



Cambridge International Examinations

Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME		
CENTRE NUMBER	CANDIDATE NUMBER	

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.



International Examinations

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	NaC1	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	
arigic .			angle	
				[4]
				[ד]
(b) (i)		ondi	ing, why the melting point of $SiCl_4$ is much lo	wer
	than that of NaCl.			

......[2

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

(iii) Draw the 'dot-and-cross' diagram of a molecule of ${\rm SiC}\,l_{\scriptscriptstyle 4}.$ 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.

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

enthalpy change =kJ mol⁻¹ [1]

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

$$\Delta H_{\rm f} \, {\rm PC} \, l_3({\rm g}) = -320 \, {\rm kJ} \, {\rm mol}^{-1}$$

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

Include a sign with your answer.

(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)		lain the meaning of the term <i>dynamic equilibrium</i> and the conditions necessary for it to ome established.

(d)		en 2.00 mol of PC $l_5(g)$ are decomposed at 450 K and 1.00 × 10 ⁵ Pa the resulting equilibrium sture contains 0.800 mol of C $l_2(g)$.		
	(i)	Calculate the partial pressure of phosphorus (V) chloride, $pPCl_5$, in this equilibrium mixture.		
		$pPCl_5 =Pa$ [2]		
	(ii)	Write the expression for the equilibrium constant, $K_{\rm p}$, for the decomposition of ${\rm PC}\it{l}_{\rm 5}(g)$.		
		\mathcal{K}_{p} =		
		[1]		
	(iii)	The partial pressures of $PCl_3(g)$ and of $Cl_2(g)$ in this equilibrium mixture are both $2.86\times 10^4 Pa$.		
		Calculate the value of $K_{\rm p}$ and state its units.		
		$K_p = \dots$		
		units =[2]		
		[Total: 12]		

(a)	Sta	te and explain the trend in ionisation energy down Group 2.	
(b)	(i)	State and explain the trend in melting point down Group 17.	
	(ii)	The melting point decreases down Group 2.	
		Explain this trend.	
			[2]
(c)	Sor	me reactions based on the Group 2 metal barium, Ba, are shown.	
	Ba($(NO_3)_2(aq) + H_2(g)$ reaction 1 $(NO_3)_2(aq) + H_2(g)$ Ba(s) $(NO_3)_2(aq) + H_2(g)$ heat in air $(NO_3)_2(aq) + H_2(g)$	
	(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	

(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.
	[3]
	[Total: 15]

4 Some reactions are shown, based on methylpropan-2-ol, (CH₃)₃COH.

$$(CH_3)_3CBr \xrightarrow{\text{reaction 1}} (CH_3)_3COH \xrightarrow{\text{reaction 3}} (CH_3)_2C=CH_2$$

$$(CH_3)_3CBr \text{ and } (CH_3)_2C+CH_2Br$$

(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]

(c)	1-br	comobutane is a structural isomer of the product of reaction 1.
	(i)	Define the term <i>structural isomer</i> 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]
(-I)	T I	
(d)		product of reaction 3, methylpropene, does not show stereoisomerism.
	(i)	Give two reasons why methylpropene does not show stereoisomerism.
		[2]

(i	ii) Methylpropene can be polymerised to form a poly(alkene).	
	State the type of polymerisation and draw the repeat unit of the polymer former methylpropene.	d from
	type of polymerisation	
	repeat unit	
		[3]
(ii	ii) State the difficulty associated with the disposal of poly(alkenes).	[0]
("	The difficulty associated with the disposal of poly(alkeries).	
		[.]
(e) N	Name the two products of reaction 4.	
r	name of (CH ₃) ₃ CBr	
r	name of (CH ₃) ₂ CHCH ₂ Br	[2]
	ITat	al· 23]

[Total: 23]

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