LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2: CHEMISTRY

SEPTEMBER 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages and 4 data sheets

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question at the top of 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

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

1.1 Which ONE of the following primary nutrients is mainly responsible for the production of healthy fruit in plants?

A Potassium
B Nitrogen
C Phosphorous
D Sulphur (2)

1.2 Which ONE of the following is a PRODUCT in ALL reactions of strong acids with strong bases?

A Na^+
B H_3O^+
C $C\ell^-$
D H_2O (2)

1.3 Which ONE of the following organic compounds is a FUNCTIONAL (group) isomer of butanoic acid?

A 2-methylpropanoic acid
B Methyl propanoate
C Ethyl propanoate
D 2-methylpropan-2-ol (2)

1.4 If a Table of Standard Reduction Potentials is compiled using magnesium as reference electrode, instead of using hydrogen(E^{θ}_{red} = 0, 00 V), what will the standard reduction potential, E^{θ}_{red} (V) of hydrogen be?

A 0,00 V
B - 2,36 V
C +2,36 V
D +1,18 V (2)

1.5 If base **P** is titrated against acid **Q**, the pH of the solution at the end point is 9.

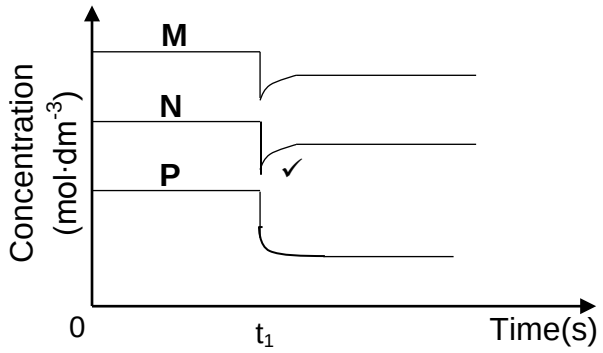
Which ONE of the following combinations CORRECTLY represents base **P** and acid **Q**?

	BASE P	**ACID Q**
A	KOH	HNO_3
B	$NaHCO_3$	HCℓ
C	NH_3	H_2SO_4
D	NaOH	CH_3COOH

(2)

1.6 Three unknown gases, **M**, **N** and **P** are present in a mixture at equilibrium.

At t_1, a change is made to the equilibrium mixture as shown in the graph below.



Which ONE of the following equations can represent the reaction that takes place?

A $2M(g) \rightleftharpoons N(g) + P(g)$
B $M(g) \rightleftharpoons N(g) + P(g)$
C $M(g) + N(g) \rightleftharpoons P(g)$
D $M(g) + N(g) \rightleftharpoons 2P(g)$

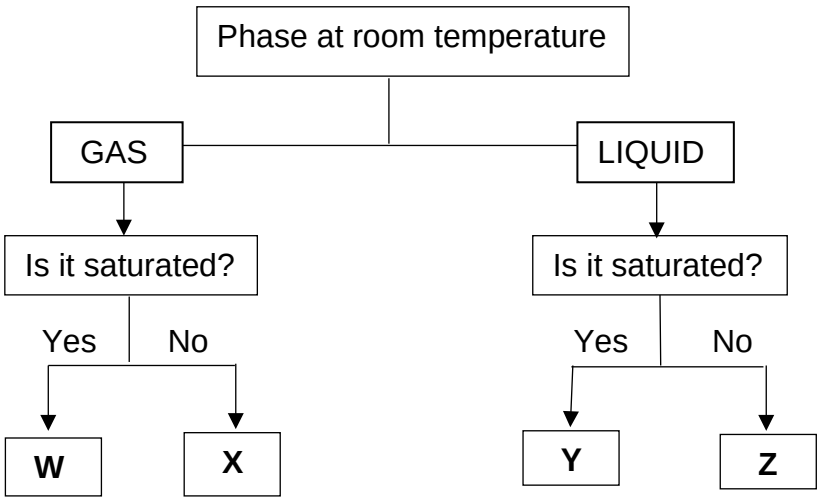
(2)

1.7 Which ONE of the following organic compounds has the LOWEST vapour pressure?

A Ethanoic acid
B Ethanal
C Ethanol
D Chloromethane

(2)

1.8 Consider the diagram below.



Which ONE of the following letters can represent PROPANE?

A W
B X
C Y
D Z

(2)

1.9 Which ONE of the following CORRECTLY describes the effect of a increase in temperature on a reaction at equilibrium?

	REACTION FAVOURED	**REACTION RATE**
A	Exothermic	Increases
B	Endothermic	Decreases
C	Endothermic	Increases
D	Exothermic	Decreases

(2)

1.10 During a demonstration, a chemistry professor wants to electroplate a nickel coin with copper.

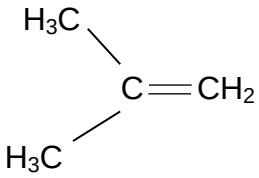
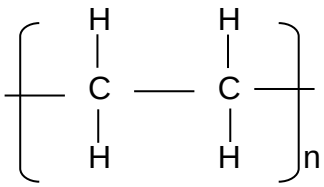
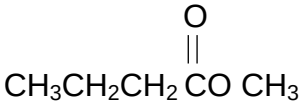
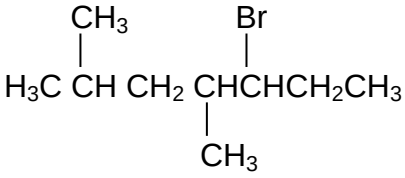
Which ONE of the following actions will produce the desired result?

A The electrolyte must contain nickel ions.
B The nickel coin must be the cathode.
C The cathode must be made of copper.
D Electrons must flow from the nickel coin.

(2)
[20]

QUESTION 2 (Start on a New Page)

The letters **A** to **E** in the table below represent six organic compounds.

A		**B**	
C		**D**	$CH_3CH_2CO_2H$
E			

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

2.1 Write down the:

2.1.1 Homologous series to which compound **C** belongs (1)

2.1.2 Name of the functional group of compound **D** (1)

2.1.3 Letter that represents an UNSATURATED compound (1)

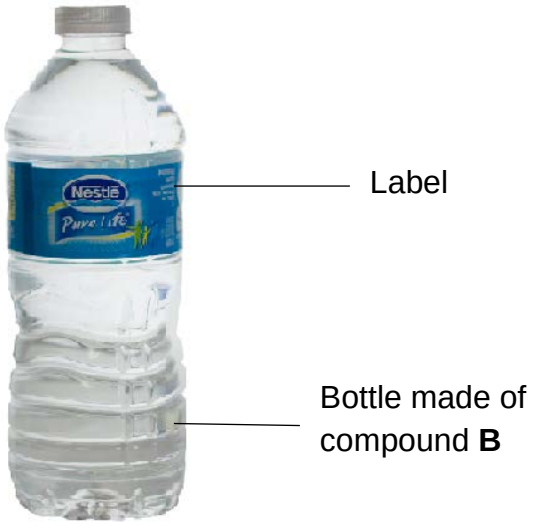
2.1.4 IUPAC name of compound **E** (3)

2.1.5 General formula of the homologous series to which compound **A** belongs (1)

2.1.6 STRUCTURAL FORMULA of the alcohol used in the preparation of compound **C** (2)

2.1.7 IUPAC name of compound **D** (1)

2.2 The diagram below shows a bottle of mineral water.



Compound **B** is a polymer.

Write down the:

2.2.1 NAME of compound **B** (1)

2.2.2 The type of polymerisation reaction that takes place during its formation (1)

2.2.3 Write down the empirical formula for:
(a) Its monomer (1)
(b) Compound **B** (1)
[14]

QUESTION 3 (Start on a new page)

The boiling points of compounds **A**, **B** and **C** from three different homologous series are determined under the same conditions.

The table below shows the results obtained during the practical investigation.

	COMPOUND	**MOLECULAR MASS ($g \cdot mol^{-1}$)**	**BOILING POINT($^{\circ}C$)**
A	$CH_3(CH_2)_2COOH$	88,1	163
B	$CH_3(CH_2)_3CH_2OH$	88,1	137
C	$CH_3(CH_2)_3CHO$	88,1	103

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

3.2 Write down the homologous series to which the FUNCTIONAL (group) isomer of compound **C** belongs. (1)

3.3 Write down the IUPAC name of compound **A**. (1)

3.4 FROM THE TABLE ABOVE, write down:

3.4.1 The dependent variable for this investigation (1)

3.4.2 ONE controlled variable (1)

3.5 Refer to the table and state the conclusion that can be drawn from the results obtained. (1)

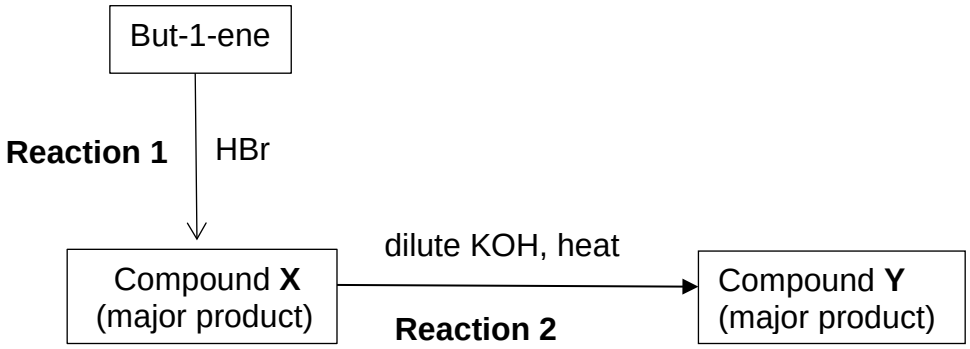
3.6 Refer to the TYPE and the STRENGTH of intermolecular forces to explain the difference in boiling points between compounds **A** and **B**. (3)

3.7 State the relationship between the strength of intermolecular forces and the vapour pressure of a substance. (1)

[11]

QUESTION 4 (Start on a New Page)

The flow diagram below shows how two organic compounds, **X** and **Y**, can be prepared with **but-1-ene** as the starting material.



4.1 For **reaction 1**, write down the:

4.1.1 Type of reaction that takes place (1)

4.1.2 balanced equation using *structural formulae* (4)

4.1.3 IUPAC name of compound **X** (2)

4.2 For **reaction 2**, write down the:

4.2.1 Type of reaction that takes place (1)

4.2.2 STRUCTURAL FORMULA of compound **Y** (2)

4.2.3 IUPAC name of the positional isomer of compound **Y** (2)

Concentrated sulphuric acid is added to compound **Y** and the mixture is heated.

4.3 Write down the STRUCTURAL FORMULA of the major organic product formed. (2)

Reaction 2 is now repeated using concentrated KOH.

4.4 Write down the:

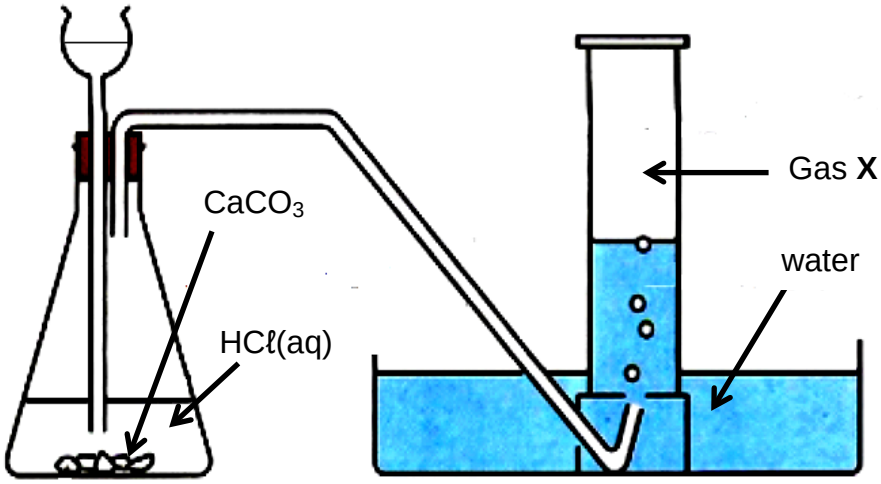
4.4.1 Homologous series to which the **major** product of this reaction belongs (1)

4.4.2 NAMES or FORMULAE of the INORGANIC products formed (2)

[17]

QUESTION 5 (Start on a New Page)

A group of grade 12 learners uses the reaction between calcium carbonate and hydrochloric acid to investigate one of the factors that influence reaction rate. They use the apparatus shown below.



The reaction that takes place is represented by the following chemical equation:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + \mathbf{X}(g) + H_2O(\ell) \quad \Delta H < 0$$

5.1 Identify the gas **X.** (2)

5.2 Two experiments are conducted by using the apparatus shown above.

The conditions for each experiment are given in the table below:

Experiment	**Mass of $CaCO_3(s)$ (g)**	**State of division of $CaCO_3(s)$**	**Concentration of HCℓ ($mol \cdot dm^{-3}$)**	**Temperature of HCℓ(aq) (°C)**
1	4	lumps	0,2	40
2	4	lumps	0,4	40

5.2.1 Define, in words, the term *reaction rate* by referring to the concentration of hydrochloric acid. (2)

5.2.2 FROM THE TABLE ABOVE, write down the independent variable for this investigation. (1)

5.2.3 Give a reason why the learners use equal masses and the same state of division of $CaCO_3(s)$. (1)

The learners observe that the reaction rate is HIGHER in **experiment 2** than in **experiment 1.**

5.2.4 Use the collision theory to explain this observation. (3)

5.2.5 Refer to **experiment 2** and calculate the volume of hydrochloric acid (in cm^3) that reacts with $CaCO_3(s)$. Assume that $CaCO_3$ is the LIMITING REAGENT. (4)

5.3 Sketch a POTENTIAL ENERGY versus REACTION COORDINATE graph for this reaction.

Label the axes and indicate the following on the graph:

- Heat of reaction
- Activation energy
- Activated complex

(4)
[17]

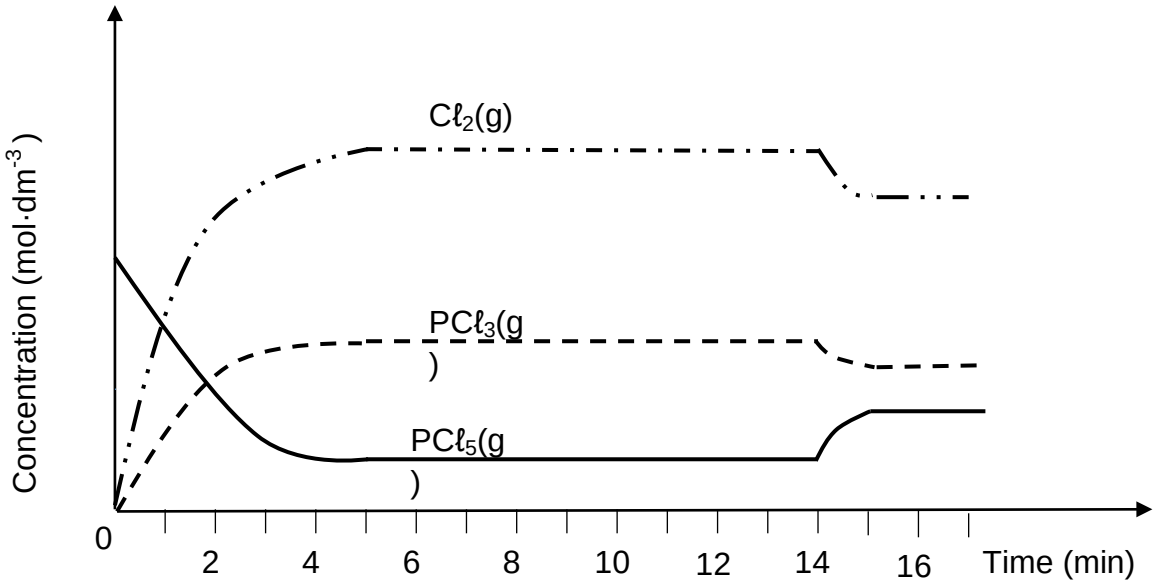
QUESTION 6 (Start on a New Page)

A company uses the decomposition of phosphorus pentachloride, $PC\ell_5(g)$, at 200 °C to produce phosphorous trichloride, $PC\ell_3(g)$.

The reaction which takes place in a sealed container is represented by the balanced equation below:

$$PC\ell_5(g) \rightleftharpoons PC\ell_3(g) + C\ell_2(g)$$

The results of the adjustments are shown in the graph below.



6.1 How much time was required for the system to come to chemical equilibrium for the FIRST time? (1)

6.2 How does the rate of the FORWARD reaction compare to that of the REVERSE reaction during the following time intervals:
(Choose from GREATER THAN, EQUAL TO or LESS THAN)

6.2.1 0,0 – 2,0 minutes (1)

6.2.2 8,0 – 10,0 minutes (1)

6.3 Initially Phosphorus pentachloride, $PC\ell_5(g)$ of unknown mass *x* is injected into an empty 2 dm^3 container at 200°C. At equilibrium, it is found that the concentration of $PC\ell_5(g)$ is 0,15 $mol \cdot dm^{-3}$.
The K_c for this reaction at 200°C is 5,55.

Calculate the initial mass of $PC\ell_5(g)$ gas injected into the container. (9)

6.4 If the change at t = 14 minutes is due to a decrease in temperature state whether the FORWARD reaction is ENDOTHERMIC or EXOTHERMIC.

Use Le Chatelier's principle to explain the answer. (3)
[15]

QUESTION 7 (Start on a New Page)

7.1 A laboratory technician prepares the following two dilute nitric acid solutions:

0,20 mol·dm^{-3} HNO_3 solution ……(**I**)
0,30 mol·dm^{-3} HNO_3 solution ……(**II**)

7.1.1 Distinguish between a *concentrated acid* and a *dilute acid*. (2)

7.1.2 Give a reason why nitric acid is classified as a strong acid. (2)

7.1.3 Determine the pH of solution (**I**) at 25 °C . (3)

7.2 A few crystals of sodium carbonate are added to water in a test tube.

7.2.1 Is the solution in the test tube ACIDIC, BASIC or NEUTRAL? (1)

7.2.2 Use a balanced ionic equation to explain the answer in QUESTION 7.2.1 (3)

7.3 A 25 g mass of impure sodium carbonate(Na_2CO_3) is treated with EXCESS dilute sulphuric acid.

The balanced chemical equation for the reaction is:

$$Na_2CO_3(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4\ (aq) + H_2O\ (\ell) + CO_2(g)$$

During the reaction, 4.48 dm^3 of carbon dioxide gas is collected at STP.

Calculate the:

7.3.1 Percentage purity of the sodium carbonate (5)

7.3.2 Mass of the impurity (2)
[18]

QUESTION 8 (Start on a New Page)

A solid solution of silver and tin in mercury is used for filling tooth cavities.
This solution is known as *dental amalgam.*

Two of the reduction half-reactions that the filling can undergo are as follows:

$$3Hg_2^{2+}(aq) + 4Ag(s) + 6e^- \rightarrow 2Ag_2Hg_3(s) \qquad E^\theta = +0,85\ V$$
$$Sn^{2+}(aq) + 3Ag(s) + 2e^- \rightarrow Ag_3Sn(s) \qquad E^\theta = -0,05\ V$$

8.1.1 Define the term *reduction* in terms of electron transfer. (2)

8.1.2 When a person whose tooth is filled with dental amalgam bites a piece of aluminium foil, the person experiences a sharp painful sensation,

Refer to the relative strengths of reducing agents to explain the painful sensation in the tooth. (3)

8.2 Consider the following galvanic cell at 25 °C.

$Pt(s)|Cr^{2+}$ (1 mol·dm^{-3}) , Cr^{3+} (1 mol·dm^{-3}) || Cu^{2+} (1 mol·dm^{-3}) | Cu(s)

8.2.1 Write down the balanced chemical equation for the net cell reaction that takes place. . (3)

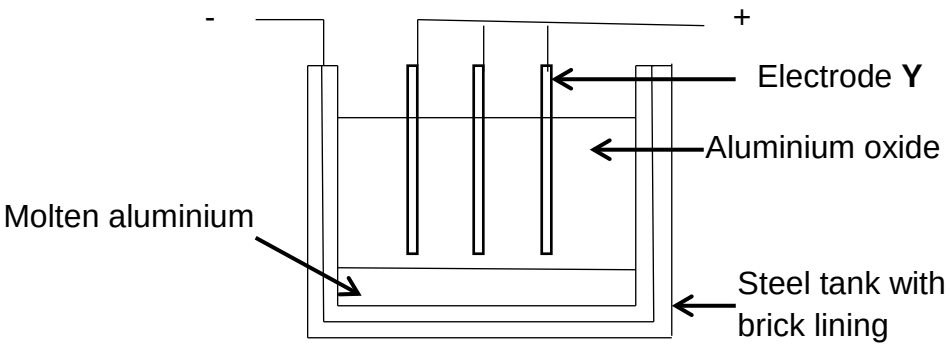
8.2.2 Calculate the cell potential of this cell. (4)

8.2.3 How will the current produced by the cell be affected if the temperature of the electrolytes in the half cells is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. Use your knowledge of REACTION RATE to give a reason for the answer. (3)

8.2.4 Fully explain how the component represented by the double lines (||) functions to maintain electrical neutrality in the half cells. (2)
[17]

QUESTION 9 (Start on a New Page)

Aluminium metal is extracted from pure aluminium oxide (Al_2O_3) in an electrolytic cell represented below.



9.1 Write down the name of the ore from which aluminium is extracted. (2)

9.2 Name the element from which both electrode **Y** is made. (1)

9.3 State ONE reason why the anode of the cell must be replaced periodically (equation is NOT required). (1)

9.4 A "special impurity" is added to the purified aluminium oxide to lower the melting point to 950 °C. State the NAME of this "special impurity". (1)

9.5 Write down the half-reaction that takes place at the cathode. (2)

9.6 In the reaction, 1890 C of charge produces 0,176 g of aluminium metal.

Show by means of a calculation, that the charge on the cations of aluminium is +3. (Hint: 1 mol of electrons has a charge of 96 500 C) (3)

[10]

QUESTION 10 (Start on a New Page)

10.1 Fertilisers are increasingly used in agriculture and food production.

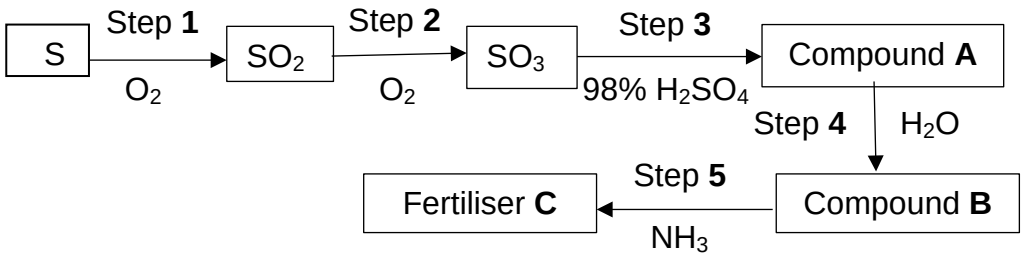
10.1.1 Suggest a reason for the increase in the use of fertilisers. (1)

One of the properties of inorganic fertilisers is that they are soluble in water.

10.1.2 Why is this property important for the plant growth? (1)

10.1.3 State ONE disadvantage of the property mentioned in QUESTION 10.1.2 for farmers who use these fertilisers. (1)

10.2 The flow diagram below represents the 5 steps followed in the industrial preparation of fertiliser **C**



10.2.1 State the NAME of the industrial process represented by steps 1-4 in the above flow diagram. (1)

10.2.2 State the chemical NAME of compound **A**. (1)

10.2.3 Write down a balanced equation for step **4**. (3)

10.2.4 Write down the NAME or FORMULA of fertiliser **C.** (1)

10.2.5 For the primary nutrient in fertiliser **C**, write down:

(a) Its function in plants (1)

(b) The name of the process through which it is extracted from the air (1)

[11]

GRAND TOTAL: 150

`

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
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 elektron*	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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ or/*of* $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$ or/*of* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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

KEY/*SLEUTEL*

- Atomic number / *Atoomgetal*: 29
- Electronegativity / *Elektronegatiwiteit*: 1,9
- Symbol / *Simbool*: Cu
- Approximate relative atomic mass / *Benaderde relatiewe atoommassa*: 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

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

Increasing oxidising ability/Toenemende oksiderende vermoë ↑

Increasing reducing ability/Toenemende reduserende vermoë ↓

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

Half-reactions/*Halfreaksies*			$E^{\ominus}$ (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

Increasing oxidising ability/Toenemende oksiderende vermoë ↓

Increasing reducing ability/Toenemende reduserende vermoë ↑