UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CHEMISTRY

Paper 2 Structured Questions AS Core

9701/02

May/June 2005

1 hour 15 minutes

Candidates answer on the Question Paper.
Additional Materials: Data Booklet

Candidate Name

Centre Number

Candidate Number

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number and candidate number in the spaces at the top of this page.
Write in dark blue or black pen in the spaces provided on the Question Paper.
You may use a pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
You may lose marks if you do not show your working or if you do not use appropriate units.
A Data Booklet is provided.
You may use a calculator.

DO NOT WRITE IN THE BARCODE.

DO NOT WRITE IN THE GREY AREAS BETWEEN THE PAGES.

For Examiner's Use	
1	
2	
3	
4	
5	
TOTAL	

This document consists of **10** printed pages and **2** blank pages.

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Answer **all** the questions in the space provided.

For Examiner's Use

1 Iron and cobalt are adjacent elements in the Periodic Table. Iron has three main naturally occurring isotopes, cobalt has one.

(a) Explain the meaning of the term *isotope*.

.....

.....

..... [2]

(b) The most common isotope of iron is ^{56}Fe; the only naturally occurring isotope of cobalt is ^{59}Co.

Use the *Data Booklet* to complete the table below to show the atomic structure of ^{56}Fe and of ^{59}Co.

	number of		
isotope	protons	neutrons	electrons
^{56}Fe			
^{59}Co			

[3]

(c) A sample of iron has the following isotopic composition by mass.

isotope mass	54	56	57
% by mass	5.84	91.68	2.17

(i) Define the term *relative atomic mass*.

.....

.....

.....

.....

(ii) By using the data above, calculate the relative atomic mass of iron to **three** significant figures.

[5]

[Total: 10]

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[Turn over

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2 Sulphur and its compounds are found in volcanoes, in organic matter and in minerals.

Sulphuric acid, an important industrial chemical, is manufactured from sulphur by the Contact process. There are three consecutive reactions in the Contact process which are essential.

(a) Write a balanced equation (using $\rightleftharpoons$ where appropriate) for **each** of these reactions **in the correct sequence**.

1 .....

2 .....

3 ..... [4]

(b) What catalyst is used?

..... [1]

Hydrogen sulphide, H_2S, is a foul-smelling compound found in the gases from volcanoes. Hydrogen sulphide is covalent, melting at –85 °C and boiling at –60 °C.

(c) **(i)** Draw a 'dot-and-cross' diagram to show the structure of the H_2S molecule.

(ii) Predict the shape of the H_2S molecule.

.....

(iii) Oxygen and sulphur are both in Group VI of the Periodic Table.

Suggest why the melting and boiling points of water, H_2O, are much higher than those of H_2S.

.....

.....

..... [4]

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Hydrogen sulphide burns with a blue flame in an excess of oxygen to form sulphur dioxide and water.

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(d) (i) Write a balanced equation for the complete combustion of H_2S.

.....

(ii) What is the change in the oxidation number of sulphur in this reaction?

from ..... to .....

(iii) What volume of oxygen, measured at room temperature and pressure, is required for the complete combustion of 8.65 g of H_2S? Give your answer to two decimal places.

[5]

Hydrogen sulphide is a weak diprotic (dibasic) acid. Its solution in water contains HS^- and a few S^{2-} ions.

(e) (i) What is meant by the term *weak acid*?

.....

.....

(ii) Write an equation, with state symbols, for the **first** ionisation of H_2S when it dissolves in water.

..... [3]

[Total: 17]

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[Turn over

3 Magnesium is the eighth most common element in the Earth's crust.

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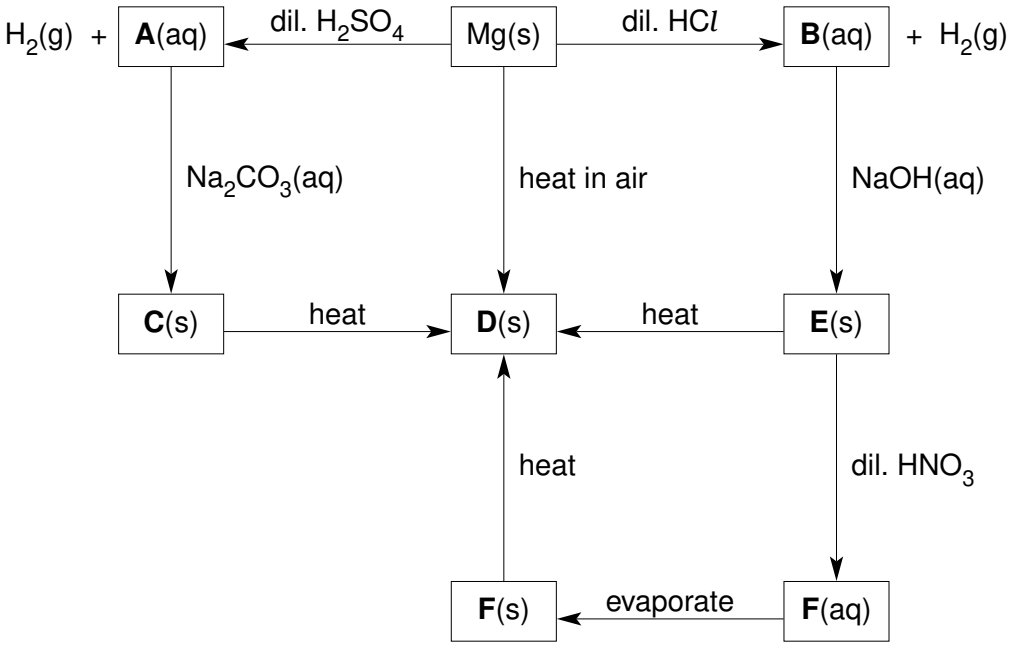
The metal is widely used in alloys which are light and strong.

Some reactions of magnesium and its compounds are shown in the reaction scheme below.



(a) Identify, by name or formula, compounds **A** to **F**.

A .....

B .....

C .....

D .....

E .....

F .....

[6]

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(b) **(i)** Construct balanced equations for the following reactions.

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magnesium to compound **A**

.....

compound **C** to compound **D**

.....

compound **F** to compound **D**

.....

(ii) Suggest a balanced equation for the effect of heat on compound **E**.

..... [4]

[Total: 10]

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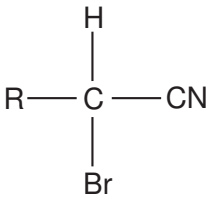
4 Compound **G**, in which R– represents the rest of the molecule, was made for use as a tear gas in World War 2.



compound **G**

Compound **G** was made by the following sequence of reactions.

$$R\text{–}CH_3 \xrightarrow{\text{stage I}} R\text{–}CH_2Cl \xrightarrow{\text{stage II}} R\text{–}CH_2CN \xrightarrow{\text{stage III}} R\text{–}CHBrCN$$

(a) (i) For stage I **and** for stage II, state the reagent(s) and condition(s) used to carry out **each** change.

stage I reagent(s) .....

condition(s) .....

stage II reagent(s) .....

condition(s) .....

(ii) Suggest the reagent(s) and condition(s) necessary to carry out stage III.

reagent(s) .....

condition(s) .....

[6]

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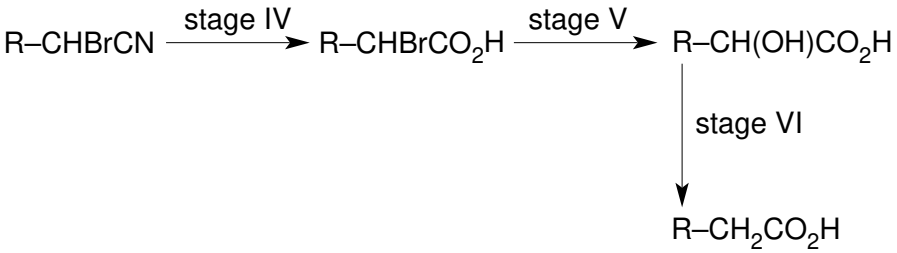
Compound **G** was not actually used in World War 2 and stocks of it had to be destroyed safely. The following sequence of reactions was used in this process.



(b) For stage IV **and** for stage V state the reagent(s) and condition(s) necessary to bring about **each** reaction.

stage IV reagent(s) .....

condition(s) .....

stage V reagent(s) .....

condition(s) ..... [4]

(c) The full sequence of stages I to VI involves some compounds which contain chiral centres.

(i) Explain what is meant by the term *chiral centre*.

.....

.....

(ii) Draw displayed formulae for the isomers of **one** compound in the full sequence of stages I to VI which you consider to be chiral.

[3]

[Total: 13]

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[Turn over

5 A student obtained the following results when analysing an organic compound, **H**.

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test		observation
test 1	relative molecular mass	72
test 2	% composition by mass	C, 66.7%; H, 11.1%; O, 22.2%
test 3	reactions with $Br_2(aq)$	Br_2 decolourised
test 4	reaction with Na(s)	$H_2(g)$ evolved
test 5	reaction with warm $Cr_2O_7^{2-}/H^+$	green colour observed

The student allowed test 5 to go to completion and then investigated the **product** of test 5 with the following result.

test 6	reaction with 2,4-dinitrophenylhydrazine	no reaction

(a) Calculate the molecular formula of **H**.

[2]

(b) What can be deduced about the nature of **H** by the following tests?

(i) test 3 .....

(ii) test 4 .....

[2]

(c) **(i)** What functional group would have given a positive result in test 6?

.....

(ii) What functional group is shown to be present in **H** by tests 5 and 6?

.....

[2]

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(d) On testing a sample of **H**, the student found that it was not chiral.

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H did, however, show *cis-trans* isomerism.

How does *cis-trans* isomerism arise in an organic molecule?

.....

.....

..... [2]

(e) Use all of the information above to draw labelled, displayed formulae of the stereoisomers of compound **H**.

[2]

[Total: 10]

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