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

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6138594413

CHEMISTRY **9701/23**

Paper 2 Structured Questions AS Core **October/November 2013**

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, 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.

For Examiner's Use	
1	
2	
3	
4	
5	
Total	

This document consists of **11** printed pages and **1** blank page.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

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

1 Ammonia, NH_3, and methane, CH_4, are the hydrides of elements which are next to one another in the Periodic Table.

(a) In the boxes below, draw the 'dot-and-cross' diagram of a molecule of **each** of these compounds. Show outer electrons only.
State the shape of **each** molecule.

NH_3	CH_4
shape	shape

[3]

(b) Ammonia is polar whereas methane is non-polar. The physical properties of the two compounds are different.

(i) Explain, using ammonia as the example, the meaning of the term *bond polarity*.

.....

.....

.....

(ii) Explain why the ammonia molecule is polar.

.....

.....

(iii) State **one** physical property of ammonia which is caused by its polarity.

.....

.....

[4]

For Examiner's Use

(c) When ammonia gas is mixed with hydrogen chloride, white, solid ammonium chloride is formed.

State **each type** of bond that is present in one formula unit of ammonium chloride and how many of each type are present.
You may draw diagrams.

.....

.....

.....

.....

..... [3]

[Total: 10]

For Examiner's Use

2 Petrol and diesel fuel are both used in internal combustion engines.
Petrol may be regarded as having the formula C_9H_{20} and diesel fuel as having the formula $C_{14}H_{30}$.

(a) (i) To which class of compounds do these two hydrocarbons belong?

.....

(ii) Write a balanced equation for the complete combustion of petrol.

.....
[2]

(b) When petrol or diesel fuel are used in internal combustion engines, several different products of the incomplete combustion of the fuel may be formed.

(i) Name **two** of these products that do not contain hydrogen.

..... and .....

(ii) Choose one of these and state a hazard it causes.

product .....

hazard .....

(iii) Write a balanced equation for the formation of **one** of the products in **(i)** from diesel fuel.

.....
[4]

For Examiner's Use

(c) Define the term *standard enthalpy change of combustion*.

.....

.....

..... [2]

(d) A 1.00 cm^3 sample of $C_{14}H_{30}$ was completely burnt in air.
The heat produced raised the temperature of 250 g of water by 34.6 °C.
Assume no heat losses occurred during this experiment.
The density of $C_{14}H_{30}$ is 0.763 g cm^{-3}.

(i) Use relevant data from the *Data Booklet* to calculate the amount of heat released in this experiment.

(ii) Use the data above and your answer to **(i)** to calculate the energy produced by the combustion of 1 mol of $C_{14}H_{30}$.

[5]

[Total: 13]

For Examiner's Use

3 The elements of Group VII of the Periodic Table show variation in their properties.

(a) (i) Complete the table below, stating the colour of each element in its normal state at room temperature.

halogen	melting point / °C	colour
chlorine	–101	
bromine	–7	
iodine	114	

(ii) Briefly explain why the melting points of the halogens increase from chlorine to iodine.

.....

.....

.....

[4]

(b) The halogens form many interhalogen compounds in which two different halogens are combined. One such compound is bromine monochloride, BrCl.

(i) Complete the electronic configurations of chlorine and bromine.

chlorine	$1s^2 2s^2 2p^6$
bromine	$1s^2 2s^2 2p^6$

(ii) Draw a 'dot-and-cross' diagram of the BrCl molecule.
Show outermost electrons only.

[2]

For Examiner's Use

(c) Interhalogen compounds like BrC*l* have similar properties to the halogens.

(i) By considering your answers to **(a)** and **(b)**, predict the physical state of BrC*l* at room temperature. Explain your answer.

physical state .....

explanation .....

.....

.....

(ii) Suggest the colour of BrC*l*.

.....

[4]

(d) Cl_2 and BrC*l* each react with aqueous KI.

(i) Describe what would be seen when Cl_2 is bubbled through aqueous KI for several minutes.

initially .....

.....

after several minutes .....

.....

(ii) Construct an equation for the reaction that occurs.

.....

(iii) Suggest an equation for the reaction that occurs between BrC*l* and aqueous KI.

.....

(iv) How do Cl_2 and BrC*l* behave in these reactions?

.....

[5]

[Total: 15]

For Examiner's Use

4 Compound **Q** is a viscous liquid which is very soluble in water.
The M_r of **Q** is 90.0.

Three possible structures for **Q** are shown below.

R	**S**	**T**
$HOCH_2CH_2CO_2H$	$HOCH_2CO_2CH_3$	$HCO_2CH_2CH_2OH$

(a) (i) What type of isomerism do **R**, **S** and **T** show?

.....

(ii) What oxygen-containing functional groups are present in **R**, **S** and **T**?
Give their **full names**.

R ..... and .....

S ..... and .....

T ..... and .....

(iii) Which functional group(s) in **(ii)** will react with sodium carbonate?

.....

(iv) Which functional group(s) in **(ii)** will react with sodium metal?

.....

[6]

(b) When 0.002 mol of **Q** is reacted with an excess of solid sodium carbonate, Na_2CO_3, 24 cm^3 of carbon dioxide, measured at room temperature and pressure, is produced.

(i) Calculate the amount, in moles, of carbon dioxide produced in this reaction.

(ii) Hence calculate the amount, in moles, of carbon dioxide produced by 1 mol of **Q**.

[2]

For Examiner's Use

When 0.002 mol of **Q** is reacted with an excess of metallic sodium, 48 cm^3 of hydrogen, measured at room temperature and pressure, is produced.

(c) (i) Calculate the amount, in moles, of hydrogen molecules produced in this reaction.

(ii) Hence calculate the amount, in moles, of hydrogen molecules produced by 1 mol of **Q**.

[2]

(d) Use your answers to **(b)** and **(c)** to deduce which structure, **R**, **S** or **T**, corresponds to the structure of **Q** and write balanced equations for the reactions that occurred.

identity of **Q** is .....

equation for reaction with sodium carbonate

.....

equation for reaction with sodium metal

..... [5]

[Total: 15]

For Examiner's Use

5 The molecular formula C_4H_9OH represents four different alcohols, **W**, **X**, **Y** and **Z**.

W	X	Y	Z
$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH(OH)CH_3$	$(CH_3)_2CHCH_2OH$	$(CH_3)_3COH$

(a) Draw the **skeletal formula** of **Z**.

[1]

(b) Acidified potassium dichromate(VI) is used as an oxidising agent in organic chemistry.

Give the **structural formula** of the organic product formed when **each** of the four alcohols above is heated under reflux with acidified potassium dichromate(VI).
If you believe that no reaction occurs, write 'no reaction' in the box.

W	
X	
Y	
Z	

[4]

For Examiner's Use

(c) One of the alcohols, **W**, **X**, **Y** or **Z**, can be dehydrated to give more than one organic product.

Identify this alcohol and give the structural formulae of **two** of the products.

alcohol	
product 1	
product 2	

[2]

[Total: 7]

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