

General Certificate of Secondary Education 2013

Science: Chemistry

Unit C2

Higher Tier



[GCH22]

GCH22

THURSDAY 20 JUNE, AFTERNOON

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided. Do not write outside the box, around each page or on blank pages.

Complete in blue or black ink only. **Do not write with a gel pen**. Answer **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is **115**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in question 5(a).

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.



1	Fireworks contain the three ingredients shown in the box below.								
				colouring agent					
				fuel					
				oxidiser					
	(a)	Mad	nasium is oft	en used in fireworks as the	colouring agent				
		(i)		colour of the flame observed					
	,	(')	burns?	colour of the harne observed	when magnesium				
					[1]				
		(ii)	Write a balar	nced symbol equation for ma	agnesium burning in air.				
	·	(,		,	[2]				
	(b) (Car	bon in the for	m of charcoal is often used	as the fuel in fireworks.				
		(i)	What is obse	erved when a sample of carb	oon burns?				
					[2]				
		(ii)	Name the proof oxygen.	oduct formed when carbon b	ourns in a limited supply				
					[1]				

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(c)	effe	disers provide the oxygen needed to allow the firework to burn ctively. A common oxidiser is potassium nitrate, which thermally omposes to produce potassium oxide, nitrogen and oxygen.	,	Examiner Only Marks Remark
	Writ	te a balanced symbol equation for this reaction.		
			[3]	
(d)	and	irklers are hand held fireworks which contain a fuel, an oxidiser iron powder. Often the iron powder is mixed with linseed oil to vent it rusting.		
	(i)	What conditions are required for iron to rust?		
			[2]	
	(ii)	What is the chemical name for rust?		
			[2]	
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	(e)	In industry, iron is manufactured in the Blast Furnace.	Examin Marks	er Only Remark
		A redox reaction which occurs in the Blast Furnace is given below:		
		$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$		
		Explain fully, in terms of change in oxygen content, why this reaction is described as a redox reaction.		
		[5]		
			Total Qu	estion 1
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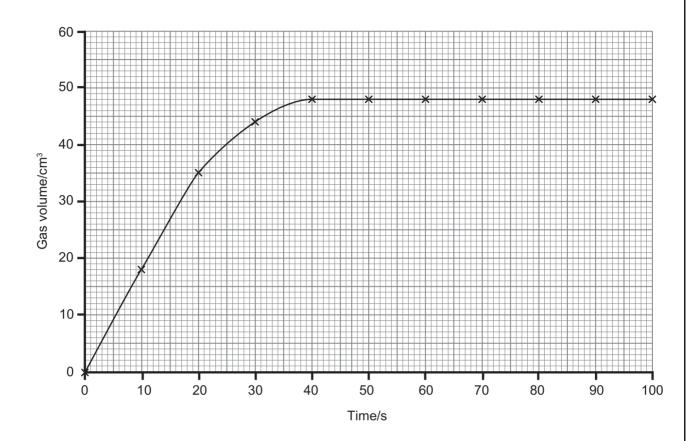
2	(a)	The rate of decomposition of a solution of hydrogen peroxide using manganese (IV) oxide (manganese dioxide) can be measured using the apparatus shown below. The manganese (IV) oxide is a cataly the reaction.	ng	Examino Marks	er Only Remark
		hydrogen peroxide solution and manganese(IV) oxide			
		5 5 5 2 2 .			
		(i) Name the piece of apparatus labelled A.	_ [1]		
		(ii) What is meant by the term catalyst?			
			_ [3]		
		(iii) Write a balanced symbol equation for the decomposition of hydrogen peroxide.			
			_ [3]		

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(b) The graph below shows data obtained at 25 °C using 25.0 cm³ of 0.16 mol/dm³ hydrogen peroxide solution with 1.0 g of solid powdered manganese(IV) oxide.



(i) Apart from the apparatus shown in the diagram in part (a), name one other piece of equipment which would be required to collect the results used to draw the graph.

______[1]

(ii) What was the total volume of gas collected?

______[1]

(iii) The reaction was repeated at 40 °C with all other factors being kept the same. Sketch the graph you would expect to obtain on the axes above. [3]

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(c) The table below shows the time taken for the decomposition of hydrogen peroxide solution to be completed. 25.0 cm³ of 0.16 mol/dm³ hydrogen peroxide solution was used with 1.0 g of different powdered metal oxides as catalysts.

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Metal oxide	Time for decomposition to be completed/s	Rate of decomposition/s ⁻¹ $rate = \left(\frac{1}{time}\right)$
Manganese(IV) oxide		
Copper(II) oxide	127	0.00787
Zinc oxide	360	0.00277

- (i) Using the graph at 25 °C in part (b), complete the table above. [2]
- (ii) State which of the metal oxides in the table is the **least** effective catalyst and explain your answer.

[2]	

Total Question 2

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3	Perfume is a mixture of essential oils dissolved in a solvent. One of the
	essential oils used in making perfume is called myrcene.

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(a) The structural formula of a molecule of myrcene is shown below.

(i) Explain why a molecule of myrcene can be classified as a hydrocarbon.

[1]

(ii) Identify the functional group present in myrcene.

_____ [1]



(b) Linalool is another essential oil used in perfume making. It gives a sweet, lavender-like smell. The structural formula of linalool is shown below.

					H 		
H	H	ÓН	H	H	н н—¢—н	H	
Ç=	=C-	-ç—	-ç-	-ç-	_c==c	- Ç —	— Н
Н	H-	–ċ—⊦	н н	Н		Н	
		Ĥ					

- (i) On the structure of linalool shown above, draw a circle around the **alcohol** functional group. [1]
- (ii) Like all alcohols, linalool (C₁₀H₁₇OH) undergoes complete combustion in excess air. Complete and balance the symbol equation below for this reaction.

$$C_{10}H_{17}OH + O_2 \longrightarrow$$
 [2]

(iii) When linalool is warmed with acidified potassium dichromate solution it is oxidised in the same way as ethanol. State the colour change which is observed in this reaction.

from ______ to _____[2]

[Turn over

Examiner Only

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_ ((c) Ethanol is an alcohol which is often used as a solvent in perfumes.						
	(i)	Write the general for	mula for alcohols.				
					[1]		
	(ii)	Draw the structural f	ormula of ethanol				
	(11)	Draw the structural i	ormula of emarion.				
					F41		
					[1]		
	(iii)		to manufacture the etha pelow to give information		es.		
	Name	Molecular formula	Structural formula	State at room temperature and pressure			
	Ethene						
		,					
					[3]		
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(d		anoic acid is a carboxylic acid which can be used to make other vents. These solvents are also used in perfumes.	Examin Marks	er Only Remark
	(i)	Draw the structural formula of ethanoic acid.		
		[1]		
	(ii)	State two observations you would make when magnesium reacts with ethanoic acid.		
		[2]		
	(iii)	Write a balanced symbol equation for the reaction of magnesium with ethanoic acid.		
		[3]		
			Total Qu	estion 3
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4 Metals may be placed in a reactivity series by observing their reactions with air, water, steam and dilute acid.	Examiner Only Marks Remark
(a) The apparatus below may be used to react zinc metal with steam.	
damp mineral wool zinc gas produced HEAT HEAT water beehive shelf	
© Barking Dog Art (i) What labels should be placed at A and B on the diagram?	
A	
B [2]	
(ii) Explain why the damp mineral wool is heated.	
[1]	
(iii) Name the gas produced in this experiment.	
[1]	
(iv) Name a metal which does not react when heated with steam.	
[1]	

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(b) X is an unknown metal. The table below gives details of some reactions of the three metals X, sodium and zinc.

Examiner Only			
Marks	Remark		

Metal	Reaction when heated in oxygen	Reaction with cold water	Reaction with dilute hydrochloric acid
X	Black coating forms on metal without burning	No reaction	No reaction
Sodium	Burns very vigorously with a yellow flame		Dangerous reaction not carried out in school laboratory
Zinc	Burns forming a yellow solid which changes to white on cooling	No reaction	Reacts steadily

(1)	Suggest the name of metal A.	
		[1]

(ii)	Describe what you would observe when sodium reacts with cold water.

(iii)	Write a balanced symbol equation for the reaction of sodium with
	water.

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(c)		minium is a metal which is extracted from its ore (bauxite) by ctrolysis.		Examine Marks	er Only Remark
	(i)	What is meant by the term electrolysis?			
			[2]		
	(ii)	What is the name of the purified bauxite which is used in the production of aluminium by electrolysis?			
			[1]		
	(iii)	Write a half equation to represent the production of aluminium during this electrolysis process.			
			[3]		
	(iv)	At what temperature is this electrolysis carried out?			
			[1]		
	(v)	Explain why the carbon anodes need to be replaced periodical during this electrolysis.	ly		
			[3]		
				Total Qu	estion 4
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5		aline batteries contain one particular metal hydroxide. The metal roxide can be represented as MOH.	Examin Marks	er Only Remark
		© iStockphoto / Thinkstock		
	dei	2g of this solid metal hydroxide were dissolved in 1000 cm ³ of onised water in a volumetric flask. 25.0 cm ³ of this solution were placed conical flask using a pipette.		
	(a)	Describe in detail how you would prepare and use a pipette to transfer 25.0 cm³ of the MOH solution into a conical flask, ensuring accuracy and safety.		
		In this question you will be assessed on using your written communication skills including the use of specialist scientific terms.		
		·		
		[6]		

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(b) 25.0 cm³ of the MOH solution were titrated with hydrochloric acid of concentration 0.125 mol/dm³ using phenolphthalein indicator. The results are shown in the table below.

Examin	er Only	
Marks	Remark	

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	Initial burette volume/cm³	Final burette volume/cm³	Titre/cm³
Rough titration	0.0	14.9	14.9
First accurate titration	14.9	28.9	14.0
Second accurate titration	28.9	42.9	14.0

(i) Calculate the average titre.

_____ cm³ [2]

(ii) State the colour change at the end-point.

From ______ to _____ [2]

(iii) Calculate the number of moles of hydrochloric acid used in the titration.

[2]

The balanced symbol equation for the reaction is:

$$MOH + HCI \rightarrow MCI + H_2O$$

(iv)	Calculate the number of moles of MOH present in 25.0 cm ³ of the solution in the conical flask.	Examiner Only Marks Remark
	[1]	
(v)	Calculate the number of moles of MOH present in 1000 cm ³ of the solution.	
	[2]	
(vi)	Using the fact that 3.92g of MOH were dissolved in 1000 cm ³ and the answer to question (b)(v) above, determine the relative formula mass of MOH.	
	[2]	
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	(vii) Determine the relative atomic mass of M using your answer to question (b)(vi).(Relative atomic masses: H = 1; O = 16)								
		[2]						
	(viii) Identify the metal, M.								
		[1]						
			Tota	al Question 5					
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6		_	investigation was carried out to compare the hardness of water ples from three towns A, B and C. Examiner Only Marks Remark											
	f		cm³ of each water sample were placed into three separate conical sks and labelled A, B and C. A sample of deionised water was also ted.											
	9	shaking until a las	ap solution was added, 1 cm ³ at a time, to each conical flask with aking until a lasting lather formed. The total volume of soap solution ded to each flask was recorded.											
		•	e experiment was repeated with fresh samples of A, B and C which d been boiled and allowed to cool, before adding the soap solution.											
	-	The results are sh												
	Wa	ter sample	Volume of soap so form a	-										
			before boiling (cm³)	after boiling (cm³)										
	Deid	onised water	2	2										
		Α	6	6										
		В	8	2										
		С	11	7										
	(
				[1]										
		(ii) Which of the temporary ha	three water samples (A, B rdness?	or C) contains only										
				[1]										
			three water samples (A, B dependent of the dependent hardness?	or C) contains both										
				[1]	[Turn over									
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(b)	Permanent hardness may be removed from water by the addition of washing soda. Explain, in terms of ions, how washing soda can soften hard water.	Examiner Only Marks Remark
	[3]	
(c)	State two disadvantages of hard water.	
	1	
	2	
	[2]	
		Total Question 6
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(a)	(i)	Write a balanced symbol equation for the reaction of ammonia with nitric acid.		
			[2]	
			[-]	
	(ii)	Describe how you would carry out a chemical test for the presence of ammonia gas, stating the observations you would make for a positive test.		
			[4]	
	(iii)	State one disadvantage of using nitrogenous fertilisers.		
			[1]	
(b)	invo	ndustry ammonia gas is produced by the Haber process which olves a reversible reaction between the gases nitrogen and rogen.		
		$N_2 + 3H_2 \rightleftharpoons 2NH_3$		
	(i)	Explain what you understand by the term reversible reaction.		
			[1]	
	(ii)	Name the catalyst used in the Haber process.		
			[1]	

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	(c)	The is a belo	ffec ow s	ted sho	by ws	y b s h	001 0V	th t v th	the	e to	en erd	npe cer	era	atu	ıre	a	nc	l th	ne	pr	es	sui	re.	Т	he	g	rap	h				Exa Mari	-	er Or Rem	
	60																											35	0°0	C					
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onia	40						/	/	_																			45	0°0	C					
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		(ii)	Pro	0°C oce ndit	SS	. V	۷h																												
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— (iii	Suggest why industry uses 450 °C and 250 atm when it is possible to obtain a higher yield of ammonia using a lower temperature and a higher pressure.	Examiner Only Marks Remai
—	IIS IS THE END OF THE QUESTION PAPER	
		Total Question
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Total Marks

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