

Cambridge International Examinations

Cambridge Ordinary Level

CANDIDATE NAME					
CENTRE NUMBER			CANDIDATE NUMBER		

CHEMISTRY 5070/22

Paper 2 Theory

May/June 2015

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 opposite.

A

E

C

D

F

F

G

Н

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

(a) Give the letter of the compound which

	(i)	is a CFC,	
			[1]
((ii)	is propanoic acid,	
			[1]
(i	iii)	is propyl ethanoate,	
			[1]
(i	iv)	can be oxidised to ethanoic acid.	
			[1]
(b)	Give	e the letters of two compounds that react together to make an ester.	
		and and	[1]
		[To	otal: 5

A2	Hyc	droge	n reacts with halogens to form hydrogen halides.						
	(a)	a) Predict which halogen reacts most violently with hydrogen.							
	(b)	The reaction between hydrogen and chlorine is exothermic.							
			$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ $\Delta H = -185 \text{ kJ/mol}$						
		(i)	Explain, in terms of bond breaking and bond forming, why this reaction is exothermic.						
			[2]						
		(ii)	When one mole of chlorine molecules reacts, 185 kJ of energy is released.						
			Calculate the amount of energy released when 106.5 g of chlorine reacts.						
			energy released = kJ [2]						
	(c)								
	,	This reaction reaches an equilibrium if carried out in a closed system.							
			$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $\Delta H = +53 \text{ kJ/mol}$						
		(i)	The reaction is studied at a temperature of 400 °C.						
			Describe and explain what happens to the position of equilibrium if the pressure is increased.						
			[2]						

	(ii)	The reaction is studied at 25 atmospheres pressure.
		Describe and explain what happens to the position of equilibrium if the temperature is decreased.
		[2]
(d)	Hyd	rogen iodide dissolves in water to form hydroiodic acid, HI(aq).
	Hyd	roiodic acid is a strong acid.
	(i)	Write an equation to show the dissociation of hydroiodic acid.
		[1]
	(ii)	Hydroiodic acid reacts with calcium.
		Write the equation for this reaction.
		[1]
	(iii)	Hydroiodic acid reacts with sodium carbonate.
		Write the ionic equation for this reaction.
		[1]
		[Total: 12]

А3	Two	isotopes of pl	nosphorus are $^{31}_{15}$ P and $^{32}_{15}$ P.		
	(a)	State one diff	erence and one similarity betw	een these two isotopes.	
		difference			
		similarity			
					[2]
	(b)	Phosphorus f	orms simple molecules which	have a relative molecular n	nass of 124.
		Suggest the f	ormula of a phosphorus molec	eule.	
					[1]
	(c)	Phosphorus h	nas a low melting point and do	es not conduct electricity.	
		(i) Explain v	why phosphorus has a low mel	ting point.	
					[1]
		(ii) Explain v	why phosphorus does not cond	luct electricity.	
					[1]
	(d)	Complete the	table for $^{31}_{15}$ P $^{3-}$.		
			number of neutrons		
			number of protons		

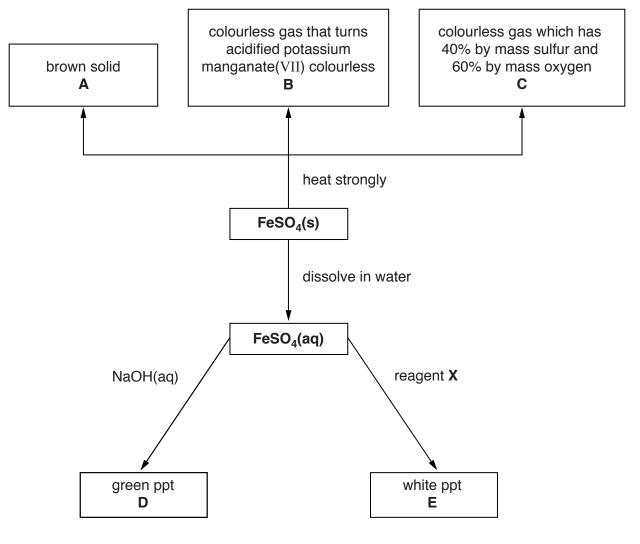
[3]

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electronic configuration

(e)	Phosphorus forms a compound called phosphine, PH ₃ .
	Draw the 'dot-and-cross' diagram to show the bonding in a molecule of phosphine.
	Only draw the outer shell electrons.
	[2
(f)	Phosphine ignites in air to make water and phosphorus(V) oxide.
	Construct the equation for this reaction.
	[2
	[Total: 12

A4 The flow chart shows some reactions of iron(II) sulfate, FeSO₄.



- (a) Iron(II) sulfate is heated strongly.
 - (i) Write the formula of gas **B**.

.....[1]

(ii) Calculate the empirical formula of gas ${\bf C}.$

Name gas C.

empirical formula is

name[3]

and one mole of gas **C**.

(iii) Two moles of iron(II) sulfate decompose to form one mole of solid A, one mole of gas B

	Deduce the formula of solid A.
	formula of A [1]
(b)	Write an ionic equation, including state symbols, for the formation of the green precipitate ${\bf D}$.
	[2]
(c)	Suggest the name of reagent X and give the formula for the white precipitate E .
	name of reagent X
	formula of precipitate E [2]
	[Total: 9]

A 5	Ele	ctrolysis is often used in the extraction and purification of elements.
	(a)	Magnesium is manufactured by the electrolysis of molten magnesium chloride.
		Write equations for the two electrode reactions that occur during this electrolysis.
		[2]
	(b)	Copper can be purified using the electrolysis of aqueous copper(II) sulfate.
		(i) What is used as the anode (positive electrode)?
		[1]
		(ii) What is used as the cathode (negative electrode)?
		[1]
	(c)	Chlorine can be made by the electrolysis of concentrated aqueous sodium chloride.
		The overall process can be represented by the following equation.
		$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
		55 dm ³ of 3.5 mol/dm ³ aqueous sodium chloride is electrolysed.
		What is the maximum volume of chlorine that can be formed, measured at room temperature and pressure?
		volume of chlorine = dm ³ [3]
		[Total: 7]

Question B6 begins on page 12.

Section B

Answer three questions from this section in the spaces provided.

The total mark for this section is 30.

B6 Ammonium carbonate, $(NH_4)_2CO_3$, is a white solid that is a component of 'smelling salts'. It decomposes when it is heated.

$$(NH_4)_2CO_3(s) \rightarrow 2NH_3(g) + H_2O(g) + CO_2(g)$$

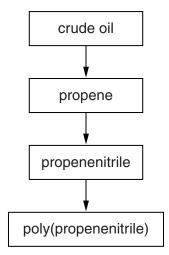
(a)	A sample of ammonium carbonate is heated strongly until it all decomposes.
	Suggest what you would observe during the experiment.
	[1
(b)	Describe how you would show that both ammonia and carbon dioxide are formed in this decomposition.
	ΓΑ

(c)	Ammonium carbonate is soluble in water but zinc carbonate is insoluble in water.
	Describe how you would prepare a sample of pure, dry zinc carbonate using a solution of ammonium carbonate.
	[3]
(d)	Excess ammonium carbonate reacts with phosphoric acid, H ₃ PO ₄ .
	Construct an equation for this reaction.
	[2]
	[Total: 10]

В7	Tita	nium can be manufactured by heating titanium(IV) chloride, ${ m TiC}\it{l}_{ m 4}$, with magnesium.
	(a)	Construct the equation for this reaction.
		[1]
	(b)	Explain why this reaction involves both oxidation and reduction.
		[2]
	(c)	What mass of titanium can be made from 125 g of titanium(IV) chloride?
		mass of titanium = g [3]
	(d)	Which metal is the less reactive, magnesium or titanium?
		Explain your answer.

(e)	Titanium(IV) chloride is a liquid with a low boiling point of 126°C.
	Suggest the structure and bonding of titanium(IV) chloride.
	[2]
(f)	Explain how titanium metal conducts electricity.
	[1]
	[Total: 10]

B8 The flow chart shows the steps involved in the manufacture of poly(propenenitrile).



(a)	Long chain alkanes such as $\mathrm{C_{17}H_{36}}$ can be cracked to form propene, $\mathrm{C_3H_6}$.
	Construct an equation to show the cracking of C ₁₇ H ₃₆ to form propene.
	[1
(b)	The equation shows the reaction to make propenenitrile.
	$2C_3H_6(g) + 2NH_3(g) + 3O_2(g) \rightarrow 2C_3H_3N(g) + 6H_2O(g)$
	Describe and explain what happens to the rate of this reaction if the temperature is increased

4		The structure	Ωf	nronono	nitrilo	ic	chown
1	G) The Situdiate	ΟI	properie	HILLINE	15	SHOWIL

$$\begin{array}{ccc}
H & H \\
C = C \\

\nearrow & C \equiv N
\end{array}$$

		H C≡N	
	(i)	Explain why propenenitrile is unsaturated.	
	(ii)	Describe a chemical test to show that propenenitrile is unsaturated.	
(d)	Dra	w part of the structure of poly(propenenitrile).	[∠]
			[2]
(e)	A fa	ctory uses 1750 tonnes of propenenitrile to produce poly(propenenitrile).	
	The	percentage yield is 95%.	
	Cald	culate the mass of poly(propenenitrile) produced.	

[Total: 10]

B9 Alkenes are a homologous series of unsaturated hydrocarbons.

The table shows information about some alkenes.

alkene	molecular formula	melting point /°C	boiling point /°C
ethene	C ₂ H ₄	-169	-105
butene	C ₄ H ₈	-185	-6
hexene	C ₆ H ₁₂	-140	63
decene	C ₁₀ H ₂₀	-66	171
dodecene	C ₁₂ H ₂₄	-35	214

(a)	Decene is a liquid at 25 °C.
	How can you make this deduction from the data in the table?
	[2]
(b)	Butene boils at -6°C.
	Use the kinetic particle theory to explain what happens when butene boils.
	[2]
(c)	A sample of ethene gas in a gas syringe is heated from 20 °C to 100 °C.
	The pressure remains constant.
	Describe and explain, in terms of the kinetic particle theory, what happens to the volume of the gas.
	[2]
(d)	At room temperature ethene diffuses faster than butene.
	Explain why.
	[1]

(e) Draw the structure, showing all the atoms and all the bonds, for two isomers with the molecular formula C₄H₈.

[2]

(f) The structure of hexene is shown.

Draw the structure, showing all the atoms and all the bonds, for the product of the reaction of hexene with steam.

[1]

[Total: 10]

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The Periodic Table of the Elements **DATA SHEET**

						=	he Perio	dic Tabl	he Periodic Table of the Elements	Element	S						
								Gro	Group								
_	=											≡	2	>		IIA	0
							-]										4
							Hydrogen										Helium 2
7	6											=	12	14	16	19	20
=	Be											Δ		z	0	ш	Ne
Lithium 3	Beryllium 4											Boron 5	Carbon 6	Nitrogen 7	Oxygen 8	Fluorine 9	Neon 10
23	24											27	28	31	32	35.5	40
Na	Mg											ΝI	Si	_		C1	Αr
Sodium 11	Magnesium 12											Aluminium 13	Silicon 14	Phosphorus 15	Sulfur 16	Chlorine 17	Argon
39	40	45	48	51	52	55	56	59	59	64		20	73		62	80	84
Y	Ca	Sc	F	>	ဝံ	Mn	Pe	රි	Z	Cn	Zu						ž
Potassium 19	Calcium 20	Scandium 21	Titanium 22	Vanadium 23	Chromium 24	Manganese 25	Iron 26	Cobalt 27	Nickel 28	Copper 29	Zinc 30	Gallium 31	Germanium 32	Arsenic 33	Selenium 34	Bromine 35	Krypton 36
82	88	88	91	93	96		101	103	106	108	112	115		122	128		131
Bb	S	>	Zr	qN	Mo	ဥ		몺	Pd	Ag		Ľ					Xe
Rubidium 37	Strontium 38	Yttrium 39	Zirconium 40	Niobium 41	Molybdenum 42	Technetium 43	Ruthenium 44	Rhodium 45	Palladium 46		Cadmium 48	Indium 49	Tin 50	Antimony 51	Tellurium 52	lodine 53	Xenon 54
133	137	139	178	181	184	186	190	192	195	197		204		209			222
S	Ba	Га	Ξ	ā	>	Be	SO.	Ä	풉	Αn		11	Pb			Αt	R
Caesium 55	Barium 56	Lanthanum 57	Hafnium 72	Tantalum 73	Tungsten 74	Rhenium 75	Osmium 76	Iridium 77	Platinum 78	Gold 79	Mercury 80	Thallium 81	82	Bismuth 83	Polonium 84	Astatine 85	Radon 86
223	226	227															
Ľ,	Ва	Ac															
Francium 87	Hadium 88	Actinium 89 †															
* 58-71	anthan	* 58-71 Lanthanoid series		140	141	144	147	150	152	157	159	162	165		169	173	175
+ 90-10	+ 90-103 Actinoid series	id series		ဝီ	፵	PZ	Pm	Sm	Ш	В	P	۵	운	ш	E	Υp	Ľ
: [} -)		Cerium 58	Praseodymium 59	Neodymium 60	Promethium 61	Samarium 62	Europium 63	Gadolinium 64	Terbium 65	Dysprosium 66	Holmium 67		Thulium 69	Ytterbium 70	Lutetium 71
-	_																

The volume of one mole of any gas is 24dm3 at room temperature and pressure (r.t.p.).

260 Lr Lawrencium 103

S59 Nobelium

258 **Md**

257 **Fm** Fermium 100

252 **Es** Einsteinium 99

251 Californium 98

247 **BK**Berkelium

Curium

Am Americium

Pu Plutonium 94

Neptunium

238

231 **Pa**

232 **7** Thorium

8

b = atomic (proton) number

a = relative atomic mass X = atomic symbol

Key

Mendelevium 101