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?

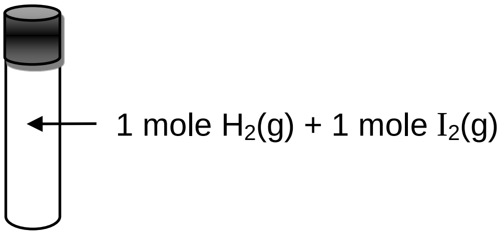
A Increasing the volume of $HC\ell(aq)$

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

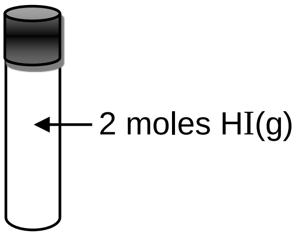
C Increasing the concentration of $HC\ell(aq)$

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 $NH_4C\ell$

D $NaC\ell$ (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	$HC\ell(aq)$	Phenolphthalein
D	$HC\ell(aq)$	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

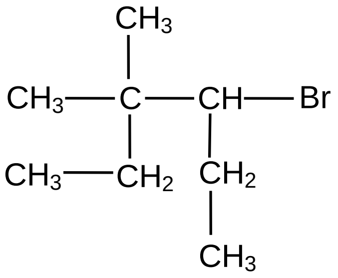
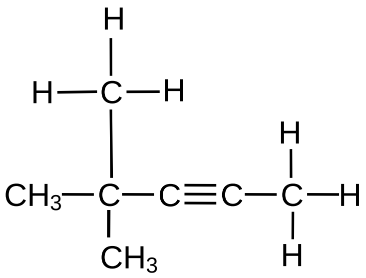
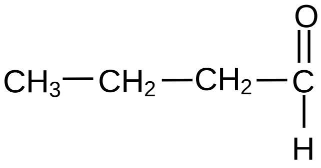
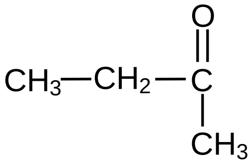
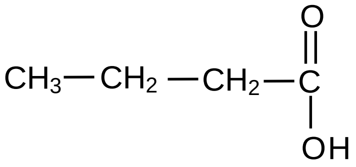
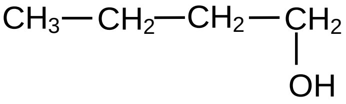
C Ni

D Mg (2)

[20]

QUESTION 2 (Start on a new page.)

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

A	 $CH_3-C(CH_3)(CH_2CH_3)-CH(CH_2CH_3)-Br$	**B**	 $CH_3-C(CH_3)_2-C\equiv C-CH_3$
C	 $CH_3-CH_2-CH_2-CHO$	**D**	 $CH_3-CH_2-CO-CH_3$
E	 $CH_3-CH_2-CH_2-COOH$	**F**	 $CH_3-CH_2-CH_2-CH_2OH$

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·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.

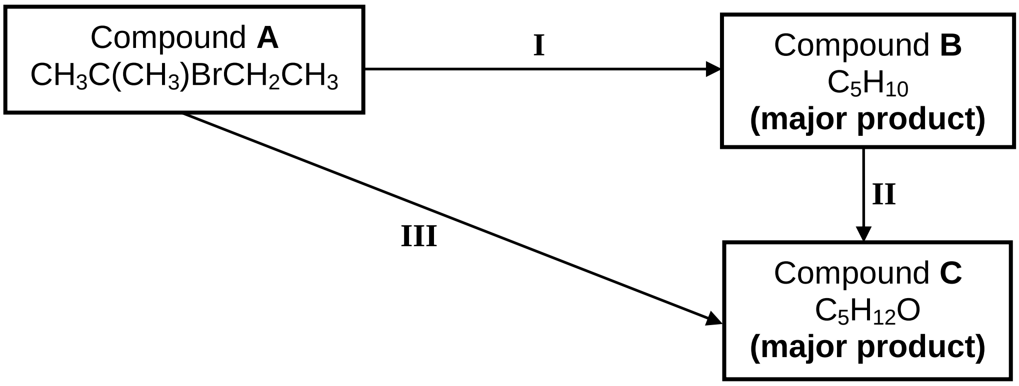
Will the vapour pressure of each compound INCREASE, DECREASE or REMAIN THE SAME? (1)

[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:

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

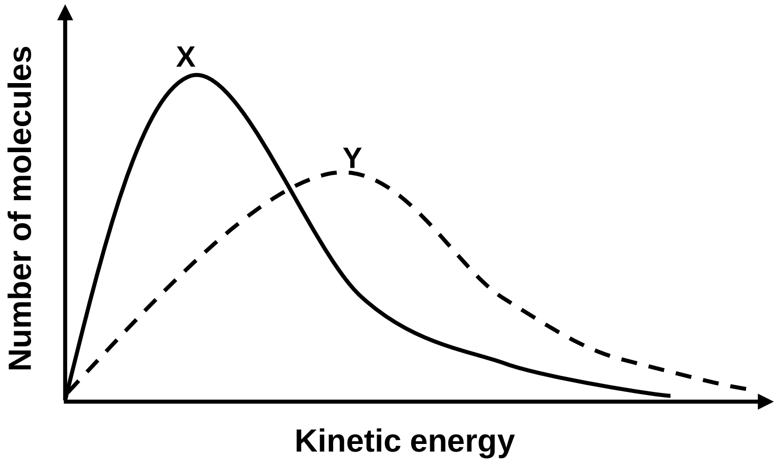
Identical samples of hydrogen peroxide are used in each experiment.

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

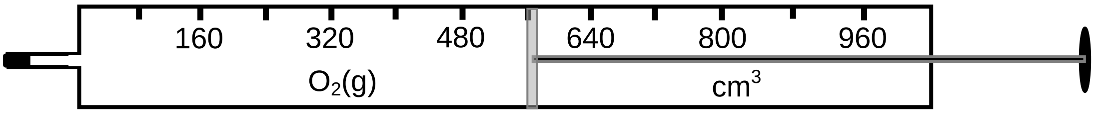
5.1 In which experiment, **A** or **B**, is the reaction rate higher? Use the collision theory to explain the answer. (4)

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.



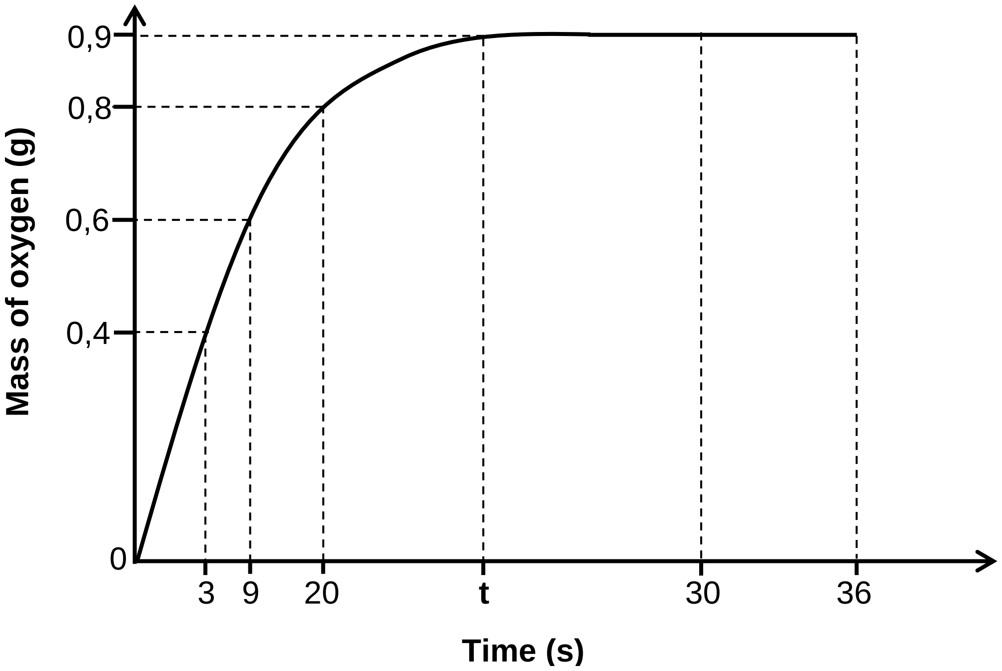
5.3.1 Write down the volume of $O_2(g)$ collected in the syringe. (2)

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.

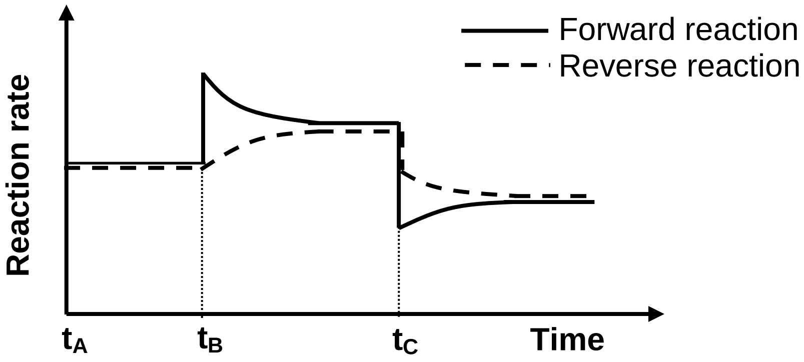
6.3 How will the amount of S(g) change as this new equilibrium is established? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

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 t_A and t_B represent? (1)

6.6.2 What change was made to the equilibrium mixture at t_B? (1)

6.6.3 Give a reason for the sudden change in the reaction rate at 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.)

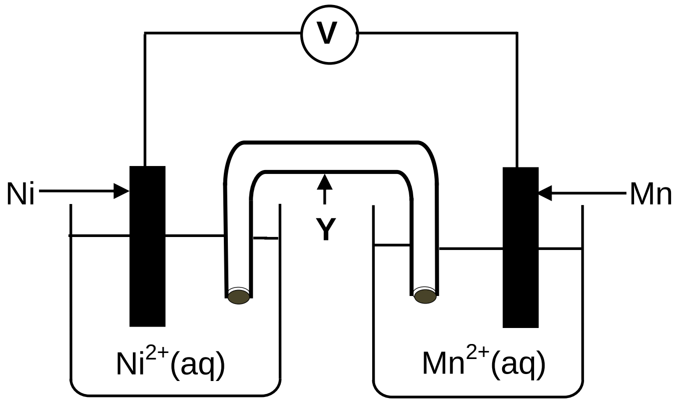
8.1 A piece of zinc (Zn) is placed in a test tube containing an acidified permanganate solution, $MnO_4^-(aq)$. After some time, it is found that a redox reaction has taken place.

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)

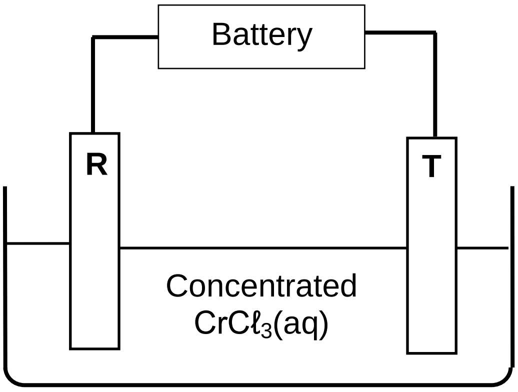
8.2.5 The concentration of $Ni^{2+}(aq)$ is now increased.

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

[15]

QUESTION 9 (Start on a new page.)

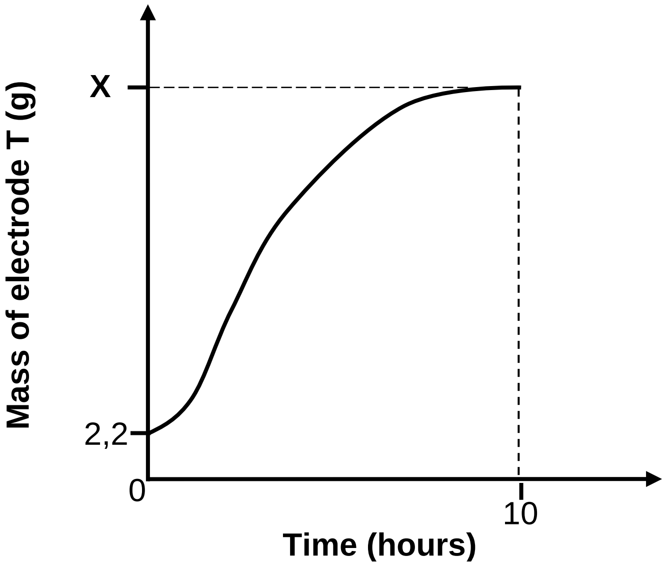
The diagram below represents a simplified cell used for the electrolysis of CONCENTRATED chromium(III) chloride, $CrC\ell_3(aq)$. Electrodes **R** and **T** are made of carbon.



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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

	29	
1,9	Cu	
	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*

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

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

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

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

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

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