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.

KWAZULU-NATAL

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?

A C_6H_8

B C_6H_{10}

C C_6H_{12}

D C_6H_{14} (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:

$$\text{Butane} \longrightarrow \text{methane} + \mathbf{Y}$$

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

A $CHCCH_3$

B CH_2CHCH_3

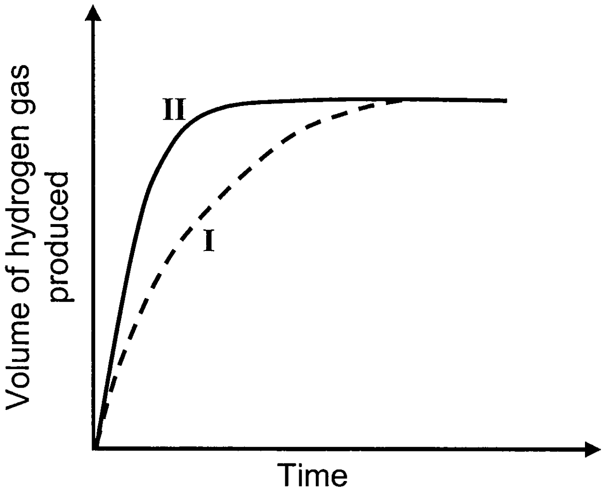
C $CH_3CH_2CH_3$

D $CH_3CHCHCH_3$ (2)

1.4 A hydrochloric acid solution, HCℓ(aq), of concentration 1 mol·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 (mol·dm^{-3})**	**TEMPERATURE (°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?

A $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

B $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

C $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

D $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ (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.

$$H_3PO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + H_2PO_4^-(aq)$$

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

A $H_3O^+(aq)$ and $H_2O(\ell)$

B $H_3PO_4(aq)$ and $H_2O(\ell)$

C $H_3PO_4(aq)$ and $H_3O^+(aq)$

D $H_3O^+(aq)$ and $H_2PO_4^-(aq)$ (2)

1.8 Consider the balanced equation for the reaction below:

$$2Cr^{2+}(aq) + Sn^{4+}(aq) \rightarrow 2Cr^{3+}(aq) + Sn^{2+}(aq)$$

The OXIDISING AGENT is:

A $Cr^{2+}(aq)$

B $Cr^{3+}(aq)$

C $Sn^{2+}(aq)$

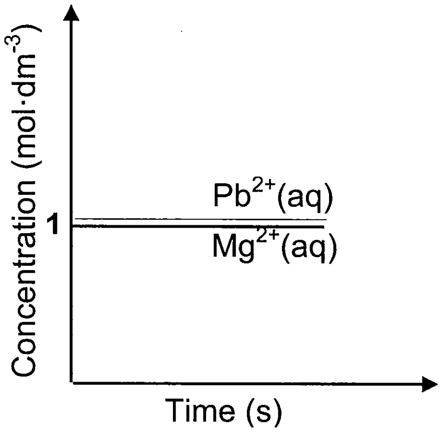
D $Sn^{4+}(aq)$ (2)

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

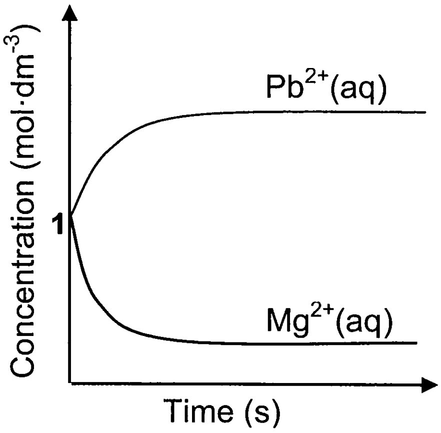
$$Mg(s) \mid Mg^{2+}(aq) \parallel Pb^{2+}(aq) \mid Pb(s)$$

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?

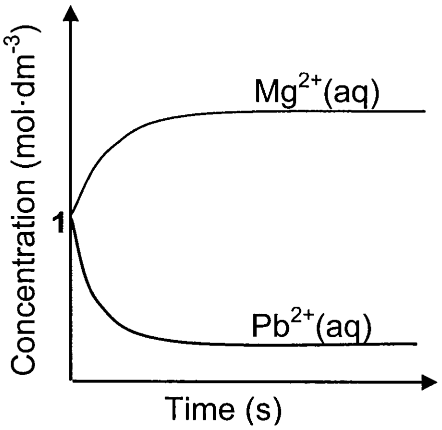
A



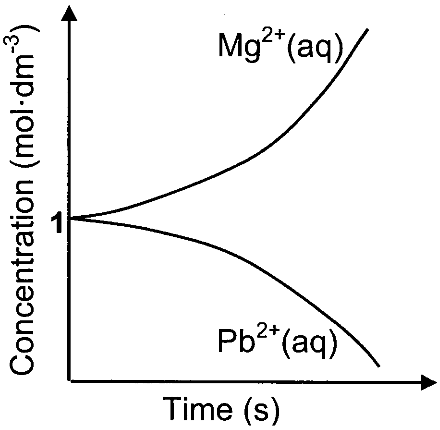
B



C



D



(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)

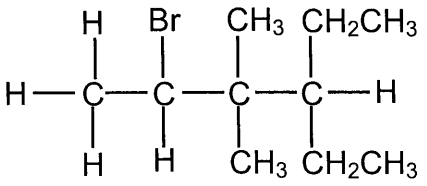
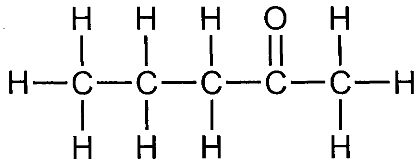
Identify the fertiliser(s) most suitable for healthy leaf growth and healthy root growth.

	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		**B**	C_xH_y
C		**D**	$CH_3(CH_2)_2CH(OH)CH_2CH_3$
E	$CH_3CH_2CH_2CH_2CH_2CH_2CHCH_2$		

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:

$$2C_xH_y + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g)$$

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 cm^3 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)

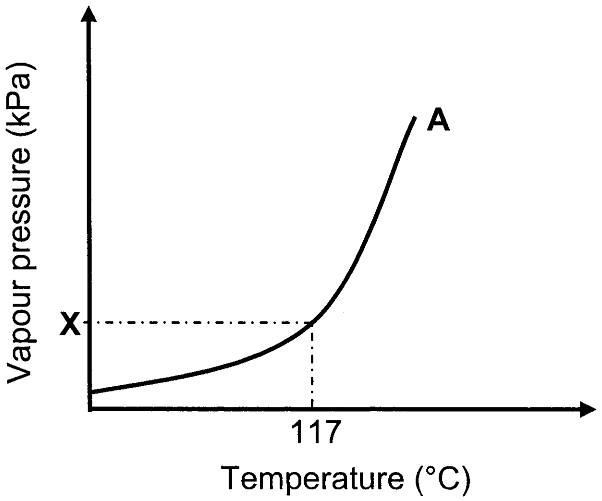
3.4 Define the term *positional isomer*. (2)

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).



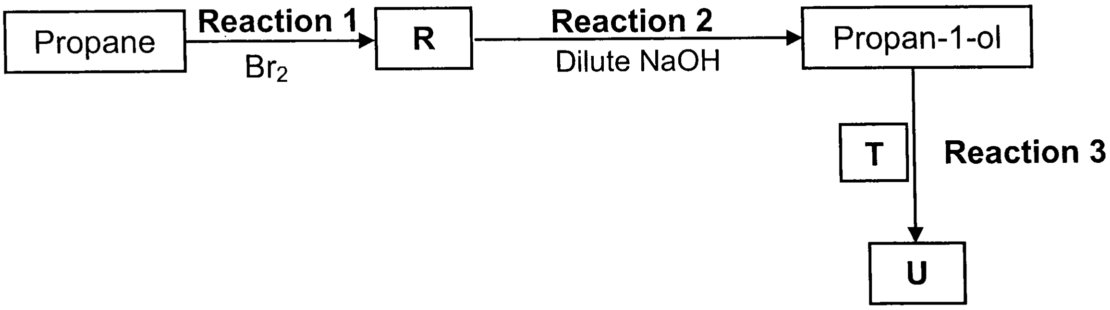
3.6.1 Write down the value of **X**. (1)

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.

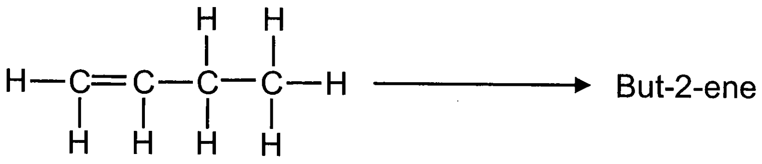
Write down the:

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.



$$\begin{array}{ccccccccc} & & & & H & & H & & \\ & & & & | & & | & & \\ H & - & C & = & C - C & - & C & - & H \\ & & | & & | \quad\; | & & | & & \\ & & H & & H \quad\; H & & H & & \end{array} \longrightarrow \text{But-2-ene}$$

The following chemicals are available in the laboratory:

concentrated H_2SO_4	H_2O	concentrated NaOH

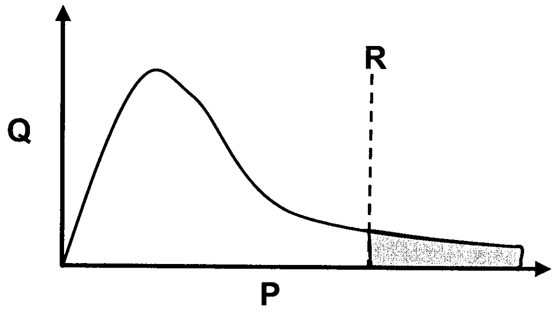
Select the chemicals required to design this preparation from the list above.

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 <u>minimum energy required for the reaction to take place</u>.

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

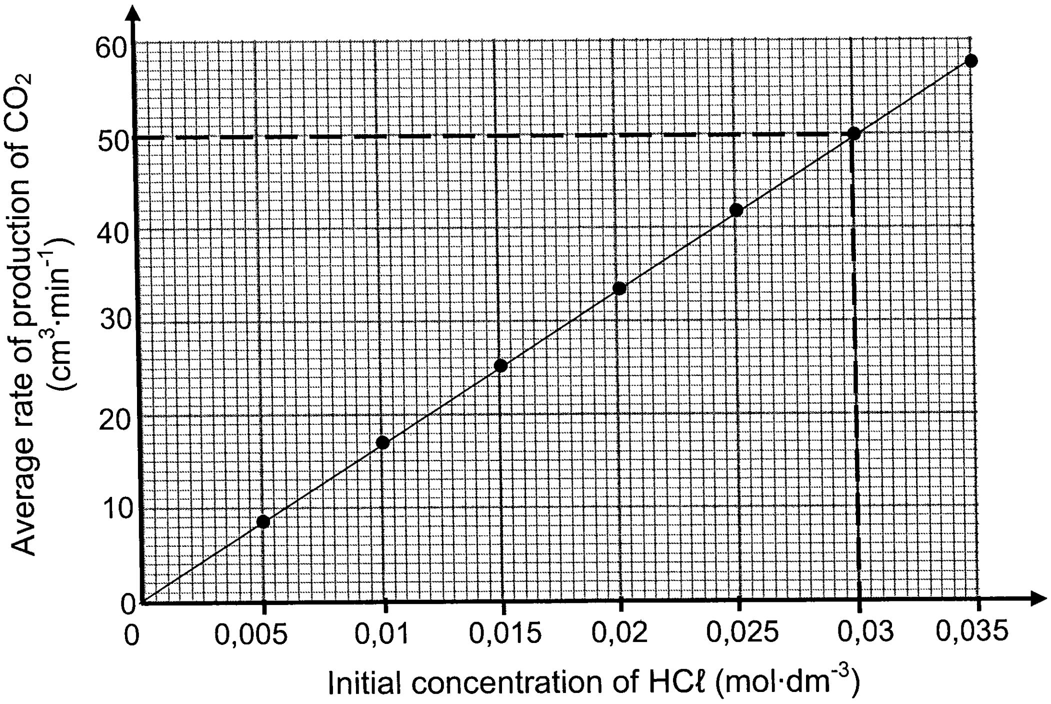
5.2.2 How will the shaded area on the graph be affected when a catalyst is added? Choose from INCREASE, DECREASE or REMAINS THE SAME. (1)

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, $CaCO_3(s)$, and EXCESS hydrochloric acid, $HC\ell(aq)$, is used to investigate reaction rate at 25 °C. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

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 $CaCO_3(s)$ in 6 g of the impure sample reacts completely with 0,03 mol·dm^{-3} $HC\ell(aq)$ 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 °C is 24 000 cm^3. (6)

[17]

QUESTION 6 (Start on a new page.)

Steam, $H_2O(g)$, reacts with hot carbon, C(s), at 1 000 °C according to the following balanced equation:

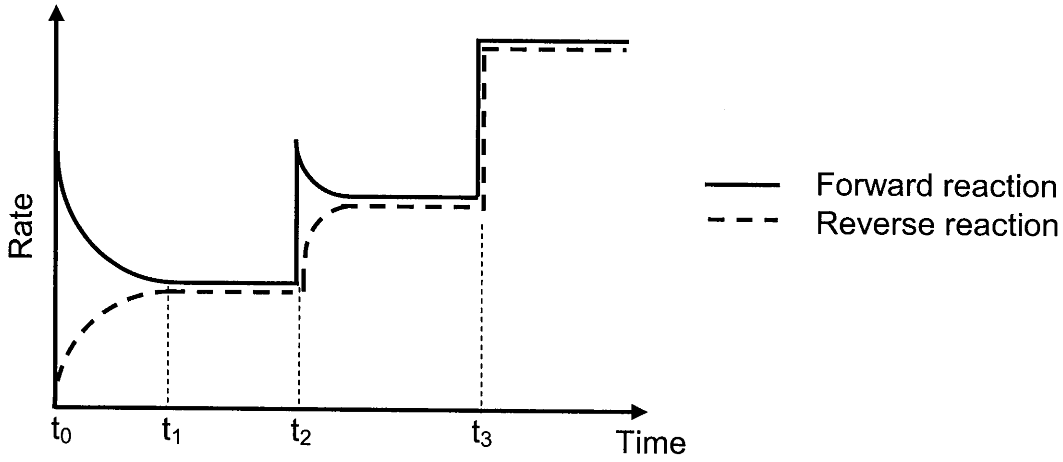
$$2H_2O(g) + C(s) \rightleftharpoons 2H_2(g) + CO_2(g)$$

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 °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 $\mathbf{t_0}$ and $\mathbf{t_1}$. (1)

6.3.2 What change was made to the equilibrium mixture at $\mathbf{t_3}$? (1)

At time $\mathbf{t_2}$, 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 cm^3 of barium hydroxide, $Ba(OH)_2(aq)$ of unknown concentration **X**

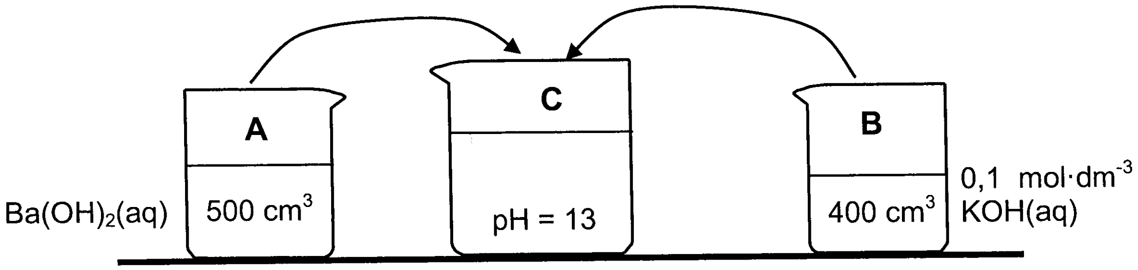
Beaker **B**: 400 cm^3 of potassium hydroxide, KOH(aq) of concentration 0,1 $mol{\cdot}dm^{-3}$

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 cm^3 of the solution neutralises 30 cm^3 of the acid.

The balanced equation for the reaction is:

$$CH_3COOH(aq) + OH^-(aq) \rightarrow CH_3COO^-(aq) + H_2O(\ell)$$

7.3.2 Is ethanoic acid, $CH_3COOH(aq)$, a WEAK acid or a STRONG acid?

Give a reason for the answer. (2)

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.

$$\mathbf{X} \mid Zn^{2+}(aq) \parallel Fe^{3+}(aq)\ ,\ Fe^{2+}(aq) \mid \mathbf{Y}$$

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)

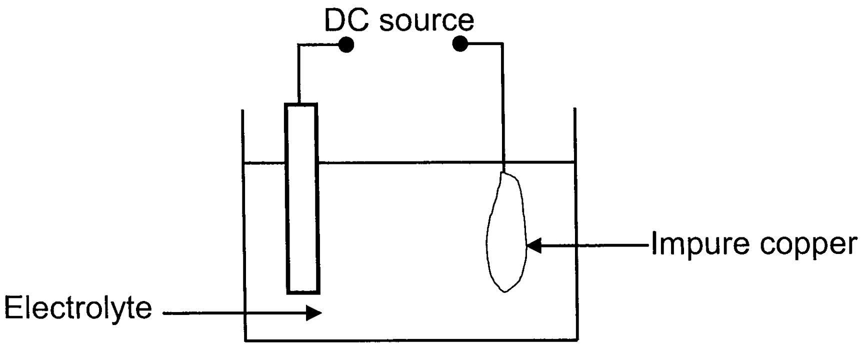
8.3 Calculate the initial emf of this cell. (4)

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 mol·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)

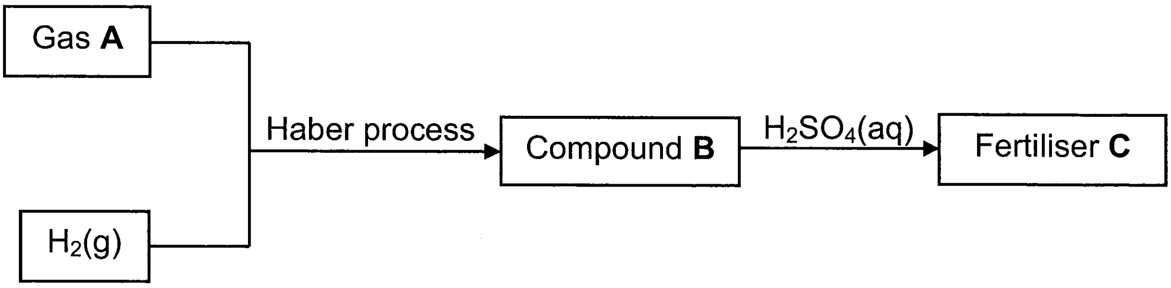
9.3 Write down the half-reaction that takes place at the cathode. (2)

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 FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising agent} - E^\theta_{reducing agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

KWAZULU-NATAL

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*: 29
Electronegativity / *Elektronegatiwiteit*: 1,9
Symbol / *Simbool*: Cu
Approximate relative atomic mass / *Benaderde relatiewe atoommassa*: 63,5

) 	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KWAZULU-NATAL

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
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 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
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 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
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 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

Half-reactions/*Halfreaksies*	E^{θ} (V)
$Li^+ + e^- \rightleftharpoons Li$	− 3,05
$K^+ + e^- \rightleftharpoons K$	− 2,93
$Cs^+ + e^- \rightleftharpoons Cs$	− 2,92
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	− 2,90
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	− 2,89
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	− 2,87
$Na^+ + e^- \rightleftharpoons Na$	− 2,71
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	− 2,36
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	− 1,66
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	− 1,18
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	− 0,91
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	− 0,76
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	− 0,74
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	− 0,44
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	− 0,41
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	− 0,40
$Co^{2+} + 2e^- \rightleftharpoons Co$	− 0,28
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	− 0,27
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	− 0,14
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	− 0,13
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	− 0,06
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2(g)}$	**0,00**
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

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)**

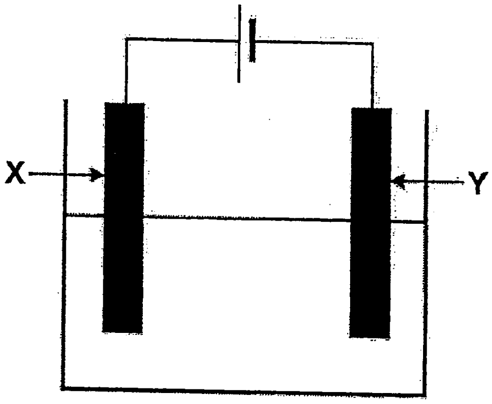
ATTENTION/*AANDAG*: **CHIEF INVIGILATOR/*HOOFTOESIGHOUER***

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	$NiSO_4(aq)$	X
B	$CuSO_4(aq)$	X
C	$NiSO_4(aq)$	Y
D	$CuSO_4(aq)$	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)
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	$-0,91$
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	$-0,83$
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	$-0,76$
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	$-0,74$
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	$-0,44$
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	$-0,41$
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	$+0,15$
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	$+0,16$
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	$+0,34$
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	$+0,40$
$Cu^+ + e^- \rightleftharpoons Cu$	$+0,52$
$Ag^+ + e^- \rightleftharpoons Ag$	$+0,80$
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	$+1,23$
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	$+1,36$

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 $Cr^{2+}(aq)$ 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]

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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.

NB the Addendum for this MEMO is at the end

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 ✓✓ ***D (the answer for the addendum to paper)*** (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

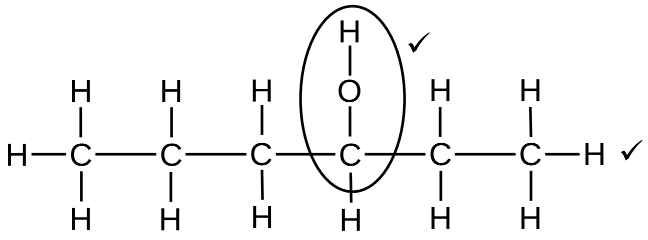
2.2.1 2-bromo-4-ethyl-3,3-dimethylhexane/*2-broom-4-etiel-3,3-dimetielheksaan*

Marking criteria/*Nasienkriteria*

- Correct stem i.e. hexane./*Korrekte stam: heksaan.* ✓
- All substituents (bromo, ethyl and dimethyl) correctly identified./*Alle substituente (broom, etiel en dimetiel) korrek geïdentifiseer.* ✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used./*Substituente 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-struktuur-formule:* $\frac{1}{2}$

(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

OPTION 1/OPSIE 1 $V(CO_2) = 8 \times V_B$ $= 8(50)$ $= 400\ cm^3$ $V(H_2O) = \frac{18}{2} V_B$ ✓ $= 9(50)$ $= 450\ cm^3$ Total volume gas formed/ *Totale volume gas gevorm* $= 400 + 450$ ✓ $= 850\ cm^3$ ✓	**Marking criteria/*Nasienkriteria*** • Use volume ratio/*Gebruik volume verhouding:* $V(CO_2) : V(B) = 2 : 1$ and/en $V(H_2O) : V(B) = 9 : 1$ ✓ • Add/*Tel bymekaar:* $V(CO_2)$ and/*en* $V(H_2O)$ ✓ • Final answer/*Finale antwoord:* $850\ cm^3$ ✓
	OPTION 2/OPSIE 2 2 mol C_XH_Y .... 16 + 18 = 34 mol gas ✓ 50 mol C_XH_Y .... 25 x 34 ✓ mol gas Total moles gas formed/*Totale volume gas gevorm* = $850\ cm^3$ ✓

(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 ✓

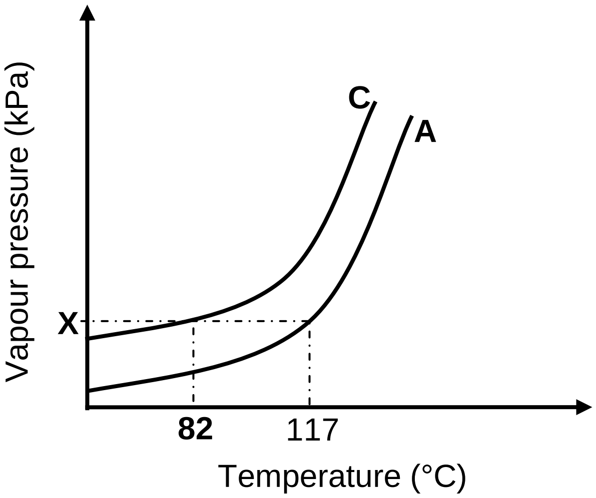
The C-atom bonded to the functional group/OH-group/hydroxyl (group) is bonded to three other C-atoms. ✓
Die C-atoom aan die funksionele groep/OH-groep/hidroksiel(groep) gebind is, is aan drie ander C-atome gebind.

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 10^5 Pa / 1 atm / 760 mmHg ✓ (1)

3.6.2



<u>Marking criteria/*Nasienkriteria*:</u>
- 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. ✓

<u>IF/*INDIEN*:</u>
- Curves start at same point/*Indien kurwes by dieselfde punt begin:* Max./*Maks.* $^1\!/_2$
- Straight line graph/*Reguitlyn grafiek.* Max./*Maks.* $^1\!/_2$

(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*. $\frac{1}{2}$

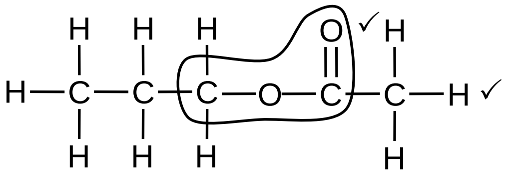
(2)

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

swaelsuur ✓ (1)

4.1.5 Ethanoic acid/*Etanoësuur* ✓✓ (2)

4.1.6

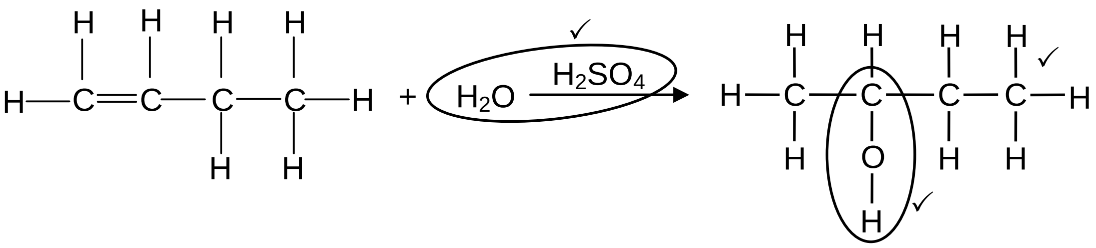


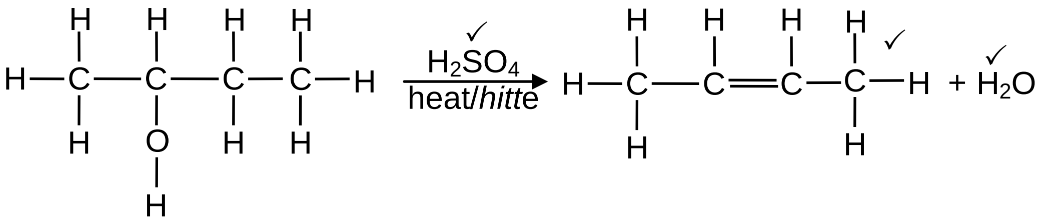
Marking criteria/*Nasienkriteria:*
- Functional group correct. ✓
  Funksionele groep korrek.
- Whole structure correct. ✓✓
  Hele struktuur korrek.

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 efffective collisions increases. ✓
- Increase raction 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.* ✓ (4)

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 $cm^3 \cdot min^{-1}$ and 26 minutes in rate = $\frac{\Delta V}{\Delta t}$ ✓
- Substitute/ *Vervang* 1 300 cm^3 /1,3 dm^3 **OR/*OF*** 24 000 $cm^3 \cdot mol^{-1}$/ 24 $dm^3 \cdot mol^{-1}$ in n = $\frac{V}{V_m}$ ✓
- Use ratio/*Gebruik verhouding* $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute/*Vervang* 100 $g \cdot mol^{-1}$ in n = $\frac{m}{M}$ ✓
- Calculate % purity/*Bereken % suiwerheid* = $\frac{m(CaCO_3)}{m(Sample/\ monster)}$ ✓ x 100
- Final answer/*Finale antwoord:* 90,33% ✓
  Range/*Gebied*: 83,33% to 90,33%

OPTION 1

Rate/*tempo* = $\frac{\Delta V}{\Delta t}$

$50 = \frac{\Delta V}{26}$ ✓

$\Delta V = 1\ 300\ cm^3$

$n(CO_2) = \frac{1300}{24\ 000}$ ✓ **OR** $\frac{1,3}{24}$

$= 0,0542$ mol

$n(CaCO_3) = n(CO_2)$

$= 0,0542$ mol ✓

$m(CaCO_3) = nM$ ✓

$= 0,0542 \times 100$

$= 5,42$ g

% purity/*suiwerheid* = $\frac{5,42}{6}$ ✓ x 100

= 90,33% ✓

OPTION 2:

Rate/*tempo* = $\frac{50}{24\ 000}$ ✓

$= 0,00208\ mol \cdot min^{-1}$ ✓

$n(CO_2) = 0,00208 \times 26$

$= 0,0542$ mol

$n(CaCO_3) = n(CO_2) = 0,0542$ mol ✓

$m(CaCO_3) = nM$ ✓

$= 0,0542(100)$

$= 5,42$ g

% purity/*suiwerheid* = $\frac{5,42}{6}$ ✓ x 100

= 90,33% ✓

(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 g·mol^{-1} in n = $\frac{m}{M}$ ✓
- Δn(CO_2) = Δn(C) = 0,225 mol. ✓
- Use mole ratio/Gebruik n(C) : n(H_2O) : n(CO_2) : n(H_2) = ! : 2 : 1 : 2 ✓
- Equilibrium/*Ewewig* n(H_2O) = initial/*aanvaklike* n(H_2O) - Δn(H_2O)
  Equilibrium/*Ewewig* n(H_2) = initial/*aanvanklike* n(H_2) + Δn(H_2)
  Equilibrium/*Ewewig* n(CO_2) = initial/*aanvanklike* n(CO_2) + Δn(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 x 10^{-3} to/*tot* 1 x 10^{-2})

OPTION 1/*OPSIE 1*

$$n(H_2O)_{initial/aanvanklik} = \frac{m}{M} = \frac{36}{18}✓ = 2 \text{ mol}$$

	H_2O	H_2	CO_2	
Initial amount (moles) *Aanvangs hoeveelheid (mol)*	2			
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,45	0,45	0,225 ✓	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	1,55	0,45	0,225	✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,775	0,225	0,1125	Divide by/ Deel deur 2 dm^3 ✓

$$K_c = \frac{[H_2]^2[CO_2]}{[H_2O]^2} ✓$$

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

$$= 0{,}00948 ✓$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* 7/8

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* 5/8

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

- Substitute/*Vervang* 18 g·mol^{-1} in n = $\frac{m}{M}$ ✓
- Divide initial/*Deel aanvanklike* n(H_2O) AND Δn(CO_2) by/*deur* 2 dm^3.✓
- Δn(CO_2) = Δn(C) = 0,225 mol OR/*OF* Δc(CO_2) = 0,1125 mol·dm^{-3}. ✓
- Use mole ratio/*Gebruik molverhouding* n(H_2O) : n(CO_2) : n(H_2) = 2 : 1 : 2 ✓
- Equilibrium/*Ewewig* c(H_2O) = initial/*aanvanklike* c(H_2O) - Δc(H_2O)
  Equilibrium/*Ewewig* c(H_2) = initial/*aanvanklike* c(H_2) + Δc(H_2) } ✓
  Equilibrium/*Ewewig* c(CO_2) = initial/*aanvanklike* c(CO_2) + Δc(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*

$$n(H_2O)_{initial/aanvanklik} = \frac{m}{M} = \frac{36}{18}✓ = 2\ mol$$

	H_2O	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

$$K_c = \frac{[H_2]^2[CO_2]}{[H_2O]^2} ✓$$
$$= \frac{[0,225]^2[0,1125]}{[0,775]^2} ✓$$
$$= 0,00948 ✓$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^7/_8$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $^5/_8$

(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/$OH^-(aq)$. ✓✓
'n Basis vorm hidroksiedione (OH^-) in water/waterige oplossing/$OH^-(aq)$.

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(KOH) = cV
= 0,1 x 0,4 ✓
= 0,04 mol
$n(OH^-)$ = n(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*: pH = $-\log[H_3O^+]$
- Substitute/*Vervang* pH = 13/pOH = 1
- Substitute/*Vervang* 1×10^{-13} in K_w/Calculate/*Bereken* pOH
- Substitute/*Vervang* of 0,1 x 0,9
- Calculate/*Bereken* $n(OH^-)$ = n(in C) – n(in B) ✓
- Use mol ratio/*Gebruik molverhouding*: $n(Ba(OH)_2)$: $n(OH^-)$ = 1 : 2. ✓
- Substitute/*Vervang* 0,5 dm^3. ✓
- Final answer/*Finale antwoord*: 0,05 $mol \cdot dm^{-3}$ ✓
  Range/*Gebied*: 0,05 to 0,06 $mol \cdot dm^{-3}$

OPTION 1/*OPSIE 1*

pH = $-\log[H_3O^+]$ **OR/*OF*** $[H_3O^+] = 10^{-pH}$ ✓
13 ✓= $-\log[H_3O^+]$ **OR/*OF*** $[H_3O] = 10^{-13}$
$[H_3O^+] = 1 \times 10^{-13}$ $mol \cdot dm^{-3}$

$[H_3O^+][OH^-] = 1 \times 10^{-14}$
$(1 \times 10^{-13})[OH^-] = 1 \times 10^{-14}$ ✓
$[OH^-]$ = 0,1 $mol \cdot dm^{-3}$

$n(OH^-)$ = cV
= 0,1 x 0,9 ✓
= 0,09 mol

OPTION 2/*OPSIE 2*

pOH = 14 - 13 = 1 ✓
pOH = $-\log[OH^-]$ ✓
1 ✓ = $-\log[OH^-]$
$[OH^-]$ = 0,1 $mol \cdot dm^{-3}$

$n(OH^-)$ = cV
= 0,1 x 0,9 ✓
= 0,09 mol

$n(OH^-)$ from/*van* $Ba(OH)_2$ in beaker/*beker* **C** = 0,09 - 0,04✓
= 0,05 mol

$n[Ba(OH)_2]$ = ½ $n(OH^-)$
= ½ (0,05) ✓
= 0,025 mol

$$c[Ba(OH)_2] = \frac{n}{V}$$

$$= \frac{0,025}{0,5 ✓}$$

$\therefore$ x = 0,05 $mol \cdot dm^{-3}$ ✓ (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 x 15 / 0,1 x 0,015 ✓ **OR/*OF***
  Use/*Gebruik* $V_a = 30\ cm^3$
- Use mol ratio/*Gebruik molverhouding* 1 : 1 ✓
- Final answer/*Finale antwoord*: $0{,}05\ mol{\cdot}dm^{-3}$.✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(OH^-) = cV$ ✓ $= 0{,}1 \times 0{,}015$ ✓ $= 0{,}0015\ mol$ $n(CH_3COOH) = n(OH^-)$ $= 0{,}0015\ mol$ ✓ $c = \frac{n}{V}$ $= \frac{0{,}0015}{0{,}03}$ $= 0{,}05\ mol{\cdot}dm^{-3}$ ✓	$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓ $\frac{c_a \times 30}{0{,}1 \times 15}$ ✓ $= \frac{1}{1}$ ✓ $c_a = 0{,}05\ mol{\cdot}dm^{-3}$ ✓

(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 <u>Iron(III) ions</u>/Fe^{3+}(aq)/Fe^{3+} ions/*Yster(III)-ione/*Fe^{3+}*-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 $Fe^{3+} + e^- \rightarrow Fe^{2+}$ ✓✓

<u>Marking criteria/*Nasienkriteria*</u>

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

(2)

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

<u>Notes/*Aantekeninge*</u>

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

(3)

8.3

<u>OPTION 1/*OPSIE 1*</u>	**<u>Notes/*Aantekeninge*</u>**
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ $= 0{,}77$ ✓$- (-0{,}76)$ ✓ $= 1{,}53$ V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $\frac{3}{4}$

<u>OPTION 2/*OPSIE 2*</u>

$Fe^{3+} + e \rightarrow Fe^{2+}$ $E^\theta = 0{,}77$ V ✓
✓
<u>$Zn \rightarrow Zn^{2+}(aq) + 2e^-$</u> E^θ <u>$= 0{,}76$</u> V ✓
$Zn + 2Fe^{3+} \rightarrow Zn^{2+} + 2Fe^{2+}$ $E^\theta = 1{,}53$ V ✓

(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/Cu^{2+}/*koper(II)-ione* ✓
Zinc(II) ions/Zn^{2+}/*sink(II)-ione* ✓ (2)

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

Notes/*Aantekeninge*

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

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Cu^{2+}/*Indien lading (+) weggelaat op* Cu^{2+} Max./*Maks:* $\frac{1}{2}$ Example/*Voorbeeld:* $Cu^2 + 2e^- \rightarrow Cu$
- Ignore phases. / *Ignoreer fases.*

(2)

9.4 Zn^{2+} is a weaker oxidising agent ✓ than Cu^{2+} ✓ and will not be reduced to Zn. ✓
Zn^{2+} is 'n swakker oksideermiddel as Cu^{2+} en sal nie na Zn gereduseer word nie. (3)

9.5 n(Cu) = ½$n_{electrons/elektrone}$
= ½(0,6) ✓
= 0,3 mol

m = nM
= 0,3 x 63,5 ✓
= 19,05 g ✓

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 ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* ⇌ 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*	**OPTION 2/*OPSIE 2***
%(N, P, K) = 35%	%(N, P, K) = 35%
$m(N,P,K) = \frac{35}{100} \times 40$ ✓ = 14 kg	$m(N,P,K) = \frac{35}{100} \times 40$ ✓ = 14 kg
m(N + P + K) = 5 + x + 2x ✓ = 14 x = 3 kg	m(N & P) = 14 – 5 = 9 kg ✓
	$x = \frac{1}{3} \times 9 = 3$ kg
	2x = 6 kg
N : P : K = 3 : 6 : 5 ✓	N : P : K = 3 : 6 : 5 ✓

(3)
[10]

TOTAL/*TOTAAL*: 150

Physical science P2 Addendum
Marking guidelines

QUESTION 1

1.10 D ✓✓ (2)

QUESTION 10

10.1 A substance that is oxidised/loses electrons. ✓✓ (2)

10.2

10.2.1 Cr/chromium ✓ (1)

10.2.2 $2C\ell^-(aq) \rightarrow C\ell_2(g) + 2e^-$ ✓✓ Ignore phases (2)

Marking guidelines

- $C\ell_2(g) + 2e^- \leftarrow 2C\ell^-(aq)$ (2⁄2) $2C\ell^-(aq) \rightleftharpoons C\ell_2(g) + 2e^-$ (1⁄2)

  $C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-(aq)$ (0⁄2) $2C\ell^-(aq) \leftarrow C\ell_2(g) + 2e^-$ (0⁄2)

- Ignore if charge omitted on electron.

- If charge (-) omitted on $C\ell^-$:

  Example*:* $2C\ell(aq) \rightarrow C\ell_2(g) + 2e^-$ ✓ Max.*:* 1⁄2

10.2.3 - 0,41 V (1)

10.3

10.3.1 No ✓ (1)

10.3.2 Zn is a stronger reducing agent ✓ than Cu ✓and will be oxidised to (Zn^{2+}). ✓

OR

Cu is a weaker reducing agent ✓ than Zn ✓and therefore Zn will be oxidised ✓ (to Zn^{2+}).

OR

Cu^{2+} is a stronger oxidising agent ✓ than Zn^{2+} ✓and therefore Cu^{2+} will be reduced ✓ (to Cu).

OR

Zn^{2+} is a weaker oxidising agent ✓ than Cu^{2+} ✓and therefore Cu^{2+} will be reduced ✓ (to Cu). (3)

[10]