education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

SEPTEMBER 2019

MARKS: 150

TIME: 3 hour

This question paper consists of 15 pages and 4 data sheets.

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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 TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable 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. Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK , for example, 1.11 E.

1.1 Consider the following statements regarding organic compounds belonging to the same homologous series.

I They have the same boiling point.
II They have the same functional group.
III They have the same molecular formula.

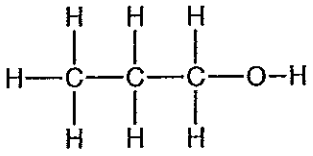
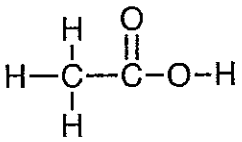
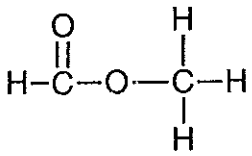
Which of the above statements is/are TRUE?

A II only
B I and II only
C II and III only
D I, II and III (2)

1.2 Which ONE of the following organic compounds is a haloalkane?

A Methane
B Tetrachloromethane
C Methyl methanoate
D Methanal (2)

1.3 The organic compounds shown in the table below have the same molar mass (60 g·mol^{-1}).

Compound	Structural formula	Boiling point (°C)
X		97
Y		?
Z		32

Which ONE of the following is most likely to be the boiling point (in °C) of compound **Y**?

A 24
B 40
C 90
D 118 (2)

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

$$4HC\ell(g) + O_2(g) \rightleftharpoons 2C\ell_2(g) + 2H_2O(g) \qquad \Delta H < 0$$

Which ONE of the following changes in equilibrium conditions will result in an INCREASE in the value of the equilibrium constant (K_c)?

A Decreasing the pressure by increasing the volume
B Decreasing the temperature
C Increasing the pressure by decreasing the volume
D Increasing the temperature (2)

1.5 Four different solutions, each with concentration 0,1 mol·dm^{-3}, are prepared. Which ONE of the solutions will have the lowest pH?

A NH_4NO_3
B Na_2CO_3
C KNO_3
D KOH (2)

1.6 A table of acid-base indicators and the pH ranges over which they change colour are given below. Which ONE of these indicators is most suitable for use in the titration of ethanoic acid with sodium hydroxide?

	Indicator	pH range
A	Bromophenol blue	3,0 – 4,6
B	Litmus	4,5 – 8,3
C	Bromothymol blue	6,0 – 7,6
D	Cresolphthalein	8,2 – 9,8

(2)

1.7 Two hypothetical half-reactions and their respective standard reduction potentials are given below.

$X_2 + 2e^- \rightleftharpoons 2X^-$ +1,09 V

$Y^+ + e^- \rightleftharpoons Y$ -2,8 V

Which ONE of the following has the greatest tendency to donate electrons?

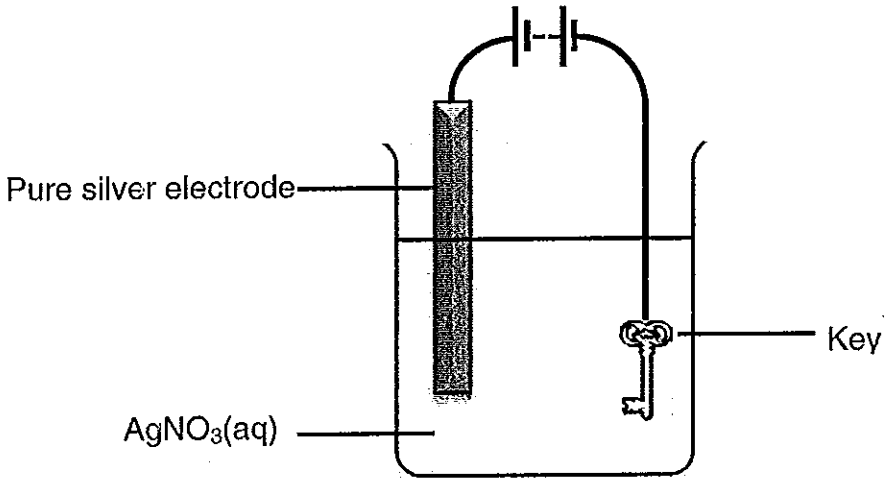
A X^-
B X_2
C Y
D Y^+ (2)

1.8 Which ONE of the following cell reactions will be spontaneous?

A $Sn^{2+}(aq) + Zn^{2+}(aq) \rightarrow Zn(s) + Sn^{4+}(aq)$
B $2H^+(aq) + Cu(s) \rightarrow Cu^{2+}(aq) + H_2(g)$
C $Cd(s) + 2Co^{3+}(aq) \rightarrow Cd^{2+}(aq) + 2Co^{2+}(aq)$
D $2C\ell^-(aq) + 2Fe^{3+}(aq) \rightarrow C\ell_2(g) + 2Fe^{2+}(aq)$ (2)

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1.9 The diagram below represents a cell used to electroplate a key with silver metal.



Which ONE of the following combinations represent the CHANGE in mass of the silver electrode and the concentration of the $AgNO_3$ electrolyte during electrolysis?

	Mass of silver electrode	**Concentration of $AgNO_3$ (aq)**
A	Decreases	Increases
B	Decreases	No change
C	Increases	No change
D	Increases	Increases

(2)

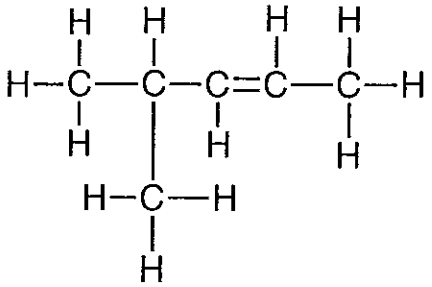
1.10 Which combination of fertilisers will best address the following needs of a crop?

	Enhance root growth	**Assist with ripening of fruit**
A	K_2SO_4	H_2NCONH_2
B	KCℓ	$Ca_3(H_2PO_4)_2$
C	$Ca_3(H_2PO_4)_2$	KCℓ
D	NH_4NO_3	$Ca_3(H_2PO_4)_2$

(2)
[20]

QUESTION 2 (Start on a new page.)

2.1 The structural formula of an unsaturated hydrocarbon is given below.



2.1.1 Define the term *unsaturated hydrocarbon.* (2)

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

2.1.3 Write down the IUPAC name of a positional isomer of the above compound. (2)

The hydrocarbon above reacts with bromine water.

2.1.4 Use structural formulae and write down a balanced equation for the reaction. (3)

2.1.5 Write down the name of the type of reaction that takes place. (1)

2.1.6 What colour change will be observed during this reaction? (1)

2.2 Butanoic acid is a functional isomer of methyl propanoate.

2.2.1 Define the term *functional isomer.* (2)

2.2.2 Draw the structural formula of butanoic acid. (2)

2.2.3 Draw the structural formula of methyl propanoate. (2)

2.2.4 Write down the IUPAC name of the alcohol used to prepare methyl propanoate. (1)

2.2.5 Write down TWO reaction conditions needed for the preparation of an ester. (2)

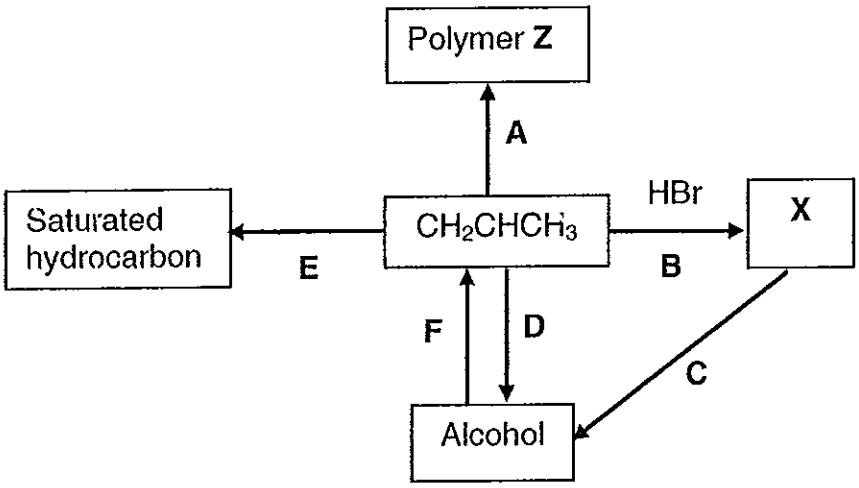
2.2.6 Which one of BUTANOIC ACID or METHYL PROPANOATE will have the higher boiling point? (1)

2.2.7 Explain the answer in QUESTION 2.2.6. (4)
[25]

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QUESTION 3 (Start on a new page.)

Consider the organic reactions (**A** to **F**) represented in the flow diagram below.



3.1 Write down the type of reaction represented by:

3.1.1 **A** (1)

3.1.2 **C** (1)

3.2 Using structural formulae, write down the balanced equation for reaction **D**. (4)

3.3 Write down the IUPAC name of compound **X**. (2)

3.4 Write down the NAME or FORMULA of the reagent that is needed in reaction **F**. (1)

3.5 What TYPE of addition reaction is represented by reaction **E**? (1)

3.6 Using MOLECULAR formulae, write down the balanced equation for the complete combustion of the saturated hydrocarbon formed in reaction **E**. (4)

[14]

QUESTION 4 (Start on a new page.)

The boiling points of four organic compounds are given in the table below.

	Compound	Boiling point (°C)
A	Ethanol	79
B	Propan-1-ol	98
C	Butan-1-ol	117
D	Pentan-1-ol	138

4.1 Write down the NAME of the functional group of the compounds **A** to **D**. (1)

4.2 Is butan-1-ol a PRIMARY or a SECONDARY alcohol? (1)

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

4.4 Use the table to explain the difference in boiling points of compounds **A** to **D**. (3)

4.5 Which one of compounds, **A** or **B**, has the higher vapour pressure? Give a reason the answer. (2)
[9]

QUESTION 5 (Start on a new page.)

Learners use the reaction of $Na_2S_2O_3(aq)$ and $HC\ell(aq)$ to investigate different factors which influence reaction rate. The balanced equation for the reaction is:

$$Na_2S_2O_3(aq) + 2HC\ell(aq) \rightarrow H_2O(\ell) + SO_2(g) + 2NaC\ell(aq) + S(s)$$

Equal volumes of the two solutions are mixed and the time taken for a certain amount of sulphur to form is measured.

5.1 The reaction conditions used and the results obtained during the first investigation are recorded in the table below.

	Temperature (°C)	Concentration of $Na_2S_2O_3$ ($mol \cdot dm^{-3}$)	Concentration of $HC\ell$ ($mol \cdot dm^{-3}$)	Time (s)
Experiment 1	20	0,5	0,5	40
Experiment 2	20	0,9	0,5	25
Experiment 3	20	1,4	0,5	15

Use the information in the table to answer the following questions.
For this investigation, write down:

5.1.1 One controlled variable (1)

5.1.2 The independent variable (1)

5.1.3 The conclusion that can be drawn from the results (2)

5.1.4 The limiting reactant ($Na_2S_2O_3$ or $HC\ell$) in **Experiment 1**. Explain the answer. (4)

5.2 The reaction conditions used and the results obtained during a second investigation are recorded in the table below.

	Temperature (°C)	Concentration of $Na_2S_2O_3$ ($mol \cdot dm^{-3}$)	Concentration of $HC\ell$ ($mol \cdot dm^{-3}$)	Time (s)
Experiment 4	20	0,5	0,5	40
Experiment 5	30	0,5	0,5	20
Experiment 6	40	0.5	0,5	10

5.2.1 Which ONE of the three experiments (**4**, **5** or **6**) has the highest rate of reaction? (1)

5.2.2 Explain the answer in QUESTION 5.2.1 in terms of the collision theory. (3)
[12]

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QUESTION 6 (Start on a new page.)

6.1 Potassium chromate (K_2CrO_4) is dissolved in water. In solution, the chromate ions (CrO_4^{2-}) reach equilibrium with the dichromate ions ($Cr_2O_7^{2-}$) according to the following balanced equation:

$$\underset{\text{yellow}}{2\,CrO_4^{2-}(aq)} + 2H^+(aq) \rightleftharpoons \underset{\text{orange}}{Cr_2O_7^{2-}(aq)} + H_2O(\ell)$$

6.1.1 A reagent is now added to the orange solution. Which reagent, NaOH(aq) or HNO_3(aq), will result in a colour change from orange to yellow? (1)

6.1.2 Which ion, $CrO_4^{2-}(aq)$ or $Cr_2O_7^{2-}(aq)$, will be present in higher concentration at a low pH? (1)

When the temperature is gradually increased, it is observed that the colour of the solution changes to yellow.

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

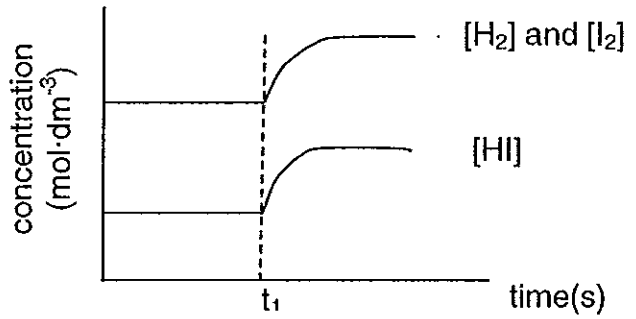
6.1.4 Explain the answer in QUESTION 6.1.3 by referring to Le Chatelier's principle. (2)

6.2 5 moles of hydrogen gas, $H_2(g)$, and 5 moles of iodine vapour, $I_2(g)$, are sealed in a 2 dm^3 vessel at a temperature of 600 K. The reaction reaches equilibrium according to the following balanced equation:

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

6.2.1 Calculate the concentration of the hydrogen iodide (HI) at equilibrium if the equilibrium constant, K_c, for the reaction at 600 K is 0,36. (8)

6.2.2 The pressure on the system is now changed. The graph below shows the change in concentrations of the reactants an products as a result of this change.



Was the pressure INCREASED or DECREASED at t_1? Explain the answer. (3)

[16]

QUESTION 7 (Start on a new page.)

7.1 Reactions **A** and **B** below represent the ionisation of two acids, HF(aq) and HBr(aq) respectively. The ionisation constants (K_a) for the two acids are given at 25 °C.

Reaction A: $HF(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + F^-(aq)$ $K_a = 6,6 \times 10^{-4}$

Reaction B: $HBr(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + Br^-(aq)$ $K_a = 1,0 \times 10^{9}$

7.1.1 Write down the NAME or FORMULA of the conjugate base of HF(aq). (1)

7.1.2 Define the term *weak acid.* (2)

7.1.3 Which acid, HF(aq) or HBr(aq), is stronger? Explain your choice. (3)

7.1.4 Water can act as an ampholyte. Define the term *ampholyte.* (2)

7.2 7,5 g IMPURE sodium hydroxide pellets, NaOH(s), is added to a flask containing 700 cm^3 of a 0,15 $mol \cdot dm^{-3}$ sulphuric acid solution, $H_2SO_4(aq)$. The balanced equation for the reaction is:

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

7.2.1 Calculate the number of moles of sulphuric acid in the flask. (3)

7.2.2 The percentage purity of the sodium hydroxide pellets used is 80%. Calculate the pH of the solution in the flask after the addition of the NaOH(s). (7)

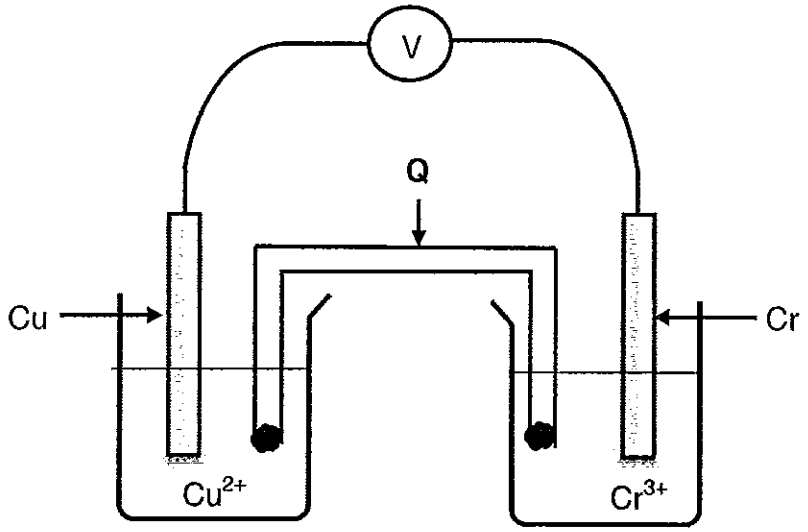
[18]

QUESTION 8 (Start on a new page.)

8.1 An iron nail, which has been thoroughly cleaned, is placed in a beaker containing a 1 mol·dm^{-3} copper(II) sulphate solution. The beaker is allowed to stand overnight. The next morning it is observed that a reddish brown precipitate formed on the iron nail.

By referring to the relative strength of reducing agents, explain why a reddish brown precipitate formed on the iron nail. (3)

8.2 A galvanic cell is set up under standard conditions as shown in the simplified diagram below.



8.2.1 State ONE function of the component labelled **Q**. (1)

8.2.2 Which electrode (Cu or Cr) is the cathode of this cell? (1)

8.2.3 Write down the overall (net) balanced cell reaction that takes place in this cell. (3)

8.2.4 Calculate the initial emf of this cell. (4)

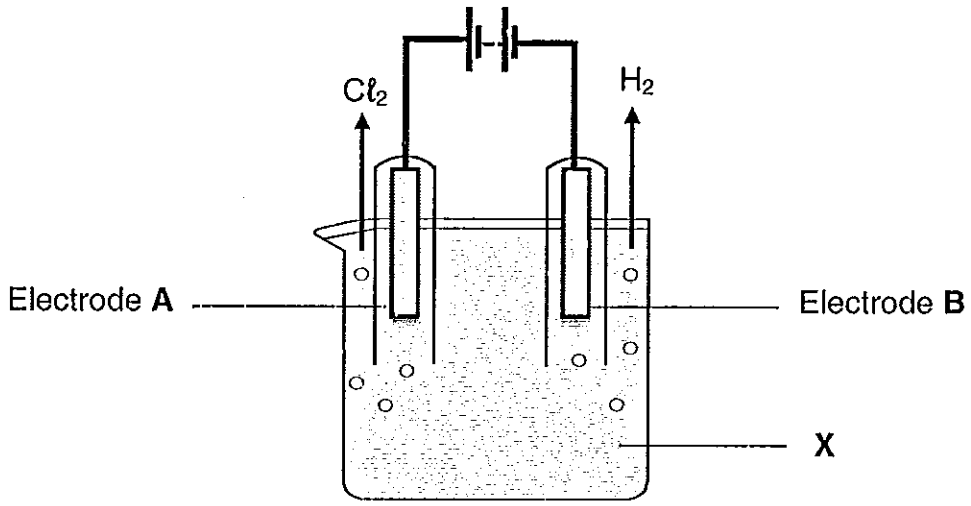
8.2.5 A similar cell is now set up using 2 mol·dm^{-3} Cu^{2+}(aq). All other conditions stay the same. How will the initial emf of this cell compare to that calculated in QUESTION 8.2.4? Choose from HIGHER THAN, LOWER THAN or EQUAL TO. Explain the answer. (3)

8.2.6 How will the initial reading on the voltmeter change as the cell reaction approaches equilibrium? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[16]

QUESTION 9 (Start on a new page.)

A simplified diagram of an electrochemical cell, used for the production of chlorine gas, is shown below.



9.1 Define the term *electrolyte*. (2)

9.2 Write down the NAME of electrolyte **X**. (1)

9.3 Write down the half-reaction which takes place at the positive electrode. (2)

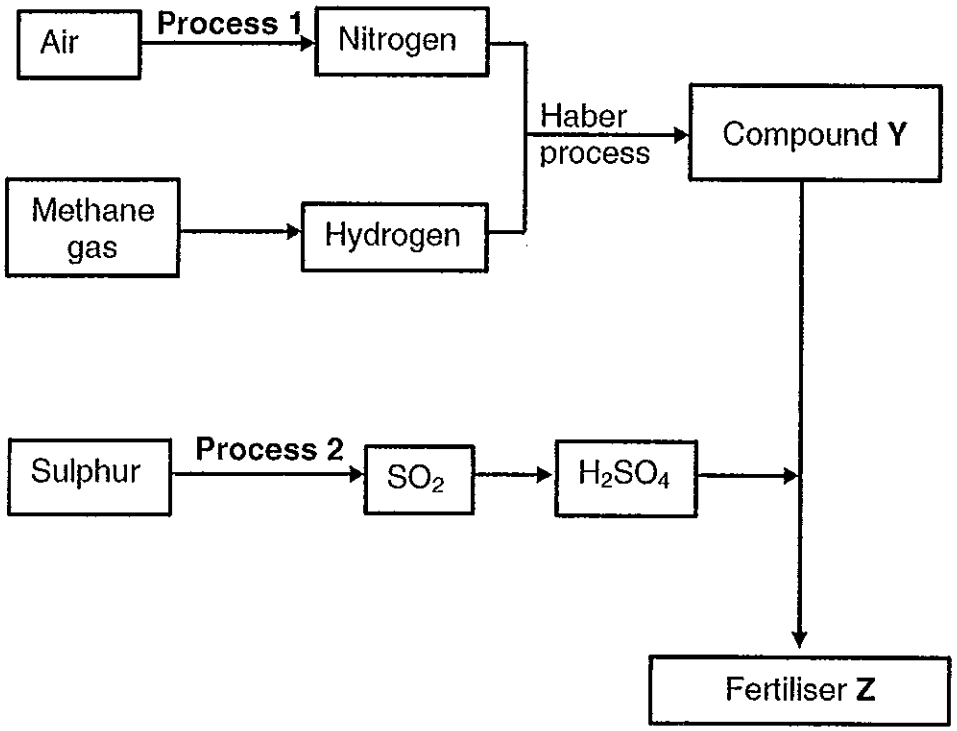
9.4 Which electrode, **A** or **B**, is the ANODE? Give a reason for the answer. (2)

9.5 Litmus added to the electrolyte turns blue around electrode **B**. Explain this observation with the aid of the relevent half-reaction. (3)

9.6 Give a reason why platinum can be used as electrodes. (1)
[11]

QUESTION 10 (Start on a new page.)

Two processes in the fertiliser industry are summarised as in the flow diagram below.



10.1 Use the information above and write down:

10.1.1 NAME of **Process 1** (1)

10.1.2 NAME or FORMULA of compound **Y** (1)

10.1.3 Write down a balanced chemical equation for the preparation of fertiliser **Z**. (3)

10.2 Calculate the number of moles of nitrogen in a 5 kg bag of fertiliser with a ratio 7:1:3(22). (4)
[9]

TOTAL: 150

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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·mol^{-1}
Standard temperature Standaardtemperatuur	T^{θ}	273 K
Avogadro's constant	N_A	$6{,}023 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-$	+ 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
$Al^{3+} + 3e^-$	$\rightleftharpoons$	Al	– 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* ↓

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

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
$Al^{3+} + 3e^- \rightleftharpoons Al$	− 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
$Cr_2O_7^{2-} + 14H^+ + \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 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 ↓

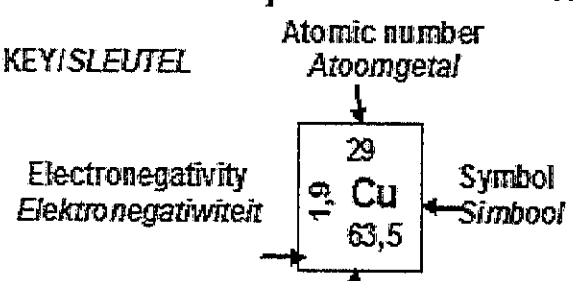
Increasing reducing ability/Toenemende reduserende vermoë ↑

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TABLE 3: THE PERIODIC TABLE OF ELEMENTS
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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 He 4
2,1 H 1																	
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 Cs 133	0,9 Ba 137	57 La 139	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	1,8 Tl 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr	0,9 Ra 226	89 Ac															

KEY/*SLEUTEL*



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

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