Province of the
EASTERN CAPE
EDUCATION

NATIONAL
SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2019

PHYSICAL SCIENCES P2 (CHEMISTRY)

MARK: 150

TIME: 3 hours

This question paper consists of 19 pages including 4 data sheets.

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 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. 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 (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The reaction represented by the balanced equation below occurs in the second step of the *contact process*.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The catalyst used in the reaction above, is …

A nickel.
B platinum.
C iron (II) oxide.
D vanadium pentoxide. (2)

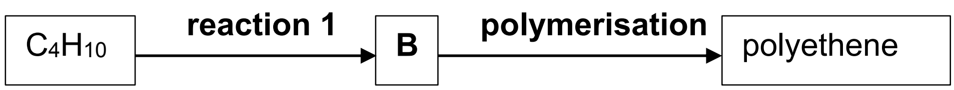
1.2 Which ONE of the following homologous series is saturated hydrocarbons?

A Esters
B Alkanes
C Alkenes
D Alkynes (2)

1.3 Which ONE of the following pairs of compounds are members of the same homologous series?

A C_3H_6 and C_4H_{10}
B CH_4O and $C_2H_4O_2$
C $C_2H_4O_2$ and $C_3H_6O_2$
D C_3H_6 and C_4H_6 (2)

1.4 In the flow diagram below, butane, C_4H_{10}, reacts to produce compound **B** in **reaction 1**. Compound **B** undergoes addition polymerisation to produce polyethene.



The name of the reaction represented by **reaction 1**, is …

A cracking.
B hydration.
C dehydration.
D dehydrohalogenation. (2)

1.5 The yield in a certain reversible reaction at equilibrium at temperature **T** and pressure **P** is 40%.

A catalyst is added to the reaction mixture at the start of the reaction and the reaction reaches equilibrium at the same temperature **T** and pressure **P**.

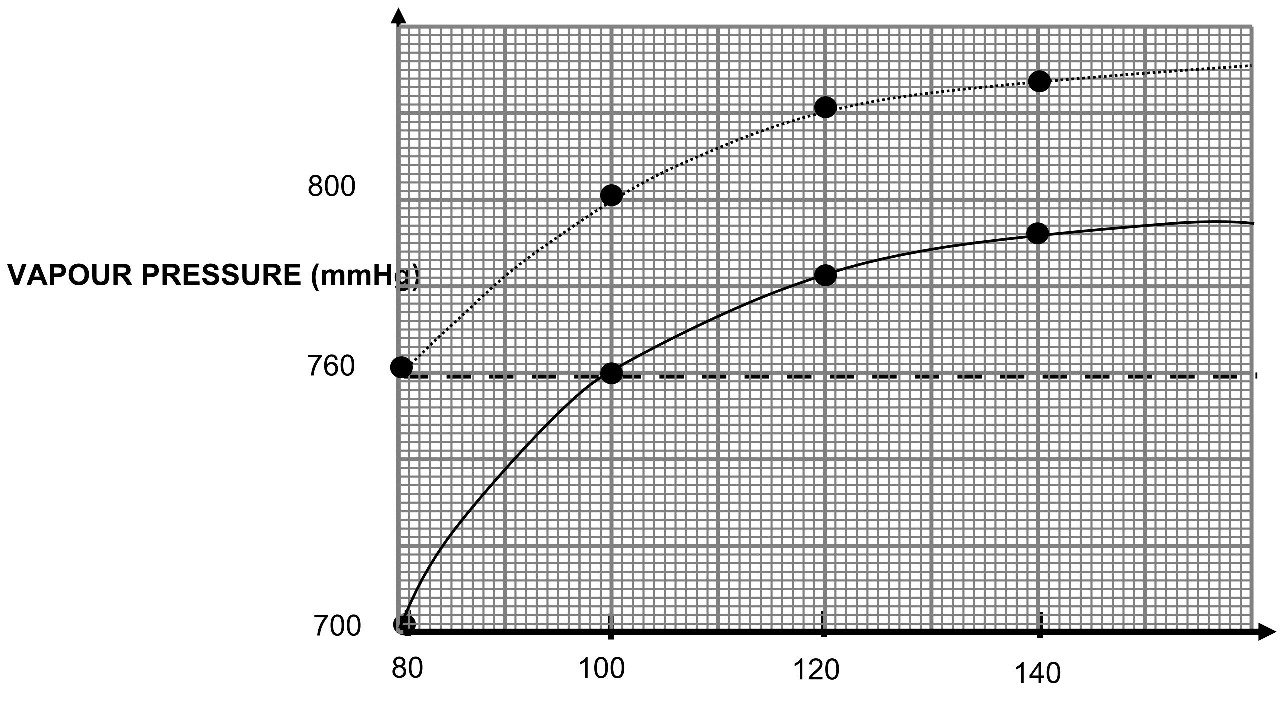
What effect will the addition of a catalyst have on the yield and rate of reaction?

	Yield	Reaction rate
A	Remains 40%	Higher
B	Remains 40%	Remains the same
C	Higher than 40%	Higher
D	Higher than 40%	Remains the same

(2)

1.6 The graphs given below show how the vapour pressure of a secondary alcohol and a tertiary alcohol of equal molecular mass change with temperature.
Atmospheric pressure = 760 mmHg

GRAPH OF VAPOUR PRESSURE VERSUS TEMPERATURE



Which ONE of the following is the boiling point (in °C) of the secondary alcohol?

A 80
B 100
C 120
D 140

(2)

1.7 The following acid-base reactions occur spontaneously at the same temperature. All the solutions have the same concentration.

$$HPO_4^{2-}(aq) + CO_3^{2-}(aq) \longrightarrow PO_4^{3-}(aq) + HCO_3^-(aq)$$

$$HPO_4^{2-}(aq) + HSO_4^-(aq) \longrightarrow H_2PO_4^-(aq) + SO_4^{2-}(aq)$$

The dissociation constants (K_b values) are as follows:

K_1 for HPO_4^-

K_2 for CO_3^{2-}

K_3 for HSO_4^-

Which ONE of the following CORRECTLY shows the order of increasing K_b values?

A K_1, K_2, K_3
B K_3, K_2, K_1
C K_2, K_1, K_3
D K_3, K_1, K_2 (2)

1.8 Which ONE of the salts below produce an acidic solution when dissolved in water?

A Na_2CO_3
B NaCℓ
C $NH_4Cℓ$
D KNO_3 (2)

1.9 Which ONE of the following is the strongest reducing agent?

A Ni
B Cr^{2+}
C Sn^{2+}
D Ag (2)

1.10 An iron nail is electroplated with silver.

The half reaction taking place at the iron nail is given by:

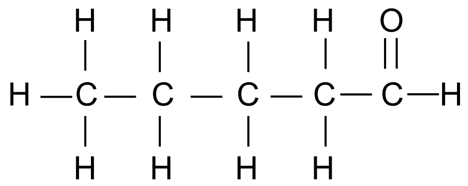
A $Fe^{2+} + 2e^- \longrightarrow Fe$
B $Fe \longrightarrow Fe^{2+} + 2e^-$
C $Ag \longrightarrow Ag^+ + e^-$
D $Ag^+ + e^- \longrightarrow Ag$ (2)
[20]

QUESTION 2 (Start on a new page.)

Three organic compounds (**A**, **B** and **C**) with different functional groups are given below.

A: 2,3-dimethylhex-2-ene

B:



C: $CH_3CH(CH_3)CH_2CH_3$

2.1 Write down TWO special properties of carbon which make it possible for carbon to form such a variety of organic compounds. (2)

2.2 Define the term *functional group*. (2)

2.3 Write down the:

2.3.1 Structural formula of compound **A** (2)

2.3.2 IUPAC name of compound **B** (2)

2.4 Compound **C,** pentane and a compound **X** are <u>compounds that have the same molecular formula but different structural formulae.</u>

Write down the:

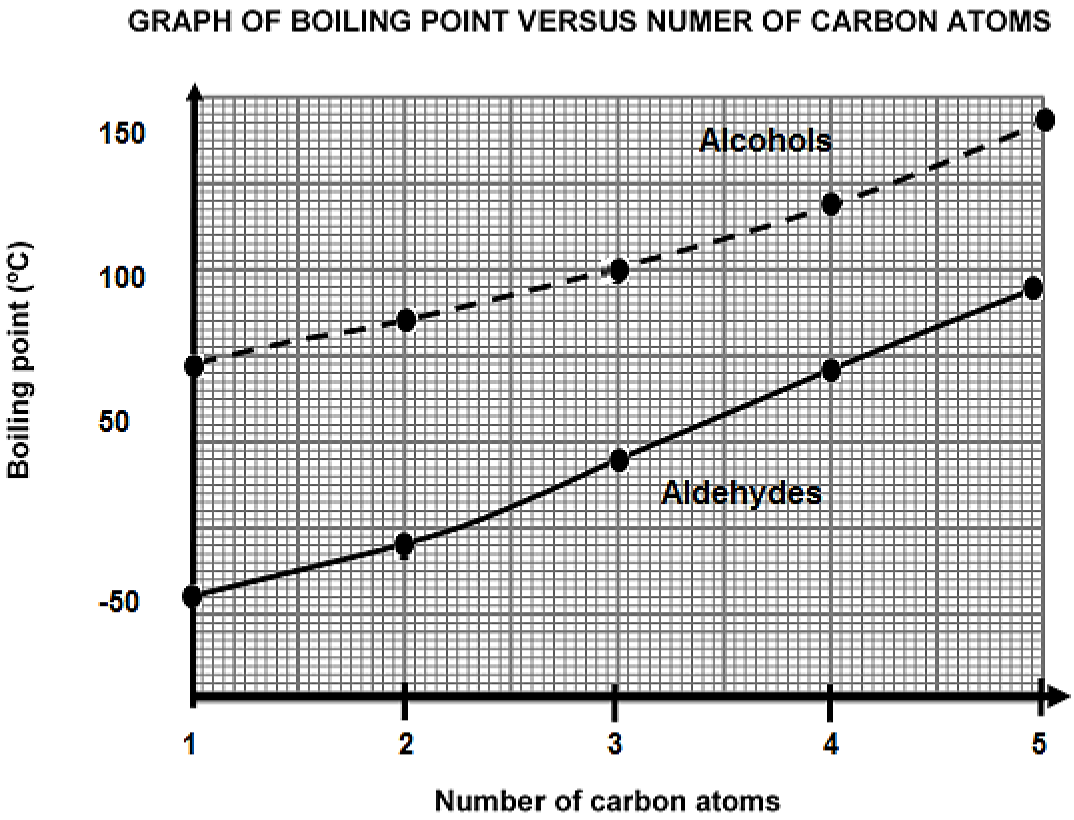
2.4.1 Term used for the underlined phrase. (1)

2.4.2 Structural formula and IUPAC name of compound **X** (4)

[13]

QUESTION 3 (Start on a new page.)

The graph of the boiling point versus the number of carbon atoms for the first five STRAIGHT CHAIN alcohols and aldehydes is shown below.



3.1 Define the term *boiling point*. (2)

3.2 Write down the IUPAC name of the alcohol with a boiling point of 100 ˚C. (2)

3.3 Explain fully why the curve for the alcohols is higher than that of the aldehydes. (5)

The boiling points of carboxylic acids are generally HIGHER than those of their corresponding alcohols.

3.4 Explain the difference between the boiling points referring to the types of intermolecular forces present in each of these compounds. (3)

[12]

QUESTION 4 (Start on a new page.)

4.1 Consider the TWO reactions of haloalkanes with sodium hydroxide (NaOH) shown below.

I: $CH_3CH_2CH_2CH_2Br \xrightarrow[\text{dilute. NaOH}]{\text{Warm ethanol}}$

II: $CH_3CH_2CHBrCH_3 \xrightarrow[\text{Conc. NaOH}]{\text{Warm ethanol}}$

4.1.1 Which reaction (**I** or **II**) is classified as elimination reaction? (1)

Write down:

4.1.2 The IUPAC name of the ORGANIC product formed in reaction **I**. (2)

4.1.3 A balanced equation for reaction **II** using structural formulae for the organic reagents. (5)

4.2 Consider the TWO organic compounds (**A** and **B**) shown below.

A: C_4H_8

B: C_4H_{10}

4.2.1 Which organic compound (**A** or **B**), will undergo addition reactions? Give a reason for the answer. (2)

4.2.2 Write down the NAME of an inorganic substance that reacts with compound **A** to produce compound **B**. (1)

4.3 Butanol reacts with organic compound **Y** in the presence of a concentrated inorganic acid to produce an ester. The equation shown below represents the reaction.

$$CH_3CH_2CH_2CH_2OH + \mathbf{Y} \longrightarrow CH_3CH_2CH_2CH_2OOCCH_2CH_3 + H_2O$$

Write down the:

4.3.1 Function of the concentrated inorganic acid in the reaction. (1)

4.3.2 Condensed structural formula of compound **Y** (2)

4.3.3 IUPAC name of the ester produced (2)

4.3.4 ONE piece of evidence that will indicate that an ester has been produced (1)

[17]

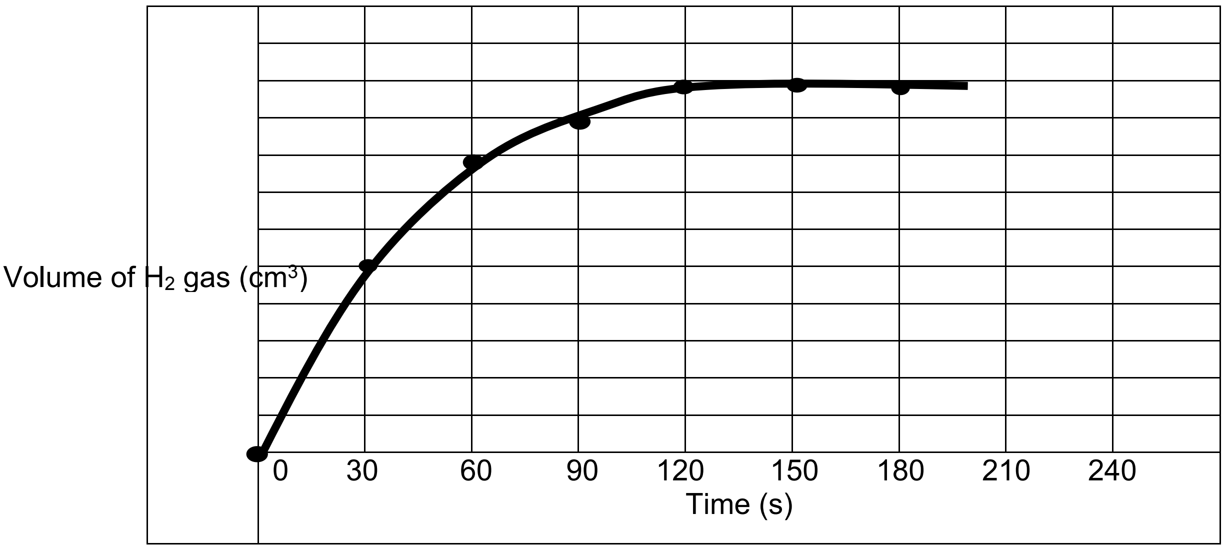
QUESTION 5 (Start on a new page.)

A group of learners use the reaction between magnesium and hydrochloric acid to measure the average rate at which hydrogen gas is produced. They add 10 cm^3 of a 1 $mol \cdot dm^{-3}$ of HCℓ to 0,048 g magnesium powder in an Erlenmeyer flask at 20 ˚C.

The balanced equation for the reaction is: $Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$

The learners' experimental results were plotted to produce **graph A.**

GRAPH A



5.1 Define *reaction rate*. (2)

5.2 Calculate the volume of hydrogen gas produced in the first minute if the average rate of production of hydrogen gas is 0,67 $cm^3 \cdot s^{-1}$. (3)

5.3 How long (in seconds) does the reaction take to run to completion? Give a reason for the answer by referring to the gradient of the graph. (2)

5.4 Calculate the mass of the reactant left in the flask when the reaction is complete. (7)

5.5 When the concentration of hydrochloric acid is increased the learners observe that the rate of reaction increases.

Use the collision theory to explain this observation. (2)

5.6 In another experiment the magnesium powder is replaced with an equal amount of zinc powder.

Redraw the graph provided above in your ANSWER BOOK and sketch on the same axis the graph that would be obtained when zinc powder is used. (2)

[18]

QUESTION 6 (Start on a new page.)

The decomposition reaction of hydrogen iodide, HI represented by the balanced equation below reaches equilibrium in a closed container at 25 °C.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \qquad \Delta H > 0$$

6.1 How does the rate of the forward reaction compare to the rate of the reverse reaction at the following stages?

Choose from HIGHER THAN, LOWER THAN or EQUAL TO

6.1.1 At equilibrium (1)

6.1.2 Before the reaction reaches equilibrium for the first time? (1)

6.2 What effect will an increase in pressure, by decreasing the volume at constant temperature have, on the concentration of H_2 at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME (2)

6.3 The reaction is started by pumping a certain amount of hydrogen iodide, HI into an empty flask which is then sealed.

The equilibrium concentration of two of the substances at 25 °C was found to be:

$[I_2]$ = 0,026 $mol{\cdot}dm^{-3}$
[HI] = 0,72 $mol{\cdot}dm^{-3}$

When temperature of the equilibrium mixture is increased, the equilibrium position shifts and a new equilibrium is established at 448 °C. At the new equilibrium the concentration of hydrogen, H_2 is found to be 0,084 $mol{\cdot}dm^{-3}$.

Calculate the equilibrium constant for the reaction at 448 °C. (7)

6.4 What effect will the increase in temperature, from 25 °C to 448 °C, have on the rate of the reverse reaction?

Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
[12]

QUESTION 7 (Start on a new page.)

7.1 Acid-base indicators are generally represented by the formula, HIn. The reaction of HIn with water can be represented by the following equation.

$$HIn + H_2O \rightleftharpoons H_3O^+ + In^-$$

colourless **pink**

Acid-base indicators are considered to be weak acids.

7.1.1 Define the term *weak acid*. (2)

7.1.2 Is H_2O acting as an ACID or a BASE in the reaction? (1)

7.1.3 Write down the formula of the conjugate base of HIn. (1)

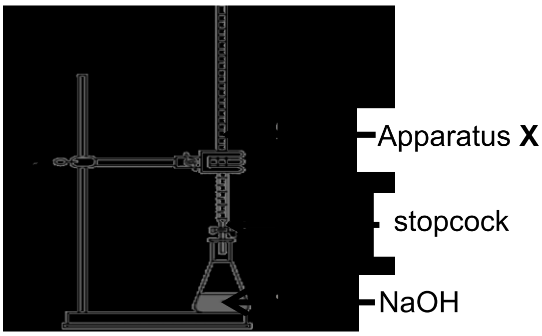
7.2 Vinegar is a solution of ethanoic acid, CH_3COOH. A certain manufacturer of vinegar claims that the vinegar she sells contains 5,80 grams of ethanoic acid per 100 mℓ vinegar solution.

A group of learners used the apparatus shown below to test the claim by the manufacturer.

They titrated a dilute sample of vinegar against a standard sodium hydroxide solution (NaOH) of concentration 0,1 $mol \cdot dm^{-3}$ using HIn as the acid-base indicator.

The balanced equation for the reaction is given below:

$$NaOH(aq) + CH_3COOH(aq) \longrightarrow CH_3COONa(aq) + H_2O(\ell)$$



7.2.1 Write down the name of apparatus **X**. (1)

7.2.2 Use the equation in QUESTION 7.1 to determine the colour change that will take place at the end-point.

Choose from PINK TO COLOURLESS or COLOURLESS TO PINK.

Use Le Chatelier's principle to explain the answer. (4)

7.2.3 Calculate the pH of the sodium hydroxide (NaOH) solution before titration. (4)

7.2.4 The dilute solution of vinegar used in the titration was obtained by adding 10 cm^3 of vinegar to water and filling up with water to a volume of 100 cm^3 of dilute vinegar solution.

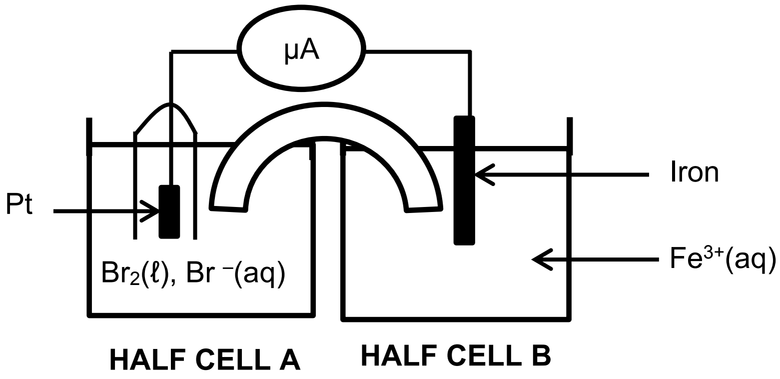
During the titration 18 cm^3 of sodium hydroxide solution of concentration 0,1 $mol \cdot dm^{-3}$ neutralises exactly 20 cm^3 of the diluted vinegar.

Determine by calculation whether the manufacturer's claim is TRUE or NOT. (8)

[21]

QUESTION 8 (Start on a new page.)

The diagram given below shows a galvanic cell set up under standard conditions.



8.1 Write down TWO functions of the salt bridge. (2)

8.2 Which half-cell, **A** or **B**, contains the cathode? (1)

8.3 Write down the balanced equation for the overall (net) cell reaction. (3)

8.4 Calculate the initial EMF of this cell. (4)

8.5 The $Br_2|Br^-$ half cell is now replaced with the $I_2|I^-$ half-cell at standard conditions.

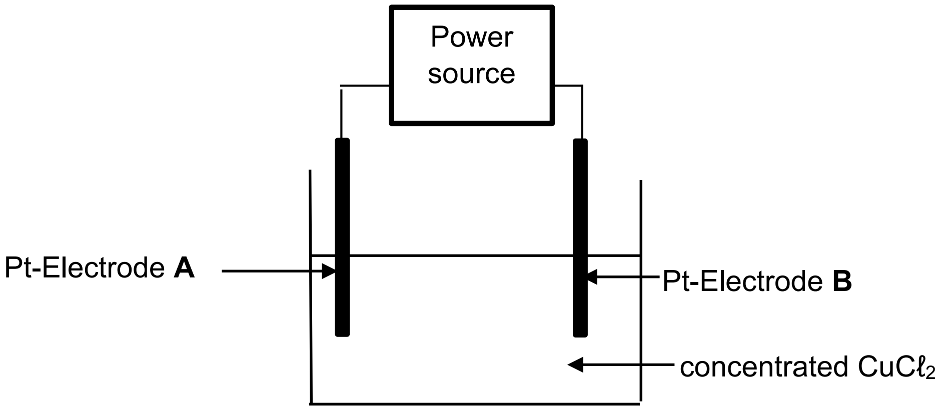
Will the initial ammeter reading be HIGHER or LOWER when the $I_2|I^-$ is used?

Explain the answer by referring to the relative strengths of the oxidising agents involved. (3)

[13]

QUESTION 9 (Start on a new page.)

The diagram below show the apparatus used to demonstrate the electrolysis of concentrated copper(II) chloride ($CuC\ell_2$) solution.



9.1 Write down the energy conversion which occurs in the cell above. (2)

9.2 Explain why an AC-power source is not suitable for this cell. (2)

A reddish-brown layer is observed on electrode **A** after the cell has been functioning for a while.

9.3 Write down the half reaction that occurs at electrode **A**.

The copper(II)chloride ($CuC\ell_2$) solution is now replaced with a concentrated solution of sodium chloride ($NaC\ell$).

It is now observed that a gas is formed at electrode **A**. (2)

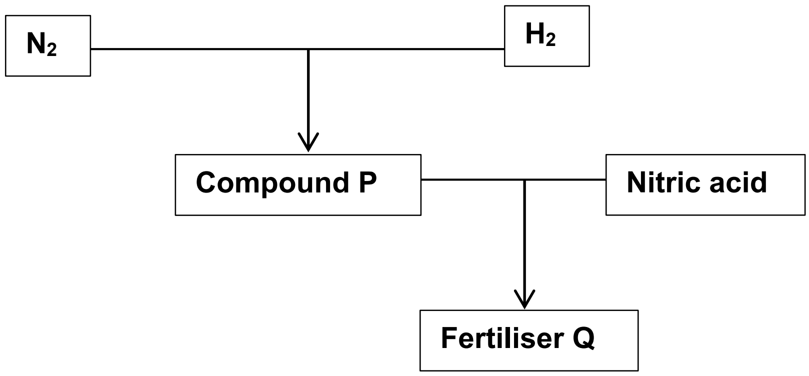
9.4 Write down the NAME of the gas that is formed at electrode **A**. (1)

9.5 Refer to the relative strengths of oxidising agents involved to explain why sodium (Na) metal does not form in this cell. (3)

[10]

QUESTION 10 (Start on a new page.)

The flow diagram below shows the industrial preparation of fertiliser **Q**.



10.1 Write down:

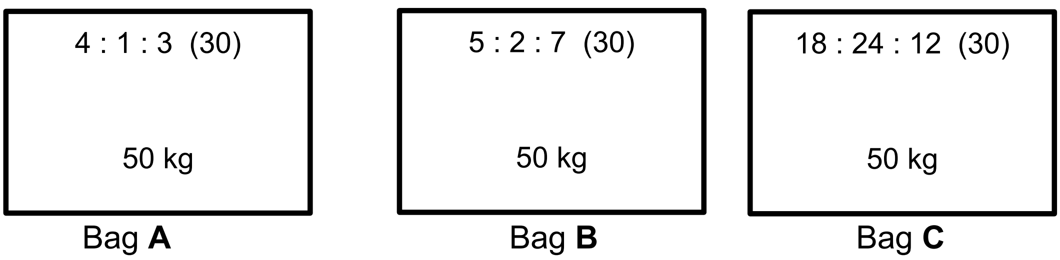
10.1.1 The name of the process used to obtain nitrogen gas (N_2) (1)

10.1.2 The name of **compound P** (2)

10.1.3 A balanced chemical equation for the production of fertiliser **Q** (3)

10.1.4 The name of the primary nutrient present in fertiliser **Q** (1)

10.2 Consider the three fertiliser bags shown below.



10.2.1 Which bag of fertiliser (**A, B** or **C**) is the most suitable for garden lawns?

Give a reason for the answer. (3)

10.2.2 Calculate mass of nitrogen in fertiliser bag **C**. (3)

10.3 Write down ONE negative impact of the overuse of fertilisers. (1)
[14]

TOTAL: 150

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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*

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 $c = \frac{m}{MV}$ $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/by 298 K
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$		

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

KEY/ *SLEUTEL*

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

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
$Ca^{2+} + 2e^-$	⇌	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