Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

4350605518

CHEMISTRY **9701/23**

Paper 2 AS Level Structured Questions **May/June 2018**

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 **11** printed pages and **1** blank page.

CAMBRIDGE International Examinations

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

1 The elements sodium to chlorine, in the third period, all form oxides.

(a) Draw a diagram to show the shape of the molecule of each of the oxides, SO_3 and Cl_2O.
Name each shape.
In SO_3 each oxygen atom forms a double bond with the sulfur atom.

SO_3	Cl_2O
.....	.....

[4]

(b) (i) Explain why the melting point of MgO is higher than that of Na_2O.

.....

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..... [2]

(ii) Explain why the melting point of SiO_2 is much higher than that of SO_3.

.....

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.....

..... [2]

(c) SO_3 is produced by the reaction between SO_2 and O_2 in the Contact process. A dynamic equilibrium is established.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -196\,kJ\,mol^{-1}$$

(i) Explain why increasing the total pressure, at constant temperature, increases the rate of production of SO_3 and increases the yield of SO_3.

rate .....

.....

.....

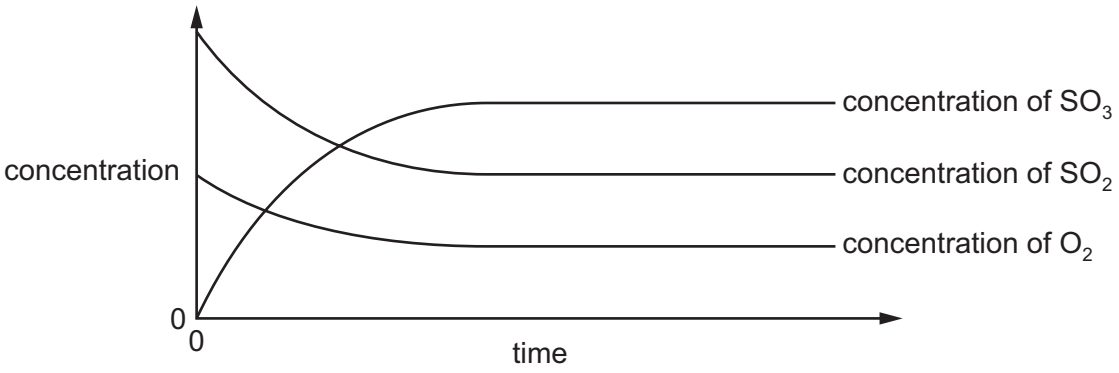
yield .....

.....

.....

[4]

The graph shows how the concentrations of all three species in the system change with time for a typical reaction mixture. The gradients of all three lines decrease with time and then level off in this dynamic equilibrium.



(ii) Explain why the gradients of the SO_2 and O_2 lines decrease with time.

.....

..... [2]

(iii) Explain why all three lines become horizontal.

.....

..... [1]

(iv) Suggest a reason why the initial gradient of the SO_2 line is steeper than that of the O_2 line.

.....

.....

..... [1]

[Turn over

(d) 2.00 moles of $SO_2(g)$ and 2.00 moles of $O_2(g)$ are sealed in a container with a suitable catalyst, at constant temperature and pressure. The resulting equilibrium mixture contains 1.98 moles of $SO_3(g)$.
The total volume of the equilibrium mixture is 40.0 dm^3.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

(i) Write the expression for the equilibrium constant, K_c, for the reaction between $SO_2(g)$ and $O_2(g)$ to produce $SO_3(g)$.

K_c =

[1]

(ii) Calculate the amount, in moles, of $SO_2(g)$ and $O_2(g)$ in the equilibrium mixture.

$SO_2(g)$ = ... mol

$O_2(g)$ = ... mol
[2]

(iii) Use your answers to **(d)(i)** and **(d)(ii)** to calculate the value of K_c for this equilibrium mixture. Give the units of K_c.

K_c = ...

units = ...
[3]

[Total: 22]

2 One reason for the wide variety of organic compounds is isomerism, either structural isomerism or stereoisomerism.

(a) (i) Explain the meaning of the term *structural isomerism*.

.....

.....

..... [2]

(ii) Explain the meaning of the term *stereoisomerism*.

.....

.....

..... [2]

(b) Pent-1-ene, $CH_2=CH(CH_2)_2CH_3$, does not show stereoisomerism.

(i) Give **two** reasons why pent-1-ene does **not** show stereoisomerism.

reason 1 .....

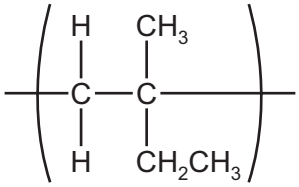
.....

reason 2 .....

.....

[2]

(ii) A structural isomer of pent-1-ene is used as the monomer to form a polymer. The repeat unit of this polymer is shown.



Draw the **displayed** formula of the monomer used to make this polymer.

Give the name of the monomer.

.....

[2]

(iii) A different structural isomer of pent-1-ene shows geometrical isomerism.

Draw the structure of **one** of the two geometrical isomers with the formula C_5H_{10}.

Give the full name of this isomer.

.....

[2]

[Total: 10]

3 The elements in Group 17, the halogens, show trends in both their chemical and physical properties. The elements and their compounds have a wide variety of uses.

(a) At room temperature fluorine and chlorine are gases, bromine is a liquid and iodine is a solid.

(i) State the trend in the volatility of the Group 17 elements down the group.

..... [1]

(ii) Explain this trend.

.....

.....

..... [2]

(b) Iodine, I_2, can be displaced from NaI(aq), by chlorine, Cl_2.

Write an equation for this reaction.

..... [1]

(c) Silver nitrate solution, $AgNO_3(aq)$, is added to separate solutions of NaI and NaCl. Precipitates form. An excess of aqueous ammonia is then added to both precipitates.

(i) Complete the table to give the colour and name of the precipitate formed in each reaction and the effect of the addition of an excess of aqueous ammonia to each of the precipitates formed.

	NaI(aq) + $AgNO_3(aq)$	NaCl(aq) + $AgNO_3(aq)$
colour of precipitate		
name of precipitate		
effect of addition of an excess of aqueous ammonia to the precipitate		

[3]

(ii) Write an ionic equation, including state symbols, to show the reaction occurring when $AgNO_3(aq)$ is added to NaI(aq).

..... [1]

(d) Solid NaI reacts with concentrated sulfuric acid to form purple fumes of $I_2(g)$ and hydrogen sulfide gas, $H_2S(g)$.
However, when solid NaC*l* reacts with concentrated sulfuric acid the only gas produced is HC*l*(g).

Explain the difference in the reactions of concentrated sulfuric acid with NaI and with NaC*l*. Your answer should refer to the role of the sulfuric acid in each reaction.

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..... [3]

(e) Chlorine is commonly used in water purification. When chlorine is added to water it reacts to produce a mixture of acids, one of which is chloric(I) acid, HC*l*O, a powerful oxidising agent.

(i) Explain the meaning of the term *oxidising agent*, in terms of electron transfer.

.....

.....

..... [1]

(ii) Suggest an equation for this reaction of chlorine with water.

..... [1]

(iii) Write an equation for the reaction of chlorine with **hot** aqueous sodium hydroxide.

Use oxidation numbers to explain why this is a redox reaction.

equation .....

.....

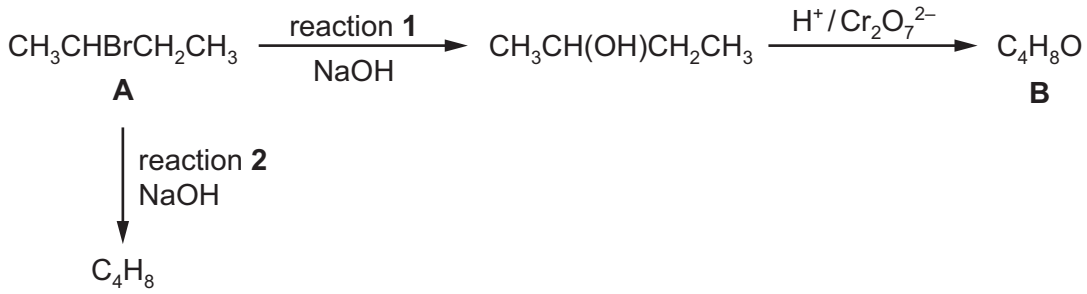
..... [2]

[Total: 15]

Question 4 starts on the next page.

4 **A** is $CH_3CHBrCH_2CH_3$.

(a) Some reactions of **A** are shown.



(i) Name **A**.

..... [1]

(ii) Name the class of compound to which **B** belongs.

..... [1]

(b) There are three structural isomers of **A**.

Draw the structures of these three isomers of **A**.

[2]

(c) Reaction **1** occurs by two different mechanisms at the same time.

These mechanisms are referred to as S_N1 and S_N2.

(i) State what the letters 'S' and 'N' represent in the abbreviation S_N1.

S .....

N .....

[1]

(ii) Complete the S_N1 mechanism for reaction **1**.

Include the structure of the intermediate and all necessary charges, dipoles, lone pairs and curly arrows.

[3]

(d) The S_N1 mechanism for reaction **1** is repeated using $CH_3CHCl CH_2CH_3$ or $CH_3CHICH_2CH_3$ in place of the $CH_3CHBrCH_2CH_3$.

State and explain how the rates of these two reactions will compare with the rate of the original reaction using $CH_3CHBrCH_2CH_3$.

.....

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.....

.....

..... [3]

(e) Reaction **2** uses the same reagent as reaction **1**, but under different conditions.

State **two** differences in the conditions needed to ensure that reaction **2** is more likely to take place than reaction **1** when this reagent is added.

.....

.....

..... [2]

[Total: 13]

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