basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

PHYSICAL SCIENCES: CHEMISTRY (P2)

2019

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 a SECONDARY alcohol?

A Ethanol

B Butan-1-ol

C Butan-2-ol

D 2-methylbutan-1-ol (2)

1.2 Which ONE of the following will RAPIDLY decolourise bromine water?

A CH_3CHCH_2

B $CH_3CH_2CH_3$

C CH_3COOCH_3

D CH_3CH_2COOH (2)

1.3 A FUNCTIONAL ISOMER of ethyl propanoate is …

A C_4H_9CHO.

B $C_5H_{11}OH$.

C C_4H_9COOH.

D $CH_3(CH_2)_3CHO$. (2)

1.4 Consider the balanced equation for a chemical reaction below.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The activation energy of the forward and reverse reactions are 156 $kJ\cdot mol^{-1}$ and 175 $kJ\cdot mol^{-1}$ respectively.

The heat of reaction, in $kJ\cdot mol^{-1}$, for this reaction is …

A –19.

B +19.

C +331.

D –331. (2)

1.5 The reaction given below reaches equilibrium in a closed container. The K_c value is 0,04 at a certain temperature.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \triangle H < 0$$

Which ONE of the following factors will change the K_c value to 0,4?

A Increase in pressure

B Decrease in pressure

C Increase in temperature

D Decrease in temperature (2)

1.6 Which ONE of the following statements best describes a state of dynamic equilibrium?

A The limiting reagent has been used up.

B The forward and reverse reactions have stopped.

C The rates of the forward and reverse reactions are equal.

D The concentration of products equals the concentration of reactants. (2)

1.7 During a titration to determine the concentration of an acid using a standard base, a learner pipettes the base into a conical flask. She then uses a small amount of water to rinse the inside of the flask so that all the base is part of the solution in the flask.

How will the extra water added to the flask affect the results of this titration?

The concentration of the acid …

A cannot be determined.

B will be lower than expected.

C will be higher than expected.

D will be the same as expected. (2)

1.8 The standard reduction potentials for two substances used to set up a galvanic cell are as follows:

$Sn^{2+} + 2e^{-} \rightleftharpoons Sn$ $E^{\theta} = – 0,14$ V

$Cu^{2+} + 2e^{-} \rightleftharpoons Cu$ $E^{\theta} = 0,34$ V

Which ONE of the following combinations gives the substances formed at each electrode when the cell is functioning?

	Cathode	**Anode**
A	Cu^{2+}	Sn
B	Sn	Cu^{2+}
C	Sn^{2+}	Cu
D	Cu	Sn^{2+}

(2)

1.9 Which ONE of the following half-reactions takes place at the POSITIVE ELECTRODE of an electrochemical cell used to electroplate an iron rod with silver?

A $Ag^{+} + e^{-} \rightarrow Ag$

B $Fe^{2+} + 2e^{-} \rightarrow Fe$

C $Ag \rightarrow Ag^{+} + e^{-}$

D $Fe \rightarrow Fe^{2+} + 2e^{-}$ (2)

1.10 Which ONE of the following elements is a primary nutrient?

A Potassium

B Sulphur

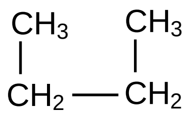
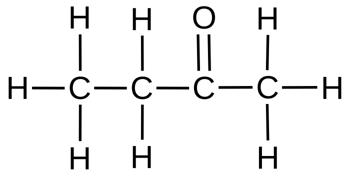
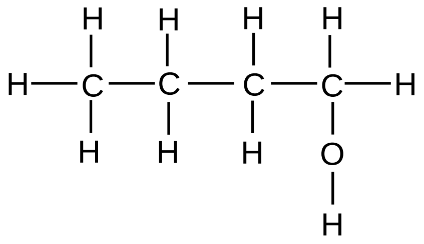
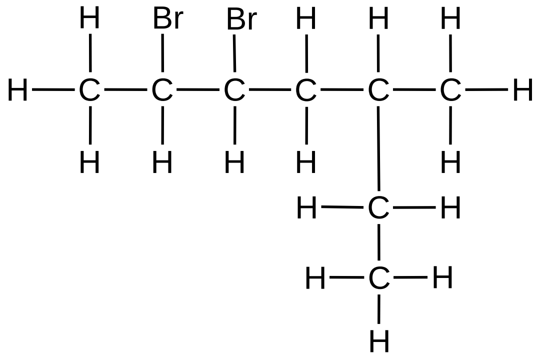
C Oxygen

D Carbon (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	 $\overset{CH_3}{\overset{\vert}{CH_2}}-\overset{CH_3}{\overset{\vert}{CH_2}}$	**B**	
C	$CH_3CCCH_2CH_3$	**D**	Butyl propanoate
E		**F**	

2.1 Is compound **C** SATURATED or UNSATURATED? Give a reason for the answer. (2)

2.2 Write down the LETTER that represents each of the following:

2.2.1 An ester (1)

2.2.2 A FUNCTIONAL ISOMER of butanal (1)

2.2.3 A compound with the general formula C_nH_{2n-2} (1)

2.2.4 A compound used as reactant in the preparation of compound **D** (1)

2.3 Write down the STRUCTURAL FORMULA of:

2.3.1 The functional group of compound **C** (1)

2.3.2 Compound **D** (2)

2.3.3 A CHAIN ISOMER of compound **A** (2)

2.4 Write down the:

2.4.1 IUPAC name of compound **F** (3)

2.4.2 Balanced equation, using MOLECULAR FORMULAE, for the complete combustion of compound **A** (3)

[17]

QUESTION 3 (Start on a new page.)

Three compounds are used to investigate one of the factors that influences boiling point. The results obtained are shown in the table below.

COMPOUND		MOLECULAR MASS ($g \cdot mol^{-1}$)	BOILING POINT (°C)
A	Butane	58	– 0,5
B	Propan-1-ol	60	98
C	Ethanoic acid	60	118

3.1 In one investigation the boiling points of compound **B** and compound **C** are compared.

3.1.1 Is this a fair investigation? Write down YES or NO. Refer to the data in the table and give a reason for the answer. (2)

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

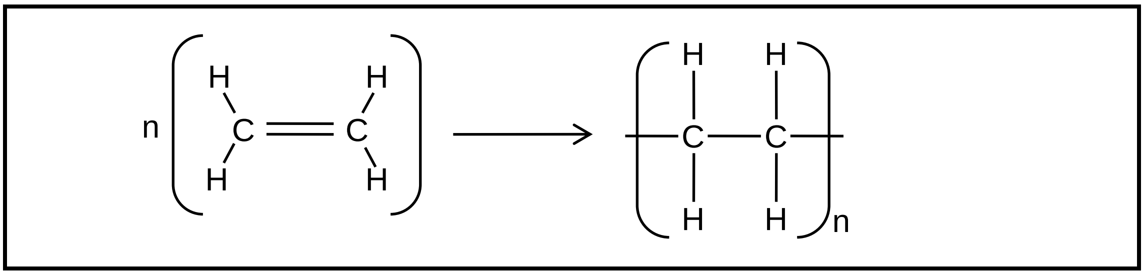
3.2 Which ONE of the compounds (**A**, **B** or **C**) has the highest vapour pressure? Give a reason for the answer. (2)

3.3 Refer to the intermolecular forces present in each compound and FULLY explain the trend in boiling points, as shown in the above table. (5)

3.4 Which compound, BUTAN-1-OL or PROPAN-1-OL, has the higher boiling point? Give a reason for the answer. (2)
[12]

QUESTION 4 (Start on a new page.)

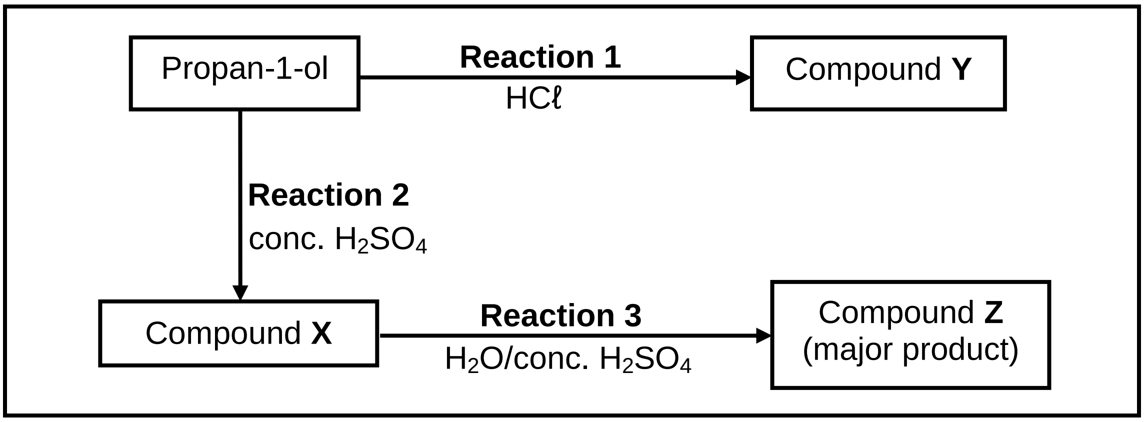
4.1 The balanced equation for a polymerisation reaction is shown below.



Write down the:

4.1.1	Type of polymerisation reaction represented by the equation	(1)
4.1.2	IUPAC name of the monomer	(1)
4.1.3	IUPAC name of the polymer	(1)

4.2 Propan-1-ol undergoes two different reactions, as shown in the diagram below.



Write down the:

4.2.1	Type of reaction represented by **reaction 2**	(1)
4.2.2	Function of concentrated H_2SO_4 in **reaction 2**	(1)
4.2.3	IUPAC name of compound **X**	(2)
4.2.4	STRUCTURAL FORMULA of compound **Y**	(2)
4.2.5	Type of reaction represented by **reaction 3**	(1)
4.2.6	IUPAC name of compound **Z**	(2)

[12]

QUESTION 5 (Start on a new page.)

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

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

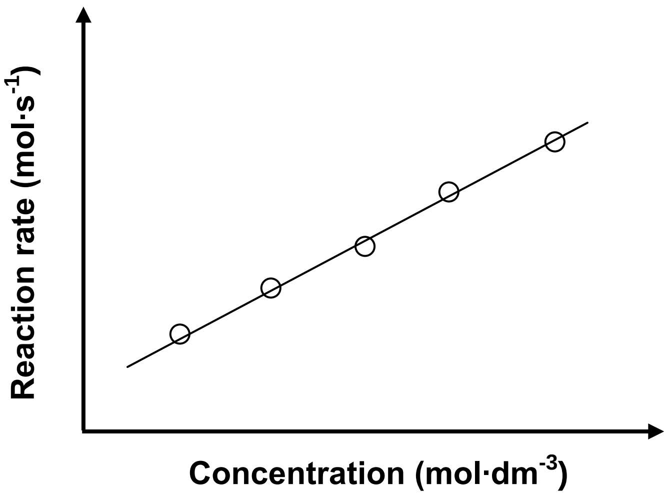
5.1 Define *reaction rate*. (2)

Three investigations (**I**, **II** and **III**) are carried out.

5.2 **INVESTIGATION I**

The results obtained in INVESTIGATION **I** are shown in the graph below.

GRAPH OF REACTION RATE VERSUS CONCENTRATION OF $Na_2S_2O_3$(aq)



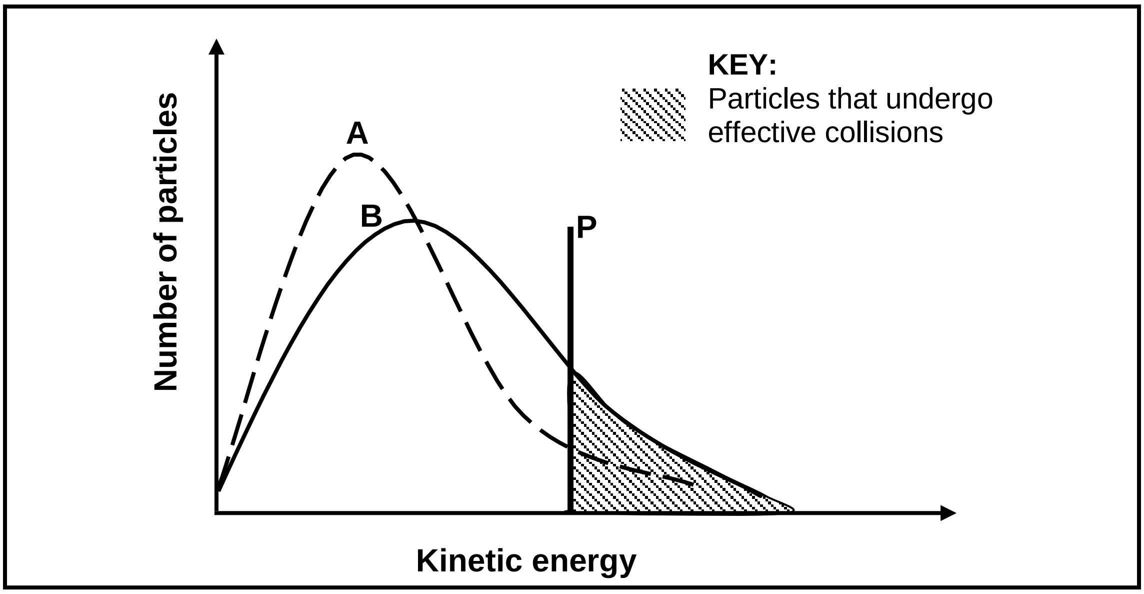
For this investigation, write down the:

5.2.1 Dependent variable (1)

5.2.2 Conclusion that can be drawn from the results (2)

5.3 **INVESTIGATION II**

The Maxwell-Boltzmann distribution curves, **A** and **B**, below represent the number of particles against kinetic energy for the reaction at two different temperatures.



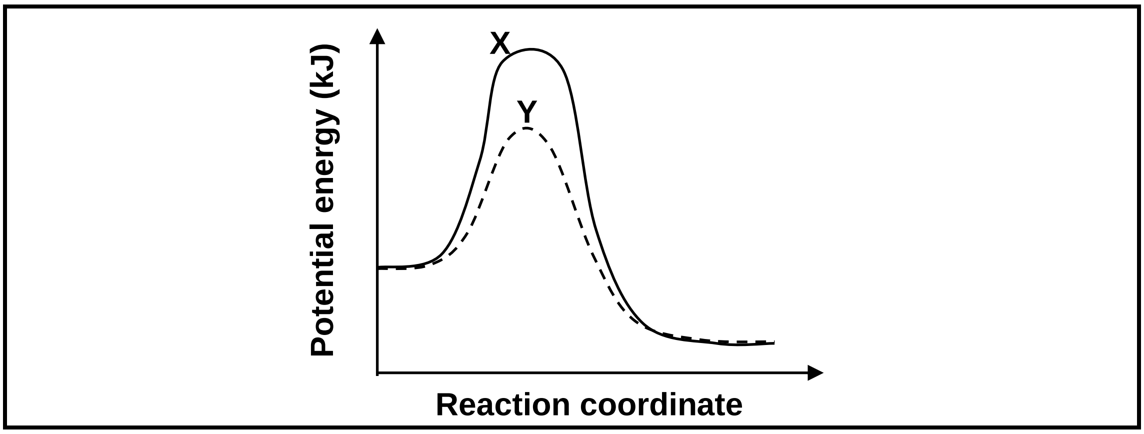
5.3.1 What does line **P** represent? (1)

5.3.2 Which curve (**A** or **B**) was obtained at the higher temperature? (1)

5.3.3 Explain, in terms of the collision theory, how an increase in temperature influences the rate of a reaction. (4)

5.4 **INVESTIGATION III**

The potential energy diagrams, **X** and **Y**, below represent the reaction under two different conditions.



Give a reason why curve **Y** differs from curve **X**. (1)

5.5 In one of the investigations, 100 cm^3 of 0,2 $mol{\cdot}dm^{-3}$ HCℓ(aq) reacts with excess $Na_2S_2O_3$(aq) and the solution is then filtered. After filtration of the solution, 0,18 g of sulphur is obtained. Calculate the PERCENTAGE YIELD of sulphur. (6)

[18]

QUESTION 6 (Start on a new page.)

The balanced equation below represents the reaction used in the Haber process to produce ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$

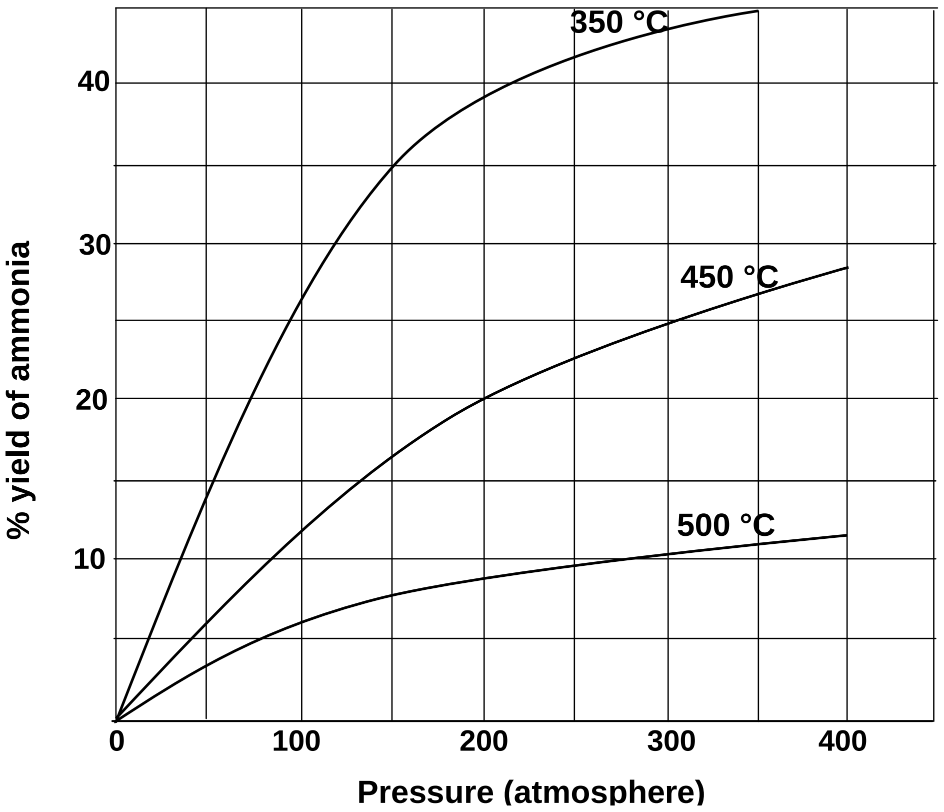
In industry the product is removed as quickly as it forms.

6.1 Write down the meaning of the double arrow used in the equation above. (1)

6.2 Give ONE reason why ammonia is removed from the reaction vessel as quickly as it forms. (1)

The graph below shows the percentage yield of ammonia at different temperatures and pressures.

GRAPH OF PERCENTAGE YIELD OF AMMONIA VERSUS PRESSURE



6.3 Write down the percentage yield of ammonia at a temperature of 450 °C and a pressure of 200 atmospheres. (1)

6.4 Refer to Le Chatelier's principle to explain EACH of the following deductions made from the graph:

6.4.1 For a given pressure, the yield of ammonia at 500 °C is much lower than that at 350 °C (3)

6.4.2 For a given temperature, the yield of ammonia at 350 atmospheres is much higher than that at 150 atmospheres (2)

6.5 A technician prepares $NH_3(g)$ by reacting 6 moles of $H_2(g)$ and 6 moles of $N_2(g)$.

6.5.1 Calculate the maximum number of moles of $NH_3(g)$ that can be obtained in this reaction. (2)

6.5.2 The above reaction now takes place in a 500 cm^3 container at a temperature of 350 °C and a pressure of 150 atmospheres. The system is allowed to reach equilibrium.

Use the graph above and calculate the equilibrium constant, K_c, for this reaction under these conditions. (7)
[17]

QUESTION 7 (Start on a new page.)

7.1 Define a *base* in terms of the Arrhenius theory. (2)

7.2 Explain how a *weak base* differs from a *strong base*. (2)

7.3 Write down the balanced equation for the hydrolysis of $NaHCO_3$. (3)

7.4 A learner wishes to identify element **X** in the hydrogen carbonate, $XHCO_3$. To do this she dissolves 0,4 g of $XHCO_3$ in 100 cm^3 of water. She then titrates all of this solution with a 0,2 mol dm^{-3} hydrochloric acid (HCℓ) solution. Methyl orange is used as the indicator during the titration.

7.4.1 Calculate the pH of the hydrochloric acid solution. (3)

7.4.2 Give a reason why methyl orange is a suitable indicator in this titration. (1)

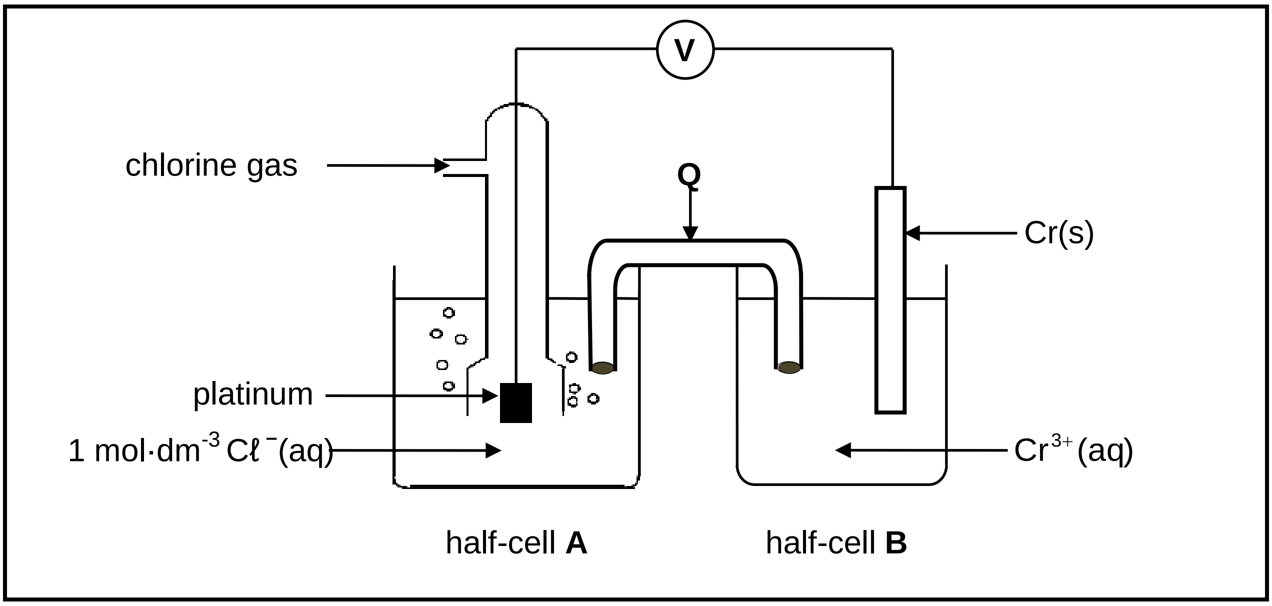
At the endpoint she finds that 20 cm^3 of the acid neutralised ALL the hydrogen carbonate solution. The balanced equation for the reaction is:

$$XHCO_3(aq) + HC\ell(aq) \rightarrow XC\ell(aq) + CO_2(g) + H_2O(\ell)$$

7.4.3 Identify element **X** by means of a calculation. (6)
[17]

QUESTION 8 (Start on a new page.)

The electrochemical cell below functions under standard conditions.



8.1 Give a reason why platinum is used as the electrode in half-cell **A**. (1)

8.2 Write down the:

8.2.1 Energy conversion that takes place in this cell (1)

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

8.2.3 Cell notation for this cell (3)

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

8.4 Silver chloride is an insoluble salt.

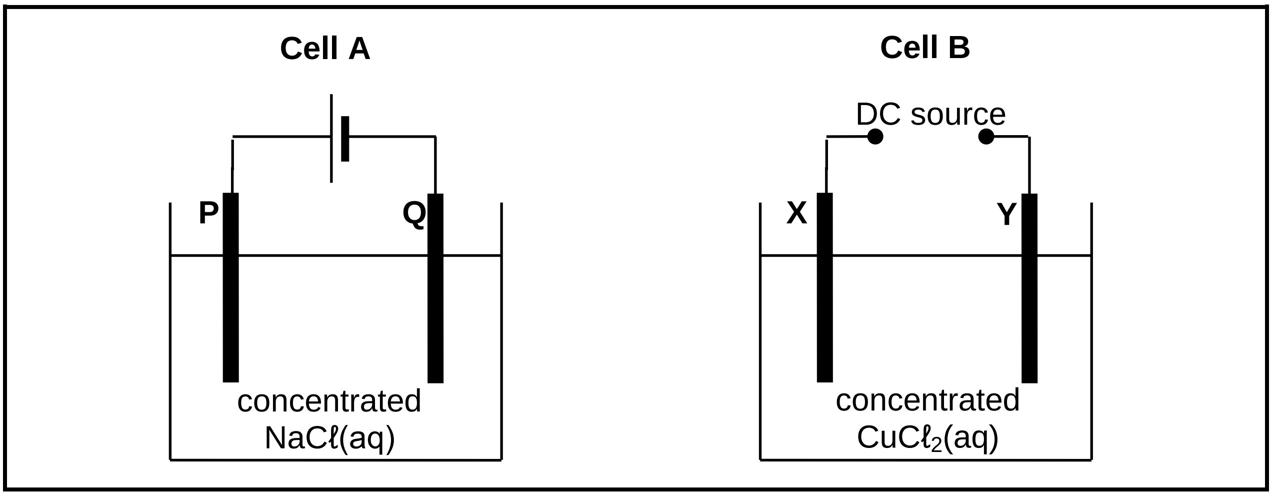
What will be the effect on the cell potential when a small amount of silver nitrate solution, $AgNO_3$(aq), is added to half-cell **A**? Choose from INCREASES, DECREASES or REMAINS THE SAME. (2)

[13]

QUESTION 9 (Start on a new page.)

The diagrams below represent two electrochemical cells.

P, **Q**, **X** and **Y** are carbon electrodes.



When cell **B** is functioning, the mass of electrode **X** increases.

9.1 What type of electrochemical cell, GALVANIC or ELECTROLYTIC, is illustrated above? (1)

9.2 Write down the half-reaction that takes place at electrode **Q**. (2)

9.3 The products formed in the two cells are compared.

  9.3.1 Name ONE substance that is produced in BOTH cells. (1)

  9.3.2 Write down the LETTERS of the TWO electrodes where this product is formed. Choose from **P**, **Q**, **X** and **Y**. (2)

9.4 Is electrode **X** the CATHODE or the ANODE? Give a reason for the answer. (2)

9.5 Write down the net (overall) cell reaction that takes place in cell **B**. (3)
[11]

QUESTION 10 (Start on a new page.)

10.1 The four steps in the manufacture of an inorganic fertiliser are listed below. These steps are NOT written in the order in which they occur.

Step I: Sulphuric acid reacts with ammonia to produce ammonium sulphate.
Step II: Sulphur dioxide reacts with oxygen to produce sulphur trioxide.
Step III: Oleum is diluted with water to produce sulphuric acid.
Step IV: Sulphur trioxide is bubbled in concentrated sulphuric acid to produce oleum.

Write down the:

10.1.1 Correct order in which the steps occur in the preparation of the inorganic fertiliser by using the numbers **I** to **IV** (1)

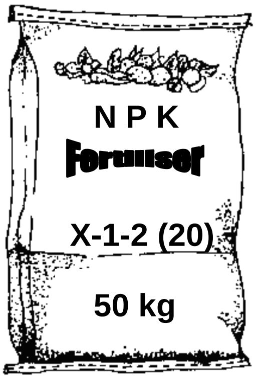
10.1.2 Balanced chemical equation for **step I** (3)

10.1.3 NAME of the catalyst used in **step II** (1)

10.1.4 Balanced chemical equation for **step IV** (3)

10.1.5 Reason why sulphur trioxide is NOT dissolved in water in **step IV** (1)

10.2 The diagram below shows a bag of NPK fertiliser. One of the numbers of the NPK ratio on the bag is labelled as **X**.



If the mass of potassium in the bag is 3,33 kg, calculate the value of **X**. (4)
[13]

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*

Atomic number
Atoomgetal

29 1,9 Cu 63,5

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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: STANDAARDREDUKSIEPOTENSIALE

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: STANDAARDREDUKSIEPOTENSIALE

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
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**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

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN

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

2019

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 16 pages./
Hierdie nasienriglyne bestaan uit 16 bladsye.

QUESTION 1/*VRAAG 1*

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

QUESTION 2/*VRAAG 2*

2.1 ⊖ Unsaturated/*Onversadig* ✓

ANY ONE/*ENIGE EEN*:

- C/It has a triple/multiple bond. ✓
  C/Dit het 'n trippelbinding/meervoudige-binding.
- C/It has a triple/multiple bond between C atoms.
  C/Dit het 'n trippelbinding/meervoudige-binding tussen C-atome.
- C/It does NOT contain the maximum number of H atoms bonded to C atoms.
  C/Dit bevat NIE die maksimum getal H-atome gebind aan C-atome nie.
- Compound C is an alkyne./*Verbinding C is 'n alkyn.* (2)

2.2

2.2.1 D ✓ (1)

2.2.2 B ✓ (1)

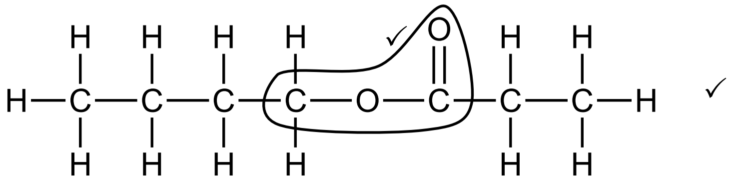
2.2.3 C ✓ (1)

2.2.4 E ✓ (1)

2.3

2.3.1 $—C\equiv C—$ ✓ (1)

2.3.2



(2)

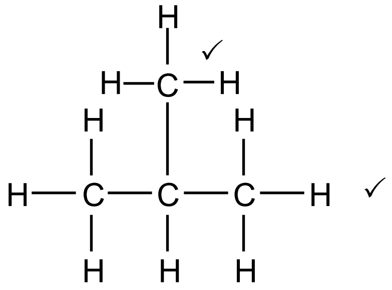
Marking criteria/*Nasienriglyne:*

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

IF/*INDIEN*:

- More than one functional group/*Meer as een funksionele groep:* $^{0}/_{2}$
- If condensed or semi structural formula used:/*Indien gekondenseerde of semi-struktuurformule gebruik:*
  Max/*Maks.* $^{1}/_{2}$

2.3.3



Marking criteria/*Nasienriglyne:*

- Three C atoms in longest chain. ✓
  Drie C-atome in langste ketting.
- One methyl substituent on C2. ✓
  Een metielsubstituent op C2.

IF/INDIEN

Any error e.g. omission of H atoms, condensed or semi structural formula/*Enige fout bv weglating van H-atome, gekondenseerde of semi-struktuurformule.* Max/*Maks.*: $\frac{1}{2}$

(2)

2.4

2.4.1 2,3-dibromo-5-methylheptane/2,3-dibromo-5-metielheptaan

Marking criteria/*Nasienriglyne:*

- Correct stem i.e. heptane./*Korrekte stam d.i. heptaan.* ✓
- All substituents (bromo and methyl) correctly identified./*Alle substituente (bromo en metiel) korrek geïdentifiseer.* ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas./*IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas .* ✓

(3)

2.4.2 $2C_4H_{10} + 13O_2$ ✓ → $8CO_2 + 10H_2O$ ✓ Bal ✓

Notes/*Aantekeninge:*

- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse Produkte 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 struktuur formules gebruik:* Max/*Maks.* $\frac{2}{3}$
- Accept coefficients that are multiples./*Aanvaar koëffisiënte wat veelvoude is.*

(3)
[17]

QUESTION 3/*VRAAG 3*

3.1

3.1.1 ⊖ Yes/*Ja* ✓

ANY ONE/*ENIGE EEN*:

- Compounds have the same molecular mass. ✓
  Verbindings het dieselfde molekulêre massa.
- Only one independent variable./*Slegs een onafhanklike veranderlike.* (2)

3.1.2 Functional group/Homologous series/Type of (organic) compound ✓
Funksionele groep/Homoloë reeks/Tipe (organiese) verbinding (1)

3.2 ⊖ A/butane/*butaan* ✓

Lowest boiling point/weakest intermolecular forces. ✓
Laagste kookpunt/swakste intermolekulêre kragte. (2)

3.3

Marking guidelines/Nasienriglyne
- Type of IMF in A./*Tipe IMK in A.*
- BOTH B and C have hydrogen bonding./*BEIDE B en C het waterstofbinding.*
- Compare number of sites for hydrogen bonding in B and C./*Vergelyk aantal punte vir waterstofbinding in B en C.*
- Compare strength of IMFs./*Vergelyk sterkte van IMKe.*
- Compare energy required./*Vergelyk energie benodig.*

- Between molecules of butane/compound **A** are London forces/dispersion forces/induced dipole forces. ✓
- Molecules of compound **B**/propan-1-ol have one site for hydrogen bonding. ✓
- Molecules of compound **C**/ethanoic acid have two/more sites for hydrogen bonding. ✓
- Strength of intermolecular forces increases from compound **A**/butane to compound **B**/propan-1-ol to compound **C**/ethanoic acid. ✓
  OR
  Intermolecular forces in compound **A**/butane are the weakest and intermolecular forces in compound **C**/ethanoic acid are the strongest.
- More energy is needed to overcome/break intermolecular forces in compound **C** than in the other two compounds. ✓

- *Tussen molekule van butaan/verbinding **A** is Londonkragte/dispersiekragte/geïnduseerde dipoolkragte.* ✓
- *Molekule van verbinding **B**/propan-1-ol het een punt vir waterstofbindings.* ✓
- Molekule van verbinding ***C**/etanoësuur het twee punte vir waterstofbindings.* ✓
- *Sterkte van intermolekulêre kragte neem toe van verbinding **A**/butaan na verbinding **B**/propan-1-ol na verbinding **C**/etanoësuur.* ✓
  OF
  *Intermolekulêre kragte tussen propaan is die swakste en intermolekulêre kragte in verbinding **C** is die sterkste.*
- *Meer energie word benodig om intermolekulêre kragte in verbinding **C** as in die ander twee verbindings te oorkom/breek.* ✓

(5)

3.4 Butan-1-ol ✓

⊖ Longer chain length./Larger molecule./Larger molecular mass./Larger molecular size./Stronger intermolecular forces./Larger surface area.✓
Langer kettinglengte./Groter molekuul./Groter molekulêre massa/Groter molekuul./Sterker intermolekulêre kragte./Groter oppervlakte. (2)

[12]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 Addition (polymerisation)/*Addisie-(polimerisasie)* ✓ (1)

4.1.2 Ethene/*eteen* ✓ (1)

4.1.3 Polyethene/polythene ✓
Poli-eteen/politeen (1)

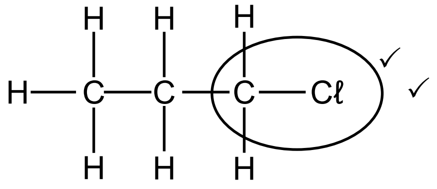
4.2

4.2.1 Dehydration/elimination ✓
Dehidrasie/dehidratering/eliminasie (1)

4.2.2 Catalyst/dehydrating agent/causes dehydration/removes water molecules ✓
Katalisator/dehidreermiddel/veroorsaak dehidrasie/verwyder watermolekule (1)

4.2.3 Prop-1-ene/propene/1-propene ✓✓ **(2 or 0)**
Prop-1-een/propeen/1-propeen **(2 of 0)** (2)

4.2.4



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/*Meer as een funksionele groep:* $\frac{0}{2}$
- If condensed or semi structural formula used:/*Indien gekondenseerde of semi-struktuurformule gebruik:*
  Max/*Maks.* $\frac{1}{2}$

(2)

4.2.5 Addition/Hydration ✓
Addisie/Hidrasie/Hidratering (1)

4.2.6 Propan-2-ol/2-propanol✓✓

Marking criteria/*Nasienriglyne:*

- Correct stem and functional group i.e propanol/*Korrekte stam en funksionele groep d.i* propanol ✓
- Name completely correct/*Naam volledig korrek:* Propan-2-ol/2-propanol ✓✓

(2)
[12]

QUESTION 5/*VRAAG 5*

5.1

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

ANY ONE/*ENIGE EEN*

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

5.2

5.2.1 Rate of the reaction/*Reaksietempo* ✓ (1)

5.2.2

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 increases with increase in concentration./Reaction rate is proportional to concentration.
Reaksietempo neem toe met toename in konsentrasie./Reaksietempo is eweredig aan konsentrasie.

IF/INDIEN
DIRECTLY proportional/*DIREK eweredig:* Max/*Maks.*: $\frac{1}{2}$ (2)

5.3

5.3.1 Activation energy/(The boundary line for the) molecules with (adequate) kinetic energy to make effective collisions. ✓
Aktiveringsenergie/(Die grenslyn vir die) molekule met (genoeg) kintiese energie vir effektiewe botsings. (1)

5.3.2 B ✓ (1)

5.3.3
- At a higher temperature particles move faster/have a higher kinetic energy. ✓
  By 'n hoër temperatuur beweeg die deeltjies vinniger/het die deeltjies hoër kinetiese energie.
- More molecules have enough/sufficient (kinetic) energy. ✓
  Meer molekule het genoeg/voldoende (kinetiese) energie.
  OR/*OF*
  More molecules have (kinetic) energy equal to or greater than activation energy.
  Meer molekule het (kinetiese) energie gelyk aan of groter as aktiveringsenergie.
- More effective collisions per unit time/second./Increased frequency of effective collisions.
  Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.
- Reaction rate increases. ✓
  Reaksietempo neem toe. (4)

5.4 Curve **Y**/it was obtained for the reaction where a catalyst was added. ✓
*Kurwe **Y**/dit is vir die reaksie waar 'n katalisator bygevoeg is, verkry.*

OR/*OF*

Curve **X** was obtained for the reaction in the absence of a catalyst.
*Kurwe **X** is verkry vir die reaksie sonder 'n katalisator.* (1)

5.5 **Marking guidelines/*Nasienriglyne***

- Any formula/*Enige formule*: $n = \frac{m}{M}$ or/*of* $c = \frac{n}{V}$ ✓
- Substitute/*Vervang* 0,1 dm^3 in n = cV ✓
- Use mole ratio/*Gebruik molverhouding*:
  $n(S)_{expected/verwag} = ½n(HCℓ)_{used/gebruik}$ ✓
- Substitution of/*Vervanging van* 32 $g{\cdot}mol^{-1}$ in $n = \frac{m}{M}$ ✓
- SUBSTITUTE in/*VERVANG in:*
  $\frac{n(S)_{produced/berei}}{n(S)_{expected/verwag}} \times 100 / \frac{m(S)_{produced/berei}}{m(S)_{expected/verwag}} \times 100$ ✓
- Final answer/*Finale antwoord:* 56,25% to 60% ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(HC\ell)_{used/gebruik} = cV$ ✓ $= 0{,}2 \times 0{,}1$ ✓ $= 0{,}02$ mol ↓ $n(S)_{expected/verwag} = \frac{1}{2}n(HC\ell)_{used/gebruik}$ $= \frac{1}{2}(0{,}02)$ ✓ $= 0{,}01$ mol $n(S)_{produced/berei} = \frac{m}{M}$ $= \frac{0{,}18}{32}$ ✓ $= 0{,}0056$ mol ↓ $\%yield/opbrengs = \frac{n(S)_{prod/berei}}{n(S)_{exp/verwag}} \times 100$ $\boxed{= \frac{0{,}0056}{0{,}01} \times 100}$ ✓ $= 56{,}25\%$ ✓	$n(HC\ell)_{used/gebruik} = cV$ ✓ $= 0{,}2 \times 0{,}1$ ✓ $= 0{,}02$ mol ↓ $n(S)_{expected/verwag} = \frac{1}{2}n(HC\ell)_{used/gebruik}$ $= \frac{1}{2}(0{,}02)$ ✓ $= 0{,}01$ mol ↓ $m(S)_{expected/verwag} = nM$ $= (0{,}01)(32)$ ✓ $= 0{,}32$ g $\%yield/opbrengs = \frac{m(S)_{prod/berei}}{m(S)_{exp/verwag}} \times 100$ $= \frac{0{,}18}{0{,}32} \times 100$ ✓ $= 56{,}25\%$ ✓

(6)

[18]

QUESTION 6/*VRAAG 6*

6.1 Reversible reaction/Both forward and reverse reactions can take place./Products can be converted back to reactants. ✓
Omkeerbare reaksie/Beide voorwaartse en terugwaartse reaksies kan plaasvind./Produkte kan terugverander word na reaktanse. (1)

6.2 To favour the forward reaction/production of ammonia./To increase the yield of ammonia./Prevent the decomposition of NH_3. ✓
Om die voorwaartse reaksie/produksie van ammoniak te bevoordeel./Om die ammoniak-opbrengs te verhoog./Voorkom die ontbinding van NH_3. (1)

6.3 20(%) ✓ (1)

6.4

6.4.1 At 500 °C lower yield of ammonia:

- The (forward) reaction is exothermic./Reverse reaction is endothermic. ✓
  Die (voorwaartse) reaksie is eksotermies./Terugwaartse reaksie is endotermies.
- An increase in temperature favours the endothermic reaction. ✓
  'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The reverse reaction is favoured.✓
  Die terugwaartse reaksie word bevoordeel.

OR/*OF*

At 350 °C higher yield of ammonia:

- The (forward) reaction is exothermic./Reverse reaction is endothermic. ✓
  Die (voorwaartse) reaksie is eksotermies./Terugwaartse reaksie is endotermies.
- A decrease in temperature favours the exothermic reaction. ✓
  'n Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The forward reaction is favoured. ✓
  Die voorwaartse reaksie word bevoordeel. (3)

6.4.2 At 350 atm higher yield of ammonia:

- An increase in pressure favours the reaction that produces the lower number of moles/number of molecules/volume of gas. ✓
  'n Toename in druk bevoordeel die reaksie wat die kleiner aantal mol/aantal molekule/volume gas lewer.
- The forward reaction is favoured. ✓
  Die voorwaartse reaksie word bevoordeel.

OR/*OF*

At 150 atm lower yield of ammonia:

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

6.5

6.5.1 1 mol N_2 reacts with 3 mol H_2 to produce 2 mol NH_3
$\therefore$ 2 mol N_2 reacts with 6 mol H_2 to produce 4 (mol) NH_3 ✓✓ **(2 or 0)**

1 mol N_2 reageer met 3 mol H_2 om 2 mol NH_3 te lewer
$\therefore$ *2 mol N_2 reageer met 6 mol H_2 om 4 (mol) NH_3 te vorm* ***(2 of 0)*** (2)

6.5.2 **POSITIVE MARKING FROM QUESTION 6.5.1.**

Marking criteria/*Nasienriglyne:*

- Calculate 35% of 4 mol NH_3 (answer from Q6.5.1). ✓
- Use mol ratio/*Gebruik molverhouding* $n(N_2) : n(H_2) : n(NH_3) = 1 : 3 : 2$ ✓
- Equilibrium/*Ewewig* $n(N_2)$ = initial/*aanvanklike* $n(N_2) - \Delta n(N_2)$
  Equilibrium/*Ewewig* $n(H_2)$ = initial/*aanvanklike* $n(H_2) - \Delta n(H_2)$ ✓
- Divide by/*Deel deur* 0,5 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*: 0,002 ✓
  Range/*Gebied*: 0,00155 to 0,002 ($1,55 \times 10^{-3}$ to 2×10^{-3})

$$n(NH_3) = \frac{35}{100} \times 4 \checkmark$$
$$= 1,4 \text{ mol}$$

	N_2	H_2	NH_3	
Initial amount (moles) *Aanvangs hoeveelheid (mol)*	6	6	0	
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,7	2,1	1,4	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	5,3	3,9 ✓	1,4	
Equilibrium concentration ($mol{\cdot}dm^{-3}$) *Ewewigskonsentrasie ($mol{\cdot}dm^{-3}$)*	10,6	7,8	2,8	Divide by 0,5 dm^3 ✓

$$K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]} \checkmark$$
$$= \frac{(2,8)^2}{(7,8)^3(10,6)} \checkmark$$
$$= 0,002 \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $\frac{6}{7}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{4}{7}$

(7)
[17]

QUESTION 7/*VRAAG 7*

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

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 A strong base ionises/dissociates completely ✓ and a weak base ionises/dissociates incompletely. ✓
'n Sterk basis ioniseer/dissosieer volledig en 'n swak basis ioniseer/dissosieer onvolledig. (2)

7.3 $HCO_3^-(aq) + H_2O(\ell)$ ✓ $\rightleftharpoons H_2CO_3(aq) + OH^-(aq)$ ✓ Bal. ✓

Accept/*Aanvaar*
$NaHCO_3(aq) + H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + NaOH(aq)$

Notes/*Aantekeninge:*
- Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓
- Ignore single arrow./*Ignoreer enkelpyl.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*
- Ignore phases/*Ignoreer fases.*

(3)

7.4

7.4.1 $pH = -\log[H_3O^+]$ ✓
$= -\log(0,2)$ ✓
$= 0,70$ ✓ (0,699) (3)

7.4.2 Titration of a weak base and a strong acid. ✓
Titrasie van 'n swak basis en 'n sterk suur.

OR/*OF*
The endpoint will be at pH < 7./*Die eindpunt sal by 'n pH < 7.* (1)

7.4.3

Marking guidelines/*Nasienriglyne:*

- Any formulae/*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* 0,2 mol·dm^{-3} & 20 x 10^{-3}/0,02 dm^3 or 20 cm^3. ✓
- Use mol ratio/*Gebruik molverhouding* n($XHCO_3$) : n(HCℓ) = 1 : 1 ✓
- Substitute/*Vervang* n($XHCO_3$) or/*of* c($XHCO_3$) AND/*EN* 0,4 g. ✓
- M(X) = 39 g·mol^{-1} ✓
- X = K/potassium/*kalium*. ✓

OPTION 1/*OPSIE 1*

c(HCℓ) = $\frac{n}{V}$ ✓

$\therefore$ 0,2 = $\frac{n}{20 \times 10^{-3}}$ ✓

n(HCℓ) = 4 x 10^{-3} mol

n($XHCO_3$) = n(HCℓ) ✓
= 4 x 10^{-3} mol

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

$\therefore 4 \times 10^{-3} = \frac{0,4}{M}$ ✓

M = 100 g·mol^{-1}

M($XHCO_3$) = M(X) + 61
= 100

$\therefore$ M(X) = 39 g·mol^{-1} ✓

X = K ✓
OR/*OF*
potassium/*kalium*

1 mol → M($XHCO_3$) 4 x 10^{-3} mol → 0,4 g ✓

M($XHCO_3$) = 100 g·mol^{-1}

M($XHCO_3$) = M(X) + 61
= 100

$\therefore$ M(X) = 39 g·mol^{-1} ✓

X = K ✓
OR/*OF*
potassium/*kalium*

OPTION 2/*OPSIE 2*

$\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓

$\frac{0,2 \times 20}{c_b \times 100}$ ✓ $= \frac{1}{1}$ ✓

c_b = 0,04 mol·dm^{-3}

$c(XHCO_3) = \frac{m}{MV}$

$\therefore$ 0,04 = $\frac{0,4}{M(0,1)}$ ✓

M($XHCO_3$) = 100 g·mol^{-1}

M($XHCO_3$) = M(X) + 61
= 100

$\therefore$ M(X) = 39 g·mol^{-1} ✓

X = K ✓
OR/*OF*
potassium/*kalium*

(6)
[17]

QUESTION 8/*VRAAG 8*

8.1 It is a conductor of electricity/a solid to connect wires to./Pt is inert or unreactive. ✓
Dit is 'n geleier van elektrisiteit/'n vaste stof waaraan drade geskakel kan word./Pt is inert of onreaktief.

OR/*OF*
$C\ell^-$(aq) and chlorine gas are not solids and cannot be used as an electrode.
$C\ell^-$(aq) en chloorgas is nie vaste stowwe nie en kan nie as 'n elektrode gebruik word nie. (1)

8.2

8.2.1 Chemical (energy) to electrical (energy) ✓
Chemiese (energie) na elektriese (energie) (1)

8.2.2 $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ ✓✓

Marking guidelines/*Nasienriglyne*

- $C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ $\frac{1}{2}$ $2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ $\frac{0}{2}$
  $2C\ell^- \leftarrow C\ell_2 + 2e^-$ $\frac{2}{2}$ $2C\ell^- \rightarrow C\ell_2 + 2e^-$ $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on $C\ell^-$/*Indien lading (-) weggelaat op $2C\ell^-$:*
  Max./*Maks:* $\frac{1}{2}$ Example/*Voorbeeld:* $C\ell_2 + 2e^- \rightarrow 2C\ell$ ✓

(2)

8.2.3 $Cr(s) \mid Cr^{3+}(aq)$ ✓ $\overset{✓}{||}$ $C\ell_2(g) \mid C\ell^-(aq) \mid Pt(s)$ ✓

OR/*OF*
$Cr(s) \mid Cr^{3+}(1\ mol{\cdot}dm^{-3}) \mid\mid C\ell_2(g) \mid C\ell^-\ (1\ mol{\cdot}dm^{-3}) \mid Pt(s)$

Accept/*Aanvaar*:
$Cr \mid Cr^{3+} \mid\mid C\ell_2 \mid C\ell^- \mid Pt$ (3)

8.3

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ $= 1{,}36$ ✓ $- (-0{,}74)$ ✓ $E^\theta_{cell} = 2{,}10\ V$ ✓	• 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*

$C\ell_2 + 2e^- \rightarrow 2C\ell^-$ $E^\theta = 1{,}36\ V$ ✓
✓
$Cr(s) \rightarrow Cr^{3+}(aq) + 3e^-$ $E^\theta = +0{,}74\ V$ ✓
$2Cr(s) + 3C\ell_2(g) \rightarrow 2Cr^{3+}(aq) + 6C\ell^-(aq)$ $E^\theta = +2{,}10\ V$ ✓

(4)

8.4 Increases/*Verhoog* ✓✓ (2)
[13]

QUESTION 9/*VRAAG 9*

9.1 Electrolytic/*Elektrolities* ✓ (1)

9.2 $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ ✓✓

Marking guidelines/*Nasienriglyne*

- $2H_2O + 2e^- \rightleftharpoons H_2 + 2OH^-$ $\frac{1}{2}$ $H_2 + 2OH^- \rightleftharpoons 2H_2O + 2e^-$ $\frac{0}{2}$
  $H_2 + 2OH^- \leftarrow 2H_2O + 2e^-$ $\frac{2}{2}$ $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on OH^-/*Indien lading (-) weggelaat op* OH^-:
  Max./*Maks:* $\frac{1}{2}$ Example/*Voorbeeld:* $2H_2O + 2e^- \rightarrow H_2 + 2OH$ ✓

(2)

9.3

9.3.1 Chlorine (gas) / $C\ell_2$ /*Chloor(gas)* ✓ (1)

9.3.2 P ✓ & Y ✓ (2)

9.4 Cathode/*Katode* ✓
Reduction takes place here./Gains electrons.✓
Reduksie vind hier plaas./Wins van elektrone. (2)

9.5 $CuC\ell_2(aq)$ ✓ $\rightarrow$ $Cu(s) + C\ell_2(g)$✓ Bal ✓
OR/OF
$Cu^{2+}(aq) + 2C\ell^- \rightarrow Cu(s) + C\ell_2(g)$

Notes/*Aantekeninge:*
- Reactants/*Reaktanse* ✓ Products/*Produkte* ✓ Balancing/*Balansering* ✓
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*
- Ignore phases/*Ignoreer fases.*

(3)
[11]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 II – IV – III - I ✓ (1)

10.1.2 $2NH_3 + H_2SO_4$ ✓ → $(NH_4)_2SO_4$ ✓ Bal ✓

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

(3)

10.1.3 Vanadium pentoxide/*Vanadiumpentoksied* ✓ (1)

10.1.4 $SO_3(g) + H_2SO_4$ ✓→ $H_2S_2O_7$ ✓ Bal ✓

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

(3)

10.1.5 Sulphuric acid will form (white) mists./The reaction is very exothermic/gives off too much heat./Corrosive reaction. ✓
Swawelsuur sal (wit) mis vorm./Die reaksie is té eksotermies/gee te veel warmte af./Vretende reaksie. (1)

10.2

Marking criteria/*Nasienriglyne:*
- Calculate m(fertiliser)./*Bereken m(kunsmis).* ✓
- Use ratio/*gebruik verhouding:* $\frac{2}{X+3}$/m(P) = ½m(K) ✓
- Use/*Gebruik* m(K) = 3,33 kg ✓
- Final answer/*Finale antwoord:* 3 ✓

OPTION 1/*OPSIE 1*

$m(\text{fertiliser}) = \frac{20}{100}\times 50$ ✓
$= 10\text{ kg}$

$m(K) = \frac{2}{X+3}\times 10$

$\therefore 3{,}33$ ✓ $= \frac{2}{X+3}$ ✓ $\times 10$

$\therefore\ X = 3$ ✓

OPTION 2/*OPSIE 2*

$m(K) = \frac{2}{X+3}$ ✓ $\times\frac{20}{100}$ x 50 ✓ = 3,33 ✓

X = 3 ✓

OPTION 3/*OPSIE 3*

$(\text{fertiliser}) = \frac{20}{100}\times 50$ ✓
$= 10\text{ kg}$

m(P) = ½m(K) ✓
= ½(3,33) = 1,665 kg

m(X) = 10 – 3,33 ✓– 1,665
= 5,005

N : P : K = 5,005 : 1,665 : 3,33
= 3 : 1 : 2

∴ X = 3 ✓

(4)
[13]

TOTAL/*TOTAAL:* 150