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

CHEMISTRY

Paper 2 Structured Questions AS Core

9701/02
October/November 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 provided.
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.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the spaces provided.

Stick your personal label here, if provided.

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.

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1 The first six ionisation energies of an element **X** are given below.

ionisation energy / kJ mol^{-1}					
first	second	third	fourth	fifth	sixth
950	1800	2700	4800	6000	12300

(a) Define the term *first ionisation energy*.

.....

.....

.....

..... [3]

(b) Write an equation, with state symbols, for the **second** ionisation energy of element **X**.

..... [2]

(c) Use the data given above to deduce in which Group of the Periodic Table element **X** is placed. Explain your answer.

Group .....

explanation .....

.....

.....

..... [3]

The first ionisation energies (I.E.) for the elements of Group IV are given below.

element	C	Si	Ge	Sn	Pb
1st I.E. / kJ mol^{-1}	1090	786	762	707	716

(d) Explain the trend shown by these values in terms of the atomic structure of the elements.

.....

.....

.....

.....

..... [4]

[Total: 12]

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2 Carbon disulphide, CS_2, is a volatile, stinking liquid which is used to manufacture viscose rayon and cellophane.

(a) The carbon atom is in the centre of the CS_2 molecule.

Draw a 'dot-and-cross' diagram of the carbon disulphide molecule.

Show outer electrons only.

[2]

(b) Suggest the shape of the molecule and give its bond angle.

shape .....

bond angle ..... [2]

(c) Explain the term *standard enthalpy change of formation*, $\Delta H_f^{\ominus}$.

.....

.....

..... [3]

(d) Calculate the standard enthalpy change of formation of CS_2 from the following data.

standard enthalpy change of formation of SO_2 = $-298\,kJ\,mol^{-1}$

standard enthalpy change of formation of CO_2 = $-395\,kJ\,mol^{-1}$

standard enthalpy change of combustion of CS_2 = $-1110\,kJ\,mol^{-1}$

[3]

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(e) Carbon disulphide reacts with nitrogen monoxide, NO, to form a yellow solid and two colourless gases which are produced in a 1:1 molar ratio.

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Deduce the identity of **each** gas and write a balanced equation for the reaction.

gases ..... and .....

equation ..... [3]

[Total: 13]

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3 Nitrogen, which makes up about 80% of the Earth's atmosphere, is very unreactive.

(a) **(i)** Explain the lack of reactivity of nitrogen.

.....

.....

.....

(ii) Nitrogen does, however, undergo some reactions. Write an equation for **one** reaction of nitrogen, stating the conditions under which it occurs.

equation .....

conditions .....

.....

.....

(iii) Suggest why nitrogen does react in the example you have chosen.

.....

.....

[6]

Ammonium nitrate, NH_4NO_3, is a commercially important compound of nitrogen.

(b) **(i)** State **one** large-scale use of ammonium nitrate.

.....

(ii) What are the environmental consequences of the uncontrolled use of ammonium nitrate?

.....

.....

.....

.....

[4]

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When solid ammonium nitrate is heated with solid sodium hydroxide in a test-tube, three products are formed. A colourless alkaline gas, **Y**, is given off, and a colourless liquid can be seen on the cooler parts of the test-tube. A white solid remains in the tube.

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(c) **(i)** Identify gas **Y**.

.....

(ii) Write an equation, with state symbols, for the reaction of ammonium nitrate with sodium hydroxide.

.....

[3]

(d) In order to produce gas **Y** in a pure state in the laboratory, it must be passed through a drying agent.

Why is concentrated sulphuric acid not suitable for drying gas **Y**?

.....

..... [1]

[Total: 14]

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[Turn over

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4 Alcohols are widely used as solvents and in the manufacture of esters.

Butan-1-ol, $C_4H_{10}O$, is an example of a primary alcohol.

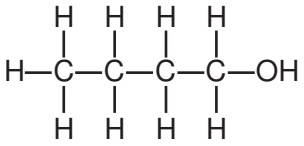
(a) What is meant by the term *primary alcohol*?

..... [1]

(b) There are three more alcohols with molecular formula $C_4H_{10}O$ that are **structural** isomers of butan-1-ol.

Complete the table below by drawing displayed formulae of **each** of these three compounds.

For **each** isomer, state whether it is a primary, secondary, or tertiary alcohol.

			
primary			
butan-1-ol	isomer 2	isomer 3	isomer 4

[6]

(c) Butan-1-ol can be oxidised to a carboxylic acid by heating with an acidified solution of potassium dichromate(VI).

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(i) What colour change would be seen during this reaction?

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

(ii) State which of the isomers you have drawn in **(b)** could also be oxidised to form a carboxylic acid.

.....

[3]

[Total: 10]

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5 Compound **Z**, an organic compound with **three** functional groups, has the molecular formula $C_4H_6O_2$. The functional groups can be confirmed by the following tests.

(a) Test for the first functional group.

Z decolourises aqueous bromine.

What functional group is shown to be present in **Z** by this test?

..... [1]

(b) Tests for the second functional group.

Z reacts with sodium to give hydrogen and a solid compound of formula $C_4H_5O_2Na$.

When **Z** is heated with ethanoic acid and a few drops of concentrated sulphuric acid, a sweet smelling liquid of molecular formula $C_6H_8O_3$ is formed.

What functional group is shown to be present in **Z** by these tests?

..... [1]

(c) Tests for the third functional group.

A few drops of **Z** form a yellow/orange precipitate when added to 2,4-dinitrophenylhydrazine reagent.

When a few drops of **Z** are warmed with Tollens' reagent, a silver mirror is formed.

What functional group is shown to be present in **Z** by these tests?

..... [1]

(d) **Z** does **not** show *cis-trans* isomerism.

Draw the displayed formula of **Z**.

[2]

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In parts **(e)** and **(f)** you may use R– to represent the part of the molecule that does not react.

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(e) What is the organic compound formed by the reactions of **Z** in **each** of the tests in **(b)**?

with sodium

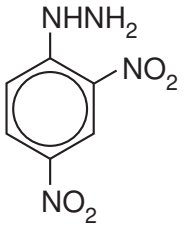
with ethanoic acid

[2]

(f) Draw the structure of the organic compound formed by **Z** in **each** of the tests in **(c)**.

with Tollens' reagent

with 2,4-dinitrophenylhydrazine,



[2]

(g) But-2-enoic acid is an isomer of **Z** which shows *cis-trans* isomerism.

Draw a displayed formula of the *cis* isomer of this acid.

[2]

[Total: 11]

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