



#### **Cambridge International Examinations**

Cambridge International General Certificate of Secondary Education (9–1)

CANDIDATE NAME				
CENTRE NUMBER		CANDIDATE NUMBER		

CHEMISTRY 0971/04

Paper 4 Theory (Extended)

SPECIMEN PAPER

For Examination from 2018

1 hour 15 minutes

No Additional Materials are required.

Candidates answer on the Question Paper.

#### **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, graphs or rough working.

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 copy of the Periodic Table is printed on page 20.

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.



1 The following table gives information about six substances.

substance	melting point / °C	boiling point / °C	electrical conductivity as a solid	electrical conductivity as a liquid
Α	839	1484	good	good
В	-188	-42	poor	poor
С	776	1497	poor	good
D	-117	78	poor	poor
E	1607	2227	poor	poor
F	-5	102	poor	good

(a)	willer substance could be a metal?	[1]
(b)	State <b>all</b> the substances that are liquid at room temperature.	[1]
(c)	Which substance could have a macromolecular structure similar to that of silicon(IV) oxide	
(d)	Which substance could be propane?	[1]
(e)	Which substance could be sodium chloride?	
		[1]
	[Total	: 5]

**2** The table gives the composition of three particles.

particle	number of protons	number of electrons	number of neutrons
Α	15	15	16
В	15	18	16
С	15	15	17

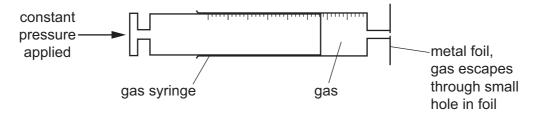
(a)	Wh	at is the evidence in the table for each of the following?	
	(i)	Particle <b>A</b> is an atom.	
			[1]
	(ii)	A, B and C are all particles of the same element.	ניו
	(iii)	Particles <b>A</b> and <b>C</b> are isotopes of the same element.	[1]
			[2]
(b)	(i)	What is the electronic structure of particle <b>A</b> ?	[1]
	(ii)	Is element <b>A</b> , a metal or a non-metal? Give a reason for your choice.	
			[1]

[Total: 6]

			4	
3		etic ticle:	theory explains the properties of matter in terms of the arrangement and movemens.	t of
	(a)		rogen is a gas at room temperature. Nitrogen molecules, $N_2$ , are spread far apart ave in a random manner at high speed.	and
		(i)	Draw the electronic structure of a nitrogen molecule. Show only the outer electron shells.	
				[2]

(	(ii)	Compare the movement and arrangement of the molecules in solid nitrogen to those nitrogen gas.	in
			[3]
` '		ealed container contains nitrogen gas. The pressure of the gas is due to the molecules gas hitting the walls of the container.	of
		the kinetic theory to explain why the pressure inside the container increases when the perature is increased.	he
		ı	വ

The following apparatus can be used to measure the rate of diffusion of a gas.



The following results were obtained.

gas	temperature /°C	rate of diffusion in cm³/min
nitrogen	25	1.00
chlorine	25	0.63
nitrogen	50	1.05

(c)	(i)	Explain why nitrogen gas diffuses faster than chlorine gas.	

		[2]
(ii)	Explain why the nitrogen gas diffuses faster at the higher temperature.	
		[1]
	[Total:	10]

			6	
4	Chror	miu	m is a transition element.	
	(a) (	i)	State <b>two</b> differences in the physical properties of chromium and sodium.	
	(i	i)	State <b>two</b> differences in the chemical properties of chromium and sodium.	[2]
				[2]
			lead anode chromium(III) sulfate(aq)  Give <b>two</b> reasons why steel objects are plated with chromium.	€.
	(i	-	The formula of the chromium(III) ion is ${\rm Cr^{3^+}}$ and of the sulfate ion is ${\rm SO_4^{2^-}}$ . Give formula of chromium(III) sulfate.	[2] the
	(ii	i)	Write the ionic half-equation for the reaction at the negative electrode (cathode).	[1]
				[2]

(iv) A colourless gas, which relights a glowing splint, is formed at the positive electrode

[1]

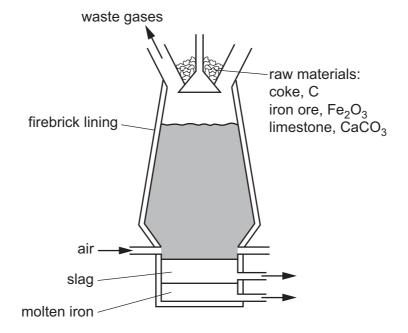
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State the name of this gas.

(anode).

(v)	During electroplating, it is necessary to add more chromium(III) sulfate but during copper plating using a copper anode, it is not necessary to add more copper(II) sulfate.
	Explain this difference.
	[2]
	[Total: 12

5 Iron is extracted from its ore, hematite, in the blast furnace.



Describe the reactions involved in this extraction.

Include one equation for a redox reaction and one for an acid/base reaction.
[5]

[Total: 5]

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6 Soluble salts can be made using a base and an ac	6
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(a)	Complete this method of preparing dry crystals of the soluble salt
	${\it cobalt}(II) \ {\it chloride-6-water} \ {\it from the insoluble base cobalt}(II) \ {\it carbonate}.$

<b>step 1</b> Add an excess of cobalt(II) carbonate to hot dilute hydrochloric acid.	
step 2	
	ı
step 3	
	<b>S</b> 1
step 4	
[4	]

**(b) (i)** 5.95g of cobalt(II) carbonate were added to 40 cm<sup>3</sup> of hydrochloric acid, concentration 2.0 mol/dm<sup>3</sup>.

Calculate the maximum yield of cobalt(II) chloride-6-water and show that the cobalt(II) carbonate was in excess.

$$CoCO_3 + 2HCl \rightarrow CoCl_2 + CO_2 + H_2O$$
  
 $CoCl_2 + 6H_2O \rightarrow CoCl_2.6H_2O$ 

### maximum yield:

	number of moles of HC1 used =
	number of moles of $CoCl_2$ formed =
	number of moles of $CoCl_2.6H_2O$ formed =
	mass of one mole of $CoCl_2.6H_2O = 238g$
	maximum yield of $CoCl_2.6H_2O = \dots g$
	to show that cobalt(II) carbonate is in excess:
	number of moles of HCl used = (use your value from above)
	mass of one mole of CoCO <sub>3</sub> = 119 g
	number of moles of CoCO <sub>3</sub> in 5.95g of cobalt(II) carbonate =[5]
(ii)	Explain how these calculations show that cobalt(II) carbonate is in excess.
	[1]
	[Total: 10]

7 Iodine reacts with chlorine to form dark brown iodine monochloride.

$$I_2 + Cl_2 \rightarrow 2ICl$$

This reacts with more chlorine to give yellow iodine trichloride. An equilibrium forms between these iodine chlorides.

$$ICl(I) + Cl_2(g) \rightleftharpoons ICl_3(s)$$
  
dark brown yellow

(a)	Wh	at do you understand by the term equilibrium?	
			••••
			[2]
(b)	Sug	en the equilibrium mixture is heated, it becomes a darker brown colour. Igest if the reverse reaction is endothermic or exothermic. Give a reason for your choic	
			[1]
(c)	The	pressure on the equilibrium mixture is decreased.	
	(i)	How would this affect the position of equilibrium? Give a reason for your choice.	
		It would move to the	
		reason	
			[1]
	(ii)	Describe what you would observe.	
			 [1]

(d) Calculate the overall energy change for the reaction between iodine and chlorine using the bond energy values shown.

$$I_2 + Cl_2 \rightarrow 2ICl$$

Bond	Energy / kJ per mol
I-I	151
C <i>l</i> -C <i>l</i>	242
I-C <i>l</i>	208

Show your working.

[3]

(e) Draw a labelled energy level diagram for the reaction between iodine and chlorine using the information in (d).

[2]

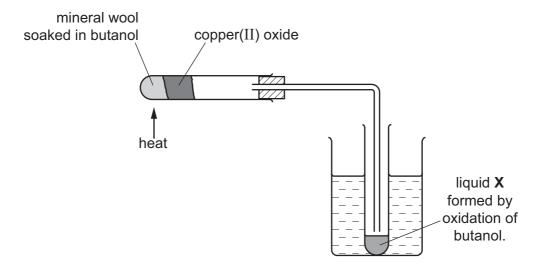
[Total: 10]

8

The alc	ohols form an homologous series.
(a) Giv	e <b>three</b> characteristics of an homologous series.
	[3]
<b>(b)</b> The	e following two alcohols are members of an homologous series and they are isomers.
	$CH_3 - CH_2 - CH_2 - CH_2 - OH$ and $(CH_3)_2CH - CH_2 - OH$
(i)	Explain why they are isomers.
	rol
	[2]
(ii)	Deduce the structural formula of another alcohol which is also an isomer of these alcohols.

[1]

(c) Copper(II) oxide can oxidise butanol to liquid  $\mathbf{X}$ , whose pH is 4.



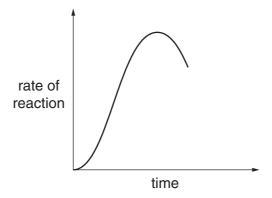
(i)	Give the I	name of	another	reagent	which	can	oxidise	butanol	ĺ.
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		[1]
(ii)	Which homologous series does liquid <b>X</b> belong to?	
		[1]
iii)	State the formula of liquid <b>X</b> .	
		[1]

(d) The alcohol ethanol can be made by fermentation. Yeast is added to aqueous glucose.

$$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

Carbon dioxide is given off and the mixture becomes warm, as the reaction is exothermic. The graph shows how the rate of reaction varies over several days.

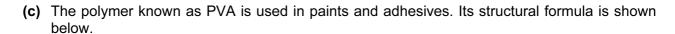


(i)	Suggest a method of measuring the rate of this reaction.	
		[2
(ii)	Why does the rate initially increase?	
		 [1
iii)	Suggest <b>two</b> reasons why the rate eventually decreases.	
		[2

[Total: 14]

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The	ere are two types of polymerisation, addition and condensation.	
(a)	Explain the difference between these two types of polymerisation.	
		•••••
		[2]
(b)	Some plastics, formed by polymerisation, are non-biodegradable.	
	Describe <b>two</b> pollution problems that are caused by non-biodegradable plastics.	
		•••••
		[2



$$\begin{array}{cccc} -\mathsf{CH}_2 - \mathsf{CH} - \mathsf{CH}_2 - \mathsf{CH} - \\ & | & | \\ & \mathsf{OCOCH}_3 & \mathsf{OCOCH}_3 \end{array}$$

Deduce the structural formula of its monomer.

[1]

(d) A condensation polymer can be made from the following monomers.

Draw the structural formula of this polymer.

[3]

[Total: 8]

	=	2	He	halium	9	N O	2	30	707	9	Ā	argan 40	36	호	wikblon	8	3	Xe	xerce	131	98	~	radon	ì														
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The volume of one mole of any gas is 24 dm3 at room temperature and pressure (r.t.p.)

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