EXAMINATION	NATIONAL SENIOR CERTIFICATE
GRADE	12
DATE	NOVEMBER 2024
SUBJECT	PHYSICAL SCIENCES
PAPER	2
MARK TOTAL	150
DURATION (HOURS)	3
NUMBER OF PAGES	21

SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE

SUID-AFRIKAANSE KOMPREHENSIEWE ASSESSERINGSINSTITUUT

INSTRUCTIONS AND INFORMATION

1. This question paper consists of **NINE** questions. Answer **ALL** the questions in the **ANSWER BOOK**.

2. Start **EACH** question on a **NEW** page in the **ANSWER BOOK**.

3. Number the answers correctly according to the numbering system used in this question paper.

4. Leave **ONE** line between two sub-questions, for example between **QUESTION 2.1** and **QUESTION 2.2**.

5. You may use a non-programmable calculator.

6. You may use appropriate mathematical instruments.

7. You are advised to use the attached **DATA SHEETS**.

8. Show **ALL** formulae and substitutions in **ALL** calculations.

9. Round off your final numerical answers to a minimum of **TWO** decimal places.

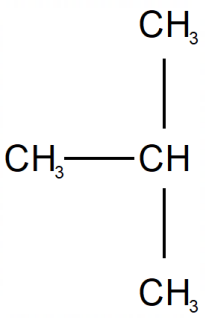
10. Give brief motivations, discussions, et cetera where required.

11. Write neatly and legibly, in **BLUE** ink only.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK, for example **1.11 D.**

1.1 The condensed structural formula of an organic compound is given below.



Which ONE of the following is the correct IUPAC name of this compound?

A butane
B methylbutane
C methylpropane
D propane (2)

1.2 Which ONE of the following molecules has the HIGHEST boiling point?

A hexane
B propane
C 2,3-dimethylbutane
D 2-methylpentane (2)

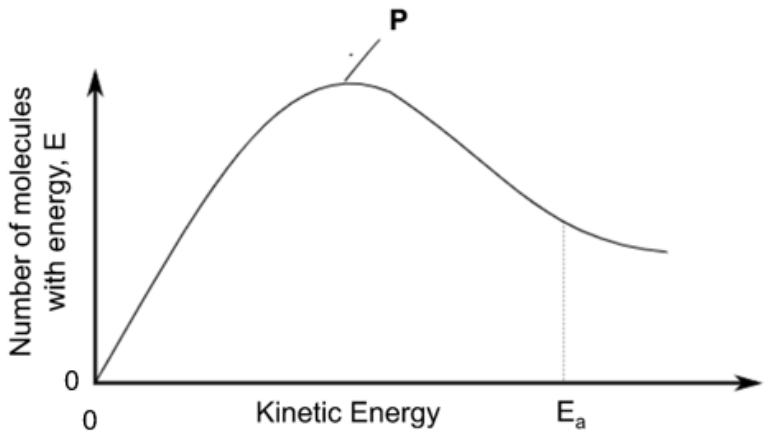
1.3 Consider the reaction represented below.

$$C_2H_6 + C\ell_2 \rightarrow C_2H_5C\ell + HC\ell$$

Which ONE of the following CORRECTLY gives the GENERAL type of reaction taking place?

A Elimination
B Substitution
C Combustion
D Addition (2)

1.4 The diagram below shows the Maxwell-Boltzmann distribution curve for one mole of a gas. **P** represents the peak of the distribution curve. The gas takes part in a reaction with an activation energy, E_a.



Which statement CORRECTLY describes the effect of an increase in temperature?

A Peak P will be higher and fewer molecules will have an average kinetic energy > E_A.

B Peak P will be higher and more molecules will have an average kinetic energy > E_A.

C Peak P will be lower and fewer molecules will have an average kinetic energy > E_A.

D Peak P will be lower and more molecules will have an average kinetic energy > E_A. (2)

1.5 A reversible reaction is shown.

$$\mathbf{2\ NOC\ell\ (g) \rightleftharpoons 2\ NO\ (g) + C\ell_2\ (g)} \qquad \mathbf{\Delta H > 0}$$

Which ONE of the following changes to the equilibrium conditions will favour the forward reaction and INCREASE the value of the equilibrium constant (Kc)?

A an increase in pressure

B an increase in temperature

C a decrease in pressure

D a decrease in temperature (2)

1.6 An acid-base indicator represented as HIn (aq), reaches dynamic equilibrium when added to water as shown in the equation below.

$$\underset{\text{Yellow}}{HIn\ (aq)} + H_2O\ (\ell) \rightleftharpoons H_3O^+\ (aq) + \underset{\text{Red}}{In^-\ (aq)} \qquad \Delta H > 0$$

At equilibrium the colour of the solution is orange (a mixture of yellow and red). Which one of the following will change the colour of the solution to yellow?

A The addition of NaOH

B The addition of H_2O

C An increase in temperature

D The addition of HCℓ (2)

1.7 Sulphuric acid (H_2SO_4) ionises in water according to the following equations:

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

Consider the following statements regarding the ionisation above:

I $H_2O\ (\ell)$ acts as a base in both reactions.

II $HSO_4^-\ (aq)$ acts as an ampholyte.

III $SO_4^{2-}\ (aq)$ is the conjugate base of $H_2SO_4\ (aq)$.

Which statement/s is/are correct for the ionisation reactions?

A I only

B I and II only

C I and III only

D I, II and III (2)

1.8 The ionisation constant, K_a, for two acids **X** and **Y** at 25 ºC is given below:

ACID	K_a-value
X	4×10^{-4}
Y	3×10^{-6}

What conclusion can be made about the acids from the information given in the table?

A X is a weak acid, and Y is a strong acid.

B X and Y are both strong acids.

C X will ionise more completely in water than Y.

D X and Y are both dilute solutions of acids. (2)

1.9 Consider the cell notation for a galvanic cell below.

Cu (s) | Cu^{2+} (aq) || $C\ell_2$ (g) | $C\ell^-$ (aq) | Pt (s)

Which substance is the REDUCING AGENT?

A Pt

B $C\ell_2$

C Cu^{2+}

D Cu (2)

1.10 A learner places a strip of zinc metal in three different solutions, **P**, **Q** and **R**. He observes the following in each solution.

P: The zinc turns black and after a while a red-brown solid forms around the zinc strip that is getting bigger.
Q: The zinc turns black and after a while a red-brown solid forms around the zinc strip that is getting smaller.
R: The solution is labelled HCℓ (aq) and gas bubbles form when the zinc strip is placed in the solution.

In which solution does the zinc strip undergo OXIDATION?

A Q only

B R only

C Q and R only

D P, Q and R (2)

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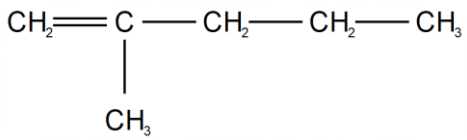
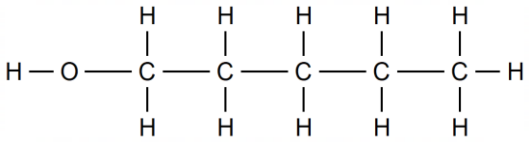
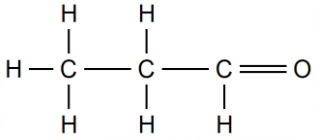
QUESTION 2 **[START ON A NEW PAGE]**

The letters **A** to **D** in the table below represent four organic compounds.

A	
B	
C	2,3-dibromo-5-methylheptane
D	

Use the information in the table to answer the questions that follow.

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

2.2 Write down the LETTER of the compound that:

2.2.1 will most likely undergo an ADDITION reaction. (1)

2.2.2 is a haloalkane. (1)

2.3 Write down the:

2.3.1 IUPAC name of compound **A**. (3)

2.3.2 STRUCTURAL formula of compound **C**. (2)

2.4 Consider compound **B**.

2.4.1 Define the term *positional isomer*. (2)

2.4.2 Write down the IUPAC name of one POSITIONAL ISOMER of compound **B**. (2)

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

2.5.1 IUPAC name of compound **D**. (2)

2.5.2 IUPAC name of the FUNCTIONAL ISOMER of compound **D**. (2)

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QUESTION 3 **[START ON A NEW PAGE]**

The boiling points of some organic compounds are given in Tables **A** and **B** below.

TABLE A	
Compound	**Boiling point (ºC)**
Methane	-164
Ethane	-89
Propane	-42
Butane	-0,5
Pentane	36
Hexane	68,7

TABLE B	
Compound	**Boiling point (ºC)**
Methanoic acid	101
Ethanoic acid	118
Propanoic acid	141
Butanoic acid	164
Pentanoic acid	186
Hexanoic acid	205

3.1 All the organic compounds in Table **A** belong to the same homologous series.

3.1.1 NAME the homologous series of the compounds in Table **A**. (1)

3.1.2 Are the compounds in Table **A** SATURATED or UNSATURATED hydrocarbons? (1)

3.1.3 Is ethane a SOLID, GAS or LIQUID at room temperature? (1)

3.1.4 Use the table to write down the boiling point of the STRUCTURAL isomer of 2,2-dimethylbutane. (1)

3.2 Write down the name of the functional group of the organic compounds in Table **B**. (1)

3.3 Pentane and propanoic acid have similar molar masses.

3.3.1 Write down the CONDENSED STRUCTURAL formula of propanoic acid. (1)

3.3.2 When comparing the boiling points of two compounds with different intermolecular forces, why is it important that the compounds have similar molar masses? (2)

3.3.3 Define *boiling point*. (2)

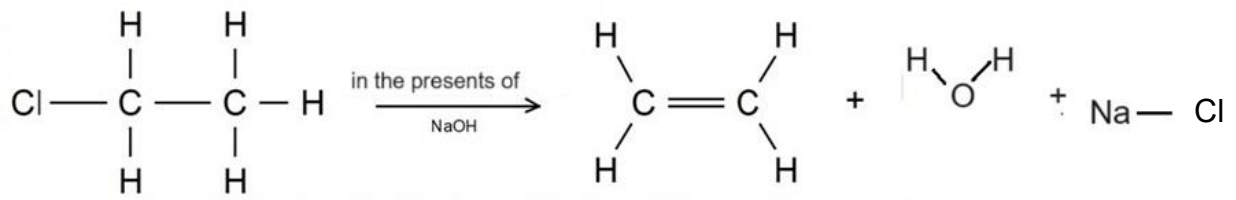
3.3.4 Fully explain why propanoic acid has a much higher boiling point than pentane. (4)

[14]

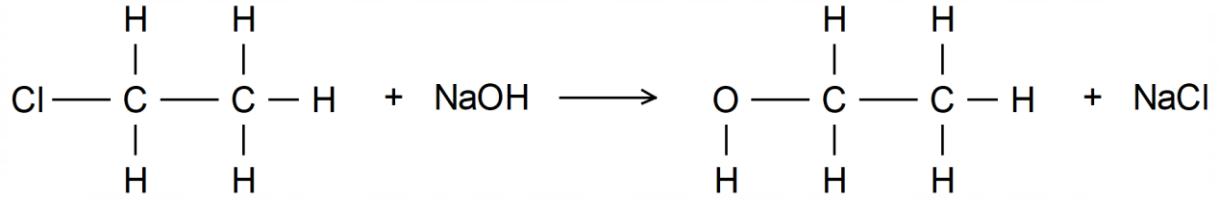
QUESTION 4 **[START ON A NEW PAGE]**

Consider the following organic reactions. Unidentified compounds are labelled with letters **W**, **X** and **Y**. Not all the relevant conditions have been included in the reactions.

Reaction A:



Reaction B:

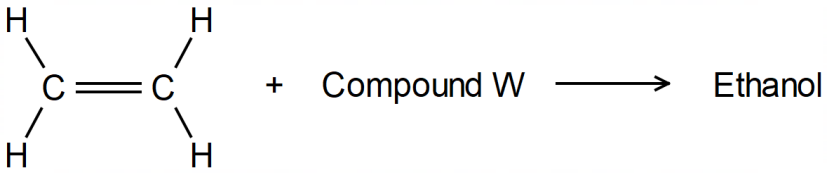


4.1 Write down the name of the GENERAL reaction that is taking place in reaction **A**. (1)

4.2 Write down the name of the SPECIFIC reaction for reaction **B**. (1)

4.3 Which reaction (**A** or **B**) will take place in the presence of dilute sodium hydroxide (NaOH)? (1)

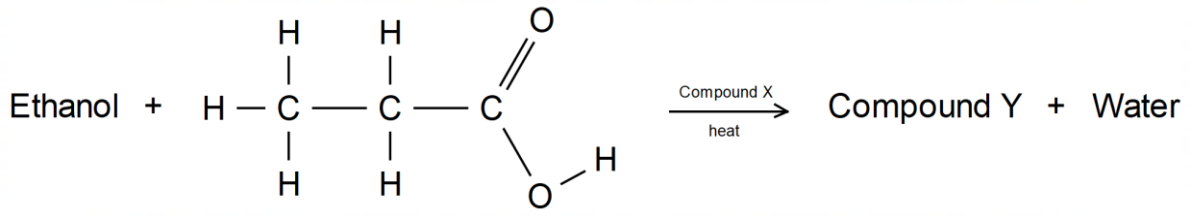
Reaction C:



4.4 What is the name of the GENERAL type of this reaction? (1)

4.5 Write down the chemical formula for compound **W**. (1)

Reaction D:



4.6 Give the IUPAC name of compound **Y**. (2)

4.7 Identify compound **X** which is needed for reaction **D** to form compound **Y**. (1)

4.8 What is the GENERAL type of reaction that takes place in reaction **D**? (1)

Reaction E:

In another reaction, ethene is bubbled through liquid bromine.

4.9 Use STRUCTURAL formulae to write down reaction **E**. (3)

4.10 What observation can be made when reaction **E** takes place? (2)

4.11 Write down the IUPAC name for the product of reaction **E**. (2)

Reaction F:

$$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$$

4.12 Write down the NAME given to reaction **F**. (1)

4.13 Rewrite the equation in your answer book and balance the reaction. (2)

[19]

QUESTION 5 **[START ON A NEW PAGE]**

The reaction between hydrochloric acid (HCℓ) and sodium thiosulphate ($Na_2S_2O_3$) is used to investigate one of the factors that affect the rate of a chemical reaction. The balanced equation for the reaction is:

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

Five experiments, **A** to **E**, are conducted during this investigation. In each experiment, 5 cm^3 of 0,15 $mol{\cdot}dm^{-3}$ HCℓ was added to 25 cm^3 of $Na_2S_2O_3$ SOLUTIONS.

The results obtained are shown in the table below.

Experiment	Volume of $Na_2S_2O_3$ (aq) (cm^3)	Concentration of $Na_2S_2O_3$ ($mol{\cdot}dm^{-3}$)	Volume of HCℓ (cm^3)	Concentration of HCℓ ($mol{\cdot}dm^{-3}$)	Rate (s^{-1})
A	25	0,01	5	0,15	0,005
B	25	0,02	5	0,15	0,009
C	25	0,04	5	0,15	0,022
D	25	0,08	5	0,15	0,042
E	25	0,10	5	0,15	0,050

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

5.2 Write down the INDEPENDENT variable for this investigation. (1)

5.3 Use the COLLISION THEORY to explain the effect of an increase in concentration on reaction rate. (3)

5.4 Consider experiment **E**.

5.4.1 Prove by calculation that HCℓ is the LIMITING REAGENT. Do not round your answer. (4)

5.4.2 Calculate the number of SULPHUR ATOMS in the precipitate produced when the reaction goes to completion. (4)

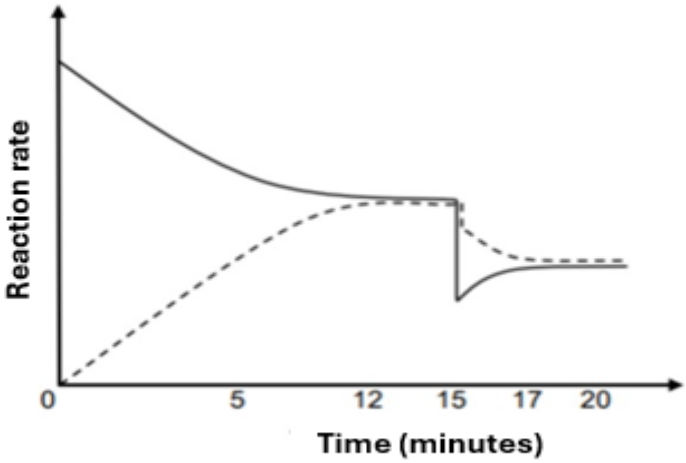
[14]

QUESTION 6 **[START ON A NEW PAGE]**

6.1 Pure hydrogen iodide (HI), sealed in a 2 dm^3 container at 448 ºC, decomposes according to the following balanced equation:

$$2\ HI\ (g) \rightleftharpoons H_2\ (g) + I_2\ (g) \qquad \Delta H > 0$$

The graph below shows how reaction rate changes with time for this reversible reaction.



6.1.1 Write down the meaning of the term *reversible reaction*. (1)

6.1.2 What is represented by the dotted line (- - -) on the graph? Choose from FORWARD REACTION or REVERSE REACTION. (1)

6.1.3 Is the statement below TRUE or FALSE?
"At t = 5 minutes the graph indicates that the concentration of HI is greater than the concentrations of H_2 and I_2." (1)

6.1.4 The rates of both the forward and reverse reactions suddenly change at t = 15 minutes. Give a reason for the sudden change in the reaction rate. (1)

6.1.5 Use the GRAPH to fully explain how you arrived at the answer to QUESTION 6.1.4. (4)

6.1.6 The equilibrium constant (K_c) for the forward reaction is 0,02 at a temperature of 448 ºC. At equilibrium it is found that 0,04 mol HI (g) is present in the container.

(a) Calculate the concentration of H_2 (g) at equilibrium. Round off to three decimal places. (6)

(b) Calculate the equilibrium constant for the reverse reaction. (1)

6.2 Initially excess ammonium hydrosulphide (NH_4HS) is placed in a 5 dm^3 container at 218 ºC. The container is sealed, and the reaction is allowed to reach equilibrium according to the following balanced equation.

$$\mathbf{NH_4HS\ (s) \rightleftharpoons NH_3\ (g) + H_2S\ (g) \qquad \Delta H > 0}$$

6.2.1 State *Le Chatelier's Principle*. (2)

6.2.2 What effect will each of the following changes have on the amount of ammonia (NH_3) at equilibrium? Choose between INCREASES, DECREASES or REMAINS THE SAME.

(a) More NH_4HS is added. (1)

(b) The temperature is increased. (1)

6.2.3 The pressure in the container is now increased by decreasing the volume of the container at a constant temperature.
How will this change affect the number of moles of H_2S (g) produced? (1)

6.2.4 Explain the answer to QUESTION 6.2.3. (2)

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QUESTION 7 **[START ON A NEW PAGE]**

7.1 A learner needs to determine the concentration of phosphoric acid (H_3PO_4), a weak, polyprotic acid. The learner decides to titrate the H_3PO_4 against a standard sodium hydroxide (NaOH) solution. The balanced chemical equation is given below:

$$\mathbf{H_3PO_4\ (aq) + 3\ NaOH\ (aq) \rightarrow Na_3PO_4\ (aq) + 3\ H_2O\ (\ell)}$$

7.1.1 Explain what is meant by the term *standard solution*. (2)

7.1.2 Calculate the mass of NaOH needed to make up 500 cm^3 of a 0,22 $mol \cdot dm^{-3}$ NaOH solution. (4)

7.2 Consider the following solutions and answer the questions that follow.

Solution A: ethanoic acid (CH_3COOH) of concentration 0,05 $mol \cdot dm^{-3}$.
Solution B: hydrochloric acid ($HC\ell$) of concentration 0,05 $mol \cdot dm^{-3}$.
Solution C: hydrochloric acid ($HC\ell$) of concentration 0,5 $mol \cdot dm^{-3}$.

Which solution (**A**, **B** or **C**) will have:

7.2.1 the highest pH? (1)

7.2.2 the lowest K_a value? (1)

7.2.3 the greater electrical conductivity? (1)

7.3 A learner is given the task of determining the percentage of magnesium oxide (MgO) in a health tablet. The learner dissolves the tablet in 0,05 dm^3 of a 0,8 $mol \cdot dm^{-3}$ hydrochloric acid ($HC\ell$).

7.3.1 Calculate the number of moles of acid present in 0,05 dm^3 of 0,8 $mol \cdot dm^{-3}$ hydrochloric acid solution. (3)

All of the magnesium oxide in the tablet reacts with the hydrochloric acid as shown in the balanced chemical equation below.

$$\mathbf{MgO\ (s) + 2\ HC\ell\ (aq) \rightarrow MgC\ell_2\ (aq) + H_2O\ (\ell)}$$

Not all of the hydrochloric acid reacts. The learner titrates the excess hydrochloric acid with a solution of sodium hydroxide (NaOH).

It takes 0,02 dm^3 of 0,5 $mol \cdot dm^{-3}$ NaOH to neutralise the excess hydrochloric acid. The hydrochloric acid and sodium hydroxide react as shown in the balanced chemical equation below.

$$\mathbf{NaOH\ (aq) + HC\ell\ (aq) \rightarrow NaC\ell\ (aq) + H_2O\ (\ell)}$$

7.3.2 The original mass of the tablet is 0,96 g. Calculate the percentage of magnesium oxide in the tablet. (7)

[19]

QUESTION 8 **[START ON A NEW PAGE]**

A galvanic cell at standard conditions is represented by the cell notation below, where **X** is an unknown electrode.

X (s) | X^{3+} (aq) || Pb^{2+} (aq) | Pb (s)

8.1 Write down the energy conversion that takes place in this cell. (1)

8.2 State two standard conditions that are applicable to the Pb^{2+} (aq) | Pb (s) half-cell. (2)

8.3 NAME the component of the cell which is represented by **||**. (1)

8.4 The initial reading on a voltmeter connected across the electrodes of this standard galvanic cell is 1,53 V. Identify metal **X** by means of a calculation. (5)

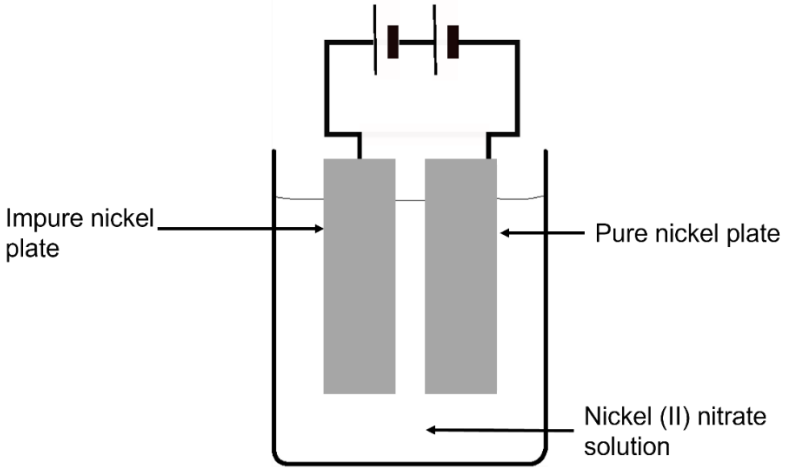
8.5 Write down the overall (net) cell reaction that takes place when this cell is in operation. (3)

8.6 How will the initial voltmeter reading be affected if the concentration of the electrolyte in the X (s) | X^{3+} (aq) half-cell is INCREASED? Choose between INCREASES, DECREASES or REMAINS THE SAME. (2)

[14]

QUESTION 9 **[START ON A NEW PAGE]**

An electrolytic cell was set up as in the diagram below. The impure nickel electrode also contains very small amounts of magnesium, silver and copper.



9.1 Define the term *electrolyte*. (2)

9.2 Write down the oxidation half-reaction. (2)

9.3 Which of the metals in the impure nickel electrode do not react and descend to the bottom of the half-cell as anode mud? (2)

9.4 Refer to the relative strengths of OXIDISING AGENTS to explain why only Ni^{2+} ions will be reduced at the cathode. (2)

9.5 Calculate the number of moles of Ni^{2+} ions that will deposit on the cathode if 0,055 g of nickel is deposited on the cathode. (3)

[11]

GRAND TOTAL: [150]

DATA SHEET FOR PHYSICAL SCIENCES

INLIGTINGSBLAD VIR FISIESE WETENSKAPPE

PAPER 2 (CHEMISTRY)

VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/ *TABEL 1: FISIESE KONSTANTES*

NAME / *NAME*	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 'n elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro se 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 $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at 298K	
$E^{\theta}_{cell/sel} = E^{\theta}_{cathode/katode} - E^{\theta}_{anode}$ Or/ of $E^{\theta}_{cell/sel} = E^{\theta}_{reduction/reduksie} - E^{\theta}_{oxidaton/oksidasie}$ Or/ of $E^{\theta}_{cell/sel} = E^{\theta}_{oxidising\ agent/\ oksideermiddel} - E^{\theta}_{reducing\ agent/\ reduseermiddel}$	

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

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																	2 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	10 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	18 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	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 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	54 Xe 131
0,7 Cs 133	0,9 Ba 137	La 139	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	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 87 Fr	0,9 88 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

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity → 1,9 / 29 / Cu / 63,5 ← **Symbol**
Elektronegatiwiteit → ***Simbool***

Approximate relative atomic mass / ***Benaderde relatiewe atoommassa***

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

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

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

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

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