Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

0017324198

CHEMISTRY **9701/23**

Paper 2 Structured Questions AS Core **May/June 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 **9** printed pages and **3** blank pages.

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

1 **(a)** Define the term *mole*.

.....

..... [1]

(b) 10 cm^3 of a gaseous hydrocarbon, C_xH_y, was reacted with 100 cm^3 of oxygen gas, an excess.

The final volume of the gaseous mixture was 95 cm^3.

This gaseous mixture was treated with concentrated, aqueous sodium hydroxide to absorb the carbon dioxide present. This reduced the gas volume to 75 cm^3.

All gas volumes were measured at 298 K and 100 kPa.

(i) Write an equation for the reaction between sodium hydroxide and carbon dioxide.

..... [1]

(ii) Calculate the volume of carbon dioxide produced by the combustion of the hydrocarbon.

volume of CO_2 produced = ... cm^3 [1]

(iii) Calculate the volume of oxygen used up in the reaction with the hydrocarbon.

volume of O_2 used = ... cm^3 [1]

(iv) Use your answers to **(b)(ii)** and **(b)(iii)**, together with the initial volume of hydrocarbon, to balance the equation below.

$$.....C_xH_y + ...O_2 \rightarrow .....CO_2 + zH_2O$$ [2]

(v) Deduce the values of *x*, *y* and *z* in the equation in **(iv)**.

x = ...

y = ...

z = ...

[3]

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(c) Another hydrocarbon, **W**, with the formula C_4H_8, reacts with hydrogen bromide, HBr, to give two products **X** and **Y**. **X** and **Y** are structural isomers of molecular formula C_4H_9Br.

Reaction of **X** with aqueous alkali produces an alcohol, **Z**, that has **no** reaction with acidified dichromate(VI).

(i) Give the structures **and** names of the compounds **W**, **X**, **Y**, and **Z**

W **X**

....

Y **Z**

....

[4]

(ii) When **W** reacts with hydrogen bromide, more **X** than **Y** is produced. Explain why.

.....

.....

.....

..... [2]

[Total: 15]

2 A sample of a hydrated double salt, $Cu(NH_4)_x(SO_4)_2.6H_2O$, was boiled with an excess of sodium hydroxide. Ammonia was given off.

The ammonia produced was absorbed in 40.0 cm^3 of 0.400 mol dm^{-3} hydrochloric acid. The resulting solution required 25 cm^3 of 0.12 mol dm^{-3} sodium hydroxide to neutralise the excess acid.

(a) Write the ionic equation for the reaction between ammonium ions and hydroxide ions.

..... [1]

(b) (i) Calculate the amount, in moles, of hydrochloric acid in 40.0 cm^3 of 0.400 mol dm^{-3} solution.

[1]

(ii) Calculate the amount, in moles, of sodium hydroxide needed to neutralise the excess acid. This will be equal to the amount of hydrochloric acid left in excess.

[1]

(iii) Calculate the amount, in moles, of hydrochloric acid that reacted with ammonia.

[1]

(iv) Calculate the amount, in moles, of ammonium ions in the sample of the double salt.

[1]

(v) The sample contained 0.413 g of copper. Use this information and your answer to **(iv)** to calculate the value of x in $Cu(NH_4)_x(SO_4)_2.6H_2O$.

[2]

(vi) Calculate the M_r of $Cu(NH_4)_x(SO_4)_2.6H_2O$.

[1]

[Total: 8]

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[Turn over

3 Nitrogen dioxide, NO_2, can enter the atmosphere in a variety of ways.

(a) (i) State one natural and one man-made source of atmospheric NO_2.

natural .....

man-made .....

[1]

(ii) Write an equation to show how NO_2 leads to the formation of nitric acid in acid rain.

..... [1]

(iii) Use equations to illustrate the catalytic role of NO_2 in the formation of sulfuric acid in acid rain.

.....

.....

..... [3]

(b) Nitrogen dioxide exists in equilibrium with dinitrogen tetroxide, N_2O_4.

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$

2.00 mol of dinitrogen tetroxide was sealed in a container at 350 K. After equilibrium had been established the total pressure was 140 kPa and the mixture of gases contained 1.84 mol of dinitrogen tetroxide.

(i) Give the expression for the equilibrium constant, K_p, for this equilibrium.

K_p =

[1]

(ii) Calculate the number of moles of NO_2 present at equilibrium.

[1]

(iii) Calculate the total number of moles of gas present at equilibrium and hence the mole fraction of each gas present at equilibrium.

[2]

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(iv) Calculate the partial pressure of each gas present at equilibrium.

[2]

(v) Calculate the value of the equilibrium constant, K_p, at 350 K.
Give your answer to **three** significant figures and include the units.

K_p = ...

units = ...
[2]

[Total: 13]

4 The halogens and their compounds have a wide variety of uses and the chemical and physical properties of the elements show regular patterns related to their positions in Group VII.

(a) Chlorine, bromine and iodine all react with hydrogen.

(i) State the trend in the reactivities of the halogens with hydrogen.

.....

..... [1]

(ii) Explain this trend in terms of bond energies.

.....

.....

..... [2]

(b) In the laboratory it is not very convenient to prepare hydrogen halides from their elements.

Hydrogen halides can be prepared from their salts.

(i) Write an equation for the reaction of calcium chloride, $CaCl_2$, with concentrated sulfuric acid.

..... [1]

(ii) Explain why hydrogen iodide is not prepared in this way.

.....

..... [1]

(iii) When potassium bromide, KBr, reacts with concentrated sulfuric acid, sulfur dioxide, SO_2, is produced. State what you would **see** and write an equation for this reaction.

.....

..... [3]

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(c) **(i)** Give the structures of the four structural isomers of C_4H_9Br **and** identify each as primary, secondary or tertiary.

....

....

[4]

(ii) Name the isomer of C_4H_9Br that contains a chiral centre and draw the three-dimensional structures of the two optical isomers.

name .....

structures

[3]

(d) Aqueous silver nitrate solution was added to separate tubes containing chloroethane, bromoethane and iodoethane. The tubes were heated in a water bath.

A yellow precipitate appeared first in the tube containing iodoethane, followed by a cream precipitate in the tube containing bromoethane and finally a white precipitate appeared in the tube containing chloroethane.

Explain these observations.

.....

.....

.....

.....

.....

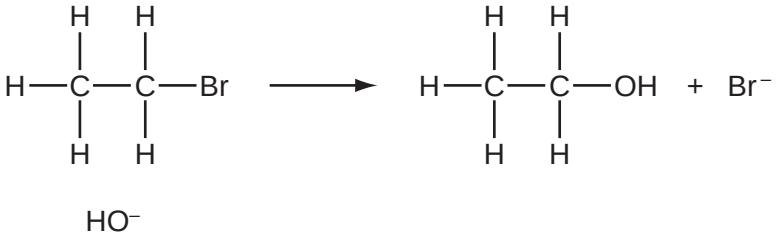
..... [2]

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(e) **(i)** Give the full name of the mechanism for the reaction between aqueous sodium hydroxide and bromoethane.

..... [2]

(ii) Complete the diagram below to represent this mechanism. Include all necessary curly arrows, partial charges and lone pairs.



[2]

(f) In the past, CFCs such as CF_3Cl were widely used as refrigerants.

(i) State a property of CFCs which makes them suitable for use as refrigerants.

..... [1]

(ii) State the damaging effect of CFCs in the upper atmosphere.

.....

Explain your answer.

.....

.....

.....

[2]

[Total: 24]

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