basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre 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.

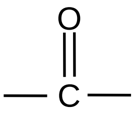
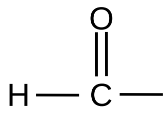
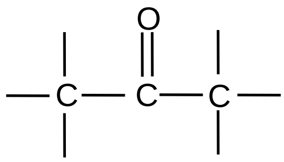
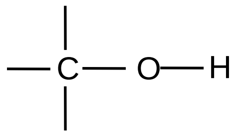
11. You are advised to use the attached DATA SHEETS.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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 D.

1.1 Which ONE of the following is the structural formula of the functional group of the KETONES?

A		**B**	
C		**D**	

(2)

1.2 Which ONE of the formulae below represents an ALKANE?

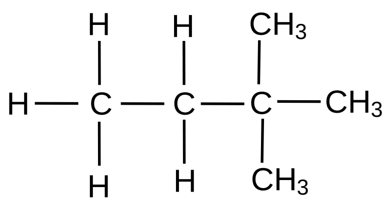
A C_2H_4

B C_5H_{10}

C $C_{14}H_{30}$

D C_8H_{14} (2)

1.3 Consider the organic compound below.



The IUPAC name of this compound is …

A 2,3-dimethyl butane.

B 3,3-dimethyl butane.

C 2,2-dimethyl butane.

D 1,1,1-trimethyl propane. (2)

1.4 Activation energy can best be described as the minimum energy required to …

A cause effective collisions.

B make reactant molecules collide.

C change the orientation of reactant molecules.

D increase the kinetic energy of reactant molecules. (2)

1.5 Which statement is CORRECT for a system in DYNAMIC EQUILIBRIUM?

A All reactants are used up.

B The forward reaction is equal to the reverse reaction.

C All substances in the reaction are of equal concentration.

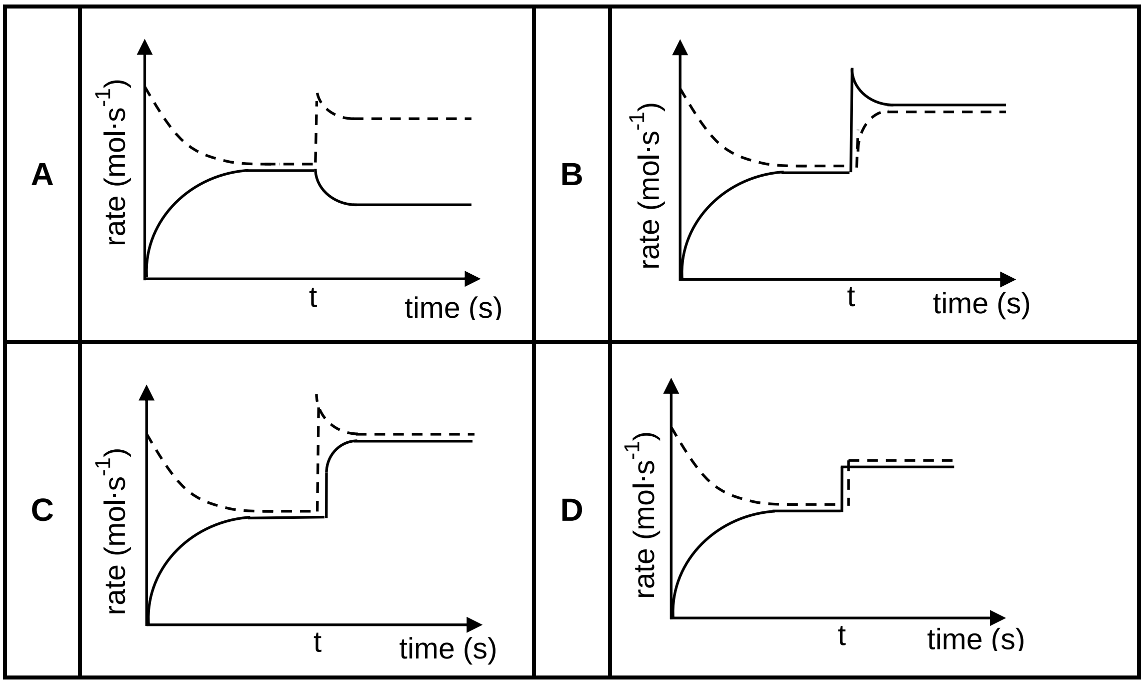
D The concentration of the reactants and products remain constant. (2)

1.6 Initially, a certain amount of P(g) was placed in an empty container. The hypothetical reaction reaches equilibrium in a closed container according to the following balanced equation:

$$P(g) \rightleftharpoons 2Q(g) \qquad \Delta H < 0$$

At time t, the temperature is increased.

Which graph below best illustrates the resulting changes in the rates of the forward and reverse reactions after the temperature is increased?



(2)

1.7 Reactions **I** and **II** below have equilibrium constants (K_c) greater than 1.

I: $H_3X + HCO_3^- \rightleftharpoons H_2X^- + H_2CO_3$ $K_c > 1$

II: $H_3O^+ + H_2X^- \rightleftharpoons H_2O + H_3X$ $K_c > 1$

Based on the reactions above, the ACIDS in order of INCREASING STRENGTH (weakest to strongest) are …

A H_3X, H_2X^-, H_3O^+

B H_2CO_3, H_3X, H_3O^+

C H_3X, H_2CO_3, H_3O^+

D H_3X, H_3O^+, H_2CO_3 (2)

1.8 Consider the cell notation for a galvanic cell below.

$$Ni(s) \mid Ni^{2+}(aq) \parallel H^+(aq) \mid H_2(g) \mid Pt(s)$$

Which ONE of the following half-reactions takes place at the ANODE of this cell?

A $2H^+(aq) + 2e^- \rightarrow H_2(g)$

B $H_2(g) \rightarrow 2H^+(aq) + 2e^-$

C $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

D $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^-$ (2)

1.9 Which ONE of the following is applicable to an ELECTROLYTIC CELL?

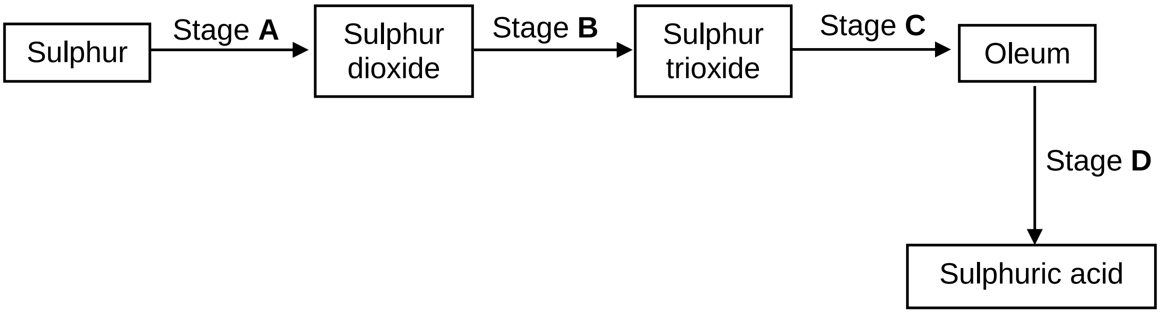
A Reduction takes place at the anode.

B Oxidation takes place at the cathode.

C It uses alternating current.

D A battery is used for the cell to function. (2)

1.10 The flow diagram below shows four stages (**A**, **B**, **C** and **D**) in the conversion of sulphur to sulphuric acid.



At which stage is a catalyst used?

A **A**

B **B**

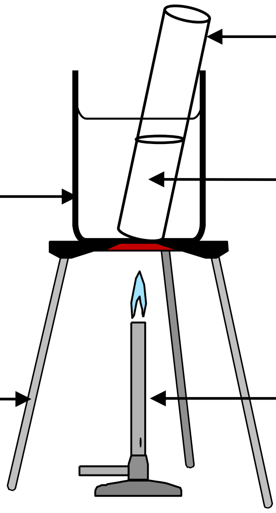
C **C**

D **D** (2)

[20]

QUESTION 2 (Start on a new page.)

A test tube containing a straight chain organic acid **X**, ethanol and a catalyst is heated in a water bath, as illustrated below.



Organic compound **Y** is produced according to the following equation:

$$\mathbf{X} + C_2H_5OH \longrightarrow \mathbf{Y} + H_2O$$

2.1 Give a reason why the test tube is heated in a water bath instead of directly over the flame. (1)

2.2 Write down the:

2.2.1 Type of reaction that takes place here (1)

2.2.2 FORMULA of the catalyst needed (1)

2.2.3 Homologous series to which compound **Y** belongs (1)

The molecular mass of compound **Y** is 144 $g\cdot mol^{-1}$ and its empirical formula is C_4H_8O.

2.3 Determine the molecular formula of compound **Y**. (2)

2.4 Write down the IUPAC name of compound **Y**. (2)

2.5 Write down the structural formula of the organic acid **X**. (2)
[10]

QUESTION 3 (Start on a new page.)

The boiling points of different organic compounds are given below.

COMPOUND		BOILING POINT (°C)
A	HCOOH	101
B	CH_3COOH	118
C	CH_3CH_2COOH	141
D	$CH_3CH_2CH_2COOH$	164

3.1 Define *boiling point*. (2)

3.2 Write down the:

3.2.1 Name of the FUNCTIONAL GROUP of these compounds (1)

3.2.2 IUPAC name of compound **C** (1)

3.2.3 Structural formula of the FUNCTIONAL isomer of compound **B** (2)

3.3 Which ONE of the compounds, **A** or **B** or **C**, has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)

3.4 The boiling point of compound **B** is now compared with of compound **X**.

COMPOUND		BOILING POINT (°C)
B	CH_3COOH	118
X	$CH_3CH_2CH_2OH$	98

3.4.1 Besides the conditions used to determine boiling points, give a reason why this is a fair comparison. (1)

3.4.2 Is compound **X** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

3.4.3 Fully explain the difference between the boiling points by referring to the types of intermolecular forces present in each of these compounds. (4)
[15]

QUESTION 4 (Start on a new page.)

4.1 Three reactions of organic compounds from the same homologous series are shown below.

I:	Butane + Br_2 $\longrightarrow$ 2-bromobutane + **P**
II:	Pentane + excess oxygen $\xrightarrow{\text{heat}}$
III:	Hexane $\longrightarrow$ C_2H_4 + **Q**

4.1.1 Define a *homologous series*. (2)

4.1.2 Name the type of reaction represented by **I**. (1)

4.1.3 Write down the formula of the inorganic compound **P**. (1)

4.1.4 Give the structural formula of a POSITIONAL isomer of 2-bromobutane. (2)

4.1.5 Using molecular formulae, write down the balanced equation for reaction **II**. (3)

Reaction **III** is an example of a cracking reaction.

4.1.6 Define a *cracking reaction*. (2)

4.1.7 Give the structural formula of organic compound **Q**. (2)

4.2 Study the flow diagram below.

2-bromobutane $\xrightarrow{\text{Hydrolysis}}$ Compound **R** $\longrightarrow$ Alkene

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

4.2.2 Compound **R** reacts in the presence of concentrated phosphoric acid to form an alkene.

Write down the structural formula of the MAJOR PRODUCT in this reaction. (2)

[17]

QUESTION 5 (Start on a new page.)

The reaction of zinc and EXCESS dilute hydrochloric acid is used to investigate factors that affect reaction rate. The balanced equation for the reaction is:

$$Zn(s) + 2HC\ell(aq) \longrightarrow ZnC\ell_2(aq) + H_2(g)$$

The reaction conditions used and the results obtained for each experiment are summarised in the table below.

The same mass of zinc is used in all the experiments. The zinc is completely covered in all reactions. The reaction time is the time it takes the reaction to be completed.

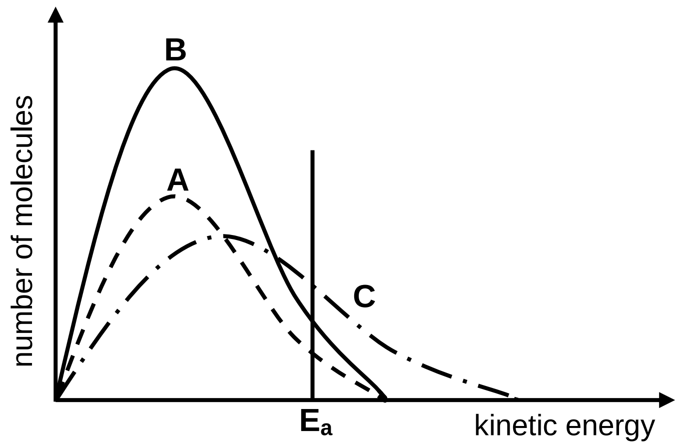
EXPERIMENT	CONCENTRATION OF HCℓ ($mol \cdot dm^{-3}$)	VOLUME OF HCℓ (cm^3)	STATE OF DIVISION OF Zn	TEMPERATURE OF HCℓ (°C)	REACTION TIME (min.)
1	2,0	200	powder	25	7
2	1,5	200	granules	25	14
3	5,0	200	powder	25	5
4	1,5	400	granules	25	**x**
5	2,0	200	powder	35	4

5.1 Experiment **1** and experiment **5** are compared. Write down the independent variable. (1)

5.2 Define *reaction rate*. (2)

5.3 Write down the value of **x** in experiment **4**. (2)

5.4 The Maxwell-Boltzmann energy distribution curves for particles in each of experiments **1**, **3** and **5** are shown below.



Identify the graph (**A** or **B** or **C**) that represents the following:

5.4.1 Experiment **3**
Give a reason for the answer. (2)

5.4.2 Experiment **5**
Give a reason for the answer. (2)

5.5 Experiment **6** is now conducted using a catalyst and the SAME reaction conditions as for Experiment **1**.

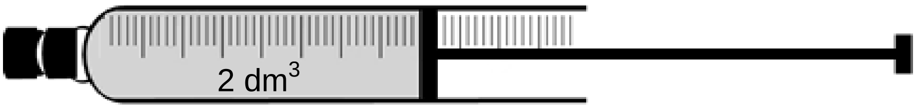
5.5.1 What is the function of the catalyst in this experiment? (1)

5.5.2 How will the heat of reaction in experiment **6** compare to that in experiment **1**? Choose from: GREATER THAN, EQUAL TO or LESS THAN. (1)

5.6 Calculate the average rate of the reaction (in $mol \cdot min^{-1}$) with respect to zinc for experiment **2** if 1,5 g of zinc is used. (4)
[15]

QUESTION 6 (Start on a new page.)

Dinitrogen tetraoxide, $N_2O_4(g)$, decomposes to nitrogen dioxide, $NO_2(g)$, in a sealed syringe of volume 2 dm^3.



The mixture reaches equilibrium at 325 °C according to the following balanced equation:

$$\underset{\text{colourless}}{N_2O_4(g)} \rightleftharpoons \underset{\text{brown}}{2NO_2(g)}$$

When equilibrium is reached, it is observed that the colour of the gas in the syringe is brown.

6.1 State Le Chatelier's principle. (2)

6.2 The syringe is now dipped into a beaker of ice water. After a while the brown colour disappears.

Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer using Le Chatelier's principle. (3)

6.3 The volume of the syringe is now decreased while the temperature is kept constant.

How will EACH of the following be affected? Choose from: INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The number of moles of $N_2O_4(g)$ (1)

6.3.2 The value of the equilibrium constant (1)

6.3.3 The rate of the forward and reverse reactions (1)

6.4 Initially **X** moles of $N_2O_4(g)$ were placed in the syringe of volume 2 dm^3. When equilibrium was reached, it was found that 20% of the $N_2O_4(g)$ had decomposed.

If the equilibrium constant, K_c, for the reaction is 0,16 at 325 °C, calculate the value of **X**. (8)
[16]

QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid is a strong acid present in acid rain. It ionises in two steps as follows:

I:	$H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + HSO_4^-(aq)$
II:	$HSO_4^-(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + SO_4^{2-}(aq)$

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Write down the FORMULA of the conjugate base of $H_3O^+(aq)$. (1)

7.1.3 Write down the FORMULA of the substance that acts as an ampholyte in the ionisation of sulphuric acid. (2)

7.2 Acid rain does not cause damage to lakes that have rocks containing limestone ($CaCO_3$). Hydrolysis of $CaCO_3$ results in the formation of ions, which neutralise the acid.

7.2.1 Define *hydrolysis* of a salt. (2)

7.2.2 Explain, with the aid of the relevant HYDROLYSIS reaction, how limestone can neutralise the acid. (3)

7.3 The water in a certain lake has a pH of 5.

7.3.1 Calculate the concentration of the hydronium ions in the water. (3)

The volume of water in the lake is 4×10^9 dm^3. Lime, CaO, is added to the water to neutralise the acid according to the following reaction:

$$CaO + 2H_3O^+ \rightleftharpoons Ca^{2+} + 3H_2O$$

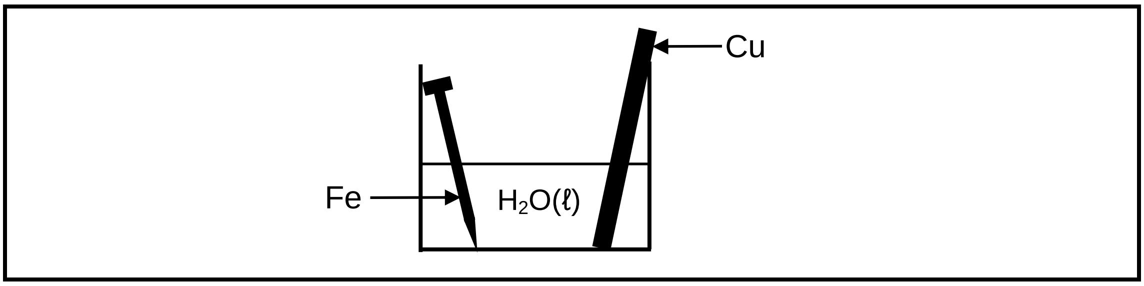
7.3.2 If the final amount of hydronium ions is $1,26 \times 10^3$ moles, calculate the mass of lime that was added to the lake. (7)
[20]

QUESTION 8 (Start on a new page.)

8.1 Corrosion is a redox reaction that takes place in the presence of oxygen and water. Rusting is the corrosion of iron leading to the formation of iron(III) ions.

8.1.1 Define *oxidation* in terms of electron transfer. (2)

A cleaned copper rod and a cleaned iron nail are placed in a beaker containing water at 25°C, as shown below.



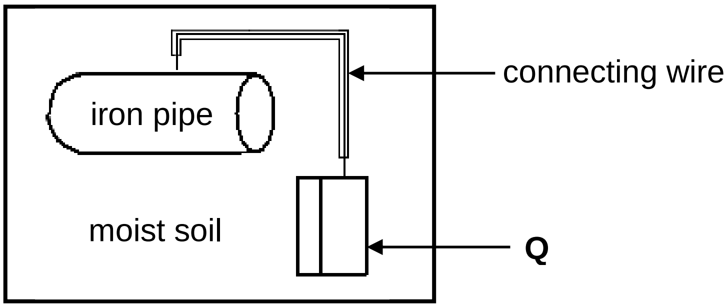
After a while it was observed that the iron nail was coated with rust. The copper rod showed no visible signs of corrosion.

8.1.2 Write down the half-reaction for the iron nail. (2)

8.1.3 Does iron act as REDUCING AGENT or OXIDISING AGENT in the beaker? (1)

8.1.4 Explain the above observation by referring to the Table of Standard Reduction Potentials. (3)

To prevent rusting of an underground iron pipe, the pipe is connected to a metal (**Q**) that corrodes easily.



8.1.5 You are given two metals, Zn and Cu, to use as metal **Q**. Which metal would more suitable? Give a reason. (2)

8.2 A galvanic cell is constructed using a Fe | Fe^{3+} half-cell and a Cu | Cu^{2+} half-cell.

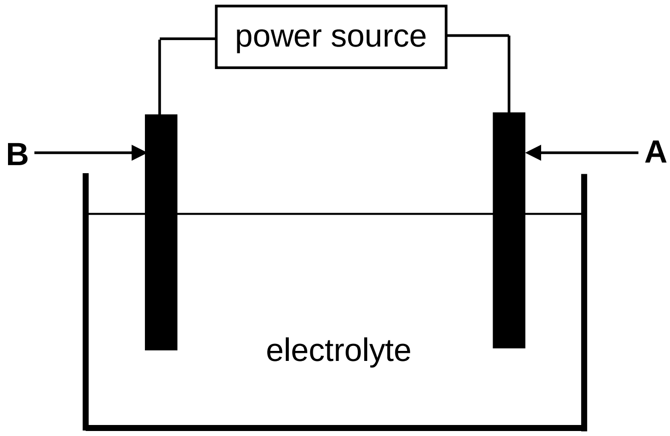
8.2.1 Write down the overall (net) cell reaction that takes place when the cell is functioning. (3)

8.2.2 Calculate the cell potential of this cell under standard conditions. (4)

[17]

QUESTION 9 (Start on a new page.)

The electrolytic cell below is set up to obtain pure copper from a piece of impure copper.



The impure copper contains other metals, such as platinum, iron, cobalt, silver and nickel.

The cell potential of the power source is adjusted so that only copper is deposited on electrode **B**.

9.1 Define an *electrolytic cell*. (2)

9.2 Write down the FORMULA of a suitable electrolyte for this cell. (1)

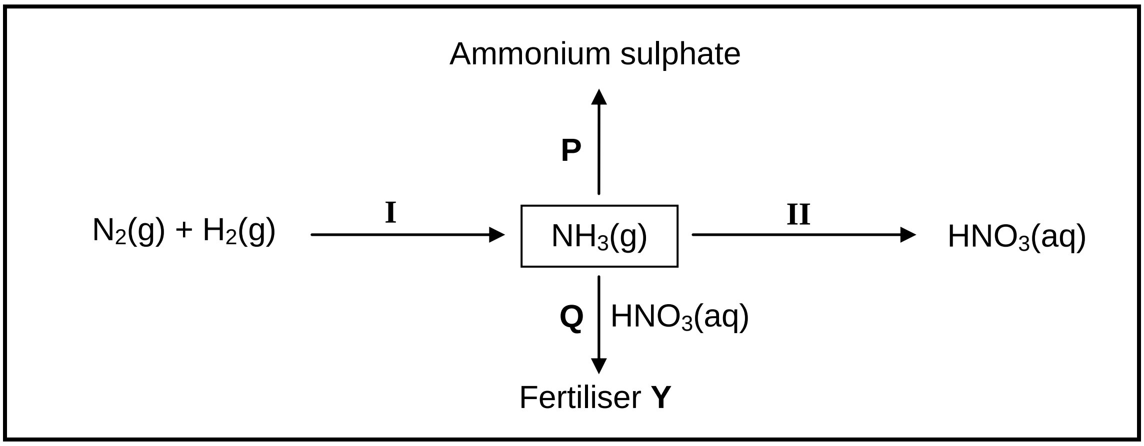
9.3 Which electrode (**A** or **B**) is the cathode?
Write down the relevant half-reaction taking place at this electrode. (3)

9.4 Sludge forms below one of the electrodes while the cell above is in operation. Which of the metals, PLATINUM, IRON, COBALT, SILVER or NICKEL, will be present in the sludge? (2)
[8]

QUESTION 10 (Start on a new page.)

In the flow diagram below, **I** and **II** represent industrial processes used in the fertiliser industry.

P and **Q** are chemical reactions that take place to produce ammonium sulphate and fertiliser **Y** respectively.



10.1 Write down the name of the industrial process:

10.1.1 **I** (1)

10.1.2 **II** (1)

10.2 Write down the NAME or FORMULA of:

10.2.1 Fertiliser **Y** (1)

10.2.2 The catalyst used in process **I** (1)

10.3 In reaction **P**, $NH_3(g)$ reacts with another substance. Write down a balanced equation for this reaction. (3)

10.4 The following substances are present in a bag of fertiliser:

- 20 kg ammonium nitrate (NH_4NO_3)
- 12 kg sodium phosphate (Na_3PO_4)
- 18 kg potassium chloride ($KC\ell$)

Calculate the NPK ratio of the fertiliser. (5)
[12]

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* $E^{\theta}_{cell} = E^{\theta}_{oxidising agent} - E^{\theta}_{reducing agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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

KEY/*SLEUTEL*

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

1 (I)	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**

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

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

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

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

NOVEMBER 2018

MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: 150

These marking guidelines consist of 18 pages.
Hierdie nasienriglyne bestaan uit 18 bladsye.

QUESTION 1/*VRAAG 1*

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

QUESTION 2/*VRAAG 2*

2.1 **ANY ONE/*ENIGE EEN*:**

- (Alcohol/ethanol) is flammable/catches fire easily. ✓
  (Alkohol/etanol) is vlambaar/slaan maklik aan die brand.
- To heat it evenly./*Om dit eweredig te verhit.*
- Water bath is used for low heat/low temperature./*Waterbad word gebruik vir lae hitte/lae temperatuur.*
- Alcohol/ethanol will evaporate too quickly./*(Alkohol/etanol) sal te vinnig verdamp.*

Accept/*Aanvaar*:
(Alcohol/ethanol) is volatile./*(Alkohol/etanol) is vlugtig.* (1)

2.2

2.2.1 Esterification/condensation ✓
Verestering/esterifikasie/kondensasie (1)

2.2.2 H_2SO_4 ✓ (1)

2.2.3 Esters ✓ (1)

2.3 $\frac{M(\text{ester})}{M(C_4H_8O)} = \frac{144}{72}$ ✓ $= 2$

$\therefore$ 2 x $C_4H_8O = C_8H_{16}O_2$ ✓

Marking guidelines/*Nasienriglyne*
• If only answer given, award 2 marks on final answer./*Indien slegs antwoord gegee, ken 2 punte toe vir finale antwoord.* • If 72 $g \cdot mol^{-1}$ calculated without substituting, no mark is awarded./*Indien 72 $g \cdot mol^{-1}$ bereken is sonder om te vervang word geen punt toegeken nie.*

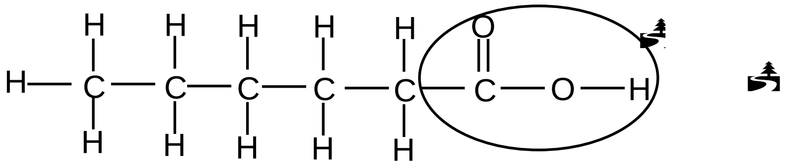
(2)

2.4 Ethyl ✓ hexanoate ✓
Etielheksanoaat

Note/*Aantekening*
Accept any other ethyl ESTER from QUESTION 2.3. *Aanvaar enige ander etiel ESTER vanaf VRAAG 2.3.*

(2)

2.5 **POSITIVE MARKING FROM QUESTION 2.4.**
POSITIEWE NASIEN VANAF VRAAG 2.4.



<u>Marking criteria/*Nasienriglyne*</u>

- Whole structure correct/*Hele struktuur korrek:* 2/2
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Maks.*: 1/2
- Accept/*Aanvaar* -OH as condensed/*gekondenseerd.*

IF/*INDIEN*

- More than one functional group/wrong functional group/*Meer as een funksionele groep/foutiewe funksionele groep:* 0/2
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:* Max/*Maks.*: 1/2

(2)
[10]

QUESTION 3/*VRAAG 3*

3.1

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

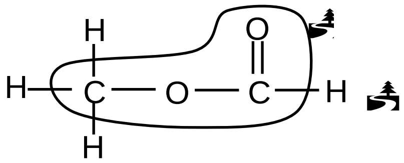
The <u>temperature</u> at which the <u>vapour pressure</u> of a substance <u>equals atmospheric/external pressure</u>.
Die <u>temperatuur</u> waar die <u>dampdruk</u> van 'n stof <u>gelyk is aan atmosferiese/ eksterne druk</u>. (2)

3.2

3.2.1 Carboxyl (group)/*karboksiel(groep)* ✓

<u>Accept/*Aanvaar*</u>
Carboxylic/*Karboksiel* (1)

3.2.2 Propanoic acid/*propanoësuur* ✓ (1)

3.2.3 

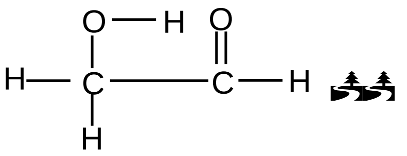
Marking criteria/*Nasienriglyne*

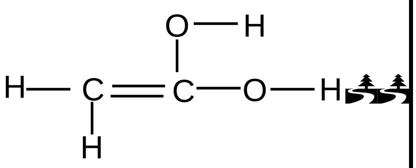
- Whole structure correct:
  Hele struktuur korrek: $\frac{2}{2}$
- Only functional group correct:
  Slegs funksionele groep korrek: Max/*Maks*: $\frac{1}{2}$

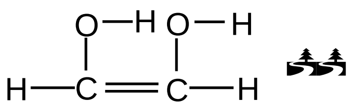
IF/*INDIEN*

- More than one functional group/wrong functional group/*Meer as een funksionele groep/foutiewe funksionele groep:* $\frac{0}{2}$
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:* Max/*Maks*: $\frac{1}{2}$

ACCEPT/*AANVAAR*
(2 or/of 0)







(2)

3.3 A ✓
Lowest boiling point./Shortest chain length. ✓
Laagste kookpunt./Kortste kettinglengte. (2)

3.4

3.4.1 The same molecular mass/molecular size. ✓
Dieselfde molekulêre massa/molekulêre grootte. (1)

3.4.2 Primary/*Primêre* ✓
-OH group is bonded to a C atom bonded to one other C atom. ✓
-OH-groep is gebind aan 'n C-atoom wat aan een ander C-atoom gebind is.
OR/*OF*
-OH group is bonded to a C atom that has two H atoms.
-OH-groep is gebind aan 'n C-atoom wat twee H-atome bevat. (2)

3.4.3

Marking guidelines/Nasienriglyne

- BOTH have hydrogen bonding./*BEIDE het waterstofbindings*.
- Compare number of sites for hydrogen bonding./*Vergelyk aantal punte vir waterstofbinding.*
- Compare strength of IMFs./*Vergelyk sterkte van IMKe.*
- Compare energy required./*Vergelyk energie benodig.*

- Both compounds/**X** and **B** have (in addition to London forces and dipole-dipole forces) hydrogen bonding./*Beide verbindings/**X** en **B** het waterstofbindings (behalwe Londonkragte en dipool-dipoolkragte).*
- Compound **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alcohol has one site for hydrogen bonding and compound **B/**ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding **OR** **B/**ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding.
  Verbinding **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alkohol *het een punt vir waterstofbindings en verbinding **B**/etanoësuu/karboksielsuur het twee/meer punte vir waterstofbindings **OF** **B**/etanoësuu/karboksielsuur het twee/meer punte vir waterstofbindings.*
- Intermolecular forces in compound **B**/ethanoic acid/carboxylic acid are stronger than intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol.
  *Intermolekulêre kragte in verbinding **B**/etanoësuur/karboksielsuur is sterker as die intermolekulêre kragte in* verbinding **X**/$CH_3CH_2CH_2OH$/ *propan-1-ol/alkohol.*
  OR/*OF*
  Intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol are weaker than intermolecular forces in compound **B**/ethanoic acid/*carboxylic acid*./*Intermolekulêre kragte in* verbinding **X**/*$CH_3CH_2CH_2OH$/propan-1-ol/alkohol is swakker as intermolekulêre kragte in verbinding **B**/etanoësuur/karboksielsuur.*
- More energy is needed to overcome/break intermolecular forces in compound **B**/ethanoic acid/carboxylic acid than in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol.
  *Meer energie word benodig om intermolekulêre kragte in verbinding **B**/etanoësuur as in verbinding **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alkohol te oorkom/breek.*
  OR/*OF*
  Less energy is needed to overcome/break intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alcohol than in compound **B**/ethanoic acid/*carboxylic acid*.
  *Minder energie word benodig om intermolekulêre kragte in verbinding **X**/ $CH_3CH_2CH_2OH$/propan-1-ol/alkohol te oorkom/breek as in verbinding **B**/etanoësuur/karboksielsuur.*

(4)

[15]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 (A series of organic) compounds that can be described by the <u>same general formula/functional group</u>. ✓✓ **(2 or 0)**
('n Reeks organiese) verbindings wat deur <u>dieselfde algemene formule/ funksionele groep</u> beskryf kan word. ***(2 of 0)***

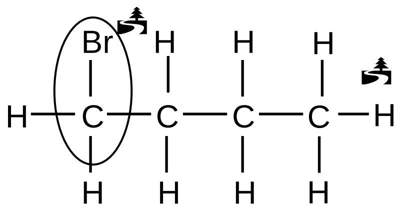
OR/*OF*

(A series of organic) compounds in which one member <u>differs from the next by a CH_2 group</u>./*('n Reeks organiese) verbindings waarin een lid van die volgende <u>verskil met 'n CH_2-groep</u>.* **(2 or/*of* 0)** (2)

4.1.2 Substitution/halogenation/bromination ✓
Substitusie/halogenasie/halogenering/brominasie/brominering (1)

4.1.3 HBr ✓ (1)

4.1.4



<u>Marking criteria/*Nasienriglyne*</u>
• Br on first C atom/*Br op eerste C-atoom:* Max/*Maks:* $\frac{1}{2}$ • Whole structure correct/*Hele struktuur korrek:* $\frac{2}{2}$ **IF/INDIEN:** Br_2 but rest of structure correct/Br_2 maar res van struktuur korrek: $\frac{1}{2}$

(2)

4.1.5 $C_5H_{12} + 8O_2$ ✓ $\rightarrow$ $5CO_2 + 6H_2O$ ✓ Bal ✓

<u>Marking guidelines/*Nasienriglyne*</u>
• Reactants ✓ *Reaktanse* — Products ✓ *Produkte* — Balancing ✓ *Balansering* • Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.* • Marking rule 6.3.10/*Nasienreël 6.3.10.* • If condensed structural formulae used/*Indien gekondenseerde struktuurformules gebruik:* Max/*Maks:* $\frac{2}{3}$

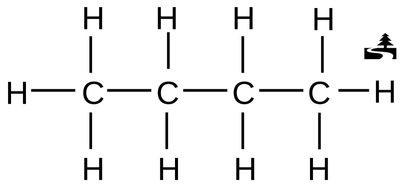
(3)

4.1.6

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

The (chemical) process in which <u>longer chain hydrocarbons/longer chain alkanes</u> are <u>broken down to shorter/more useful hydrocarbons/molecules/ chains/alkanes and alkenes</u>.
Die (chemiese) proses waarin <u>langketting koolwaterstowwe/langketting-alkane afgebreek word in korter/meer bruikbare koolwaterstowwe/molekule/ kettings/alkane en alkene.</u> (2)

4.1.7



<u>Marking guidelines/*Nasienriglyne*</u>

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

(2)

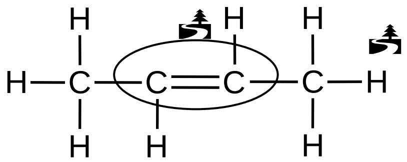
4.2

4.2.1 Butan-2-ol ✓✓ **OR/*OF*** 2-butanol ✓✓

<u>IF/*INDIEN:*</u>
Butanol or/*of* butan-1-ol $\frac{1}{2}$

(2)

4.2.2



<u>Marking criteria/*Nasienriglyne*</u>

- Only functional group correct/*Slegs funksionele groep korrek:* Max/Maks: $\frac{1}{2}$
- Whole structure correct: *Hele struktuur korrek:* $\frac{2}{2}$

(2)
[17]

QUESTION 5/*VRAAG 5*

5.1 Temperature/*Temperatuur* ✓ (1)

5.2

<u>NOTE/*LET WEL*</u>
Give the mark for <u>per unit time</u> only if in context of reaction rate.
Gee die punt vir <u>per eenheidtyd</u> slegs indien in konteks met reaksietempo.

<u>ANY ONE/*ENIGE EEN*</u>

- <u>Change in concentration</u> ✓ of products/reactants <u>per (unit) time</u>. ✓
  <u>Verandering in konsentrasie</u> van produkte/reaktanse <u>per (eenheid) tyd</u>.
- <u>Change in amount/number of moles/volume/mass</u> of products or reactants <u>per (unit) time</u>.
  <u>Verandering in hoeveelheid/getal mol/volume/massa</u> van produkte of reaktanse <u>per (eenheid) tyd.</u>
- <u>Amount/number of moles/volume/mass of products formed/reactants used per (unit) time</u>.
  <u>Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.</u>
- <u>Rate of change in concentration/amount/number of moles/volume/mass</u>.
  <u>Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa</u>. ✓✓ **(2 or/*of* 0)** (2)

5.3 14 (min) ✓✓ (2)

5.4

5.4.1 Graph/*grafiek* **B** ✓
(Experiment **3)** has the highest (acid) concentration/more particles/higher number of moles. ✓
(*Eksperiment **3)** het die hoogste (suur)konsentrasie/meer deeltjies/groter aantal mol.* (2)

5.4.2 (Graph/*grafiek*) **C** ✓
(Experiment 5) is at highest temperature/more particles with sufficient kinetic energy/HCℓ is at 35°C ✓
(*Eksperiment 5) is by die hoogste temperatuur/meer deeltjies met genoeg kinetiese energie/HCℓ is by 35°C*. (2)

5.5

5.5.1 Speeds up the reaction./Increases the reaction rate./Provides alternate pathway./Lowers the (net) activation energy. ✓
Versnel die reaksie./Verhoog die reaksietempo./Verskaf alternatiewe roete./Verlaag die (netto) aktiveringsenergie. (1)

5.5.2 Equal to/*Gelyk aan* ✓ (1)

5.6

$$n(Zn) = \frac{m}{M}$$

$$= \frac{1{,}5}{65} \checkmark$$

$$= 0{,}023 \text{ mol}$$

$$\text{rate/}\textit{tempo} = -\frac{\Delta n}{\Delta t}$$

$$= -\left(\frac{0 - 0{,}023 \checkmark}{14 \checkmark 0}\right)$$

$$= 1{,}65 \times 10^{-3} \text{ (mol·min}^{-1}) \checkmark$$

Marking guidelines/*Nasienriglyne*
- Substitute/*vervang* 65 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Substitute change in mol to calculate rate./*Vervang verandering in mol om tempo te bereken.* ✓
- Substitute change in time to calculate rate./*Vervang verandering in tyd om tempo te bereken.* ✓
- Final answer/*Finale antwoord*: 1,65 x 10^{-3} mol·min^{-1} ✓
  Range/*Gebied:*
  1,43 x 10^{-3} to/*tot* 1,65 x 10^{-3} (mol·min^{-1})

Notes/*Aantekeninge*
- Ignore if zeros omitted in calculation of reaction rate./*Ignoreer indien nulle uitgelaat in berekening van reaksietempo.*
- Accept negative answer i.e. -1,65 x 10^{-3} mol·min^{-1}/*Aanvaar negatiewe antwoord d.i. -1,65 x 10^{-3} mol·min^{-1}.*

(4)

[15]

QUESTION 6/*VRAAG 6*

6.1 When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium ✓ by favouring the reaction that will cancel/oppose the disturbance. ✓
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n (nuwe) ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk. (2)

6.2 Endothermic/*Endotermies* ✓

- Decrease in temperature favours the exothermic reaction. ✓
  Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The reverse reaction is favoured./*Die terugwaartse reaksie word bevoordeel.* ✓
  OR/*OF*
  Number of moles/amount/concentration of N_2O_4/colourless gas increases.
  Aantal mol/hoeveelheid/konsentrasie van N_2O_4/kleurlose gas neem toe.
  OR/*OF*
  Number of moles/amount of NO_2/brown gas decreases./*Aantal mol/ hoeveelheid NO_2 /bruin gas neem af.* (3)

6.3

6.3.1 Increases/*Verhoog* ✓ (1)

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

6.3.3 Increases/*Verhoog* ✓ (1)

6.4 CALCULATIONS USING NUMBER OF MOLES / *BEREKENINGE WAT GETAL MOL GEBRUIK*

Marking guidelines/*Nasienriglyne*

- $\Delta n(N_2O_4)$ = 20% of/*van* **x**/0,2**x**. ✓
- **USE** ratio/***GEBRUIK*** *verhouding:* $N_2O_4 : NO_2$: = 1 : 2. ✓
- $n(N_2O_4)_{eq/ewe} = n(N_2O_4)_{initial/begin} - \Delta n(N_2O_4)$.
  $n(NO_2)_{eq/ewe} = n(NO_2)_{initial/begin} + \Delta n(NO_2)$. } ✓
- Divide equilibrium moles by 2 dm^3/*Deel ewewigsmol deur 2 dm^3.* ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of K_c value/*Vervanging van K_c-waarde*. ✓
- Substitution of concentrations into correct K_c expression. ✓
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 1,6 (mol) ✓

OPTION 1/*OPSIE 1*

	N_2O_4	NO_2	
Initial amount (moles) *Aanvangshoeveelheid (mol)*	**x**	0	
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,2**x** ✓	0,4**x**	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	0,8**x**	0,4**x**	✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,4**x**	0,2**x**	Divide by 2 dm^3 ✓

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$ ✓

$0,16$ ✓ $= \frac{(0,2\mathbf{x})^2}{(0,4\mathbf{x})}$ ✓

$\mathbf{x}$ = 1,6 (mol) ✓

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.* $\frac{5}{8}$

OPTION 2/*OPSIE 2*

$\Delta n(N_2O_4) = \frac{20}{100}\mathbf{x}$ ✓ $= 0,2\mathbf{x}$

$\Delta n(NO_2) = 2\Delta n(N_2O_4) = 0,4\ \mathbf{x}$ ✓

$n(N_2O_4)_{eq/ewe} = \mathbf{x} - 0,2\mathbf{x} = 0,8\mathbf{x}$ **AND** $n(NO_2)_{eq/ewe} = 0 + 0,4\mathbf{x}$ ✓

$c(N_2O_4)_{eq/ewe} = \frac{0,8\mathbf{x}}{2} = 0,4\mathbf{x}$
$c(NO_2)_{eq/ewe} = \frac{0,4\mathbf{x}}{2} = 0,2\mathbf{x}$ } ✓

$K_c = \frac{[NO_2]^2}{[N_2O_4]}$ ✓

$0,16$ ✓ $= \frac{(0,2\mathbf{x})^2}{(0,4\mathbf{x})}$ ✓

$\mathbf{x}$ = 1,6 (mol) ✓

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

Marking guidelines/*Nasienriglyne*

- Initial $n(N_2O_4)$/**x** divide by 2 dm^3. ✓
  *Aanvanklike $n(N_2O_4)$/**x** gedeel deur 2 dm^3.*
- $\Delta c(N_2O_4)$ = 20% of initial concentration/0,1x. ✓
- **USE** ratio/***GEBRUIK*** *verhouding:* $c(N_2O_4) : c(NO_2) = 1 : 2$. ✓
- $c(N_2O_4)_{eq/ewe} = c(N_2O_4)_{initial/begin} - \Delta c(N_2O_4)$.
  $c(NO_2)_{eq/ewe} = c(NO_2)_{initial/begin} + \Delta c(NO_2)$. } ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of K_c value/*Vervanging van K_c-waarde*. ✓
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c-uitdrukking.
- Final answer/*Finale antwoord*: 1,6 (mol) ✓

OPTION 3/*OPSIE 3*

	N_2O_4	NO_2	
Initial concentration ($mol\cdot dm^{-3}$) *Aanvanklike konsentrasie ($mol\cdot dm^{-3}$)*	$\frac{x}{2} = 0,5\mathbf{x}$	0	Divide by 2 dm^3 ✓
Change ($mol\cdot dm^{-3}$) *Verandering ($mol\cdot dm^{-3}$)*	0,1**x** ✓	0,2**x**	ratio ✓ *verhouding*
Equilibrium concentration ($mol\cdot dm^{-3}$) *Ewewigskonsentrasie ($mol\cdot dm^{-3}$)*	0,4**x**	0,2**x**	✓

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} \checkmark$$

$$0,16 \checkmark = \frac{(0,2\mathbf{x})^2}{0,4\mathbf{x}} \checkmark$$

$$\mathbf{x} = 1,6 \text{ (mol)} \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie:* Max./*Maks.* $\frac{6}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{5}{8}$

(8)
[16]

QUESTION 7/*VRAAG 7*

7.1

7.1.1 An acid is a proton donor. ✓✓
'n Suur is 'n protondonor/skenker. (2)

7.1.2 H_2O ✓ (1)

7.1.3 HSO_4^- ✓✓ (2)

7.2

7.2.1 Reaction of a salt with water/H_2O. ✓✓
Reaksie van 'n sout met water/H_2O.

Accept/*Aanvaar*
Reaction of cations or anions with water
Reaksie van katione of anione met water (2)

7.2.2
- $CO_3^{2-}(aq) + 2H_2O(\ell)$ ✓ $\rightleftharpoons H_2CO_3(aq) + 2OH^-(aq)$ ✓
  OR/*OF*
  $CO_3^{2-}(aq) + H_2O(\ell) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$
  Accept/*Aanvaar:*
  $CaCO_3(aq) + 2H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + Ca(OH)_2(aq)$
- The formation of $OH^-(aq)$ neutralises the excess acid. ✓
  Die vorming van $OH^-(aq)$ neutraliseer die oormaat suur.

Marking guidelines/*Nasienriglyne*
- Reactants ✓ Products ✓
  Reaktanse *Produkte*
- The formation of $OH^-(aq)$ neutralises the excess acid. ✓
  Die vorming van $OH^-(aq)$ neutraliseer die oormaat suur.
- Ignore single arrows and phases./*Ignoreer enkelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- Ignore balancing./*Ignoreer balansering.* (3)

7.3

7.3.1 $pH = -log[H_3O^+]$ ✓
5 ✓ $= -log[H_3O^+]$
$[H_3O^+] = 1 \times 10^{-5}\ mol{\cdot}dm^{-3}$ ✓ (3)

7.3.2 **POSITIVE MARKING FROM QUESTION 7.3.1.**
POSITIEWE NASIEN VAN VRAAG 7.3.1.

Marking guidelines/*Nasienriglyne*

- Any formula/*Enige formule*: $c = \frac{n}{V}$ /$n = \frac{m}{M}$ / $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ /$c = \frac{m}{MV}$ ✓
- Substitute/*vervang* V = 4 x 10^9 dm^3 ✓
- Calculate n_a(reacted) = n_a(initial) – n_a(final) ✓✓
  Bereken n_a(reageer) = n_a(begin) – n_a(finaal)
- Use/*Gebruik* n(CaO) : n(H_3O^+) = 1:2 ✓
- Substitution of/*Vervanging van* 56 g·mol^{-1} ✓
- Final answer/*Finale antwoord*: m = 1,08 x 10^6 g to/*tot* 1,09 x 10^6 g ✓

IF final answer is negative:/***INDIEN*** finale antwoord negatief is Max/Maks: $\frac{6}{7}$

OPTION 1/*OPSIE 1*

$c(H_3O^+)_{ini/aanv.} = \frac{n}{V}$ ✓

$1 \times 10^{-5} = \frac{n}{4 \times 10^9}$ ✓

$n_a = 4 \times 10^4$ mol

$n(H_3O^+)_{react/rea} = 4 \times 10^4 - 1{,}26 \times 10^3$ ✓✓
$= 3{,}87 \times 10^4$ mol

$n(CaO) = ½n(H_3O^+)$
$= ½ \times 3{,}87 \times 10^4$ ✓
$= 1{,}94 \times 10^4$ mol

OPTION 2/*OPSIE 2*

$c(H_3O^+)_{fin} = \frac{n}{V}$ ✓
$= \frac{1{,}26 \times 10^3}{4 \times 10^9}$ ✓
$= 3{,}15 \times 10^{-7}$ mol·dm^{-3}

$c(H_3O^+)_{rea} = 1 \times 10^{-5} - 3{,}15 \times 10^{-7}$ ✓✓
$= 9{,}69 \times 10^{-6}$ mol·dm^{-3}

$n(H_3O^+)_{rea} = cV$
$= (9{,}65 \times 10^{-6})(4 \times 10^9)$
$= 3{,}87 \times 10^4$ mol
$n(CaO) = ½n(H_3O^+)$
$= ½ \times 3{,}87 \times 10^4$ ✓
$= 1{,}94 \times 10^4$ mol

$n(CaO) = \frac{m}{M}$

$1{,}94 \times 10^4 = \frac{m}{56}$ ✓

$\therefore$ m = 1,09 x 10^6 g ✓

OR/*OF*

1 mol : 56 g ✓
1,94 x 10^4 mol : m
$\therefore$ m = 1,09 x 10^6 g ✓

OPTION 3/*OPSIE 3*

$c(H_3O^+)_{fin} = \frac{n}{V}$ ✓
$= \frac{1{,}26 \times 10^3}{4 \times 10^9}$ ✓
$= 3{,}15 \times 10^{-7}$ mol·dm^{-3}

$c(H_3O^+)_{rea} = 1 \times 10^{-5} - 3{,}15 \times 10^{-7}$ ✓✓
$= 9{,}69 \times 10^{-6}$ mol·dm^{-3}
$c(CaO) = ½c(H_3O^+)$ ✓ $= 4{,}845 \times 10^{-6}$ mol·dm^{-3}

$c = \frac{m}{MV}$ $\therefore$ $4{,}845 \times 10^{-6} = \frac{m}{56(4 \times 10^9)}$ ✓ $\therefore$ m = 1,09 x 10^6 g ✓

(7)
[20]

QUESTION 8/*VRAAG 8*

8.1

8.1.1 Loss of electrons./*Verlies aan elektrone*. ✓✓ **(2 or/*of* 0)** (2)

8.1.2 $Fe \rightarrow Fe^{3+} + 3e^-$ ✓✓

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

(2)

8.1.3 Reducing agent/*Reduseermiddel* ✓ (1)

8.1.4 Fe is a stronger reducing agent ✓ than Cu ✓ and (Fe) will be oxidised ✓ (to Fe^{3+})./*Fe is 'n sterker reduseermiddel as Cu en (Fe) sal geoksideer word (na* Fe^{3+}*).*

OR/*OF*

Cu is a weaker reducing agent ✓ than Fe ✓and (Cu) will not be oxidised ✓ (to Cu^{2+})./*Cu is 'n swakker reduseermiddel as Fe en (Cu) sal nie geoksideer word nie (na* Cu^{2+}*).* (3)

8.1.5 Zinc/Zn ✓
Stronger reducing agent (than Fe)./*Sterker reduseermiddel (as Fe).* ✓

OR/*OF*

Zn will undergo oxidation (before Fe)./*Zn sal oksidasie (voor Fe) ondergaan.*

OR/*OF*

Cu is a weaker reducing agent (than Fe)./*Cu is 'n swakker reduseermiddel (as Fe).* (2)

8.2

8.2.1 $3Cu^{2+} + 2Fe$ ✓ $\rightarrow 3Cu + 2Fe^{3+}$ ✓ Bal. ✓

Marking guidelines/*Nasienriglyne*		
• Reactants ✓ *Reaktanse*	Products ✓ *Produkte*	Balancing ✓ *Balansering*
• Ignore double arrows./*Ignoreer dubbelpyle.*		
• Marking rule 6.3.10/*Nasienreël 6.3.10.*		

(3)

8.2.2

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = 0,34 ✓ – (-0,06) ✓ = 0,40 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*: $\frac{3}{4}$

OPTION 2/*OPSIE 2*

$Cu^{2+} + 2e^- \rightarrow Cu$ ✓	E^{θ} = 0,34 V ✓
$Fe \rightarrow Fe^{3+} + 3e^-$	E^{θ} = 0,06 V ✓
$3Cu^{2+} + 2Fe \rightarrow 3Cu + 2Fe^{3+}$	E^{θ} = +0,40 V ✓

(4)
[17]

QUESTION 9/*VRAAG 9*

9.1 A cell in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
'n Sel waarin elektriese energie omgeskakel word na chemiese energie.
*(**2 of 0**)*

OR/*OF*
A cell in which electrical energy/electricity is used to obtain a chemical change/reaction. **(2 or 0)**
*'n Sel waarin elektriese energie/elektrisiteit gebruik word om 'n chemiese verandering/reaksie te veroorsaak. (**2 of 0**)* (2)

9.2 Any soluble copper(II) salt e.g./*Enige oplosbare koper(II)-sout bv.*
$CuSO_4/Cu(NO_3)_2/CuCℓ_2$ ✓ (1)

9.3 B ✓

$Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓

Marking guidelines/*Nasienriglyne*

- $Cu \leftarrow Cu^{2+} + 2e^-$ ($\frac{2}{2}$) $Cu \rightleftharpoons Cu^{2+} + 2e^-$ ($\frac{0}{2}$)
  $Cu^{2+} + 2e^- \rightleftharpoons Cu$ ($\frac{1}{2}$) $Cu \rightarrow Cu^{2+} + 2e^-$ ($\frac{0}{2}$)
- Ignore if charge on electron is omitted./*Ignoreer indien lading op elektron uitgelaat is.*
- If a charge of an ion is omitted e.g. $Cu^2 + 2e^- \rightarrow Cu$ /*Indien lading op ioon uitgelaat is bv.* $Cu^2 + 2e^- \rightarrow Cu$ Max./*Maks*: $\frac{1}{2}$

(3)

9.4 Platinum/Pt ✓ **AND/*EN*** silver/Ag/*silwer* ✓ (2)
[8]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Haber (process)/*Haber(proses)* ✓ (1)

10.1.2 Ostwald (process)/*Ostwald(proses)* ✓ (1)

10.2

10.2.1 Ammonium nitrate/*Ammoniumnitraat*/NH_4NO_3 ✓ (1)

10.2.2 Iron/iron oxide/Fe/FeO ✓
Yster/ysteroksied/Fe/FeO (1)

10.3 $2NH_3 + H_2SO_4$ ✓ $\rightarrow$ $(NH_4)_2SO_4$ ✓ Bal ✓ (3)

Marking guidelines/*Nasienriglyne*

- Reactants ✓ *Reaktanse* | Products ✓ *Produkte* | Balancing ✓ *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

10.4

Marking guidelines/*Nasienriglyne*

- Any ONE molar mass correct/*Enige EEN molêre massa korrek:* $80\ g\cdot mol^{-1}$/$164\ g\cdot mol^{-1}$/$74{,}5\ g\cdot mol^{-1}$ ✓
- m(N) = 7 (kg) **OR/*OF*** 0,14 ✓
- m(P) = 2,27 (kg) **OR/*OF*** 0,045 ✓
- m(K) = 9,42 (kg) **OR/*OF*** 0,188 ✓
- Final answer/*Finale antwoord*: 3 : 1 : 4 ✓
  ACCEPT/*AANVAAR*: 3,08 : 1 : 4,15 **OR/*OF*** 7 : 2,27 : 9,42

OPTION 1/*OPSIE 1*

NH_4NO_3:
80 g ✓ → 28 g N
20 kg → $\frac{28}{80}$ x 20
$\therefore$ m(N) = 7 kg ✓

Na_3PO_4:
164 g → 31 g P
12 kg → $\frac{31}{164}$ x 12
$\therefore$ m(P) = 2,27 kg ✓

KCℓ:
74,5 g → 39 g K
18 kg → $\frac{39}{74{,}5}$ x 18
$\therefore$ m(K) = 9,42 kg ✓

$\therefore$ N : P : K
7 : 2,27 : 9,42
3 : 1 : 4 ✓

OPTION 2/*OPSIE 2*

$n(NH_4NO_3) = \frac{m}{M}$
$= \frac{20\,000}{80}$ ✓ = 250 mol
$n(N) = 2n(NH_4NO_3)$ = 500 mol
m(N) = 500 x 14
= 7 000 g = 7 kg ✓

$n(Na_3PO_4) = \frac{12\,000}{164}$ = 73,17 mol
m(P) = 73,17 x 31
= 2 268 g = 2,27 kg ✓

$n(KC\ell) = \frac{18\,000}{74{,}5}$ = 241,61 mol
m(K) = 241,61 x 39
= 9 423 g = 9,42 kg ✓

$\therefore$ N : P : K
7 : 2,27 : 9,42
3 : 1 : 4 ✓

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
NH_4NO_3: %N = $\frac{28}{80}$ ✓ x 100 = 35% m(N) = $\frac{35}{100} \times 20 = 7$ kg ✓ Na_3PO_4: %P = $\frac{31}{164}$ x 100 = 18,9% m(N) = $\frac{18,9}{100} \times 12 = 2,27$ kg ✓ KCℓ: %K = $\frac{39}{74,5}$ x 100 = 52,34% m(K) = $\frac{52,34}{100} \times 18 = 9,42$ kg ✓ ∴ N : P : K = 7 : 2,27 : 9,42 = 3 : 1 : 4 ✓	NH_4NO_3: %N = $\frac{28}{80}$ ✓ x 100 = 35% Na_3PO_4: %P = $\frac{31}{164}$ x 100 = 18,9% KCℓ: %K = $\frac{39}{74,5}$ x 100 = 52,34% N: $\frac{20}{50}$ x 35 = 0,14 ✓ P: $\frac{12}{50}$ x 18,9 = 0,045 ✓ K: $\frac{18}{50}$ x 52,34 = 0,188 ✓ N : P : K = 0,14 : 0,045 : 0,188 = 3 : 1 : 4 ✓

(5)
[12]

TOTAL/*TOTAAL*: 150