Please check the examination details be	ow before ente	ering your candidate information				
Candidate surname	Other names					
Centre Number Candidate N	umber					
Pearson Edexcel International GCSE (9-1)						
Time 1 hour 15 minutes	Paper reference	4CH1/2C				
Chemistry		◆				
UNIT: 4CH1						
PAPER: 2C						
		J				
(Vou rough bases						
You must have: Calculator, ruler		Total Marks				
Calculator, ruler						

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
 - there may be more space than you need.
- Show all the steps in any calculations and state the units.

Information

- The total mark for this paper is 70.
- The marks for **each** question are shown in brackets
 - use this as a guide as to how much time to spend on each question.

Advice

- Read each question carefully before you start to answer it.
- Write your answers neatly and in good English.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶





The Periodic Table of the Elements

0	4 He helium 2	20 Ne neon 10	40 Ar argon 18	84 Kr krypton 36	131 Xe xenon 54	[222] Rn radon 86	fully
7		19 F fluorine 9	35.5 CI chlorine 17	80 Br bromine 35	127 	[210] At astatine 85	orted but not
9		16 O oxygen 8	32 S sulfur 16	79 Se selenium 34	128 Te tellurium 52	[209] Po polonium 84	ve been repo
2		14 N nitrogen 7	31 P phosphorus 15	75 As arsenic 33	122 Sb antimony 51	209 Bi bismuth 83	s 112–116 har authenticated
4		12 C carbon 6	28 Si silicon 14	73 Ge germanium 32	119 Sn tin 50	207 Pb	Elements with atomic numbers 112–116 have been reported but not fully authenticated
က		11 boron 5	27 AI aluminium 13	70 Ga gallium 31	115 In indium 49	204 T thallium 81	ents with ato
	'			65 Zn zinc 30	112 Cd cadmium 48	201 Hg mercury 80	Elem
				63.5 Cu copper 29	108 Ag silver 47	197 Au gold 79	Rg roentgenium
				59 Nickel 28	106 Pd palladium 46	195 Pt platinum 78	Ds darmstadtum 110
				59 Co cobalt 27	103 Rh rhodium 45	192 Ir iridium 77	[268] Mt meitnerium 109
	1 H hydrogen 1			56 Fe iron 26	Ru ruthenium 44	190 Os osmium 76	[277] Hs hassium 108
'				55 Mn manganese 25	[98] Tc technetium 43	186 Re rhenium 75	[264] Bh bohrium 107
		nass ool umber		52 Cr chromium 24	96 Mo molybdenum 42	184 W tungsten 74	[266] Sg seaborgium 106
	Key	relative atomic mass atomic symbol name atomic (proton) number		51 V vanadium 23	93 Nb niobium 41	181 Ta tantalum 73	[262] Db dubnium 105
		relativ ato atomic		48 Ti titanium 22	91 Zr zirconium 40	178 Hf hafinium 72	[261] Rf rutherfordium 104
	·			45 Sc scandium 21	89 Y yttrium 39	139 La* lanthanum 57	[227] Ac* actinium 89
2		9 Be beryllium 4	24 Mg magnesium 12	40 Ca calcium 20	88 Sr strontium 38	137 Ba barium 56	[226] Ra radium 88
~		7 Li lithium 3	23 Na sodium 11	39 K potassium 19	85 Rb rubidium 37	133 Cs caesium 55	[223] Fr francium 87

^{*} The lanthanoids (atomic numbers 58–71) and the actinoids (atomic numbers 90–103) have been omitted.

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Answer ALL questions.

Some questions must be answered with a cross in a box \boxtimes . If you change your mind about an answer, put a line through the box \boxtimes and then mark your new answer with a cross \boxtimes .

1 This question is about gases in the atmosphere.

The box gives the names of some gases.

argon carbon dioxide hydrogen nitrogen oxygen water vapour

- (a) Choose gases from the box to answer these questions.
 - (i) Identify the least reactive gas in the atmosphere.

(1)

(ii) Identify the most abundant gas in the atmosphere.

(1)

(iii) Identify the gas that is not normally found in the atmosphere.

(1)

(b) State an environmental problem caused by increasing amounts of carbon dioxide in the atmosphere.

(1)

(c) Describe a test for carbon dioxide.

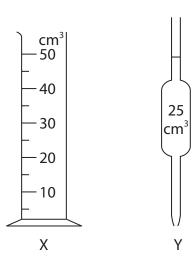
(2)

(Total for Question 1 = 6 marks)

2C-JU-22



2 (a) The diagram shows two pieces of apparatus, X and Y.



(i) Give the name of each piece of apparatus.

(2)

Υ

(ii) In a titration, a student adds 25.0 cm³ of barium hydroxide solution to a conical flask.

Give a reason why it is better to use Y rather than X.

(1)

- (b) The student uses methyl orange indicator in the titration.
 - (i) State the colour of methyl orange in barium hydroxide solution.

(1)

(ii) Give a reason why universal indicator is **not** suitable for use in a titration.

(c) The student adds some dilute nitric acid to a burette and does the titration.

The equation for the reaction is

$$Ba(OH)_2 + 2HNO_3 \rightarrow Ba(NO_3)_2 + 2H_2O$$

The student finds that 21.50 cm³ of nitric acid of concentration 0.600 mol/dm³ neutralises 25.0 cm³ of barium hydroxide solution.

Calculate the concentration, in mol/dm³, of the barium hydroxide solution.

(3)

(d) State why sulfuric acid would not be a suitable acid to use in this titration.

(1)

(Total for Question 2 = 9 marks)





3	This que	stion	is about G	roup 7, the halog	ens.		
	(a) Whic	h hal	ogen has t	he palest colour?			(1)
	X	A	astatine				(1)
	×	В	bromine				
	×	C	fluorine				
	\boxtimes	D	iodine				
	(b) Whic	h hal	ogen is a s	olid at room temp	oerature?		(1)
	\boxtimes	A	astatine				(-/
	\boxtimes	В	bromine				
	\boxtimes	C	chlorine				
	\boxtimes	D	fluorine				
	chlor			ciccuomic comig	urations of a fluorine atom an Electronic configuration		
				fluorine	2.7		
				chlorine	2.8.7		
	Expla	in th	e relative r	eactivities of fluo	rine and chlorine using the in	formation in	
	the ta				, and the second		(4)
•••••							

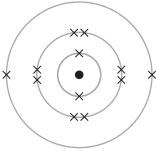
(d) Lithium reacts with chlorine to form lithium chloride.(i) Write a chemical equation for the reaction of lithium with chlorine.	(1)
(ii) Describe tests to show that the product of the reaction is lithium chloride.	(5)
(Total for Question 3 = 12 m	narks)

- **4** This question is about magnesium and magnesium compounds.
 - (a) Magnesium burns in oxygen to form magnesium oxide.

State two observations that would be seen during the reaction.

(2)

(b) The diagram shows the electron configurations of a magnesium atom and an oxygen atom.



magnesium atom

oxygen atom

Describe the changes in the electronic configurations when magnesium reacts with oxygen to form the ionic compound magnesium oxide, MgO

(2)

- (c) Magnesium can be produced by the electrolysis of molten magnesium chloride.
 - (i) State why magnesium cannot be produced by heating magnesium oxide with carbon.





(ii) Explain the different ways that magnesium and magnesium chloride conduct electricity.

(4)

magnesium

magnesium chloride

(d) During the electrolysis of molten magnesium chloride, magnesium is formed at the negative electrode.

The ionic half-equation for the reaction is

$$Mg^{2+} + 2e^{-} \rightarrow Mg$$

(i) State why this is a reduction reaction.

(1)

(ii) Write an ionic half-equation for the formation of chlorine at the positive electrode.

(1)

(Total for Question 4 = 11 marks)

5 (a) An organic compound has this percentage composition by mass.

$$C = 40\%$$
 $H = 6.7\%$ $O = 53.3\%$

(i) Show that the empirical formula of the compound is CH₂O

(2)

(ii) Draw the structural formula of a compound with the molecular formula $\mathsf{C_2H_4O_2}$

- (b) Methanoic acid (HCOOH) reacts with sodium carbonate solution to give three products.
 - (i) Complete the equation for this reaction.

(2)

2HCOOH + $Na_2CO_3 \rightarrow \dots + \dots + \dots + \dots + \dots$

(ii) State what you would observe in this reaction.

(1)

(c) Methanoic acid also reacts with propanol to form an ester.

The equation for the reaction is

$$HCOOH + C_3H_7OH \rightleftharpoons HCOOC_3H_7 + H_2O$$

(i) Give the name of the ester that forms.

(1)

(ii) State what is meant by the \rightleftharpoons symbol.

(1)

(iii) When this reaction occurs in a sealed container, the reaction can reach dynamic equilibrium.

Give one characteristic of a reaction at dynamic equilibrium.



(d) A polyester forms when butanedioic acid reacts with ethanediol.

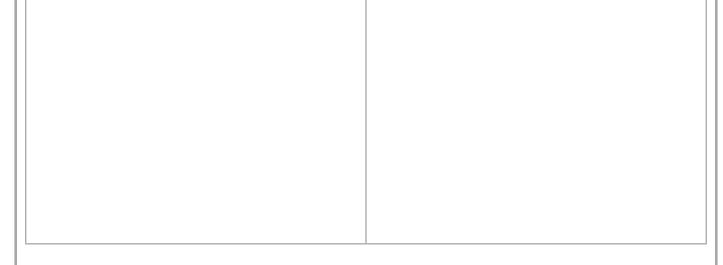
The diagram shows the repeat unit of the polyester that forms.

(i) Give the name of this type of polymerisation.

(1)

(ii) Draw the structural formulae of the two monomers used to make this polyester.

(2)



(Total for Question 5 = 12 marks)



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Titanium is an important metal in industry.

Titanium dioxide (TiO₂) can be converted into titanium metal in two stages.

- titanium dioxide is converted into titanium(IV) chloride (TiCl₄) Stage 1
- Stage 2 titanium(IV) chloride is converted into titanium
- (a) This is the equation for the reaction in stage 1.

$$TiO_2 + 2Cl_2 + C \rightarrow TiCl_4 + CO_2$$

Calculate the volume, in dm³, of chlorine gas at rtp needed to react completely with 20 tonnes of titanium dioxide.

Give your answer in standard form.

[1 tonne =
$$10^6$$
 g M_r of $TiO_2 = 80$]

[molar volume of chlorine gas at rtp = $24 \,\text{dm}^3$]

(4)

.....dm³ volume of chlorine gas =



(b) In stage 2, titanium(IV) chloride vapour is passed through molten magnesium in a container filled with argon.

This is the equation for the reaction in stage 2.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

Explain why the container is filled with argon rather than air.

(2)

(c) Aeroplanes are made of an alloy containing aluminium and titanium.

Explain why the alloy is stronger than pure titanium metal.

You may include diagrams in your answer.

(3)

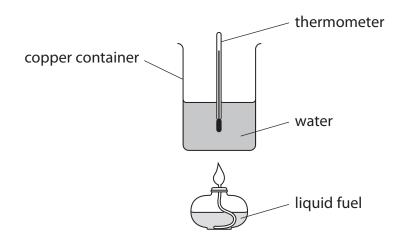
(Total for Question 6 = 9 marks)



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7 A student uses this apparatus to find the heat energy supplied by a liquid fuel.



The student burns some fuel to heat the water in the copper container and measures the change in temperature.

(a) The student notices that the bottom of the container turns black.

Give the name of the black substance that forms on the bottom of the container.

(1)

(b) In one experiment, the student burns 0.92 g of ethanol.

The student calculates that the heat energy absorbed by the water is 18.2 kJ.

Show that the results of this experiment give an approximate value for the enthalpy of combustion of ethanol of $\Delta H = -900 \, \text{kJ/mol}$.

 $[M_r \text{ of ethanol} = 46]$

(2)

(c) The data book value of ΔH for the combustion of ethanol is -1367 kJ/mol.

Give two reasons why the student's value is much lower than the data book value.

(2)

1

2

(d) The equation shows the combustion of methane.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$
 $\Delta H = -890 \text{ kJ/mol}$

This is the equation showing the displayed formulae.

The table shows the bond energies for O=O, C=O and O-H

Bond	0=0	c=o	О—Н
Bond energy in kJ/mol	498	805	463

(i) Calculate the bond energy of the C—H bond, using information from the equation and the table.

(4)

(ii) Complete the energy level diagram to show the products and ΔH .

(2)

Energy
$$CH_4 + 2O_2$$

(Total for Question 7 = 11 marks)

TOTAL FOR PAPER = 70 MARKS

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