2e ⁻ ← Cu (0/2)

- Ignore if charge omitted on electron./Ignoreer indien lading weggelaat op elektron.
- If charge (+) omitted on Cu²⁺/Indien lading (+) weggelaat op Cu²⁺ Max./Maks: 1/2 Example/Voorbeeld: Cu²⁺ + 2e⁻ → Cu
- Ignore phases. / Ignoreer fases. (2)

9.4

Zn²⁺ is a weaker oxidising agent ✓ than Cu²⁺ ✓ and will not be reduced to Zn. ✓
Zn²⁺ is 'n swakker oksideermiddel as Cu²⁺ en sal nie na Zn gereduseer word nie. (3)

9.5

$$\begin{aligned}
 n(\text{Cu}) &= \frac{1}{2}n_{\text{electrons/elektrone}} \\
 &= \frac{1}{2}(0,6) \checkmark \\
 &= 0,3 \text{ mol} \\
 m &= nM \\
 &= 0,3 \times 63,5 \checkmark \\
 &= 19,05 \text{ g} \checkmark
 \end{aligned}$$

Marking criteria/Nasienkriteria

- Use mol ratio/Gebruik molverhouding:
 n(Cu) : n(electrons) = 1 : 2. ✓
- Substitute/Vervang 63,5 g·mol⁻¹ in m = nM ✓
- Final answer/Finale antwoord: 19,05 g ✓

(3)
[12]

QUESTION 10/VRAAG 10

10.1

10.1.1 Nitrogen/ N_2 /*Stikstof* ✓ (1)10.1.2 Iron/Iron(II) oxide/ Fe/FeO /*yster/yster(II)oksied* ✓ (1)10.1.3 Ammonia/ NH_3 /*ammoniak* ✓ (1)10.1.4 (Fractional) distillation (of liquid air) ✓
(*Fraksionele*) *distillasie (van vloeibare lug)* (1)10.1.5 $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ bal ✓**Notes/Aantekeninge**

- Reactants ✓ Products ✓ Balancing ✓
Reaktanse ✓ *Produkke* ✓ *Balansering* ✓
- Ignore/*Ignoreer* \rightleftharpoons and phases / *en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

10.2

Marking criteria/Nasienkriteria

- Calculate/*Bereken* $m(N,P,K)$. ✓
- Determine/*Bepaal* $m(x)$. ✓
- Final answer/*Finale antwoord*: 3 : 6 : 5 ✓

**OPTION 1/OPSIE 1**

$$\%(N, P, K) = 35\%$$

$$m(N,P,K) = \frac{35}{100} \times 40 \checkmark$$

$$= 14 \text{ kg}$$

$$m(N + P + K) = 5 + x + 2x \checkmark$$

$$= 14$$

$$x = 3 \text{ kg}$$

$$N : P : K = 3 : 6 : 5 \checkmark$$

OPTION 2/OPSIE 2

$$\%(N, P, K) = 35\%$$

$$m(N,P,K) = \frac{35}{100} \times 40 \checkmark$$

$$= 14 \text{ kg}$$

$$m(N \& P) = 14 - 5 = 9 \text{ kg} \checkmark$$

$$x = \frac{1}{3} \times 9 = 3 \text{ kg}$$

$$2x = 6 \text{ kg}$$

$$N : P : K = 3 : 6 : 5 \checkmark$$

(3)

[10]**TOTAL/TOTAAL:****150**