Basic Education

KwaZulu-Natal Department of Basic Education

REPUBLIC OF SOUTH AFRICA

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2016

NATIONAL SENIOR CERTIFICATE

GRADE 12

MARKS : 150

TIME : 3 Hours

This question paper consists of 18 pages and 4 Data Sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. The 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 pocket 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 where applicable.
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. Write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 The main product formed during the Ostwald process is …

A Ammonia.

B Ammonium nitrate.

C Nitric acid.

D Sulphuric acid. (2)

1.2 Which of the following compounds is an isomer of propanoic acid?

A propan -1,2,3 - triol

B 2 - methylpropan -1 - ol

C ethyl ethanoate

D methyl ethanoate (2)

1.3 The boiling points of helium and argon are – 269 °C and – 186 °C respectively.

The difference in boiling point is due to the presence of stronger ...

A ionic bonds between argon atoms.

B Van der Waals forces between argon atoms.

C hydrogen bonds between helium atoms.

D covalent bonds between helium atoms. (2)

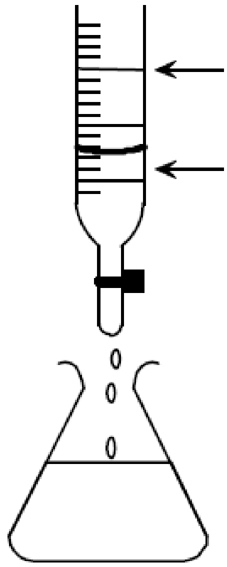
1.4 If base **X** is titrated against acid **Y**, the pH of the solution at the end point is 8.

The base **X** and acid **Y** are most likely to be:

	X	Y
A	NaOH	CH_3COOH
B	Na_2CO_3	HCl
C	NaOH	H_2SO_4
D	Na_2CO_3	CH_3COOH

(2)

1.5 A group of learners were doing a titration experiment using HCl and NaOH, as shown below. They accidentally exceed the endpoint.



Which one of the following is **correct** for the solution now in the beaker?

A $[H^+] < [OH^-]$ and pH < 7

B $[H^+] = [OH^-]$ and pH < 7

C $[H^+] > [OH^-]$ and pH < 7

D $[H^+] > [OH^-]$ and pH = 7 (2)

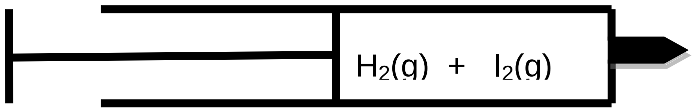
1.6 Dilute nitric acid is gradually added to a flask of distilled water at 25°C. How does this affect the hydrogen ion concentration $[H^+]$ and the ionisation constant (K_w) of water?

	$[H^+]$	**(K_w)**
A	Increases	Increases
B	Does not increase	Increases
C	Increases	Stay the same
D	Does not increase	Stay the same

(2)

1.7 A mixture of $H_2(g)$ and $I_2(g)$ is sealed in a gas syringe. The mixture is then allowed to reach equilibrium at a constant temperature according to the equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$



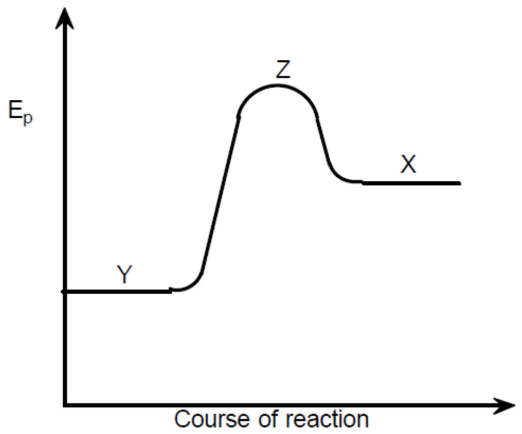
What will happen to the **concentration and yield** of HI if the piston is moved inwards while the temperature remains constant?

	HI	Yield of HI
A	Increases	Stay the same
B	Decreases	Stay the same
C	Decreases	Increases
D	Increases	Decreases

(2)

1.8 Consider the potential-energy diagram for the reaction:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$



Which one of the following is **correct**?

A X represents the energy of $CaCO_3$

B Y represents the energy of $CaO + CO_2$

C X represents the energy of $CaO + CO_2$

D Z represents a catalyst (2)

1.9 The following reaction takes place in a closed container:

$$N_2H_4(g) \rightleftharpoons N_2(g) + 2H_2(g) \qquad \Delta H = -95{,}4 \text{ kJ mol}^{-1}$$

Which one of the statements below is **correct**?

A Increasing the temperature favours the forward reaction.

B Increasing the temperature increases the Kc value.

C Increasing the temperature has no effect on the amount of products formed.

D Increasing the temperature speeds up both forward and reverse reactions. (2)

1.10 A polymer formed as a result of addition polymerisation is most likely to be derived from a monomer that is …

A Unsaturated

B A hydrocarbon

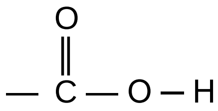
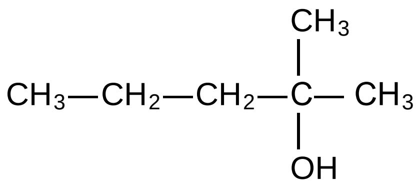
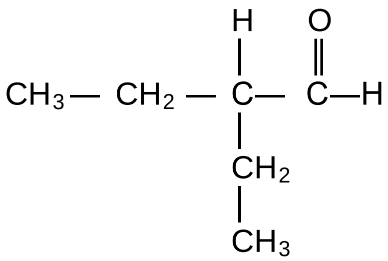
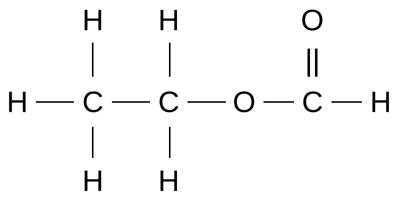
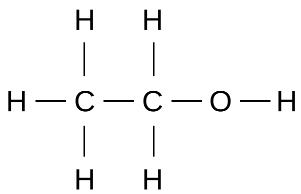
C An alcohol

D A carboxylic acid (2)

[20]

QUESTION 2 (Start on a new page.)

Consider the following representation of organic molecules **A** to **J** listed in the table below to answer the questions that follow:

A	Butan-2-ol	**B**	
C		**D**	$CH_2 = CH - Cl$
E		**F**	
G	4-methylpentanoic acid	**H**	Pentanal
I		**J**	C_4H_8

2.1 Choose from the list a substance that is used in the laboratory preparation of **F**.
Write down the **LETTER** only. (2)

2.2 Which ONE of the above represents a SECONDARY alcohol? (1)

2.3 Write down the name for compound **D**. (2)

2.4 Write down the letter that represents an aldehyde. (1)

2.5 Write down the homologous series to which compounds **B** belongs. (1)

2.6 Draw the STRUCTURAL FORMULA of compound **G**. (2)

2.7 Draw the STRUCTURAL FORMULA of the functional group for compound **H.** (1)

[10]

QUESTION 3 (Start on a new page.)

3.1 The boiling point of methane is -161° C and the boiling point of pentane is 36° C.

Comments made by Rama, a Grade 12 learner:
"Pentane has a longer carbon chain than methane therefore more bonds need to be broken to separate the molecule into its individual atoms. Breaking of these bonds requires energy which explains why pentane has a higher boiling point than methane."

3.1.1 Consider Rama's explanation and EXPLAIN why it is **INCORRECT**. (1)

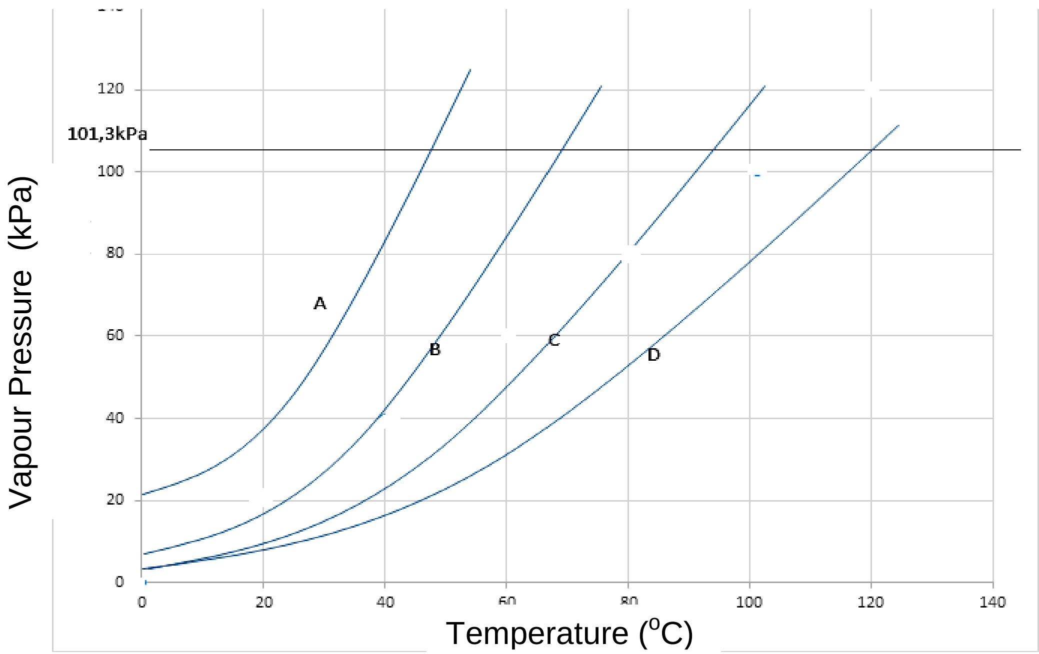
3.1.2 Provide a correct explanation for the difference in the boiling points. (2)

3.1.3 Write down the NAME and draw the STRUCTURAL FORMULA of an isomer of pentane which has a lower boiling point than pentane. (3)

3.2 Draw the STRUCTURAL FORMULAE of the positional isomer of but-1-ene. (2)

The following graph shows the relationship between vapour pressure of organic molecules and temperature. The bold line indicates the external atmospheric pressure. The four curves (**A**, **B**, **C** and **D**) represent the organic molecules belonging to the following homologous series: **an unbranched alkane, a branched alkane, an unbranched primary alcohol and an unbranched aldehyde**.
All four molecules have the same number of C atoms

VAPOUR PRESSURE OF ORGANIC COMPOUNDS AT DIFFERENT TEMPERATURES



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

3.4 Which ONE of the four curves (**A**, **B**, **C** or **D**) represents the

3.4.1 Straight chain alkane (1)

3.4.2 Single branched alkane (1)

3.5 Fully EXPLAIN your choice in QUESTION 3.4 by referring the TYPE and STRENGTH of the INTERMOLECULAR FORCES. (3)

3.6 Which ONE of the four curves (**A**, **B**, **C** or **D**) represents the

4.4.1 Primary alcohol (1)

4.4.2 Aldehyde (1)

[17]

QUESTION 4 (Start on a new page.)

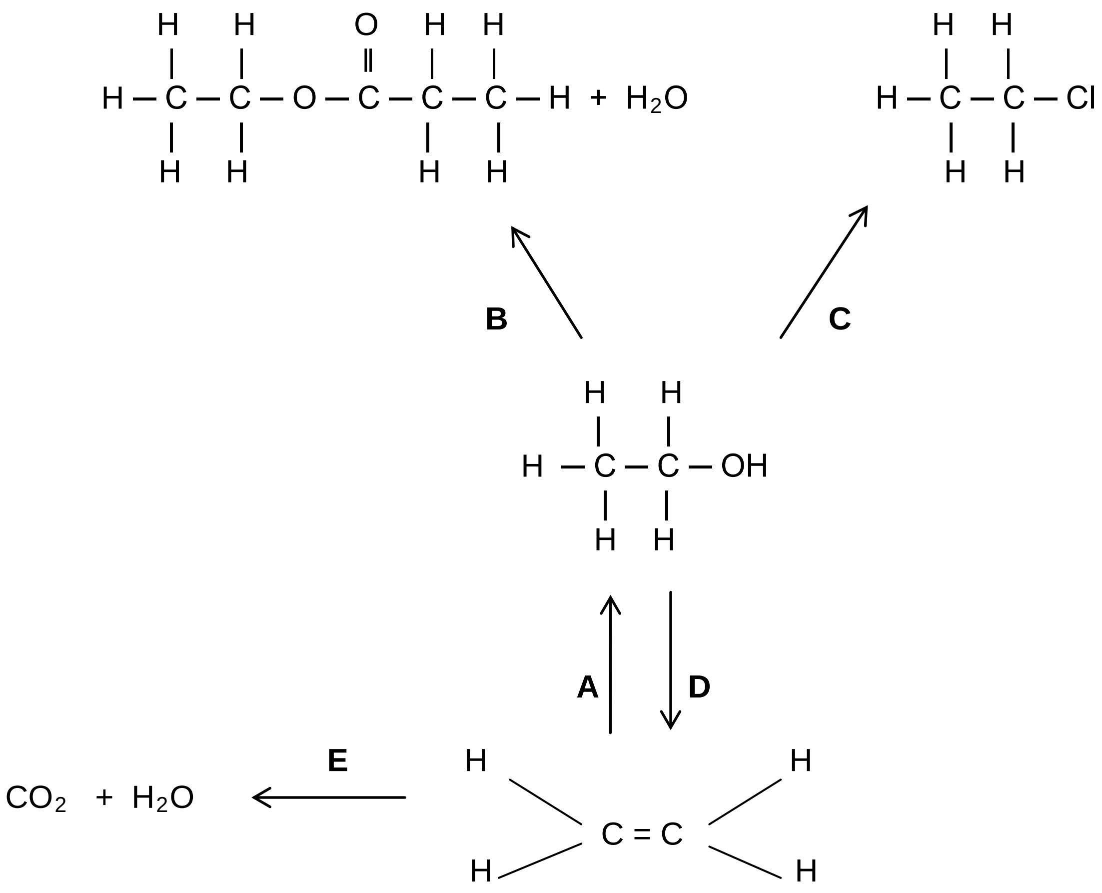
4.1 A group of Grade 12 learners are in a school laboratory preparing an ester using methanol and ethanoic acid. The balanced chemical equation for this reaction is given below:

$$CH_4O + C_2H_4O_2 \rightarrow C_3H_6O_2 + H_2O$$

4.1.1 Write down the IUPAC name of the ester formed. (2)

4.1.2 When 50 g of impure methanol fully reacts with excess ethanoic acid, it produces 68,88 g $C_3H_6O_2$. Calculate the percentage purity of the methanol. (5)

4.2



4.2.1 Name the type of reaction indicated by A, C, D and E. (4)

4.2.2 The product of reaction C can be converted, by a single reaction, to the product of reaction D. State the necessary reagents and conditions for this conversion to take place. (3)

4.2.3 Reactions B and D use the same catalyst. Write down the name or formula of this catalyst. (1)

4.2.4 The product of reaction D can undergo polymerization. Name the polymer that will be produced. (1)

4.2.5 Using condensed formulae, write a balanced reaction for the combustion of ethanol. (3)

[19]

QUESTION 5 (Start on a new page)

Ketiwe conducts an experiment to investigate the various factors that influence the rate of chemical reactions. She places a sample of calcium carbonate in a beaker. The beaker is placed on a sensitive balance and an excess of hydrochloric acid (HCl) is added.

The following reaction occurs:

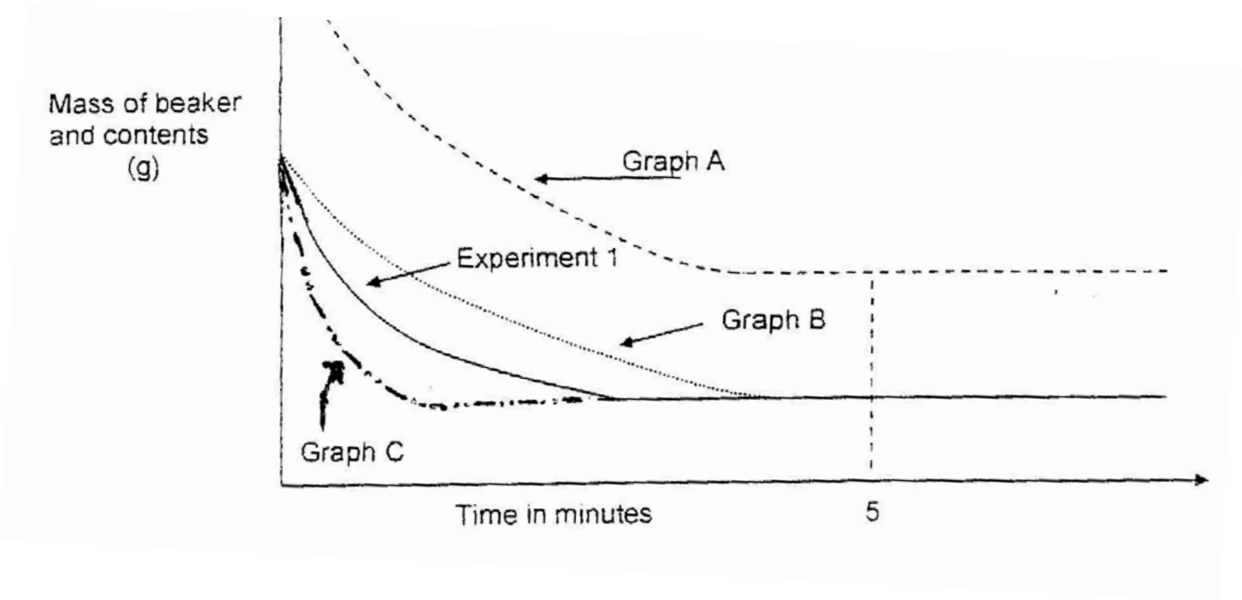
$$CaCO_3 + HCl \rightarrow CaCl_2 + H_2O + CO_2$$

Ketiwe repeats the experiment a number of times under different conditions, always with the same volume of HCl, which remains in excess.

The following table summarizes the different experimental conditions for four of her experiments.

Expt	Mass of $CaCO_3$ (g)	Concentration of HCl ($mol{\cdot}dm^{-3}$)	Temperature of HCl (^oC)	State of $CaCO_3$
1	10	2	25	granules
2	10	2	15	granules
3	20	2	25	granules
4	10	2	25	powder

During each experiment the mass of the beaker and its contents is recorded every minute. The graphs below indicate the changes in mass of the beaker and its contents during the reaction, as a function of time, for the four experiments:



5.1 What is meant by the rate of a chemical reaction? (2)

5.2 Name the quantity that was kept constant during all 4 experiments. (1)

5.3 Give a reason for the decrease in mass as each reaction progresses. (2)

5.4 Why are all the graphs horizontal lines after five minutes? (2)

5.5 Which one of the graphs (A, B, or C) represents the results of:

5.5.1 Experiment 2 (1)

5.5.2 Experiment 3 (1)

5.5.3 Experiment 4 (1)

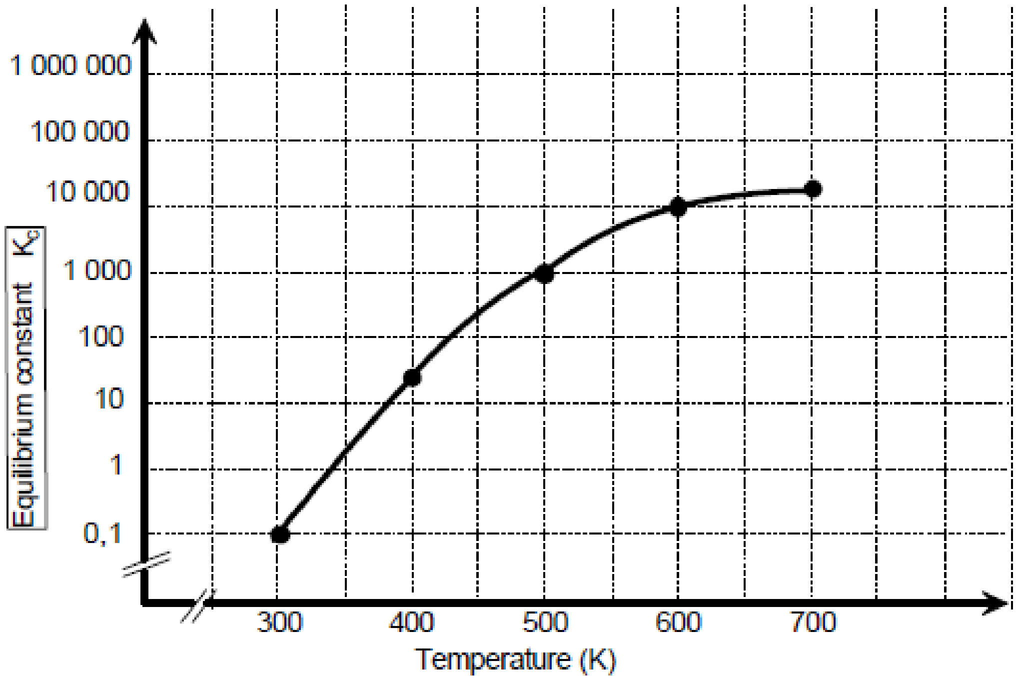
5.6 If a suitable catalyst is used in experiment 1, which of the graphs (A,B or C) will be obtained? Explain your answer. (4)

[14]

QUESTION 6 (Start on a new page)

6.1 The graph below shows the effect of a temperature change on the value of K_c for the following reaction taking place in a closed container:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$



6.1.1 What effect does an increase in temperature have on the amount of NO_2 formed? (1)

6.1.2 Which reaction was favoured due to an increase in temperature? Write only FORWARD or REVERSE. (1)

6.1.3 State Le Chatelier's Principle. (2)

6.1.4 Using Le Chatelier's Principle, explain whether the forward reaction is EXOTHERMIC or ENDOTHERMIC. (4)

6.1.5 Write down TWO factors, other than temperature, that can be used to increase the rate of the forward reaction at 500K. (2)

6.2 Consider the hypothetical reaction that takes place between A_2 and B in a closed container.

$$\underset{\text{colourless}}{A_2(g)} + \underset{\text{colourless}}{2B(g)} \rightleftharpoons \underset{\text{dark red}}{2AB(g)} \qquad \Delta H > 0$$

X mol of gas A_2 and 2,0 mol of gas B are sealed in a 1,0 dm^3 container. After a few minutes equilibrium is reached and the contents of the container turns light red.

At equilibrium it is found that 0,40 mol of gas AB is present in the container. The value of K_c is 0,50.
Determine X, the quantity (in mol) of gas A_2 that was originally sealed in the container. (8)

[18]

QUESTION 7 (Start on a new page.)

7.1 Magnesium hydroxide ($Mg(OH)_2$) is often used to relieve an upset stomach. The pH of the HCℓ(aq) in a person's stomach is 1.

7.1.1 Calculate the concentration of the hydrochloric acid in the person's stomach. (3)

7.1.2 Will the pH in the stomach **INCREASE, DECREASE** or **STAY THE SAME** after taking a dose of $Mg(OH)_2$? (1)

7.1.3 A person takes a dose of $Mg(OH)_2$. Write down the balanced equation for the reaction that takes place in the stomach. (3)

7.2 Explain what is meant by a neutralization reaction. (2)

7.3 12 cm^3 of NaOH of concentration 0,1 $mol·dm^{-3}$ and 48 cm^3 of $Ba(OH)_2$ of unknown concentration are mixed in a large flask, and the solution is homogenized. This solution is completely neutralized by 54 cm^3 of a 0,05 $mol·dm^{-3}$ H_2SO_4 solution. Calculate the concentration of the $Ba(OH)_2$ solution. (8)

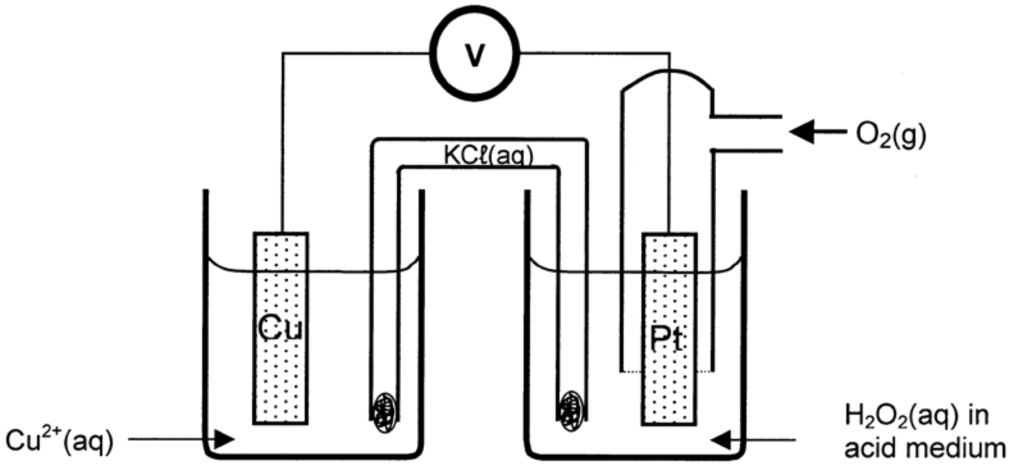
[17]

QUESTION 8 (Start on a new page.)

8.1 A group of learners set up a standard electrochemical cell using the following half – cells:

$$Pt, O_2\ (g), H^+(aq)\ |\ H_2O_2(aq)\ \text{ and } Cu^{2+}(aq)\ |\ Cu(s)$$

Potassium chloride (KCl) solution is used in the salt bridge.



8.1.1 Which electrode is the cathode? (1)

8.1.2 Write down the oxidation half-reaction. (2)

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

8.1.4 Calculate the initial emf of the cell. (4)

8.2 A second group of learners set up another standard electrochemical cell using the following half-reactions:

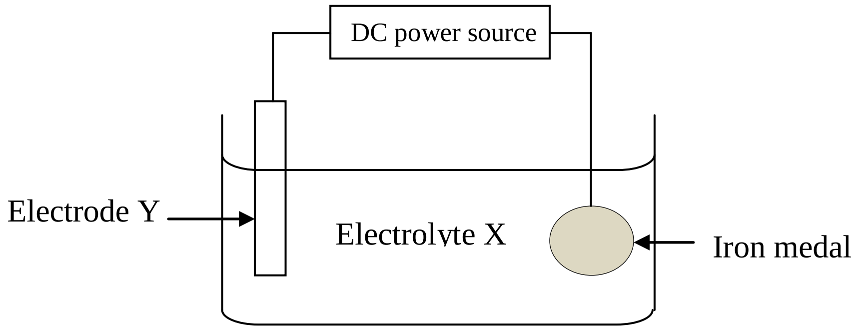
$$Ce^{3+} + 3e^- \rightarrow Ce \qquad E^\ominus = -2{,}30\ V$$
$$Pd^{2+} + 2e^- \rightarrow Pd \qquad E^\ominus = +0{,}99\ V$$

Write the balanced equation for the nett overall reaction. (3)

[12]

QUESTION 9 (Start on a new page.)

The simplified diagram below shows an electrolytic cell used at an electroplating company to coat iron medals with silver.



9.1 Write down the energy conversion that takes place in this cell. (1)

9.2 What physical change takes place at electrode Y when the cell is in operation? (2)

9.3 Which type of reaction (OXIDATION or REDUCTION) takes place at electrode Y? (1)

9.4 Write down the:

9.4.1 Equation for the half-reaction that takes place at the iron medal (2)

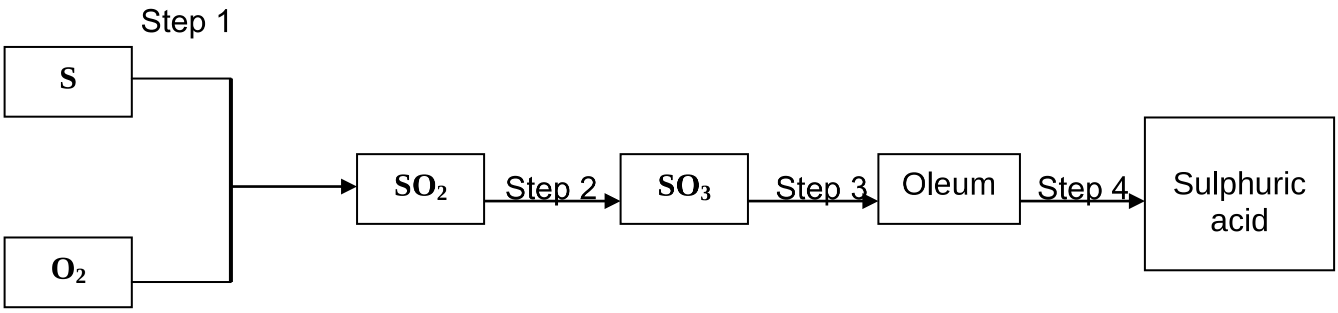
9.4.2 NAME or FORMULA of electrolyte **X** (1)

9.5 Give a reason why the concentration of electrolyte **X** remains constant during electroplating. (2)

[9]

QUESTION 10 (Start on a new page.)

10.1 Some of the steps in the industrial preparation of sulphuric acid are outlined below.



10.1.1 Write down a balanced equation for the reaction leading to the formation of SO_3 in Step 2. (2)

10.1.2 In which step is a catalyst used? (1)

10.1.3 Name the catalyst used. (1)

10.2 The rapidly increasing human population is resulting in an ever-increasing demand for food. To meet this demand, farmers apply fertiliser to the same cultivated land each year.

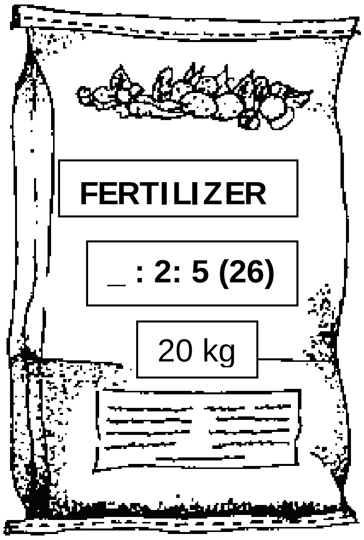
10.2.1 Explain why farmers have to apply fertiliser to the same land each year. (1)

10.2.2 Write down ONE negative impact that over-fertilisation can have on humans. (1)

10.2.3 What process occurs when excess fertilizers run into rivers? (1)

10.2.4 Write down the FORMULA of the fertiliser formed when sulphuric acid reacts with ammonia. (2)

10.3 Mr. Viljoen (a farmer) finds an old 20 kg bag of fertilizer. The label on the bag is only partially visible (see diagram below). He has the contents analysed and it is determined that the percentage of potassium in the bag is 13%.



10.3.1 What does the number (26) on the label represent? (1)

10.3.2 Determine the unknown component in the N.P.K ratio (4)

[14]

TOTAL MARKS: 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* $E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}\ /\ E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$	

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

Please turn over

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

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 oxidising ability/*Toenemende oksiderende vermoë* ↑

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

Co