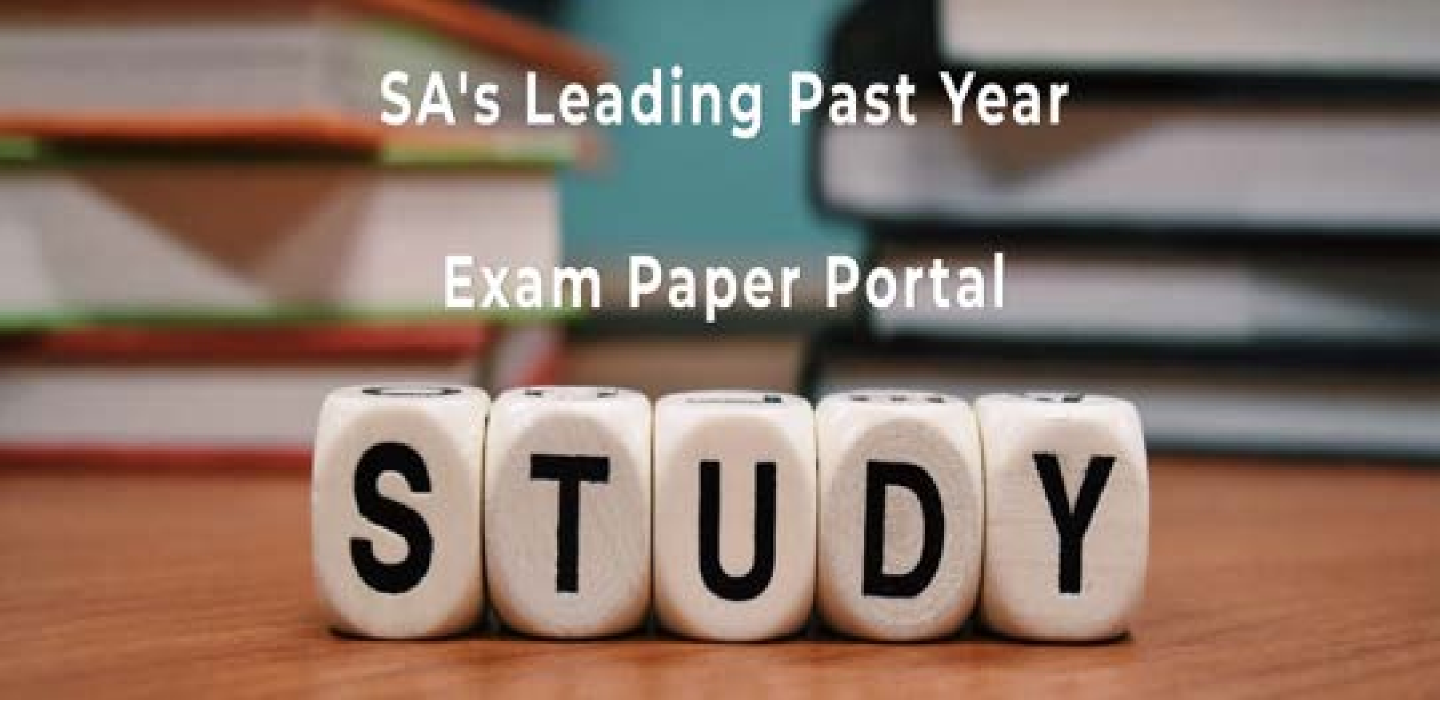
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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2013

MARKS: 150

TIME: 3 hours

This question paper consists of 15 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 industrial preparation of nitrogen gas from liquid air (1)

1.2 The removal of water from a compound during a reaction (1)

1.3 A theory used to explain how factors, such as temperature, change the rate of a reaction (1)

1.4 The general term used to describe a substance that donates electrons to another substance (1)

1.5 The general term used to describe a class of organic compounds in which one member differs from the previous one by a CH_2 group (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 Which ONE of the following is the functional group of aldehydes?

A ─ COO ─

B ─ COOH

C ─ CHO

D ─ OH (2)

2.2 Which ONE of the following hydrocarbons always gives a product with the same IUPAC name when ANY ONE of its hydrogen atoms is replaced with a chlorine atom?

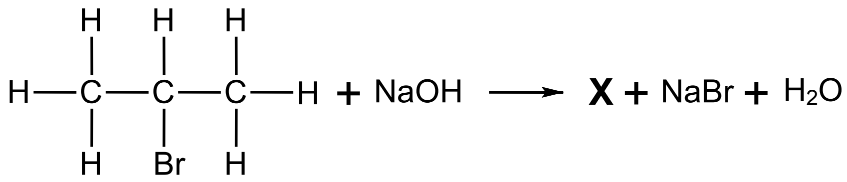
A Hexane

B Hex-1-ene

C Cyclohexane

D Cyclohexene (2)

2.3 The equation below represents the reaction that takes place when an organic compound and concentrated sodium hydroxide are strongly heated. **X** represents the major organic product formed.



Which ONE of the following is the correct IUPAC name for compound **X**?

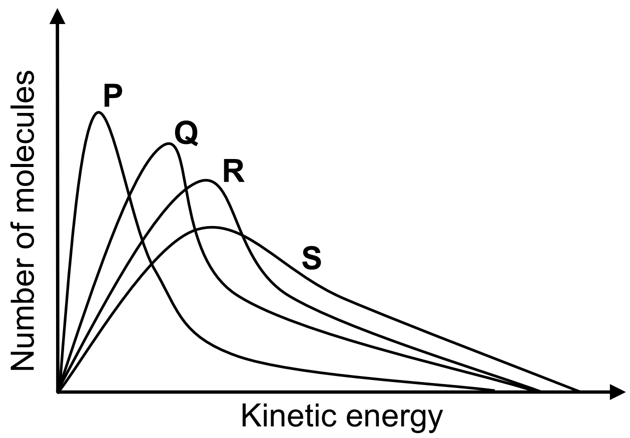
A Prop-1-ene

B Prop-2-ene

C Propan-1-ol

D Propan-2-ol (2)

2.4 The graphs below represent the molecular distribution for a reaction at different temperatures.



Which ONE of the graphs above represents the reaction at the highest temperature?

A P

B Q

C R

D S (2)

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

$$CuO(s) + H_2(g) \rightleftharpoons Cu(s) + H_2O(g) \quad \Delta H < 0$$

Which ONE of the following changes will increase the yield of products?

A Increase temperature.

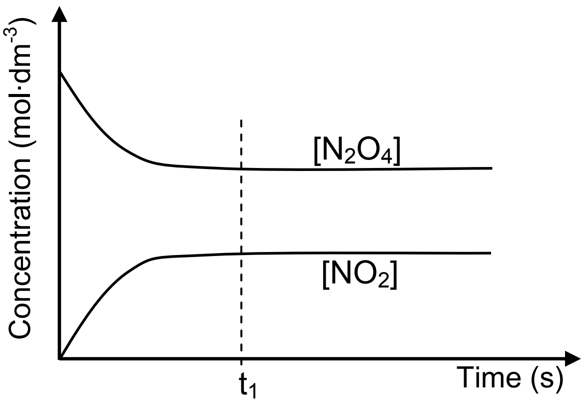
B Decrease temperature.

C Increase pressure by decreasing the volume.

D Decrease pressure by increasing the volume. (2)

2.6 The graph below represents the decomposition of $N_2O_4(g)$ in a closed container according to the following equation:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$



Which ONE of the following correctly describes the situation at t_1?

A The N_2O_4 gas is used up.

B The NO_2 gas is used up.

C The rate of the forward reaction equals the rate of the reverse reaction.

D The concentrations of the reactant and the product are equal. (2)

2.7 Which ONE of the following is the strongest oxidising agent?

A $F_2(g)$

B $F^-(aq)$

C $Li(s)$

D $Li^+(aq)$ (2)

2.8 Which ONE of the following statements about a galvanic cell in operation is CORRECT?

A ΔH for the cell reaction is positive.

B The overall cell reaction is non-spontaneous.

C The emf is negative.

D ΔH for the cell reaction is negative. (2)

2.9 The function of the salt bridge in a galvanic cell in operation is to ...

A allow anions to travel to the cathode.

B maintain electrical neutrality in the half-cells.

C allow electrons to flow through it.

D provide ions to react at the anode and cathode. (2)

2.10 The major product formed at the ANODE in a membrane cell is ...

A hydrogen.

B oxygen.

C chlorine.

D hydroxide ions. (2)
[20]

TOTAL SECTION A: 25

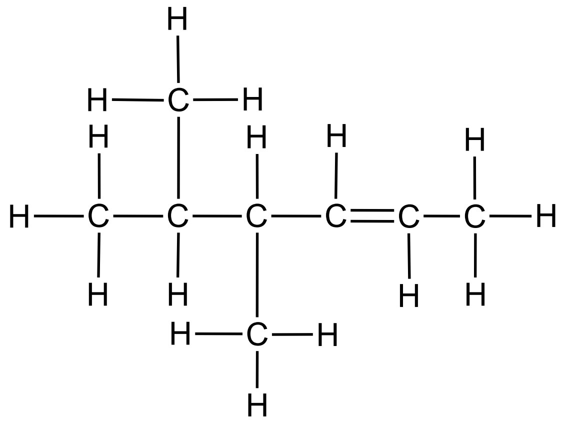
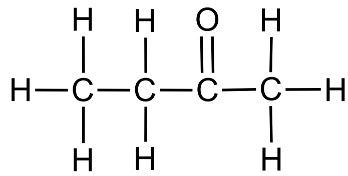
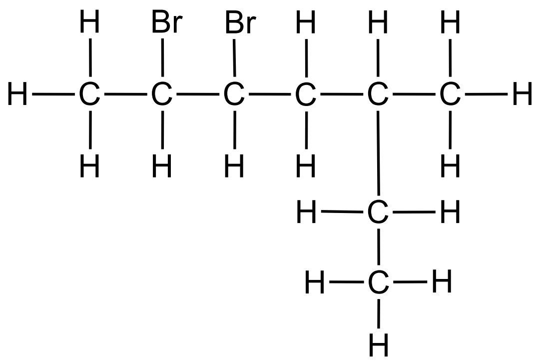
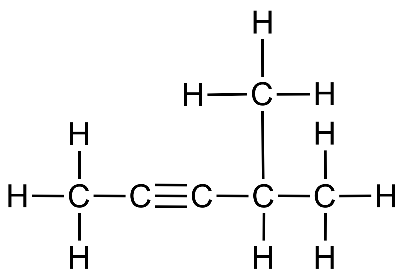
SECTION B

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		**B**	
C	$CH_3CH{=}CHCH_2CH_2CH_3$	**D**	Pentyl propanoate
E		**F**	

3.1 Write down the letter(s) that represent(s) the following:

3.1.1 Alkenes (2)

3.1.2 A ketone (1)

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

3.1.4 A structural isomer of cyclohexene (2)

3.2 Write down the IUPAC name of compound:

3.2.1 **A** (2)

3.2.2 **E** (2)

3.2.3 **F** (2)

3.3 Compound **D** is prepared by reacting two organic compounds in the presence of an acid as catalyst.

Write down the:

3.3.1 Homologous series to which compound **D** belongs (1)

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

3.3.3 IUPAC name of the organic acid used to prepare compound **D** (1)

3.3.4 NAME or FORMULA of the catalyst used (1)
[17]

QUESTION 4 (Start on a new page.)

A laboratory technician is supplied with three unlabelled bottles containing an alcohol, an aldehyde and an alkane respectively of comparable molecular mass. She takes a sample from each bottle and labels them **P**, **Q** and **R**.

In order to identify each sample, she determines the boiling point of each under the same conditions. The results are shown in the table below.

SAMPLE	BOILING POINT (°C)
P	76
Q	36
R	118

4.1 For this investigation, write down the:

4.1.1 Independent variable (1)

4.1.2 Dependent variable (1)

4.2 From the passage above, write down a phrase that shows that this investigation is a fair test. (1)

4.3 Which sample (**P**, **Q** or **R**) is the:

4.3.1 Alkane (1)

4.3.2 Alcohol (1)

4.3.3 Refer to boiling point and the type of intermolecular forces present between alcohol molecules to give a reason for the answer in QUESTION 4.3.2. (2)

4.4 The alkane is identified as pentane. Will the boiling point of hexane be HIGHER THAN or LOWER THAN that of pentane? Refer to MOLECULAR STRUCTURE, INTERMOLECULAR FORCES and ENERGY needed to explain the answer. (4)
[11]

QUESTION 5 (Start on a new page.)

Two straight chain compounds, **P** and **Q**, each have the following molecular formula:

P: C_4H_{10}

Q: C_4H_8

5.1 Write down the name of the homologous series to which **Q** belongs. (1)

5.2 Compound **P** reacts with chlorine to form 2-chlorobutane.

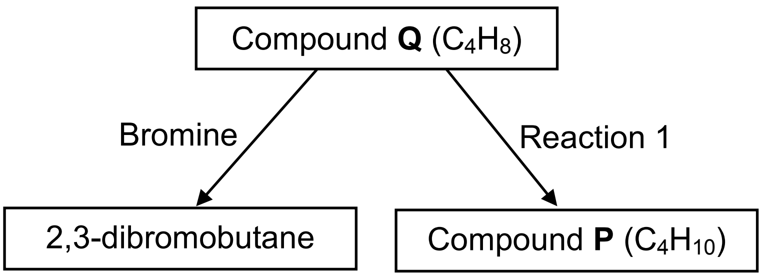
Write down:

5.2.1 A balanced chemical equation, using MOLECULAR FORMULAE, for the reaction that takes place (3)

5.2.2 The type of reaction that takes place (1)

5.2.3 One reaction condition (other than the solvent needed) (1)

5.3 Compound **Q** takes part in reactions as shown in the flow diagram below.



Write down the:

5.3.1 Structural formula for 2,3-dibromobutane (2)

5.3.2 IUPAC name of compound **Q** (2)

5.3.3 Balanced equation, using structural formulae, for **reaction 1** (4)

5.3.4 Type of reaction that occurs in **reaction 1** (1)
[15]

QUESTION 6 (Start on a new page.)

A hydrogen peroxide solution dissociates slowly at room temperature according to the following equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

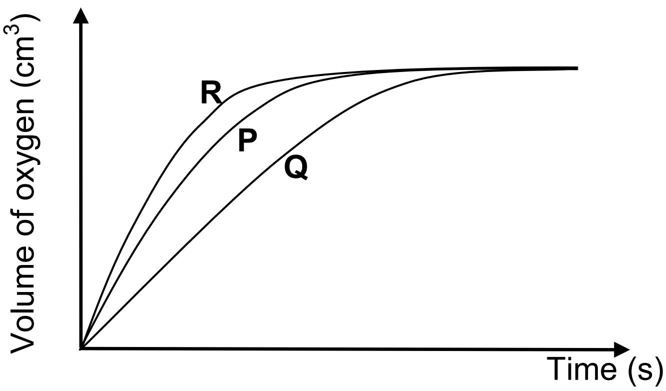
During an investigation, learners compare the effectiveness of three different catalysts on the rate of decomposition of hydrogen peroxide. They place EQUAL AMOUNTS of sufficient hydrogen peroxide into three separate containers. They then add EQUAL AMOUNTS of the three catalysts, **P**, **Q** and **R**, to the hydrogen peroxide in the three containers respectively and measure the rate at which oxygen gas is produced.

6.1 For this investigation, write down the:

6.1.1 Independent variable (1)

6.1.2 Dependent variable (1)

The results obtained are shown in the graph below.



6.2 Which catalyst is the most effective? Give a reason for the answer. (2)

6.3 Fully explain, by referring to the collision theory, how a catalyst increases the rate of a reaction. (3)

In another experiment, the learners obtain the following results for the decomposition of hydrogen peroxide:

TIME (s)	H_2O_2 CONCENTRATION ($mol \cdot dm^{-3}$)
0	0,0200
200	0,0160
400	0,0131
600	0,0106
800	0,0086

6.4 Calculate the AVERAGE rate of decomposition (in $mol \cdot dm^{-3} \cdot s^{-1}$) of $H_2O_2(aq)$ in the first 400 s. (3)

6.5 Will the rate of decomposition at 600 s be GREATER THAN, LESS THAN or EQUAL TO the rate calculated in QUESTION 6.4? Give a reason for the answer. (2)

6.6 Calculate the mass of oxygen produced in the first 600 s if 50 cm^3 of hydrogen peroxide decomposes in this time interval. (5)

[17]

QUESTION 7 (Start on a new page.)

A chemical engineer studies the reaction of nitrogen and oxygen in a laboratory. The reaction reaches equilibrium in a closed container at a certain temperature, **T**, according to the following balanced equation:

$$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$$

Initially, 2 mol of nitrogen and 2 mol of oxygen are mixed in a 5 dm^3 sealed container. The equilibrium constant (K_C) for the reaction at this temperature is 1,2 x 10^{-4}.

7.1 Is the yield of NO(g) at temperature **T** HIGH or LOW? Give a reason for the answer. (2)

7.2 Calculate the equilibrium concentration of NO(g) at this temperature. (8)

7.3 How will each of the following changes affect the YIELD of NO(g)? Write down only INCREASES, DECREASES or REMAINS THE SAME.

7.3.1 The volume of the reaction vessel is decreased at constant temperature. (1)

7.3.2 An inert gas such as argon is added to the mixture. (1)

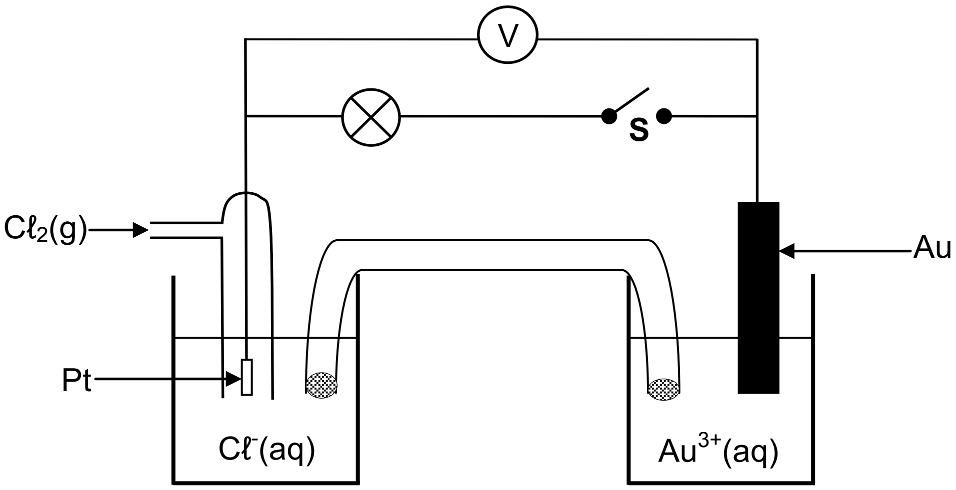
7.4 It is found that K_C of the reaction increases with an increase in temperature. Is this reaction exothermic or endothermic? Explain the answer. (3)

[15]

QUESTION 8 (Start on a new page.)

The diagram below shows a galvanic cell operating under standard conditions. The cell reaction taking place when the cell is functioning is:

$$6C\ell^-(aq) + 2Au^{3+}(aq) \rightarrow 3C\ell_2(g) + 2Au(s)$$



With switch **S** OPEN, the initial reading on the voltmeter is 0,14 V.

8.1 Write down the:

8.1.1 NAME or FORMULA of the oxidising agent (1)

8.1.2 Half-reaction which takes place at the anode (2)

8.1.3 Cell notation for this cell (3)

8.2 Calculate the standard reduction potential of Au. (4)

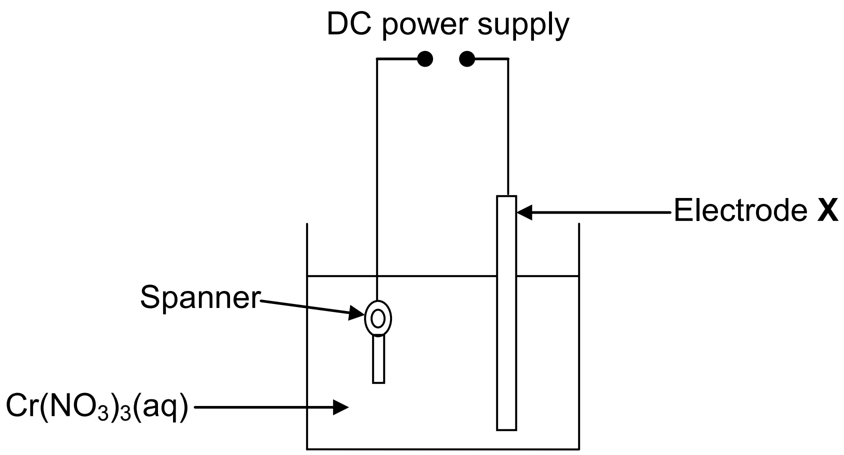
Switch **S** is now closed and the bulb lights up.

8.3 How will the reading on the voltmeter now compare to the INITIAL reading of 0,14 V? Write down only LARGER THAN, SMALLER THAN or EQUAL TO. Give a reason for the answer. (2)

[12]

QUESTION 9 (Start on a new page.)

The diagram below represents a simplified electrolytic cell used to electroplate a spanner with chromium. The spanner is continuously rotated during the process of electroplating.



A constant current passes through the solution and the concentration of $Cr(NO_3)_3(aq)$ remains constant during the process. In the process, a total of 0,03 moles of electrons is transferred in the electrolytic cell.

9.1 Define the term *electrolysis*. (2)

9.2 Write down the:

9.2.1 Half-reaction that occurs at the spanner (2)

9.2.2 NAME or FORMULA of the metal of which electrode **X** is made (1)

9.2.3 NAME or FORMULA of the oxidising agent (1)

9.3 Calculate the gain in mass of the spanner. (4)
[10]

QUESTION 10 (Start on a new page.)

Lead-acid batteries consist of several cells. A sulphuric acid solution is used as electrolyte in these batteries.

10.1 Define the term *electrolyte.* (2)

The standard reduction potentials for the half-reactions that take place in a cell of a lead-acid battery are as follows:

$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons PbSO_4(s) + 2H_2O(\ell)$ $E^\theta = +1,69$ V

$PbSO_4(s) + 2e^- \rightleftharpoons Pb(s) + SO_4^{2-}(aq)$ $E^\theta = -0,36$ V

10.2 Write down the half-reaction that takes place at the anode of this cell. (2)

10.3 Write down the overall cell reaction when the cell delivers current. (3)

10.4 A number of the cells above are connected in series to form a 300 V battery which operates at standard conditions.

Calculate the:

10.4.1 Maximum energy stored in the battery if its capacity is 7 500 A·h (5)

10.4.2 Minimum number of cells in this battery (5)
[17]

QUESTION 11 (Start on a new page.)

11.1 A farmer wants to produce the following fruit and vegetables for the market:

spinach; potatoes; apples

Write down the NAME of the most important primary nutrient required to enhance:

11.1.1 Root growth of potato plants (1)

11.1.2 Leaf growth of spinach (1)

11.1.3 Flower and fruit production of apple trees (1)

11.2 Ammonia must be produced in large quantities to produce nitrogen-based fertilisers.

11.2.1 Write down the name of the process used in the industrial preparation of ammonia. (1)

11.2.2 Write down a balanced chemical equation for the reaction that takes place in the process named in QUESTION 11.2.1. (3)

11.3 Ammonium hydrogen phosphate, $(NH_4)_2HPO_4$, is a type of fertiliser used in agriculture.

Refer to the type of elements of which this fertiliser is composed to give a reason why it will be advantageous for a farmer to use this fertiliser instead of a fertiliser such as ammonium nitrate, NH_4NO_3. (2)

11.4 Describe ONE negative impact on humans when fertiliser runs off into dams and rivers as a result of rain. (2)
[11]

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	$22,4\ dm^{3}\cdot mol^{-1}$
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*

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$
$q = I\Delta t$ $W = Vq$	$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ 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

KEY/*SLEUTEL*

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

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															
				58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
				90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

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