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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Monday 20 November 2023

Morning (Time: 1 hour 15 minutes)

Paper reference **4CH1/2C**

Chemistry

UNIT: 4CH1
PAPER: 2C

You must have:
Calculator, ruler

Total Marks

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 ▶

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P 7 3 4 2 5 A 0 1 2 4

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The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112–116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** 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.

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Answer ALL questions.

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

1 This question is about Group 7, the halogens.

(a) What is the total number of electrons in one fluorine atom?

(1)

☒ **A** 7

☒ **B** 9

☒ **C** 10

☒ **D** 19

(b) What is the charge on a bromide ion?

(1)

☒ **A** 1–

☒ **B** 1+

☒ **C** 2–

☒ **D** 2+

(c) Which of these describes the element iodine at room temperature?

(1)

☒ **A** brown liquid

☒ **B** brown solid

☒ **C** grey solid

☒ **D** purple gas

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(d) When a halogen is added to a solution containing halide ions, a displacement reaction may occur.

The table shows whether a reaction occurs.

Halogen added	Chloride ion in solution	Bromide ion in solution	Iodide ion in solution
chlorine		reaction	reaction
bromine	no reaction		reaction
iodine	no reaction	no reaction	

Using information from the table, explain the order of reactivity of the three halogens.

(3)

(Total for Question 1 = 6 marks)

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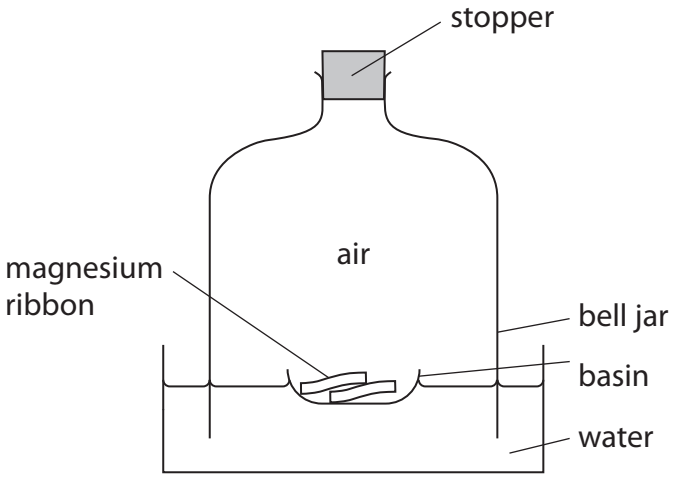
2 This question is about gases in the atmosphere.

A teacher uses this apparatus to determine the percentage of oxygen in air.



The teacher removes the stopper, ignites the magnesium ribbon and immediately replaces the stopper.

The magnesium reacts with oxygen to form magnesium oxide.

During the reaction the water level in the bell jar rises.

When the flame goes out, some magnesium remains in the basin.

(a) (i) Give the appearance of the magnesium oxide.

(1)

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.....

(ii) Give a chemical equation for the reaction of magnesium with oxygen.

(1)

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(iii) Explain why the water in the bell jar rises.

(2)

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(b) The volume of air in the bell jar at the start of the reaction is 2000 cm^3.

When the reaction ends, the apparatus cools down to room temperature.

Calculate the expected volume of gas in the bell jar at room temperature.

(3)

volume of gas = ... cm^3

(c) State why the gas remaining in the bell jar at the end of the reaction is approximately 99% nitrogen.

(1)

.....

.....

(Total for Question 2 = 8 marks)

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3 This question is about aluminium.

(a) State why aluminium cannot be extracted by heating aluminium oxide with carbon.

(1)

.....

.....

(b) Aluminium is a metal with many uses.

Aluminium is malleable, a good conductor of heat and electricity, and has a low density compared to most other metals.

Explain two uses of aluminium that are related to its properties.

(4)

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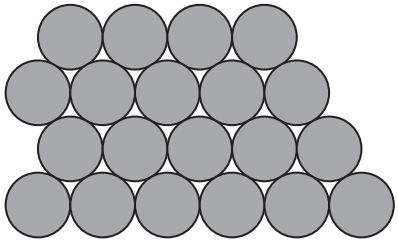
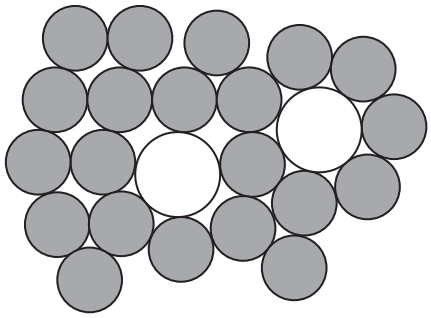
(c) The diagram represents the structure of pure aluminium, and the structure of an alloy of aluminium.



Pure aluminium



Alloy of aluminium

Use the diagram to explain why the alloy is harder than pure aluminium.

(3)

(Total for Question 3 = 8 marks)

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4 A student uses this method to investigate the reaction between sodium hydroxide solution and dilute hydrochloric acid.

- pour 25 cm^3 of dilute hydrochloric acid into a glass beaker
- measure the temperature of the acid
- add 5 cm^3 of sodium hydroxide solution and stir the mixture
- record the highest temperature reached
- continue to add further 5 cm^3 portions of sodium hydroxide solution until a total of 40 cm^3 has been added
- record the temperature after adding each 5 cm^3 portion of sodium hydroxide solution

(a) State two factors that the student must keep constant to make this a valid investigation.

(2)

1 .....

2 .....

(b) Explain how using a polystyrene cup, instead of a glass beaker, would increase the accuracy of the results.

(2)

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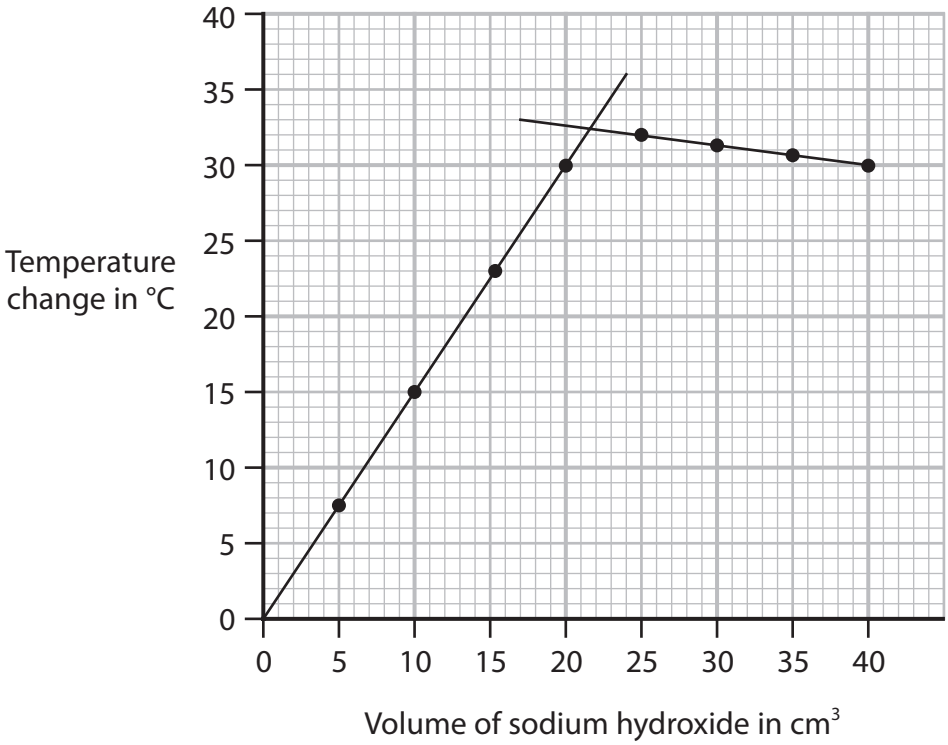
(c) The graph shows the student's results.



(i) Use the graph to determine the maximum temperature change in °C.

(1)

maximum temperature change = ... °C

(ii) Explain the shape of the graph.

(3)

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(d) The student repeats the experiment using a polystyrene cup.

These are the student's results.

Maximum temperature change	35 °C
Volume of hydrochloric acid	25 cm^3
Volume of sodium hydroxide solution added for complete reaction	22 cm^3

Calculate the heat energy change (*Q*) in kJ.

[for the solution, 1.0 cm^3 has a mass of 1.0 g c = 4.2 J / g / °C]

(4)

Q = ... kJ

(Total for Question 4 = 12 marks)

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5 This question is about carboxylic acids and esters.

(a) Ethanoic acid reacts with magnesium to form two products.

(i) Complete the equation for this reaction.

(2)

..... + ... → $(CH_3COO)_2Mg$ + ...

(ii) Give two observations that could be made during this reaction.

(2)

1 .....

2 .....

(b) Propanoic acid reacts with methanol to form an ester.

(i) Give the name of a suitable catalyst for this reaction.

(1)

.....

(ii) What is the structural formula of the ester that forms?

(1)

☒ **A** $HCOOCH_2CH_2CH_3$

☒ **B** $CH_3COOCH_2CH_2CH_3$

☒ **C** $CH_3CH_2COOCH_3$

☒ **D** $CH_3CH_2CH_2COOCH_3$

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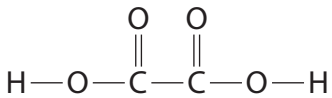
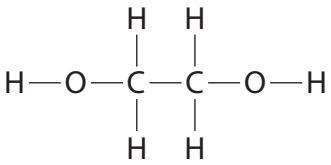
(c) A polyester can be made by reacting ethanedioic acid with ethanediol.

These are the displayed formulae of the two reactants.



ethanedioic acid



ethanediol

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

(1)

.....

(ii) Give the name of the other product of this reaction.

(1)

.....

(iii) Draw the displayed formula for the repeat unit of the polyester that forms.

(2)

(d) State what is meant by the term **biopolyester**.

(1)

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(Total for Question 5 = 11 marks)

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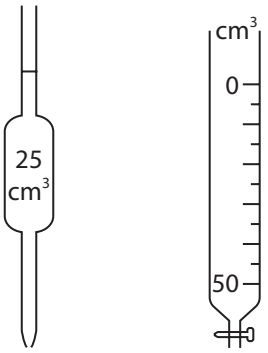
6 (a) The diagram shows two pieces of apparatus used in a titration.



X Y

Not to scale

Give the names of these pieces of apparatus.

(2)

X .....

Y .....

(b) Give the name of a suitable indicator that can be used in an acid-alkali titration.

(1)

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(c) A student does a titration using sodium carbonate solution and dilute nitric acid.

This is the equation for the reaction.

$$Na_2CO_3 + 2HNO_3 \rightarrow 2NaNO_3 + CO_2 + H_2O$$

The table shows the concentrations of the two solutions and the volume of sodium carbonate used in the titration.

Concentration of nitric acid in mol / dm^3	0.350
Concentration of sodium carbonate solution in mol / dm^3	0.220
Volume of sodium carbonate solution in cm^3	25.0

Use the equation and the data in the table to answer these questions.

(i) Calculate the volume of dilute nitric acid that the student would need to neutralise the sodium carbonate solution.

(3)

volume of nitric acid = ... cm^3

(ii) Calculate the volume, in cm^3, of carbon dioxide gas at rtp that would be produced from the 25.0 cm^3 of the sodium carbonate solution.

[at rtp, molar volume = 24 000 cm^3]

(2)

volume of carbon dioxide = ... cm^3

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(d) Describe a test to show that sodium carbonate solution contains carbonate ions.

(3)

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(Total for Question 6 = 11 marks)

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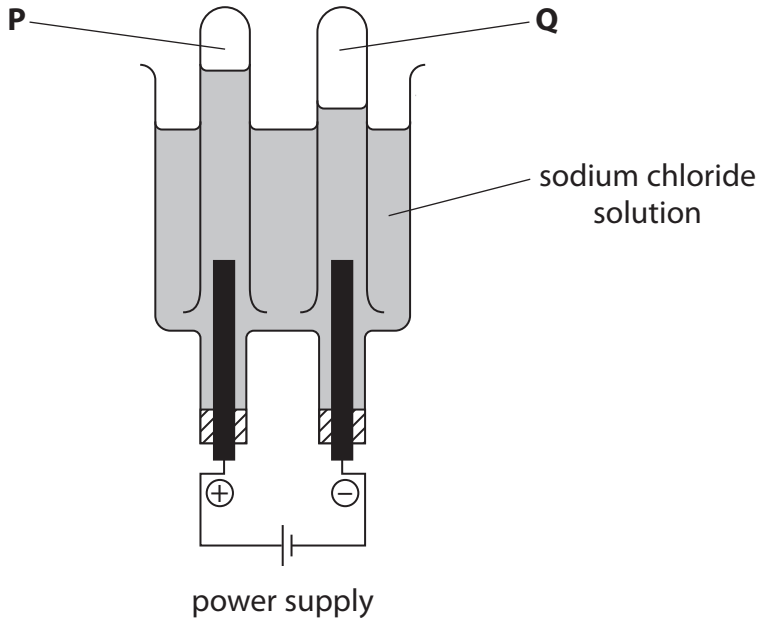
7 (a) Sodium chloride is an ionic compound.

Explain why sodium chloride conducts electricity when it is molten or in solution, but not when it is solid.

(2)

(b) A solution of sodium chloride can be electrolysed using this apparatus.



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(i) If the solution is dilute, a significant amount of oxygen collects at **P**.

Complete the ionic half-equation for this reaction.

(1)

.....H_2O → .....H^+ + ...O_2 + ...e^-

(ii) If the solution is concentrated, chlorine is the main product that collects at **P**.

This is the ionic half-equation for the reaction.

$$2Cl^- \rightarrow Cl_2 + 2e^-$$

State why this is an oxidation reaction.

(1)

.....

.....

(c) The gas that collects at **Q** is hydrogen.

(i) Give a test for hydrogen.

(1)

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.....

(ii) Explain how hydrogen gas forms at the negative electrode.

(3)

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(d) Hydrogen reacts with oxygen to form water.

The equation shows the covalent bonds in the molecules.

$$2H—H + O=O \rightarrow 2H—O—H$$

The table gives the bond energies.

Bond	H—H	O=O	O—H
Bond energy in kJ / mol	436	498	463

(i) Use the equation and the values in the table to calculate the enthalpy change, ΔH, for the reaction.

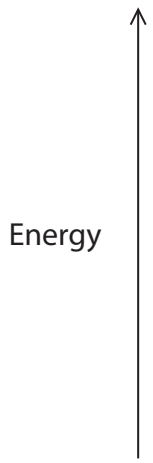
Include a sign in your answer.

(3)

$\Delta H =$ ..... kJ

(ii) Complete the diagram to show the energy levels of the reactants and products, and the enthalpy change, ΔH.

(3)



(Total for Question 7 = 14 marks)

TOTAL FOR PAPER = 70 MARKS

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