Province of the
EASTERN CAPE
EDUCATION

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NATIONAL
SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2024

PHYSICAL SCIENCES P2
(CHEMISTRY)

MARKS: **150**

TIME: **3 hours**

* I P H S C E 2 *

This question paper consists of 18 pages, including 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and surname in the appropriate space on the ANSWER BOOK.
2. This question paper consists of EIGHT 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, 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. 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. 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. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 Which ONE of the following bonds will have the highest bond energy?

A $H - H$

B $C - H$

C $C = C$

D $C \equiv C$ (2)

1.2 Consider the following compounds and their respective boiling points.

COMPOUNDS	BOILING POINT (˚C)
He	-268,9
HBr	-66
HF	19,5

The correct arrangement for the decreasing strength of the intermolecular forces of the given compounds is …

A HF, He, HBr.

B HBr, He, HF.

C HF, HBr, He.

D He, HBr, HF. (2)

1.3 Which ONE of the following is NOT a property of the ideal gas?

A There are no forces of attraction between the molecules.

B The collisions between molecules are elastic.

C The volume occupied by the gas is equal to the total volume of the gas molecules.

D It has a low density. (2)

1.4 The molar mass of hydrated oxalic acid $(COOH)_2{\cdot}\mathbf{x}H_2O$ is 126 g·mol^{-1}.

The number of water molecules (**x**) present in the hydrated compound is …

A 1.

B 2.

C 3.

D 4. (2)

1.5 10 moles of zinc (Zn) are allowed to react with 5 moles of hydrochloric acid ($HC\ell$) in a test tube according to the balanced equation:

$$Zn + 2\,HC\ell \rightarrow ZnC\ell_2 + H_2$$

How many moles of hydrochloric acid ($HC\ell$) and zinc chloride ($ZnC\ell_2$) is in the test tube after the completion of the reaction?

	$HC\ell$	**$ZnC\ell_2$**
A	2,5	2,5
B	0	2,5
C	5	10
D	0	10

(2)

1.6 Which ONE of the following is the conjugate acid of HPO_4^{2-}?

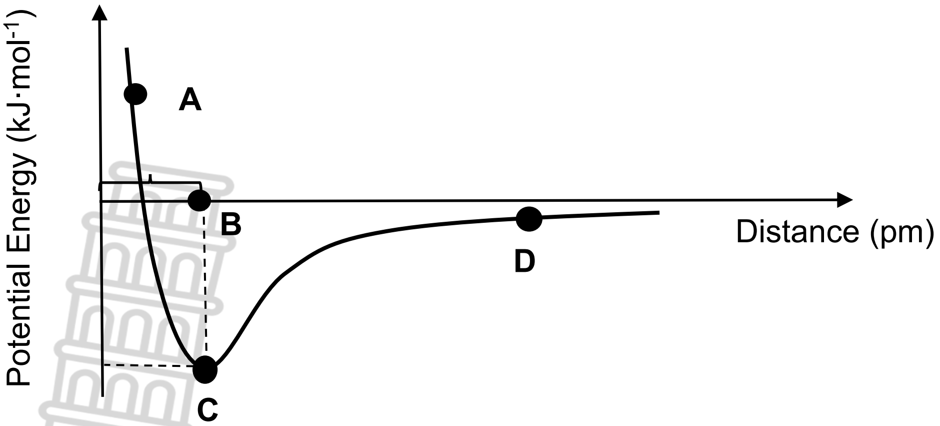
A PO_4^{3-}

B $H_2PO_4^{-}$

C H_3PO_4

D $H_2PO_4^{2-}$ (2)

1.7 Consider the potential energy versus distance curve below.



(I) At point **A** the repulsive forces are stronger than attractive forces

(II) Point **B** represents bond length

(III) At point **C** net attractive and repulsive forces is zero

Which of the above statement(s) regarding the above curve is CORRECT?

A **I** and **II** only

B **I** and **III** only

C **II** and **III** only

D **I, II** and **III** (2)

1.8 Which ONE of the following indicates the CORRECT colour of phenolphthalein in HCℓ and NaOH?

	HCℓ	**NaOH**
A	Yellow	Blue
B	Colourless	Pink
C	Pink	Colourless
D	Blue	Yellow

(2)

1.9 Which ONE of following solutions will have the lowest pH if all solutions have the SAME concentration?

A H_2SO_4 (aq)

B HCℓ (aq)

C NaOH (aq)

D $Ba(OH)_2$ (aq) (2)

1.10 Consider the following statements regarding a REDUCING AGENT:

(I) The substance that causes reduction.

(II) The substance that is reduced.

(III) The substance that is oxidised.

Which of the above statement(s) regarding the reducing agent is CORRECT?

A **I** only

B **I** and **II** only

C **II** and **III** only

D **I** and **III** only (2)

[20]

QUESTION 2 (Start on a new page.)

Consider the following compounds.

I_2	HOCℓ	NH_3	H_2S	KBr

2.1 Define *covalent bond.* (2)

2.2 Write down the formula of the compound from the given list that:

2.2.1 Is non-polar (1)

2.2.2 Forms a bond as a result of transferring of electrons (1)

2.2.3 Has one lone pair of electrons (1)

2.2.4 Has a pure covalent bond (1)

2.3 Draw the Lewis structure of the following compounds:

2.3.1 HOCℓ (2)

2.3.2 H_2S (2)

2.4 The ammonium ion (NH_4^+) is formed from ammonia (NH_3).

2.4.1 Identify the bond responsible for the formation of NH_4^+. (1)

2.4.2 Use the Lewis structure to show the formation of NH_4^+ from NH_3. (4)

2.5 Write down the molecular shape of:

2.5.1 HOCℓ (1)

2.5.2 NH_3 (1)

2.6 Will I_2 be soluble in $CCℓ_4$? Write down only YES or NO. (1)

2.7 Explain the answer to QUESTION 2.6 by referring to the molecular polarity and intermolecular forces involved in the compounds. (3)

2.8 The following table shows the average bond energies of atoms that are bonded to the hydrogen atom.

BONDS	**AVERAGE BOND ENERGY ($kJ\cdot mol^{-1}$)**
C – H	413
O – H	463
F – H	565

2.8.1 Define the term *bond energy.* (2)

2.8.2 Explain the trend observed in the bond energy in the table above. (2)
[25]

QUESTION 3 (Start on a new page.)

Learners investigated the boiling points of the compounds listed in the table below.

Compound		**Boiling point (˚C)**
A	CH_4	-161,5
B	SiH_4	-111,8
C	GeH_4	- 88,6
D	SnH_4	-52

3.1 Define *boiling point.* (2)

3.2 Is this a fair investigation? Write only YES or NO.

Give a reason for the answer. (2)

3.3 Write down the phase of the above compounds at room temperature. (1)

3.4 Explain the trend observed in boiling points of the compounds in the table above by referring to the molecular mass, intermolecular forces, and energy involved. (3)

3.5 Which compound in the table above has the highest vapour pressure at a given temperature? Explain the answer by referring to the data in the table above. (2)

3.6 The boiling point of HF and HCℓ is compared.

Compound		**Boiling point (˚C)**
E	HF	19,5
F	HCℓ	**X**

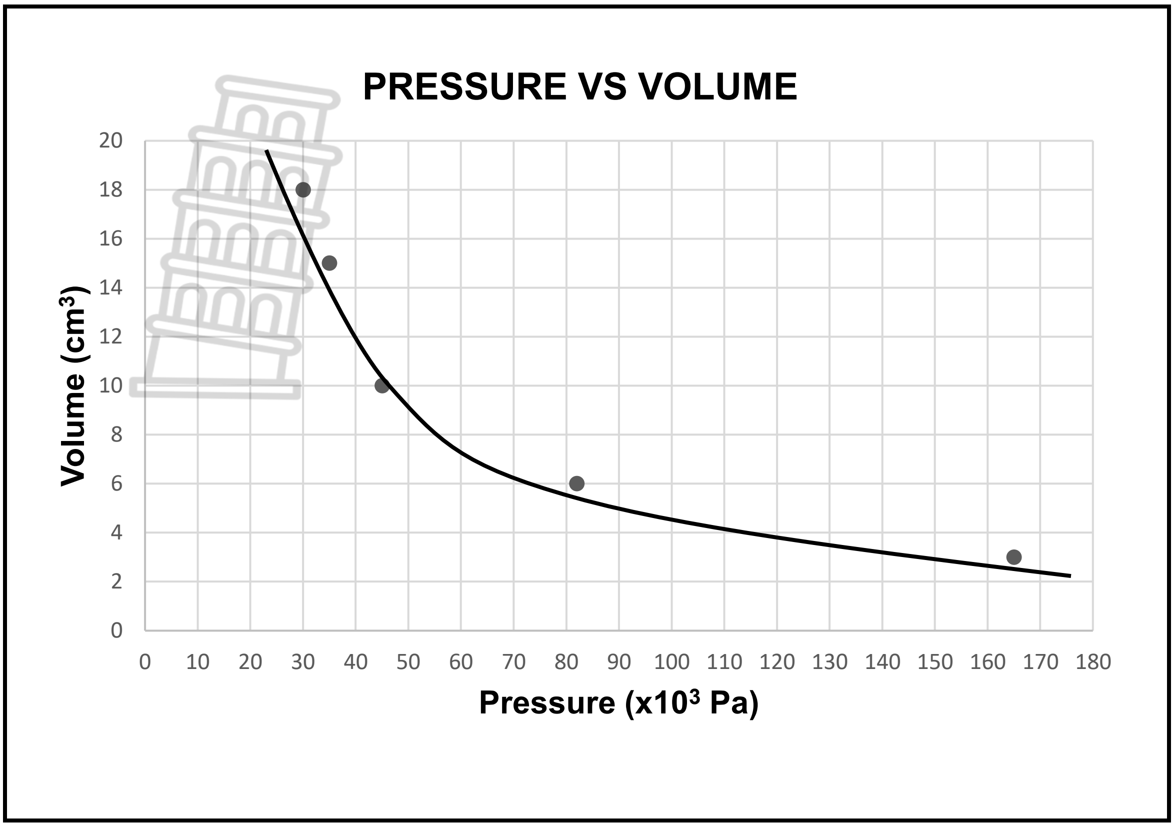
3.6.1 Will the value of **X** be HIGHER THAN, LOWER THAN or EQUAL TO 19,5 ˚C? (1)

3.6.2 Fully explain the answer to QUESTION 3.6.1. (4)

[15]

QUESTION 4 (Start on a new page.)

Learners investigated the relationship between pressure and volume of a gas. The graph below shows the results obtained during the investigation.



4.1 Name and state the law the experiment is based on. (3)

4.2 Write down a hypothesis for this investigation. (2)

4.3 Read and write down the pressure from the graph when the volume is 12 cm^3. (1)

4.4 Calculate the volume at 200 kPa. (4)

4.5 Redraw the above graph and label it **A**. On the same set of axes draw the graph to show how a real gas will deviate at a high pressure. Label this graph as **B**. (2)

[12]

QUESTION 5 (Start on a new page.)

Consider the decomposition reaction of dinitrogen pentoxide:

$$2\ N_2O_{5(g)} \rightarrow 2\ N_2O_{4(g)} + O_{2(g)}$$

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

Heat the of reactants (H_r)	26,6 kJ·mol^{-1}
Activation energy (E_a)	6,73 kJ·mol^{-1}
Heat of the reaction (ΔH)	-7,28 kJ·mol^{-1}

5.1 Define the term *activation energy.* (2)

5.2 Is the above reaction ENDOTHERMIC or EXOTHERMIC?

Give a reason for the answer. (2)

5.3 Calculate the heat of the products. (2)

5.4 Draw the potential energy versus course of reaction graph for the above reaction.

On the graph indicate values for:

- Heat of reactants ($H_{reactants}$)
- Heat of products ($H_{products}$)
- Energy at the activated complex
- Heat of the reaction (ΔH) (5)

5.5 On the same graph drawn in QUESTION 5.4, use a dotted line and draw the shape of the graph when a catalyst is added to the original reaction. (2)

[13]

QUESTION 6 (Start on a new page)

6.1 Compound **Q** (C_XH_Y) reacts with oxygen according to the balanced equation:

$$\mathbf{P}\ C_XH_Y + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$$

The molar mass of compound **Q** is 58 g·mol^{-1}.

6.1.1 Define *empirical formula.* (2)

6.1.2 Use the principle of conservation of mass and determine the value **P**. (3)

The percentage composition of compound **Q** is:

Carbon	Hydrogen
82,76%	17,24%

6.1.3 Determine the molecular formula of compound **Q**. (5)

6.2 5 g of sodium carbonate (Na_2CO_3) reacts with 250 cm^3 of hydrochloric acid (HCℓ).

$$Na_2CO_3(s) + 2\ HC\ell(aq) \rightarrow 2\ NaC\ell(aq) + H_2O(\ell) + CO_2(g)$$

The percentage of hydrochloric acid (HCℓ) that reacted with sodium carbonate (Na_2CO_3) is 76%.

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

Calculate the:

6.2.2 Amount of hydrochloric acid that reacted with sodium carbonate. (4)

6.2.3 Volume of carbon dioxide that was produced.

Take the molar volume at room temperature as 24,45 dm^3. (4)

6.2.4 The hydrochloric acid that was used in the reaction was obtained by diluting 100 cm^3 HCℓ to 250 cm^3 hydrochloric acid (HCℓ) solution.

Calculate the concentration of the concentrated hydrochloric acid (HCℓ). (4)

[24]

QUESTION 7 (Start on a new page.)

7.1 Carbonic acid ionises in water according to the following balanced equation:

$$H_2CO_3\,(aq) + H_2O(\ell) \rightleftharpoons HCO_3^-(aq) + H_3O^+(aq)$$

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

Write down the:

7.1.2 FORMULAE of the TWO substances that can act as an ampholyte (2)

7.1.3 FORMULAE of TWO acids from the reaction (2)

7.1.4 Balanced equation between carbonic acid and sodium hydroxide (NaOH) (3)

7.2 2 g of NaOH is dissolved in water to make a 100 cm^3 solution.

Calculate the:

7.2.1 Concentration of NaOH (3)

7.2.2 pH of NaOH (4)

7.3 **5 g** of **impure** magnesium carbonate ($MgCO_3$), is added to 9,033 x 10^{22} molecules of hydrochloric acid ($HC\ell$).

The balanced equation for the reaction that takes place is given below:

$$MgCO_3(s) + 2\,HC\ell\,(aq) \rightarrow MgC\ell_2\,(aq) + CO_2(g) + H_2O(\ell)$$

The reaction is allowed to proceed until all the pure magnesium carbonate completely reacts. The excess hydrochloric acid is neutralised by adding 55 cm^3 of sodium hydroxide solution of concentration 0,8 $mol{\cdot}dm^{-3}$.

The balanced equation for the neutralisation reaction is:

$$HC\ell\,(aq) + NaOH\,(aq) \rightarrow NaC\ell\,(aq) + H_2O\,(\ell)$$

Calculate the:

7.3.1 Initial number of moles of hydrochloric acid (3)

7.3.2 Percentage purity of magnesium carbonate (8)

[27]

QUESTION 8 (Start on a new page.)

8.1 A solution of nickel (II) nitrate is placed in a zinc container. It was observed, after some time, that a chemical reaction has taken place. The net ionic equation is:

$$Zn\ (s) + Ni^{2+}(aq) \rightleftharpoons Zn^{2+}\ (aq) + Ni\ (s)$$

8.1.1 Explain the term *redox reaction*. (2)

8.1.2 Which ONE of Zn or Ni^{2+} is the oxidising agent?

Explain the answer by referring to the oxidation numbers. (3)

8.1.3 Give a reason why the nitrate ion (NO_3^-) is not written in the net ionic equation above. (1)

8.2 The reaction between dichromate ions ($Cr_2O_7^{2-}$) and tin (II) ions (Sn^{2+}) in an acid medium is given below.

$$Cr_2O_7^{2-} + Sn^{2+} + H^+ \rightarrow Cr^{3+} + Sn^{4+} + H_2O\ (\ell)$$

8.2.1 Determine the oxidation number of Cr in $Cr_2O_7^{2-}$. (2)

8.2.2 Write down the reduction half-reaction. (2)

8.2.3 Use the Table of Standard Reduction Potentials and write down the balanced net ionic equation. (4)

[14]

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

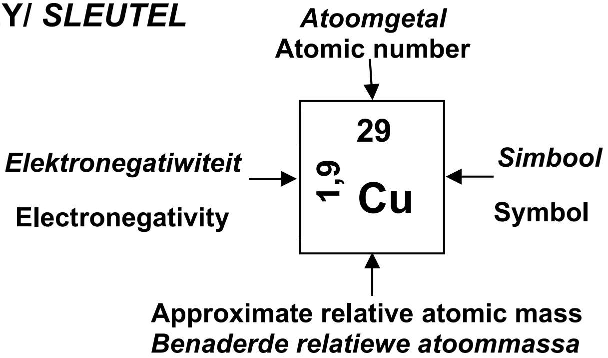
NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1,013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume teen STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron Lading op elektron	e	$-1,6 \times 10^{-19}$ C
Avogadro's constant Avogadro se konstante	N_A	$6,02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$ **OR/OF** $n = \frac{N}{N_A}$ **OR/OF** $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/by 298 K

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

KEY/ *SLEUTEL*



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* ↑

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

Increasing 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/*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
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87

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EDUCATION

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NATIONAL SENIOR CERTIFICATE/ *NASIONALE SENIORSERTIFIKAAT*

GRADE/*GRAAD 11*

NOVEMBER 2024

PHYSICAL SCIENCES P2 MARKING GUIDELINE/ *FISIESE WETENSKAPPE V2 NASIENRIGLYN*

MARKS/*PUNTE*: 150

This marking guideline consists of 11 pages./
Hierdie nasienriglyn bestaan uit 11 bladsye.

QUESTION/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 C ✓✓ (2)

1.4 B ✓✓ (2)

1.5 B ✓✓ (2)

1.6 B ✓✓ (2)

1.7 D ✓✓ (2)

1.8 B ✓✓ (2)

1.9 A ✓✓ (2)

1.10 D ✓✓ (2)
[20]

QUESTION/*VRAAG* 2

2.1 The sharing of electrons between two atoms to form a molecule. ✓✓
Die deel van elektrone tussen atome om 'n molekuul te vorm. ✓✓ (2)

2.2. 2.2.1 I_2 ✓ (1)

2.2.2 KBr ✓ (1)

2.2.3 NH_3 ✓ (1)

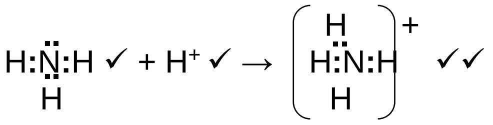
2.2.4 I_2 ✓ (1)

2.3 2.3.1 H:Ö:Cℓ: ✓✓ (2)

2.3.2 H:S:H ✓✓ (2)

2.4 2.4.1 Dative covalent bond / coordinate covalent bond ✓
Datiewe kovalente binding / koördinate-kovalente binding ✓ (1)

2.4.2



$$\mathrm{H{:}}\underset{\mathrm{H}}{\overset{\cdot\cdot}{\underset{\cdot\cdot}{\mathrm{N}}}}\mathrm{{:}H}\ \checkmark + \mathrm{H^+}\ \checkmark \rightarrow \left(\begin{array}{c}\mathrm{H}\\ \mathrm{H{:}\overset{\cdot\cdot}{N}{:}H}\\ \mathrm{H}\end{array}\right)^+\ \checkmark\checkmark$$

(4)

2.5 2.5.1 Bent / *Gebuig* ✓ (1)

2.5.2 Trigonal pyramidal / *Trigonaal piramidaal* ✓ (1)

2.6 Yes / *Ja* ✓ (1)

2.7 I_2 is a non-polar molecule and only contains London forces.✓
$CCℓ_4$ is a non-polar molecule and only contains London forces.✓
Both compounds are non-polar and only has London forces and "like dissolves like" ✓

I_2 is 'n nie-polêre molekule en bevat slegs London-kragte ✓
$CCℓ_4$ is 'n nie-polêre molekule en bevat slegs London-kragte ✓
Beide verbindings is nie-polêr en bevat slegs London-kragte en "soort los soort op" ✓ (3)

2.8 2.8.1 Bond energy is the energy needed to break one mole of its molecules into separate atoms.✓✓
Bindingsenergie is die energie benodig om een mol van sy molekule in aparte atome op te breek. ✓✓ (2)

2.8.2 The atomic size decreases in period (from C to F).
The bond length decreases the C to F atom. ✓
The shorter the bond length the more energy is needed to break them ✓
Die atomiesegrootte neem af in ŉ periode (vanaf C na F).
Die bindingslengte neem vanaf C na F atoom af. ✓
Hoe korter die bindinglengte hoe meer energie word benodig om dit te breek ✓ (2)

[25]

QUESTION/*VRAAG* 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk van ŉ stof gelyk aan die atmosferiese druk is. ✓✓ (2)

3.2 YES./ *JA* ✓

Only one independent variable / All variables are controlled except molecular mass ✓
Slegs een onafhanklike veranderlike / Alle veranderlike behalwe vir molekulêremassa is beheer ✓ (2)

3.3 Gas ✓ (1)

3.4
- The molecular mass increases from A to D ✓
- The strength of the London forces increases with an increase in the molecular size/mass. ✓
- More energy will be required to overcome the intermolecular forces from A to D ✓

- *Die molekulêre massa neem toe vanaf A to D*
- *Die sterkte van die London-kragte neem toe met ŉ toename in die molekulêremassa/grootte* ✓
- *Meer energie word benodig om die intermolekulêrekragte vanaf A tot D te oorkom* ✓

OR/*OF*

- The molecular mass decreases from D to A ✓
- The strength of the London forces decreases with decrease in molecular size/mass. ✓
- Less energy will be required to overcome the intermolecular forces from D to A ✓

- *Die molekulêre massa neem af vanaf D tot A* ✓
- *Die sterkte van die London-kragte neem af soos die molekulêremassa / grootte afneem* ✓
- *Minder energie word benodig om die intermolekulêrekragte vanaf D tot A te oorkom* ✓

(3)

3.5 Compound A / *Verbinding A* CH_4 ✓
It has the lowest boiling point / *Dit het die laagste kookpunt* ✓ (2)

3.6 3.6.1 Lower than / *Laer as* ✓ (1)

3.6.2
- HF has hydrogen bonds ✓
- HCℓ has dipole dipole forces ✓
- Hydrogen bonds are stronger than dipole dipole forces ✓
- More energy is needed to overcome intermolecular forces in HF ✓

- *HF het waterstofbinding*
- *HCℓ het dipool-dipoolkragte*
- Waterstofbinding is sterker as die dipool-dipoolkragte
- *Meer energie word benodig om die intermolekulêrekragte in HF te oorkom*

OR / *OF*

- HF has hydrogen bonds ✓
- HCℓ has dipole dipole forces ✓
- Dipole dipole forces is weaker than Hydrogen bonds ✓
- Less energy is needed to overcome intermolecular forces in HCℓ ✓

- *HF het waterstofbinding* ✓
- *HCℓ het dipool-dipoolkragte* ✓
- Dipool-dipoolkragte is swakker as die waterstofbinding ✓
Minder energie word benodig om die intermolekulêrekragte in HCℓ te oorkom ✓ (4)

[15]

QUESTION/*VRAAG* 4

4.1 Boyle's law ✓
The pressure of an enclosed gas is inversely proportional to the volume it occupies at constant temperature.✓✓

Boyle se wet ✓
Die druk van 'n ingeslote gas is omgekeerd eweredig aan die volume wat dit by konstante temperatuur beslaan. ✓✓ (3)

4.2

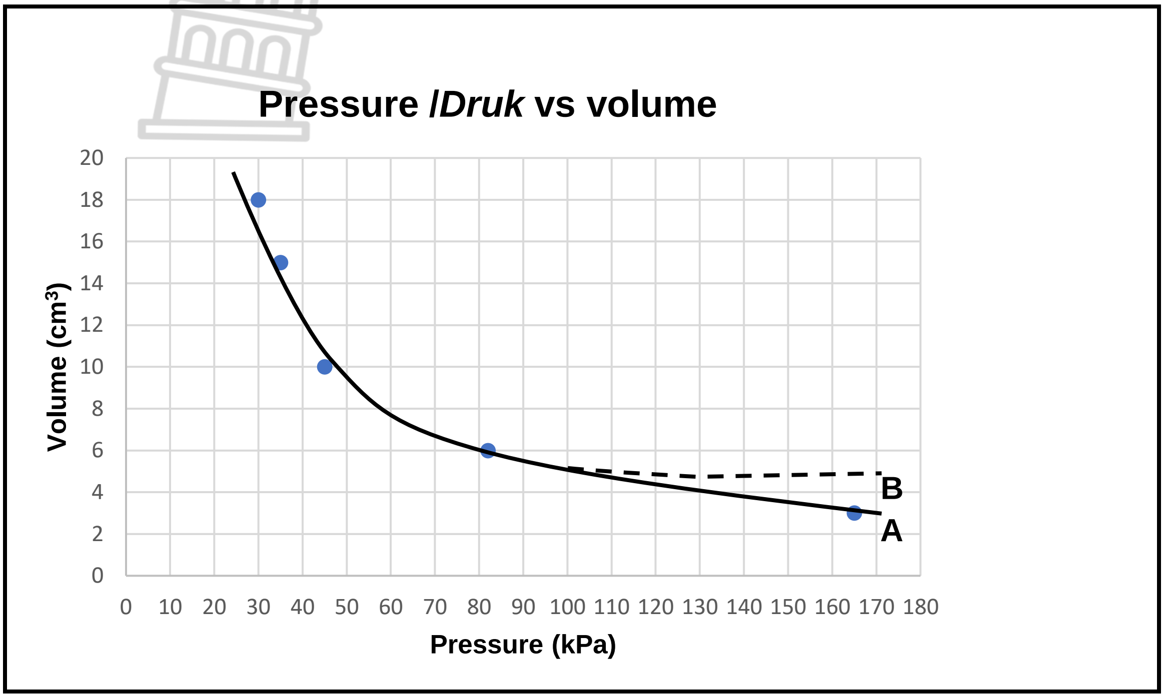
Criteria for hypothesis / *Nasienkriteria vir hipotese*
The independent and dependent variables are stated correctly ✓ *Die onafhanklike en afhanklike veranderlike korrek gestel* ✓
A Statement about the relationship between the independent and dependent variables ✓ *'n Stelling rondom die verwantskap tussen onafhanklike en afhanklike veranderlike* ✓

The higher the pressure of a gas the lower its volume ✓✓
Hoe hoër die druk van 'n gas hoe laer is sy volume ✓✓ (2)

4.3 40 x 10^3 Pa ✓ /4 KPa (1)

4.4 $p_1V_1 = p_2V_2$ ✓
(40 x 10^3) (12) ✓ = (200 x 10^3)V_2 ✓
V_2 = 2,4 cm^3 ✓
(Use any correct co-ordinates from the graph / *Gebruik enige korrekte koördinate vanaf die grafiek*) (4)

4.5 **Marking Criteria/ *Nasienkriteria***
Curve of **B** is higher than curve **A** at high pressure ✓✓
*Kurwe van **B** is hoër as die kurwe van **A** by hoë druk* ✓✓



(2)
[12]

QUESTION/*VRAAG* 5

5.1 The minimum energy needed to for a reaction to take place. ✓✓
Die minimum energie wat benodig word vir 'n reaksie om plaas te vind. ✓✓ (2)

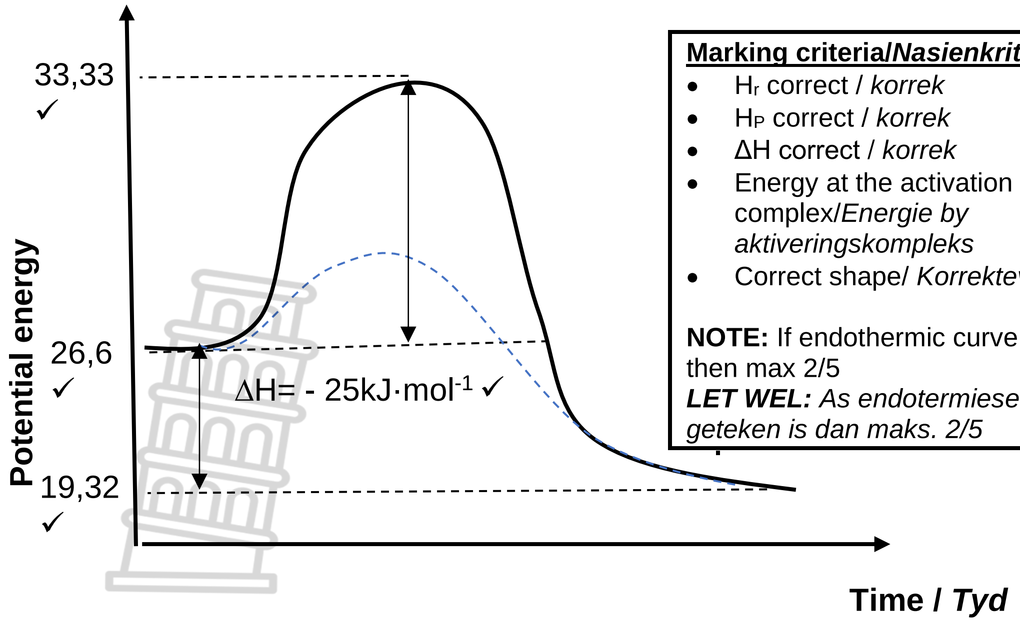
5.2 Exothermic / *Eksotermies*. ✓ ΔH < 0 ✓ (2)

5.3 $\Delta H = H_p - H_r$

$- 7,28 = H_p - 26,6$ ✓

$H_p = 19,32$ kJ·mol^{-1} ✓ (2)

5.4



Marking criteria/*Nasienkriteria*

- H_r correct / *korrek*
- H_P correct / *korrek*
- ΔH correct / *korrek*
- Energy at the activation complex/*Energie by aktiveringskompleks*
- Correct shape/ *Korrektevorm*

NOTE: If endothermic curve is drawn then max 2/5
LET WEL: *As endotermiese kurwe geteken is dan maks. 2/5*

(5)

5.5 **See sketch Question 5.4 / *Sien skets VRAAG 5.4***
Marking criteria / *Nasienkriteria*

- Curve start at the initial potential energy of reactants and end at the final potential energy of the products. / *Kurwe begin die aanvangs potensiële energie van die reaktanse en eindig by die finale potensiële energie van die produkte* ✓
- Curve peak is lower / *Kurwe piek is laer* ✓ (2)

[13]

QUESTION/*VRAAG* 6

6.1 6.1.1 The simplest whole number ratio of atoms in a compound. ✓✓
Die eenvoudigste heelgetal verhouding van atome in verbinding. ✓✓ (2)

6.1.2 P (58) + 13 (32) ✓ = 8 (44) + 10(18) ✓

P = 2 ✓ (3)

6.1.3 **OPTION 1: Using percentage composition/ *OPSIE 1: Gebruik die persentasie samestelling***

Mol C : Mol H

$\frac{82,76}{12}$ ✓ : $\frac{17,24}{1}$ ✓

6,90 : 17,24

1 : 2,5

2 : 5 ✓

Marking criteria/*Nasienkriteria*

- % C divide by M (C)
  % C gedeel deur M (C)
- % H divide by M (H)
  % H gedeel deur M(H)
- Simplest mole ratio
  Eenvoudigste molverhouding
- Ratio / *verhouding*
- Molecular formula
  Molekulêre formule

Empirical formula / *Empiriese formule* : C_2H_5

Formula mass / *Formule massa* = 2 (12) + 1(5) = 29

Ratio / *Verhouding* = 58 / 29 = 2 ✓

Molecular formula / *Molekulêre formule* = C_4H_{10} ✓

OPTION 2: Using conservation of mass/ *OPSIE 2 : Gebruik die behoud van massa*

Number of carbon reactants / *Aantal koolstowwe in reakstanse* = Number of carbon products / *Aantal koolstowwe in produkte*
2 C = 8 C ✓

C = 4
Number of hydrogens reactants/ *Aantal waterstofatome in reakstanse* = Number of hydrogens products / *Aantal waterstofatome in produkte*
2 H = 10 H_2 ✓

H = (10)(2) / 2 ✓

H = 10

✓ Both / *Beide*

Molecular formula / *Molekulêre formule* = C_4H_{10} ✓ (5)

6.2 6.2.1 Limiting reagent is a reactant that is completely used up in a chemical reaction. ✓✓
Die beperkende reagens is die stof wat volledig opgebruik word tydens 'n chemiese reaksie. ✓✓ (2)

6.2.2

$$n = \frac{m}{M} \checkmark$$

$$n = \frac{5}{106} \checkmark$$

n = 0,047 mol
n (HCℓ) = 2(0,047) ✓
n (HCℓ) = 0,094 mol ✓ (4)

6.2.3 n (Na_2CO_3) = n (CO_2) = 0,047 mol ✓

V = nV_m ✓

V = (0,047)(24,45) ✓

V = 1,149 dm^3 ✓ (4)

6.2.4

n (HCℓ) initial / *aanvangs* = 0,094 x 100 / 76 ✓= 0,124 mol	
$c = \frac{n}{V}$ ✓ $c = \frac{0,124}{0,1}$ ✓ $c = 1,24\ mol\cdot dm^{-3}$ ✓	$c = \frac{n}{V}$ ✓ $c = \frac{0,124}{0,25}$ $c = 0,496\ mol\cdot dm^{-3}$ $c_1V_1 = c_2V_2$ $(0,496)(250) = c_2(100)$ ✓ $c_2 = 1,24\ mol\cdot dm^{-3}$ ✓

(4)

[24]

QUESTION/*VRAAG* 7

7.1 7.1.1 Au Acid is a substance that produces hydrogen ions (H^+)/ hydronium ions (H_3O^+) when it dissolves in water. ✓✓
'n Suur is 'n stof wat waterstofione (H^+)/ hidroniumione (H_3O^+) vorm wanneer dit in water oplos. ✓✓ (2)

7.1.2 H_2O ✓ and/ *en* HCO_3^- ✓ (2)

7.1.3 H_2CO_3 ✓and/ *en* H_3O^+ ✓ (2)

7.1.4 $H_2CO_3 + 2\ NaOH$ ✓ → $Na_2CO_3 + 2\ H_2O$ ✓ (✓ bal) (3)

7.2 7.2.1

OPTION 1/ *OPSIE 1*	**OPTION 2 / *OPSIE 2***
$c = \frac{m}{MV}$ ✓ $c = \frac{2}{(40)(0,1)}$ ✓ $c = 0,5\ mol\cdot dm^{-3}$ ✓	$n = \frac{m}{M}$ $n = \frac{2}{40}$ $n = 0,05$ $c = \frac{n}{V}$ ✓ $c = \frac{0,05}{0,1}$ ✓ $c = 0,5\ mol\cdot dm^{-3}$ ✓

(3)

7.2.2

OPTION 1 / *OPSIE 1*	**OPTION 1 / *OPSIE 1***
NaOH → Na^+ + OH^- [NaOH] = [OH^-] [OH^-] = 0,5 mol·dm^{-3} [OH^-][H_3O^+] = 1 x 10^{-14} [H_3O^+] (0,5) = 1 x 10 $^{-14}$ ✓ [H_3O^+] = 2 x 10 $^{-14}$ mol·dm^{-3} pH = - log[H_3O^+] ✓ = - log (2 x 10^{-14}) ✓ = 13,70 ✓	pOH = -= log [OH^-] pOH = -log(0,5) ✓ pOH = 0,30 pH +pOH = 14 ✓ pH + 0,30 = 14 ✓ pH = 13,70 ✓

(4)

7.3 7.3.1

$n = \frac{N}{N_A}$ ✓

$= \frac{9,033 \times 10^{22}}{6,02 \times 10^{23}}$ ✓

n = 0,15 mol ✓ (3)

7.3.2 **Positive marking from QUESTION 7.3.1/ *Positiewe nasien vanaf VRAAG 7.3.1***

Marking criteria / *Nasienkriteria*

- Formula / Formule c = n/V
- Subst. of NaOH values into / *Vervang waardes van NaOH in* n = cV
- **Using** mol ratio/ ***Gebruik*** *die molverhouding* HCℓ : NaOH = 1 : 1
- Determine the mol of HCℓ in reaction 1 / *Bepaal die mol HCℓ in reaksie 1*
- **Using** ratio / ***Gebruik*** *die molverhouding* HCℓ : $MgCO_3$ = 2 : 1
- Subst. into / *Vervang in* m = nM
- Subst. into percentage formula / *Vervang in persentasie formule*
- Final answer / *Finale antwoord*

n (NaOH) = cV ✓

n (NaOH = $0,8 \times \frac{55}{1\,000}$ ✓

n = 0,044 mol

NaOH : HCℓ
1 : 1

n(HCℓ) excess = 0,044 mol ✓

n(HCℓ) reaction 1 = n(HCℓ) initial – n(HCℓ) excess
= 0,15 – 0,044 ✓
= 0,106 mol

HCℓ : $MgCO_3$
2 : 1
0,106 : $n(MgCO_3)$ = 0,053 mol ✓

m = nM
= 0,053 x 84 ✓
= 4,452 g

$\% \text{ purity} = \frac{\text{pure mass}}{\text{Sample mass}} \times 100\%$

$= \frac{4,452}{5} \times 100\ \%$ ✓

= 89,04 % ✓ (8)

[27]

QUESTION/*VRAAG* 8

8.1 8.1.1 A redox is a reaction that involves an electron transfer. ✓✓
ʼn Redoksreaksie is ʼn reaksie wat ʼn elektronoordrag behels. ✓✓

OR / *OF*

It is a reaction that always involve changes in oxidation numbers. ✓✓
Dit is ʼn reaskie wat altyd ʼn verandering in oksidasiegetalle behels. ✓✓ (2)

8.1.2 Ni^{2+} ✓

Oxidation number decreases from +2 to 0. ✓✓
Die oksidasiegetal neem af vanaf +2 na 0. ✓✓ (3)

8.1.3 Nitrate ion (NO_3^-) is spectator ion / undergoes no changes in its oxidation state. ✓
Nitraatioon (NO_3^-) is ʼn toeskouerioon/ ondergaan geen verandering in sy oksidasiegetal (1)

8.2 8.2.1 $Cr_2O_7^{2-}$
$2x + 7(-2) = -2$ ✓
$x = +6$ ✓ (2)

8.2.2 $Cr_2O_7^{2-} + 14\ H^+ + 6e^- \rightarrow 2\ Cr^{3+} + 7\ H_2O$ ✓✓ (2)

8.2.3 $Sn^{2+} \rightarrow Sn^{4+} + 2e^-$ ✓
$Cr_2O_7^{2-} + 14\ H^+ + 6e^- \rightarrow 2\ Cr^{3+} + 7\ H_2O$
$3\ Sn^{2+} + Cr_2O_7^{2-} + 14\ H^+$ ✓ $\rightarrow 3Sn^{4+} + 2\ Cr^{3+} + 7\ H_2O$ ✓ (✓ bal) (4)

[14]

TOTAL/*TOTAAL:* 150