GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION
PREPARATORY EXAMINATION
2016

10842

PHYSICAL SCIENCES: CHEMISTRY

SECOND PAPER

TIME: **3 hours**

MARKS: **150**

17 pages + 4 information sheets

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(Second Paper)

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INSTRUCTIONS AND INFORMATION:

1. Write your name in the appropriate space on the ANSWER BOOK.

2. This question paper consists of 11 questions. Answer ALL the questions in the ANSWER BOOK.

3. Start the answer to each question on a NEW page.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line open between 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.

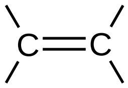
11. Give brief discussions, et cetera where required.

12 Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

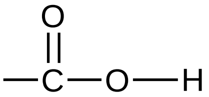
Four options are given as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 Which ONE of the following is the functional group of the carboxylic acids?

A 

B —O—H

C —C≡C—

D 

$$-\overset{\overset{\displaystyle O}{||}}{C}-O-H$$

(2)

1.2 Consider the reaction represented below:

$$HC\ell O_2 + H_2O \rightleftharpoons H_3O^+ + C\ell O_2^-$$

Which **ONE** of the following is a conjugate acid-base pair in the above reaction?

A $HC\ell O_2$ and $C\ell O_2^-$

B $HC\ell O_2$ and H_2O

C $C\ell O_2^-$ and H_3O^+

D $HC\ell O_2$ and H_3O^+ (2)

1.3 Which **ONE** of the following compounds has the highest boiling point?

A CH_3CH_3

B $CH_3CH_2CH_3$

C $CH_3CH_2CH_2CH_3$

D $CH_3CH_2CH_2CH_2CH_3$ (2)

1.4 A learner leaves a coil of copper wire overnight in a clear solution of silver nitrate. The next morning the learner observes that the solution turned blue. Which **ONE** of the equations below represents the reaction that takes place?

A $Cu + Ag^+ \rightarrow Cu^+ + Ag$

B $2Ag + Cu^{2+} \rightarrow Cu + 2Ag^+$

C $2Ag^+ + Cu^+ \rightarrow 2Ag + Cu^{2+}$

D $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2Ag$ (2)

1.5 The half-reactions below take place in an electrochemical cell.

$$Pt^{2+} + 2e^- \rightarrow Pt$$

$$Cs^+ + e^- \rightarrow Cs$$

Which **ONE** of the statements below is **TRUE** for this cell when it delivers current?

A The mass of the Cs electrode increases.

B Pt^{2+} undergoes oxidation more easily than Cs.

C Pt^{2+} undergoes reduction more easily than Cs^+.

D Electrons will flow from the Pt electrode to the Cs electrode in the external circuit. (2)

1.6 Two reactions, **X** and **Y**, represented below reach equilibrium in two separate, sealed containers.

Reaction **X**: $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$

Reaction **Y**: $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

The pressure in both containers is increased by decreasing the volume of the container. How will the number of moles of the products in each container change?

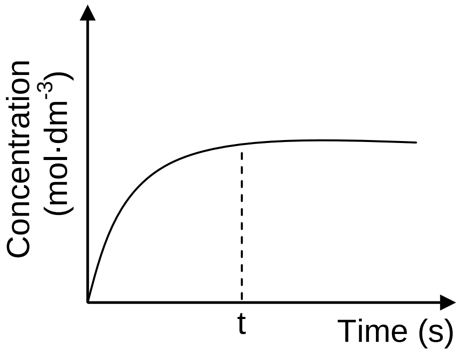
	X	**Y**
A	Increases	Decreases
B	Stays the same	Increases
C	Stays the same	Decreases
D	Increases	Stays the same

(2)

1.7 Carbon monoxide, CO(g), and hydrogen, H_2(g), react in a closed container to form methanol, CH_3OH(g), according to the following balanced equation:

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The graph below shows the change in concentration of methanol with time.



Which **ONE** of the following statements, best explains the horizontal section of the graph after time *t*?

A The forward reaction has stopped.
B The rates of the forward and reverse reactions are equal.
C There is no CO(g) left to react with the H_2(g).
D All the reacting gases have been converted to methanol. (2)

1.8 When base **X** is titrated against acid **Y**, the pH of the solution at the end point is 8. Which ONE of the following represents base X and acid **Y**?

	X	**Y**
A	NaOH	CH_3COOH
B	Na_2CO_3	$HC\ell$
C	NaOH	H_2SO_4
D	Na_2CO_3	CH_3COOH

(2)

1.9 Two of the half-reactions below take place in a standard electrochemical cell with an emf of 1,2 V.

$R^+ + e^- \rightleftharpoons R$ $E^{\theta}_{red} = -1{,}5\ V$

$P^{2+} + 2e^- \rightleftharpoons P$ $E^{\theta}_{red} = -0{,}3\ V$

$Q^+ + e^- \rightleftharpoons Q$ $E^{\theta}_{red} = -0{,}9\ V$

$S^{2+} + 2e^- \rightleftharpoons S$ $E^{\theta}_{red} = +1{,}5\ V$

The cell notation of this cell is:

A $S(s)|S^{2+}(aq)||P^{2+}(aq)|P(s)$

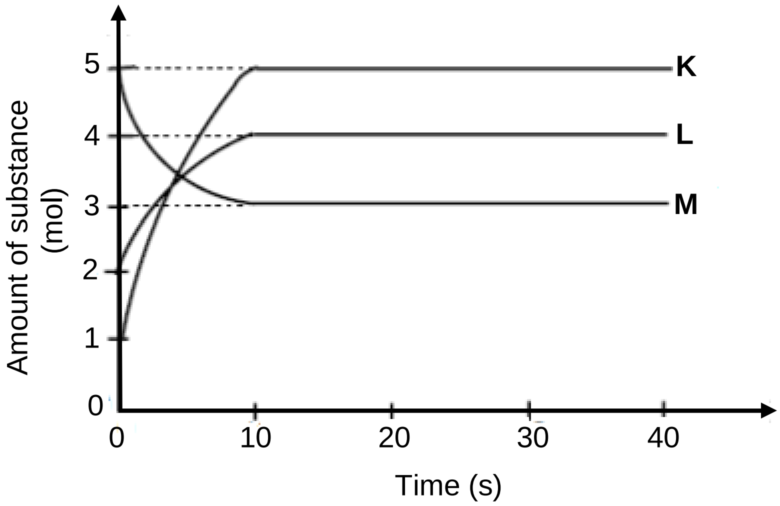
B $P(s)|P^{2+}(aq)||Q^+(aq)|Q(s)$

C $R(s)|R^+(aq)||S^{2+}(aq)|S(s)$

D $R(s)|R^+(aq)||P^{2+}(aq)\ |\ \ (s)$

(2)

1.10 The graph below shows the relationship between the amount of substance and time in a chemical reaction involving substances K, L and M.



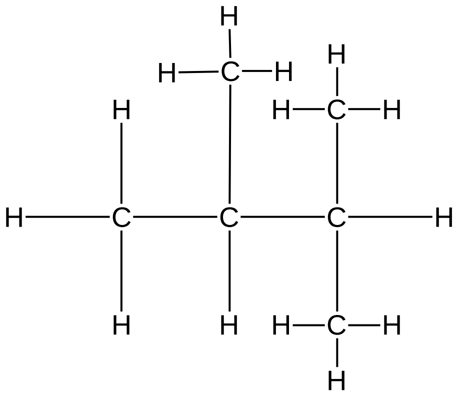
The equation for the reaction can be represented as:

A $3M \rightarrow 4K + 5L$
B $5M \rightarrow 2K + L$
C $M \rightarrow 2K + L$
D $M \rightarrow K + 2L$

(2)
[20]

QUESTION 2

2.1 Consider the structural formula of an organic compound below.

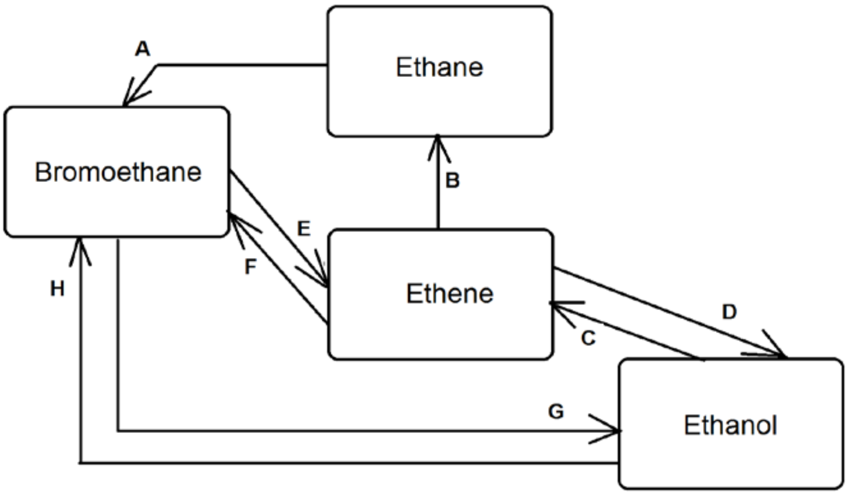


2.1.1 Is the above compound a SATURATED or an UNSATURATED hydrocarbon? Give a reason for the answer. (2)

2.1.2 Write down the IUPAC name of the above compound. (2)

2.2 Draw the structural formula of 4,4-dimethylhexan-2-one. (3)

2.3 In industry ethene is used to synthesise a variety of organic compounds. The flow diagram below illustrates some of the reactions that ethene can undergo.



Write down:

2.3.1 The general formula of the homologous series to which ethene belongs. (1)

2.3.2 A balanced equation, using *structural formulae***,** for reaction **B**. (3)

2.3.3 The type of reaction represented by **G**. (1)

2.3.4 The FORMULA of the inorganic reactant needed for reaction **F**. (1)

2.3.5 The letter that represents a dehydrohalogenation reaction. (1)

2.3.6 How the base used in reaction **E** differs from the base used in reaction **G**. (1)

2.3.7 The NAME or FORMULA of the catalyst used in reaction **C**. (1)
[16]

QUESTION 3

3.1 Write down the name of the homologous series to which each of the following compounds belongs:

3.1.1 CH_3CHO (1)

3.1.2 CH_3COCH_3 (1)

3.2 3.2.1 Define the term *positional isomer*. (2)

3.2.2 Write down the structural formula of an isomer of 1-chloropropane. (2)

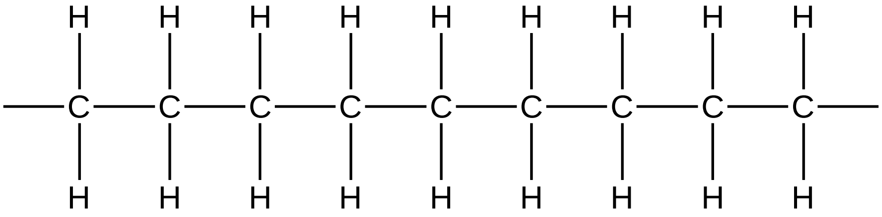
3.3 The compound responsible for a fruity scent, pentyl butanoate, is prepared in the laboratory.

Write down the:

3.3.1 IUPAC names of TWO compounds needed for this preparation. (2)

3.3.2 Type of reaction that takes place. (1)

3.4 Consider the structural formula of a polymer shown below.



$$-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-$$

Write down the:

3.4.1 IUPAC name of this polymer. (1)

3.4.2 Structural formula of the monomer used to prepare this polymer. (1)

3.4.3 Type of polymer of which it is an example. (1)
[12]

QUESTION 4

The table below shows data collected for four organic compounds during two practical investigations. The compounds are represented by the letters **A**, **B, C** and **D**. The boiling point of compound **B** is unknown and recorded as **X**.

Investigation	**Organic compound**		**Relative molecular mass**	**Boiling point (˚C)**
I	**A**	$CH_3CH_2CH_2CH_2CH_3$	72,15	36,1
	B	$CH_3CH(CH_3)CH_2CH_3$	72,15	**X**
II	**C**	$CH_3CH_2CH_2CH_2OH$	74,12	117
	D	CH_3CH_2COOH	74,08	141,2

4.1 For investigation **II**, write down the:

4.1.1 Dependent variable. (1)

4.1.2 Independent variable. (1)

4.1.3 Controlled variable (1)

4.2 Will the boiling point of compound **B**, be HIGHER THAN, LOWER THAN or EQUAL TO the boiling point of compound **A**? (1)

4.3 Fully explain the answer to QUESTION 4.2. (3)

4.4 How will the vapour pressure of compound **C** compare to that of compound **D**? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. (1)

4.5 Fully explain the answer to QUESTION 4.4 (3)

4.6 Write down the STRUCTURAL FORMULA and IUPAC NAME of a FUNCTIONAL isomer of compound **D**. (4)

[15]

QUESTION 5

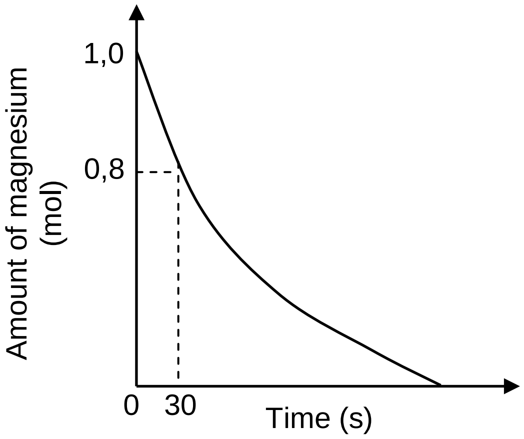
A group of learners use the reaction between magnesium and nitric acid to investigate one of the factors that affects reaction rate. The reaction that takes place is represented by the balanced equation below.

$$Mg(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2(g)$$

They add magnesium ribbon to *dilute* nitric acid and measure the mass of magnesium used per unit time. The experiment is repeated using *concentrated* nitric acid.

5.1 Write down an investigative question for this investigation. (2)

The results obtained for the reaction with dilute nitric acid are represented in the graph below:



5.2 Which substance, **Mg** or **HNO_3**, is in excess? Use the information on the graph to give a reason for the answer. (2)

5.3 Define the term *reaction rate*. (2)

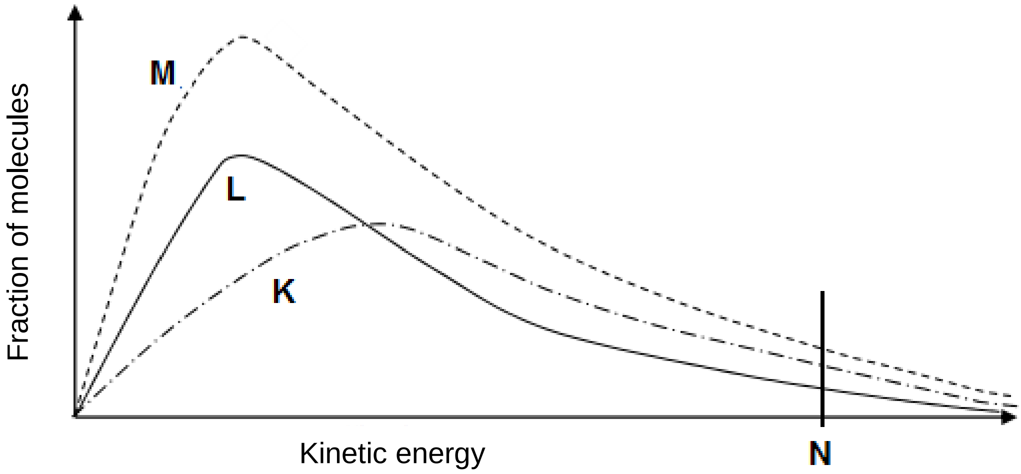
5.4 Calculate the average rate of the reaction (in gram per second) during the first 30 s. (5)

5.5 Copy the above graph in your answer book. On the same set of axes use a **DOTTED LINE** to show the curve that will be obtained when concentrated nitric acid is used. No numerical values are required. (2)

[13]

QUESTION 6

6.1 Curve **L** shown below, is the Maxwell-Boltzman distribution curve for a gas in a closed container at 250 °C.



6.1.1 Name the energy represented by **N**. (1)

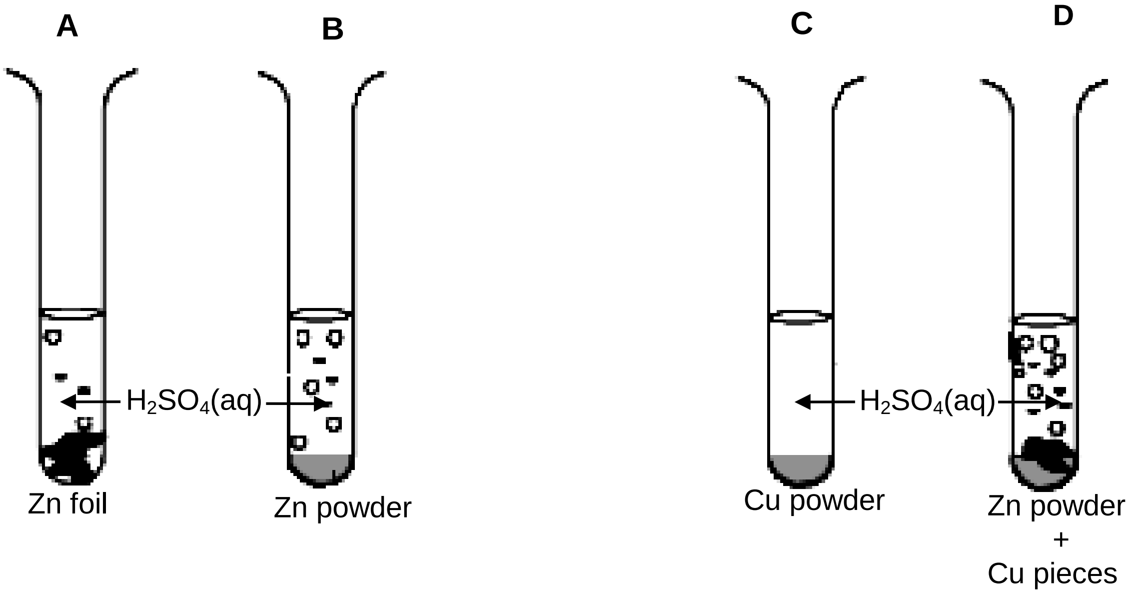
6.1.2 Write down the change in reaction conditions that resulted in:

(a) Curve **M**. (1)

(b) Curve **K**.

Use the collision theory to explain how this change affects the rate of the reaction. (4)

6.2 A series of experiments are carried out to compare the reactions of zinc foil, zinc powder, copper powder and a mixture of zinc powder and copper pieces with dilute sulfuric acid of concentration 1 mol·dm^{-3}. Hydrogen gas is produced in all test tubes where a reaction takes place. The diagram shows the test tubes some time after the metals have been added to the acid.



6.2.1 Refer to the relative strengths of oxidizing agents or reducing agents to explain why no reaction takes place in test tube **C**. (3)

6.2.2 How does the rate of the reaction in test tube **B** compare to that in:
(Choose from GREATER THAN, SMALLER THAN or EQUAL TO.)

(a) Test tube **A**?
Give a reason for your answer. (2)

(b) Test tube **D**?
Give a reason for your answer. (2)

[13]

QUESTION 7

7.1 The reaction represented below reaches equilibrium in a closed container.

$$4C(s) + 5H_2(g) \rightleftharpoons C_4H_{10}(g)$$

The equilibrium constants for this reaction at two different temperatures are given in the table below.

TEMPERATURE (K)	**EQUILIBRIUM CONSTANT (K_c)**
400	$1,58 \times 10^{-3}$
600	$1,58 \times 10^{-9}$

7.1.1 Is the forward reaction ENDOTHERMIC or EXOTHERMIC? (1)

7.1.2 Use Le Chatelier's principle to explain your answer in QUESTION 7.1.1. (3)

7.1.3 The pressure in the container is now decreased by increasing the volume of the container. What effect will this have on the value of the equilibrium constant?

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

7.1.4 Give a reason for the answer to QUESTION 7.1.3. (1)

7.2 Exactly 24,0 mol $SO_3(g)$ is sealed in an empty 2,0 dm^3 container. The reaction reaches equilibrium at 700 K after 8 minutes according to the following balanced equation.

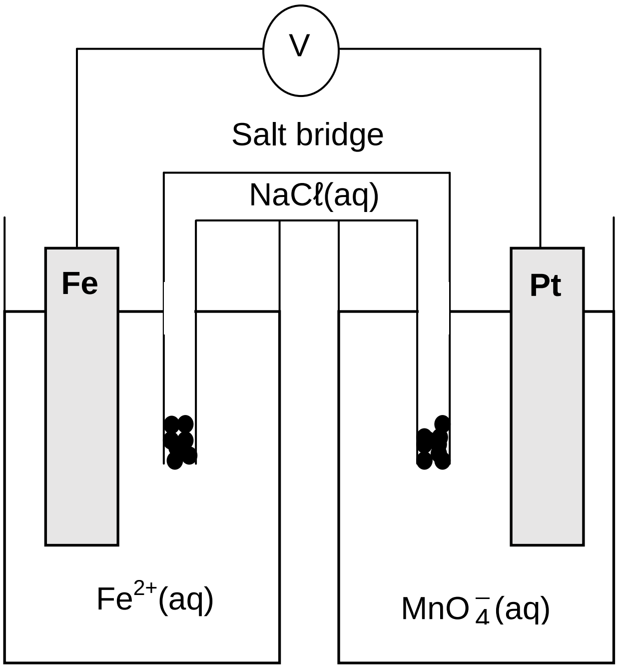
$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$$

If the reaction mixture contains 10,0 mol $O_2(g)$ at equilibrium at 700 K, calculate the equilibrium constant (K_c) at 700 K. (7)

[13]

QUESTION 8

An electrochemical cell is set up as shown in the diagram below.



8.1 What is the function of the salt bridge? (1)

8.2 Briefly explain the main difference between the cell illustrated above and an electrolytic cell by referring to the energy transferred. (2)

8.3 Which electrode, **Fe** or **Pt,** is the cathode? Give a reason for the answer. (2)

8.4 Write down the FORMULA of the reducing agent in this cell. (1)

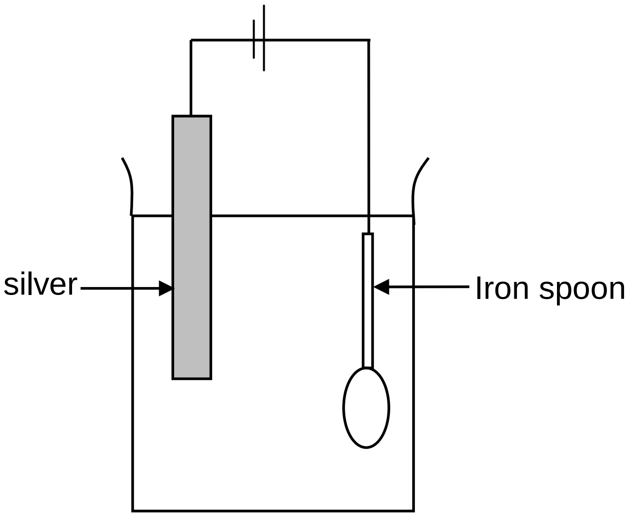
8.5 Write down the overall cell reaction that takes place in this cell. (3)

8.6 Calculate the initial reading on the voltmeter when this cell functions under standard conditions. (4)

[13]

QUESTION 9

The diagram below shows a simplified cell used to electroplate an iron spoon with silver.



9.1 Define the term *electrolyte*. (2)

9.2 Write down the:

- 9.2.1 NAME of a substance that can be used as electrolyte in this cell. (1)
- 9.2.2 NAME or FORMULA of the substance which is oxidised. (1)
- 9.2.3 Half-reaction that takes place at the cathode. (2)

9.3 Calculate the number of electrons transferred if 2 gram of silver is plated on the spoon. (4)

[10]

QUESTION 10

10.1 A factory accidentally spills sulphuric acid into a nearby river. The fish species in the river CANNOT survive in water with a pH LOWER THAN 5,8.

Analysis of water samples from the river shows that the hydrogen ion concentration is $5{,}6 \times 10^{-6}$ $mol \cdot dm^{-3}$. Show with the aid of a calculation that the fish will not survive in the river. (3)

10.2 A sample of seawater is treated with 500 cm^3 of a 2,5 $mol \cdot dm^{-3}$ sodium hydroxide solution to remove the magnesium ions. The reaction that takes place is represented by the following balanced equation:

$$Mg(NO_3)_2(aq) + 2NaOH(aq) \rightarrow Mg(OH)_2(s) + 2NaNO_3(aq)$$

After removal of the precipitate, the excess NaOH(aq) is titrated with 95 cm^3 of a 0,2 $mol \cdot dm^3$ sulphuric acid solution. The balanced equation for the reaction is:

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

Calculate the:

10.2.1 Number of moles sodium hydroxide added to the seawater. (3)

10.2.2 Original mass of magnesium nitrate in the seawater. (6)

[12]

QUESTION 11

11.1 A fertilizer bag is labelled 1:4:2(30).

Explain the meaning of the:

11.1.1 Ratio, 1:4:2. (2)

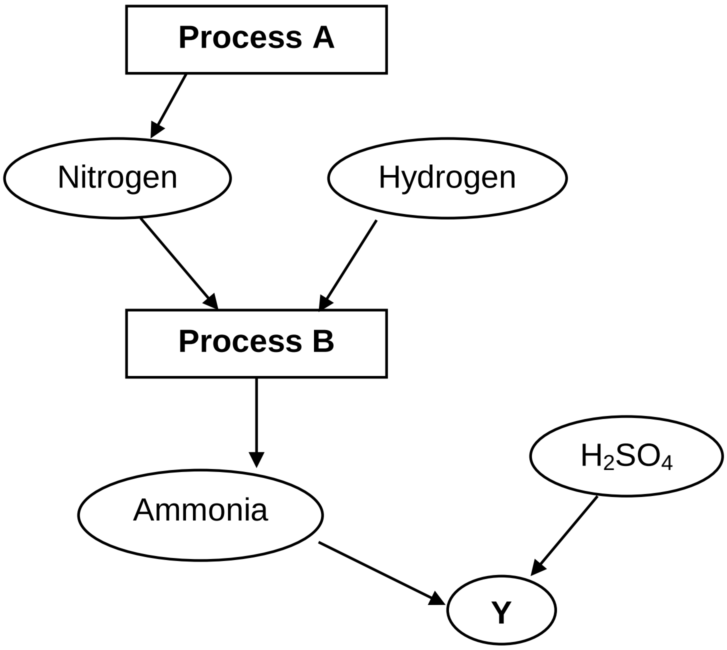
11.1.2 Value in brackets (30). (1)

11.2 Consider the two nitrogen containing fertilisers:

Ammonium nitrate:	NH_4NO_3
Urea:	$(NH_2)_2CO$

Which of the above fertilisers will provide the greatest amount of nitrogen per kg of fertiliser used? (4)

11.3 The flow diagram below shows two industrial processes, **A** and **B,** used in the production of fertilizers.



Write down the:

11.3.1 NAME of process **A**. (1)

11.3.2 Balanced equation for the reaction that takes place in the process **B**. (3)

11.3.3 FORMULA and the NAME of the fertilizer represented by **Y**. (2)

[13]

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*

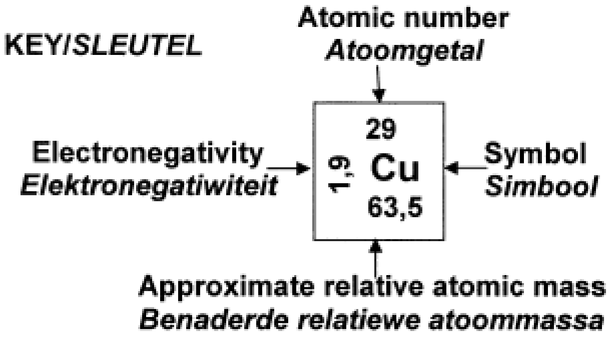
NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure ***Standaarddruk***	p^{θ}	$1{,}013 \times 10^{5}$ Pa
Molar gas volume at STP ***Molêre gasvolume by STD***	V_m	$22{,}4\ dm^{3}\cdot mol^{-1}$
Standard temperature ***Standaardtemperatuur***	T^{θ}	273 K
Charge on electron	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's' number		$6{,}02\times10^{23}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n=\frac{m}{M}$	$n=\frac{N}{N_A}$
$c=\frac{n}{V}$ or $c=\frac{m}{MV}$	$n=\frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b}=\frac{n_a}{n_b}$	pH = -log[H_3O^+]
$E^{\theta}_{cell}=E^{\theta}_{cathode}-E^{\theta}_{anode}$ / $E^{\theta}_{sel}=E^{\theta}_{katode}-E^{\theta}_{anode}$ $E^{\theta}_{cell}=E^{\theta}_{reduction}-E^{\theta}_{oxidation}$ / $E^{\theta}_{sel}=E^{\theta}_{reduksie}-E^{\theta}_{oksidasie}$ $E^{\theta}_{cell}=E^{\theta}_{oxidising\,agent}-E^{\theta}_{reducing\,agent}$ / $E^{\theta}_{sel}=E^{\theta}_{oksideermiddel}-E^{\theta}_{reduseermiddel}$	

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

KEY/*SLEUTEL*



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^{θ} (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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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

Increasing oxidising ability/*Toenemende oksiderende 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
$\mathbf{2H^{+} + 2e^{-} \rightleftharpoons H_2(g)}$	**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
$Pt^{2+} + 2\ e^{-} \rightleftharpoons Pt$	+ 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
$H_2O_2 + 2H^{+} +2\ e^{-} \rightleftharpoons 2H_2O$	+1,77
$Co^{3+} + e^{-} \rightleftharpoons Co^{2+}$	+ 1,81
$F_2(g) + 2e^{-} \rightleftharpoons 2F^{-}$	+ 2,87

Increasing reducing ability/*Toenemende reduserende vermoë*

END