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)

Time 1 hour 15 minutes

Paper reference **4CH1/2C**

Chemistry

June 2022

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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Q:1/1/1/

P 7 0 9 4 7 A 0 1 2 0

Pearson

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.

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 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)

.....

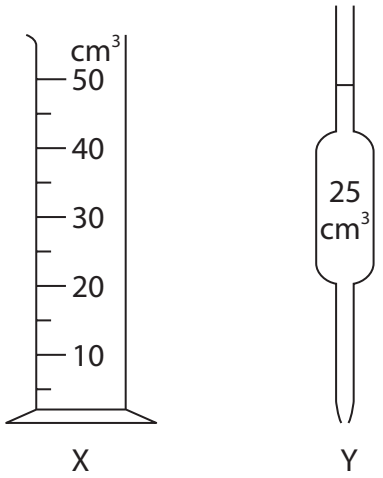
.....

.....

.....

(Total for Question 1 = 6 marks)

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



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

(2)

X .....

Y .....

(ii) In a titration, a student adds 25.0 cm^3 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.

(1)

.....

.....

.....

(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 cm^3 of nitric acid of concentration 0.600 mol/dm^3 neutralises 25.0 cm^3 of barium hydroxide solution.

Calculate the concentration, in mol/dm^3, of the barium hydroxide solution.

(3)

concentration = ... mol/dm^3

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

(1)

.....

.....

(Total for Question 2 = 9 marks)

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3 This question is about Group 7, the halogens.

(a) Which halogen has the palest colour?

(1)

- ☒ **A** astatine
- ☒ **B** bromine
- ☒ **C** fluorine
- ☒ **D** iodine

(b) Which halogen is a solid at room temperature?

(1)

- ☒ **A** astatine
- ☒ **B** bromine
- ☒ **C** chlorine
- ☒ **D** fluorine

(c) The table shows the electronic configurations of a fluorine atom and a chlorine atom.

	Electronic configuration
fluorine	2.7
chlorine	2.8.7

Explain the relative reactivities of fluorine and chlorine using the information in the table.

(4)

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(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 marks)

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4 This question is about magnesium and magnesium compounds.

(a) Magnesium burns in oxygen to form magnesium oxide.

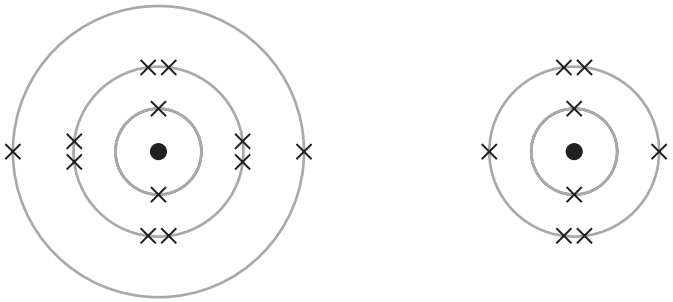
State two observations that would be seen during the reaction.

(2)

1 .....

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.

(1)

.....

.....

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(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 CH_2O

(2)

(ii) Draw the structural formula of a compound with the molecular formula $C_2H_4O_2$

(1)

(b) Methanoic acid (HCOOH) reacts with sodium carbonate solution to give three products.

(i) Complete the equation for this reaction.

(2)

$2HCOOH + Na_2CO_3 \rightarrow$ ..... + ... + ...

(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.

(1)

.....

.....

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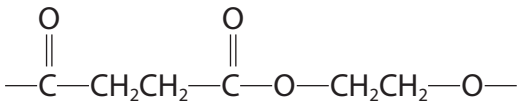
(d) A polyester forms when butanedioic acid reacts with ethanediol.

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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6 Titanium is an important metal in industry.

Titanium dioxide (TiO_2) can be converted into titanium metal in two stages.

Stage 1 titanium dioxide is converted into titanium(IV) chloride ($TiCl_4$)

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 dm^3, 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 dm^3]

(4)

volume of chlorine gas = ... dm^3

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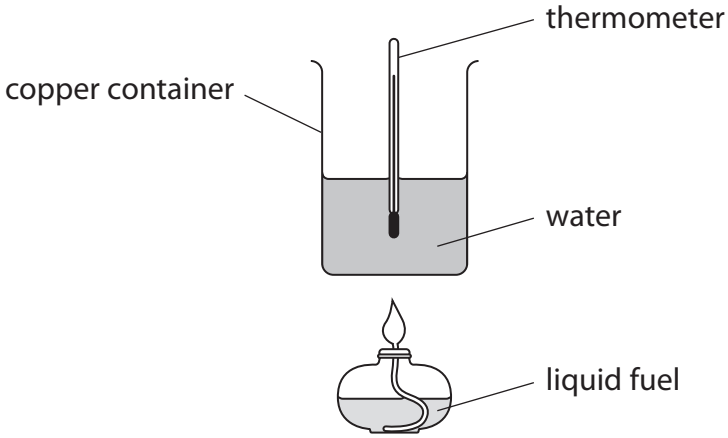
7 A student uses this apparatus to find the heat energy supplied by a liquid fuel.



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 $\Delta H = -900$ kJ/mol.

[M_r 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 .....

.....

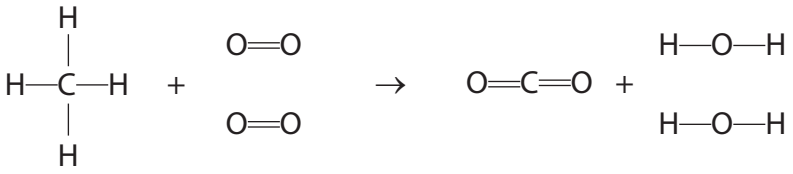
2 .....

.....

(d) The equation shows the combustion of methane.

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

This is the equation showing the displayed formulae.



The table shows the bond energies for O═O, C═O and O—H

Bond	O═O	C═O	O—H
Bond energy in kJ/mol	498	805	463

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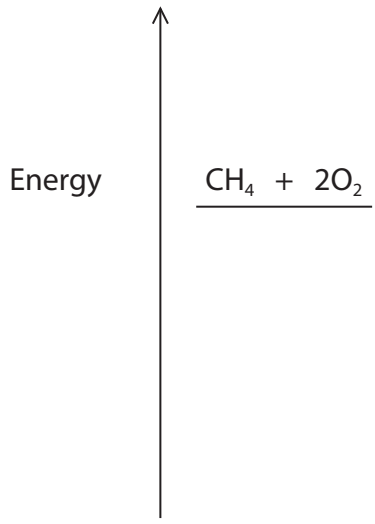
(i) Calculate the bond energy of the C—H bond, using information from the equation and the table.

(4)

C—H bond energy = ... kJ/mol

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

(2)



(Total for Question 7 = 11 marks)

TOTAL FOR PAPER = 70 MARKS

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