Education and Sport Development

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NORTH WEST PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages, 4 data sheets and 1 graph sheet.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on your ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK, except for QUESTION 6.3 which should be answered on the included GRAPH SHEET. Write your name on this sheet in the space provided and insert it inside the back cover of your 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. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Consider the organic compounds below:

(i) C_3H_8 (ii) C_5H_{12}

Which ONE of the following statements does NOT apply to these compounds? They ...

A both burn in oxygen.

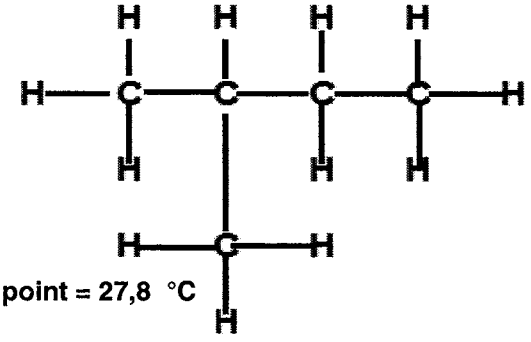
B are both unsaturated.

C are both alkanes.

D are both hydrocarbons. (2)

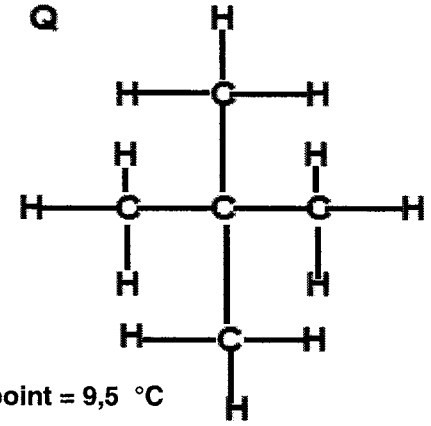
1.2 TWO isomers of C_5H_{12} and their respective boiling points are shown below:

P



Boiling point = 27,8 °C

Q



Boiling point = 9,5 °C

Which ONE of the following statements is CORRECT about the structural formula of compound Q above? It has:

A Less side chains and weaker intermolecular forces

B More side chains and weaker intermolecular forces

C Less side chains and greater intermolecular forces

D More side chains and greater intermolecular forces (2)

1.3 Activation energy can best be described as the minimum energy required to ...

A make reactant molecules to collide.

B cause effective collisions.

C change the orientation of reactant molecules.

D increase the kinetic energy of reactant molecules. (2)

1.4 Which ONE of the following reaction conditions is suitable for the dehydrohalogenation of haloalkanes?

A No water should be present

B Presence of the catalyst H_2SO_4

C Strongly heated under reflux with ethanolic KOH/NaOH

D React with aqueous sodium hydroxide or potassium hydroxide (2)

1.5 The table below shows pH ranges of some indicators in acid and basic solutions.

INDICATORS	**pH RANGES**
Methyl orange	3,1 – 4,4
Methyl red	4,2 – 6,2
Bromothymol blue	6,0 – 7,8
Phenolphthalein	8,3 – 10,0

The indicator best suited for the titration of ethanoic acid against a solution of sodium hydroxide, is ...

A methyl orange.

B methyl red.

C bromothymol blue.

D phenolphthalein. (2)

1.6 Which ONE of the following is the correct balanced equation for the combustion of sulphur (IV) dioxide?

A $2SO_2(g) + 2O_2(g) \rightarrow 2SO_3(g)$

B $2SO_2(g) + 2O_2(g) \rightarrow SO_3(g)$

C $SO_2(g) + 2O_2(g) \rightarrow 2SO_3(g)$

D $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$ (2)

1.7 Consider the following redox reaction:

$$H_2S(g) + 2FeCl_3(aq) \rightarrow 2FeCl_2(aq) + S(s) + 2HCl(aq)$$

The oxidation half-reaction for the above reaction is ...

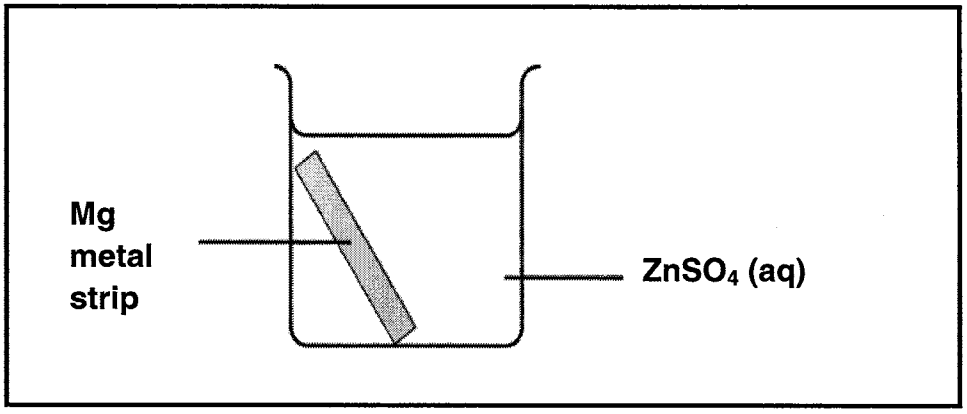
A $H_2S \rightarrow S + 2H^+ + 2e^-$.

B $Fe^{3+} + e^- \rightarrow Fe^{2+}$.

C $S + 2H^+ + 2e^- \rightarrow H_2S$.

D $Cl_2 + 2e^- \rightarrow 2Cl^-$. (2)

1.8 A strip of magnesium metal is placed in a zinc sulphate ($ZnSO_4$) solution.



The reaction that takes place is represented by the equation below:

$$Mg(s) + ZnSO_4(aq) \rightarrow MgSO_4(g) + Zn(s)$$

According to the above reaction ...

A Zn is the oxidising agent.

B Mg is the oxidising agent.

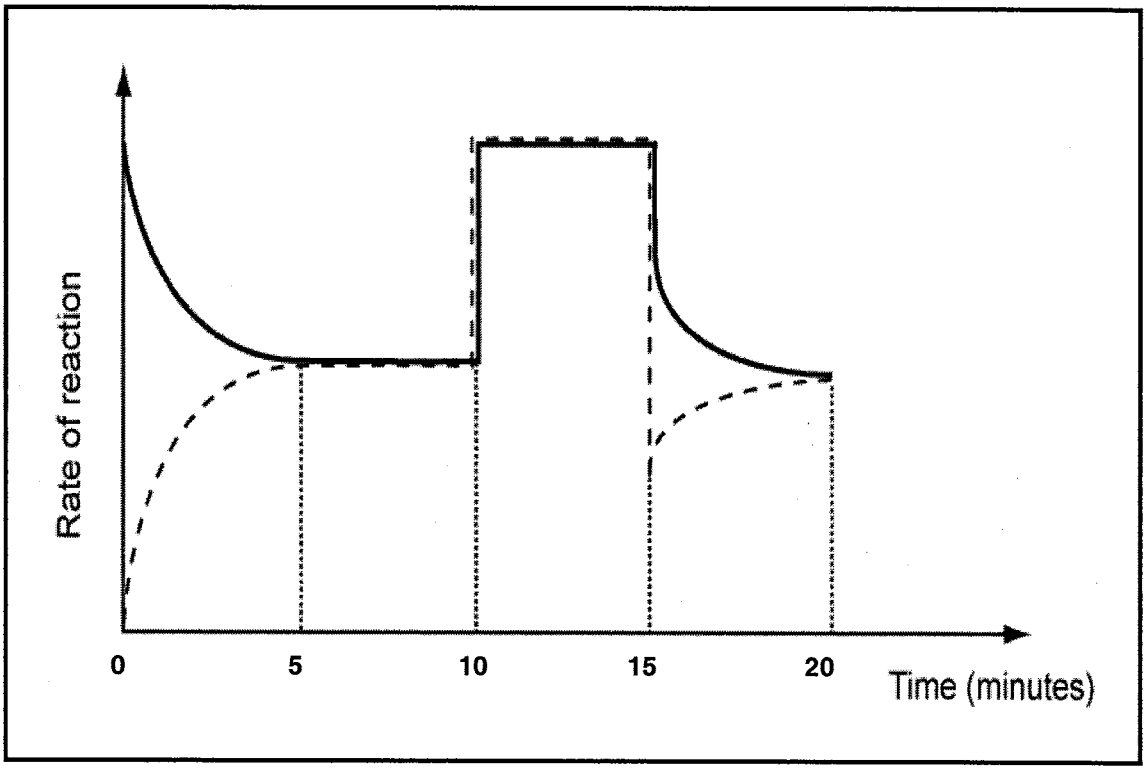
C Mg is reduced.

D Zn is oxidised. (2)

1.9 The following reversible reaction reaches equilibrium in a closed container:

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

Equilibrium was first established after 5 minutes. (The broken line represents the reverse reaction.)



What change in the conditions was made at t = 10 minutes to cause the rate of **both** the forward and the reverse reactions to increase by the same amount?

A Temperature was increased

B A catalyst was added

C Temperature was decreased

D Pressure was increased (2)

1.10 Which ONE of the following terms is TRUE about sulphuric acid?

A Dilute acid

B Weak acid

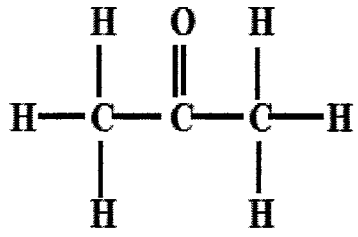
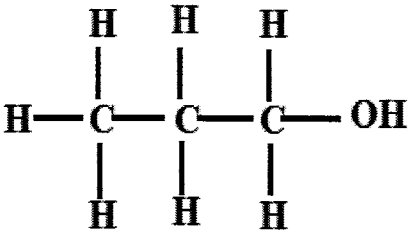
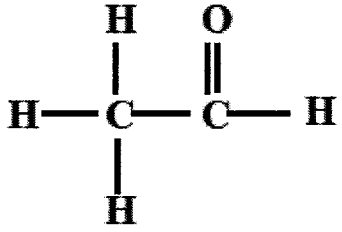
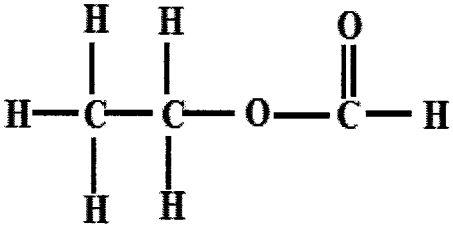
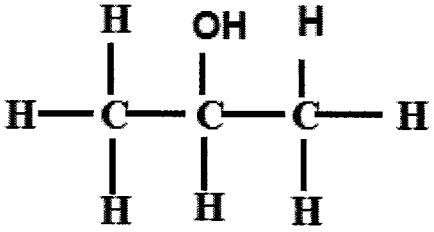
C Diprotic acid

D Triprotic acid (2)

[20]

QUESTION 2 (Start on a new page.)

Study the following organic compounds, represented by the letters **A** to **F** in the table below:

 **A**	**Propanoic acid** **B**	 **C**
 **D**	 **E**	 **F**

2.1 Define the term *functional isomers*. (2)

2.2 Identify **TWO** FUNCTIONAL ISOMERS. Only write down the corresponding LETTERS for the correct answers. (2)

2.3 Compound **B** and **C** react in the presence of an organic acid.

2.3.1 Write down the structural formula of the main organic product. (2)

2.3.2 Name the ORGANIC product. (1)

2.4 Compound **C** undergoes an ELIMINATION reaction in the presence of concentrated sulphuric acid. Use structural formulae to write down a balanced equation for the reaction. (3)

2.5 Name the:

2.5.1 Specific type of ELIMINATION reaction taking place in QUESTION 2.4 (1)

2.5.2 Organic PRODUCT formed (1)

2.6 Write down the following:

2.6.1 The IUPAC name of compound **A** (2)

2.6.2 The homologous series to which compound **D** belongs (1)

[15]

QUESTION 3 (Start on a new page.)

The table shows the data collected for three organic compounds **A**, **B** and **C**, with different functional groups, during a practical investigation.

COMPOUND		MELTING POINTS (°C)
A	CH_3CH_3	–183,3
B	CH_3CH_2OH	–114
C	CH_3COOH	16,6

3.1 Name the following in this investigation:

3.1.1 The independent variable (1)

3.1.2 The dependent variable (1)

3.1.3 The control variable (1)

3.2 Write down the homologous series to which compound **C** belongs. (2)

3.3 Write down the general formula for compound **A**. (2)

3.4 Describe the trend in the melting points from **A** to **C**, as shown in the table. (2)

3.5 Explain the trend in QUESTION 3.4 above. Make reference to INTERMOLECULAR FORCES and ENERGY involved. (5)
[14]

QUESTION 4 (Start on a new page.)

4.1 A sample of the compound 2-bromo-2-methylpropane is dissolved in ethanol in the presence of diluted potassium hydroxide.

4.1.1 Write down the structural formula of 2-bromo-2-methylpropane. (2)

4.1.2 Using structural formulae only, write a balanced equation for the reaction in QUESTION 4.1.1. (3)

4.1.3 Indicate TWO reaction conditions for this chemical reaction. (2)

4.1.4 Name the type of reaction that occurs in QUESTION 4.1.2. (2)

4.2 Polymers are large molecules consisting of repeating monomer units.

4.2.1 What is a *condensation polymer*? (2)

4.2.2 Write down the structural formula for the monomer from which polyvinyl chloride is derived. (2)

4.2.3 Give the name of the monomer. (2)

4.3 Classify the following as addition or condensation polymers:

4.3.1 Polyester (1)

4.3.2 Polyvinylchloride (1)

4.4 State ONE use of polyvinyl chloride. (1)
[18]

QUESTION 5 (Start on a new page.)

5.1 Define an acid in terms of the Brønsted-Lowry theory. (2)

5.2 Consider the reaction below:

$$HF + H_2O \rightleftharpoons H_3O^+ + F^-$$

5.2.1 Identify the reactant which acts as a Brønsted-Lowry base. (1)

5.2.2 Write down the formula of the conjugate acid of the base identified in QUESTION 5.2.1. (1)

5.3 Sulphuric acid (H_2SO_4) is a strong acid.

5.3.1 Explain why sulphuric acid is considered a strong acid. (2)

5.3.2 Calculate the pH of a 0,025 mol.dm^{-3} sulphuric acid solution. (4)

5.4 A certain solution **X**, has a pH of 12,8.

5.4.1 Which of the ions, OH^- or H^+ is in excess? (1)

5.4.2 Acetic acid (CH_3COOH) is added to solution **X**. Is the pH of the solution going to INCREASE, DECREASE or REMAINS THE SAME? (1)

5.5 A learner accidentally spills 15 cm^3 of 0,4 $mol.dm^{-3}$ sulphuric acid solution in the laboratory. He adds 25 cm^3 of 0,2 $mol.dm^{-3}$ of sodium hydroxide to the spilled sulphuric acid in an attempt to neutralise it.

The equation for the reaction is given below:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

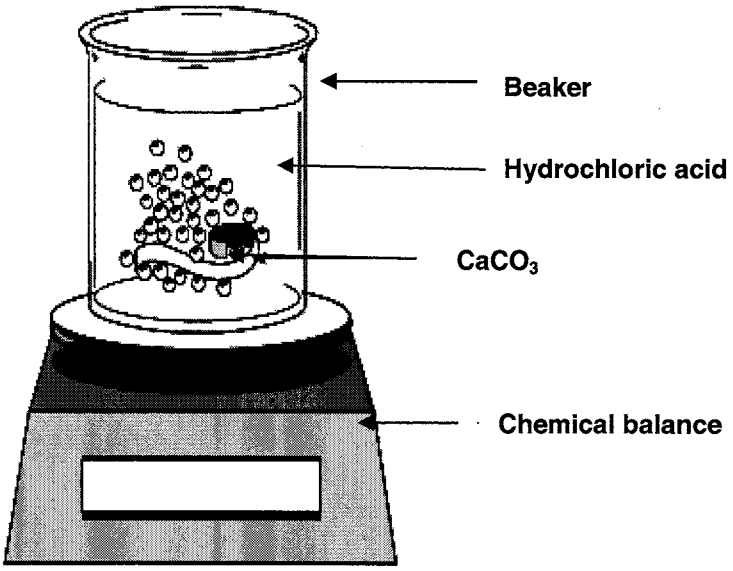
Show by calculations that the addition of the sodium hydroxide solution will not neutralise the sulphuric acid spill. (6)
[18]

QUESTION 6 (Start on a new page.)

The apparatus below is being used to investigate the effect of a certain factor on the rate of reaction of calcium carbonate powder and calcium carbonate chunks with a diluted hydrochloric acid solution.

A known mass of calcium carbonate powder was added to an excess of diluted hydrochloric acid and the decrease in mass over a certain time interval was recorded. Readings were taken at 30 second intervals.

The procedure was then repeated, this time using 'chunks' of the calcium carbonate.



Experiment A: Reaction of calcium carbonate powder and hydrochloric acid

Time (s)	0	1,0	2,0	3,0	4,0	5,0	6,0	7,0
Mass of calcium carbonate powder (g)	92	91,1	90,4	90,1	90	90	90	90
Decrease in mass (g)	0	0,9	1,6	1,9	2,0	2,0	2,0	2,0

Experiment B: Reaction of calcium carbonate chunks and hydrochloric acid

Time (s)	0	1,0	2,0	3,0	4,0	5,0	6,0	7,0
Mass of calcium carbonate chunks (g)	92	91,4	91	90,6	90,3	90,1	90	90
Decrease in mass (g)	0	0,5	1,0	1,4	1,7	1,9	2,0	2,0

6.1 Formulate an investigative question for this investigation. (2)

6.2 Write down a balanced chemical equation for the reaction between calcium carbonate and diluted hydrochloric acid. (3)

6.3 Using the tables above, draw TWO graphs on the GRAPH SHEET comparing the decrease in mass versus time for each of experiments **A** and **B**. Use the same set of axes and label the graphs **A** and **B** respectively. (6)

6.4 Which reaction reaches completion first? (1)

6.5 How does the loss in mass compare after the completion of both reactions? (1)

6.6 What conclusion can be drawn from this investigation? (2)
[15]

QUESTION 7 (Start on a new page.)

Study the reversible reaction represented by the balanced equation below:

$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$$

Initially **X** moles of $H_2(g)$ is mixed with 0,3 moles of $CO_2(g)$ in a sealed 10 dm^3 container. When equilibrium was reached, the concentration of CO was 0,02 mol. dm^{-3} and the equilibrium constant (K_c) at that specific temperature was 4.

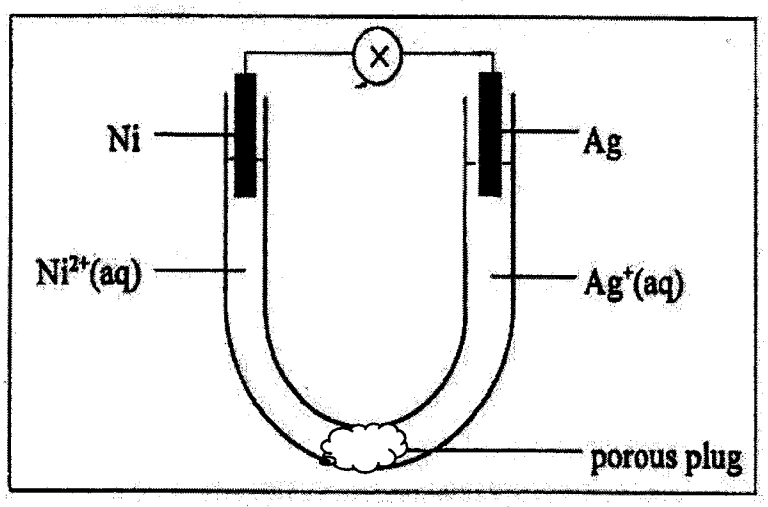
7.1 State Le Chatelier's principle. (2)

7.2 Calculate the initial number of moles **X** of $H_2(g)$ that was in the container. (8)

7.3 The reaction is now carried out at a much higher temperature. It is found that the value of K_c decreases at this higher temperature. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain your answer. (4)
[14]

QUESTION 8 (Start on a new page.)

The diagram represents a galvanic cell (**A**). A small light bulb connected in the external circuit glows brightly.



8.1. State TWO conditions under which this cell will be a standard cell. (2)

8.2. Give the equation for the reaction which occurs at the Ag/Ag^{+} half-cell. (2)

8.3. Which electrode is the anode? (1)

8.4. What happens to the emf of the cell as it continues to deliver current? (1)

8.5. Write down the overall reaction for this cell. (3)

8.6 If 0,4 moles of electrons flow to the cathode, what will be the decrease in mass of the anode? (3)

8.7 A SECOND galvanic cell (**B**) is constructed using:

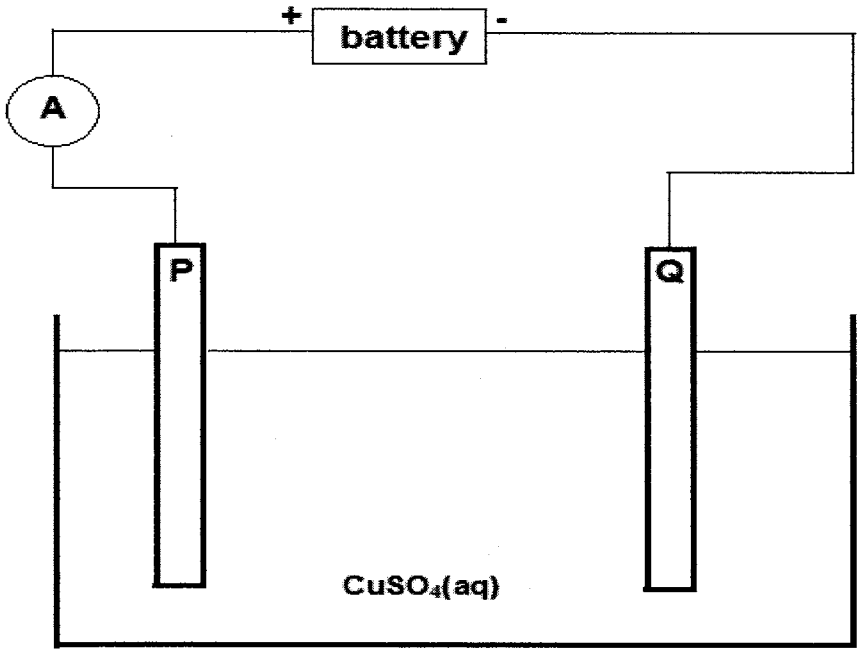
$Mg(s)$ in $Mg(NO_3)_2(aq)$ and $Ag(s)$ in $AgNO_3(aq)$

Without any calculations, determine which of the TWO galvanic cells (**A** or **B**) will result in the highest potential difference. Explain your answer by referring to the relative strengths of the two reducing agents as well as the relative strengths of the two oxidising agents involved. (3)

[15]

QUESTION 9 (Start on a new page.)

Copper metal can be purified by electrolysis, using the cell shown below.



9.1 Define the term *electrolysis.* (2)

9.2 Which electrode, **P** or **Q**, consists of the impure copper? Explain your answer. (3)

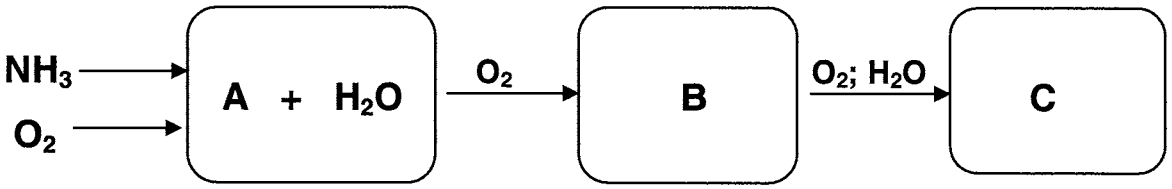
9.3 Write down the half-cell reaction that takes place at electrode **Q**. (2)

9.4 Explain why the concentration of the copper (II) sulphate solution remains constant if the only impurities are silver and platinum. (2)

9.5 State TWO uses of copper. (2)
[11]

QUESTION 10 (Start on a new page.)

Study the diagram below, illustrating the industrial preparation of nitric acid.



10.1 Write down a balanced equation for the formation of product **A**. (3)

10.2 Name the catalyst used during the reaction in QUESTION 10.1. (1)

10.3 What NAME is given to the reaction in QUESTION 10.1? (2)

10.4 Give the FORMULA of product **C**. (1)

10.5 Name the process used to produce product **C**. (1)

10.6 Fertilisers enable plants to grow better and faster, thus improving food production. However, deficiency or excess of primary nutrients in plants can be detrimental to the environment and humans.

State any TWO symptoms of a deficiency of Potassium as a primary nutrient in plants. (2)

[10]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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

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

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)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2.0 B 11	2.5 C 12	3.0 N 14	3.5 O 16	4.0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1.5 Aℓ 27	1.8 Si 28	2.1 P 31	2.5 S 32	3.0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1.5 Ti 48	1.6 V 51	1,6 Cr 52	1.5 Mn 55	1.8 Fe 56	1.8 Co 59	1.8 Ni 59	1.9 Cu 63,5	1.6 Zn 65	1.6 Ga 70	1.8 Ge 73	2.0 As 75	2.4 Se 79	2.8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1.9 Tc	2.2 Ru 101	2.2 Rh 103	2.2 Pd 106	1.9 Ag 108	1.7 Cd 112	1.7 In 115	1.8 Sn 119	1.9 Sb 122	2.1 Te 128	2.5 I 127	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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	1.8 81 Tℓ 204	1.8 82 Pb 207	1.9 83 Bi 209	2.0 84 Po	2.5 85 At	86 Rn
0,7 87 Fr	0,9 88 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

KEY/*SLEUTEL*

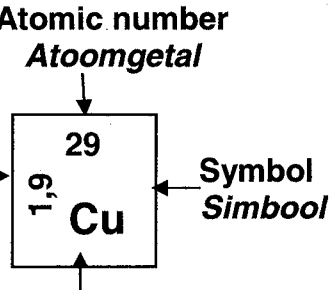


TABLE 4A: STANDARD REDUCTION POTENTIALS

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
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	- 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↓

Increasing reducing ability/*Toenemende reduserende vermoë* ↑

GRAPH SHEET

NAME: _____

QUESTION 6.3