

## **Cambridge International Examinations**

Cambridge Ordinary Level

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

405321100

CHEMISTRY 5070/21

Paper 2 Theory

October/November 2016
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 compounds to answer the questions below.

Ba(NO <sub>3</sub> ) <sub>2</sub>
CaCO <sub>3</sub>
CaO
CH <sub>4</sub>
$C_3H_8$
$Fe_2O_3$
$KMnO_4$
NaNO <sub>3</sub>
NO
SO <sub>2</sub>
$V_2O_5$
$Zn(NO_3)_2$

Each of these compounds can be used once, more than once or not at all.

Which compound

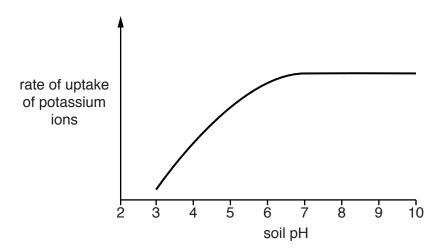
(a)	is an atmospheric pollutant formed by lightning activity,
	[1]
(b)	is the main constituent of natural gas,
	[1]
(c)	dissolves in water to form an aqueous solution which gives a white precipitate on addition of aqueous sodium sulfate,
	[1]
(d)	is a catalyst in the contact process for the manufacture of sulfuric acid,
	[1]
(e)	is a product of the thermal decomposition of limestone?
	[1]

[Total: 5]

**A2** Sulfuric acid is a strong acid.

(a)	(i)	What is meant by the term strong acid?
		[1]
	(ii)	Describe how you could measure the pH of dilute sulfuric acid.
		[1]
(b)	Maı	ny plants cannot grow in soils which are too acidic.
	Des	scribe and explain how soils which are too acidic can be treated to reduce the acidity.
		[2]
(0)	The	graph shows the affect of sail pH on the rate of untake of notaceium ions by plant roots

(c) The graph shows the effect of soil pH on the rate of uptake of potassium ions by plant roots.



Describe how the rate of uptake of potassium ions varies with soil pH.	
	[1]
	[Total: 5

The	table shows	some informa	tion about differe	nt alcohols.	
	alcohol	formula	melting point /°C	boiling point /°C	density in g/cm <sup>3</sup>
	ethanol	C <sub>2</sub> H <sub>5</sub> OH	-117	79	0.789
	propanol	C <sub>3</sub> H <sub>7</sub> OH	-126	98	0.804
	butanol	C <sub>4</sub> H <sub>9</sub> OH	-89	117	
	pentanol	C <sub>5</sub> H <sub>11</sub> OH	-79	138	0.815
	hexanol	C <sub>6</sub> H <sub>13</sub> OH	-47	158	0.820
(iii)	What is the answer.	physical state		oom temperature	
(iii)		physical state	of pentanol at ro		and pressure?
Hov	answer.	ity change in t	of pentanol at ro	oom temperature	and pressure?
Hov Exp	answer. v does viscos	ity change in t	of pentanol at ro	series of alcohols	and pressure?
Hov Exp	answer. v does viscos	ity change in t	of pentanol at ro	series of alcohols	and pressure?
Hov Exp  Cor	answer.  v does viscos  lain your ans	ity change in t	of pentanol at ro	series of alcohols	and pressure?

(ii) Draw the structure of propanoic acid, showing all the atoms and all the bonds.

[1]

[Total: 11]

**A4** Peroxodisulfate ions,  $S_2O_8^{\ 2-}$ , react with iodide ions in aqueous solution.

$$\mathrm{S_2O_8}^{2-}\mathrm{(aq)} \ + \ 2\mathrm{I^-(aq)} \ \longrightarrow \ 2\mathrm{SO_4}^{2-}\mathrm{(aq)} \ + \ \mathrm{I_2(aq)}$$

The table shows how the relative rate of this reaction changes when different concentrations of peroxodisulfate ions and iodide ions are used.

experiment	concentration of S <sub>2</sub> O <sub>8</sub> <sup>2-</sup> in mol/dm <sup>3</sup>	concentration of I <sup>-</sup> in mol/dm <sup>3</sup>	relative rate of reaction
1	0.008	0.02	1.7
2	0.016	0.02	3.3
3	0.032	0.02	6.8
4	0.008	0.04	3.4
5	0.008	0.08	6.9

(a)		the information in the table to describe how increasing the concentration of each of the affects the relative rate of reaction.	∍se
	perc	oxodisulfate ions	
	iodio	de ions	
			 [2]
(b)	Iron	(III) ions, Fe <sup>3+</sup> , catalyse this reaction.	
	Ехр	lain how catalysts increase the rate of a reaction.	
			.[1]
(c)	Iron	(III) ions react with iodide ions.	
		$2I^{-}(aq) + 2Fe^{3+}(aq) \rightarrow I_{2}(aq) + 2Fe^{2+}(aq)$	
	(i)	Explain how iron(III) ions are acting as an oxidising agent in this reaction.	
			.[1]
	(ii)	What colour change is observed when this reaction happens?	

	(iii)	Describe a test for iron(III) ions.
		test
		observation
		[2]
(d)	Iron	(II) ions react with peroxodisulfate ions. The products are iron(III) ions and sulfate ions.
	Cor	struct the equation for this reaction.
		[1]
		[Total: 8]

		8	
<b>A5</b>	Pota	assium chlorate, $KClO_3$ , decomposes to form potassium chloride and oxygen.	
		$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$	
	(a)	Calculate the percentage by mass of oxygen in potassium chlorate.	
			[2]
	(b)	Calculate the maximum volume of oxygen formed at room temperature and pressure with 12.25 g of potassium chlorate is completely decomposed.	her
			[3]
	(-)	Detections ablevide can be made by vegeting notesting with ableving	

**(c)** Potassium chloride can be made by reacting potassium with chlorine.

Explain in terms of gain and loss of electrons, how potassium ions and chloride ions are formed when potassium reacts with chlorine.
ro.
[3]
Predict <b>two</b> physical properties of potassium chloride.

[Total: 10]

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(ii)

<b>A6</b>	Dry	air c	contains nitrogen, oxygen, argon and other gases.	
	(a)	Sta	te the percentage compositions by volume of nitrogen and oxygen present in dry air.	
		nitro	ogen%	
		оху	gen%	[1]
	(b)	The	e formula for oxygen gas is O <sub>2</sub> .	
		(i)	Draw a 'dot-and-cross' diagram of an oxygen molecule.	
			Show only the outer shell electrons.	
				[1]
		(ii)	What is the formula of argon gas?	
				.[1].
	(c)		nium is extracted from titanium( ${ m IV}$ ) chloride by reduction with molten sodium in an argosphere and not in air.	gon
		Sug	ggest why this reaction is carried out in an argon atmosphere and not in air.	
				.[2]
	(d)	Sta	te one other use of argon.	
				[1].
			[Tota	l: 6]

### **Section B**

Answer three questions from this section in the spaces provided.

The total mark for this section is 30.

**B7** Ethenyl ethanoate, CH<sub>3</sub>CO<sub>2</sub>CH=CH<sub>2</sub>, is manufactured by passing a mixture of ethanoic acid, ethene and oxygen over a catalyst at 200 °C.

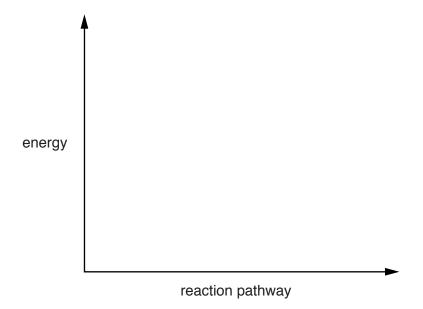
$$CH_3CO_2H + CH_2=CH_2 + \frac{1}{2}O_2 \rightarrow CH_3CO_2CH=CH_2 + H_2O_2$$

The reaction is exothermic.

(a) Draw an energy profile diagram for this reaction on the axes shown.

On your diagram label

- the reactants and products,
- the enthalpy change for the reaction,
- the activation energy.



[3]

[2]

(b) Ethenyl ethanoate is an unsaturated compound.

Describe a chemical test for an unsaturated compound.

test .....

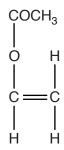
observation .....

(c) The catalyst used in the manufacture of ethenyl ethanoate contains copper.

Copper reacts with concentrated nitric acid.

Complete the equation for this reaction.

(d) The structure of ethenyl ethanoate is shown.



Draw the structure of the addition polymer formed from ethenyl ethanoate.

[2]

[Total: 10]

**B8** Ethanol can be manufactured by reacting ethene with steam in a closed reaction vessel.

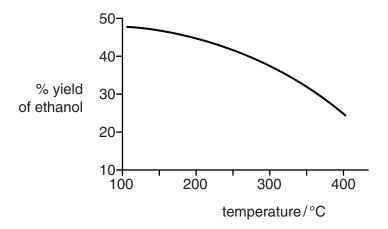
$$\mathsf{C_2H_4(g)} \ + \ \mathsf{H_2O(g)} \ \Longleftrightarrow \ \mathsf{C_2H_5OH(g)}$$

The reaction is exothermic.

(a) State two conditions for this reaction.

	[2]

(b) The graph shows the percentage yield of ethanol at different temperatures.



(1)	Describe now, and explain why, the percentage yield changes with temperature.
	[3
(ii)	Suggest why the reaction is carried out at 300 °C and not at 200 °C.
	[2]
	scribe how, and explain why, the position of equilibrium changes when the pressure is eased.
	[O

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(c)

(d)	Ethanol reacts with methanoic acid, HCO <sub>2</sub> H, to form ethyl methanoate and water.
	Construct the equation for this reaction.
	[1]
	[Total: 10]

В9	Tin	and silver are metals.	
	(a)	State <b>two</b> properties which are characteristic of most metals.	
			[2]
	(b)	Draw a labelled diagram to show how a tin rod can be electroplated with silver.	
			[3]
	(c)	A 9.50 g sample of a chloride of tin contains 5.95 g of tin.	
	(-)	Deduce the empirical formula of this chloride of tin.	
		beduce the empirical formula of this emonds of thi.	
		empirical formula	[2]

When a sample of 13.5g of  $tin({\rm II})$  oxide is reacted with oxygen, 12.7g of  $tin({\rm IV})$  oxide is formed.

Calculate the percentage yield of tin(IV) oxide.

 	%	[3]

[Total: 10]

B10 A student pr	epared some cry	stals of hydrat	ed lithium ni	itrate by reacti	ng aqueous	lithium hydr	oxide
with dilute ni	itric acid.						

$${\rm LiOH} \ + \ {\rm HNO_3} \ + \ 2{\rm H_2O} \ \rightarrow \ {\rm LiNO_3.3H_2O}$$

(a)	Explain how you would carry out this procedure to obtain pure dry crystals of hydrated lithinitrate.	um
		.[4]
(b)	The student used 20.0 cm <sup>3</sup> of 0.500 mol/dm <sup>3</sup> of lithium hydroxide to prepare the crystals.	
	Calculate the maximum mass of hydrated lithium nitrate crystals that could be made.	
	g	[3]
(c)	A sample of hydrated lithium nitrate is heated in a test-tube.	
	$2LiNO_3.3H_2O(s) \ \ \boldsymbol{\longrightarrow} \ \ Li_2O(s) \ \ + \ \ 2NO_2(g) \ + \ \ 4NO_2(g) \ + \ \ 6H_2O(l)$	
	What is observed during this reaction?	
		.[1]
(d)	Explain why lithium oxide conducts electricity when molten.	
		.[1]

(e)	Predict the products of electrolysis of molten lithium oxide at
	the anode (positive electrode),
	the cathode (negative electrode).
	[1]
	[Total: 10]

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The Periodic Table of Elements

	=	ه ۲ ۲	helium 4	10	Ne	neon 20	18	Ā	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>n</u>	tellurium 128	84	Ро	polonium –	116	_	livermorium -
	>			7	Z	nitrogen 14	15	₾	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	Sn	tin 119	82	Ър	lead 207	114	ŀΙ	flerovium -
	=			2	В	boron 11	13	Αl	aluminium 27	31	Ga	gallium 70	49	In	indium 115	81	11	thallium 204			
										30	Zu	zinc 65	48	р	cadmium 112	80	Нĝ	mercury 201	112	C	copernicium _
										29	Cn	copper 64	47	Ag	silver 108	62	Αn	gold 197	111	Rg	roentgenium -
Group										28	Ż	nickel 59	46	Pq	palladium 106	78	귙	platinum 195	110	Ds	darmstadtium -
Ğ										27	ပိ	cobalt 59	45	R	rhodium 103	77	'n	iridium 192	109	¥	meitnerium -
		- I	hydrogen 1							26	Fe	iron 56	44	Ru	ruthenium 101	92	SO	osmium 190	108	Hs	hassium
										25	Mn	manganese 55	43				Re	rhenium 186	107	B	bohrium —
				L	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	14	qN	niobium 93	73	Та	tantalum 181	105	В	dubnium -
					atc	rel				22	j	titanium 48	40	Zr	zirconium 91	72	Έ	hafnium 178	104	짶	rutherfordium -
										21	လွ	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	26	Ba	barium 137	88	Ra	radium –
	_			8	=	lithium 7	1	Na	sodium 23	19	×	potassium 39	37	S S	rubidium 85	22	Cs	caesium 133	87	ដ	francium -

rı Lu	lutetium 175	103	۲	lawrencium	ı
Vb	ytterbium 173	102	N <sub>o</sub>	nobelium	ı
mT	thulium 169	101	Md	mendelevium	ı
68 Er	erbium 167	100	Fm	fermium	ı
67 H0	holmium 165	66	Es	einsteinium	ı
°° 2	dysprosium 163	86	ర్	californium	ı
65 <b>Tb</b>	terbium 159	97	BK	berkelium	ı
Gd	gadolinium 157	96	Cm	curium	ı
ез Eu	europium 152	92	Am	americium	ı
62 Sm	samarium 150	94	Pu	plutonium	ı
61 Pm	promethium -	93	Np	neptunium	ı
<b>PN</b>	neodymium 144	92	$\supset$	uranium	238
59 Pr	praseodymium 141	91	Ра	protactinium	231
58 Ce	cerium 140	06	T	thorium	232
57 <b>La</b>	lanthanum 139	88	Ac	actinium	1

lanthanoids

actinoids

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