

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

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

125349937

CHEMISTRY 9701/22

Paper 2 Structured Questions AS Core

May/June 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.



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

1

Ammonium sulfate is a fertiliser which is manufactured by the reaction between ammonia and sulfuric acid.						
(a)	Ammonia is described as a weak base and sulfuric acid as a strong acid.					
	By using an equation, explain clearly what is meant by the term weak base.					
		[3]				
(b)		monia and sulfuric acid are both manufactured by processes which involve chemical illibria.				
	(i)	Sulfuric acid is produced from sulfur trioxide which is made by the Contact process.				
		State three important operating conditions for the Contact process for the manufacture of sulfur trioxide.				
		For each of your conditions, you should avoid the use of vague phrases such as 'high temperature'.				
		condition 1				
		condition 2				
		condition 3				
	(ii)	How is the sulfur trioxide produced converted into sulfuric acid?				
		[4]				

(c) Chloropropanols such as 1,3-dichloropropan-2-ol (1,3-DCP) are present in some foods.

C!CH2CH(OH)CH2C!

1,3-DCP

(i) What will be produced when 1,3-DCP is reacted separately with the following reagents under suitable conditions? In each case give the structural formula.

concentrated sulfuric acid

an excess of ammonia

(ii) Describe as fully as you can what type of reaction occurs with ammonia.

[Total: 11]

[4]

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Examiner's Use 2 Chile saltpetre is a mineral found in Chile and Peru, and which mainly consists of sodium nitrate, NaNO₃. The mineral is purified to concentrate the NaNO₃ which is used as a fertiliser and in some fireworks.

In order to find the purity of a sample of sodium nitrate, the compound is heated in NaOH(aq) with Devarda's alloy which contains aluminium. This reduces the sodium nitrate to ammonia which is boiled off and then dissolved in acid.

$$3NaNO_3(aq) + 8Al(s) + 5NaOH(aq) + 18H_2O(l) \rightarrow 3NH_3(g) + 8NaAl(OH)_4(aq)$$

The ammonia gas produced is dissolved in an excess of H₂SO₄ of known concentration.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

The amount of unreacted H₂SO₄ is then determined by back-titration with NaOH of known concentration.

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

- (a) A 1.64 g sample of impure NaNO₃ was reacted with an excess of Devarda's alloy. The NH₃ produced was dissolved in 25.0 cm³ of 1.00 mol dm⁻³ H₂SO₄. When all of the NH₃ had dissolved, the resulting solution was titrated with NaOH(aq). For neutralisation, 16.2 cm³ of 2.00 mol dm⁻³ NaOH were required.
 - (i) Calculate the amount, in moles, of H_2SO_4 present in the 25.0 cm³ of 1.00 mol dm⁻³ H_2SO_4 .
 - (ii) Calculate the amount, in moles, of NaOH present in 16.2 cm³ of 2.00 mol dm⁻³ NaOH.
 - (iii) Use your answer to (ii) to calculate the amount, in moles, of H₂SO₄ that reacted with 16.2 cm³ of 2.00 mol dm⁻³ NaOH.
 - (iv) Use your answers to (i) and (iii) to calculate the amount, in moles, of H₂SO₄ that reacted with the NH₃.

(\	Use your answer to (iv) to calculate the amount, in moles, of NH ₃ that reacted with the H ₂ SO ₄ .	For Examiner's Use
(v	Use your answer to (v) to calculate the amount, in moles, of NaNO ₃ that reacted with the Devarda's alloy.	n
(vi	i) Hence calculate the mass of NaNO ₃ that reacted.	
(vii	 Use your answer to (vii) to calculate the percentage by mass of NaNO₃ present in the impure sample. Write your answer to a suitable number of significant figures. 	1
	[9]
	The above reaction is an example of a redox reaction. What are the oxidation numbers of nitrogen in NaNO ₃ and in NH ₃ ?	
١	NaNO ₃ NH ₃ [1]
	[Total: 10]

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This question refers to the elements in the section of the Periodic Table shown below. Н He F В С Li Be Ν 0 Ne Si Ρ S Na Mg AlClAr K Ca transition elements Ga Ge As Se Br Kr (a) From this list of elements, identify in each case one element that has the property described. Give the **symbol** of the element. (i) An element that when placed in cold water sinks and reacts readily. (ii) An element whose molecules contain π bonding. (iii) An element that forms a gaseous toxic oxide. (iv) The element which has a giant molecular structure and forms an oxide which also has a giant molecular structure. (v) An element that forms a covalent chloride which dissolves in water to give a conducting solution. (vi) The element in Period 3 (Na to Ar) with the greatest electrical conductivity. [6]

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(b)		me of the elements in Period 3 (Na to Ar) burn with a coloured flame when heated in gen or chlorine.							
	(i)	Give the symbol of one such element, the formula of the oxide formed, and state the flame colour that would be seen.							
		symbol of element							
		formula of oxid	le						
		flame colour							
	(ii)		nt you have use f the solution pro						
		formula of chlo	oride						
		pH of solution							[4]
(c)			h both bromine of chlorine and						
			substance	Cl_2	BrC1	IC1			
			m.p./°C	-101	-66	24			
	(i)	Showing outer	electrons only	draw a 'd	ot-and-c	ross' dia	gram of t	he bonding	g in IC <i>1</i> .
	(ii)	Suggest why the	he melting point	s increas	e from C	Cl_2 to IC	1.		
	(iii)) Suggest which of these three molecules has the largest permanent dipole. Explain your answer.							
		[5]							

[Total: 15]

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4	Crotyl alcohol	CH ₂ CH=CHCH ₂ OH	is a colourless lig	juid which is used as	a solvent
_	Cictyi dicciici,		, io a coloalicoo iiq	jala Willion lo acca ac	a convent.

(a) In the boxes below, write the **structural formula** of the organic compound formed when crotyl alcohol is reacted separately with each reagent under suitable conditions. If you think no reaction occurs, write 'NO REACTION' in the box.

A	Br ₂ in an inert organic solvent	
В	PCl ₅	
С	H ₂ and Ni catalyst	
D	NaBH ₄	
Е	K ₂ Cr ₂ O ₇ /H ⁺ heat under reflux	

[5]

(b) Draw the **displayed formula** of the organic compound formed when crotyl alcohol is reacted with cold, dilute acidified potassium manganate(VII).

[1]

(c) Draw the **skeletal formula** of the compound formed in reaction E.

[2]

(d) Crotyl alcohol is obtained from crotonaldehyde, CH ₃ CH=CHCHO.				
	(i)	Describe one test that would confirm the presence of a small amount of unreacted crotonaldehyde in the crotyl alcohol. Give the name of the reagent used and state what you would see.		
		reagent		
		observation		
	(ii)	What type of reaction is the conversion of crotonaldehyde into crotyl alcohol?		
		[3]		

(e) Compound **P**, another unsaturated compound, is found in some blue cheeses. The percentage composition by mass of compound **P** is C: 73.7%; H: 12.3%; O: 14.0%.

Calculate the empirical formula of compound **P**.

[2]

[Total: 13]

5

A student reacted together an alcohol and a carboxylic acid under appropriate conditions to produce an ester. A sweet smelling organic liquid, \mathbf{Q} , with the empirical formula C_2H_4O was produced. The M_r of **Q** was found by experiment to be 87.5. (a) What is the molecular formula of Q? (b) In the boxes below, draw the structural formulae of four isomers with this formula that are esters. W X Υ Ζ

[4]

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A sample of **Q** was hydrolysed by heating with aqueous sulfuric acid.

The resulting mixture was heated under reflux with acidified potassium dichromate (VI) to give a **single** organic product, \mathbf{R} .

The product, **R**, was collected and subjected to the following tests.

A sample of **R** gave no reaction with Tollens' reagent.

A second sample of **R** gave no reaction with 2,4-dinitrophenylhydrazine reagent.

A third sample of ${\bf R}$ gave an effervescence with sodium carbonate.

(c)	(i)	What does the result of the test with Tollens' reagent show about R ?	
	(ii)	What does the result of the test with 2,4-dinitrophenylhydrazine reagent show abou R ?	t
	(iii)	What functional group does the result of the test with sodium carbonate show to be present in R ?	
		[3]
(d)	(i)	What is the identity of the single organic compound, R ?	
	(ii)	Which of your structures, W , X , Y or Z , represents the ester, Q ?	
		[2]
(e)	Wh	ich, if any, of your esters, W , X , Y or Z , is chiral?	
		[1]
		[Total: 11]

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