KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES P2 (CHEMISTRY)

NOVEMBER 2023

MARKS: 150

TIME : 3 Hours

This question paper consists of 13 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 sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

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

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

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1 to1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following statements is CORRECT for an ENDOTHERMIC REACTION?

A The temperature of the surrounding increases.

B The enthalpy change for the reaction is negative.

C Heat flows from the surroundings into the system.

D The enthalpy of the products is less than the enthalpy of the reactants. (2)

1.2 Two different gases, occupying the same volume at STP, will have the same…

A mass.

B mass to volume ratio.

C molar mass.

D number of molecules. (2)

1.3 Which of the following statements best describes a POLAR COVALENT BOND between two atoms?

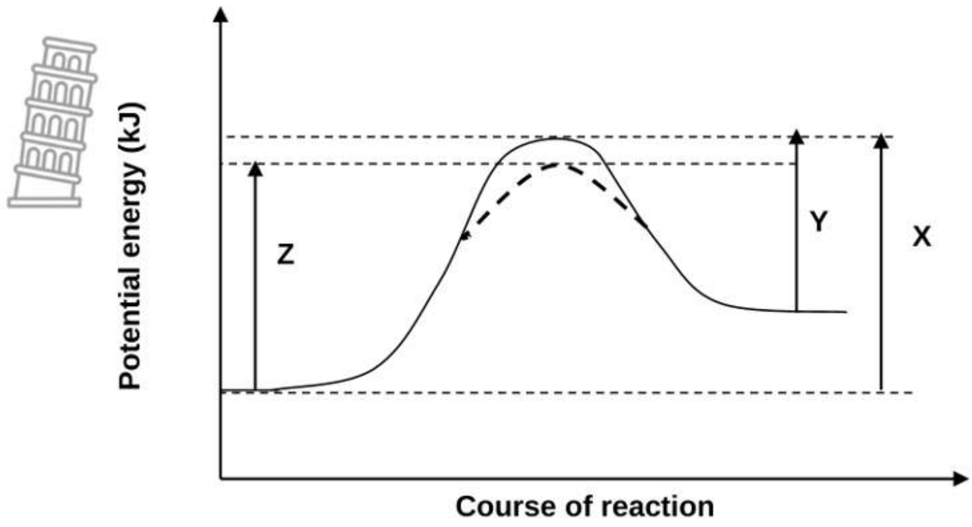
A A band of delocalised electrons attract the nuclei of the two atoms.

B Bond pairs are shared unequally between the two atoms.

C The difference in electronegativity between the two atoms is zero.

D Electrons are transferred from the less electronegative atom to the more electronegative atom. (2)

1.4 The energy changes represented by X, Y and Z on the potential energy graph below takes place during a catalysed, reversible chemical reaction.



Which ONE of the following represents the heat of the reaction for the FORWARD reaction?

A Y – X

B Y – Z

C Z – X

D X – Z (2)

1.5 The shape of the $PC\ell_5$ molecule as predicted by the VSEPR theory is …

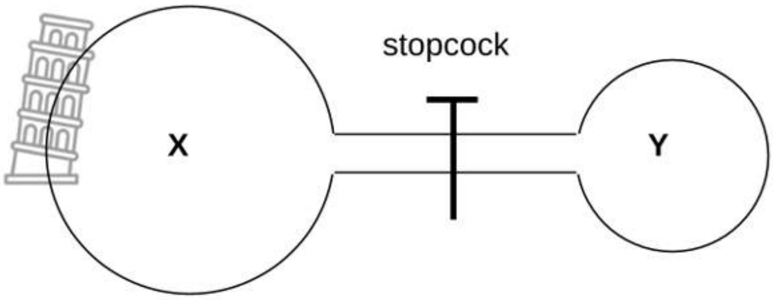
A tetrahedral.

B trigonal planar

C trigonal pyramidal.

D trigonal bi-pyramidal. (2)

1.6 The sketch shows two containers, X and Y, connected by a tube containing a closed stopcock.



The volume of container **X** is V and contains a gas at a pressure p. Container **Y** is evacuated. The volume of the tube is negligible.

When the stopcock is opened at constant temperature the pressure of the gas in container **X** changes to $\frac{3}{4}$p.

What is the volume of container **Y**?

A $\frac{1}{3}$ V

B $\frac{2}{3}$ V

C $\frac{3}{4}$ V

D $\frac{4}{3}$ V (2)

1.7 Consider the reaction represented by the balanced equation below:

$$H_3PO_4(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + H_2PO_4^-(aq)$$

Which ONE of the following is a conjugate acid-base pair?

A H_3PO_4(aq) and $H_2PO_4^-$ (aq)

B H_3O^+(aq) and $H_2PO_4^-$ (aq)

C H_3PO_4(aq) and $H_2O(\ell)$

D H_3PO_4(aq) and H_3O^+(aq) (2)

1.8 The number of ions present in 5 moles of aluminium oxide, $A\ell_2O_3$, is given by…

A $10 \times 6{,}02 \times 10^{23}$

B $5 \times 6{,}02 \times 10^{23}$

C $25 \times 6{,}02 \times 10^{23}$

D $6 \times 6{,}02 \times 10^{23}$ (2)

1.9 In which ONE of the following reactions is $HC\ell$ the REDUCING AGENT?

A $HC\ell(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + C\ell^-$

B $NH_3(aq) + HC\ell(aq) \rightarrow NH_4C\ell(aq)$

C $MnO_2(aq) + 4\,HC\ell(aq) \rightarrow MnC\ell_2(aq) + H_2O(\ell) + C\ell_2(g)$

D $CaCO_3(s) + 2\,HC\ell(aq) \rightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$ (2)

1.10 Consider the following reactions of a metal P:

(i) P reacts with a solution of silver nitrate to form a deposit of metallic silver.

(ii) P does not react with a solution of zinc sulphate.

Which ONE of the following statements is CORRECT for reactions (i) and (ii)?

A P is a reducing agent in both reactions.

B P is an oxidising agent in both reactions.

C P is an oxidising agent in reaction (i) only.

D P is a reducing agent in reaction (i) only. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **F** in the table below represent six covalent molecules.

MOLECULE	**A**	**B**	**C**	**D**	**E**	**F**
FORMULA	H_2O	NH_3	HF	OF_2	HOCℓ	HCN

2.1 Define the term *lone pair of electrons.* (2)

2.2 Draw Lewis structures for the following molecules:

2.2.1 H_2O (2)

2.2.2 HOCℓ (2)

2.3 For molecule A, write down the:

2.3.1 Number of bonding pairs of electrons. (1)

2.3.2 Number of lone pairs of electrons. (1)

2.4 Consider the bond between the O and the H atoms in molecule A, and that between the O and the F atom in molecule D. Which of these two bonds, O-H or O-F, is more polar? Give a reason for the answer. (3)

2.5 What is the shape of molecule A? (1)

2.6 Write down the letter of the molecules that has the same shape as molecule A. (1)

2.7 Refer to the polarity and intermolecular forces of A and B to explain why molecule B is soluble in molecule A. (2)

2.8 The results in the table below were obtained during an investigation to determine the values of the bond length of the different bonds in molecule F (HCN).

BONDING ATOMS	BOND LENGTH (nm)
C and H	0,109
C and N	0,116

2.8.1 Define *bond length*. (2)

2.8.2 Explain why the bond length for the bond between the C and N atoms is longer than the bond length between the C and H atoms. (2)

2.8.3 What is the bond order for the bond between the C and N atoms? (2)
[21]

QUESTION 3 (Start on a new page.)

During an investigation, the BOILING POINTS of the hydrides of two group VI elements were determined. The results of the investigation are shown in the table below.

Compound	Formula	Boiling Point (°C)
P	H_2S	X
Q	H_2O	100

3.1 Define *boiling point*. (2)

3.2 Write down the dependent variable for this investigation. (1)

3.3 Write down the name of the strongest intermolecular forces that exist between molecules of:

3.3.1 **P** (1)

3.3.2 **Q** (1)

3.4 Will the value X, in the table be EQUAL TO, LESS THAN or GREATER THAN 100 °C? (1)

3.5 Fully explain the answer to QUESTION 3.5. (2)

3.6 The boiling point of the hydride of a third group VI element, Se, is now determined. Will the boiling point of H_2Se be EQUAL TO, LESS THAN or GREATER THAN that of H_2S? Give a reason for the answer. (2)

3.7 Will the boiling point of ammonia (NH_3), be EQUAL TO, LESS THAN or GREATER THAN 100 °C? Fully explain the answer. (4)

[14]

QUESTION 4 (Start on a new page.)

4.1 The relationship between pressure and volume of an enclosed gas at 25 °C is investigated, by varying the pressure exerted by the gas, and observing the corresponding volume occupied by the gas in each case.
The results obtained are shown in the table below:

PRESSURE (kPa)	Volume in cm^3	$\frac{1}{V}$ in cm^{-3}
60	50	0,020
D	35	0,029
100	30	0,033
150	20	0,050
200	15	0,067

4.1.1 NAME and STATE the gas law being investigated. (3)

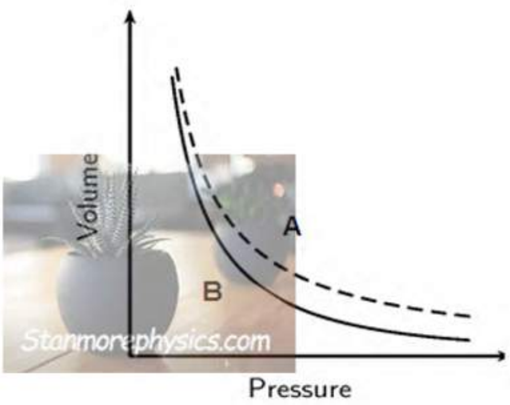
4.1.2 Write down TWO controlled variables for this investigation. (2)

4.1.3 Write down the dependent variable for this investigation. (1)

4.1.4 Use the results in the table to explain why a graph of pressure(p) versus the inverse of volume ($\frac{1}{V}$) will be a straight line graph. (3)

4.1.5 Calculate the value represented by the letter D in the table. (2)

4.2 The graphs, **A** and **B** below were obtained during an investigation to identify the conditions under which a gas will deviate from ideal gas behaviour.



4.2.1 Which graph, **A** or **B** represents the deviation from ideal gas behaviour? (1)

4.2.2 State the relevant condition under which the deviation from ideal behaviour referred to in QUESTION 4.2.1 occurs. (2)

4.2.3 Explain the answer to question 4.2.2. (3)
[17]

QUESTION 5 (Start on a new page)

The balanced equation below represents a hypothetical reaction:

$$X(g) + Y(g) \rightarrow XY(g)$$

The table below shows the different energies for the above reaction.

Energy of the Reactants (E_R)	351 $kJ.mol^{-1}$
Energy of the Products (E_P)	109,2 $kJ.mol^{-1}$
Activation energy (E_A)	1370 $kJ.mol^{-1}$

5.1 Is the above reaction EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer by referring to the data in the table. (2)

5.2 Calculate the heat of reaction for the above reaction. (3)

5.3 Define the term *activated complex.* (2)

5.4 Sketch a potential energy versus course of reaction graph for the above reaction. The graph need not be drawn to scale. Clearly label the axes and indicate the following numerical values on the Y-axis.

- Energy of the reactants
- Energy of the products
- Energy of the activated complex (5)

5.5 The following reaction NOW takes place:

$$XY(g) \rightarrow X(g) + Y(g)$$

For the above reaction write down the value of the:

5.5.1 Heat of reaction. (1)

5.5.2 Activation energy. (2)

[15]

QUESTION 6 (Start on a new page)

A compound contains 30,4 % nitrogen and 69,6 % oxygen by mass.

6.1 Define the term *empirical formula.* (2)

6.2 Determine the empirical formula of the compound. (5)

6.3 Write down the molecular formula of the compound if the molecular mass of the compound is 92 $g.mol^{-1}$. (2)

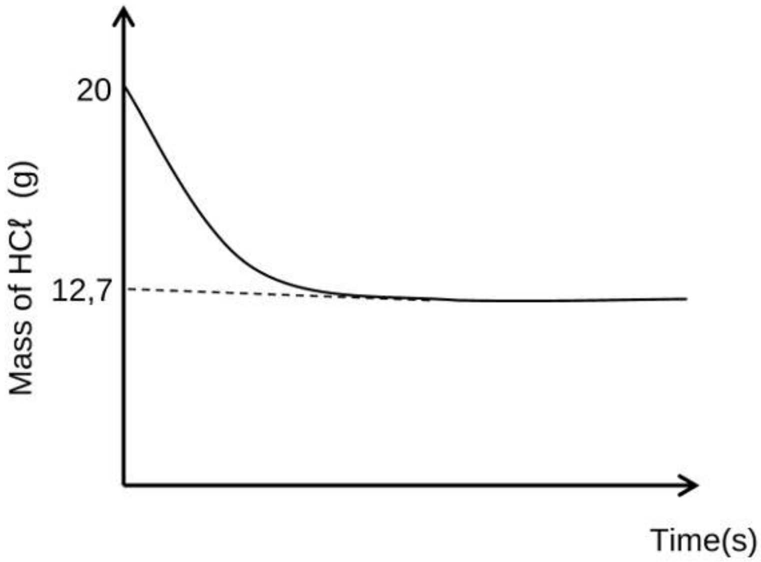
[9]

QUESTION 7 (Start on a new page.)

A sample of IMPURE solid calcium carbonate, $CaCO_3$, of mass 12,5 g reacted with dilute hydrochloric acid, HCℓ(aq), according to the following balanced equation:

$$CaCO_3(s) + 2\,HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

The graph below shows how the mass of the HCℓ(aq) changes with time.



7.1 Define the term *limiting reagent.* (2)

7.2 Write down the name or formula of the limiting reagent in the above reaction. (2)

7.3 Calculate the: (1)

7.3.1 Percentage purity of the calcium carbonate. (6)

7.3.2 Maximum volume of CO_2(g) produced at STP (4)

In another reaction, **X** g of the SAME IMPURE $CaCO_3$ is now reacted with excess HCℓ.

7.3.3 Calculate the mass of the impure $CaCO_3$ that must be used to produce 12,6 g of H_2O. (5)

[20]

QUESTION 8 (Start on a new page.)

8.1 Oxalic acid ionizes in water according to the following balanced equation:

$$H_2C_2O_4(aq) + 2H_2O(\ell) \rightleftharpoons C_2O_4^{2-}(aq) + 2H_3O^+(aq)$$

8.1.1 Define an *acid according to the Arrhenius theory*. (2)

8.1.2 Write down the formula of the TWO BASES in this reaction. (2)

8.2 Sulphuric acid, H_2SO_4, ionizes in TWO steps as follows:

STEP I: $H_2SO_4(aq) + H_2O(\ell) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$

STEP II: $HSO_4^-(aq) + H_2O(\ell) \rightarrow SO_4^{2-}(aq) + H_3O^+(aq)$

Write down the NAME or FORMULA of the substance that acts as an ampholyte when H_2SO_4 ionises. Give a reason for the answer. (3)

8.3 The acid HF ionizes according to the following equation:

$$HF(aq) \rightleftharpoons H^+(aq) + F^-(aq)$$

When a 0,10 mol.dm^{-3} solution of HF is prepared, it is found that the concentration of the F^- ions at 25 °C is 0,018 mol.dm^{-3}.

Is HF a strong acid? Choose from YES or NO. Give a reason for the answer. (3)

8.4 The salt sodium ethanoate (CH_3COONa) is formed when a weak acid reacts with a strong base.
Write a balanced chemical equation for the neutralisation reaction between an acid and a base that will form CH_3COONa. (3)

8.5 HBr(aq) reacts with $Zn(OH)_2$ according to the following balanced equation:

$$Zn(OH)_2(s) + 2HBr(aq) \rightarrow ZnBr_2(aq) + 2H_2O(\ell)$$

X grams of pure $Zn(OH)_2(s)$ is reacted with 90 cm^3 of HBr(aq) of concentration 0,45 mol.dm^{-3}.

The excess HBr(aq) is then completely neutralised by 16,5 cm^3 of NaOH(aq) of concentration 0,5 mol.dm^{-3}, according to the following balanced equation:

$$HBr(aq) + NaOH \rightarrow NaBr(aq) + H_2O(\ell)$$

Calculate X. (9)
[22]

QUESTION 9 (Start on a new page.)

The reaction between potassium permanganate ($KMnO_4$) and hydrogen sulphide(H_2S) in an acidic medium is given below.

$$KMnO_4 + H_2S + HC\ell \rightarrow KC\ell + MnC\ell_2 + S + H_2O$$

9.1 Define the term *oxidation* in terms of electron transfer. (2)

9.2 Write down the:

9.2.1. Name or formula of the reducing agent. Explain the answer by referring to the oxidation numbers. (2)

9.2.2 Name or formula of the substance that is reduced. (1)

9.2.3 Reduction half reaction. (2)

9.2.4 Oxidation half reaction. (2)

9.2.5 Balanced net ionic equation. (3)
[12]

TOTAL: 150

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*
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 electron*	E	$-1,6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6,02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$c=\frac{n}{V}$ or/*of* $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b}=\frac{n_a}{n_b}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

KEY/*SLEUTEL*

Electronegativity / *Elektronegatiwiteit*	Atomic number / *Atoomgetal*	Symbol / *Simbool*	Approximate relative atomic mass / *Benaderde relatiewe atoommassa*
1,9	29	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 oxidising ability/*Toenemende oksiderende vermoë*

↓ Increasing reducing ability/*Toenemende reduserende vermoë*

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
$a^{2+} + 2e^-$	⇌	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

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

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
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**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
$Pt^{2+} + 2e^-$	⇌	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
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+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*

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES P2 (CHEMISTRY)

NOVEMBER 2023

MARKING GUIDELINE

MARKS : 150

TIME : 3 Hours

This marking guideline consists of 7 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

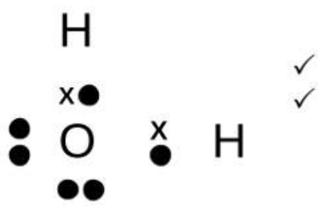
1.1 C✓✓
1.2 D✓✓
1.3 B✓✓
1.4 Accept all options✓✓
1.5 D✓✓
1.6 A✓✓
1.7 A✓✓
1.8 C✓✓
1.9 C✓✓
1.10 D✓✓

[20]

QUESTION 2

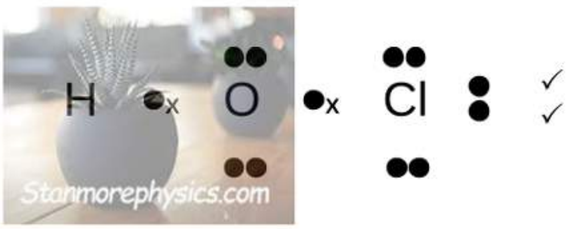
2.1 A pair of electrons in the valence shell of an atom that is not shared with another atom. ✓✓ (2)

2.2.1



(2)

2.2.2



(2)

2.3.1 2✓ (1)

2.3.2 2✓ (1)

2.4 O-F✓
The difference in electronegativity between O-F is greater than that between O-H / F has a higher electronegativity than H. ✓✓ (3)

2.5 Angular/bent✓ (1)

2.6 D✓ (1)

2.7 NH_3 has polar molecules with hydrogen bonds/dipole-dipole forces and H_2O has polar molecules with hydrogen bonds/dipole-dipole forces. ✓
Forces are of the same order/comparable strengths. ✓

OR

Both molecules are polar / The strengths of the dipoles are of the same order/comparable. ✓
Polar solutes dissolve in polar solvents / Like dissolves in like✓ (2)

2.8 2.8.1 The average distance between the nuclei of two bonded atoms. ✓ ✓ (2)

2.8.2 The N atom is bigger than the H atom, ✓ resulting in a bigger distance between the N and C nuclei. ✓ (2)

2.8.3 3 ✓✓ (2)
[21]

QUESTION 3 (Start on a new page.)

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓ (2)

3.2 Boiling point. ✓ (1)

3.3

3.3.1 Dipole- dipole forces ✓ (1)

3.3.2 Hydrogen bonding✓ (1)

3.4 Less than✓ (1)

3.5 Hydrogen bonding between H_2O molecules is stronger than the dipole-dipole forces between H_2S molecules. ✓
More energy is required to overcome the intermolecular forces between water molecules. ✓ (2)

3.6 Greater than✓ Se is a bigger atom than Sulphur✓ (therefore forming a stronger dipole). (2)

3.7 LESS THAN. ✓
NH_3 molecules have one site for hydrogen bonding, while H_2O molecules have two sites for hydrogen bonding. ✓ The intermolecular forces between molecules of NH_3 are weaker✓ than that between molecules of H_2O
Less energy will therefore be required to overcome the intermolecular forces in NH_3. ✓ (4)
[14]

QUESTION 4 (Start on a new page.)

4.1.1 Boyle's Law✓. The pressure exerted by a fixed quantity of gas is inversely proportional to the volume occupied by the gas✓ at constant temperature. ✓ (3)

4.1.2 Temperature✓
Mass of gas/number of moles of gas✓ (2)

4.1.3 pressure✓ (1)

4.1.4 The gradient of the graph is the product of pressure and volume✓
According to the table the product of pressure and volume is a constant✓
Thus yielding a constant gradient✓ (3)

4.1.5

$$p_1V_1 = p_2V_2$$
$$(60)(50) = (D)(35) \quad ✓$$
$$D = 85{,}71 \text{ kPa} \quad ✓$$
(2)

4.2

4.2.1 **A**✓ (1)

4.2.2 High pressure ✓✓ (2)

4.2.3 The volume of the molecules of the gas and the intermolecular forces influence the measured value✓
Causing it to be greater than the theoretical value✓
Forces of repulsion between the gas particles prevents them from moving closer. ✓ (3)
[17]

QUESTION 5 (Start on a new page)

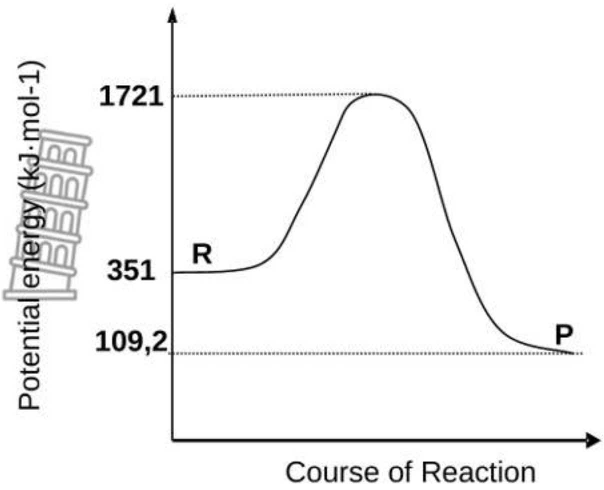
5.1 EXOTHERMIC. ✓
The energy of the products is less than the energy of reactants/energy was released✓ (2)

5.2

$$\Delta H = H_P - H_R \quad ✓$$
$$= 109{,}2 - 351 \quad ✓$$
$$= -241{,}8 \text{ kJ.mol}^{-1} ✓$$
(3)

5.3 The unstable transition state from reactants to products✓✓ (2)

5.4



Marking guidelines/*Nasienriglyne:*	
Axes correctly labelled	✓
Energy of Reactants correctly indicated.	✓
Energy of Products correctly indicated.	✓
Energy of Activated complex correctly indicated	✓
Correct shape as shown.	✓

(5)

5.5.1 241,8 kJ.mol^{-1}✓ (1)

5.5.2 1611,8 kJ.mol^{-1}✓✓ (2)

[15]

QUESTION 6

6.1 Simplest (whole number) ratio in which the atoms have combined. ✓✓ (2)

6.2

	N	O	
%	30,4	69,6	
Mass in 100g)	30,4	69,6	
$n = \frac{m}{M}$ ✓	$\frac{30,4}{14}$	$\frac{69,6}{16}$	✓
	= 2,17	= 4,35	✓
R	1	2	✓

Empirical formula = NO_2✓

(5)

6.3 N_2O_4✓✓ (2)

[9]

QUESTION 7

7.1 The reagent that is used up completely in a reaction. ✓✓ (2)

7.2 Calcium carbonate/$CaCO_3$✓✓ (2)

7.3.1

$n(CaCO_3)$ reacted	=	$(\frac{1}{2})n(HC\ell)$ ✓
	=	$(\frac{1}{2})(\frac{m}{M})$
	=	$(\frac{1}{2})(\frac{20-12,7}{36,5})$ ✓✓ ✓
	=	0,1 mol
$m(CaCO_3)$ reacted	=	nM
	=	(0,1)(100) ✓
	=	10g
% purty	=	$(\frac{10}{12,5})$ x 100✓
	=	80 %✓

(7)

7.3.2

$n(CO_2)$produced	=	$n(CaCO_3)$ ✓
	=	0,1 mol
n	=	$\frac{V}{V_m}$ ✓
0,1	=	$\frac{V}{22,4}$ ✓
V	=	2,24 dm^3✓

(4)

7.3.3

$n(CaCO_3)$	=	$n(H_2O)$ ✓
n	=	$\frac{m}{M}$
	=	$\frac{12,6}{18}$ ✓
	=	0,7 mol
$m(CaCO_3)$	=	nM
	=	(0,7)(100) ✓
	=	70 g
70	=	$\frac{80}{100}$ x X ✓
X	=	87,5 g✓

(5)
[20]

QUESTION 8 (Start on a new page.)

8.1.1 An acid is a substance that produces hydrogen ions(H^+)/hydronium ions(H_3O^+) when it dissolves in water. ✓✓ (2)

8.1.2 H_2O✓ and $C_2O_4^{2-}$ ✓ (2)

8.2 HSO_4^- ✓ Acts as a base in step I, ✓ and as an acid in step II✓ (3)

8.3 NO. ✓ The concentration of F^- ions is lower than concentration of HF. ✓
HF Ionises incompletely✓ (3)

8.4 $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$ LHS✓ RHS✓ Balancing✓ (3)

8.5

$$
\begin{aligned}
n(HBr)initial &= cV ✓\\
&= (0,45)\left(\frac{90}{1000}\right) ✓\\
&= 0,0405\ mol.dm^{-3}\\
n(HBr)excess &= n(NaOH)\ ✓ \textit{(ratio)}\\
&= cV\\
&= (0,5)\left(\frac{16,5}{1000}\right) ✓\\
&= 8,25 \times 10^{-3}\ mols\\
n((Zn(OH)_2) &= \frac{1}{2}n(HBr)\ ✓ \textit{(ratio)}\\
&= \frac{1}{2}\underline{(0,0405 - 8,25 \times 10^{-3})}\ ✓✓\\
&= 0.016125\ mols\\
X = m((Zn(OH)_2) &= nM\\
&= (0.016125)(99)\ ✓\\
&= 1,596375\ g\ /\ 1,6\ g ✓
\end{aligned}
$$

(9)
[22]

QUESTION 9 (Start on a new page.)

9.1 Oxidation is the loss of electrons✓✓ (2)

9.2.1. Hydrogen sulphide/H_2S/S^{2-}✓ S undergoes an increase in oxidation no.✓ (2)

9.2.2 Potassium permanganate/permanganate ion/$KMnO_4$/MnO_4^-/Mn^{7+}✓ (1)

9.2.3 $\underline{MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O}$ ✓✓ (2)

9.2.4 $\underline{H_2S \rightarrow S + 2H^+ + 2e^-}$✓✓ (2)

9.2.5 $2\ MnO_4^- + 5\ H_2S + 6\ H^+ \rightarrow 2\ Mn^{2+} + 5\ S + 8\ H_2O$
(LHS ✓; RHS ✓ ; Balanced correctly ✓) (3)
[12]

TOTAL 150