basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2022

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two 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. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following terms describes hydrocarbons that contain only single bonds?

A Isomers

B Saturated

C Unsaturated

D Homologous series (2)

1.2 Which ONE of the following combinations correctly indicates the STRONGEST intermolecular forces found in ethanoic acid and methyl propanoate respectively?

	ETHANOIC ACID	METHYL PROPANOATE
A	Hydrogen bonds	Hydrogen bonds
B	Dipole-dipole forces	London forces
C	Hydrogen bonds	London forces
D	Hydrogen bonds	Dipole-dipole forces

(2)

1.3 A test tube contains a liquid hydrocarbon.

When bromine water (Br_2) is added to the test tube, the mixture decolourises IMMEDIATELY.

Which ONE of the following combinations correctly identifies the COMPOUND and the TYPE OF REACTION that takes place in the test tube?

	COMPOUND	TYPE OF REACTION
A	Hexane	Addition
B	Hexane	Substitution
C	Hex-2-ene	Addition
D	Hex-2-ene	Substitution

(2)

1.4 Which ONE of the following statements is the CORRECT definition for the rate of a reaction?

A The time taken for the reaction to take place

B The speed at which the reaction takes place

C The rate of change in concentration of the products or reactants

D The rate of change in concentration of the products or reactants per unit time (2)

1.5 Consider the balanced equation for the reaction between magnesium powder and EXCESS dilute hydrochloric acid, $HC\ell(aq)$:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Which ONE of the following will NOT increase the rate of this reaction?

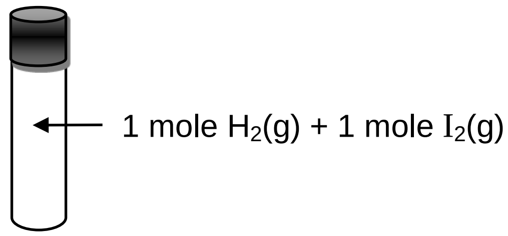
A Increasing the volume of $HC\ell(aq)$

B Increasing the temperature of $HC\ell(aq)$

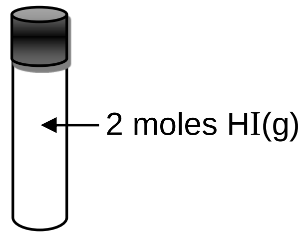
C Increasing the concentration of $HC\ell(aq)$

D Adding more magnesium powder (2)

1.6 Two identical sealed gas jars, **R** and **S**, initially contain gases as shown below.



Gas jar R



Gas jar S

Equilibrium is reached in both gas jars at 500 °C according to the following balanced equation:

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

Which ONE of the following statements is TRUE at equilibrium?

A **S** will contain 1 mole of $I_2(g)$.

B **R** will contain a larger amount of $I_2(g)$ than **S**.

C **R** and **S** will contain the same amount of $HI(g)$.

D **S** will contain a larger amount of $HI(g)$ than **R**. (2)

1.7 Which ONE of the following salts, when dissolved in water, will NOT change the pH of the water?

A Na_2CO_3

B $(COO)_2Na_2$

C $NH_4Cℓ$

D NaCℓ (2)

1.8 A dilute acid is titrated against a potassium hydroxide solution, KOH(aq).

At the equivalence point the pH is 7.

Which ONE of the following combinations correctly identifies the acid and the MOST SUITABLE indicator for this titration?

	ACID	**INDICATOR**
A	$(COOH)_2(aq)$	Phenolphthalein
B	$(COOH)_2(aq)$	Bromothymol blue
C	HCℓ(aq)	Phenolphthalein
D	HCℓ(aq)	Bromothymol blue

(2)

1.9 Which ONE of the following statements is TRUE for an oxidising agent?

A It gains electrons.

B It causes another species in the reaction to be reduced.

C Its oxidation number does not change during a chemical reaction.

D Its oxidation number increases during a chemical reaction. (2)

1.10 Which ONE of the following metals will reduce $Cd^{2+}(aq)$ to Cd(s), but will NOT reduce $Mn^{2+}(aq)$ to Mn(s)?

A Zn

B Ag

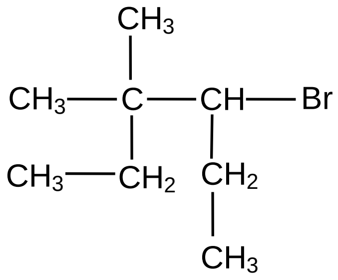
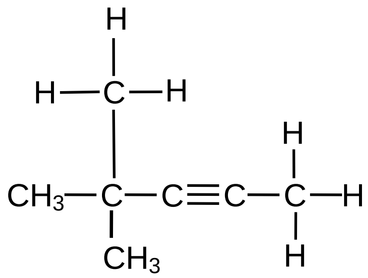
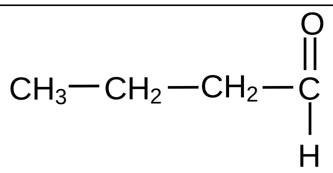
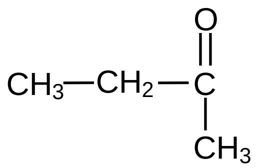
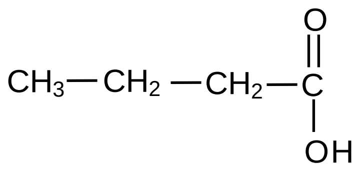
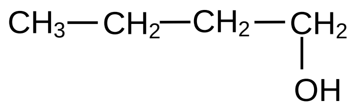
C Ni

D Mg (2)

[20]

QUESTION 2 (Start on a new page.)

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

A		**B**	
C		**D**	
E		**F**	

2.1 Write down the:

2.1.1 Letters that represent TWO organic compounds that are isomers of each other (1)

2.1.2 Type of isomers (CHAIN, FUNCTIONAL or POSITIONAL) identified in QUESTION 2.1.1 (1)

2.1.3 GENERAL FORMULA of the homologous series to which compound **B** belongs (1)

2.1.4 NAME of the functional group of compound **F** (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound **A** (3)

2.2.2 Compound **B** (2)

2.2.3 Compound **C** (2)

2.3 Compound **F** reacts with a carboxylic acid to form compound **S** in the presence of a strong acid.

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

Compound **S** has an EMPIRICAL FORMULA of C_3H_6O and a molecular mass of 116 $g{\cdot}mol^{-1}$.

2.3.2 Write down the MOLECULAR FORMULA of the carboxylic acid. (3)
[15]

QUESTION 3 (Start on a new page.)

3.1 The melting points of some organic compounds are given in the table below.

COMPOUND	IUPAC NAME	MELTING POINTS (^oC)
A	Propanone	-95,4
B	Butanone	-86,9
C	Pentan-2-one	-77,8
D	3-methylbutanone	-92

3.1.1 To which homologous series do the above compounds belong? (1)

The melting points of compounds **A**, **B** and **C** are compared.

3.1.2 Write down the controlled variable for this comparison. (1)

The melting points of compounds **C** and **D** are compared.

3.1.3 Fully explain the difference in the melting points of these two compounds. (4)

3.2 The table below shows the results obtained from an experiment to determine the vapour pressure of different STRAIGHT CHAIN primary alcohols at 300 K.

ALCOHOL	VAPOUR PRESSURE (kPa)
CH_3OH	16,8
C_2H_5OH	7,88
C_3H_7OH	2,8
C_4H_9OH	0,91
$C_5H_{11}OH$	0,88
$C_6H_{13}OH$	0,124

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

3.2.2 Write down a suitable conclusion for this investigation. (2)

3.2.3 Write down the IUPAC name of the alcohol with the HIGHEST boiling point. (3)

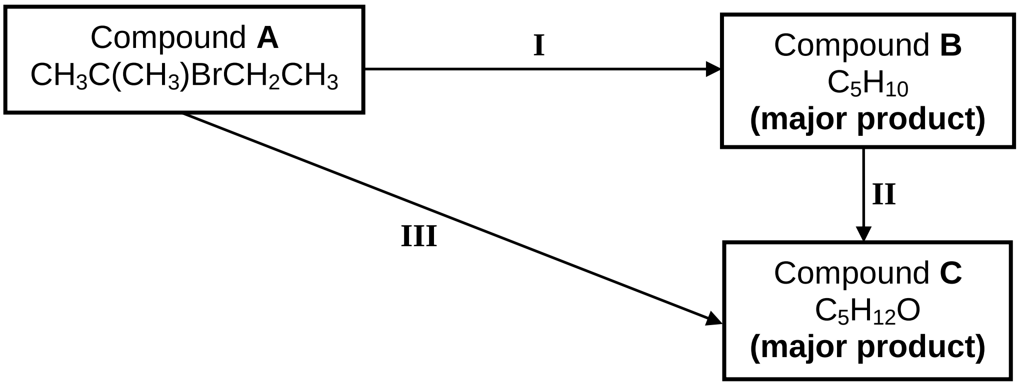
3.2.4 The experiment is now repeated at 320 K.

Will the vapour pressure of each compound INCREASE, DECREASE or REMAIN THE SAME? (1)
[14]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how compound **A** can be used as a starting reactant to prepare two different compounds.

I, **II** and **III** represent three organic reactions.



4.1 Is compound **A** a PRIMARY, SECONDARY or TERTIARY haloalkane? Give a reason for the answer. (2)

4.2 Consider reaction **I**.

4.2.1 Besides heat, write down the other reaction condition needed. (1)

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

4.2.3 Using STRUCTURAL FORMULAE for the organic compounds, write down a balanced equation for the reaction. (5)

4.3 Consider reaction **II**.

Write down the:

4.3.1 STRUCTURAL FORMULA of compound **C** (2)

4.3.2 NAME or FORMULA of the inorganic reagent needed (1)

4.3.3 Type of addition reaction that takes place (1)

4.4 Consider reaction **III**.

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

4.4.2 Besides heat, write down the other reaction condition needed. (1)
[15]

QUESTION 5 (Start on a new page.)

Three experiments, **A**, **B** and **C**, are carried out to investigate some of the factors that affect the rate of decomposition of hydrogen peroxide, $H_2O_2(\ell)$.

The balanced equation for the reaction is:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

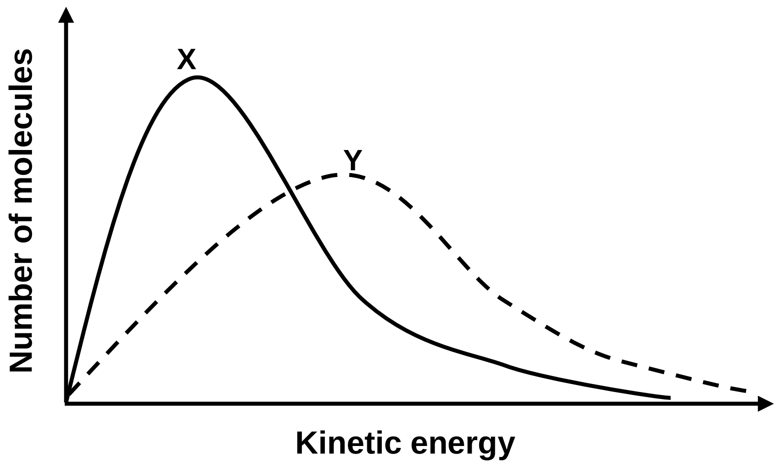
Identical samples of hydrogen peroxide are used in each experiment.

The conditions used in each experiment are summarised in the table below.

EXPERIMENT	TEMPERATURE (°C)	
A	25	Without catalyst
B	25	With catalyst
C	35	Without catalyst

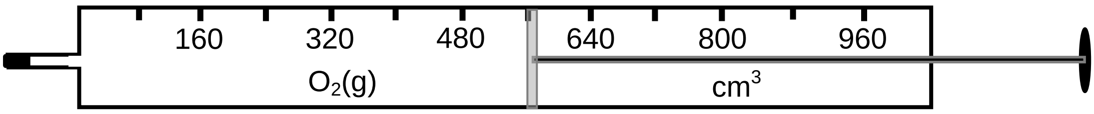
5.1 In which experiment, **A** or **B**, is the reaction rate higher? Use the collision theory to explain the answer. (4)

5.2 The Maxwell-Boltzmann distribution curves, **X** and **Y**, for two of the above experiments are shown below.



Identify the curve (**X** or **Y**) that represents experiment **C**. (2)

5.3 The volume of oxygen gas, $O_2(g)$, produced in experiment **B** during the first 3,6 s is collected in a syringe, as shown below.



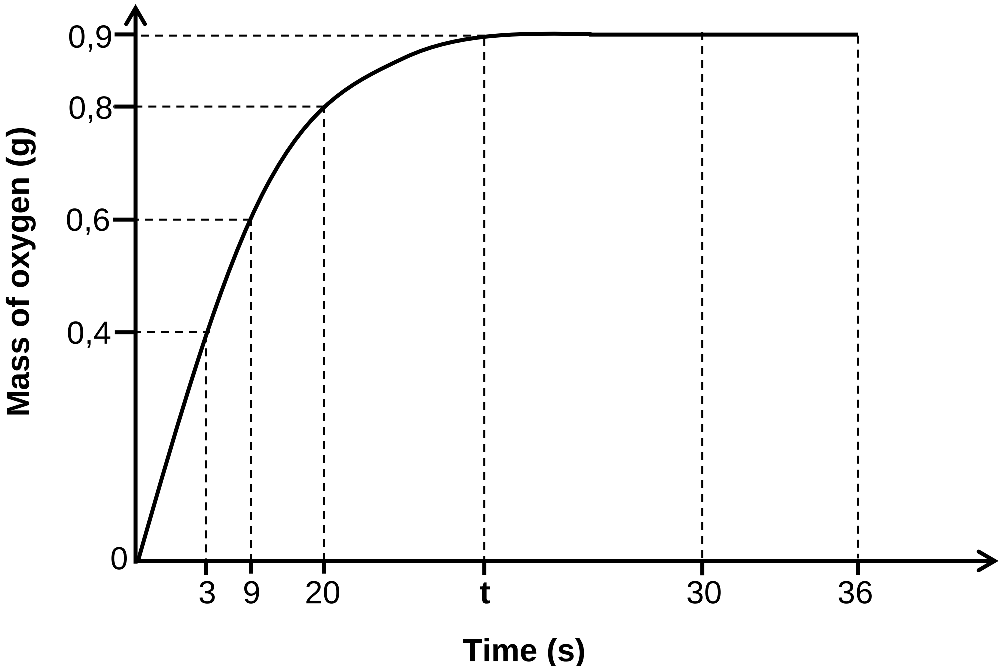
5.3.1 Write down the volume of $O_2(g)$ collected in the syringe. (2)

The balanced equation for the reaction is:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

5.3.2 Calculate the mass of water, $H_2O(\ell)$, that was produced during the first 3,6 s. Take the molar gas volume to be 24 000 $cm^3 \cdot mol^{-1}$ at 25 °C. (4)

5.4 The graph below, NOT drawn to scale, is obtained for the mass of oxygen gas produced over a period of time in experiment **A**.



Use the information in the graph to answer the following questions:

5.4.1 Write down the rate of production of oxygen gas for the interval 30 s to 36 s. (1)

5.4.2 Will the rate of the reaction in the interval 3 s to 9 s be GREATER THAN, SMALLER THAN or EQUAL TO the rate of the reaction in the interval 9 s to 20 s? (1)

5.4.3 The average rate of decomposition of hydrogen peroxide is $2,1 \times 10^{-3}$ $mol \cdot s^{-1}$.

Calculate the value of time **t** on the graph. (5)

[19]

QUESTION 6 (Start on a new page.)

Carbon, C(s), reacts with sulphur, S(g), according to the following balanced equation:

$$C(s) + 2S(g) \rightleftharpoons CS_2(g) \qquad \Delta H > 0$$

The system reaches equilibrium at temperature T in a sealed 2 dm^3 container.

The K_c value is 9,4 at temperature T.

6.1 State Le Chatelier's principle. (2)

At equilibrium, 1 mole of carbon disulphide, $CS_2(g)$, is present in the container.

6.2 Calculate the concentration of S(g) present at equilibrium. (4)

The volume of the container is now DOUBLED at temperature T. After a while, a NEW equilibrium is established.

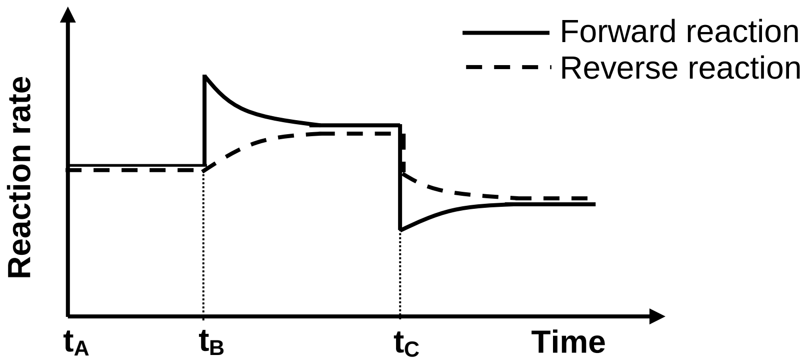
6.3 How will the amount of S(g) change as this new equilibrium is established? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 Explain the answer to QUESTION 6.3 in terms of Le Chatelier's principle. (3)

6.5 If the concentration of $CS_2(g)$ CHANGES by **x** $mol \cdot dm^{-3}$, write down an expression for the equilibrium constant, K_c, in terms of **x**.

Show ALL your workings. NO simplification or solving for **x** is required. (5)

6.6 The reaction rate-time graph below represents further changes made to the equilibrium mixture. The volume of the container is kept constant.



6.6.1 What do the parallel lines between $\mathbf{t_A}$ and $\mathbf{t_B}$ represent? (1)

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

6.6.3 Give a reason for the sudden change in the reaction rate at $\mathbf{t_C}$. (1)

6.6.4 Fully explain the answer to QUESTION 6.6.3. (3)

[21]

QUESTION 7 (Start on a new page.)

7.1 Ethanoic acid is a weak acid that reacts with water according to the following balanced equation:

$$CH_3COOH(aq) + H_2O(\ell) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq)$$

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

7.1.2 Give a reason why ethanoic acid is classified as a WEAK acid. (1)

7.1.3 Write down the formulae of the TWO bases in the equation above. (2)

7.2 A flask contains 300 cm^3 of dilute sodium hydroxide, NaOH(aq), of concentration 0,167 $mol \cdot dm^{-3}$.

7.2.1 Calculate the number of moles of sodium hydroxide in the flask. (3)

Ethanoic acid of volume 500 cm^3 and of unknown concentration, **X**, is now added to this flask to give a solution of volume 800 cm^3.

It is found that the pH of the mixture is 11,4.

The balanced equation for the reaction is:

$$NaOH(aq) + CH_3COOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$$

Calculate the:

7.2.2 Concentration of the $OH^-(aq)$ in the mixture (4)

7.2.3 Initial concentration, **X**, of the ethanoic acid solution (6)
[18]

QUESTION 8 (Start on a new page.)

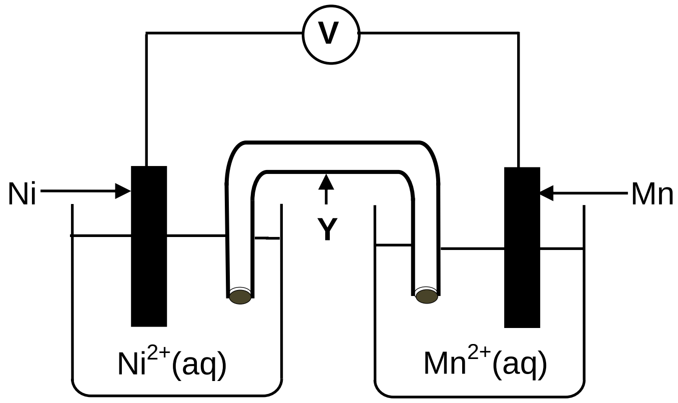
8.1 A piece of zinc (Zn) is placed in a test tube containing an acidified permanganate solution, $MnO_4^-(aq)$. After some time, it is found that a redox reaction has taken place.

Use the Table of Standard Reduction Potentials to answer the following questions:

8.1.1 Write down the NAME or FORMULA of the reducing agent. (1)

8.1.2 Refer to the relative strengths of the OXIDISING AGENTS to explain why a redox reaction has taken place. (3)

8.2 A standard electrochemical cell is set up as shown below.



8.2.1 Write down the function of component **Y**. (1)

8.2.2 In which direction will electrons flow in the external circuit? Choose from 'Ni to Mn' OR 'Mn to Ni'. (2)

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

8.2.4 Write down the balanced equation for the net cell reaction taking place. (3)

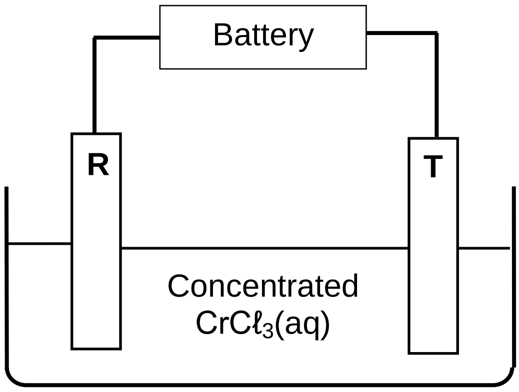
8.2.5 The concentration of $Ni^{2+}(aq)$ is now increased.

Will the reading on the voltmeter INCREASE, DECREASE or REMAIN THE SAME? (1)

[15]

QUESTION 9 (Start on a new page.)

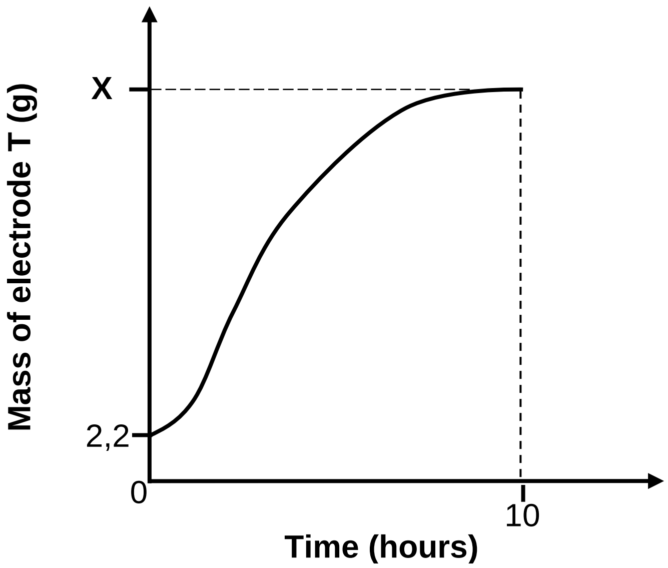
The diagram below represents a simplified cell used for the electrolysis of CONCENTRATED chromium(III) chloride, $CrC\ell_3(aq)$. Electrodes **R** and **T** are made of carbon.



The net cell reaction is: $2CrC\ell_3(aq) \rightarrow 2Cr(s) + 3C\ell_2(g)$

9.1 Define the term *electrolysis*. (2)

9.2 The graph below, NOT drawn to scale, represents the changes in the mass of electrode **T** during electrolysis.



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

A current of 2,5 A passes through the cell for 10 hours.

Calculate the:

9.2.2 Total charge that flows through the cell during this time (3)

9.2.3 Value of **X** as shown on the graph (6)
[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* $E^{\theta}_{cell} = E^{\theta}_{oxidising agent} - E^{\theta}_{reducing agent} / E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$q = I\Delta t$ $n = \frac{Q}{e}$ or/*of* $n = \frac{Q}{q_e}$	

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

KEY/*SLEUTEL*

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

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 strength of oxidising agents/*Toenemende sterkte van oksideermiddels* ↑

Increasing strength of reducing agents/*Toenemende sterkte van reduseermiddels* ↓

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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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 strength of oxidising agents/*Toenemende sterkte van oksideermiddels*

Half-reactions/*Halfreaksies*			E^θ (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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 strength of reducing agents/*Toenemende sterkte van reduseermiddels* 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 2022

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages.
Hierdie nasienriglyne bestaan uit 19 bladsye.

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 D ✓✓ (2)

1.3 C ✓✓ (2)

1.4 C ✓✓ (2)

1.5 A ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 D ✓✓ (2)

1.9 A ✓✓ (2)

1.10 A ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1
2.1.1 C & D ✓ (1)

2.1.2 Functional/*Funksionele* ✓ (1)

2.1.3 C_nH_{2n-2} ✓ (1)

2.1.4 Hydroxyl (group)/*Hidroksiel(groep)* ✓ (1)

2.2
2.2.1 4-bromo-3,3-dimethylhexane/*4-bromo-3,3-dimetielheksaan* ✓✓✓

<u>Marking criteria:</u>
- Correct stem i.e. <u>hexane</u>. ✓
- All substituents (bromo and dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

<u>Nasienkriteria:</u>
- *Korrekte stam d.i. <u>heksaan</u>.* ✓
- *Alle substituente (bromo en dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

2.2.2 4,4-dimethylpent-2-yne/4,4-dimethyl-2-pentyne ✓✓
4,4-dimetielpent-2-yn/4,4-dimetiel-2-pentyn

Marking criteria/*Nasienkriteria:*
- Correct stem and substituents: dimethyl and pentyne ✓
  Korrekte stam en substituente: dimetiel en pentyn
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓
  IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.

(2)

2.2.3 Butanal/*Butanaal* ✓✓

Marking criteria/*Nasienkriteria*:
- Correct functional group: -al /
  Korrekte funksionele groep: –aal ✓
- IUPAC name correct/*IUPAC-naam korrek* ✓

(2)

2.3
2.3.1 Esterification/condensation ✓
Esterfikasie/verestering/kondensasie (1)

2.3.2 $M(C_3H_6O) = 58\ g{\cdot}mol^{-1}$

$$\frac{\text{molecular mass of molecular formula}}{\text{molecular mass empirical formula}}$$

$$= \frac{116}{58} = 2$$

Compound S = $C_6H_{12}O_2$ ✓
$C_2H_4O_2$ ✓✓

Marking criteria/*Nasienkriteria*:
- $C_6H_{12}O_2$ ✓
- $C_2H_4O_2$ ✓✓
- If only correct answer given ✓✓✓
  Indien slegs korrekte antwoord gegee

NOTE/*LET WEL*
- Condensed or structural formula/*Gekondenseerde of struktuurformule*:
  Max./*Maks.* $^2/_3$

(3)
[15]

QUESTION 3/*VRAAG 3*

3.1.1 Ketone/*Ketoon* ✓ (1)

3.1.2 Functional group/homologous series ✓
Funksionele groep/homoloë reeks (1)

3.1.3

Marking criteria:
• Compare structures. ✓
• Compare the strength of intermolecular forces. ✓
• Compare the energy required to overcome intermolecular forces. ✓
• State the difference in melting point. ✓
Nasienkriteria:
• *Vergelyk strukture.* ✓
• *Vergelyk die sterkte van intermolekulêre kragte.* ✓
• *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓
• *Noem die verskil in smeltpunte.* ✓

Pentan-2-one/C

- **Structure:**
  Longer chain length/less branched/less compact/less spherical/larger surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Stronger/more intermolecular forces/Van der Waals forces/*London forces/* dipole-dipole forces. ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces/Van der Waals forces/dipole-dipole forces. ✓
- Higher melting point. ✓

NOTE
IF higher boiling point - Max. $^3/_4$

OR

3-methylbutanone/D

- **Structure:**
  Shorter chain length/more branched/more compact more spherical/smaller surface area (over which intermolecular forces act). ✓
- **Intermolecular forces:**
  Weaker/less intermolecular forces/Van der Waals forces/*London forces/* dipole-dipole forces. ✓
- **Energy:**
  Less energy needed to overcome or break intermolecular forces/Van der Waals force/dipole-dipole forces. ✓
- Lower melting point.✓

NOTE
IF lower boiling point - Max. $^3/_4$

Pentan-2-oon/C

- ***Struktuur*:**
  Langer kettinglengte/minder vertak/minder kompak/minder sferies/groter oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte*:**
  Sterker/meer intermolekulêre kragte/Van der Waalskragte/Londonkragte/ dipool-dipoolkragte. ✓
- *Meer energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte te oorkom/breek.* ✓
- *Hoër smeltpunt.* ✓

LET WEL

***INDIEN** hoër kookpunt - Maks.* $^{3}/_{4}$

OF

3-metielbutanoon/D

- ***Struktuur*:**
  Korter kettinglengte/meer vertak/meer kompak/meer sferies/kleiner oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte*:**
  Swakker/minder intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte. ✓
- ***Energie*:**
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte/ Londonkragte/dipool-dipoolkragte te oorkom/breek. ✓
- *Laer smeltpunt.* ✓

LET WEL

***INDIEN** laer kookpunt - Maks.* $^{3}/_{4}$ (4)

3.2.1

Marking criteria/*Nasienkriteria*

If any one of the underlined key words phrases in the **correct context** (vapour pressure) is omitted, deduct 1 mark./*Indien enige van die onderstreepte sleutelwoorde of frases in die **korrekte konteks** (dampdruk) uitgelaat is, trek 1 punt af.*

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

3.2.2

Marking criteria/*Nasienkriteria:*

- Dependent and independent variables correctly identified. ✓
  Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.
- Correct relationship between dependent and independent variables stated. ✓
  Korrekte verwantskap tussen die afhanklike en onafhanklike veranderlikes gestel.

Vapour pressure decreases with increase in number of C atoms/chain length. ✓✓
Dampdruk neem af met toename in aantal C-atome/kettinglengte.
OR/*OF*
Vapour pressure increases with decrease in number of C atoms/chain length.
Dampdruk neem toe met afname in aantal C-atome/kettinglengte. (2)

3.2.3 Hexan-1-ol/1-Hexanol ✓✓✓
Heksan-1-ol/1-Heksanol

<u>Marking criteria/*Nasienkriteria*</u>
- Correct chain length i.e. hex ✓
  Korrekte kettinglengte d.i. heks
- **IF** hexanol/***INDIEN*** *heksanol*
  Max/*Maks*: $^2/_3$
- Whole name correct./*Volledige naam korrek.* $^3/_3$

(3)

3.2.4 Increases/*Toeneem* ✓ (1)

[14]

QUESTION 4/*VRAAG 4*

4.1 Tertiary/*Tersiêre* ✓

The halogen/bromine/functional group (-X) is bonded to a C atom that is bonded to three other C atoms/ a tertiary C atom. ✓
Die halogeen/broom/funksionele groep (-X) is gebind aan 'n C-atoom wat aan drie ander C-atome gebind is/ 'n tersiêre C-atoom.

OR/*OF*

The functional group (— C —) is bonded to three other C atoms.
(C bonded above; X/Br bonded below)

Die funksionele groep (— C —) is gebind aan drie ander C-atome.
(C bonded above; X/Br bonded below)

(2)

4.2.1 <u>Concentrated strong base</u> ✓
OR
<u>Concentrated</u> NaOH/KOH/LiOH/sodium hydroxide/ potassium hydroxide/ lithium hydroxide
OR
<u>Strong base</u>/NaOH/KOH/LiOH/sodium hydroxide/ potassium hydroxide/lithium hydroxide <u>in ethanol</u>.

<u>Gekonsentreerde sterk basis</u>
OF
<u>Gekonsentreerde NaOH</u> /KOH/ LiOH /natriumhidroksied/ kaliumhidroksied/ litiumhidroksied
OF
<u>Sterk basis</u>/NaOH /KOH/ LiOH / natriumhidroksied/kaliumhidroksied/litium-hidroksied <u>in etanol</u> (1)

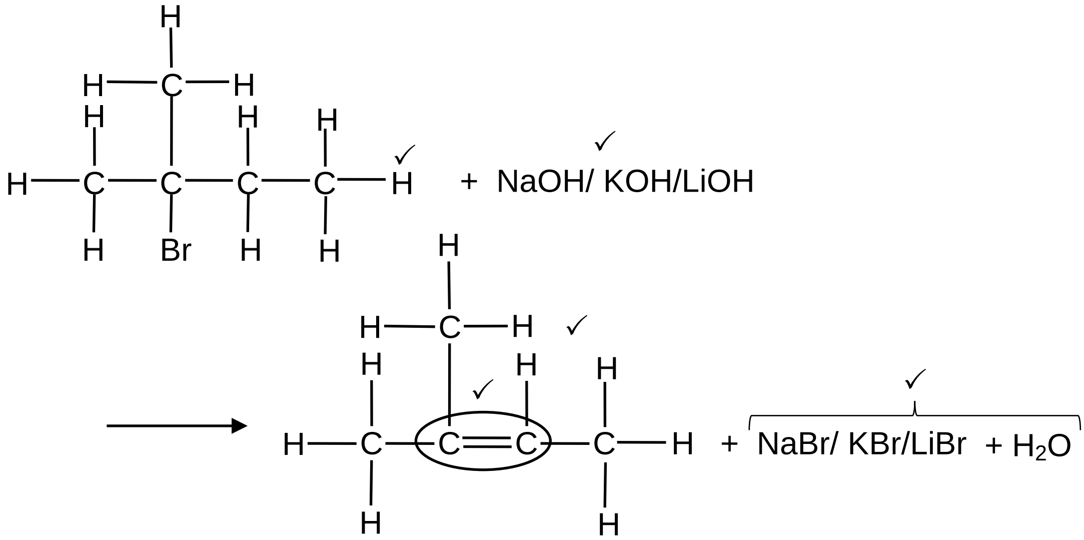
4.2.2 Elimination/dehydrohalogenation/dehydrobromination ✓
Eliminasie/dehidrohalogenering/dehidrohalogenasie/dehidrobrominasie/ dehidrobromonering (1)

4.2.3

Marking criteria*:*
- Whole structural formula correct for compound A. ✓
- React (2-bromo-2-methylbutane) with NaOH/KOH/LiOH. ✓
- Functional group of alkene correct. ✓
- Whole structural formula of alkene correct. ✓
- NaBr/KBr/LiBr + H_2O ✓

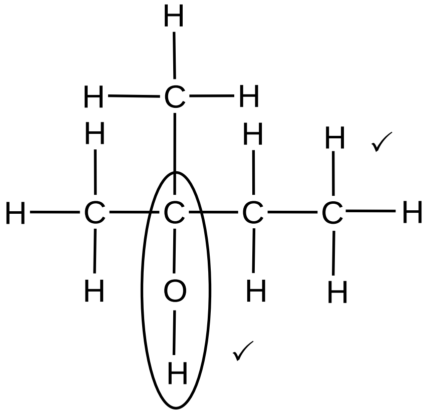
Nasienkriteria:
- *Hele struktuurformule vir verbinding A korrek.* ✓
- *Reageer (2-bromo-2-metielbutaan) met NaOH/KOH/LiOH.* ✓
- *Funksionele groep van alkeen korrek.* ✓
- *Hele struktuurformule van alkeen korrek.* ✓
- *NaBr/KBr/LiBr + H_2O* ✓

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.* $^3/_5$
- Any additional reactants or products /*Enige addisionele reaktanse of produkte:* Max./*Maks.* $^4/_5$
- Molecular formulae used:/M*olekulêre formule gebruik:* Max./*Maks.* $^2/_5$
- No or incorrect inorganic reactants or products:/ *Geen of verkeerde anorganiese reaktanse of produkte:* Max./*Maks.* $^3/_5$
- Marking rule 6.3.10/*Nasienreël 6.3.10*



(5)

4.3.1



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

(2)

4.3.2 Water/H_2O ✓ (1)

4.3.3 Hydration/*Hidrasie* ✓ (1)

4.4.1 Substitution/Hydrolysis/*Substitusie/Hidrolise* ✓ (1)

4.4.2 Dilute strong base ✓
OR: Dilute NaOH/KOH/LiOH/sodium hydroxide/potassium hydroxide/lithium hydroxide
OR: NaOH(aq)/KOH(aq)/LiOH(aq)
OR: (Add) water/H_2O

Verdunde sterk basis
OF: *Verdunde NaOH/KOH/LiOH/natriumhidroksied/ kaliumhidroksied/ litiumhidroksied*
OF**:** *NaOH(aq)/KOH(aq)/LiOH(aq)*
OF: *(Voeg) water/H_2O (by)* (1)

[15]

QUESTION 5/*VRAAG 5*

5.1 B ✓

- The catalyst provides an alternative route of lower activation energy. ✓
- More molecules have enough/sufficient (kinetic) energy./More molecules have (kinetic) energy equal to or higher than the activation energy. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓

- *Die katalisator verskaf 'n alternatiewe roete van laer aktiveringsenergie.*
- *Meer molekule het genoeg/voldoende (kinetiese) energie./Meer molekule het (kinetiese) energie gelyk aan of groter hoër as die aktiveringsenergie.*
- *Meer effektiewe botsings per eenheidtyd./Hoër frekwensie van effektiewe botsings.* (4)

5.2 Y ✓✓ (2)

5.3
5.3.1 560 (cm^3) / 0,56 dm^3 ✓✓ (2)

5.3.2 **POSITIVE MARKING FROM QUESTION 5.3.1.**
POSITIEWE NASIEN VANAF VRAAG 5.3.1.

<table>
<tr>
<td><u>Marking criteria:</u>
(a) Substitute <u>24 000 and 560</u>/<u>24 and 0,56</u> in $n = \frac{V}{V_m}$ ✓
(b) USE mol ratio: $n(H_2O) : n(O_2) = 2 : 1$ ✓
(c) Substitute <u>18 and n(H2O)</u> in $m = nM$ ✓
(d) Final answer: 0,83 g ✓
Range: 0,72 to 0,9 g</td>
<td><u>Nasienkriteria:</u>
(a) Vervang <u>24 000 en 560</u>/<u>24 en 0,56</u> in $n = \frac{V}{V_m}$ ✓
(b) GEBRUIK molverhouding: $n(H_2O) : n(O_2) = 2 : 1$ ✓
(c) Vervang <u>18 en n(H2O)</u> in $m = nM$ ✓
(d) Finale antwoord: 0,83 g ✓
Gebied: 0,72 tot 0,9 g</td>
</tr>
<tr>
<td><u>OPTION 1/OPSIE 1</u>
$n(O_2) = \frac{V}{V_m}$
$= \frac{560}{24\ 000}$ ✓(a)
$= 0,023$ mol (0,0233)
$n(H_2O) = 2n(O_2)$
$n(H_2O) = 2(0,023)$ ✓(b)
$= 0,046$ mol (0,0467)
$m = nM$
$= \underline{0,046 \times 18}$ ✓(c)
$= 0,83$ g ✓(d)</td>
<td><u>OPTION 2/OPSIE 2</u>
1 mol …….24 000 cm^3
x mol …….560 cm^3 ✓(a)
x = 0,023 mol (0,0233)
$n(H_2O) = 2n(O_2)$
$n(H_2O) = 2(0,023)$ ✓(b)
$= 0,046$ mol (0,0467)
$m = nM$
$= \underline{0,0466 \times 18}$ ✓(c)
$= 0,83$ g ✓(d)</td>
</tr>
</table>

(4)

5.4

5.4.1 0 ($g \cdot s^{-1}$) / zero / *nul* ✓ (1)

5.4.2 Greater than/*Groter as* ✓ (1)

5.4.3

<table>
<tr>
<td>

<u>Marking criteria</u>

a) Substitute 0,9 g in $\frac{m}{M}$ ✓
b) Substitute 32 in $\frac{m}{M}$ ✓
c) USE mol /rate ratio: $n(H_2O_2) : n(O_2) = 2 : 1$ ✓
d) Substitute <u>$2,1 \times 10^{-3}$ and $n(H_2O_2)$</u> in rate formula ✓
OR: Substitute <u>rate O_2</u> ($1,05 \times 10^{-3}$) <u>and $n(O_2)$</u> in rate formula
OR: Substitute rate O_2 ($0,0336\ g{\cdot}s^{-1}$) in rate formula
e) Final correct answer: 26,67 (s) ✓
Range: 26,67 to 28,57 (s)

</td>
<td>

<u>Nasienkriteria:</u>

a) Vervang 0,9 g in $\frac{m}{M}$ ✓
b) Vervang 32 in $\frac{m}{M}$ ✓
c) GEBRUIK mol-/tempoverhouding: $n(H_2O_2) : n(O_2) = 2 : 1$ ✓
d) Vervang <u>$2,1 \times 10^{-3}$ en $n(H_2O_2)$</u> in tempoformule ✓
OF: *Vervang <u>tempo</u>* <u>O_2</u> ($1,05 \times 10^{-3}$) *<u>en $n(O_2)$</u> in tempoformule*
OF: *Vervang tempo* O_2 ($0,0336\ g{\cdot}s^{-1}$) *in tempoformule*
e) Finale korrekte antwoord: 26,67 (s) ✓
Gebied: 26,67 tot 28,57 *(s)*

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<u>OPTION 1/*OPSIE 1*</u>

$n(O_2) = \frac{m}{M}$
$= \frac{0,9 ✓(a)}{32 ✓(b)}$
$= 0,028$ mol (0,0281)
$n(H_2O_2) = 2n(O_2)$
$= 2(0,028)$ ✓**(c)**
$= 0,056$
rate/*tempo* $= \frac{\Delta n}{\Delta t}$
✓**(d)** $2,1 \times 10^{-3} = \frac{0,056 - 0}{\Delta t}$
$\Delta t = 26,67$ (s) ✓**(e)**

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

1 mol ……………….32 g ✓**(b)**
x mol ……………….0,9 g ✓**(a)**
x = 0,0275 mol
$n(H_2O_2) = 2n(O_2)$
$= 2(0,0275)$ ✓**(c)**
$= 0,056$ mol
rate/*tempo* $= \frac{\Delta n}{\Delta t}$
✓**(d)** $2,1 \times 10^{-3} = \frac{0,056 - 0}{\Delta t}$
$\Delta t = 26,67$ (s) ✓**(e)**

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<u>OPTION 3/*OPSIE 3*</u>

$n(O_2) = \frac{m}{M}$
$= \frac{0,9 ✓(a)}{32 ✓(b)}$
$= 0,028$ mol (0,0281)
$Rate(O_2) = ½\ rate(H_2O_2)$
$= ½\ (2,1 \times 10^{-3})$ ✓**(c)**
$= 1,05 \times 10^{-3}$
rate/*tempo* $= \frac{\Delta n}{\Delta t}$
✓**(d)** $1,05 \times 10^{-3} = \frac{0,028}{\Delta t}$
$\Delta t = 26,67$ (s) ✓**(e)**

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<u>OPTION 4/*OPSIE 4*</u>

rate $H_2O_2 = 2,1 \times 10^{-3}\ mol{\cdot}s^{-1}$
$Rate(O_2) = ½\ rate(H_2O_2)$
$= ½\ (2,1 \times 10^{-3})$ ✓**(c)**
$= 1,05 \times 10^{-3}$
In one second:
$n(O_2) = \frac{m}{M}$
$1,05 \times 10^{-3} = \frac{m}{32 ✓(b)}$
$m(O_2) = 0,0336$ g
rate = $0,0336\ g{\cdot}s^{-1}$
rate $= \frac{\Delta m}{\Delta t}$ ✓**(a)**
✓**(d)** $0,0336 = \frac{0,9 - 0}{\Delta t}$
$\Delta t = 26,79$ (s) ✓**(e)**

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(5)
[19]

QUESTION 6/*VRAAG 6*

6.1

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

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

6.2

$$K_c = \frac{[CS_2]}{[S]^2} \checkmark$$

$$\overset{\checkmark}{9,4} = \frac{0,5 \checkmark}{[S]^2}$$

$[S] = 0,23\ mol{\cdot}dm^{-3}$ ✓

NOTE/*LET WEL*
- Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $^2/_4$
- No K_c expression but correct substitution/*Geen K_c-uitdrukking but korrekte vervanging: Max/Maks.* $^3/_4$

(4)

6.3 Increases/*Neem toe* ✓ (1)

6.4
- Increasing/doubling the volume will <u>decrease the pressure</u>. ✓
- The reaction that produces a greater number of moles/amount of gas (1 mole gas to 2 moles gas) is favoured. ✓
- Reverse reaction is favoured. ✓

- *Verhoging/verdubbeling van volume sal die <u>druk verlaag</u>.*
- *Die reaksie wat 'n groter aantal mol/hoeveelheid gas (1 mol gas na 2 mol gas) lewer word bevoordeel.*
- *Terugwaartse reaksie word bevoordeel.* (3)

6.5 **POSITIVE MARKING FROM 6.2./*POSITIEWE NASIEN VAN VRAAG 6.2.***

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK
Marking criteria*:*
(a) Initial concentration is halved. ✓
(b) Change in $[CS_2]$ and [S] **USING** ratio*:* *S* : CS_2 = 2 : 1 ✓
(c) Equilibrium [S] = initial [S] + change in [S] ✓
(d) Equilibrium $[CS_2]$ = initial $[CS_2]$ - change in $[CS_2]$ ✓
(e) ***CORRECT*** final answer. ✓
Nasienkriteria:
(a) Aanvanklike konsentrasie is gehalveer.✓
*(b) Verandering in $[CS_2]$ en [S] deur **GEBRUIK** van verhouding S : CS_2 = 2 : 1* ✓
(c) Ewewig [S] = aanvanklike [S] + verandering in [S] ✓
(d) Ewewig $[CS_2]$ = aanvanklike $[CS_2]$ - verandering in $[CS_2]$ ✓
(e) ***KORREKTE** finale antwoord.* ✓

OPTION 1/*OPSIE 1*

	S	CS_2	
Initial concentration ($mol{\cdot}dm^{-3}$) *Aanvangskonsentrasie ($mol{\cdot}dm^{-3}$)*	0,23 x ½ = 0,115	0,5 x ½ = 0,25	✓**(a)**
Change in concentration ($mol{\cdot}dm^{-3}$) *Verandering in konsentrasie ($mol{\cdot}dm^{-3}$)*	2x	x	✓**(b)**
Equilibrium concentration ($mol{\cdot}dm^{-3}$) *Ewewigskonsentrasie ($mol{\cdot}dm^{-3}$)*	0,115 + 2x	0,25 - x	
	✓**(c)**	✓**(d)**	

$$K_c = \frac{[CS_2]}{[S]^2}$$

$$9{,}4 = \frac{0{,}25 - x}{(0{,}115 + 2x)^2}$$ ✓**(e)**

Wrong K_c expression
Verkeerde K_c- uitdrukking: Max./*Maks.* $^4/_5$

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK
Marking criteria*:*
(a) n(initial) = c(initial) x 2. ✓
(b) Change in n(S) and $n(CS_2)$ **USING** ratio*:* *S* : CS_2 = 2 : 1 ✓
(c) Equilibrium n(S) = initial n(S) + change in n(S) ✓
(d) Equilibrium $n(CS_2)$ = initial $n(CS_2)$ - change in $n(CS_2)$ ✓
(e) **CORRECT** final answer. ✓

Nasienkriteria:
(a) n(aanvanklik) = c(aanvanklik) x 2 ✓
(b) Verandering in n(S) en $n(CS_2)$ deur ***GEBRUIK*** *van verhouding: S :* CS_2 *= 2 : 1* ✓
(c) Ewewig n(S) = aanvanklike n(S) + verandering in n(S) ✓
(d) Ewewig $n(CS_2)$ *= aanvanklike* $n(CS_2)$ *- verandering in* $n(CS_2)$ ✓
(e) ***KORREKTE*** *finale antwoord.* ✓

OPTION 2/*OPSIE 2*

	S	CS_2	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,46	1	✓**(a)**
Change (mol) *Verandering (mol)*	8x	4x	✓**(b)**
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)* ✓**(c)**	0,46 + 8x	1 – 4x	✓**(d)**
Equilibrium concentration ($mol\cdot dm^{-3}$) *Ewewigskonsentrasie* ($mol\cdot dm^{-3}$)	$\frac{0,46 + 8x}{4}$	$\frac{1 - 4x}{4}$	

$$K_c = \frac{[CS_2]}{[S]^2}$$

$$9,4 = \frac{\frac{1 - 4x}{4}}{\left(\frac{0,46 + 8x}{4}\right)^2} \checkmark\textbf{(e)}$$

Wrong K_c expression
Verkeerde K_c-uitdrukking: Max./*Maks.* $^4/_5$

(5)

6.6
6.6.1 (Chemical) equilibrium / Rate of the forward and reverse reactions are equal. / Concentrations of reactants and products are constant. ✓
(*Chemiese) ewewig / Tempo van voorwaartse en terugwaartse reaksie dieselfde./Konsentrasies van reaktante en produkte is konstant.* (1)

6.6.2 Increase in the amount/concentration of S/reactant **OR** S was added. ✓
Toename in die hoeveelheid/konsentrasie S/reaktans ***OF*** *S is bygevoeg.* (1)

6.6.3 Decrease in temperature/*Verlaging in temperatuur* ✓ (1)

6.6.4
- The rates of the forward and reverse reactions decrease. ✓
- The reverse reaction is favoured / faster than the forward reaction.
  OR
  The forward reaction decreases more. ✓
- A decrease in temperature favours the exothermic reaction. ✓

- *Die voorwaartse en terugwaartse reaksietempo neem af.*
- *Die terugwaartse reaksie word bevoordeel/is vinniger as die voorwaartse reaksie.*
  OF
  Die voorwaartse reaksie neem meer af.
- *'n Verlaging in die temperatuur bevoordeel die eksotermiese reaksie.* (3)

[21]

QUESTION 7/*VRAAG 7*

7.1

7.1.1 (An acid is a) proton donor/H^+ (ion) donor. ✓✓ (**2 or 0)**
('n Suur is 'n) protonskenker/H^+(-ioon) skenker. ***(2 of 0)*** (2)

7.1.2 (Weak acids) ionise/dissociate incompletely/partially (in water)/have a low K_a value. ✓
(Swak sure) ioniseer/dissosieer onvolledig/gedeeltlik (in water)/het 'n lae K_a-waarde. (1)

7.1.3 H_2O ✓ and CH_3COO^- ✓ (2)

7.2

7.2.1 n(NaOH) = cV ✓
n = $\underline{(0,167)(0,300)}$ ✓
∴ n(NaOH) = 0,05 mol ✓ (5 x 10^{-2} mol) (3)

7.2.2

Marking criteria:	***Nasienkriteria:***
a) Any formula: $pH = -\log[H_3O^+]$ / $pH = -\log[H^+]$ / $pOH = -\log[OH^-]$ / $[H_3O^+][OH^-] = 10^{-14}$ / $pH + pOH = 14$ ✓ b) Substitute 11,4 in $pH = -\log[H_3O^+]$/ $pH + pOH = 14$ ✓ c) Substitute calculated $[H_3O^+]$ in $[H_3O^+][OH^-]$ / 2,6 in $pOH = -\log[OH^-]$ ✓ d) Final answer: $2,51 \times 10^{-3}$ mol·dm^{-3} ✓ (0,003 mol·dm^{-3})	*a)* Enige formule: $pH = -\log[H_3O^+]$ / $pH = -\log[H^+]$ / $pOH = -\log[OH^-]$ / $[H_3O^+][OH^-] = 10^{-14}$ / $pH + pOH = 14$ ✓ *b) Vervang* 11,4 in $pH = -\log[H_3O^+]$/ $pH + pOH = 14$ ✓ *c) Vervang berekende* $[H_3O^+]$ in $[H_3O^+][OH^-]$ / 2,6 in $pOH = -\log[OH^-]$ ✓ *d) Finale antwoord:* $2,51 \times 10^{-3}$ mol·dm^{-3} ✓ (0,003 mol·dm^{-3})

OPTION 1/*OPSIE 1*

$pH = -\log[H_3O^+]$ Any one/*Enige een* ✓**(a)**

$11,4$ ✓**(b)** $= -\log[H_3O^+]$ **OR/*OF*** $[H_3O^+] = 10^{-11,4}$

$[H_3O^+] = 3,98 \times 10^{-12}$

$[H_3O^+][OH^-] = 10^{-14}$

✓**(c)**

$(3,98 \times 10^{-12})[OH^-] = 1 \times 10^{-14}$

$[OH^-] = 2,51 \times 10^{-3}$ mol·dm^{-3} ✓**(d)** (0,003)

OPTION 2/*OPSIE 2*

$pH + pOH = 14$ Any one/*Enige een* ✓**(a)**

$\underline{11,4 + pOH = 14}$ ✓**(b)**

$pOH = 2,6$

$pOH = -\log[OH^-]$ ✓

$2,6$ ✓**(c)** $= -\log[OH^-]$

$[OH^-] = 2,51 \times 10^{-3}$ mol·dm^{-3} ✓**(d)** (0,003) (4)

7.2.3 **POSITIVE MARKING FROM QUESTION 7.2.1. AND 7.2.2.**
POSITIEWE NASIEN VANAF VRAAG 7.2.1. EN 7.2.2.

Marking criteria:

a) Substitute [NaOH] = 0,00251 mol·dm^{-3} (answer from Q7.2.2) and 0,8 in $c = \frac{n}{V}$ ✓
b) Subtract: $n(NaOH)_{initial}$ (from Q7.2.1) – $n(NaOH)_{mixture}$ ✓✓
c) Use of ratio: $n(OH^-) = n(CH_3COOH)$ ✓
d) Substitute 0,5 and $\Delta n(CH_3COOH)$[calculated by subtraction] into $c = \frac{n}{V}$ ✓
e) Final correct answer: 0,096 mol·dm^{-3} ✓
Range: 0,095 to 0,1 mol·dm^{-3}

Nasienkriteria:

a) *Vervang [NaOH] = 0,00251 mol·dm^{-3} (antwoord van Q7.2.2) en 0,8 in $c = \frac{n}{V}$* ✓
b) *Trek af: $n(NaOH)_{aanvanklik}$ (vanaf Q7.2.1) – $n(NaOH)_{mengsel}$* ✓✓
c) *Gebruik verhouding: $n(OH^-) = n(CH_3COOH)$* ✓
d) *Vervang 0,5 en $\Delta n(CH_3COOH)$ [bereken deur aftrekking] in $c = \frac{n}{V}$* ✓
e) *Finale korrekte antwoord: 0,096 mol·dm^{-3}* ✓
Gebied: 0,095 tot 0,1 mol·dm^{-3}

$n(NaOH)mixture = cV$
$= 0,00251 \times 0,8$ ✓**(a)**
$= 0,002$ mol (0,0024)

$n(NaOH)_{reacted} = 0,05 – 0,002$ ✓✓**(b)**
$= 0,048$ mol (0,0476)

$n(NaOH)_{reacted} = n(CH_3COOH)_{used}$
$= 0,048$ mol ✓**(c)**

$[CH_3COOH] = \frac{n}{V}$
$= \frac{0,048}{0,5}$ ✓**(d)**
$= 0,096$ mol·dm^{-3} ✓**(e)**
(0,0952)

NOTE/*LET WEL*
IF/*INDIEN:*

- $\frac{c_aV_a}{c_bV_b} = \frac{1}{1}$ Max./*Maks*. $^1/_6$
- Answer from Q7.2.1 substituted in $c = \frac{n}{V}$ to obtain an answer of 0,01 mol·dm^{-3}./
Antwoord van Q7.2.1 vervang in $c = \frac{n}{V}$ om 0,01 mol·dm^{-3} as antwoord te kry.
Max./*Maks*. $^1/_6$

(6)
[18]

QUESTION 8/*VRAAG 8*

8.1

8.1.1 Zn/zinc/*sink* ✓ (1)

8.1.2 MnO_4^- is a stronger oxidising agent ✓ than Zn^{2+}/Zn(II) ions ✓ and will oxidise Zn ✓ (to Zn^{2+}/Zn(II) ions).

MnO_4^- is 'n sterker oksideermiddel as Zn^{2+}/Zn(II)-ione *en sal Zn oksideer (na Zn^{2+}*/Zn(II)*-ione).*

OR/*OF*

Zn^{2+}/Zn(II) ion is a weaker oxidising agent ✓ than MnO_4^- ✓ and therefore MnO_4^- will be reduced ✓ (to Mn^{2+}/Mn(II) ions).

Zn^{2+}/Zn(II) ione is 'n swakker oksideermiddel as MnO_4^- *en dus word* MnO_4^- *gereduseer (to Mn^{2+}/Mn(II)-ione).* (3)

8.2

8.2.1 Provides path for movement of ions. / Completes the circuit. / Ensures electrical neutrality in the cell. / Restore charge balance. ✓

Verskaf pad vir beweging van ione. / Voltooi die stroombaan. / Verseker elektriese neutraliteit in die sel. / Herstel balans van lading. (1)

8.2.2 Mn to/*na* Ni ✓✓ (2)

8.2.3

OPTION 1/*OPTION 1*	**NOTE/*LET WEL***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = - 0,27✓– (- 1,18)✓ = 0,91 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* $^3/_4$
OPTION 2/*OPSIE 2* ✓ $Ni^{2+} + 2e^- \rightarrow Ni$ E = -0,27 ✓ $Mn \rightarrow Mn^{2+} + 2e^-$ E = 1,18 ✓ $Ni^{2+} + Mn \rightarrow Mn^{2+} + Ni$ E = 0,91 V ✓	

(4)

8.2.4 $Ni^{2+} + Mn$ ✓ $\rightarrow$ $Mn^{2+} + Ni$ ✓ Bal. ✓

Marking criteria/*Nasienkriteria:*		
• Reactants ✓ *Reaktanse* ✓	Products ✓ *Produkte* ✓	Balancing ✓ *Balansering* ✓
• Ignore/*Ignoreer* ⇌ and phases/*en fases*		
• Marking rule 6.3.10/*Nasienreël 6.3.10*		

(3)

8.2.5 Increase/*Toeneem* ✓ (1)

[15]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE*:***

- The chemical process in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
- The use of electrical energy to produce a chemical change.
- The process during which an electric current passes through a solution / molten ionic compound.

***ENIGE EEN**:*

- *Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.* ***(2 of 0)***
- *Die gebruik van elektriese energie om 'n chemiese verandering te veroorsaak.*
- *Die proses waar 'n elektriese stroom deur 'n oplossing / gesmelte ioniese verbinding beweeg.* (2)

9.2.1 $Cr^{3+}(aq) + 3e^- \rightarrow Cr$ ✓✓

Marking criteria/*Nasienkriteria:*

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

(2)

9.2.2 $q = I\Delta t$ ✓
$= \underline{(2,5)(10 \times 60 \times 60)}$ ✓
$= 9 \times 10^4$ C ✓ (90 000 C) (3)

9.2.3 **POSITIVE MARKING FROM QUESTION 9.2.2.**
POSITIEWE NASIEN VANAF VRAAG 9.2.2.

Marking criteria:	***Nasienkriteria:***
a) Substitute $1{,}6 \times 10^{-19}$ C in $n = \frac{Q}{e}$ ✓ b) N(Cr) = n(electrons) divide by 3 ✓ c) n(Cr) = N(Cr) divided by N_A ✓ d) Substitution of 52 into $n = \frac{m}{M}$ ✓ e) m(Cr) $\underline{+ 2{,}2}$ ✓ f) Final answer: 18,32 (g) ✓ Range: *18,32 to 18,40* (g)	a) *Vervang $1{,}6 \times 10^{-19}$ C in $n = \frac{Q}{e}$* ✓ b) *N(Cr) = n(elektrone) gedeel deur 3* ✓ c) *n(Cr) = N(Cr) gedeel deur N_A* ✓ d) *Vervang 52 in $n = \frac{m}{M}$* ✓ e) *m(Cr) $\underline{+ 2{,}2}$* ✓ f) *Finale antwoord: 18,32 (g)* ✓ *Gebied: 18,32 tot 18,40 (g)*
OPTION 1/*OPSIE 1* $n = \frac{Q}{e} / \frac{Q}{q_e}$ $= \frac{9 \times 10^4}{1{,}6 \times 10^{-19}}$ ✓**(a)** $= 5{,}63 \times 10^{23}$ electrons $N(\text{Cr atoms}) = \frac{5{,}63 \times 10^{23}}{3}$ ✓**(b)** $= 1{,}88 \times 10^{23}$ $n(\text{Cr}) = \frac{N}{N_A}$ $= \frac{1{,}88 \times 10^{23}}{6{,}02 \times 10^{23}}$ ✓**(c)** $= 0{,}31$ mol $n(\text{Cr}) = \frac{m}{M}$ $m(\text{Cr}) = 0{,}31 \times 52$ ✓**(d)** $= 16{,}12$ g $m(\text{X}) = 16{,}12\ \underline{+ 2{,}2}$ ✓**(e)** $= 18{,}32$ (g) ✓**(f)**	**OPTION 2/*OPSIE 2*** $n(\text{Cr}) = \frac{9 \times 10^4}{3 \times 96\,500}$ ✓✓**(a & c)** ✓**(b)** $= 0{,}31$ mol $m(\text{Cr}) = 0{,}31 \times 52$ ✓**(d)** $= 16{,}12$ g $m(\text{X}) = 16{,}12\ \underline{+ 2{,}2}$ ✓**(e)** $= 18{,}32$ (g) ✓**(f)**

(6)
[13]

TOTAL/*TOTAAL*: 150