education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

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

INSTRUCTIONS AND INFORMATION

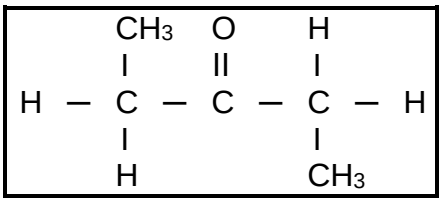
1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of NINE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question 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

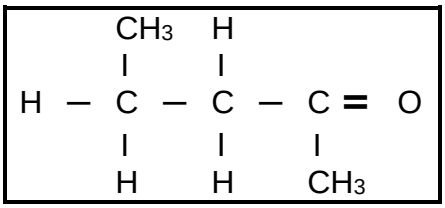
Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter(A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following organic compounds represents pentan-2-one?

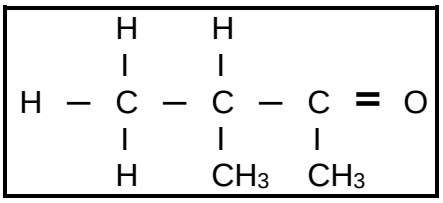
A



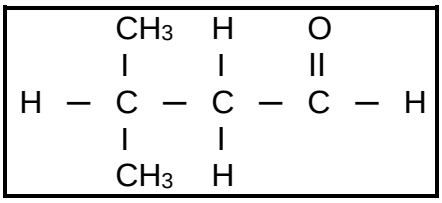
B



C



D



(2)

1.2 The table below shows four organic compounds with the same number of carbon atoms.

I	$CH_3\ CH_2\ CH_3$
II	$CH_3\ CH_2\ CH_2C\ell$
III	$CH_3\ CH_2\ COOH$
IV	$CH_3\ CH_2\ CH_2OH$

Which ONE of the following represents the boiling point of compound **III**?

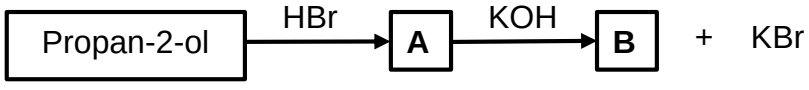
A -42 ^{O}C

B 46,6 ^{O}C

C 97 ^{O}C

D 141,2 ^{O}C (2)

1.3 Consider the following flow diagram below representing the organic reactions:



The formula for the compound **B** is …

A $CH_3\ CH_2\ CH_3$.

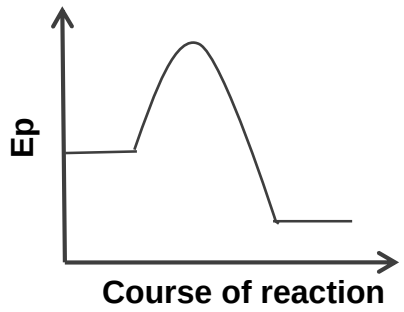
B $CH_3\ CHBr\ CH_3$.

C $CH_3\ CHOH\ CH_3$.

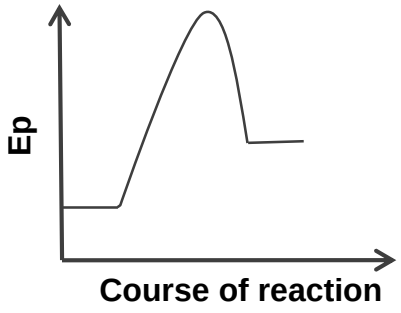
D $CH_3\ CHOH\ CH_2Br$. (2)

1.4 Which ONE of the following potential energy curve represents the reaction which takes place spontaneously?

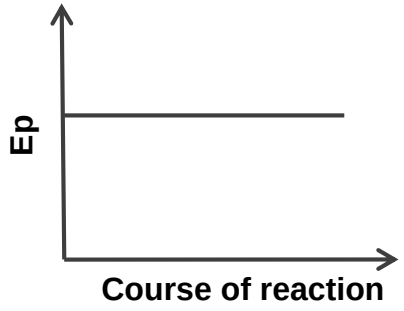
A



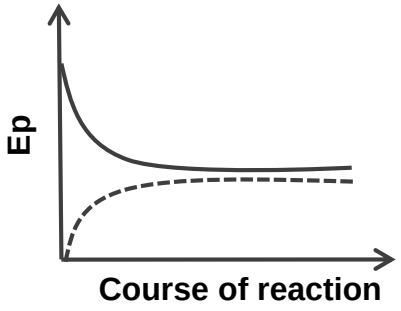
B



C



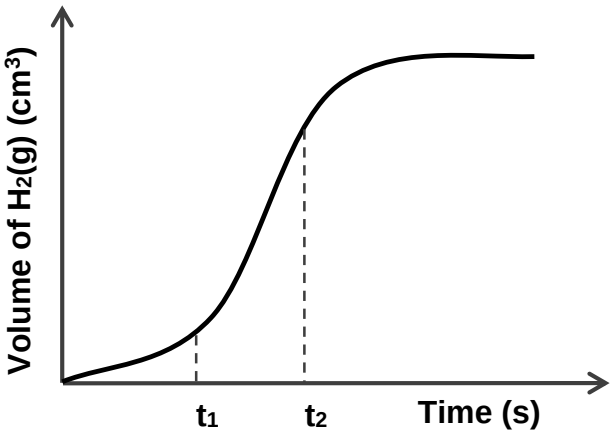
D



1.5 Consider the balanced chemical reaction below:

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

The graph below represents the volume of H_2 gas produced over a period of time.



The increase in rate of reaction between $\mathbf{t_1}$ and $\mathbf{t_2}$ is due to the …

A increase in pressure.

B endothermic reaction.

C exothermic reaction.

D nature of the substance. (2)

1.6 Consider the following equilibrium reaction that takes place in a closed container:

$$4K(s) + O_2(g) \rightleftharpoons 2K_2O(s) \quad \Delta H < 0$$

The number of moles of O_2 at equilibrium can be increased by:

A Adding K(s)

B Adding $K_2O(s)$

C Decreasing the pressure

D Increasing the temperature (2)

1.7 An indicator is used during a neutralisation reaction in order to …

A measure the heat liberated.

B detect the acid and the alkali.

C speed up the rate of reaction between the acid and the alkali.

D show when exactly reacting quantities of acid and alkali are present. (2)

1.8 A 0,2 $mol \cdot dm^{-3}$ sodium hydroxide solution in water, will be a better conductor of electricity than a 0,2 $mol \cdot dm^{-3}$ ammonia solution in water, because the sodium hydroxide solution:

A Is a weaker base than the ammonia solution

B Contains more hydronium ions than the ammonia solution

C Is a strong base, contains less ions than the ammonia solution

D Is a strong base, contains more ions than the ammonia solution (2)

1.9 When a piece of copper is added to silver nitrate solution, silver is displaced. Iron reacts slowly with warm dilute hydrochloric acid to produce hydrogen but silver and copper do not react. The metals in order of reactivity, with the most reactive first, are …

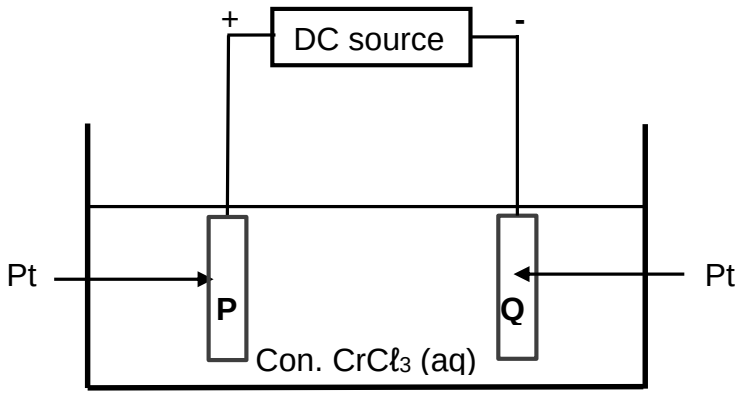
A iron, silver and copper.

B iron, copper and silver.

C copper, silver and iron.

D silver, copper and iron. (2)

1.10 The diagram below represents a simplified cell used for the electrolysis of concentrated chromium (III) chloride $CrC\ell_3$ (aq). The electrodes **P** and **Q** are made up of Pt.



The half reaction that takes place at electrode **Q** is …

A $Pt \rightarrow Pt^{2+} + 2e^-$

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

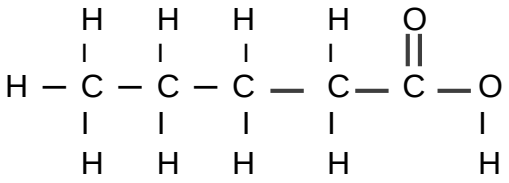
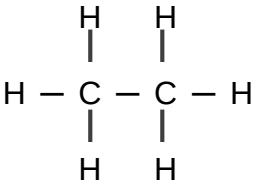
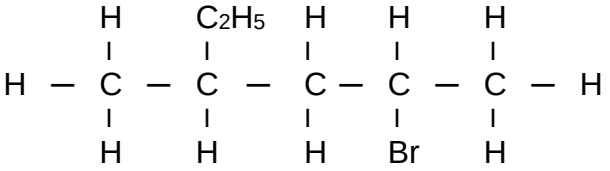
C $Cr^{3+} + 3e^- \rightarrow Cr$

D $2C\ell^- \rightarrow C\ell_2(g) + 2e^-$ (2)

[20]

QUESTION 2 (Start on a new page.)

A to G in the table below represent seven organic compounds.

A	3-methylpent-1-yne	**B**	$CH_3CH_2CH_2CH_2CHO$
C		**D**	
E		**F**	2-methyl-2-pentanol
G	$CH_3CH_2OOCCH_2CH_2CH_3$		

2.1 Define the term *homologous series*. (2)

2.2 Write down the GENERAL FORMULA of the homologous series to which compound **D** belongs. (1)

2.3 Write down the IUPAC name of the following compounds:

2.3.1 **C** (2)

2.3.2 **E** (3)

2.4 Write down the:

2.4.1 STRUCTURAL FORMULA of the compound **A** (3)

2.4.2 STRUCTURAL FORMULA of the compound **G** (2)

2.5 For compound **B**, write down the:

2.5.1 NAME of the functional group to which it belongs (1)

2.5.2 STRUCTURAL FORMULA of its FUNCTIONAL isomer (1)

2.6 Compound **F** is an alcohol.

2.6.1 Is compound **F** a PRIMARY, SECONDARY or TERTIARY alcohol? (1)

2.6.2 Give a reason for the answer to QUESTION 2.6.1. (2)

[18]

QUESTION 3 (Start on a new page.)

Learners investigate the melting points and boiling points of the four organic compounds as shown in the table below.

COMPOUND		MELTING POINT (ºC)	BOILING POINT (ºC)
A	Pentane	-130	36
B	2-methylbutane	-160	28
C	Butan-1-ol	-89,8	117
D	Butanoic acid	-7,9	164
E	2-methylpropanoic acid	-47	155

3.1 Define the term *melting point*. (2)

3.2 The melting points of compound **A** and **B** is compared.

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

3.2.2 Explain the trend in the melting points? (3)

3.3 The boiling points of compound **A**, **C** and **D** are compared.

3.3.1 Identify the compound with induced dipole (London forces) only. (1)

3.3.2 Write down the STRUCTURAL FORMULA of the functional group for compound **D.** (1)

3.3.3 Explain the difference in the boiling points by referring to the TYPE OF INTERMOLECULAR FORCES. (4)

3.4 Which ONE of the compounds **D** or **E** has the highest VAPOUR PRESSURE? (1)

3.5 Refer to the data in the table above to explain the answer to QUESTION 3.4. (2)
[15]

QUESTION 4 (Start on a new page.)

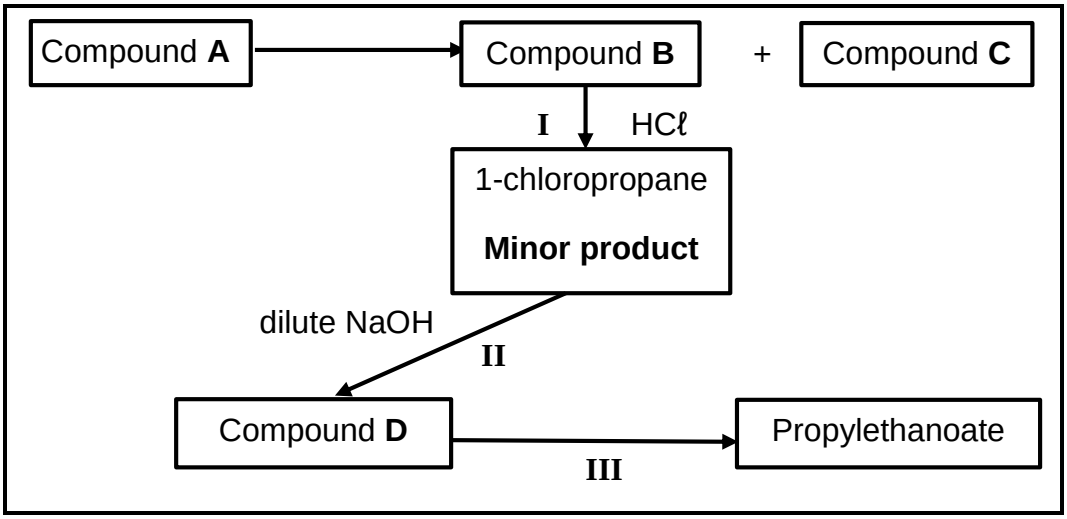
A saturated hydrocarbon **A**, undergoes CRACKING to form two organic compounds an ALKENE **B,** and an ALKANE **C**.

COMPOUND	MOLECULAR MASS ($g \cdot mol^{-1}$)
B	42
C	58

The flow diagram below shows how compound **A** can be used to prepare an ester.

A, B, C and **D** represent organic compounds.

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



4.1 Define the term *cracking*. (2)

4.2 Write down the:

4.2.1 IUPAC name of the compound **B** (2)

4.2.2 STRUCTURAL FORMULA of compound **A** (2)

4.2.3 The type of reaction represented by reaction **I** (1)

4.2.4 STRUCTURAL FORMULA of the MAJOR product in reaction **I** (2)

4.2.5 Balanced equation for the reaction **II**. Use CONDENSED STRUCTURAL FORMULAE for the organic compounds. (3)

4.2.6 Balanced equation for the reaction **III.** Use STRUCTURAL FORMULAE for the organic compounds. (4)

4.2.7 Balanced chemical equation for the COMBUSTION reaction of COMPOUND **C**. Use a MOLECULAR FORMULA for the organic compound. (3)

[19]

QUESTION 5 (Start on a new page.)

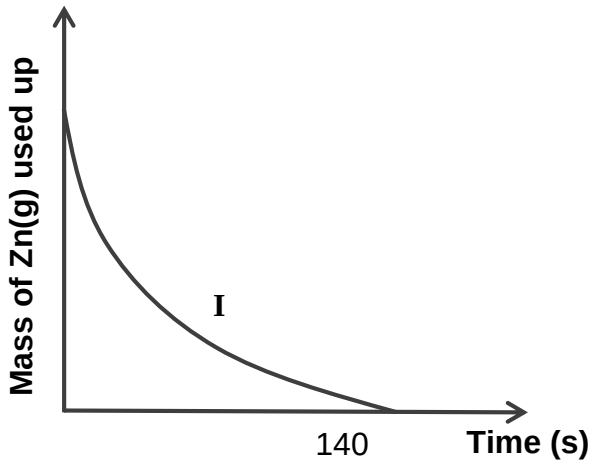
A group of learners uses the reaction between zinc and EXCESS dilute hydrochloric acid to investigate the factors that affects the rate of a chemical reaction at 20 ^{o}C.
The balanced equation for the reaction is:

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

They conduct the experiments. The reaction conditions used for each experiment is summarised in the table below:

Experiment	Zn mass (g)	Zn state of division	HCℓ concentration (mol·dm^{-3})	Final temperature (^{o}C)	Volume H_2 gas (cm^3)	Reaction time (s)
I	0,1	Granules	0,5	25	33	140
II	0,1	Granules	0,75	25	33	120
III	0,1	Granules	0,5	30	33	110
IV	0,1	Powder	0,5	25	33	50

The result obtained in EXPERIMENT **I** is shown in the graph (not drawn to scale) below.



5.1 Define the term *rate of reaction*. (2)

5.2 Calculate the average rate (in mol·s^{-1}) at which Zn(s) is used up in EXPERIMENT **I**. (5)

.

5.3 Write down an investigative question for EXPERIMENT **II.** (2)

EXPERIMENT **I** and EXPERIMENT **III** are compared.

5.4 How does the rate of reaction in EXPERIMENT **III** compare to that in EXPERIMENT **I**?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

5.5 Use COLLISION THEORY to explain the answer to QUESTION 5.4. (3)

5.6 Redraw the graph above in the ANSWER BOOK and label this curve as **I**.

On the same set of axes, sketch the graph for EXPERIMENT **IV.**

Label this graph as **IV**. (2)

5.7 Draw a potential energy diagram for these experiments. (2)
[17]

QUESTION 6 (Start on a new page.)

The equation below represents an equilibrium reaction in a sealed 1 dm^3 container:

$$NO_2(g) + NO(g) \rightleftharpoons N_2O(g) + O_2(g) \quad \Delta H = 192\ kJ{\cdot}mol^{-1}$$

6.1 What does the double arrow (⇌) represent? (1)

6.2 Is the reverse reaction ENDOTHERMIC or EXOTHERMIC reaction? (1)

6.3 Equilibrium was reached at a certain temperature. The concentration of each reactant and product in the container at equilibrium was:

$[NO_2] = 0,06\ mol{\cdot}dm^{-3}$ $[N_2O] = 0,18\ mol{\cdot}dm^{-3}$

$[NO] = 0,29\ mol{\cdot}dm^{-3}$ $[O_2] = 0,38\ mol{\cdot}dm^{-3}$

ONE of the factors affecting the equilibrium is changed and a NEW EQUILIBRIUM is established. At the new equilibrium the NO_2 concentration is $0,12\ mol{\cdot}dm^{-3}$.

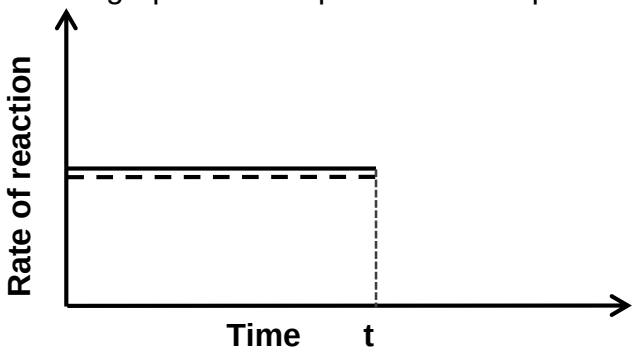
6.3.1 State Le Chatelier's principle. (2)

6.3.2 Calculate the K_c value at the NEW EQUILIBRIUM. (6)

6.3.3 Which factor was changed? (1)

6.3.4 Use Le Chatelier's principle to explain the answer to QUESTION 6.3.3. (4)

The reaction rate-time graph below represents the equilibrium mixture.



Pressure is increased to the equilibrium mixture at **t**.

6.3.5 Redraw the graph above in your ANSWER BOOK. Use the same set of axes, complete the graph showing the effect of pressure on the reaction rate at **t**. (2)

[17]

QUESTION 7 (Start on a new page.)

7.1 Solutions of two acids, HA and HB, each has a concentration of X mol·dm^{-3}. The pH of HA solution is 0,8 and pH of HB is 2,8.

7.1.1 Which acid is stronger? Choose from HA or HB. (1)

7.1.2 Explain the answer to QUESTION 7.1.1. (2)

The solution, HB, ionises in one step as follows:

$$HB(aq) + H_2O(\ell) \rightarrow B^-(aq) + H_3O^+(aq)$$

7.1.3 Define the term *ionisation*. (2)

7.1.4 Calculate the concentration of the HB(aq). (3)

7.2 The HA solution reacts with calcium carbonate, $CaCO_3$.

The balanced equation for the reaction is:

$$CaCO_3(aq) + 2HA(aq) \rightarrow CaA_2(aq) + H_2O(\ell) + CO_2(g)$$

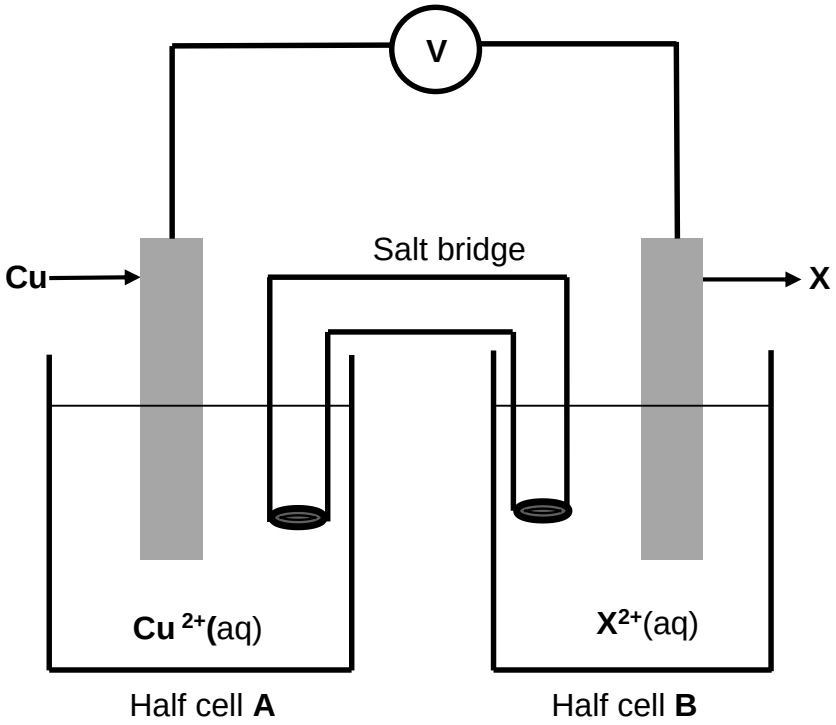
50 cm^3 of the HA solution is added to a 25 cm^3 of a 0,08 mol·dm^{-3} $CaCO_3$ solution:

7.2.1 Calculate the number of moles of the reactant which is in EXCESS? Show ALL your calculations (9)

7.2.2 Identify the reactant in QUESTION 7.2.1 (1)
[18]

QUESTION 8 (Start on a new page.)

The galvanic cell is set up under standard conditions as shown below. Metal **X** CORRODES as the reaction proceeds.



8.1 Define the term *galvanic cell*. (2)

8.2 State ONE function of the salt bridge. (1)

8.3 Which electrode is the CATHODE? Write only **X** or **Cu**.

Give a reason for your answer. (2)

8.4 Write down the:

8.4.1 Half reaction that takes place in half cell **B** to obtain a voltmeter reading of 0,47 V. Show ALL your calculations (6)

8.4.2 Overall (net) balanced equation for the cell reaction. (3)

8.5 The voltmeter is replaced with an ammeter.

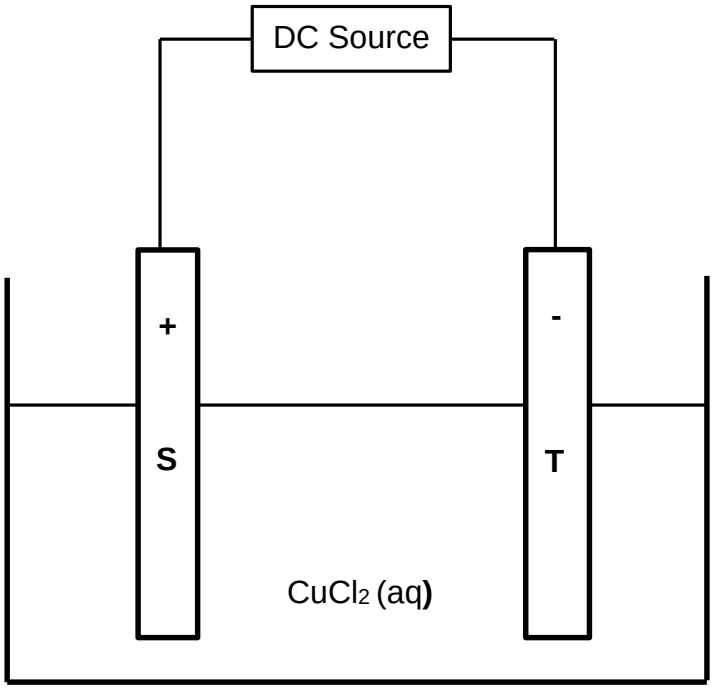
8.5.1 How does the mass lost by the anode compare to mass gained by the cathode? Choose from GREATER THAN, LESS THAN or EQUAL TO. (1)

8.5.2 Explain the answer to QUESTION 8.5.1. (2)

[17]

QUESTION 9 (Start on a new page.)

The diagram below represents the electrolytic cell, where the carbon rods are used as electrodes and a concentrated copper(II)chloride ($CuCl_2$) is used as an electrolyte.



9.1 Define the term *electrolysis.* (2)

9.2 In which direction will electrons flow in the external circuit? Choose from **S** to **T** or **T** to **S**. (1)

9.3 At which electrode is chlorine gas formed? Write only **S** or **T**. (1)

9.4 Write down the half reaction that supports your answer in QUESTION 9.3. (2)

Electrode **S** and **T** are now replaced with copper electrodes.

9.5 Explain why chlorine gas is NOT formed as mentioned in QUESTION 9.3? (3)
[9]

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 x 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 x 10^{-19} C
Avogadro's constant *Avogadro-konstante*	N_A	6,02 x 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 x 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 ELEMENTE1

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)
2,1 **H** 1																	**He** 4
1,0 **Li** 7	1,5 **Be** 9											2,0 **B** 11	2,5 **C** 12	3,0 **N** 14	3,5 **O** 16	4,0 **F** 19	**Ne** 20
0,9 **Na** 23	1,2 **Mg** 24											1,5 **Aℓ** 27	1,8 **Si** 28	2,1 **P** 31	2,5 **S** 32	3,0 **Cℓ** 35,5	**Ar** 40
0,8 **K** 39	1,0 **Ca** 40	1,3 **Sc** 45	1,5 **Ti** 48	1,6 **V** 51	1,6 **Cr** 52	1,5 **Mn** 55	1,8 **Fe** 56	1,8 **Co** 59	1,8 **Ni** 59	1,9 **Cu** 63,5	1,6 **Zn** 65	1,6 **Ga** 70	1,8 **Ge** 73	2,0 **As** 75	2,4 **Se** 79	2,8 **Br** 80	**Kr** 84
0,8 **Rb** 86	1,0 **Sr** 88	1,2 **Y** 89	1,4 **Zr** 91	**Nb** 92	1,8 **Mo** 96	1,9 **Tc**	2,2 **Ru** 101	2,2 **Rh** 103	2,2 **Pd** 106	1,9 **Ag** 108	1,7 **Cd** 112	1,7 **In** 115	1,8 **Sn** 119	1,9 **Sb** 122	2,1 **Te** 128	2,5 **I** 127	**Xe** 131
0,7 **Cs** 133	0,9 **Ba** 137	**La** 139	1,6 **Hf** 179	**Ta** 181	**W** 184	**Re** 186	**Os** 190	**Ir** 192	**Pt** 195	**Au** 197	**Hg** 201	1,8 **Tℓ** 204	1,8 **Pb** 207	1,9 **Bi** 209	2,0 **Po**	2,5 **At**	**Rn**
0,7 **Fr**	0,9 **Ra** 226	**Ac**															

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit*

Symbol *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

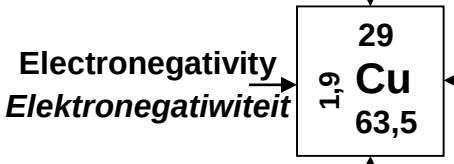


TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

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

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

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

$Li^+ + e^- \rightleftharpoons Li$	− 3,05

TABLE 4B: STANDARD REDUCTION POTENTIALS

TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*	E^θ (V)

NSC

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

$Li^+ + e^-$	$\rightleftharpoons$	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 strength of reducing agents/*Toenemende sterkte van reduseermiddels*