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

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|---|---|
| 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.


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

*For Examiner's Use*

**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]

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**(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]

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**(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]

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**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]

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**(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)** C$l_2$ and BrC$l$ each react with aqueous KI.

**(i)** Describe what would be seen when C$l_2$ 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 C$l_2$ 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]

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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]

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**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]

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**(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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