

Cambridge International Examinations

Cambridge Ordinary Level

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

277705994

CHEMISTRY 5070/22

Paper 2 Theory

May/June 2017

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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.

Section A

Answer all questions.

Write your answers in the spaces provided in the Question Paper.

Section B

Answer any three questions.

Write your answers in the spaces provided in the Question Paper.

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.



Section A

Answer all the questions in this section in the spaces provided.

The total mark for this section is 45.

A1 Choose from the following chlorides to answer the questions.

ammonium chloride
calcium chloride
carbon tetrachloride
copper(II) chloride
hydrogen chloride
magnesium chloride
zinc chloride

Each chloride can be used once, more than once or not at all.

Which chloride

(a)	is a coloured solid,	
		.[1]
(b)	reacts with warm aqueous sodium hydroxide to produce a gas that turns damp litmus paper blue,	red
		.[1]
(c)	reacts with water to form a strong acid,	
		.[1]
(d)	contains a cation with a charge of +1,	
		.[1]
(e)	has a simple molecular structure similar to methane?	
		.[1]

[Total: 5]

A2 The table shows some information about six particles.

(a) Complete the table.

particle	proton (atomic) number	number of neutrons in particle	number of electrons in particle
³⁵ C <i>l</i>	17	18	
	17	20	17
³⁹ K ⁺	19		18
⁷⁹ Br ⁻		44	36
⁸¹ Br	35		35
	37	48	36

(b)	(i)	What is meant by the term isotopes?
	(ii)	Identify two atoms which are isotopes of the same element.
	(11)	and[1]
		[Total: 8]

[6]

3	ACI	as ar	e neutralised by insoluble bases.
	(a)	Ма	gnesium chloride is a soluble salt that can be prepared from an insoluble base.
		(i)	Name the acid and an insoluble base that can be used to make magnesium chloride.
			[1]
		(ii)	Describe the experimental method used to prepare pure crystals of magnesium chloride from this acid and base.
			[4]

(b) Aqueous barium chloride and aqueous potassium sulfate can be used to prepare

Write the ionic equation, including state symbols, for this reaction.

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barium sulfate in a precipitation reaction.

(c)	Potassium	sulfate	can b	e prepared	by	reacting	aqueous	potassium	hydroxide	with	dilute
	sulfuric acid	d.									

$${\rm 2KOH} \, + \, {\rm H_2SO_4} \, \longrightarrow \, {\rm K_2SO_4} \, + \, {\rm 2H_2O}$$

In an experiment, $20.0\,\mathrm{cm^3}$ of $0.650\,\mathrm{mol/dm^3}$ sulfuric acid is just neutralised by aqueous potassium hydroxide.

(i) Calculate the maximum mass of potassium sulfate, K_2SO_4 , that could be prepared.

[The relative formula mass of $\mathrm{K_2SO_4}$ is 174.]

maximum mass of potassium sulfate = g [2]

(ii) After crystallisation, 1.72g of dry potassium sulfate was obtained. Calculate the percentage yield of potassium sulfate.

percentage yield of potassium sulfate = % [1]

[Total: 10]

A 4	Soc	lium oxide, Na ₂ O, is an ionic compound.	
	(a)	State the electronic configuration for each of the ions in sodium oxide.	
		sodium ion	
		oxide ion	
	(b)	When molten sodium oxide is electrolysed, sodium and oxygen are formed.	[2]
		Construct equations for the two electrode reactions.	
		reaction at the negative electrode	
		reaction at the positive electrode	
			[2]
	(c)	Explain how molten sodium oxide conducts electricity.	[4]
			[41]
	(d)	Sodium oxide reacts with water to give sodium hydroxide.	[']
		Construct the equation for this reaction.	
			[1]

[Total: 6]

A5 Ethanoic acid and butanoic acid are both carboxylic acids.

H O—H	H H H O—H
H-C-C	H-C-C-C-C
H	

ethanoic acid

butanoic acid

(a)	Nar	ne a reagent that can be used to make ethanoic acid from ethanol.
		[1]
(b)	Dilu	te ethanoic acid reacts with all carbonates and with some metals.
	(i)	Name one metal that will react with dilute ethanoic acid and name the products of this reaction.
		name of metal
		products[2]
	(ii)	Construct an equation to show the reaction of dilute ethanoic acid with calcium carbonate.
		[2]
(c)	Dra	w the structure of a carboxylic acid that is an isomer of butanoic acid.
	Sho	ow all of the atoms and all of the bonds.

[1]

(d) Lactic acid is both an alcohol and a carboxylic acid.

Lactic acid is a monomer that can be polymerised to form a polyester.

(i)	What type of polymerisation occurs during this reaction?
	[1]
(ii)	This polyester is biodegradable.
	Suggest an advantage of a polymer being biodegradable.
	[1]
	[Total: 8]

A6 Respiration is a reaction that takes place in living cells to release energy.

The overall reaction involves the oxidation of glucose.

$$\mathrm{C_6H_{12}O_6} \, + \, \mathrm{6O_2} \, \rightarrow \, \mathrm{6CO_2} \, + \, \mathrm{6H_2O}$$

The reaction is exothermic and is catalysed by enzymes.

(a) Draw an energy profile diagram for respiration using the axes shown.

Label

- · the axes,
- the enthalpy change,
- the reactants and products.



(b)	Explain how a catalyst such as an enzyme can speed up a chemical reaction.
	[2]
(c)	Respiration, combustion and photosynthesis are important processes in the carbon cycle.
	Describe how the carbon cycle regulates the amount of carbon dioxide in the atmosphere.
	[3]

[3]

[Total: 8]

Section B

Answer three questions from this section in the spaces provided.

The total mark for this section is 30.

B7 Copper reacts with hot concentrated aqueous sulfuric acid.

$$Cu(s) + 2H_2SO_4(aq) \rightarrow CuSO_4(aq) + SO_2(g) + 2H_2O(l)$$

(a)	sulf	gest what you would observe when copper reacts with hot concentrated aqueous uric acid.
		[1]
(b)	(i)	Name the salt of formula CuSO ₄ .
		[1]
	(ii)	Copper is oxidised when it reacts with concentrated sulfuric acid.
		Use the equation to explain that copper has been oxidised.
		[1]
(c)	An e	excess of copper is added to 25.0 cm ³ of hot 14.0 mol/dm ³ H ₂ SO ₄ .
	Use	this information, together with the equation, to calculate the maximum volume of SO_2 ned.
	The	gas volume is measured at room temperature and pressure.

volume of $SO_2 = \dots [3]$

(d)		a small sample of ${\rm CuSO_4(aq)}$, a student adds aqueous sodium hydroxide drop by drop it is in excess.
	(i)	Describe what would be observed.
		[1]
	(ii)	The student repeats the experiment but adds aqueous ammonia instead of aqueous sodium hydroxide.
		Describe what would be observed.
		[2]
(e)	Cop	per(I) chloride, $CuCl$, decomposes to form $CuCl_2$ and Cu .
	Con	struct the equation for this reaction.
		[1]
		[Total: 10]

B8

	ogen dioxide, $\mathrm{NO_2}$, reacts with itself to make dinitrogen tetroxide, $\mathrm{N_2O_4}$, in an exothermic stion.
This	reaction is investigated at 140 °C in a sealed container.
A dy	namic equilibrium mixture is established.
	$2NO_2(g) \rightleftharpoons N_2O_4(g)$
NO	g(g) is a dark brown gas.
N ₂ C	$O_4(g)$ is a colourless gas.
(a)	What is the meaning of the symbol ← ?
	[1]
(b)	What is an exothermic reaction?
	[1]
(c)	Suggest why a sealed container must be used to establish any equilibrium.
	[1]
(d)	The pressure of the equilibrium mixture is decreased.
	The temperature is kept at 140 °C.
	Predict and explain what will happen to the colour of the equilibrium mixture.
	[2]

(e)	The	temperature of the equilibrium mixture is increased.
	The	pressure is kept constant.
	Pred	dict and explain what will happen to the colour of the equilibrium mixture.
		[2
(f)	Nitro	ogen dioxide reacts with water to make nitric acid, HNO ₃ , and nitrous acid, HNO ₂ .
	Nitri	c acid is a strong acid and nitrous acid is a weak acid.
	(i)	Describe an experiment to distinguish between separate solutions of a strong acid and a weak acid.
		[2
	(ii)	Nitrogen dioxide reacts with aqueous potassium hydroxide.
		Give the formula of each of the two salts formed in this reaction.
		and[1
		[Total: 10

В9	Met	hane	e, ethane and propane are all gases at room temperature.							
	(a)	Sta	te a use of methane.							
	(b)	Describe one source of methane in the atmosphere.								
	(c)	Sta	te one possible environmental consequence of the presence of methane in the losphere.							
	(d)		ane reacts with chlorine in the presence of ultraviolet light to give a number of different							
		compounds. A 1.00 g sample of one of these compounds contains 0.040 g of hydrogen, 0.242 g of carbon and 0.718 g of chlorine.								
		(i)	Calculate the empirical formula of this compound.							
			omnivia al farmaula							
		/::\	empirical formula							
		(ii)	The relative molecular mass of the compound is 99.							
			Deduce the molecular formula of the compound.							
			[1]							

(e) (i)	What is meant by the term diffusion?
	[1]
(ii)	Explain why propane diffuses faster at 100 °C than at 60 °C.
	[1]
(iii)	Explain why diffusion could be used to separate a mixture of methane and propane.
	[2]
	[Total: 10]

B10 The table shows some information about the homologous series of unbranched alcohols.

name	structure	boiling point / °C
methanol	CH ₃ OH	65
ethanol	CH ₃ CH ₂ OH	79
propanol	CH ₃ CH ₂ CH ₂ OH	97
butanol	CH ₃ CH ₂ CH ₂ CH ₂ OH	117
pentanol	CH ₃ CH ₂ CH ₂ CH ₂ CH ₂ OH	138

(a)	One	e of the characteristics of a homologous series is that it has a general formula.	
	(i)	What is the general formula for the homologous series of unbranched alcohols?	
			[1]
	(ii)	Predict the boiling point of hexanol, an alcohol with six carbon atoms per molecule.	
		°C	[1]
(b)	Des	scribe the manufacture of ethanol by the fermentation of aqueous glucose.	
			[3]

	••
(c)	Butanol reacts with ethanoic acid to make an ester.
	Name and draw the structure of this ester.
	Show all of the atoms and all of the bonds within the ester linkage.
	name
	structure
	[2]
(d)	Ethanol is a gas at 100 °C.
	Describe the changes in the arrangement and movement of the molecules when ethanol is cooled from 100 $^{\circ}\text{C}$ to 25 $^{\circ}\text{C}.$
	101
	[3]
	[Total: 10]

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The Periodic Table of Elements

	=	2 He	helium 4	10	Ne	neon 20	18	Αľ	argon 40	36	궃	krypton 84	54	Xe	xenon 131	98	Ru	radon			
	=>			6	ш	fluorine 19	17	Cl	chlorine 35.5	35	Ŗ	bromine 80	53	Н	iodine 127	85	¥	astatine -			
	5			80	0	oxygen 16	16	ഗ	sulfur 32	34	Se	selenium 79	52	<u>a</u>	tellurium 128	84	Ро	polonium	116		livermorium -
	>			7	z	nitrogen 14	15	۵	phosphorus 31	33	As	arsenic 75	51	Sp	antimony 122	83	Ξ	bismuth 209			
	≥			9	ပ	carbon 12	14	S	silicon 28	32	Ge	germanium 73	20	S	tin 119	82	Ъ	lead 207	114	lΉ	flerovium -
	≡			2	М	boron 11	13	Αſ	aluminium 27	31	Ga	gallium 70	49	In	indium 115	81	<i>1</i> L	thallium 204			
										30	Zu	zinc 65	48	ပ	cadmium 112	80	Hg	mercury 201	112	C	copernicium
										29	Cn	copper 64	47	Ag	silver 108	79	Αn	gold 197	111	Rg	roentgenium -
Group										28	z	nickel 59	46	Pd	palladium 106	78	풉	platinum 195	110	Ds	darmstadtium -
) Dig										27	රි	cobalt 59	45	뫈	rhodium 103	77	Г	iridium 192	109	M	meitnerium -
		- エ	hydrogen 1							26	Ьe	iron 56	44	Ru	ruthenium 101	9/	Os	osmium 190	108	Hs	hassium –
										25	Mn	manganese 55	43	ပ	technetium -	75	Re	rhenium 186	107	Bh	bohrium –
					pol	ass				24	ပ်	chromium 52	42	Mo	molybdenum 96	74	≯	tungsten 184	106	Sg	seaborgium -
			Key	atomic number	atomic symbo	name relative atomic mass				23	>	vanadium 51	41	qN	niobium 93	73	Та	tantalum 181	105	Op	dubnium –
					atc	rek				22	j=	titanium 48	40	Zr	zirconium 91	72	Ξ	hafnium 178	104	꿏	rutherfordium -
										21	Sc	scandium 45	39	>	yttrium 89	57–71	lanthanoids		89–103	actinoids	
	=			4	Be	beryllium 9	12	Mg	magnesium 24	20	Ca	calcium 40	38	Š	strontium 88	99	Ba	barium 137	88	Ra	radium -
	_			က	:=	lithium 7	£	Na	sodium 23	19	¥	potassium 39	37	&	rubidium 85	55	S	caesium 133	87	Ē	francium -

_					
7.1	'n	lutetium 175	103	ئ	lawrencium -
70	Υp	ytterbium 173	102	8 N	nobelium -
69	Tm	thulium 169	101	Md	mendelevium –
89	Ē	erbium 167	100	Fm	fermium -
29	웃	holmium 165	66	Es	einsteinium –
99	ò	dysprosium 163	86	ర	californium -
65	Д	terbium 159	97	Ř	berkelium –
64	gq	gadolinium 157	96	Cm	curium
63	En	europium 152	92	Am	americium -
62	Sm	samarium 150	94	Pn	plutonium
61	Pm	promethium -	93	ď	neptunium -
09	ΡN	neodymium 144	92	\supset	uranium 238
69	Ą	praseodymium 141	91	Pa	protactinium 231
58	Se	cerium 140	06	H	thorium 232
22	Га	lanthanum 139	88	Ac	actinium -

lanthanoids

actinoids

The volume of one mole of any gas is $24\,\mathrm{dm}^3$ at room temperature and pressure (r.t.p.)