Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 11

NOVEMBER 2019

PHYSICAL SCIENCES P2 (CHEMISTRY) (EXEMPLAR)

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages, including 4 datasheets.

INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.

2. This question paper consists of TEN 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 bonds below will have the SHORTEST bond length?

A C – O

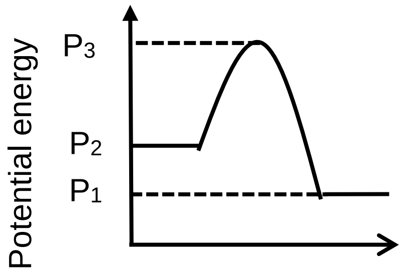
B C – N

C C – F

D C – Br (2)

1.2 When sulphuric acid reacts with water, the temperature of the reaction mixture increases.

Which ONE of the following correctly describes the heat of the reaction (ΔH) between sulphuric acid and water from the graph below?



A $P_3 – P_2$

B $P_1 – P_2$

C $P_3 – P_1$

D $P_2 – P_1$ (2)

1.3 Substance **P** is soluble in substance **R**.

Which ONE of the following most likely represents **P** and **R**?

	P	**R**
A	HCℓ	$CCℓ_4$
B	HCℓ	H_2O
C	NaCℓ	$CCℓ_4$
D	I_2	H_2O

(2)

1.4 The boiling points of three compounds are given in the table shown below.

Compound	Boiling point (K)
$C\ell_2$	238
Br_2	332
I_2	457

The increase in boiling point from top to bottom of the table is due to an increase in the strength of …

A London forces.

B ion-dipole forces.

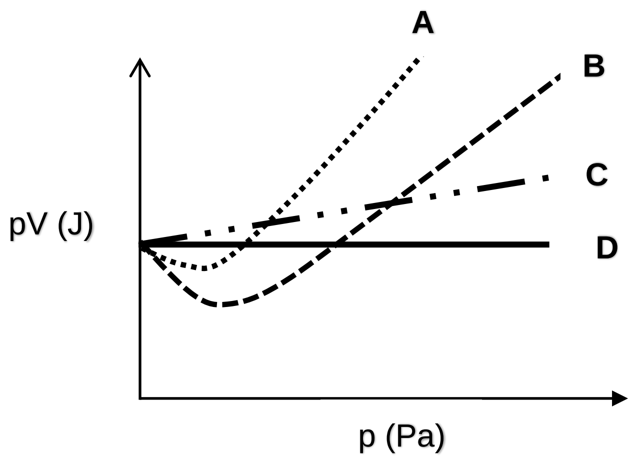
C dipole-dipole forces.

D hydrogen bonds. (2)

1.5 The pV vs p sketch graphs for four gases, He, CO, CH_4, and an ideal gas are shown below.

Which sketch graph CORRECTLY shows the pV vs p relationship for He?

SKETCH GRAPHS OF pV vs p VALUES



(2)

1.6 Consider the following acid-base reaction.

$$HC\ell + NH_3 \rightarrow NH_4^+ + C\ell^-$$

Which pair of substances represents a conjugate acid-base pair?

A $HC\ell$ and NH_3

B NH_4^+ and $C\ell^-$

C $HC\ell$ and $C\ell^-$

D $HC\ell$ and NH_4^+ (2)

1.7 Which ONE of the quantities given below is defined as follows?

A measure of the average kinetic energy of gas particles.

A Volume

B Enthalpy

C Pressure

D Temperature (2)

1.8 5 grams of each of the salts given below is completely dissolved in water to make 100 cm^3 of solution at 30 ˚C.

Which salt solution will have the highest concentration of sodium ions (Na^+)?

A $NaC\ell(aq)$

B $Na_2CO_3(aq)$

C $Na_2SO_4(aq)$

D $NaHCO_3(aq)$ (2)

1.9 Consider the following redox reaction:

$$Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$$

Electrons are transferred from …

A $Zn_{(s)}$ to $Zn^{2+}_{(aq)}$.

B $Cu^{2+}_{(aq)}$ to $Cu_{(s)}$.

C $Zn_{(s)}$ to $Cu^{2+}_{(aq)}$.

D $Zn^{2+}_{(aq)}$ to $Cu_{(s)}$. (2)

1.10 The oxidation number of sulphur (S) in HSO_4^- is …

A -2.

B +6.

C +1.

D +4. (2)

[20]

QUESTION 2 (Start on a new page.)

Study the molecules given below and answer the questions that follow.

$CC\ell_4$, NH_3, HCN, H_2S and OF_2

2.1 Define the term *molecule*. (2)

2.2 Use the VSERP model to predict the molecular geometry of the following:

2.2.1 $CC\ell_4$ (1)

2.2.2 NH_3 (1)

2.3 Draw the Lewis structures for the following molecules:

2.3.1 OF_2 (2)

2.3.2 HCN (2)

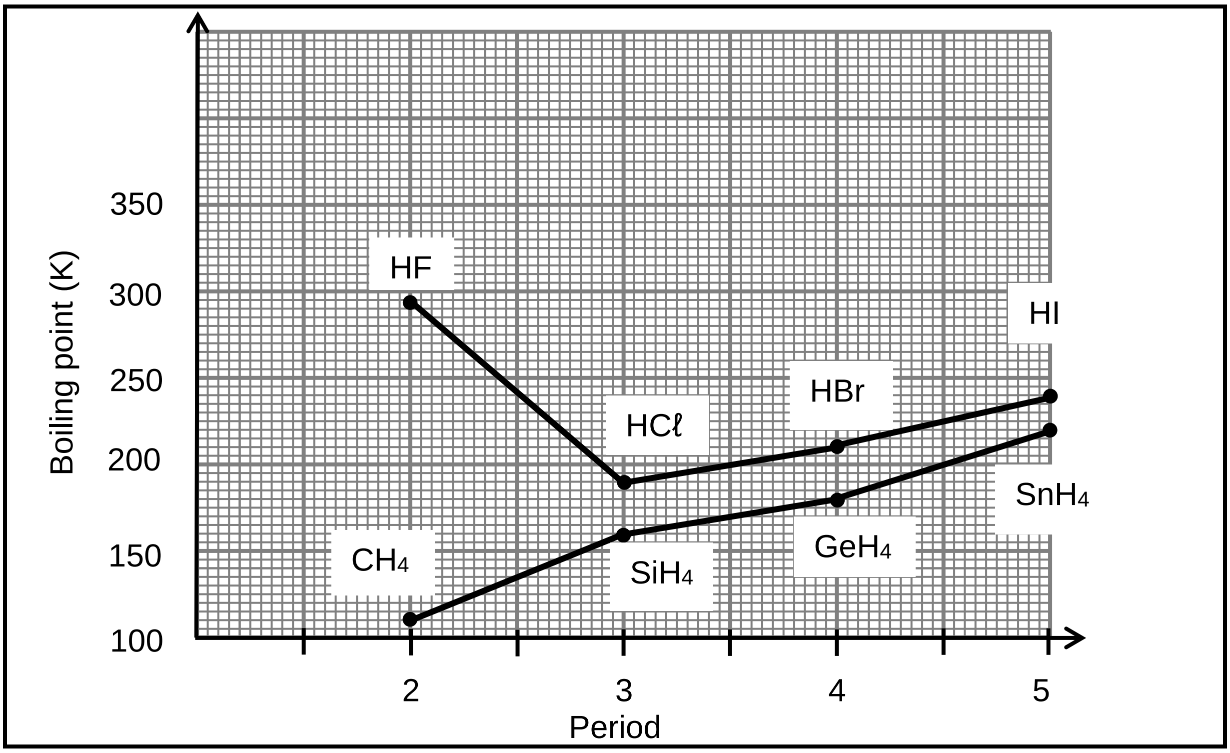
2.4 Explain why it is possible for NH_3 to form a dative covalent bond with H^+ but it is not possible for $CC\ell_4$ to form a dative covalent bond with H^+. (2)

2.5 Is the H_2S molecule POLAR or NON-POLAR? Explain the answer. (4)

[14]

QUESTION 3 (Start on a new page.)

The boiling points of the hydrogen halides and group 4 hydrogen compounds are compared in the graph below.



3.1 Define *boiling point*. (2)

3.2 Write down the boiling point of HCℓ. (1)

3.3 Explain why the boiling points of the hydrogen halides are higher than those of corresponding group 4 hydrides from period 3 to 5, by referring to the type of intermolecular forces present in these compounds and energy involved. (4)

HF is the halide with the HIGHEST boiling point.

3.4 Write down the name of the intermolecular force present in HF responsible for the high boiling point. (2)

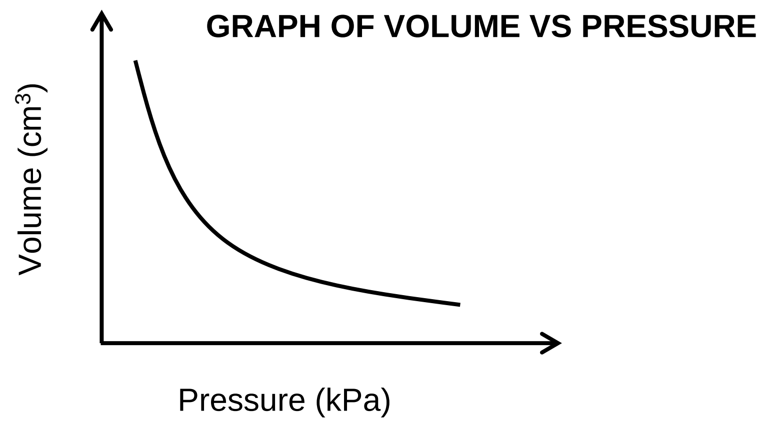
3.5 Which one of HBr and GeH_4 will have the highest vapour pressure? Give a reason for the answer by referring to data in the graph. (2)

[11]

QUESTION 4 (Start on a new page.)

4.1 An experiment was conducted to investigate the relationship between pressure and volume of a fixed gas at a constant temperature of 20,5 °C.

The following graph was obtained from the results.



4.1.1 Write down the name of the law which formulates the pressure-volume relationship shown by the graph. (1)

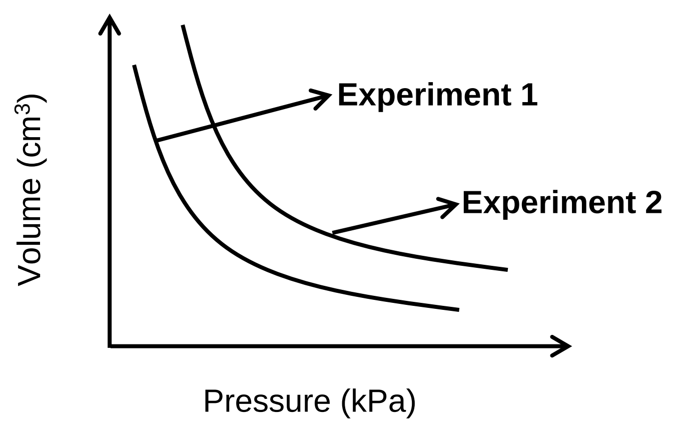
For the investigation write down the:

4.1.2 Investigative question (2)

4.1.3 Controlled variable (1)

4.1.4 Explanation for the relationship between pressure and volume as shown by the graph using the Kinetic Molecular Theory. (3)

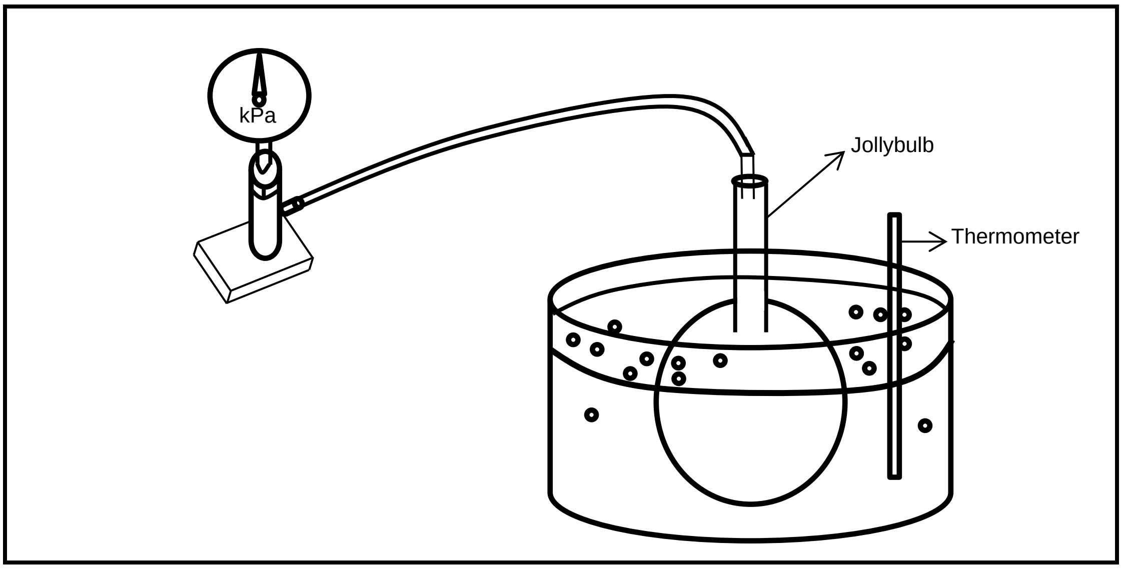
4.2 The experiment is repeated at a different temperature. The results of the experiment are plotted on the same axis.



4.2.1 Which experiment (**1** or **2**) was carried out at a HIGHER temperature? Explain your answer. (3)

4.2.2 Give a reason why real gases deviate from ideal gas behaviour at high pressure. (2)

4.3 The diagram below shows the apparatus that is used to demonstrate the relationship between pressure and temperature at constant volume.



A certain gas is trapped inside the Jolly bulb. At temperature 25 ˚C the gas exerts a pressure of 101 kPa. The water-bath is then heated to a temperature of 60 ˚C.

4.3.1 Write down the name of the law which is studied using the above apparatus. (1)

4.3.2 Calculate the reading on the pressure gauge at 60 ˚C. (4)

The water-bath is heated to temperatures higher than 60 ˚C.

It is observed that after some time, while the water-bath is being heated, the reading on the pressure gauge remains constant.

4.3.3 At what temperature is the water in the water-bath when the reading on the pressure gauge remains constant? (1)

[18]

QUESTION 5 (Start on a new page.)

In 1783 Jacques Charles filled an air-balloon with 2 600 g of diatomic gas **X**. The pressure of the gas was 100×10^3 Pa at a temperature of 23 ˚C and it occupied a volume of 31,98 m^3.

5.1 Give the term for a gas that obeys the general gas equation pV = kT under all pressure and temperature conditions. (1)

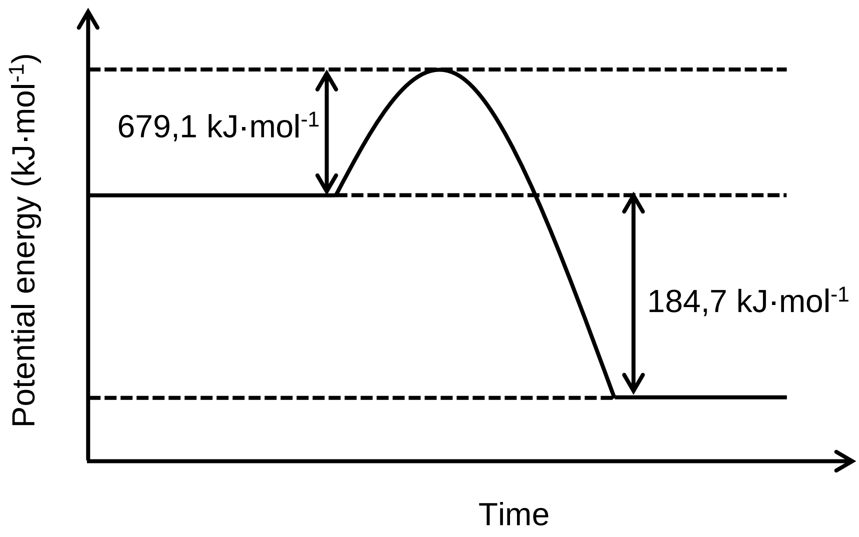
5.2 Determine, by calculation, the FORMULA of the gas. (7)

[8]

QUESTION 6 (Start on a new page.)

The diagram shows the potential energy changes during the following chemical reaction:

$$2\,H_{2\,(g)} + C\ell_{2\,(g)} \rightarrow 2\,HC\ell_{\,(g)}$$



6.1 Define *activation energy.* (2)

6.2 Is the reaction EXOTHERMIC or ENDOTHERMIC?

Give a reason for the answer. (2)

6.3 What is the total bond energy (H_2 and $C\ell_2$) of the reactants?
Give a reason for the answer. (3)

6.4 Determine the energy released by the bond formation of the HCℓ molecule. (3)

6.5 What effect will the addition of a catalyst have on the value 184,7 $kJ \cdot mol^{-1}$?

Write down only INCREASE, DECREASE or NO EFFECT.

Give a reason for the answer. (2)
[12]

QUESTION 7 (Start on a new page.)

7.1 The chemical composition of a particular compound is:

11,79% Carbon
69,57% Chlorine
18,64% Fluorine

The molar mass of the compound is 204 $g \cdot mol^{-1}$.

Determine, by calculations, the molecular formula of the compound. (7)

7.2 When heated, lithium reacts with nitrogen to form lithium nitride.

The balanced equation: $6\ Li_{(s)} + N_{2\ (g)} \rightarrow 2\ Li_3N_{(s)}$

12,3 g of lithium is heated with 33,6 g of N_2.

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

7.2.2 Determine by calculation which substance is the limiting reagent. (6)

The actual yield of Li_3N in the above reaction is 5,89 g.

7.2.3 Calculate the percentage yield of Li_3N. (5)
[20]

QUESTION 8 (Start on a new page.)

8.1 Sulphuric acid (H_2SO_4) can react with water through a multistep reaction. The two reactions below show the multistep reaction.

(I) $H_2SO_{4\ (aq)} + H_2O_{(\ell)} \rightleftharpoons HSO_4^-{}_{(aq)} + H_3O^+{}_{(aq)}$

(II) $HSO_4^-{}_{(aq)} + H_2O_{(\ell)} \rightleftharpoons SO_4^{2-}{}_{(aq)} + H_3O^+{}_{(aq)}$

8.1.1 Define an *acid* according to the Lowry-Bronsted model. (2)

8.1.2 Is water acting as a base or an acid in reactions **I** and **II**?

Give a reason for the answer. (2)

8.1.3 Write down the chemical formula of the substance that acts as an ampholyte in the above reactions. (2)

8.1.4 Write down a balanced chemical equation for the reaction between sulphuric acid and sodium hydrogen carbonate. (3)

8.2 An eggshell contains calcium carbonate ($CaCO_3$) and impurities.

An EXCESS amount of a standard dilute acetic acid solution (CH_3COOH) of concentration 0,5 mol·dm^{-3} and volume 250 cm^3 is allowed to react COMPLETELY with an eggshell of mass 56 g.

The equation for the reaction is given by the balanced equation shown below:

$$2\ CH_3COOH_{(aq)} + CaCO_{3\ (s)} \rightarrow Ca(CH_3COO)_{2\ (aq)} + H_2O_{(\ell)} + CO_{2\ (g)}$$

The acetic acid that remained unreacted is neutralised by 25 cm^3 of sodium hydroxide (NaOH) with a concentration of 0,968 mol·dm^{-3} .

The equation for the reaction is given by the balanced equation below:

$$CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(\ell)}$$

8.2.1 Define a *standard solution*. (2)

8.2.2 Calculate the percentage of calcium carbonate ($CaCO_3$) in the egg shell. (10)

[21]

QUESTION 9 (Start on a new page.)

The reaction between magnesium metal and hydrochloric acid is an example of a redox reaction. The balanced equation is:

$$Mg_{(s)} + 2\ HC\ell_{(aq)} \rightarrow MgC\ell_{2\ (aq)} + H_{2\ (g)}$$

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

9.2 Write down the FORMULA or SYMBOL of a substance whose oxidation number does NOT CHANGE during the reaction. (2)

9.3 Write down the symbol of the reducing agent. Explain the answer in terms of oxidation numbers. (3)

9.4 Write down the balanced reduction-half reaction. (2)

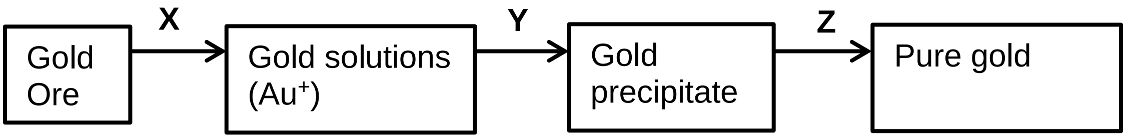
In another redox reaction Fe^{2+} is oxidised to Fe^{3+} ions by dichromate ions ($Cr_2O_7^{2-}$) in an acidic medium. The dichromate ions ($Cr_2O_7^{2-}$) are reduced to Cr^{3+} ions.

9.5 Write down the balanced equation for the net redox reaction by using the ion-electron method. (Show ALL steps in the balancing of the equation.) (7)

[16]

QUESTION 10 (Start on a new page.)

The flow diagram below shows the purification process of gold in the mining industry.



10.1 Give the name of the location in South Africa where the gold-rich ore is mined. (1)

The reaction for process **X** is:

$$4\ Au + 8\ NaCN + O_2 + 2\ H_2O \rightarrow 4\ NaAu(CN)_2 + 4\ NaOH$$

10.2 Classify the above reaction as REDOX, ACID-BASE or PRECIPITATION reaction.

Give a reason for the answer in terms of oxidation numbers. (2)

10.3 Write down the name of the metal used in process **Y** in the recovery of gold. (2)

Process **Y** is out-dated and the metal named in QUESTION 10.3 is replaced in the modern recovery method of gold.

10.4 Write down the name of the new substance used in process **Y**. (2)

10.5 Why is an extremely (very) high temperature needed in process **Z**? (3)

[10]

TOTAL: 150

NATIONAL SENIOR CERTIFICATE
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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*

NAAM/*NAME*	SIMBOOL/*SYMBOL*	WAARDE/*VALUE*
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^+] $K_w = [H_3O^+][OH^-] = 1x10^{-14}$ at /by 298K

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$

$E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$

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

KEY/ *SLEUTEL*

Elektronegatiwiteit Electronegativity	*Atoomgetal* Atomic number	*Simbool* Symbol	*Benaderde relatiewe atoommassa* Approximate relative atomic mass
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)
2,1 1 H 1																	2 He 4
1,0 3 Li 7	1,5 4 Be 9											2.0 5 B 11	2.5 6 C 12	3.0 7 N 14	3.5 8 O 16	4.0 9 F 19	10 Ne 20
0,9 11 Na 23	1,2 12 Mg 24											1.5 13 Aℓ 27	1.8 14 Si 28	2.1 15 P 31	2.5 16 S 32	3.0 17 Cℓ 35,5	18 Ar 40
0,8 19 K 39	1,0 20 Ca 40	1,3 21 Sc 45	1,5 22 Ti 48	1,6 23 V 51	1,6 24 Cr 52	1,5 25 Mn 55	1,8 26 Fe 56	1,8 27 Co 59	1,8 28 Ni 59	1,9 29 Cu 63,5	1,6 30 Zn 65	1,6 31 Ga 70	1,8 32 Ge 73	2,0 33 As 75	2,4 34 Se 79	2,8 35 Br 80	36 Kr 84
0,8 37 Rb 86	1,0 38 Sr 88	1,2 39 Y 89	1,4 40 Zr 91	41 Nb 92	1,8 42 Mo 96	1,9 43 Tc	2,2 44 Ru 101	2,2 45 Rh 103	2,2 46 Pd 106	1,9 47 Ag 108	1,7 48 Cd 112	1,7 49 In 115	1,8 50 Sn 119	1,9 51 Sb 122	2,1 52 Te 128	2,5 53 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 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

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
$Ca^{2+} + 2e^-$	⇌	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

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

Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE/
NASIONALE SENIOR
SERTIFIKAAT

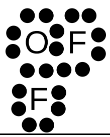
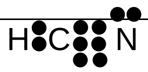
GRADE/*GRAAD* 11

NOVEMBER 2019

PHYSICAL SCIENCES P2
FISIESE WETENSKAPPE V2
(CHEMISTRY/*CHEMIE*)
MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: **150**

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

QUESTION 1 / *VRAAG* 1		
1.1	C ✓✓	(2)
1.2	B ✓✓	(2)
1.3	B ✓✓	(2)
1.4	A ✓✓	(2)
1.5	C ✓✓	(2)
1.6	C ✓✓	(2)
1.7	D ✓✓	(2)
1.8	B ✓✓	(2)
1.9	C ✓✓	(2)
1.10	B ✓✓	(2)
		[20]
QUESTION 2 / *VRAAG* 2		
2.1	A group of two or more atoms covalently bonded and it functions as a unit. ✓✓ *'n Groep van twee of meer atome wat kovalent gebind en as 'n eenheid funksioneer.*	(2)
2.2.1	Tetrahedral ✓ *Tetraëdries*	(1)
2.2.2	Trigonal bipyramidal ✓ *Trigonaal bipiramidaal*	(1)
2.3.1	 ✓✓	(2)
2.3.2	 ✓✓	(2)
2.4	The nitrogen (N) atom in NH_3 contains a lone pair electrons. ✓ No lone pair in $CCℓ_4$. Nitrogen (N) atom in NH_3 can donate its lone pair into the vacant orbital of H^+✓ *Die stikstof (N) atoom in NH_3 bevat 'n alleenpaar elektrone.* *Geen enkelpaar elektrone in $CCℓ_4$ nie* *Stikstof (N) atoom in NH_3 kan sy alleenpaar elektrone in die vakante wentelbaan van H^+ skenk*	(2)

2.5	Polar. ✓ • Sulphur atoms more electronegative than the hydrogen atom • Sulphur atom pulls the bonding electrons more towards itself. } ✓ • (The change in electronegative is 2,5 – 2,1 = 0,4) • The sulphur atom has a partial negative charge and hydrogen atom has a partial positive charge. ✓ • The H_2S molecule has an asymmetrical bent/angular shape. ✓ *Polêr.* • *Swawelatome is meer elektronegatief as die waterstofatoom* • *Swawelatoom trek die bindingselektrone meer na hom toe.* • *(Die verskil in elektronegatief is 2,5 – 2,1 = 0,4)* • *Die swawelatoom het 'n gedeeltelik negatiewe lading en waterstofatoom het 'n gedeeltelik positiewe lading.* • *Die H_2S-molekule het 'n asimmetriese buiging / hoekige vorm.*	(4)
		[14]
QUESTION 3/*VRAAG 3*		
3.1	The temperature at which the vapour pressure of a liquid is equal to the external (atmospheric) pressure. ✓✓ *Die temperatuur waarteen die dampdruk van 'n vloeistof gelyk is aan die eksterne (atmosferiese) druk.*	(2)
3.2	Boiling point. Accept answers in the range (180 to 190) ✓ (K) *Kookpunt. Aanvaar antwoorde tussen (180 tot 190) (K)*	(1)
3.3	• Group 4 hydrogen hydrides have London /dispersion/induced-dipole forces ✓ • Hydrogen halides have dipole-dipole forces ✓ • The dipole-dipole forces are stronger than the London/dispersion/induced-dipole forces ✓ • More energy will be required to overcome the dipole-dipole/ intermolecular forces in hydrogen halides ✓ • *Groep 4 waterstofhidriede het London-/ verspreiding / geïnduseerde-dipool kragte* • *Waterstofhaliede het dipool-dipool kragte* • *Die dipool-dipoolkragte is sterker as die London-/verspreidingskragte/ geïnduseerde-dipool kragte.* • *Meer energie sal benodig word om die dipool-dipool / intermolekulêre kragte in waterstofhaliede te oorkom*	(4)
3.4	HF has <u>hydrogen bonds</u> ✓✓ *HF het <u>waterstofbindings</u>*	(2)
3.5	GeH_4 ✓.It has a lower boiling point. ✓ *GeH_4 . Dit het die laagste kookpunt*	(2)
		[11]

QUESTION 4/*VRAAG 4*		
4.1.1	Boyle's (law /*wet*)	(1)
4.1.2	What effect will a (change in) pressure have on the volume of a fixed amount gas at constant temperature? ✓✓ *Watter effek sal 'n (verandering in) druk op die volume van 'n vasgestelde gas by konstante temperatuur hê?*	(2)
4.1.3	Temperature. ✓ *Accept* mass / number of moles of gas *Temperatuur. Aanvaar massa / aantal mol gas*	(1)
4.1.4	• According to the Kinetic Molecular Theory, the pressure exerted by a gas depends on the number of collisions per unit time per unit area. ✓ • The same number of particles in a smaller volume (area) leads to an increase in the number of collisions per unit volume (area) ✓ • The more collisions per unit volume (area) results in an increase in pressure. ✓ • *Volgens die Kinetiese Molekulêre Teorie hang die druk wat 'n gas uitoefen af van die aantal botsings per tydseenheid per eenheidsarea.* • *Dieselfde aantal deeltjies in 'n kleiner volume (oppervlakte) lei tot 'n toename in die aantal botsings per eenheid volume (oppervlakte)* • *Meer botsings per eenheid volume (oppervlakte) lei tot 'n toename in druk.*	(3)
4.2.1	**Experiment 2**. ✓ • The product of pressure and volume (pV) is higher for the same amount of gas. ✓ • $pV \propto T$ ✓ ***Eksperiment 2**.* • *Die produk van druk en volume (pV) is hoër vir dieselfde hoeveelheid gas.* • $pV \propto T$	(3)
4.2.2	• The intermolecular forces thus increase and the gas liquifies. ✓ • The volume becomes constant at extreme pressure. ✓ • *Die intermolekulêre kragte neem dus toe en die gas word 'n vloeistof.* • *Die volume word konstant by uiterste druk.*	(2)
4.3.1	Guy-Lussac (law/ *wet*) ✓	(1)

4.3.2	$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ ✓ $\frac{(101)}{(25+273)}$ ✓ $= \frac{p_2}{(60+273)}$ ✓ ($V_1 = V_2$) p_2 = 112,86 kPa ✓	(4)
4.3.3	100 ˚C✓ or/*of* 373 K	(1)
		[18]
QUESTION 5/*VRAAG 5*		
5.1	Ideal ✓ (gas) *Ideale (gas)*	(1)
5.2	pV = nRT ✓ $(100 \times 10^3)(31,98)$ ✓ = n (8,31)(23 + 273) ✓ n = 1300,12 mol M = m/n✓ M = (2600)/(1300,12) ✓ M = 2 $g \cdot mol^{-1}$ ✓ H_2 ✓	(7)
		[8]

QUESTION 6/*VRAAG 6*		
6.1	Minimum energy required to start a chemical reaction ✓✓ *Minimum energie benodig om ŉ chemiese reaksie te begin.*	(2)
6.2	Exothermic ✓ The total potential energy of the products is less than the total potential energy of the reactants. ✓ **OR** More energy is released than the energy taken in. **OR** The heat of the reaction is less than zero/negative. *Eksotermies* *Die totale potensiële energie van die produkte is minder as die totale potensiële energie van die reaktante* ***OF*** *Meer energie word vrygestel as die energie wat ingeneem word* ***OF*** *Die reaksiewarmte is minder as nul / negatief.*	(2)
6.3	679,1 $kJ\cdot mol^{-1}$ ✓ The energy needed to break all the bonds✓✓ / Activation energy *Die energie wat benodig word om al die bindings te breek / Aktiveringsenergie*	(3)
6.4	Bond formation/*Bindingsvorming* = 184,7 + 679,1✓ Bond formation/*Bindingsvorming* = 863,8 $kJ\cdot mol^{-1}$ 863,8 $kJ\cdot mol^{-1}$ is the energy released for two HCℓ molecules/*is die energie wat vrygestel word vir twee HCℓ- molekules* Bond energy for each/ *Bindingsenergie vir elke* HCℓ = 863,8 / 2 ✓ Bond energy for each/ *Bindingsenergie vir elke* HCℓ = 431,9 $kJ\cdot mol^{-1}$✓	(3)
6.5	No effect. ✓ Catalyst only has an effect on the activation energy and no effect on the heat of the reaction ✓ *Geen effek.* *Katalisator het slegs ŉ invloed op die aktiveringsenergie en het geen invloed op die hitte van die reaksie nie.*	(2)
		[12]

QUESTION 7/*VRAAG 7*		
7.1	**OPTION 1/ *OPSIE 1***	
	$n = \frac{m}{M}$✓ $n = \frac{11,79}{12}$✓ $n = 0,9825\ mol$ || $n = \frac{m}{M}$ $n = \frac{69,57}{35,5}$✓ $n = 1,9597\ mol$ || $n = \frac{m}{M}$ $n = \frac{18,64}{19}$✓ $n = 0,9811\ mol$	
	$\frac{0,9825}{0,9811} = \frac{1,9597}{0,9811} = \frac{0,9811}{0,9811}$✓ Ratio/*Verhouding* = 1:2:1 Empirical formula/ *Empiriese formule*: $CCℓ_2F$ Relative formula mass/ *Relatiewe formulemassa* = 12 +2(35,5) + 19 = 102 Ratio/*Verhouding* = 204/102 = 2✓ Molecular formula/ *Molekulêre formule*: $C_2Cℓ_4F_2$✓(Order of elements not important/ *Volgorde van elemente nie belangrik nie*)	
	OPTION 2/*OPSIE 2*	
	m(C) = $204 \times \frac{11,79}{100}$ ✓= 24,05 g m(Cℓ)= $204 \times \frac{69,57}{100}$ ✓= 141,92 g m(F) = $204 \times \frac{18,64}{100}$ ✓= 38,03 g n(C) = $\frac{24,05}{12}$ = 2 mol✓ n(Cℓ) = $\frac{141,92}{35,5}$ = 4 mol✓ n(F) = $\frac{38,03}{19}$ = 2 mol✓ Molecular formula/ *Molekulêre formule*: $C_2Cℓ_4F_2$✓ (Order of elements not important/*Volgorde van elemente nie belangrik nie*)	(7)
7.2.1	Limiting reagent is the substance that is completely used up during a chemical reaction ✓✓ *Die beperkende reagens is die stof wat tydens 'n chemiese reaksie volledig opgebruik word.*	(2)

7.2.2	$n(Li) = \frac{m}{M}$ ✓ $n(N_2) = \frac{m}{M}$ $n(Li) = \frac{12,3}{7}$ ✓ $n(N_2) = \frac{33,6}{28}$ ✓ $n(Li) = 1,76\ mol$ $n(N_2) = 1,20\ mol$	
	Stoichiometri ratio = $\frac{6\ mol\ Li}{1\ mol\ N_2}$ ✓ Available ratio = $\frac{1,76}{1,2} = \frac{1,47}{1}$ ✓ Therefore Li is limiting reagent ✓ *Daarom is Li die beperkende reagens* **OR** $n(N_2)$ required if ALL 1,76 mol of Li react. *n (N_2) benodig as AL 1,76 mol Li reageer* $n(N_2) = 1,76 \times \frac{1}{6} = 0,29\ mol$ ✓ required/*benodig* 1,2 mol is available ✓ *1,2 mol is beskikbaar* Therefore Li is the limiting reagent ✓ *Daarom is Li die beperkende reagens* **OR** n(Li) required if ALL 1,20 mol of N_2 react. $n(N_2) = 1,20 \times \frac{6}{1} = 7,2\ mol$ ✓ required/*benodig* Only 1,76 mol is available ✓ Therefore Li is the limiting reagent ✓ *Slegs 1,76 mol is beskikbaar* *Daarom is Li die beperkende reagens*	(6)
	Positive marking from 7.2.2/ *Positiewe nasien vanaf 7.2.2*	
7.2.3	Theoretical yield/*Teoretiese opbrengs* n(Li) : n (Li_3N) 6 : 2 ✓ $n(Li_3N) = 1,76 \times \frac{2}{6}$ ✓ $n(Li_3N)$ = 0,59 mol $n = \frac{m}{M}$ $0,59 = \frac{m}{35}$ ✓ m = 20,65 g %yield/*opbrengs* = $\frac{5,89}{20,65} \times 100\ \%$ ✓ %yield/ *opbrengs* = 28,52 % ✓	(5)
		[20]

QUESTION 8/*VRAAG 8*		
8.1.1	Acid is a substance that donates protons (H^+) *'n Suur is 'n stof wat protone (H^+) skenk*	(2)
8.1.2	Base. ✓ It <u>accepts protons</u> (H^+) in both reactions ✓ *Basis.* *Dit <u>aanvaar protone</u> (H^+) in albei reaksies*	(2)
8.1.3	HSO_4^-✓✓	(2)
8.1.4	H_2SO_4 + 2 $NaHCO_3$ ✓→ Na_2SO_4 + 2 H_2O + 2 CO_2 ✓ (✓ Balanced/ *Gebalanseerd*) *Accept/Aanvaar* H_2SO_4 + $NaHCO_3$ → $NaHSO_4$ + H_2O + CO_2	(3)
8.2.1	A standard solution is a solution of which the <u>concentration is</u> exactly <u>known</u>. ✓✓ *'n Standaardoplossing is 'n oplossing waarvan die <u>konsentrasie presies bekend is</u>.*	(2)
8.2.2	Reaction 2/ *Reaksie 2* n(NaOH) = cv ✓ n(NaOH) = (0,968)(0,025) ✓ n(NaOH) = 0,0242 mol Mole Ratio/*Verhouding* CH_3COOH : NaOH 1 : 1 n(CH_3COOH) = 0,0242 mol ✓ Original/*Oorspronlik* (CH_3COOH) n(CH_3COOH) = cv n(CH_3COOH) = (0,5)(0,25) ✓ n(CH_3COOH) =0,125 mol n(reacted) = 0,125-0,0242 ✓ n(reacted) = 0,1008 mol Reaction 1/*Reaksie* Mole Ratio CH_3COOH : $CaCO_3$ 2 : 1 ✓ n($CaCO_3$) = 0,1008/2✓ n($CaCO_3$) = 0,0504 mol m($CaCO_3$) = nM m($CaCO_3$) = (0,0504)(100) ✓ m($CaCO_3$) = 5,04 g % purity / *suiwerhede*= $\frac{5,04}{56} \times 100\%$ ✓ %purity/ *suiwerhede* = 9%✓	(10)
		[21]

QUESTION 9/*VRAAG 9*		
9.1	Oxidation is the loss in electrons ✓✓ *Oksidasie is die verlies in elektrone*	(2)
9.2	$C\ell^-$ ✓✓	(2)
9.3	Mg ✓ Mg oxidation number increases from 0 ✓ to +2 ✓ *Mg oksidasiegetal neem toe vanaf 0 na +2*	(3)
9.4	$2\ H^+_{(aq)} + 2\ e^- \rightarrow H_{2\ (g)}$ ✓✓	(2)
9.5	6✓ ($Fe^{2+} \rightarrow Fe^{3+} + e^-$) ✓ $14H^+$✓ + $Cr_2O_7^{2-}$ + $6e^-$ ✓→ $2\ Cr^{3+}$✓ + $7\ H_2O$ ✓ $6\ Fe^{2+} + 14\ H^+ + Cr_2O_7^{2-} \rightarrow 6\ Fe^{3+} + 2\ Cr^{3+} + 7\ H_2O$ ✓	
	Marking guideline/*Nasienriglyne* • Correct oxidation half reaction/ *Korrekte oksidasie-halfreaksie* • $7\ H_2O$ in the reduction half reaction/*reduksie-halfreaksie* • $14\ H^+$ in the reduction half reaction/*reduksie-halfreaksie* • $2\ Cr^{3+}$ balancing the Cr^{3+} ions/*Balansering van die Cr^{3+} ione* • $6e^-$ in reduction half reaction/ *reduksie-halfreaksie* • ×6 the oxidation half reaction/ *oksidasie-halfreaksie* • Correct final balanced equation/*Korrekte finale gebalanseerde vergelyking*	(7)
		[16]

QUESTION 10/*VRAAG 10*		
10.1	Witwatersrand ✓	(1)
10.2	Redox reaction ✓ Oxidation number of gold changes from 0 to +1 ✓ **OR** Oxidation number of oxygen decreases from 0 to -2. *Redoksreaksie* *Oksidasiegetal van goud verander vanaf 0 na +1* ***OF*** *Oksidasiegetal van suurstof verminder vanaf 0 to -2.*	(2)
10.3	Zinc ✓✓ *Sink*	(2)
10.4	Activated carbon ✓✓ *Geaktiveerde koolstof*	(2)
10.5	Process Z is the smelting process of gold. ✓ Gold has a very high boiling point. ✓ Large amount of energy is needed for gold to change state. ✓ *Proses Z is die smeltproses van goud.* *Goud het ŉ baie hoë kookpunt.* *ŉ Groot hoeveelheid energie is nodig om die fase van goud te verander.*	(3)
		[10]
	TOTAL/*TOTAAL:*	**150**