Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

2865542814

CHEMISTRY **9701/22**

Paper 2 AS Level Structured Questions **October/November 2017**

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 The elements sodium to sulfur react with chlorine. The melting points of some of the chlorides formed are shown.

chloride	NaCl	$MgCl_2$	$AlCl_3$	$SiCl_4$	PCl_3	SCl_2
melting point / K	1074	987	463	203	161	195

(a) Predict the shapes of $AlCl_3$ and PCl_3.

Draw diagrams to show the shapes, name the shapes and state the bond angles.

$AlCl_3$	PCl_3
shape	shape .....
angle	angle .....

[4]

(b) **(i)** Explain, in terms of structure and bonding, why the melting point of $SiCl_4$ is much lower than that of NaCl.

.....

.....

.....

.....

..... [3]

(ii) Explain why the melting point of $SiCl_4$ is higher than that of PCl_3.

.....

.....

..... [2]

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(iii) Draw the ‘dot-and-cross’ diagram of a molecule of $SiCl_4$.
Show outer electrons only.

[1]

[Total: 10]

2 At 450 K phosphorus(V) chloride, $PCl_5(g)$, decomposes to form phosphorus(III) chloride, $PCl_3(g)$, and chlorine, $Cl_2(g)$. A dynamic equilibrium is established as shown.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad \Delta H = +124\,kJ\,mol^{-1}$$

(a) The enthalpy change of formation of $PCl_3(g)$ under these conditions is given.

$$\Delta H_f\ PCl_3(g) = -320\,kJ\,mol^{-1}$$

Calculate the enthalpy change of formation of $PCl_5(g)$ under these conditions.

Include a sign with your answer.

enthalpy change = ... $kJ\,mol^{-1}$ [1]

(b) (i) State and explain the effect of increasing temperature on the rate of decomposition of $PCl_5(g)$.

.....

.....

..... [2]

(ii) State and explain the effect of increasing temperature on the percentage of $PCl_5(g)$ that decomposes.

.....

.....

..... [2]

(c) Explain the meaning of the term *dynamic equilibrium* and the conditions necessary for it to become established.

.....

.....

.....

..... [2]

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(d) When 2.00 mol of $PCl_5(g)$ are decomposed at 450 K and 1.00×10^5 Pa the resulting equilibrium mixture contains 0.800 mol of $Cl_2(g)$.

(i) Calculate the partial pressure of phosphorus(V) chloride, $p PCl_5$, in this equilibrium mixture.

$p PCl_5$ = ... Pa [2]

(ii) Write the expression for the equilibrium constant, K_p, for the decomposition of $PCl_5(g)$.

K_p =

[1]

(iii) The partial pressures of $PCl_3(g)$ and of $Cl_2(g)$ in this equilibrium mixture are both 2.86×10^4 Pa.

Calculate the value of K_p and state its units.

K_p = ...

units = ...
[2]

[Total: 12]

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[Turn over

3 The elements in Group 2 show trends in their properties that are typical of metals.
The elements in Group 17 show trends in their properties that are typical of non-metals.

(a) State and explain the trend in ionisation energy down Group 2.

.....

.....

..... [2]

(b) **(i)** State and explain the trend in melting point down Group 17.

.....

.....

..... [2]

(ii) The melting point decreases down Group 2.

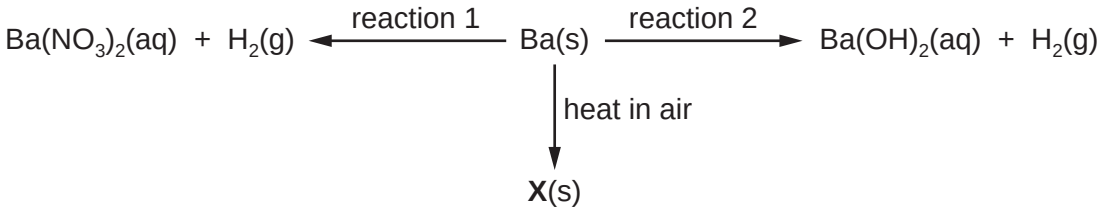
Explain this trend.

.....

.....

..... [2]

(c) Some reactions based on the Group 2 metal barium, Ba, are shown.



(i) State the reagent needed for each of reactions 1 and 2.

reaction 1 .....

reaction 2 .....
[2]

(ii) Name **X** and write an equation for its formation.

name .....

equation .....
[2]

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(iii) The $Ba(NO_3)_2(aq)$, produced by reaction 1, is heated to dryness. The anhydrous solid is then heated strongly and decomposes. Barium oxide is produced, together with two other products.

Identify the **two** other products of this decomposition reaction and state what would be observed.

.....

..... [2]

(iv) State what would be observed when excess $MgSO_4(aq)$ is added to the $Ba(OH)_2(aq)$ produced in reaction 2. Explain your answer.

.....

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.....

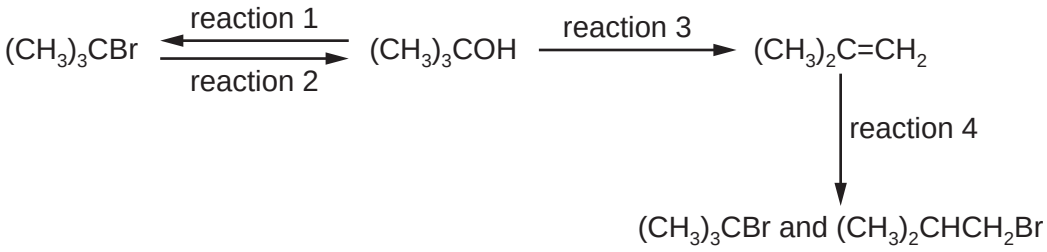
..... [3]

[Total: 15]

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[Turn over

4 Some reactions are shown, based on methylpropan-2-ol, $(CH_3)_3COH$.



(a) For each of the reactions state the reagent(s), the particular conditions required, if any, and the type of reaction.

For the type of reaction choose from the list.
Each type may be used once, more than once or not at all.
Each reaction may be described by one or more than one type.

hydrolysis dehydration substitution

oxidation addition condensation

reaction	reagent(s) and conditions	type(s) of reaction
1		
2		
3		
4		

[5]

(b) Draw a diagram to show the S_N1 mechanism of reaction 2.
Include all necessary charges, dipoles, lone pairs and curly arrows.

[3]

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(c) 1-bromobutane is a structural isomer of the product of reaction 1.

(i) Define the term *structural isomer* and name the three different types of structural isomerism.

definition .....

.....

.....

.....

types of structural isomerism

1 .....

2 .....

3 .....

[4]

(ii) 1-bromobutane is treated with the same reagents as in reaction 2. Butan-1-ol is formed.

Identify the mechanism of this reaction.
Explain why this reaction proceeds via a different mechanism from that of reaction 2.

mechanism .....

explanation .....

.....

.....

.....

.....

[3]

(d) The product of reaction 3, methylpropene, does **not** show stereoisomerism.

(i) Give **two** reasons why methylpropene does **not** show stereoisomerism.

.....

.....

..... [2]

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[Turn over

(ii) Methylpropene can be polymerised to form a poly(alkene).

State the type of polymerisation and draw the repeat unit of the polymer formed from methylpropene.

type of polymerisation .....

repeat unit

[3]

(iii) State the difficulty associated with the disposal of poly(alkenes).

.....

..... [1]

(e) Name the two products of reaction 4.

name of $(CH_3)_3CBr$ .....

name of $(CH_3)_2CHCH_2Br$ .....

[2]

[Total: 23]

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