



education

Department:
Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2009

MARKS: 150

TIME: 3 hours

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



INSTRUCTIONS AND INFORMATION

1. Write your examination number and centre number in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions.
3. This question paper consists of TWO sections:

SECTION A (25)
SECTION B (125)
4. Answer SECTIONS A and B in the ANSWER BOOK.
5. Non-programmable calculators may be used.
6. Appropriate mathematical instruments may be used.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Data sheets and a periodic table are attached for your use.
9. Give brief motivations, discussions, et cetera where required.



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 A group of organic compounds with the carbonyl group as functional group (1)
- 1.2 The stage in a reversible reaction when the rate of the forward reaction equals the rate of the reverse reaction (1)
- 1.3 The reactant which undergoes an increase in oxidation number during a chemical reaction (1)
- 1.4 The component of a galvanic cell that ensures electrical neutrality in both half-cells (1)
- 1.5 A unit of measurement used to indicate battery capacity (1)
- [5]**

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Correct each statement so that it is TRUE. Write down the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example, "... IS NOT ...", will not be accepted.

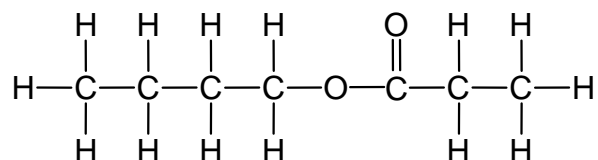
- 2.1 Cyclohexane is an example of an arene. (2)
- 2.2 A catalyst increases the rate of a reaction by lowering the heat of the reaction. (2)
- 2.3 For the heterogeneous equilibrium $\text{NH}_4\text{Cl(s)} \rightleftharpoons \text{NH}_3\text{(g)} + \text{HCl(g)}$,
$$K_c = \frac{[\text{NH}_3\text{(g)}][\text{HCl(g)}]}{[\text{NH}_4\text{Cl(s)}]}$$
 (2)
- 2.4 During the extraction of aluminium from bauxite, carbon is reduced at the anode. (2)
- 2.5 Plants absorb nitrogen in the form of ammonia to ensure healthy growth. (2)
- [10]**



QUESTION 3: 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 (3.1 – 3.5) in the ANSWER BOOK.

3.1 The structural formula of an ester is shown below.



Which ONE of the following pairs of compounds can be used to prepare the above ester?

- A Propanoic acid and butan-1-ol
- B Propanoic acid and butan-2-ol
- C Butanoic acid and propan-1-ol
- D Butanoic acid and propan-2-ol (2)

3.2 Which ONE of the following reaction types can be used to prepare ethene from octane?

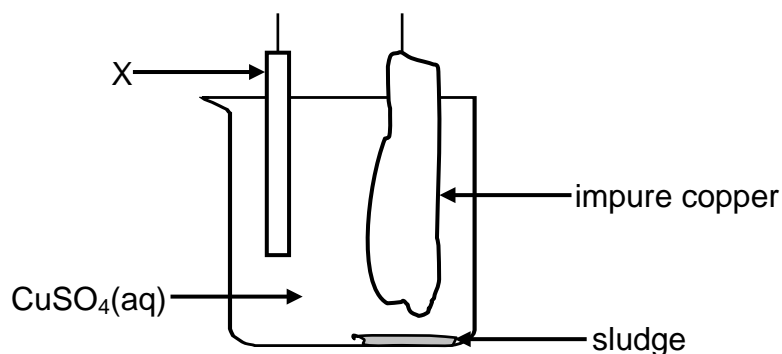
- A Addition
- B Hydrogenation
- C Cracking
- D Substitution (2)

3.3 When the equilibrium constant of a reversible reaction has a value much greater than 1 ($K_c > 1$), it indicates that ...

- A a higher concentration of products than reactants will be formed.
- B a lower concentration of products than reactants will be formed.
- C the reaction will reach equilibrium quickly.
- D the reaction will take a long time to reach equilibrium. (2)



- 3.4 The diagram below represents a cell that may be used for refining copper. The impure copper contains silver metal and zinc metal.



Which ONE of the following half-reactions will take place at electrode X?

- A $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$
- B $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
- C $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
- D $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$ (2)

- 3.5 Which ONE of the reactions below occurs when the fertiliser ammonium nitrate is prepared from nitric acid?

- A Decomposition
 - B Oxidation
 - C Acid-base
 - D Dehydration (2)
- [10]

TOTAL SECTION A: 25



SECTION B**INSTRUCTIONS AND INFORMATION**

1. Answer this section in the ANSWER BOOK.
2. Start each question on a new page. Leave one line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.
3. The formulae and substitutions must be shown in ALL calculations.
4. Round off your answers to TWO decimal places where applicable.

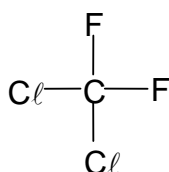
QUESTION 4 (Start on a new page.)**The environmental effects of CFCs and their substitutes**

The ozone layer protects the earth and its inhabitants from the dangerous ultraviolet rays of the sun. It was discovered that gases such as chlorofluorocarbons (CFCs) had damaged the ozone layer, creating a huge hole through which dangerous ultraviolet light could reach the earth.

CFCs were widely used as cooling agents in air conditioners and refrigerators and as propellants in aerosol cans because of their special physical properties. CFCs can be produced by the reaction of alkanes with chlorine, followed by the reaction of the resulting product with fluorine.

Since the banning of CFCs in the year 2000, hydrocarbons such as propane and 2-methylpropane are now used as more environmentally friendly alternatives to CFCs. Both these hydrocarbons and CFCs are greenhouse gases. However, CFCs have greater global warming potential.

- 4.1 The structural formula for a commonly used CFC is given below.



- Write down the IUPAC name for this CFC. (2)
- 4.2 Which physical property of CFCs makes them suitable for use as cooling agents and propellant gases? (1)
- 4.3 CFCs have a negative impact on the environment.
- 4.3.1 State this negative impact. (1)
- 4.3.2 Describe how this negative impact also affects human health. (2)



- 4.4 Use condensed structural formulae to write a balanced equation for the preparation of chloroethane from ethane. (3)
- 4.5 State ONE reaction condition needed for the reaction in QUESTION 4.4 to occur. (1)
- 4.6 Write down a structural formula of an isomer of 2-methylpropane. (2)
- 4.7 Give TWO reasons why propane and 2-methylpropane are considered more environmentally friendly than CFCs. (2)
- [14]**

QUESTION 5 (Start on a new page.)

The table below shows data collected for four organic compounds, represented by the letters A – D, during a practical investigation.

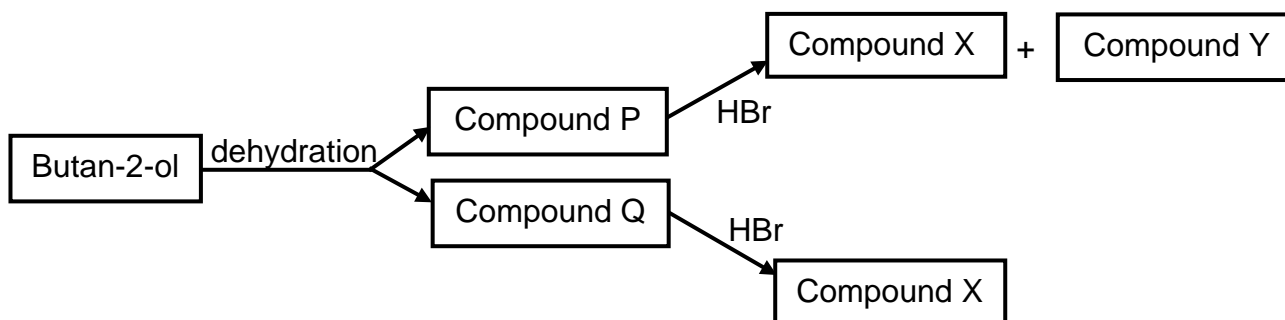
	Organic compound	Relative molecular mass	Boiling point (°C)
A	CH ₃ CH ₂ CH ₃	44	- 42
B	CH ₃ CHO	44	21
C	CH ₃ CH ₂ NH ₂	45	17
D	CH ₃ CH ₂ OH	46	78

- 5.1 Is compound A a saturated or an unsaturated hydrocarbon? Give a reason for your answer. (2)
- 5.2 To which homologous series does compound B belong? (1)
- 5.3 Write down the IUPAC name for each of the following compounds:
- 5.3.1 B (1)
- 5.3.2 C (1)
- 5.4 Write down the structural formula of a secondary amine that is a structural isomer of compound C. (2)
- 5.5 Which variable was controlled during this investigation? (1)
- 5.6 Name the following in this investigation:
- 5.6.1 The dependent variable (1)
- 5.6.2 The independent variable (1)
- 5.7 Refer to intermolecular forces to explain the difference in boiling points between compounds A and D. (3)
- 5.8 Which ONE of compound B or C will have the highest vapour pressure at a specific temperature? Give a reason for your answer. (2)
- [15]**



QUESTION 6 (Start on a new page.)

The flow diagram below shows the conversion of an alcohol into haloalkanes.

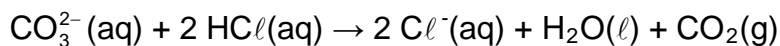


- 6.1 Name the type of organic reaction of which dehydration is an example. (1)
- 6.2 To which homologous series do compounds P and Q belong? (1)
- 6.3 What type of reaction takes place when compound P is converted to compounds X and Y as illustrated above? (1)
- 6.4 Use structural formulae to write a balanced equation for the preparation of compound Q as illustrated above. (4)
- 6.5 Which compound, P or Q, will be the major product? Give a reason for your answer. (2)
- 6.6 Write down the structural formula and the IUPAC name for compound X. (3)
- 6.7 A learner indicates that he can convert butan-2-ol directly into compound X. Name the type of reaction that will take place during a direct conversion. (1)

[13]

QUESTION 7 (Start on a new page.)

The active ingredient in a certain antacid tablet is the carbonate ion ($\text{CO}_3^{2-}(\text{aq})$). This ion reacts with the hydrochloric acid in your stomach according to the following reaction:



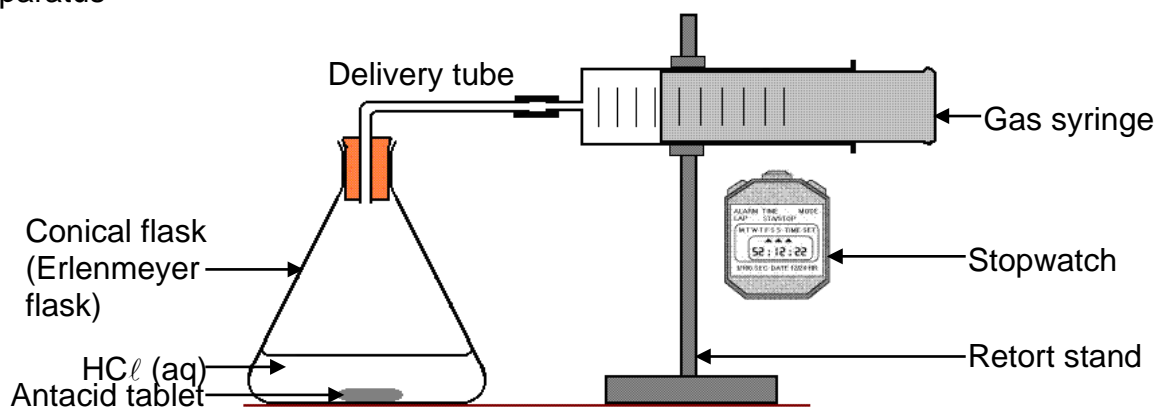
The formation of CO_2 gas is an indication that some of the acid has been neutralised and this brings relief from indigestion.

A group of learners use two of these antacid tablets to investigate **one of the factors that influence the reaction rate**. They follow the method and use the apparatus given below, to conduct the investigation.

Method:

1. Place one antacid tablet in a conical (Erlenmeyer) flask and add $20 \text{ cm}^3 \text{ HCl}(\text{aq})$.
2. Simultaneously start the stopwatch and close the flask with the rubber stopper that is at the end of the delivery tube attached to the gas syringe.
3. Measure the volume of the CO_2 gas formed in intervals of 30 seconds.
4. Repeat 1 to 3 above, but grind the second antacid tablet to a fine powder prior to the reaction.

Apparatus



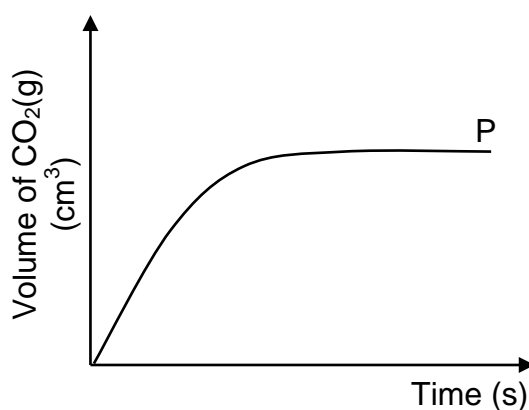
- 7.1 Define the term *reaction rate*. (2)
- 7.2 Write down an investigative question for this investigation. (2)
- 7.3 State THREE variables that must be controlled during this investigation. (3)

- 7.4 Apart from the apparatus illustrated on page 9, the learners need at least TWO other pieces of apparatus to conduct the investigation.

Write down the NAMES of the two pieces of apparatus, as well as the PURPOSE of each, in your ANSWER BOOK. (4)

- 7.5 The learners measure the volume of CO₂ gas formed at 30-second intervals in Step 3 of the method. Write down the NAME of the apparatus that they used for measuring the volume of the CO₂. (1)

- 7.6 Consider the sketch graph below for the reaction of hydrochloric acid with the SOLID antacid tablet.



Redraw the above sketch graph in your ANSWER BOOK. On the same set of axes, sketch the curve Q that was obtained for the reaction of the POWDERED antacid tablet with hydrochloric acid.

Clearly label the curves P and Q on the re-drawn sketch graph. (3)

- 7.7 The instruction on an antacid packet recommends that antacid tablets must be chewed for faster relief. Explain how chewing the tablets bring about faster relief. (2)

[17]

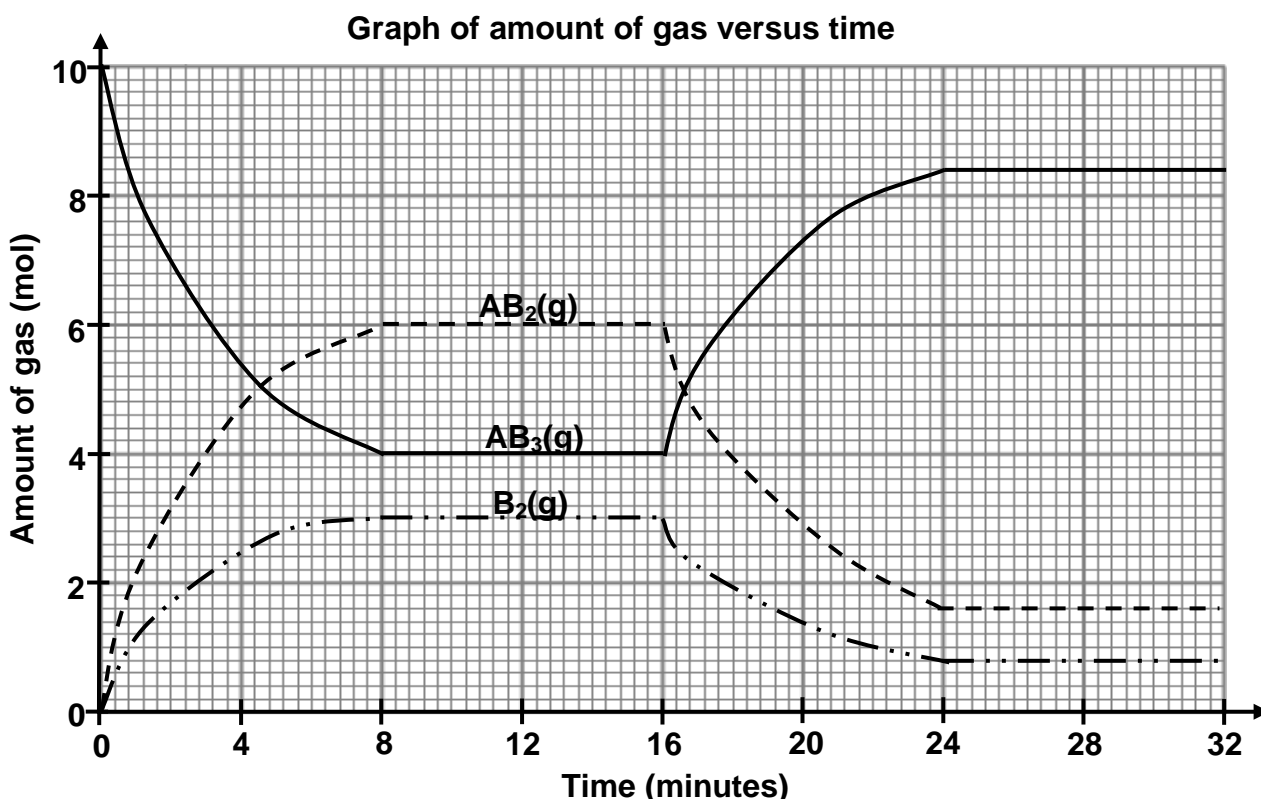


QUESTION 8 (Start on a new page.)

The following equation represents a hypothetical reaction that reaches equilibrium in a 2 dm³ closed container at 500 °C after 8 minutes.



The course of the reaction is illustrated in the graph below.

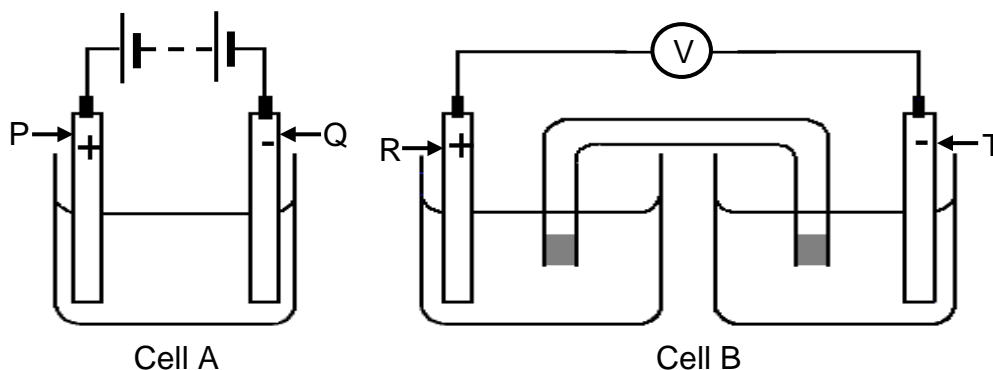


- 8.1 Use the information in the graph to calculate the value of the equilibrium constant at 500 °C. (7)
- 8.2 The temperature is increased to 600 °C at the 16th minute.
- 8.2.1 Is the forward reaction endothermic or exothermic? Use Le Chatelier's principle to explain your answer. (3)
- 8.2.2 How does the equilibrium constant between t = 8 minutes and t = 16 minutes compare to that between t = 24 minutes and t = 32 minutes? Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)
- 8.3 The volume of the container is decreased from 2 dm³ to 1 dm³ after 32 minutes, while keeping the temperature constant at 600 °C. How will each of the following be affected?
- 8.3.1 The value of K_c (1)
- 8.3.2 The number of moles of AB₃(g). Use Le Chatelier's principle to explain your answer. (4)

[16]

QUESTION 9 (Start on a new page.)

The diagrams below represent two types of electrochemical cells. The electrodes of Cell A are labelled P and Q, and the electrodes of Cell B are labelled R and T.



- 9.1 Use the labels P, Q, R or T to identify the anode in:
- 9.1.1 Cell A (1)
- 9.1.2 Cell B (1)
- 9.2 Cell A represents the type of cell that can be used to plate an iron coin with **nickel**.
- 9.2.1 Write down the formula of the ION that can be used as oxidising agent in this cell. (1)
- 9.2.2 Which electrode, P or Q, should consist of the iron coin? Write down the relevant half-reaction that will occur at this electrode. (3)
- 9.2.3 The concentration of the electrolyte does not change during this process. Explain how this is possible. (2)
- 9.2.4 Apart from it looking attractive, what is the advantage of electroplating iron? (1)
- 9.3 An Al/Al^{3+} and a Ag^+/Ag half-cell is used to construct Cell B. A reading is noted on the voltmeter.
- 9.3.1 State the energy conversion that occurs in this cell. (2)
- 9.3.2 Write down a balanced equation for the overall (or net) cell reaction taking place in this cell. (3)
- 9.3.3 Calculate the EMF of this cell at standard conditions. (4)
- 9.3.4 Distilled water is added to the Ag^+ solution. How will the EMF of the cell be affected? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)
- 9.3.5 In which direction will electrons flow in the external circuit? Write only 'from Al to Ag' or 'from Ag to Al'. (1)

[20]

QUESTION 10 (Start on a new page.)

Four possible steps in the manufacture of an artificial fertiliser are listed below.

STEP I: Methane reacts with steam to produce hydrogen.

STEP II: Hydrogen and nitrogen react in the presence of a catalyst to produce ammonia.

STEP III: Sulphur dioxide (SO_2) is oxidised in the presence of a catalyst to produce sulphur trioxide (SO_3), which is then used to produce sulphuric acid.

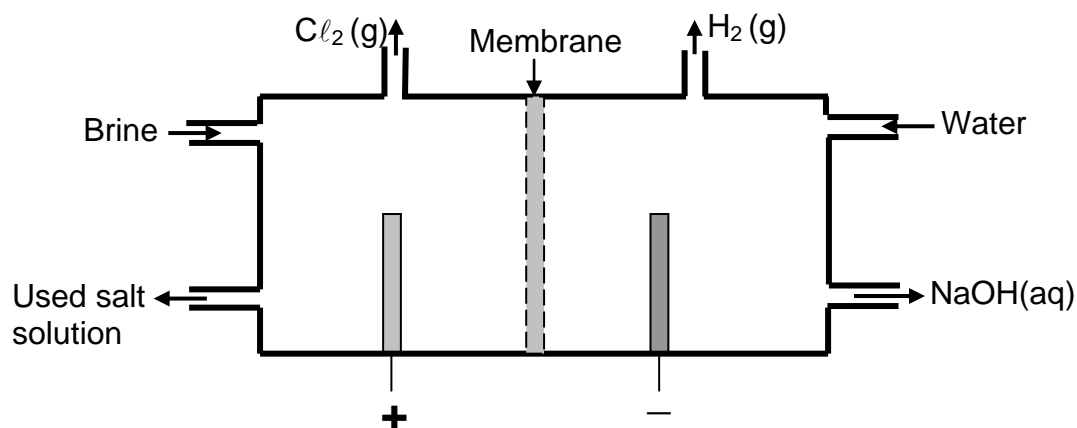
STEP IV: Ammonia reacts with the sulphuric acid to produce a fertiliser.

- 10.1 Write a balanced equation for the reaction in Step II. (3)
- 10.2 What is the name of the industrial process represented by Step III? (1)
- 10.3 Write down a balanced chemical equation for Step IV. (3)
- 10.4 A community is protesting against a fertiliser plant being set up close to a lake, which is their only source of drinking water.
- Give TWO reasons to justify their protest. (2)
- [9]**



QUESTION 11 (Start on a new page.)

Industrially, chlorine gas is produced by the electrolysis of brine. In addition to chlorine gas, hydrogen gas and sodium hydroxide are also produced.



- 11.1 Write down the equation for the half-reaction that takes place at the cathode. (2)
- 11.2 Write the balanced overall (net) cell reaction, omitting spectator ions, for this cell. (3)
- 11.3 State TWO functions of the membrane in the above cell. (2)
- 11.4 Use the relative strengths of oxidising agents present in a brine solution to explain why sodium metal is NOT one of the products in this process. (2)
- 11.5 Chlorine is used in many useful products such as plastics, drugs and disinfectants. Environmentalists are protesting against the large-scale production of chlorine. They base their argument on the negative impact of chlorine on humans.

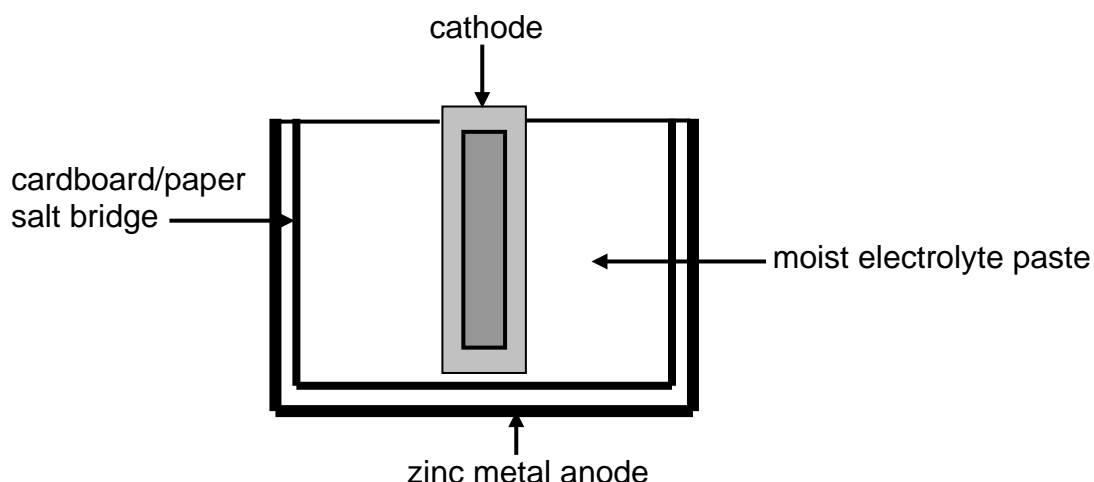
Name ONE negative impact of chlorine on humans.

(1)
[10]



QUESTION 12 (Start on a new page.)

A sketch of a dry cell, such as the one used in a torch or radio, is shown below.



In some types of dry cells, the electrolyte paste is made of ammonium chloride which is acidic. In other types of cells the paste is alkaline, due to an alkali such as potassium hydroxide. The alkaline cells are known to last longer than those containing ammonium chloride.

- 12.1 Why is the above cell referred to as a *dry cell*? (1)
- 12.2 Give a reason why alkaline cells last longer than cells that contain acid. (2)
- 12.3 A certain alkaline battery made to operate over a 20-hour period is marked 1,5 V; 1 000 mA·h.
- 12.3.1 Calculate the maximum work (in joule) that can be done by this battery. (4)
- 12.3.2 Calculate the maximum constant current that the battery can supply for 20 hours. (3)
- 12.4 Give ONE reason why rechargeable batteries have less impact on global warming than non-rechargeable batteries. (1)

[11]**TOTAL SECTION B: 125****GRAND TOTAL: 150**

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$c = \frac{n}{V}$ or $c = \frac{m}{MV}$
$q = I \Delta t$	$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta / E_{\text{sel}}^\theta = E_{\text{katode}}^\theta - E_{\text{anode}}^\theta$
$W = Vq$	$E_{\text{cell}}^\theta = E_{\text{reduction}}^\theta - E_{\text{oxidation}}^\theta / E_{\text{sel}}^\theta = E_{\text{reduksie}}^\theta - E_{\text{oksidasie}}^\theta$
	$E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta / E_{\text{sel}}^\theta = E_{\text{oksideermiddel}}^\theta - E_{\text{reduseermiddel}}^\theta$



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 1 H																	2 He 4
1,0 3 Li	1,5 4 Be											2,0 5 B	2,5 6 C	3,0 7 N	3,5 8 O	4,0 9 F	10 Ne 20
0,9 11 Na	1,2 12 Mg											1,5 13 Al	1,8 14 Si	2,1 15 P	2,5 16 S	3,0 17 Cl	18 Ar 40
0,8 19 K	1,0 20 Ca	1,3 21 Sc	1,5 22 Ti	1,6 23 V	1,6 24 Cr	1,5 25 Mn	1,8 26 Fe	1,8 27 Co	1,8 28 Ni	1,9 29 Cu 63,5	1,6 30 Zn	1,6 31 Ga	1,8 32 Ge	2,0 33 As	2,4 34 Se	2,8 35 Br	36 Kr 84
0,8 37 Rb	1,0 38 Sr	1,2 39 Y	1,4 40 Zr	1,6 41 Nb	1,8 42 Mo	1,9 43 Tc	2,2 44 Ru	2,2 45 Rh	2,2 46 Pd	1,9 47 Ag	1,7 48 Cd	1,7 49 In	1,8 50 Sn	1,9 51 Sb	2,1 52 Te	2,5 53 I	54 Xe 131
0,7 55 Cs	0,9 56 Ba	57 La	1,6 72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	1,8 81 Tl	1,8 82 Pb	1,9 83 Bi	2,0 84 Po	2,5 85 At	86 Rn 222
0,7 87 Fr	0,9 88 Ra 226	89 Ac															
			58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175	
			90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

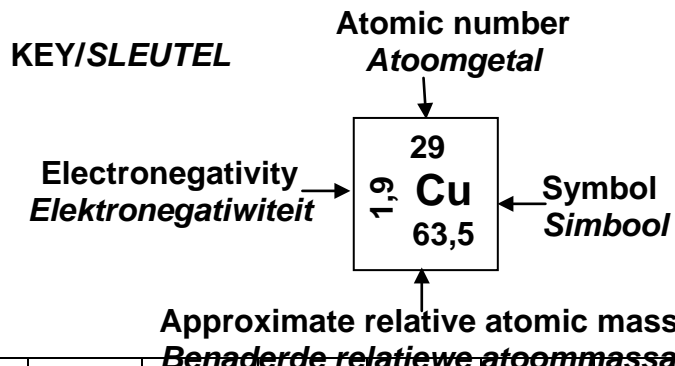


TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD REDUKSIEPOTENSIALE

Half-reactions/ <i>Halfreaksies</i>	E^{\ominus} (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
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 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 reducerende vermoë*



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

Half-reactions/ <i>Halfreaksies</i>	E^{\ominus} (V)
$\text{Li}^+ + e^- \rightleftharpoons \text{Li}$	-3,05
$\text{K}^+ + e^- \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^+ + e^- \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2e^- \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2e^- \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2e^- \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^+ + e^- \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2e^- \rightleftharpoons \text{Mg}$	-2,36
$\text{Al}^{3+} + 3e^- \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2e^- \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2e^- \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2e^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-$	-0,83
$\text{Zn}^{2+} + 2e^- \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3e^- \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2e^- \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + e^- \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2e^- \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2e^- \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2e^- \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2e^- \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2e^- \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3e^- \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2e^- \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + e^- \rightleftharpoons \text{Cu}^+$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^+ + 2e^- \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2e^- \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4e^- \rightleftharpoons 4\text{OH}^-$	+0,40
$\text{SO}_2 + 4\text{H}^+ + 4e^- \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^+ + e^- \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2e^- \rightleftharpoons 2\text{I}^-$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + e^- \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^- + 2\text{H}^+ + e^- \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^+ + e^- \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2e^- \rightleftharpoons \text{Hg}(\ell)$	+0,85
$\text{NO}_3^- + 4\text{H}^+ + 3e^- \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2e^- \rightleftharpoons 2\text{Br}^-$	+1,07
$\text{Pt}^{2+} + 2e^- \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^+ + 2e^- \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6e^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{Cl}^-$	+1,36
$\text{MnO}_4^- + 8\text{H}^+ + 5e^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2e^- \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + e^- \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2e^- \rightleftharpoons 2\text{F}^-$	+2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

