Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

9698895364

CHEMISTRY **9701/23**

Paper 2 Structured Questions AS Core **October/November 2014**

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A Data Booklet is provided.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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

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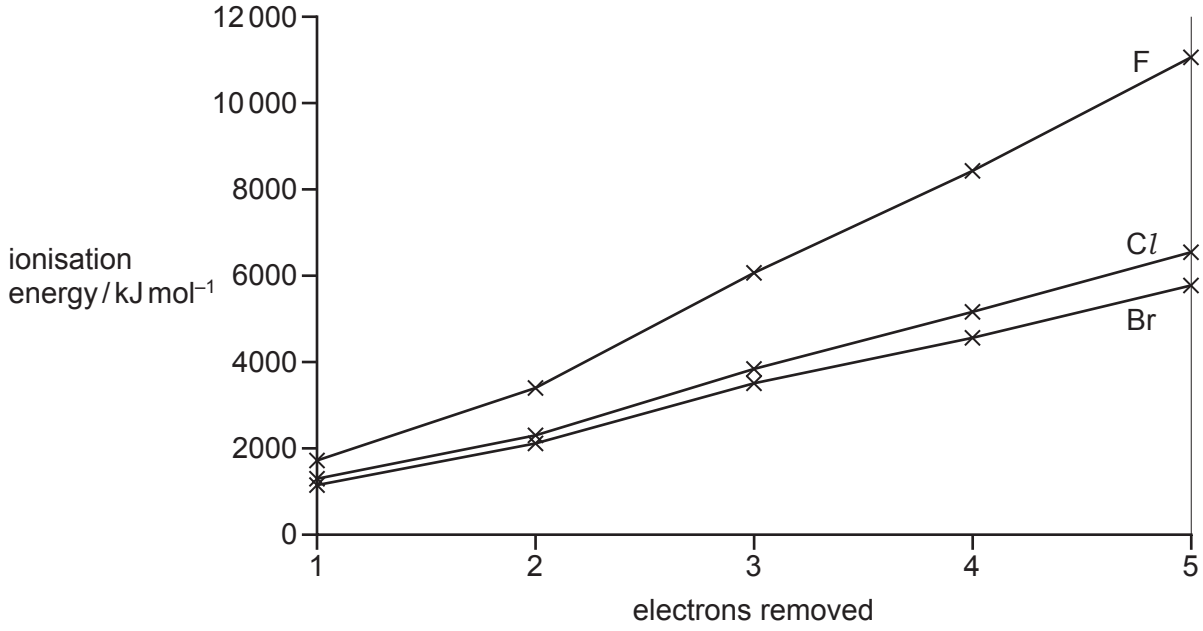
Answer **all** the questions in the spaces provided.

1 **(a)** Successive ionisation energies for the elements fluorine, F, to bromine, Br, are shown on the graph.



(i) Explain why the first ionisation energies decrease down the group.

.....

.....

.....

..... [3]

(ii) Explain why there is an increase in the successive ionisation energies of fluorine.

.....

.....

..... [2]

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(b) Group VII is the only group in the Periodic Table containing elements in all three states of matter at room conditions.

State and explain, in terms of intermolecular forces, the trend in the boiling points of the elements down Group VII.

.....

.....

.....

.....

.....

..... [4]

(c) Compounds containing different halogen atoms covalently bonded together are called interhalogen compounds.

(i) One interhalogen compound can be prepared by the reaction between iodine and fluorine. This compound has M_r = 222 and the percentage composition by mass: F, 42.8; I, 57.2.

Calculate the molecular formula of this interhalogen compound.

molecular formula ..... [3]

(ii) Another interhalogen compound has the formula ICl.

Draw a 'dot-and-cross' diagram of a molecule of this compound, showing outer shell electrons only. Explain whether or not you would expect this molecule to be polar.

.....

.....

..... [2]

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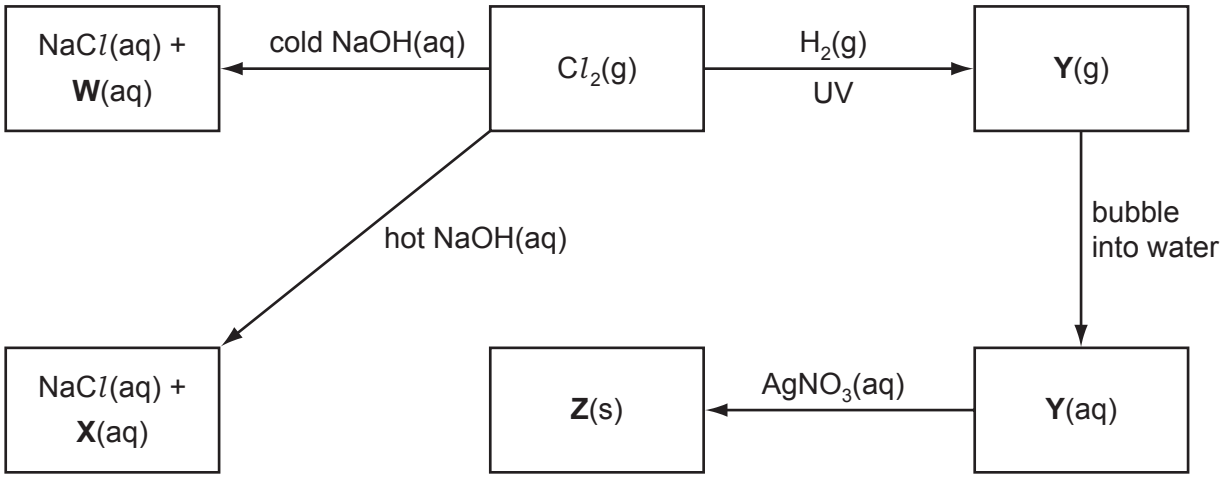
[Turn over

(d) Some reactions involving chlorine and its compounds are shown in the reaction scheme below.



(i) Give the **formulae** of **W**, **X**, **Y** and **Z**.

W .....

X .....

Y .....

Z .....

[4]

(ii) Write an equation for the reaction of chlorine with **hot** NaOH(aq).

..... [2]

(iii) State the oxidation numbers of chlorine at the start and at the end of the reaction in **(ii)**.

..... [2]

(iv) Write an **ionic** equation for the reaction of **Y** with $AgNO_3$(aq). Include state symbols.

..... [1]

[Total: 23]

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Question 2 starts on the next page.

2 The Haber process for the manufacture of ammonia, NH_3, was originally devised at the start of the 20th century and was developed into a full-scale industrial process by Carl Bosch in 1913.

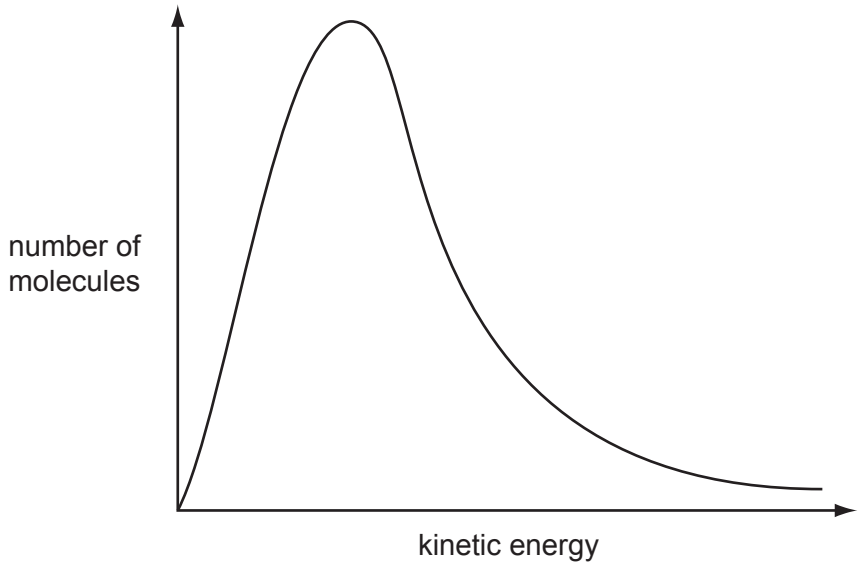
The key step in the process is the reversible reaction of nitrogen and hydrogen in the presence of an iron catalyst.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92\,kJ\,mol^{-1}$$

(a) The hydrogen for this reaction can be formed by reacting methane with steam, during which carbon monoxide is also produced. Write an equation for this reaction.

..... [1]

(b) Use the Boltzmann distribution shown to explain why a catalyst increases the rate of this reaction.



.....

.....

.....

..... [4]

(c) Draw a three-dimensional diagram to show the shape of an ammonia molecule. Name this shape and state the bond angle.

shape ..... bond angle ..... [3]

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(d) The Haber process is typically carried out at a temperature of 400 °C.

(i) With reference to Le Chatelier's Principle and reaction kinetics, state and explain one advantage and one disadvantage of using a higher temperature.

.....

.....

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.....

.....

..... [4]

(ii) State the expression for the equilibrium constant, K_p, for the formation of ammonia from nitrogen and hydrogen in the Haber process.

K_p =

[1]

(iii) 2.00 moles of nitrogen and 3.00 moles of hydrogen were put in a vessel and left to reach equilibrium.

At equilibrium, the pressure was 2.00×10^7 Pa and the mixture contained 1.60 moles of ammonia.

Calculate K_p. Include the units.

K_p = ...

units = ...

[5]

[Total: 18]

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[Turn over

3 **P**, **Q**, **R** and **S** are structural isomers with the molecular formula C_5H_{10}.

All four compounds readily decolourise bromine in the dark.

P, **R** and **S** do not exhibit stereoisomerism but **Q** exists as a pair of geometrical (cis-trans) isomers.

All four compounds react with hot concentrated, acidified potassium manganate(VII) to produce a variety of products as shown in the table.

compound	products
P	CO_2 and $CH_3CH_2CH_2CO_2H$
Q	CH_3CO_2H and $CH_3CH_2CO_2H$
R	CO_2 and **T** (C_4H_8O)
S	CH_3CO_2H and $(CH_3)_2CO$

T reacts with 2,4-dinitrophenylhydrazine reagent, 2,4-DNPH, to form an orange crystalline product but does not react with Fehling's reagent.

(a) Give the structural formulae of **P**, **Q**, **R**, **S** and **T**.

P ..... **Q** .....

R ..... **S** .....

T ..... [5]

(b) **(i)** Explain what is meant by the term *stereoisomerism*.

.....

.....

..... [2]

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(ii) Draw the **displayed** formulae of the geometrical isomers of **Q** and name them both.

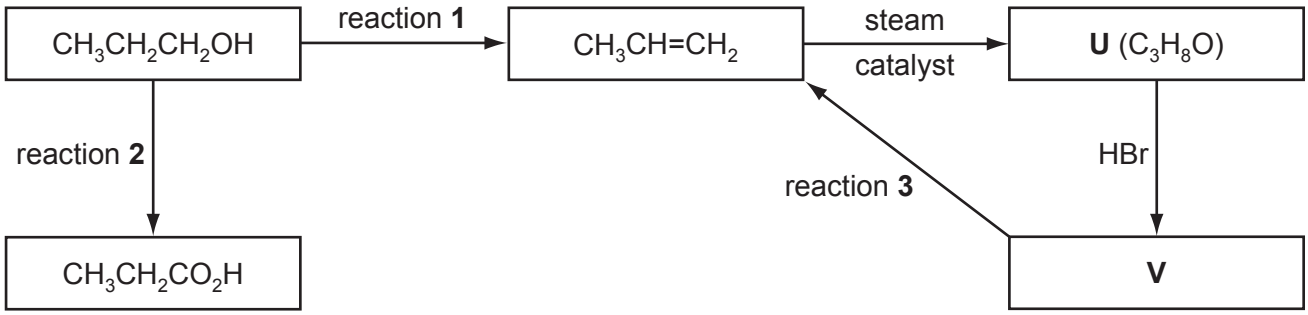
name ..... name ..... [2]

(c) Name the organic product of the reaction of **T** with sodium borohydride, $NaBH_4$.

..... [1]

[Total: 10]

4 A series of reactions based on propan-1-ol is shown.



(a) Suggest a suitable reagent and conditions for reaction **1**.

..... [2]

(b) **(i)** Write an equation for reaction **2**, using [O] to represent the oxidising agent.

..... [1]

(ii) Suggest a suitable reagent and conditions for reaction **2**.

..... [2]

(c) Give the structural formulae of **U** and **V**.

U .....

V .....
[2]

(d) Suggest a suitable reagent and conditions for reaction **3**.

.....

..... [2]

[Total: 9]

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