basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2012

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1.   Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK.

2.   Answer ALL the questions in the ANSWER BOOK.

3.   This question paper consists of TWO sections:

        SECTION A (25)
        SECTION B (125)

4.   You may use a non-programmable calculator.

5.   You may use appropriate mathematical instruments.

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

7.   Data sheets and a periodic table are attached for your use.

8.   Give brief motivations, discussions, et cetera where required.

9.   Round off your final numerical answers to a minimum of TWO decimal places.

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1   The homologous series to which propan-2-one belongs   (1)

1.2   The IUPAC name of the alkene with two carbon atoms   (1)

1.3   The minimum energy needed for a chemical reaction to occur   (1)

1.4   The general name used for a substance that increases the rate of a reaction without being consumed in the reaction   (1)

1.5   The chemical name of brine   (1)

[5]

QUESTION 2: 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 (2.1–2.10) in the ANSWER BOOK.

2.1   Consider the organic compound represented below.
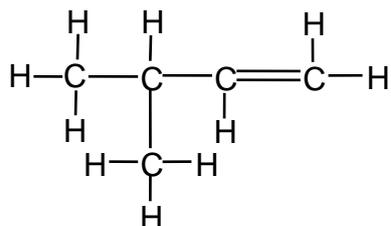
The compound is ...

A   saturated and branched.

B   unsaturated and branched.

C   saturated and straight-chained.

D   unsaturated and straight-chained.   (2)

2.2   A structural isomer of butane is ...

A   propane.

B   2-methylbutane.

C   2-methylpropane.

D   2,2-dimethylpropane.   (2)

2.3   The alcohols form a homologous series. This means that alcohols have ...

    A   similar chemical properties.

    B   similar physical properties.

    C   the same molecular formula.

    D   the same structural formula.   (2)

2.4   The energy distribution diagrams for particles in a fixed mass of gas at two different temperatures, T_1 and T_2, are shown below.
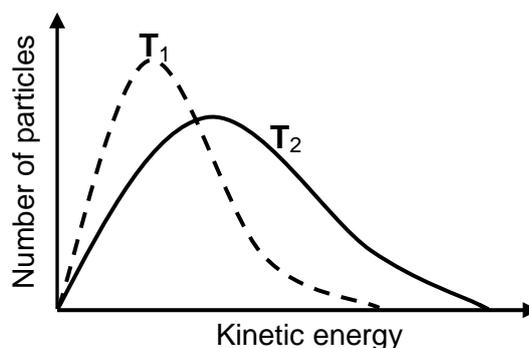
    Which ONE of the following is the correct interpretation of the diagrams as the temperature of the gas changes from **T_1** to **T_2**?

	Activation energy (E_A)	**Number of effective collisions**
A	Remains the same	Increases
B	Decreases	Decreases
C	Decreases	Increases
D	Remains the same	Decreases

(2)

2.5   The expression for the equilibrium constant (K_C) of a hypothetical reaction is given as follows:

$$K_C = \frac{[D]^2[C]}{[A]^3}$$

    Which ONE of the following equations for a reaction at equilibrium matches the above expression?

    A $3A(s) \rightleftharpoons C(g) + 2D(g)$

    B $3A(\ell) \rightleftharpoons C(aq) + 2D(aq)$

    C $3A(aq) + B(s) \rightleftharpoons C(g) + D_2(g)$

    D $3A(aq) + B(s) \rightleftharpoons C(aq) + 2D(aq)$ (2)

2.6   The reaction represented by the balanced equation below reaches equilibrium in a closed container.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \qquad \Delta H < 0$$
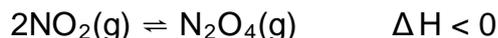
Which ONE of the following changes will INCREASE the yield of $N_2O_4(g)$?

A   Add a catalyst.

B   Remove NO_2 gas from the container.

C   Increase the temperature of the system.

D   Decrease the temperature of the system.   (2)

2.7   In a redox reaction, an oxidising agent is ...

A   reduced because it loses electrons.

B   reduced because it gains electrons.

C   oxidised because it loses electrons.

D   oxidised because it gains electrons.   (2)

2.8   In a galvanic (voltaic) cell, electrons move from the ...

A   anode to the cathode through the salt bridge.

B   cathode to the anode through the salt bridge.

C   anode to the cathode in the external circuit.

D   cathode to the anode in the external circuit.   (2)

2.9   During the extraction of aluminium from aluminium oxide, cryolite is added to ...

A   increase the yield of aluminium.

B   decrease the yield of aluminium.

C   increase the melting point of aluminium oxide.

D   decrease the melting point of aluminium oxide.   (2)

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

A   N

B   C

C   Mg

D   Na   (2)
[20]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS

1. Start EACH question on a NEW page.

2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3   (Start on a new page.)

The letters **A** to **F** in the table below represent six organic compounds.

A	$CH \equiv C - CH_2 - CH_2 - CH_3$	**B**	$CH_3CH_2CH_2CHCH_3$ $\quad\quad\quad\quad\quad \mid$ $\quad\quad\quad\quad\quad OH$
C	$CH_2 = C - CH_2$ with CH_3 above and CH_3 below the central C	**D**	Pentanoic acid
E	structural formula of aldehyde with branched chain	**F**	$CH_3 - CH_2 - O - \overset{\overset{\displaystyle O}{\|}}{C} - CH_2 - CH_3$

3.1   Write down the letter(s) that represent(s) each of the following:
        (A compound may be used more than once.)

       3.1.1   An alkyne (1)

       3.1.2   Two compounds that are structural isomers (2)

       3.1.3   A compound containing a carboxyl group (1)

       3.1.4   An aldehyde (1)

       3.1.5   An alcohol (1)

3.2   Write down the:

       3.2.1   IUPAC name of compound **C** (2)

       3.2.2   Structural formula of compound **D** (2)

3.3   Compound **F** is prepared in the laboratory.

      3.3.1   How can one quickly establish whether compound **F** is indeed being formed?   (1)

      3.3.2   Write down the IUPAC name of the alcohol needed to prepare compound **F**.   (2)

      3.3.3   Write down the IUPAC name of compound **F**.   (2)
[15]

QUESTION 4   (Start on a new page.)

During a practical investigation the boiling points of the first six straight-chain ALKANES were determined and the results were recorded in the table below.

ALKANE	MOLECULAR FORMULA	BOILING POINT (°C)
Methane	CH_4	−164
Ethane	C_2H_6	−89
Propane	C_3H_8	−42
Butane	C_4H_{10}	−0,5
Pentane	C_5H_{12}	36
Hexane	C_6H_{14}	69

4.1   Write down the:

      4.1.1   Most important use of the alkanes in the above table   (1)

      4.1.2   General formula of the alkanes   (1)

Refer to the table to answer QUESTION 4.2 and QUESTION 4.3 below.

4.2   For this investigation, write down the following:

      4.2.1   Dependent variable   (1)

      4.2.2   Independent variable   (1)

      4.2.3   Conclusion that can be drawn from the above results   (2)

4.3   Write down the NAME of an alkane that is a liquid at 25 °C.   (1)

4.4   Alkanes burn readily in oxygen. Write down a balanced equation, using molecular formulae, for the combustion of propane in excess oxygen.   (3)

4.5   Will the boiling points of the structural isomers of hexane be HIGHER THAN, LOWER THAN or EQUAL TO that of hexane? Refer to MOLECULAR STRUCTURE, INTERMOLECULAR FORCES and ENERGY NEEDED to explain the answer.   (4)
[14]

QUESTION 5   (Start on a new page.)

The flow diagram below shows how three organic compounds can be prepared from 2-bromo-3-methylbutane.

Compound **A**		Compound **B**

Reaction 1   **Reaction 2**

Reaction 3

2-bromo-3-methylbutane

An alkene
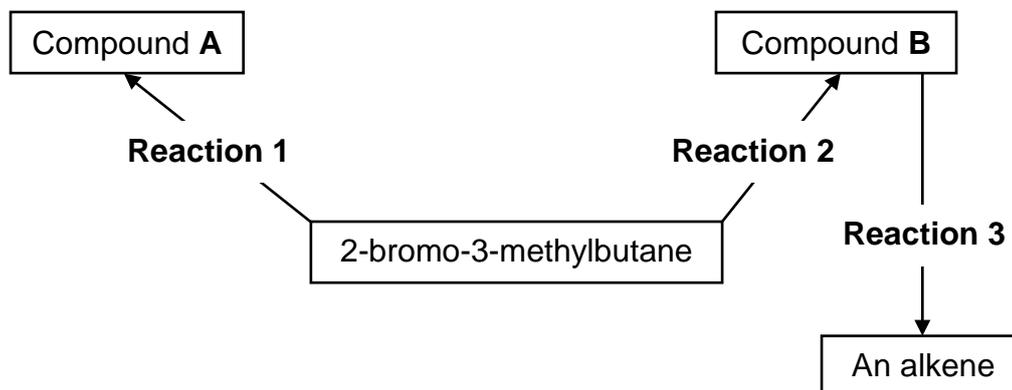
5.1   Write down the:

      5.1.1   Homologous series to which 2-bromo-3-methylbutane belongs   (1)

      5.1.2   Structural formula of 2-bromo-3-methylbutane   (2)

5.2   **Reaction 2** takes place in the presence of a dilute sodium hydroxide solution.

      Write down the:

      5.2.1   Name of the type of reaction which takes place   (1)

      5.2.2   Structural formula of compound **B**   (2)

5.3   **Reaction 1** takes place in the presence of concentrated sodium hydroxide.

      Write down:

      5.3.1   Another reaction condition needed for this reaction   (1)

      5.3.2   The name of the type of reaction which takes place   (1)

      5.3.3   The structural formula of compound **A**, the major product formed   (2)

5.4   **Reaction 3** takes place when compound **B** is heated in the presence of concentrated sulphuric acid. Write down the IUPAC name of the major product formed.   (2)

[12]

QUESTION 6　(Start on a new page.)

Calcium carbonate chips are added to an excess dilute hydrochloric acid solution in a flask placed on a balance as illustrated below. The cotton wool plug in the mouth of the flask prevents spillage of reactants and products, but simultaneously allows the formed gas to escape. The balanced equation for the reaction that takes place is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$
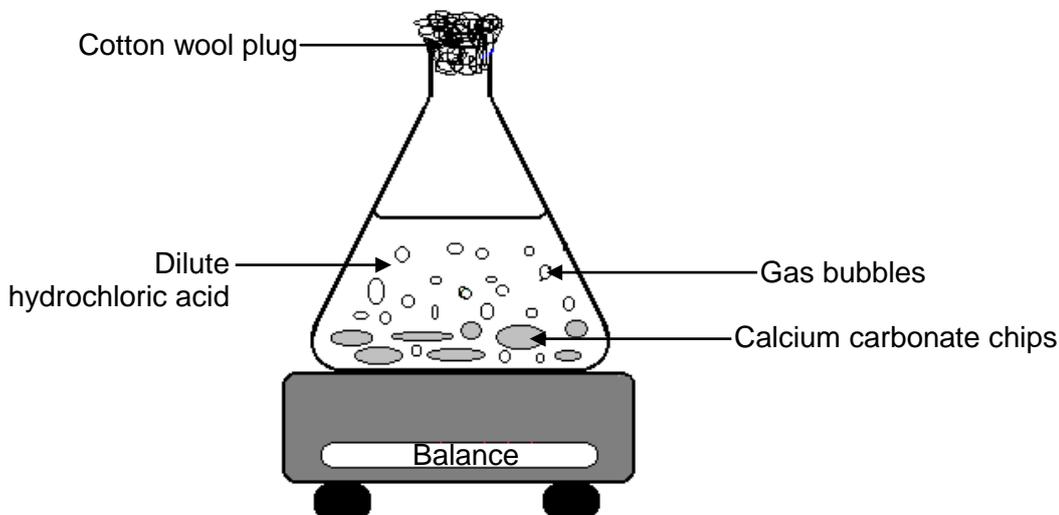
6.1　Write down the NAME of the gas that escapes through the cotton wool plug while the reaction takes place. (1)

The loss in mass of the flask and its contents is recorded in intervals of 2 minutes. The results obtained are shown in the graph below.

Graph of loss in mass versus time
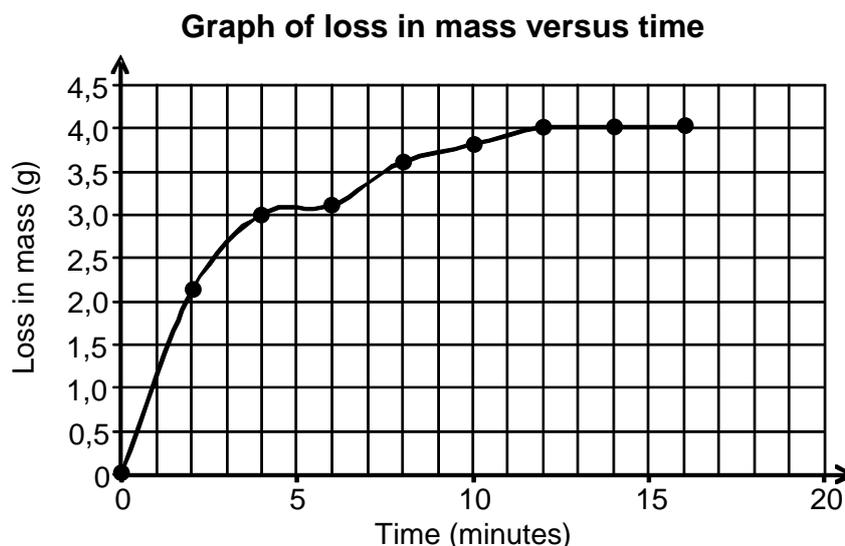
6.2　From the graph, write down the following:

6.2.1　The coordinates of the point that represents results that were measured incorrectly (1)

6.2.2　How long (in minutes) the reaction lasts (1)

6.2.3　How long (in minutes) it takes 75% (three quarters) of the reaction to occur (1)

6.3   The experiment is now repeated using hydrochloric acid of a higher concentration. It is found that the rate of the reaction INCREASES. Use the collision theory to explain this observation.   (2)

6.4   How would a higher concentration of hydrochloric acid affect the following:
        (Write down only INCREASES, DECREASES or REMAINS THE SAME.)

        6.4.1   Loss in mass per unit time   (1)

        6.4.2   Total loss in mass   (1)

        6.4.3   Time for the reaction to reach completion   (1)

6.5   Apart from concentration and temperature changes, write down TWO other changes that can be made to increase the rate of this reaction.   (2)

6.6   Calculate the mass of calcium carbonate used when the reaction is completed. Assume that all the gas that was formed, escaped from the flask.   (5)
                                                                                          [16]

QUESTION 7   (Start on a new page.)

A hypothetical reaction is represented by the balanced equation below.

$$A(g) + 2B(g) \rightleftharpoons 2C(g)$$
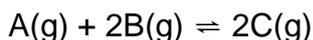
Initially 3 moles of A(g) and 6 moles of B(g) are mixed in a 5 dm^3 sealed container. When the reaction reaches equilibrium at 25 °C, it is found that 4 moles of B(g) is present.

7.1   Define the term *chemical equilibrium*.   (2)

7.2   Show by calculation that the equilibrium concentration of C(g) is 0,4 $mol \cdot dm^{-3}$.   (3)

7.3   How will an increase in pressure, by decreasing the volume of the container, influence the amount of C(g) in the container at 25 °C?
        Write down INCREASES, DECREASES or REMAINS THE SAME. Explain the answer.   (3)

7.4   The initial number of moles of B(g) is now increased while the initial number of moles of A(g) remains constant at 25 °C.

        Calculate the number of moles of B(g) that must be ADDED to the original amount (6 mol) so that the concentration of C(g) is 0,8 $mol \cdot dm^{-3}$ at equilibrium. The equilibrium constant (K_C) for this reaction at 25 °C is 0,625.   (9)
                                                                                          [17]

QUESTION 8 (Start on a new page.)

8.1 A strip of aluminium is placed in a beaker containing a blue solution of a copper(II) salt. After a while the solution becomes colourless.
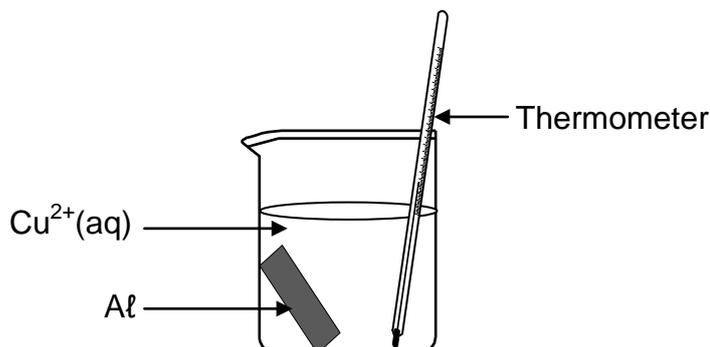
8.1.1 How would the reading on the thermometer change as the reaction proceeds? Write down INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

8.1.2 Refer to the reducing ability of aluminium to explain why the solution becomes colourless. (2)

8.1.3 Write down the balanced net IONIC equation for the reaction that takes place. (3)

8.2 The electrochemical cell shown below functions at standard conditions.
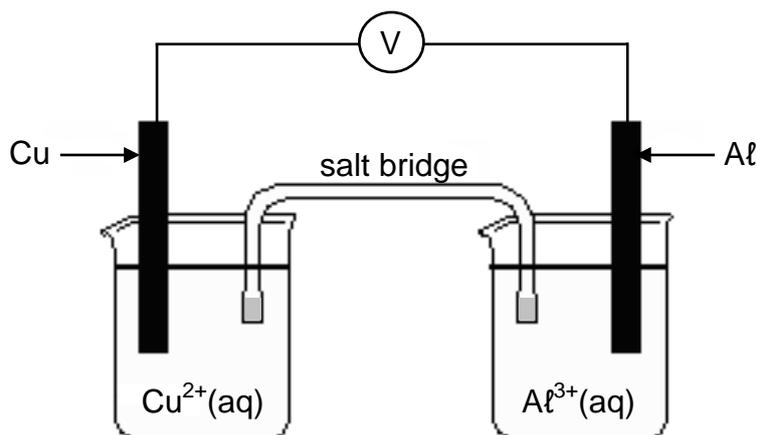
8.2.1 Which electrode (Cu or Aℓ) is the anode? (1)

8.2.2 Write down the cell notation for this cell. (3)

8.2.3 Calculate the emf of this cell. (4)

The salt bridge is now removed.

8.2.4 What will the reading on the voltmeter be? Give a reason for your answer. (2)

[17]

QUESTION 9   (Start on a new page.)

The simplified diagram below shows an electrolytic cell used at an electroplating company to coat iron spoons with silver.
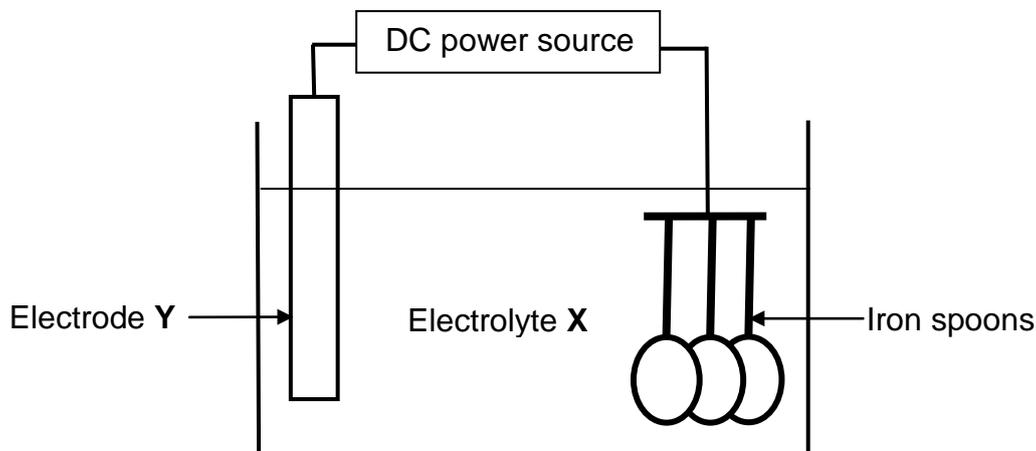
9.1   Write down the energy conversion that takes place in this cell.   (1)

9.2   Direct current (DC) is used in this process. Give a reason why alternating current (AC) is NOT used.   (1)

9.3   Which type of reaction (OXIDATION or REDUCTION) takes place at the spoons?   (1)

9.4   Write down the:

      9.4.1   Equation for the half-reaction that takes place at electrode **Y**   (2)

      9.4.2   NAME or FORMULA of electrolyte **X**   (1)

9.5   Give a reason why the concentration of electrolyte **X** remains constant during electroplating.   (2)

9.6   Apart from the income generated, write down ONE major reason why the company electroplates the spoons.   (1)

9.7   Write down the TWO major expenses for the company during the process.   (2)

[11]

QUESTION 10   (Start on a new page.)

The following half-reactions take place when a non-rechargeable alkaline cell is in use:

$$Zn(s) + 2OH^-(aq) \rightarrow ZnO(s) + H_2O(\ell) + 2e^- \quad \dots\dots\dots\dots\dots(1)$$

$$MnO_2(s) + 2H_2O(\ell) + 2e^- \rightarrow Mn(OH)_2(s) + 2OH^-(aq) \dots\dots(2)$$
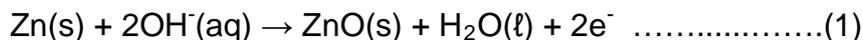
10.1   Write down the general name used for non-rechargeable cells.   (1)

10.2   Which ONE of the above equations (**1** or **2**) represents the half-reaction that takes place at the cathode? Give a reason for your answer.   (2)

10.3   Give a reason why the cell 'dies' after delivering current for a while.   (1)

10.4   The emf of the alkaline cell is 1,5 V. The maximum electrical work that can be done by this cell is 3×10^4 J.

Calculate the:

10.4.1   Cell capacity of this cell in A·h   (4)

10.4.2   Maximum constant current that this cell can deliver for 20 hours   (3)

[11]

QUESTION 11   (Start on a new page.)

11.1   The flow diagram below represents processes used in the fertiliser industry.
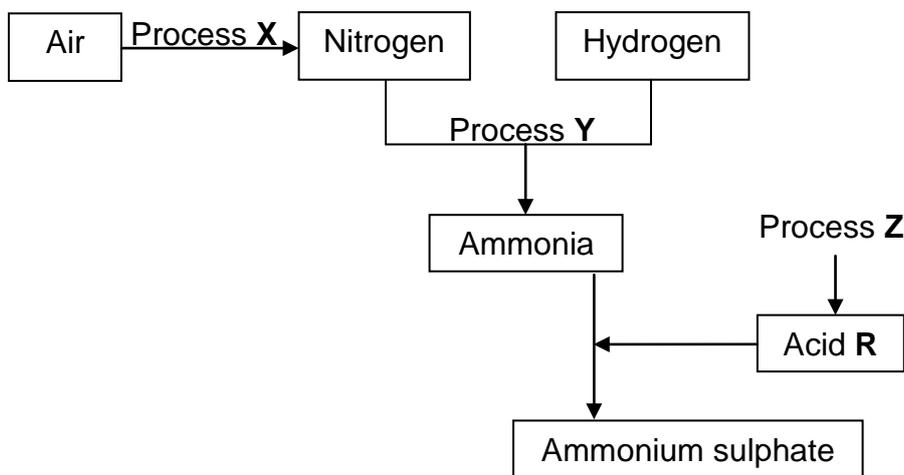
Write down:

11.1.1   The name of industrial process **X**   (1)

11.1.2   A balanced equation for process **Y**   (3)

11.1.3   The name of industrial process **Z**   (1)

11.1.4   A balanced equation for the preparation of ammonium sulphate
using acid **R**   (3)

11.1.5   The name of the type of reaction taking place in
QUESTION 11.1.4.   (1)

11.2   Ammonium nitrate is one of the most common compounds used as fertiliser.

11.2.1   Write down the NAME or FORMULA of the acid needed to prepare
ammonium nitrate from ammonia.   (1)

11.2.2   Write down TWO properties of ammonium nitrate that make it
suitable for use as a fertiliser.   (2)

[12]

TOTAL SECTION B: 125
GRAND 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·mol^{-1}
Standard temperature *Standaardtemperatuur*	T^θ	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \dfrac{m}{M}$	$c = \dfrac{n}{V}$ or/*of* $c = \dfrac{m}{MV}$
$q = I\,\Delta t$ $W = Vq$	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$ 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 1																	2 **He** 4
1,0 **Li** 3 7	1,5 **Be** 4 9											2,0 **B** 5 11	2,5 **C** 6 12	3,0 **N** 7 14	3,5 **O** 8 16	4,0 **F** 9 19	**Ne** 10 20
0,9 **Na** 11 23	1,2 **Mg** 12 24											1,5 **Aℓ** 13 27	1,8 **Si** 14 28	2,1 **P** 15 31	2,5 **S** 16 32	3,0 **Cℓ** 17 35,5	**Ar** 18 40
0,8 **K** 19 39	1,0 **Ca** 20 40	1,3 **Sc** 21 45	1,5 **Ti** 22 48	1,6 **V** 23 51	1,6 **Cr** 24 52	1,5 **Mn** 25 55	1,8 **Fe** 26 56	1,8 **Co** 27 59	1,8 **Ni** 28 59	1,9 **Cu** 29 63,5	1,6 **Zn** 30 65	1,6 **Ga** 31 70	1,8 **Ge** 32 73	2,0 **As** 33 75	2,4 **Se** 34 79	2,8 **Br** 35 80	**Kr** 36 84
0,8 **Rb** 37 86	1,0 **Sr** 38 88	1,2 **Y** 39 89	1,4 **Zr** 40 91	**Nb** 41 92	1,8 **Mo** 42 96	1,9 **Tc** 43 101	2,2 **Ru** 44 101	2,2 **Rh** 45 103	2,2 **Pd** 46 106	1,9 **Ag** 47 108	1,7 **Cd** 48 112	1,7 **In** 49 115	1,8 **Sn** 50 119	1,9 **Sb** 51 122	2,1 **Te** 52 128	2,5 **I** 53 127	**Xe** 54 131
0,7 **Cs** 55 133	0,9 **Ba** 56 137	**La** 57 139	1,6 **Hf** 72 179	**Ta** 73 181	**W** 74 184	**Re** 75 186	**Os** 76 190	**Ir** 77 192	**Pt** 78 195	**Au** 79 197	**Hg** 80 201	1,8 **Tℓ** 81 204	1,8 **Pb** 82 207	1,9 **Bi** 83 209	2,0 **Po** 84	2,5 **At** 85	**Rn** 86
0,7 **Fr** 87	0,9 **Ra** 88 226	**Ac** 89															

KEY/SLEUTEL

Atomic number / *Atoomgetal* → 29
Electronegativity / *Elektronegatiwiteit* → 1,9 **Cu** ← Symbol / *Simbool*
Approximate relative atomic mass / *Benaderde relatiewe atoommassa* → 63,5

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
$2H^+ + 2e^-$	$\rightleftharpoons$	**$H_2(g)$**	**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
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

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

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