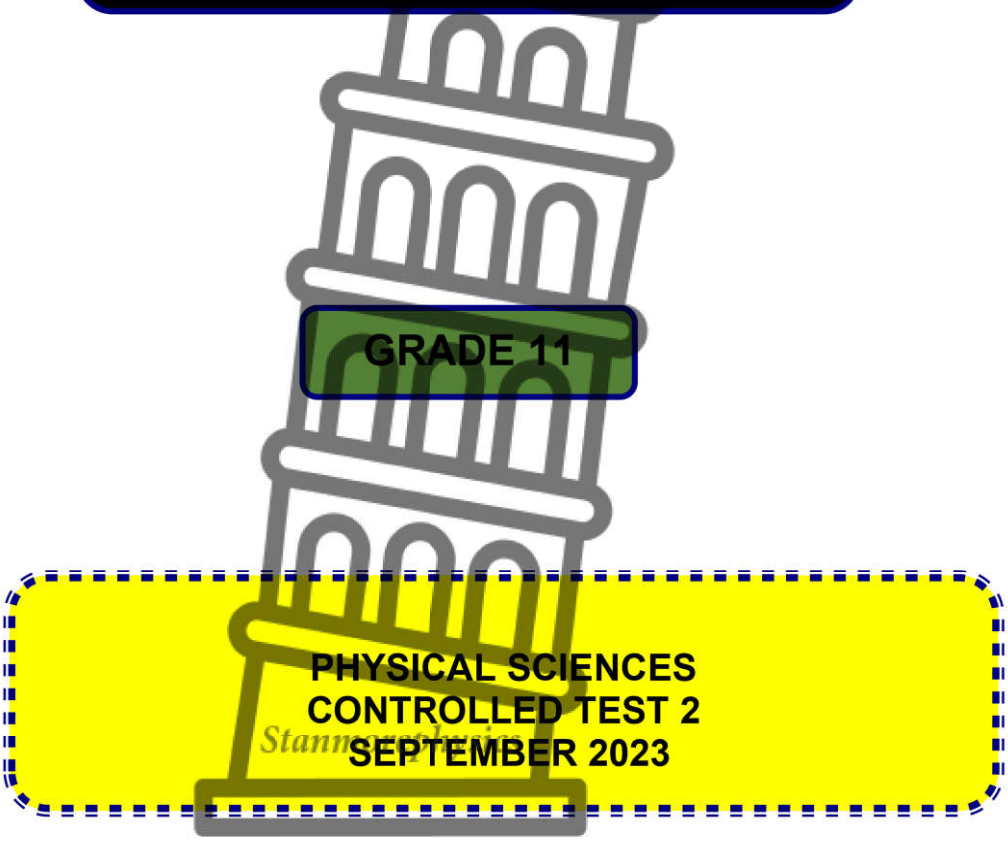
LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

MOPANI EAST DISTRICT

NATIONAL SENIOR CERTIFICATE



GRADE 11

PHYSICAL SCIENCES CONTROLLED TEST 2 SEPTEMBER 2023

MARKS: 100

TIME: 2 hours

This question paper consists of 13 pages including the cover page and DATA SHEETS

INSTRUCTIONS AND INFORMATION

1. Write your name and class in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of 8 QUESTIONS. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a new page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, for example QUESTION 2.1 and QUESTION 2.2.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, et cetera where required.
10. Write neatly and legibly.

QUESTION 1 (MULTIPLE CHOICE QUESTIONS)

Various options are provided as possible answers to the following questions.

Choose the correct answer and write only the letter (A – D) next to the question numbers (1.1 – 1.10) in the ANSWER BOOK, e.g. 1.11E.

1.1 If the pressure on 100 g of an enclosed nitrogen gas is doubled and the temperature is kept constant, the average speed of the nitrogen gas molecules will…

A be doubled

B be four times greater

C be four times smaller

D remain the same. (2)

1.2 The CORRECT formula for nitric acid:

A NH_3

B CH_3COOH

C HNO_3

D H_2SO_4 (2)

1.3 Consider the following acid – base reactions:

$NH_3(aq) + H_2O(l) \rightarrow NH_4^+(aq) + OH^-(aq)$

$SO_4^{2-}(aq) + HNO_3(aq) \rightarrow HSO_4^-(aq) + NO_3^-(aq)$

The substances acting as proton acceptors in the above reactions are:

A H_2O and SO_4^{2-}
B NH_3 and SO_4^{2-}
C NH_3 and HNO_3
D H_2O and HNO_3 (2)

1.4 Ozone (O_3) decomposes to form oxygen gas (O_2) according to the equation: $2O_3\ (g) \rightarrow 3O_2\ (g)$

Which ONE of the following is NOT CORRECT about the equation for the reaction? According to the equation …

A 2 moles of O_3 decompose to produce 3 moles of O_2

B 2 grams of O_3 decompose to produce 3 grams of O_2

C 96 grams of O_3 decompose to produce 96 grams of O_2

D $1{,}204 \times 10^{24}$ molecules of O_3 decompose to produce $1{,}806 \times 10^{24}$ molecules of O_2 (2)

1.5 The mass of 0,2 mol of bromine would be….

A 31.96 g

B 320 g

C 3,196 g

D 0,332 g (2)

[10]

QUESTION 2 (Start on a NEW page)

A chemical substance consists of 85,71% carbon and 14,29% hydrogen. The molecular mass of the substance is 42 $g \cdot mol^{-1}$.

2.1 Determine the empirical formula for the substance. (5)

2.2 Determine the molecular formula of the substance. (4)

2.3 Define the term *limiting reactant*. (2)

2.4 16,70 g of I_2O_2 are mixed with 11,2 g of CO and heated to form CO_2 and I_2.

$$I_2O_2 + 2CO \rightarrow 2CO_2 + I_2$$

2.4.1 Determine which reactant is the limiting reactant. (6)

2.4.2 How many grams of the other reactant are in excess? (4)

[21]

QUESTION 3 (Start on a NEW page)

Pure $CuSO_4$ is a white substance that turns blue in the presence of water. The following reaction represents this process:

$$CuSO_4.xH_2O \rightarrow {}_xH_2O + CuSO_4$$

Blue **White**

49,90 g blue copper sulphate is heated until 31,90 g pure white copper sulphate remains.

3.1 What is the percentage purity of $CuSO_4$ in the initial blue sample? (3)

3.2 How many moles $CuSO_4$ is present in the blue $CuSO_4$? (5)

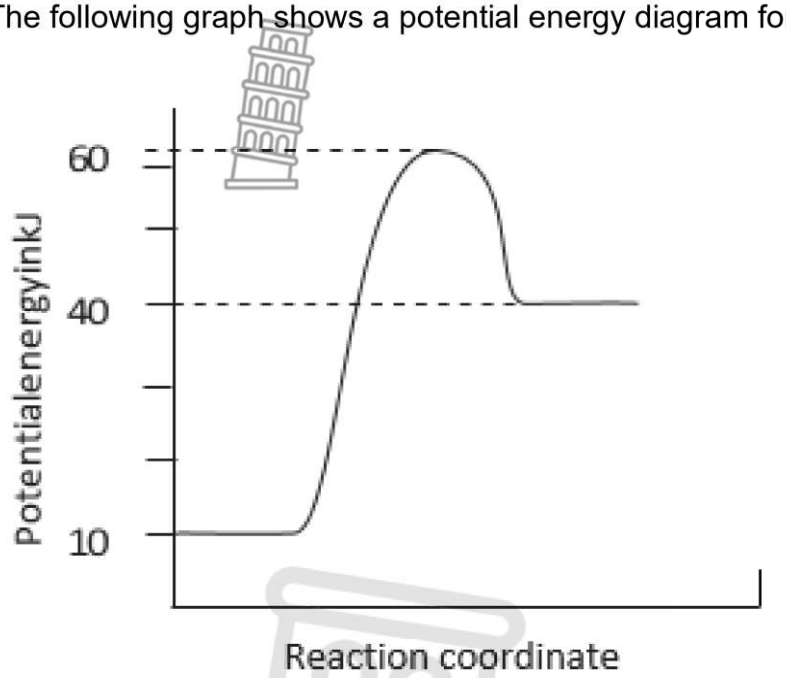
3.3 Calculate the value of x in the reaction. (7)

3.4 How many water molecules evaporate? (2)

[17]

QUESTION 4 (Start on a NEW page)

The following graph shows a potential energy diagram for the reaction A + B → C + D.



4.1 Is the forward reaction endothermic or exothermic? Motivate your answer. (3)

4.2 Calculate ΔH for the forward reaction. (2)

4.3 Define activation complex. (2)

4.4 What is the energy of the activated complex? (2)

4.5 Define activation energy. (2)

4.6 A catalyst is now added to the reaction. Explain what a catalyst does and why it is added to chemical reactions. (3)

4.7 How does the catalyst influence the reverse reaction? (2)

4.8 Redraw the graph to indicate the mechanism of how a catalyst will influence the reaction (2)

[18]

QUESTION 5 (Start on a new page)

Sulphuric acid is a strong acid and reacts with water in two steps as shown in the reactions below.

$H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+$

$HSO_4^+ + H_2O \rightarrow SO_4^{2-} + H_3O^+$

5.1 What is meant by the term diprotic acid? (2)

5.2 Identify the ampholyte in the above equations. (2)

5.3 Write down any one of the conjugate acid-base pairs in the first reaction. Clearly identify the acid and the base. (3)

5.4 Give an example of any salt that will form with the acid in the second reaction. (1)

5.5 What colour will bromothymol blue be if it is added to the second reaction? (1)

5.6 A solution of potassium hydroxide (KOH) is prepared by dissolving 3,36g crystals of KOH in 250 cm^3 of solution.

5.6.1 Is KOH a WEAK or STRONG base? Explain your answer. (2)

5.6.2 Calculate the concentration of the potassium hydroxide solution. (4)

5.7 25 cm^3 of potassium hydroxide solution of concentration 0,25 $mol.dm^{-3}$ completely neutralises a dilute solution of sulphuric acid (H_2SO_4) in a flask. The incomplete equation below represents the reaction that takes place:

$$2KOH\ (aq) + H_2SO_4\ (aq) \rightarrow K_2SO_4(aq) + D$$

5.7.1 Write down the NAME of the salt formed. (1)

5.7.2 Write down the FORMULA of compound D. (1)

5.7.3 Calculate the mass of sulphuric acid in the flask. (5)

[22]

QUESTION 6 (Start on a new page)

An investigation was done to determine the relationship between the pressure and volume of a fixed mass of gas. The table below shows the results of the investigation.

Pressure (kPa)	Volume (cm^3)
25	5
12,5	10
6,25	20
5,0	25
4,2	30
3,5	35

6.1 Use the results to draw a graph of volume versus pressure. (4)

6.2 Which law describes the relationship between pressure and volume of a fixed amount of gas? (2)

6.3 Calculate the volume of the gas, in cm^3, if the pressure exerted on the gas is 35,00 kPa. (4)

6.4 Write down TWO conditions under which the gas used will behave like an ideal gas (2)

[12]

TOTAL MARKS: 100

DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Molar gas constant *Molêre gaskonstante*	R	$8{,}31\ J{\cdot}K^{-1}{\cdot}mol^{-1}$
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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$\frac{p_1V_1}{T_1}=\frac{p_2V_2}{T_2}$	$pV=nRT$
$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$n=\frac{V}{V_m}$	$c=\frac{n}{V}$ OR/*OF* $c=\frac{m}{MV}$

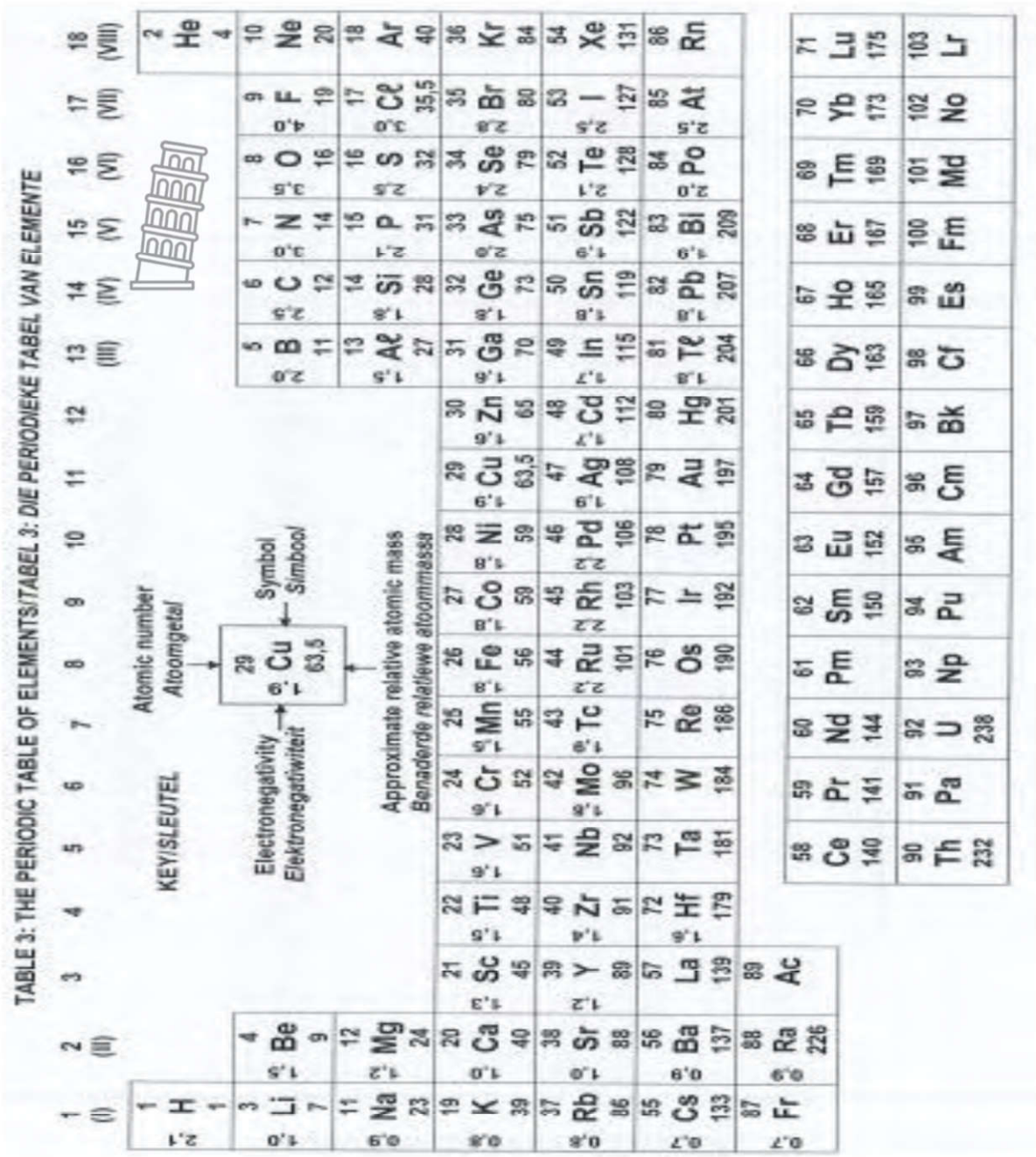


TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

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
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 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
$Br_2(l) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(l)$	+ 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
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	– 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 oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NSC EXAMINATION

GRADE 11

PHYSICAL SCIENCES
CONTOLLED TEST 2
MARKING GUIDELINES
2023

MARKS: 100

This marking guidelines consists of 06 pages including the cover page.

QUESTION 1

1.1 D ✓✓ (2)
1.2 C ✓✓ (2)
1.3 B ✓✓ (2)
1.4 B ✓✓ (2)
1.5 A ✓✓ (2)
[10]

QUESTION 2

2.1

C	H
n = m/M	n = m/ M
= 85,71/ 14 ✓	= 14,29/ 1 ✓
= 7,143 mol ✓ / 7,143	= 14,29 mol / 7,143 ✓
= 1	= 2

∴ Empirical formula = CH_2 ✓ (5)

2.2 $M(CH_2) = 12 + 2(1)$ ✓
$= 14 g.mol^{-1}$ ✓
∴ $\frac{42}{14} = 3$ ✓
Molecular formula = $3(CH_2)$
$= C_3H_6$ ✓ (4)

2.3 A reactant that is completely used up during a chemical reaction. (2)
✓✓

2.4.1 $n_1 = \frac{m}{M} = \frac{16,7}{286} = 0,06$ mol ✓

$n_2 = \frac{11,2}{28} = 0,4$ mol ✓
But $n(I_2O_2)$ requires $2n(CO)$ ✓
0,06 mol (I_2O_2) require 0,12 mol CO ✓
Since there are 0,4 mol of CO, then I_2O_2 is the limiting reactant. ✓✓ (6)

2.4.2 Excess mols = 0,4 – 0,12 ✓
= 0,28 mol
∴m = Nm ✓
= 0,28 x 28✓
= 7,84g ✓ (4)
[21]

QUESTION 3

3.1 % purity = $\frac{31,9}{49,9}$ ✓ x 100✓
= 63,93%✓ (3)

3.2 M($CuSO_4$) = 63,5 + 32 + 64✓ = 159,5 g.mol^{-1} ✓
n = $\frac{m}{M}$ ✓ = $\frac{31,9}{159,5}$ ✓ = 0,2 mol✓ (5)

3.3 49,90 – 31,90 = 18g ✓
∴ n (H_2O) = $\frac{m}{M}$ ✓ = $\frac{18}{18}$ ✓= 1 mol ✓
Then $\frac{0,2}{0,2}$ mol $CuSO_4$: $\frac{1}{0,2}$ mol H_2O ✓
1 mol $CuSO_4$: 5 mol H_2O ✓ (7)
∴ x = 5 ✓

3.4 n = $\frac{N}{NA}$
N = 1 x 6,02 x 10^{23}
= 6,02 x 10^{23} molecules ✓✓ (2)
[17]

QUESTION 4

4.1 Endothermic. ✓✓. Energy of the products is higher✓ than the energy of the reactants ✓ (4)

4.2 $\Delta H = E_P - E_R$ ✓
= 40 - 10
= 30 kJ✓ (2)

4.3 Activated complex is an unstable, temporary arrangement of atoms that forms just before atoms start to combine. ✓✓ (2)

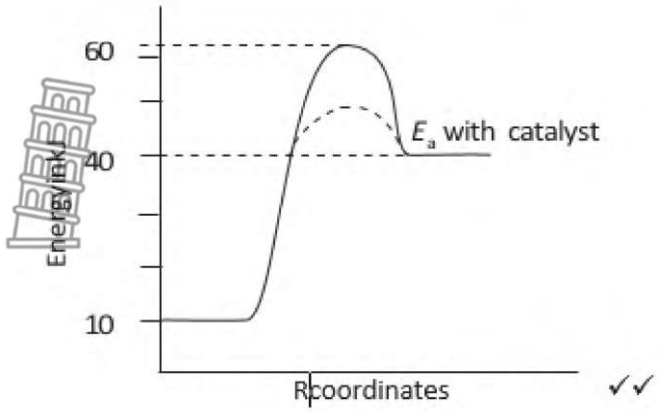
4.4 60 J ✓✓ (2)

4.5 Minimum energy required to initiate or start a reaction. ✓✓ (2)
OR
The minimum energy that must be absorbed by a system to cause it to react.

4.6 It lowers the activation energy✓ and increases the rate of the reaction. ✓ (2)

4.7 It increases the rate of the reverse reaction. ✓✓ (2)

4.8



✓✓

(2)
[18]

QUESTION 5

5.1 An acid that can donate 2 protons. ✓✓ (2)

5.2 $H_2SO_4^+$ ✓✓ (2)

5.3 H_2SO_4 (acid) ✓ and HSO_4^- (conjugate base) ✓ OR
H_2O (base) and H_3O^+ (conjugate acid) pair correctly identified✓ (3)

5.4 Any SO_4 salt, e.g. $CaSO_4$ ✓ (1)

5.5 yellow ✓ (1)

5.6.1 Strong base ✓. It ionises completely. ✓ (2)

5.6.2

OPTION 1

$c = \frac{m}{MV}$ ✓

$= \frac{3,36}{56\ X\ 0,25}$ ✓✓

= 0,24 mol.dm^{-3} ✓

OPTION 2

$n = \frac{m}{M} = \frac{3,36}{56}$

= 0,06 mol ✓

$\therefore c = \frac{n}{V}$ ✓

$= \frac{0,06}{0,25}$ ✓

= 0,24 mol.dm^{-3} ✓ (4)

5.7.1 Potassium sulphate ✓ (1)

5.7.2 H_2O ✓ (1)

5.7.3 MARKING CRITERIA

- Using formula n = c V or m = n M
- Substituting 0,25 and 0,025 into n = c V
- Using ratio 2: 1
- Substituting 98 into m = n M
- Final answer: 0,31 g **ACCEPT 0,306g**

$n(KOH) = c\ V$ ✓

$= (0,25)\ (0,025)$ ✓

$= 6,25 \times 10^{-3}$ mol

$n(H_2SO_4) = \frac{1}{2}(KOH)$

$= \frac{1}{2}(6,25 \times 10^{-3})$ ✓

$= 3,125 \times 10^{-3}$ mol

$\therefore m(H_2SO_4) = n\ M$

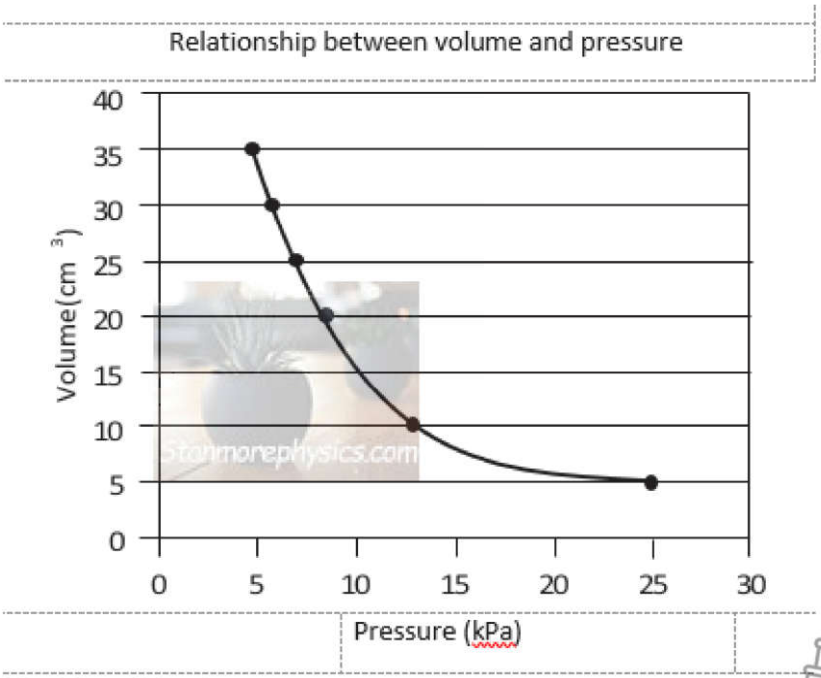
$= 3,125 \times 10^{-3} \times 98$ ✓

= 0,31 g ✓ (accept 0,306g) (5)

[22]

QUESTION 6

6.1



(4)

Marking Criteria

- Heading on the graph ✓
- Axis correctly labelled with units ✓
- Shape of graph ✓✓

6.2 Boyle's Law. ✓✓ (2)

6.3 $p_1V_1 = p_2V_2$ ✓
(25 x 5) ✓ = (35 x V_2) ✓
V_2 = 3,57 cm^3 ✓ (4)

6.4 High temperature ✓; low pressure ✓ (2)
[12]

TOTAL [100]