LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2: CHEMISTRY

SEPTEMBER 2015

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 4 data sheets.

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 at the top of a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. 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.

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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 numbers (1.1 – 1.10) in the ANSWER BOOK.

1.1 Which ONE of the following primary nutrients is obtained from BONE MEAL?

A Phosphorus

B Nitrogen

C Potassium

D Sulphur (2)

1.2 Which ONE of the following pairs of organic compounds contains members of the same homologous series?

A C_3H_8 and C_4H_8

B C_3H_7Br and $C_3H_7C\ell$

C $C_3H_6O_2$ and C_3H_8O

D C_3H_6O and C_3H_8O (2)

1.3 The reaction of propane with bromine can be classified as …

A an elimination reaction

B an addition reaction

C a redox reaction

D a substitution reaction (2)

1.4 The compound $C_4H_8O_2$ could be

I an alcohol

II a carboxylic acid

III an ester

Which ONE of the above statement(s) is/are CORRECT?

A I only

B I and II only

C I and III only

D II and III only (2)

1.5 Which ONE of the following will reduce $A\ell^{3+}$ to $A\ell$?

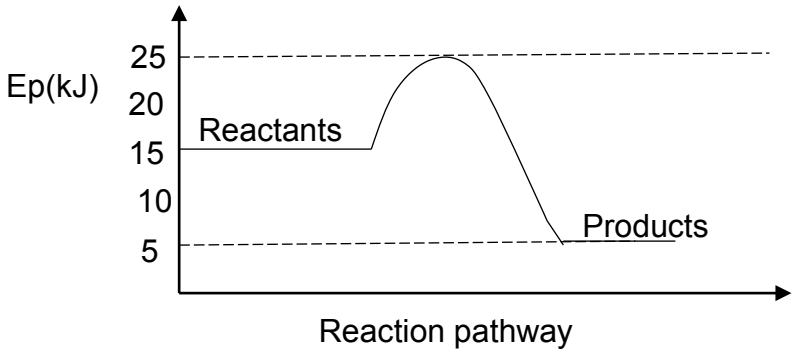
A Mg

B Mn

C Zn

D Fe (2)

1.6 The graph below represents the relationship between the potential energy (Ep) and reaction pathway for a certain reversible chemical reaction.



The activation energy for the REVERSE reaction is:

A 5 kJ

B 10 kJ

C 15 kJ

D 20 kJ (2)

1.7 A mixture, initially consisting of 2 mol CO(g) and 2 mol $H_2(g)$ with methanol, CH_3OH, as the product, comes to equilibrium according to the following reaction equation:

$$CO_2(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Which ONE of the following statements is CORRECT? At equilibrium, the mixture will contain …

A 1 mol CH_3OH

B 2 mol CH_3OH

C less than 1 mol CH_3OH

D more than 1 mol CH_3OH (2)

1.8 Ammonium sulphate is dissolved in water. Which ONE of the following statements regarding the solution which is formed, is CORRECT?

A pH = 7

B $[H_3O^+]\cdot[OH^-] < 1 \times 10^{-14}$

C $[H_3O^+] > [OH^-]$

D $[H_3O^+] < [OH^-]$ (2)

1.9 Which ONE of the following combinations CORRECTLY shows the products formed during the electrolysis of brine?

	ANODE	**CATHODE**
A	Chlorine	Hydrogen
B	Hydrogen	Oxygen
C	Oxygen	Hydrogen
D	Hydrogen	Chlorine

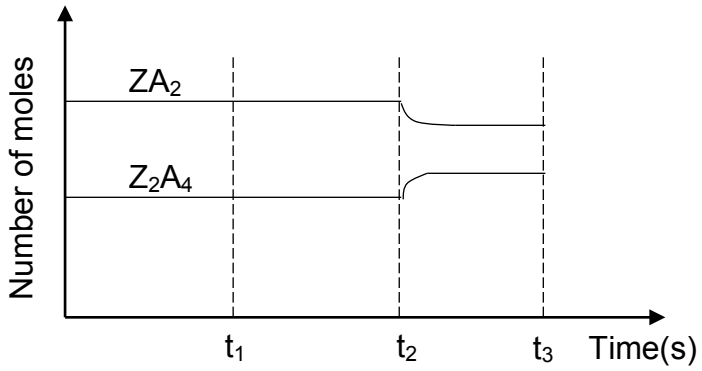
(2)

1.10 The reaction represented by the equation

$$Z_2A_4(g) \rightleftharpoons 2ZA_2(g) \qquad \Delta H > 0$$

is initially at equilibrium.

The situation is represented by the graph below.



The value of K_c at BOTH TIMES $\mathbf{t_1}$ and $\mathbf{t_3}$ is 0,25.

Which ONE of the following BEST explains the change that occurred at $\mathbf{t_2}$?

A Z_2A_4 was added to the reaction mixture

B The pressure increased without any change in temperature

C The temperature was lowered

D A catalyst was added to the reaction mixture

(2)

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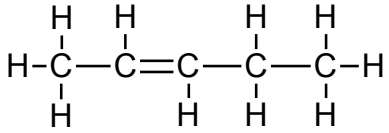
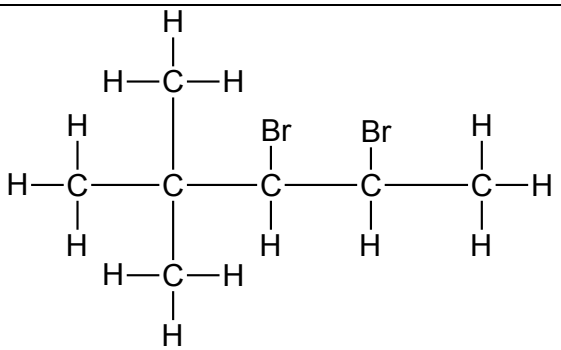
QUESTION 2 (Start on a new page)

The letters **P** to **U** in the table below represent six organic compounds.

P		**Q**	Methylpropanoate
R	3-Methylbutan-2-ol	**S**	$CH_3CH_2CH_2CO_2H$
T		**U**	$CH_3CH_2CH_2COCH_2CH_3$

2.1 Write down the LETTER(S) that represent(s) the following:

(A compound/ letter may be used more than once)

2.1.1 A ketone. (1)

2.1.2 A carboxylic acid (1)

2.1.3 A compound with the general formula C_nH_{2n} (1)

2.1.4 Two compoounds that are FUNCTIONAL ISOMERS. (1)

2.2 Write down the IUPAC name of compound:

2.2.1 **T** (3)

2.2.2 **U** (2)

2.3 Write down the STRUCTURAL FORMULA of compound:

2.3.1 **Q** (2)

2.3.2 **R** (2)

2.4 Compound **R** is a secondary alcohol. Explain the validity of this statement. (1)

[14]

QUESTION 3 (Start on a new page)

A grade 12 learner used three organic compounds, hexane, pentan-1-ol and butanoic acid to investigate the effect of INTERMOLECULAR FORCES on the BOILING POINTS of organic compounds.

The results obtained are shown in the table below.

COMPOUND		**MOLECULAR MASS** ($g \cdot mol^{-1}$)	**BOILING POINT** (°c)
X	C_6H_{14}	88,0	69
Y	$CH_3(CH_2)_2OH$	88,0	138
Z	$C_4H_8O_2$	88,0	164

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

3.2 Write down the NAME of the functional group of compound **Z**. (1)

3.3 FROM THE TABLE ABOVE, write down:

3.3.1 The dependent variable for this investigation (1)

3.3.2 One controlled variable (1)

3.4 The learner finds that the boiling point of compoound **X** is LOWER than that of compound **Y**.

Explain this observation by referring to the TYPE of INTERMOLECULAR FORCES present in each of these compounds. (3)

3.5 Consider the boiling points of compounds **Y** and **Z**.

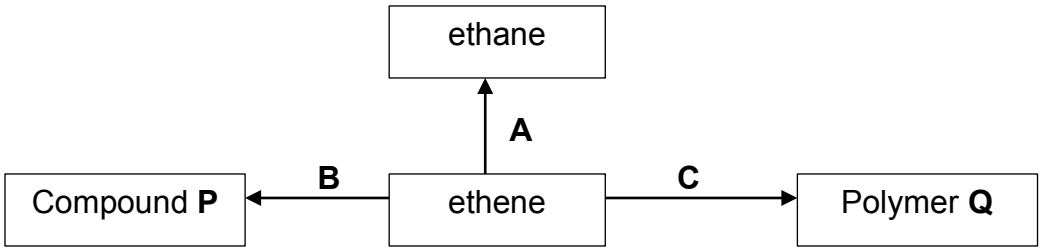
3.5.1 With reference to the intermolecular forces present in EACH of these compounds, suggest a reason for this difference in boiling points. (2)

3.5.2 Which ONE of these compounds, **Y** or **Z**, has a lower vapour pressure? Refer to the DATA IN THE TABLE to provide an explanation for the answer. (2)

[12]

QUESTION 4 (Start on a new page)

The flow diagram below shows how some organic compounds can be prepared from ethene. A, B and C represent different organic reactions.



4.1 For reaction **A**, write down:

4.1.1 The FORMULA or NAME of the other reagent needed (1)

4.1.2 The type of addition reaction (1)

4.1.3 The FORMULA or NAME of the catalyst used (1)

4.1.4 One use of the reaction in the FOOD industry. (1)

4.2 Reaction **B** takes place when ethene reacts with hydrogen bromide (HBr).

For this reaction, write down the:

4.2.1 Name of the reaction that takes place (1)

4.2.2 Balanced equation using structural formulae (4)

4.2.3 Name of the homologous series to which compound **P** belongs (1)

4.3 Consider reaction **C**.

4.3.1 Ethene is a monomer of compound **Q.** Explain clearly what this statement means. (2)

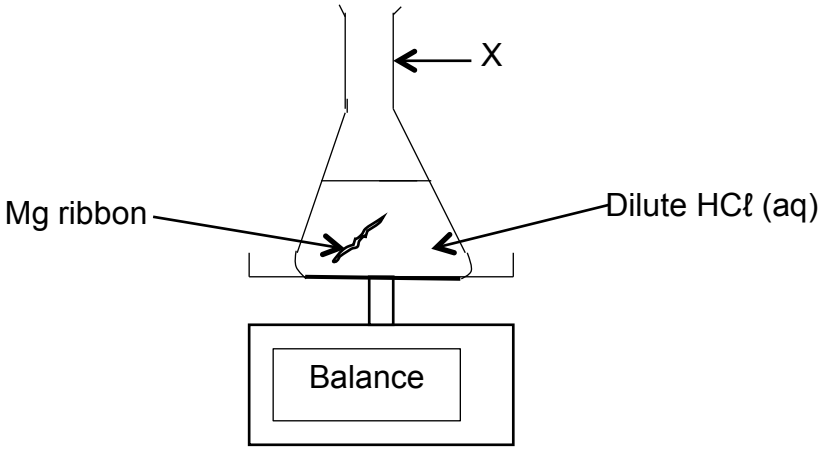
4.3.2 Reaction **C** is an example of polymerisation reactions. Name the type of polymerisation of which reaction **C** is an example. (1)

4.3.3 Write down the STRUCTURAL FORMULA of polymer **Q** indicating ONLY two repeating units. (2)

[15]

QUESTION 5 (Start on a new page)

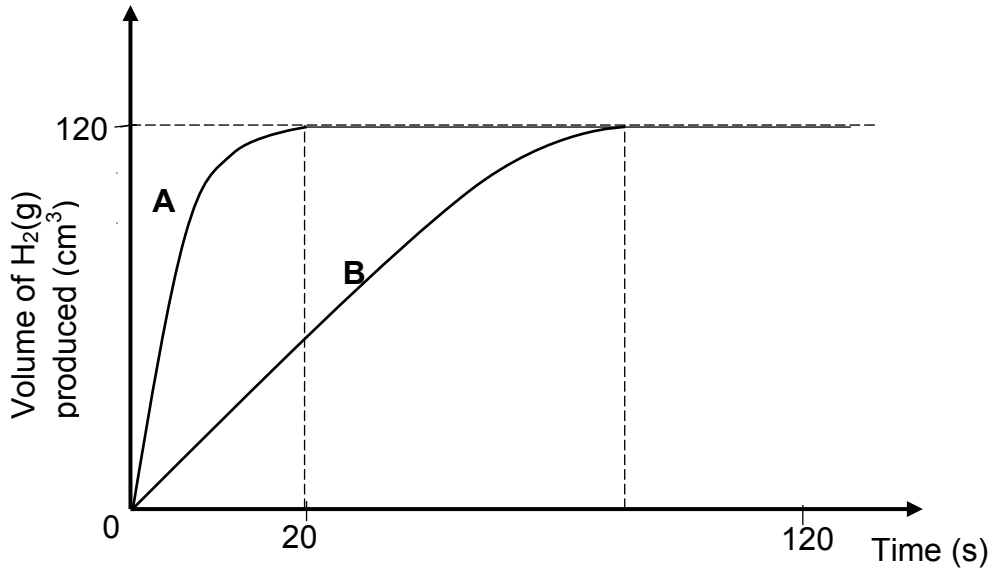
In an experiment to investigate the rate of reaction, a 0,12 g piece of magnesium ribbon was allowed to react with EXCESS dilute hydrochloric acid at room temperature (20°C).



The experiment was then repeated with the same mass of magnesium and the same volume of hydrochloric acid but of different concentration as shown in the table below.

EXPERIMENT	MASS OF Mg (g)	VOLUME OF HCℓ (cm^3)	[HCℓ] ($mol \cdot dm^{-3}$)
1	0,12	90	0,25
2	0,12	90	0,50

The results of the experiments are shown in the graph below.



5.1 Write down the name of the flask labelled **X.** (1)

5.2 For this investigation, write down the following:

5.2.1 The independent variable (1)

5.2.2 A suitable hypothesis (2)

5.3 Explain, very carefully, why the last part of BOTH curves, **A** and **B**, is horizontal. (1)

5.4 How long did the reaction in the experiment **2** take to reach completion? (1)

5.5 Which experiment, **1** or **2**, gave curve **A**? Refer to the data in the table to justify the answer. (2)

5.6 Which curve, **A** or **B**, represents the faster reaction? Refer to the shape of the curve to explain the answer. (2)

5.7 Why is it important that the same mass of magnesium ribbon and same volume of HCℓ acid used in both experiments? (1)

5.8 State a suitable conclusion that can be drawn for this investigation. (1)

5.9 The equation for the reaction that takes place is as follows:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

Calculate the total mass (in grams) of hydrogen gas that was produced in this reaction. Assume the molar gas volume at 20 °C is equal to 24,0 dm^3. (4)

5.10 The experiment is now repeated using magnesium powder of mass 0,12 g instead of magnesium ribbon. It is found that the reaction rate INCREASES. Use the collision theory to explain this observation. (2)

[18]

QUESTION 6 (Start on a new page)

112,84 g of mercury(II) oxide is heated in a 250 cm^3 sealed container. The decomposition that takes place in the container is represented by the following equation:

$$2HgO(s) \rightleftharpoons 2Hg(\ell) + O_2(g) \qquad \Delta H > 0$$

Equilibrium is reached at 650 ° C. Analysis shows that, at equilibrium, the mass of mercury(II) oxide (HgO) is 69,44 g.

6.1 For this reaction, a sealed container is classified as a CLOSED SYSTEM. Explain why this is so. (2)

6.2 Calculate the equilibrium constant (K_c) at 650 ° C for this reaction. (9)

6.3 The volume of the container is now decreased to 125 cm^3 while the temperature is KEPT CONSTANT. The system reaches a NEW equilibrium. How will each of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The number of moles of HgO(s) present in the NEW equilibrium mixture (1)

6.3.2 The value of the equilibrium constant (K_c) (1)

6.3.3 The concentration of $O_2(g)$ in the new equilibrium mixture. (1)

6.4 Use Le Chatelier's Principle to explain the answer to QUESTION 6.3.1. (2)

[16]

QUESTION 7 (Start on a new page)

7.1 Like all equilibrium constants, the ionic product, K_w, of water changes its value as the temperature changes, as shown in the table below.

TEMPERATURE (° C)	K_w VALUE
25	$1,0 \times 10^{-14}$
65	$2,92 \times 10^{-14}$

7.1.1 Is the ionisation of water EXOTHERMIC or ENDOTHERMIC? (1)

7.1.2 Water is an ampholyte. Explain what this statement means. (1)

7.1.3 Show, by means of a suitable calculation, that the pH of water at 65 °C is 6,77. (4)

7.2 A learner is asked to prepare 200 cm^3 of a sodium hydroxide (NaOH) solution of concentration 0,5 $mol \cdot dm^{-3}$.

7.2.1 Determine the mass of sodium hydroxide pellets he needs to use to do this. (4)

Using an accurate balance the learner accurately measures the correct mass of the NaOH pellets. To the pellets he now adds exactly 200 cm^3 of pure water.

7.2.2 Will his solution have the correct concentration? State only YES or NO. (1)

7.2.3 Explain the answer to QUESTION 7.2.2. (1)

300 cm^3 of a 0,1 $mol \cdot dm^{-3}$ solution of sulphuric acid (H_2SO_4) is added to 200 cm^3 of a 0,5 $mol \cdot dm^{-3}$ solution of NaOH at 25 °C.

The equation for the reaction that takes place is:

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

7.2.4 Name the piece of apparatus that can be used to accurately measure 300 cm^3 of the solution of H_2SO_4 . (1)

7.2.5 Classify, stating a reason, sulphuric acid as a STRONG or a WEAK acid. (2)

7.2.6 Calculate the number of moles of H_2SO_4 which were added

to the NaOH solution. (3)

7.2.7 Calculate the concentration of the hydronium ion (H_3O^+) in the FINAL mixture. (4)

[22]

QUESTION 8 (Start on a new page)

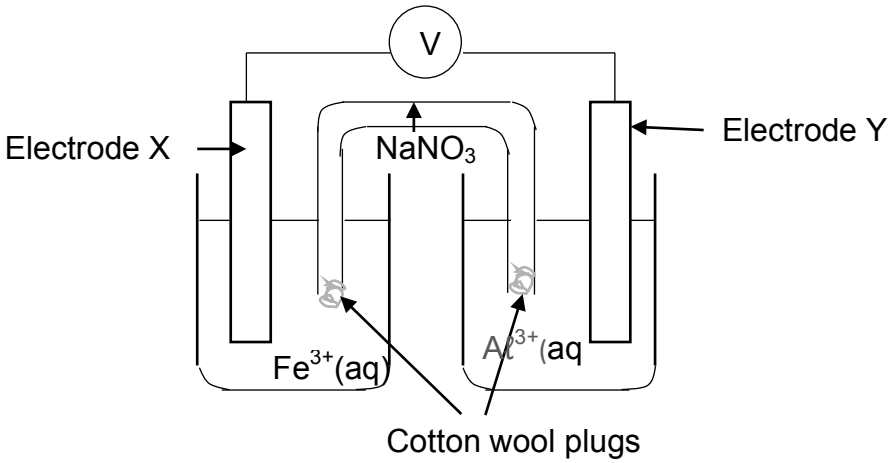
8.1 A medical practitioner at a certain hospital gave a patient two medicines, **A** and **B**.

- Medicine **A** contains permanganate ions (MnO_4^-)
- Medicine **B** contains aluminium ions ($A\ell^{3+}$)

8.1.1 Define the term *reduction* in terms of electron transfer. (1)

8.1.2 The medical practitioner did not notice that one of the medicines would poison the patient after ingestion. Bearing in mind that the acid in the stomach is hydrochloric acid, (HCℓ), state which medicine (**A** or **B**) is poisonous when swallowed.
Refer to the RELATIVE STRENGTH OF OXIDISING AGENTS to explain the answer. (4)

8.2 A learner sets up a standard galvanic (voltaic) cell using the following half-cells: $Fe^{3+}(aq)/ Fe^{2+}(aq)$ and $A\ell^{3+}(aq)/ A\ell(s)$



8.2.1 Write down the NAME or SYMBOL of electrode **X** (1)

8.2.2 Which electrode, **X** or **Y**, undergoes a decrease in mass? (1)

8.2.3 Determine the initial emf for this cell under standard coditions. (3)

8.2.4 Describe ONE measurement that must be made before a voltmeter is connected in the circuit. (1)

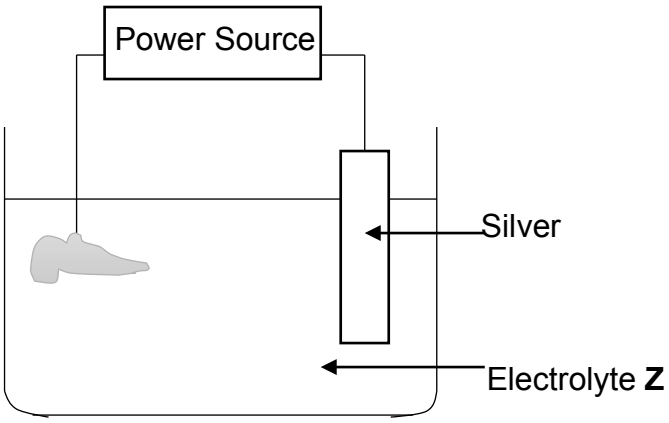
8.2.5 The ends of a salt bridge are stopped by bits of cotton wool. Explain why this is a good idea. (1)

8.2.6 Write down the balanced, net ionic equation for the overall cell reaction. (2)

[14]

QUESTION 9 (Start on a new page)

The simpified diagram below represents an electrolytic cell used by a grandmother to preserve her grandchild's first leather shoe by electroplating it with silver.



9.1 Define the term *electrolyte.* (1)

9.2 Will the shoe be the ANODE or CATHODE of the cell? (1)

9.3 Write down the:

9.3.1 Half-reaction that occurs on the surface of the shoe. (2)

9.3.2 Chemical NAME or FORMULA of the electrolyte **Z**. (1)

9.4 Explain why the shoe must be coated with graphite before the plating process. (1)

9.5 The shoe is continuously rotated during the process of electroplating. Give a clear explanation for this observation. (1)

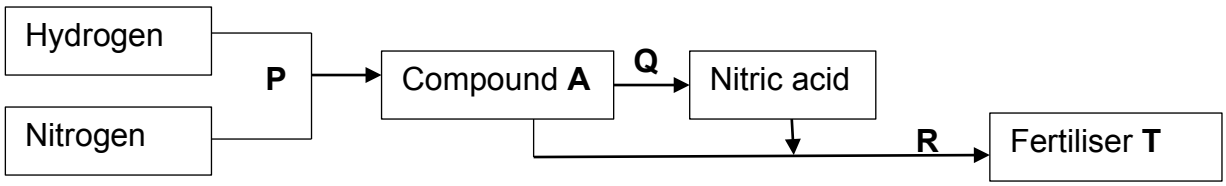
9.6 A constant current of 0,193 A passes through the solution for 2500 s and the concentration of the electrolyte remains constant during the process.

Calculate the mass of silver which is plated onto the shoe. (3)

[10]

QUESTION 10 (Start on a new page)

The flow diagram below shows the three steps (**P**, **Q** and **R**) in the industrial preparation of fertiliser **T**.



10.1 Write down the:

10.1.1 Name of commpound **A**. (1)

10.1.2 NAME or FORMULA of the catalyst used in step **Q**. (1)

10.1.3 Source of hydrogen used in step **P**. (1)

10.2 In step **R**, compound **A** reacts with nitric acid to form fertiliser **T**. Write down the NAME or FORMULA of fertiliser **T**. (1)

10.3 The reaction

$$4NH_3(g) + 6NO(g) \rightarrow 5N_2(g) + 6H_2O(g)$$

is a secondary reaction which takes place in the first stage of process **Q**.

Explain in detail why this secondary reaction is undesirable. (1)

10.4 State ONE positive impact of fertilisers on humans. (1)

A farmer stores fertilisers with N:P:K ratios of **2:5:3** and **14:1:5**.
He wants to grow tomatoes and apples.

10.5 Which ONE of the fertilisers, **2:5:3** or **14:1:5** should be used? (1)

10.6 Fully explain the answer to QUESTION 10.2. (2)

[9]

TOTAL 150

NATIONAL SENIOR CERTIFICATE

DATA FOR PHYSICAL SCIENCES GRADE 12

PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Avogadro's constant	N_A	$6,02 \times 10^{23}$ mol^{-1}
Standard pressure	p^θ	$1,013 \times 10^5$ Pa
Molar gas volume at STP	V_m	22,4 dm^3·mol^{-1}
Standard temperature	T^θ	273 K
Charge on electron	e	$-1,6 \times 10^{-19}$ C

TABLE 2: FORMULAE

$n = \frac{m}{M}$	$c = \frac{n}{V}$ $\quad c = \frac{m}{MV}$ $\quad \frac{C_a V_a}{C_b V_b} = \frac{n_a}{n_b}$ $n = \frac{N}{N_A}$ $\quad n = \frac{V}{V_m}$ $\quad$ pH= -log[H_3O^+] K_w = [H_3O^+][OH^-] = 1×10^{-14} at 298 K
$c = \frac{m}{MV}$	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ $E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ $E^\theta_{cell} = E^\theta_{oxidising\,agent} - E^\theta_{reducing\,agent}$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

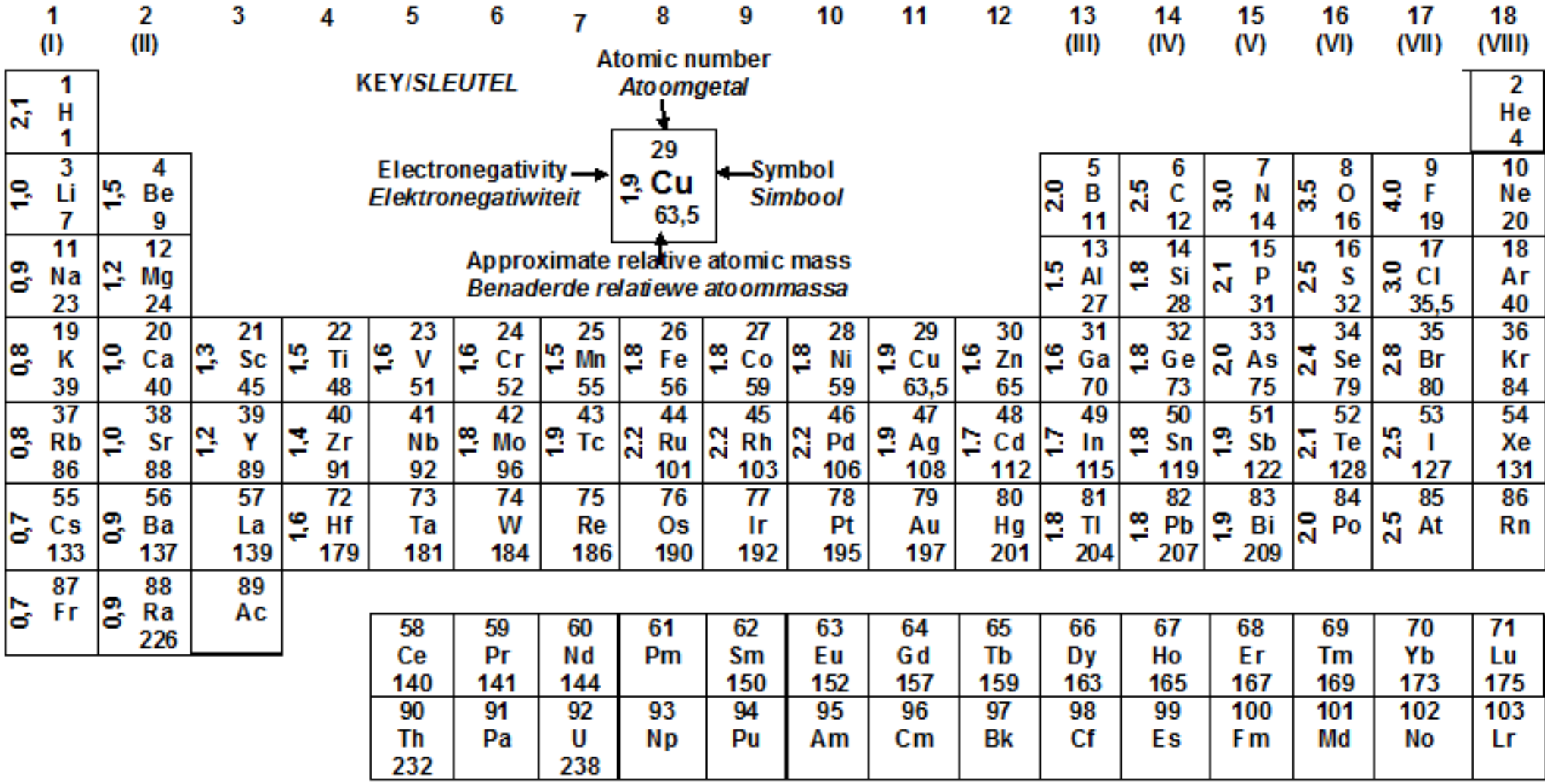


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TABLE 4A: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

Increasing reducing ability/*Toenemende reduserende vermoë* ↓

Half-reactions			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

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TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

Half-reactions			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

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