GAUTENG PROVINCE

EDUCATION

REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2015

10842

PHYSICAL SCIENCES

SECOND PAPER

MARKS: 150

TIME: 3 hours

Pages 18 and 4 formula sheets

PHYSICAL SCIENCES: Paper 2

1084E

10842E

X10

2

P.T.O.

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

PHYSICAL SCIENCES
(Second Paper)

TIME: 3 hours

MARKS: 150

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 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. Non-programmable calculators may be used.
7. Appropriate mathematical instruments may be used.
8. Data sheets and a periodic table are attached for your use.
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. Write only the letter (A – D) of the most correct answer next to the question number (1.1 – 1.10) in the ANSWER BOOK, for example 1.11 D

1.1 Which ONE of the following compounds is a ketone?

A CH_3COOH

B $CH_3CH(OH)CH_3$

C CH_3COCH_3

D CH_3CH_2CHO (2)

1.2 A chemical reaction reaches equilibrium. Which ONE of the following statements regarding this equilibrium is TRUE?

A The concentrations of the individual reactants and products are equal.

B The concentrations of the individual reactants and products are constant.

C The concentrations of the individual reactants are zero.

D The concentrations of the individual products increase until the reaction stops. (2)

1.3 Which ONE of the following is a primary nutrient needed by plants?

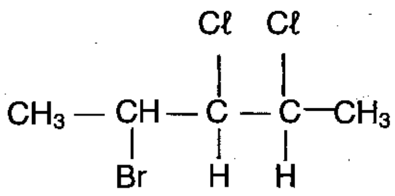
A Ca

B C

C Mg

D N (2)

1.4 The condensed structural formula of an organic compound is shown below:



Which ONE of the following is the correct IUPAC name for this compound?

A 2,3-dichloro-4-bromo-1-methylbutane

B 4-bromo-2,3-dichloropentane

C 2-bromo-3,4-dichloropentane

D 2-bromo-3,4-dichloro-1-methylbutane (2)

1.5 Consider the following esterification reaction:

$$CH_3OH + X \rightarrow CH_3COOCH_3 + H_2O$$

The IUPAC name of the reactant most likely represented by **X** is:

A Methanoic acid

B Ethanoic acid

C Methanol

D Ethanol (2)

1.6 Consider the chemical reaction represented by the following balanced equation:

$$2Mg(s) + SO_2(g) \rightleftharpoons 2MgO(s) + S(s)$$

Which ONE of the following statements is CORRECT?

A SO_2 is an oxidising agent.

B SO_2 is an acid.

C SO_2 is a base.

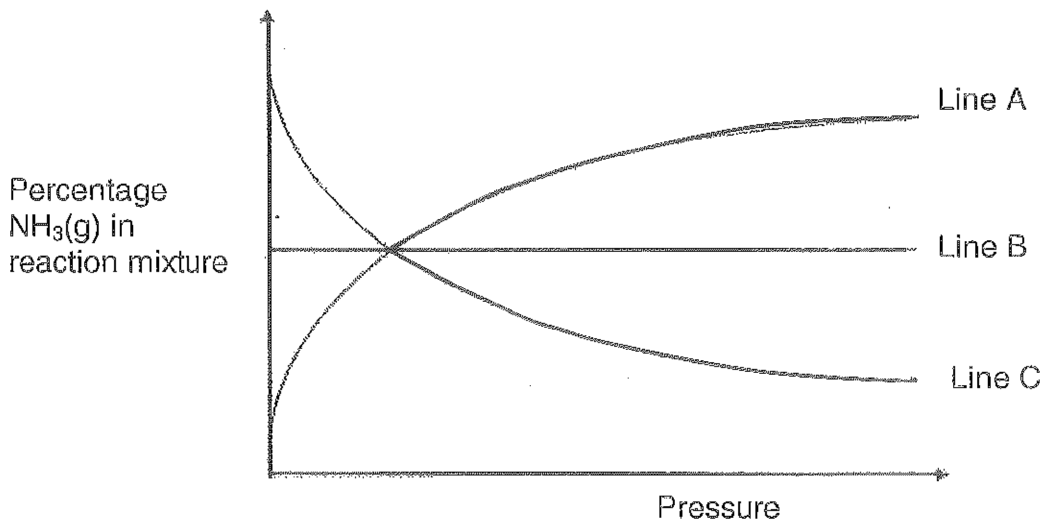
D SO_2 is a reducing agent. (2)

1.7 The reaction represented by the balanced equation below reaches equilibrium in a closed container at a certain temperature.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

The pressure of this system is increased by decreasing the volume while maintaining a constant temperature. The percentage of $NH_3(g)$ in the reaction mixture is recorded and graphed.

The results are indicated below.



The line that shows the correct relationship between the percentage of $NH_3(g)$ in the reaction mixture, and the increasing pressure, is:

A Line A

B Line B

C Line C

D None of the above (2)

1.8 Which ONE of the following solutions has the HIGHEST pH value?

A $0,1\ mol{\cdot}dm^{-3}\ Mg(OH)_2$

B $0,1\ mol{\cdot}dm^{-3}\ NH_3$

C $0,1\ mol{\cdot}dm^{-3}\ HC\ell$

D $0,1\ mol{\cdot}dm^{-3}\ H_2SO_4$ (2)

1.9 Which ONE of the following represents the products formed during the hydrolysis of calcium carbonate?

A $H_3O^+(aq)$ and $CO_3^{2-}(aq)$

B $OH^-(aq)$ and $HCO_3^-(aq)$

C $Ca^{2+}(aq)$ and $CO_3^{2-}(aq)$

D $Ca^{2+}(aq)$ and $OH^-(aq)$ (2)

1.10 Which ONE of the following solutions can be stored in ~~an~~ aluminium container?

A $CuSO_4(aq)$

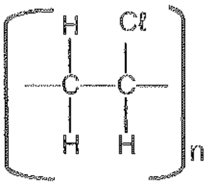
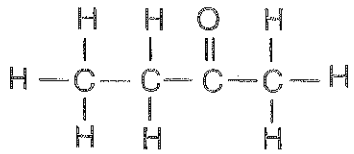
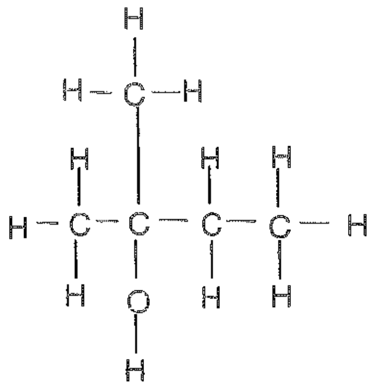
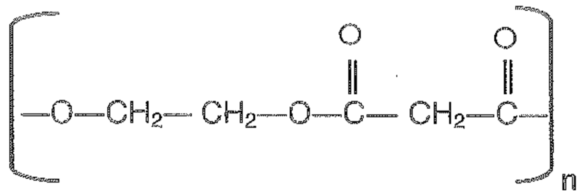
B $ZnSO_4(aq)$

C $NaC\ell(aq)$

D $Pb(NO_3)_2(aq)$ (2)
[20]

QUESTION 2 (Start on a new page.)

Consider the organic compounds represented by the letters **A** to **F** in the table below.

A	$CH_3CH_2CH_2CHO$	**B**	2 – methylbut-2-ene
C		**D**	
E		**F**	

2.1 Write down the LETTER that represents the following:

2.1.1 An addition polymer (1)

2.1.2 A compound that is a functional isomer of compound **D** (1)

2.2 Write down the IUPAC name of the following:

2.2.1 Compound **A** (1)

2.2.2 Compound **E** (2)

2.3 Compound **B** is one of the reactants needed to produce compound **E**.
Write down the ...

2.3.1 NAME or FORMULA for the other reactant needed for this reaction. (1)

2.3.2 structural formula of compound **B**. (3)

2.3.3 type of reaction that takes place. (1)

2.4 The table contains a compound that occurs as a result of condensation polymerisation.

2.4.1 Define the term ***condensation polymerisation***. (2)

2.4.2 Write down the **LETTER** that represents the compound that is a condensation polymer. (1)

[13]

QUESTION 3 (Start on a new page.)

3.1 An organic compound with a molecular formula of C_4H_6 has two positional isomers.

3.1.1 Define the term ***positional isomer***. (2)

3.1.2 Write down the structural formulae of TWO positional isomers of C_4H_6 and also give their IUPAC names. (4)

3.2 Heptane can undergo cracking to form an alkene with three carbon atoms and a branched four-carbon alkane.

3.2.1 Write down a balanced equation using structural formulae. (3)

3.2.2 Write down the IUPAC names of the products formed in this reaction. (2)

3.3 An investigation is conducted to determine the boiling points of different types of homologous series. The table below shows the boiling points of compounds from different homologous series.

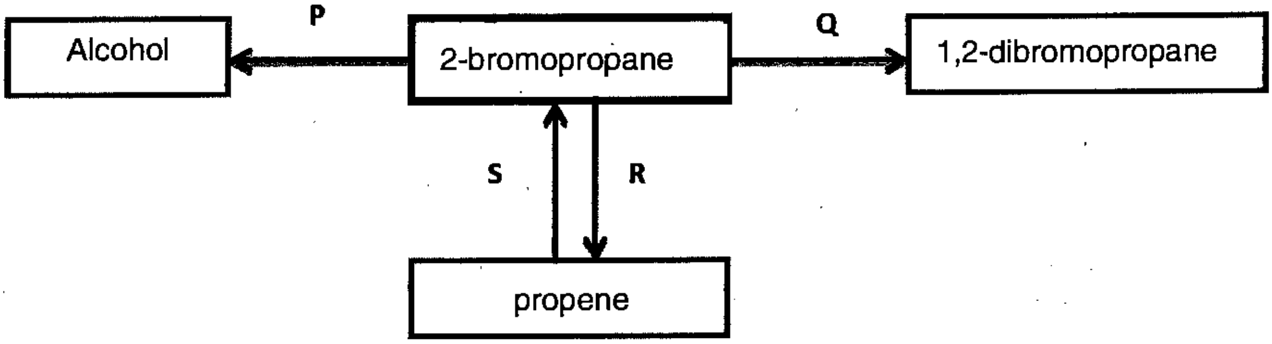
Organic compound	Boiling point (°C)
Propane	-42
Propan-1-ol	97
Propanoic acid	141

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

3.3.2 Explain the difference in boiling points of propan-1-ol and propanoic acid by referring to the TYPE of INTERMOLECULAR FORCES present in the compounds. (3)
[16]

QUESTION 4 (Start on a new page.)

The flow diagram below shows various chemical reactions of haloalkanes. P, Q and R represent reaction types.



4.1 Write down the type of reaction represented by:

4.1.1 **Q** (1)

4.1.2 **R** (1)

4.2 For reaction **P**, write down the following:

4.2.1 The structural formula of the alcohol formed (2)

4.2.2 The IUPAC name of the alcohol formed (1)

4.3 In reaction **S**, propene reacts with compound X to form 2-bromopropane.

Write down the:

4.3.1 **NAME** of compound X (1)

4.3.2 Balanced equation using structural formulae (4)
[10]

QUESTION 5 (Start on a new page.)

Learners perform **THREE** investigations (**A**, **B** and **C**) to study THREE factors which affect the rate of a chemical reaction. They use the reaction between solid calcium carbonate ($CaCO_3$) and EXCESS hydrochloric acid ($HC\ell$) solution, represented by the balanced equation below, in all three investigations.

$$CaCO_3(s) + 2HC\ell(aq) \longrightarrow CaC\ell_2(aq) + H_2O(\ell) + CO_2(g)$$

The calcium carbonate is **COMPLETELY COVERED** in all the investigations.

5.1 **INVESTIGATION A:**

The learners conduct two experiments using the conditions as shown in the table below.

	Mass of $CaCO_3$ (g)	State of $CaCO_3$	Concentration of $HC\ell$ ($mol\cdot dm^{-3}$)	Temperature of $HC\ell$ (°C)
Experiment 1	2	powder	0,2	25
Experiment 2	2	lumps	0,2	25

5.1.1 Which factor influencing reaction rate is being investigated? (1)

5.1.2 The learners now repeat **Experiment 1**, but use 4 g of calcium carbonate in excess acid, instead of 2 g. They find that the rate of the reaction **INCREASES.**

Use the collision theory to explain why the rate increases. (3)

5.1.3 If the learners do NOT use excess acid in the reaction of the 4 g of calcium carbonate, they find that 15% of the mass of the original sample of $CaCO_3$ remains unreacted after completion of the reaction.

Calculate the volume of acid (in dm^3) of the given concentration needed to react with the remaining calcium carbonate. (5)

5.2 **INVESTIGATION B:**

The learners conduct two experiments using the conditions in the table below.

	Mass of $CaCO_3$ (g)	State of $CaCO_3$	Concentration of HCℓ ($mol{\cdot}dm^{-3}$)	Temperature of HCℓ (°C)
Experiment 3	2	lumps	0,2	25
Experiment 4	2	lumps	1,0	25

5.2.1 Identify the independent variable in this investigation **B**. (1)

5.2.2 The reactions in both **experiments 3** and **4** run to completion.

How will the yield of CO_2 produced in **experiment 4** compare that of **experiment 3**?

Write down SMALLER THAN, LARGER THAN or EQUAL TO. (1)

5.2.3 Give a reason for your answer to QUESTION 5.2.2 (1)

5.3 **INVESTIGATION C:**

The learners conduct two experiments using the conditions as shown below.

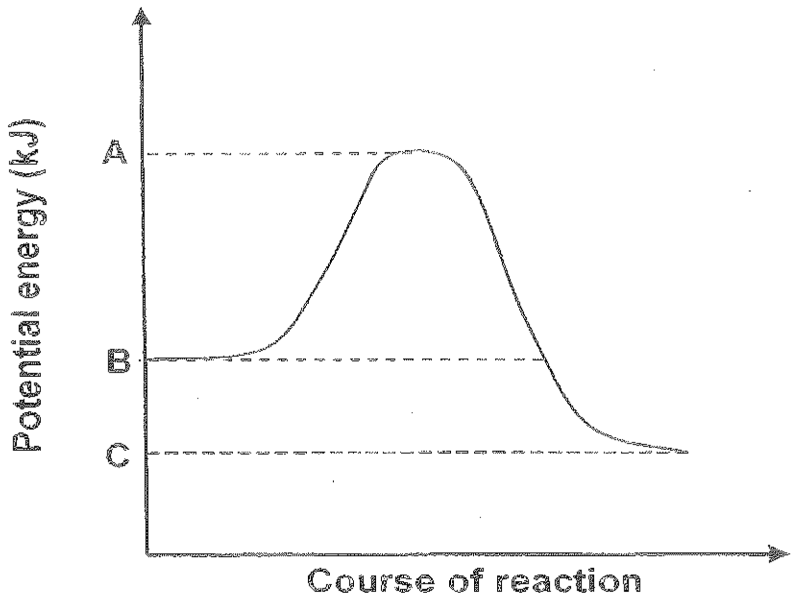
	Mass of $CaCO_3$ (g)	State of $CaCO_3$	Concentration of HCℓ ($mol{\cdot}dm^{-3}$)	Temperature of HCℓ (°C)
Experiment 5	4	powder	0,2	25
Experiment 6	4	powder	0,2	35

5.3.1 In which **experiment**, **5** or **6**, will the particles have the highest kinetic energy? (1)

5.3.2 On the same set of axes, draw sketch graphs of the number of molecules versus kinetic energy (also known as a Maxwell-Boltzmann distribution curve) for each of **experiment 5** and **experiment 6.**

- Label both axes
- **Clearly** label each graph as **experiment 5** and **experiment 6** (3)

5.4 The graph below shows changes in potential energy for the reaction between calcium carbonate and hydrochloric acid.



5.4.1 Is this reaction exothermic or endothermic? (1)

5.4.2 Give a reason for your answer to QUESTION 5.4.1. (1)
[18]

QUESTION 6 (Start on a new page.)

A certain amount of nitrogen monoxide gas and oxygen gas react in a 50 cm^3 closed container at 230 °C to form nitrogen dioxide gas. The reaction reaches equilibrium according to the following balanced equation:

$$2\,NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = -114\ kJ\cdot mol^{-1}$$

colourless brown

At 230 °C, the equilibrium constant for this reaction is 6,44 x 10^5.

6.1 Initially, 1 mol of NO(g) and an unknown quantity of O_2(g) were placed in the container. At equilibrium, the **number of particles** of NO(g) present is 3,01 x 10^{21} . Calculate the initial number of moles of O_2(g) placed in the container. (9)

6.2 The above reaction is the second step of the Ostwald process. What would be the significance of such a high K_c for the industrial production of NO_2 (g)? (1)

6.3 Will the colour of the mixture of gases become LIGHTER or DARKER as the temperature is decreased to room temperature? (1)

6.4 Using Le Chatelier's principle, explain the answer to QUESTION 6.3. (3)

6.5 How will a change in the pressure of the gases influence the equilibrium constant at room temperature?

Write down only **INCREASES, DECREASES** or **NO EFFECT.** (1)

[15]

QUESTION 7 (Start on a new page.)

7.1 Define a ***Brønsted-Lowry base.*** (2)

7.2 7.2.1 Calculate the pH of a 0,12 mol·dm^{-3} HCℓ solution. (3)

7.2.2 Write down the **FORMULA** for the conjugate base of HCℓ. (1)

7.3 7.3.1 Why is HSO_4^- regarded as an ampholyte? (1)

7.3.2 Write down an equation for the reaction of HSO_4^- with water to form the hydronium ion. (3)

7.4 Bongiwe and Sam plan to do a titration. Prior to the titration each of them prepares a burette using the method given in the table below.

Bongiwe	Sam
She rinses the burette with the acid before filling it to the mark with acid.	He rinses the burette with water before filling it to the mark with acid.

Explain why Sam used an **INCORRECT** method. (1)

7.5 A solution of potassium hydroxide is made by dissolving 8,0 g of potassium hydroxide in 250 cm^3 of distilled water.

7.5.1 Calculate the concentration of the potassium hydroxide solution. (3)

7.5.2 25,0 cm^3 of this solution prepared as above is titrated and neutralised against 40,0 cm^3 of a DILUTE sulphuric acid solution.

The reaction is as follows:

$$H_2SO_4\,(aq) + 2KOH\,(aq) \longrightarrow K_2SO_4(aq) + 2H_2O(\ell)$$

Calculate the concentration of the **DILUTE** acid. (4)

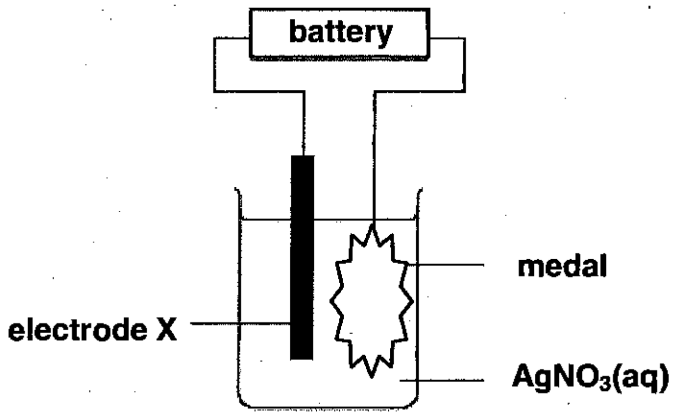
7.5.3 The dilute sulphuric acid solution in QUESTION 7.5.2 was prepared by adding 10,0 cm^3 of concentrated sulphuric acid to 490,0 cm^3 of distilled water.

Calculate the concentration of the **CONCENTRATED** acid. (4)

[22]

QUESTION 8 (Start on a new page.)

The simplified diagram below represents an electrolytic cell used to electroplate a medal with a thin layer of silver.



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

8.2 Which electrode (ANODE or CATHODE) must the medal be? Explain how you arrived at your answer. (3)

8.3 Write down the

8.3.1 NAME or SYMBOL of the element of which electrode X is made. (1)

8.3.2 equation of the half-reaction that takes place at the medal. (2)

8.4 Write down the visible changes that will occur at the following:

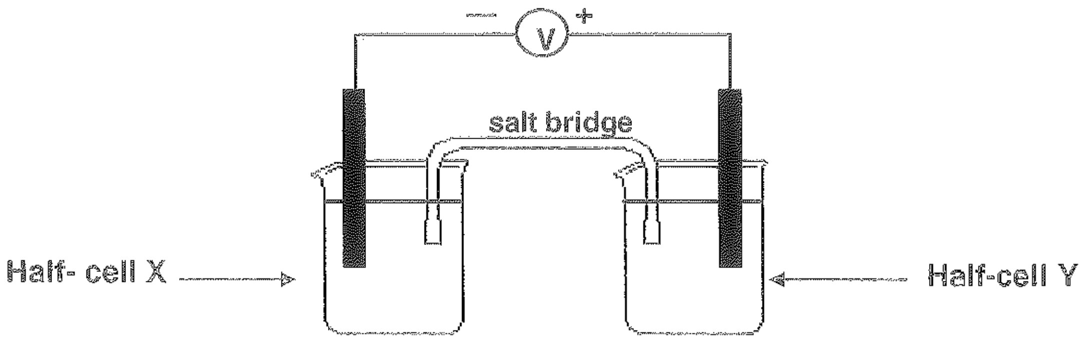
8.4.1 Electrode X (1)

8.4.2 The medal (1)

8.5 Explain why the concentration of the electrolyte remains constant during electroplating. (2)
[11]

QUESTION 9 (Start on a new page.)

Learners use an electrochemical cell as shown in the diagram below in an investigation to compare the reducing abilities of different metals.



9.1 Name the type of electrochemical cell depicted in the above diagram. (1)

9.2 What will the voltmeter reading be if the salt bridge is removed? (1)

9.3 Name TWO conditions that will need to be kept constant during this investigation. (2)

9.4 What will be the independent variable in this investigation? (1)

In their investigation, they use different combinations of the three half-cells in the table below to compare the reducing abilities of Cu, Zn and Aℓ. The cell potential for each combination of half-cells is recorded in the table.

COMBINATION	HALF-CELL X	HALF-CELL Y	VOLTMETER READING (V)
1	Cu/Cu^{2+}	$A\ell/A\ell^{3+}$	-1,8
2	$A\ell/A\ell^{3+}$	Zn/Zn^{2+}	+0,8
3	Zn/Zn^{2+}	Cu/Cu^{2+}	+1,0

9.5 Write down a

9.5.1 possible reason why the voltmeter reading for the copper-aluminium cell is negative. (2)

9.5.2 suitable conclusion for this investigation. (2)

9.6 Write down the NAME or SYMBOL of the

9.6.1 metal which is oxidised in cell 2. (1)

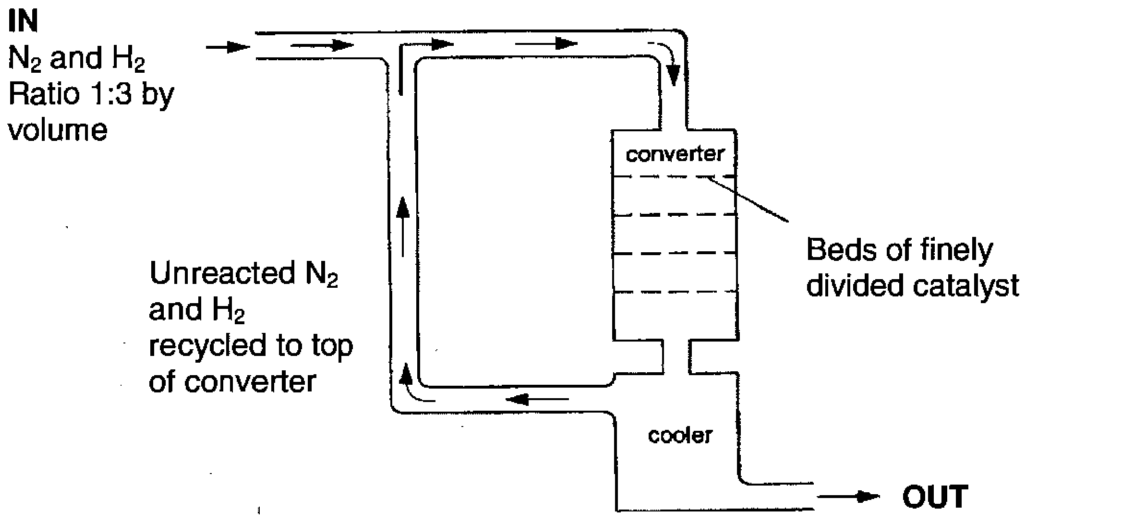
9.6.2 reducing agent in cell 3. (1)

9.7 Omitting spectator ions, write down a balanced equation for the net (overall) cell reaction taking place in cell 2. (3)

[14]

QUESTION 10 (Start on a new page.)

The diagram below illustrates the Haber process for the preparation of ammonia.



From "O level chemistry" SAP.

10.1 10.1.1 NAME the catalyst used in this process. (1)

10.1.2 Using the COLLISION THEORY, explain why the FINELY DIVIDED catalyst will be more effective than a LARGE SOLID catalyst of the same mass. (2)

10.1.3 Give ONE reason, other than cost, why the unreacted nitrogen and hydrogen are recycled. (2)

10.2 A farmer adds calcium hydroxide, $Ca(OH)_2$, and ammonium sulphate, $(NH_4)_2SO_4$ alternately to the soil.

10.2.1 Explain the USE of EACH substance. (2)

10.2.2 The following reaction can occur when these two substances react:

$$Ca(OH)_2(aq) + (NH_4)_2SO_4(aq) \longrightarrow CaSO_4(s) + 2\,NH_3(g) + 2H_2O(\ell)$$

Explain why the farmer should NOT add both substances at the same time. (1)

10.3 In one of the steps of the Ostwald process, the following reaction takes place,

$$4NO(g) + 2H_2O(\ell) + 3O_2(g) \longrightarrow 4HNO_3(aq)$$

Calculate the maximum mass of nitric acid which can be made from 720 dm^3 of nitrogen(II)oxide (NO) at room temperature.
Assume that the molar gas volume at room temperature is 24 dm^3. (3)
[11]

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*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$n=\frac{V}{V_m}$	$c=\frac{n}{V}$ or/*of* $c=\frac{m}{MV}$
$pH = -\log[H_3O^+]$	$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K
$\frac{C_aV_a}{C_bV_b}=\frac{n_a}{n_b}$	
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ 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
Symbol / *Simbool*	Cu
Approximate relative atomic mass / *Benaderde relatiewe atoommassa*	63,5
Electronegativity / *Elektronegatiwiteit*	1,9

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 **H** 1 (2,1)																	2 **He** 4
3 **Li** 7 (1,0)	4 **Be** 9 (1,5)											5 **B** 11 (2,0)	6 **C** 12 (2,5)	7 **N** 14 (3,0)	8 **O** 16 (3,5)	9 **F** 19 (4,0)	10 **Ne** 20
11 **Na** 23 (0,9)	12 **Mg** 24 (1,2)											13 **Aℓ** 27 (1,5)	14 **Si** 28 (1,8)	15 **P** 31 (2,1)	16 **S** 32 (2,5)	17 **Cℓ** 35,5 (3,0)	18 **Ar** 40
19 **K** 39 (0,8)	20 **Ca** 40 (1,0)	21 **Sc** 45 (1,3)	22 **Ti** 48 (1,5)	23 **V** 51 (1,6)	24 **Cr** 52 (1,6)	25 **Mn** 55 (1,5)	26 **Fe** 56 (1,8)	27 **Co** 59 (1,8)	28 **Ni** 59 (1,8)	29 **Cu** 63,5 (1,9)	30 **Zn** 65 (1,6)	31 **Ga** 70 (1,6)	32 **Ge** 73 (1,8)	33 **As** 75 (2,0)	34 **Se** 79 (2,4)	35 **Br** 80 (2,8)	36 **Kr** 84
37 **Rb** 86 (0,8)	38 **Sr** 88 (1,0)	39 **Y** 89 (1,2)	40 **Zr** 91 (1,4)	41 **Nb** 92	42 **Mo** 96 (1,8)	43 **Tc** (1,9)	44 **Ru** 101 (2,2)	45 **Rh** 103 (2,2)	46 **Pd** 106 (2,2)	47 **Ag** 108 (1,9)	48 **Cd** 112 (1,7)	49 **In** 115 (1,7)	50 **Sn** 119 (1,8)	51 **Sb** 122 (1,9)	52 **Te** 128 (2,1)	53 **I** 127 (2,5)	54 **Xe** 131
55 **Cs** 133 (0,7)	56 **Ba** 137 (0,9)	57 **La** 139	72 **Hf** 179 (1,6)	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 **Tℓ** 204 (1,8)	82 **Pb** 207 (1,8)	83 **Bi** 209 (1,9)	84 **Po** (2,0)	85 **At** (2,5)	86 **Rn**
87 **Fr** (0,7)	88 **Ra** 226 (0,9)	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**

P.T.O.

TABLE 4A: STANDARD REDUCTION POTENTIALS / *TABEL 4A: STANDAARD REDUKSIEPOTENSIALE*

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

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

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

Half-reactions/*Halfreaksies*	E^θ (V)
$Li^+ + e^- \rightleftharpoons Li$	− 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
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**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

END