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)

Friday 13 June 2025

Morning (Time: 1 hour 15 minutes)

Paper reference **4CH1/2CR**

Chemistry

UNIT: 4CH1
PAPER: 2CR

You must have:
Calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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 5 8 2 3 A 0 1 2 4

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.

(a) The box gives the names of some gases.

carbon dioxide	carbon monoxide	helium
neon	nitrogen	oxygen

Choose gases from the box to answer questions (i) to (iv).

You may use each gas once, more than once or not at all.

(i) Identify **two** gases in Group 0 of the Periodic Table.

(1)

.....

(ii) Identify the gas that makes up about 21% of the atmosphere.

(1)

.....

(iii) Identify a greenhouse gas.

(1)

.....

(iv) Identify the toxic gas formed by incomplete combustion of a hydrocarbon.

(1)

.....

(b) Describe a test to show that a gas is carbon dioxide.

(2)

.....

.....

.....

.....

(Total for Question 1 = 6 marks)

2 Crude oil is a mixture of hydrocarbons.

(a) Name the process used to separate crude oil into fractions.

(1)

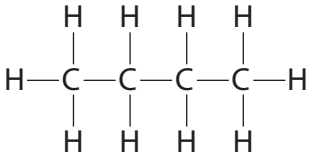
.....

(b) Give one use for the bitumen fraction.

(1)

.....

(c) The diagram shows the displayed formula of one of the alkanes in the refinery gases fraction.



(i) Determine the molecular formula of this alkane.

(1)

.....

(ii) Name this alkane.

(1)

.....

(iii) Give the general formula of the homologous series of alkanes.

(1)

.....

(Total for Question 2 = 5 marks)

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3 This question is about a compound called potassium permanganate.

(a) A teacher makes a saturated solution of potassium permanganate using this method.

The teacher adds 25 cm^3 of water at 50 °C to a beaker.

The teacher then adds solid potassium permanganate one spatula at a time, while stirring, until the solution is saturated.

(i) Give the meaning of the term **saturated solution**.

(1)

.....

.....

(ii) Give a reason why crystals form when the saturated solution cools from 50 °C to room temperature.

(1)

.....

.....

(b) The teacher pours 25 cm^3 of a saturated solution of potassium permanganate at room temperature into an evaporating dish.

The teacher leaves the solution until all the water has evaporated.

The teacher records the mass of the evaporating dish and the mass of the evaporating dish with the dry crystals.

mass of evaporating dish = 64.10 g

mass of evaporating dish with dry crystals = 65.35 g

Calculate the solubility of potassium permanganate in grams per 100 g of water.

[1.00 cm^3 of water has a mass of 1.00 g]

(2)

solubility = ... g per 100 g of water

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(c) The equation shows the thermal decomposition of potassium permanganate.

$$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

(i) Describe a test to show that oxygen gas is produced.

(1)

.....

.....

(ii) Calculate the M_r of K_2MnO_4

(1)

M_r = ...

(d) Potassium permanganate is an oxidising agent.

Give a reason why potassium permanganate is an oxidising agent.

(1)

.....

.....

(Total for Question 3 = 7 marks)

4 This question is about Group 1 metals.

(a) A teacher adds a small piece of lithium metal to a trough containing water.

(i) Complete the equation for the reaction between lithium and water by adding the state symbols.

(2)

$$2Li(\ldots\ldots) + 2H_2O(\ldots\ldots) \rightarrow 2LiOH(\ldots\ldots) + H_2(\ldots\ldots)$$

(ii) Give two observations made when the lithium is added to the water.

(2)

1 .....

.....

2 .....

.....

(iii) The reaction produces 375 cm^3 of hydrogen gas at room temperature and pressure (rtp).

Show, by calculation, that the mass of lithium added is between 0.20 g and 0.30 g.

[1 mol of gas has a volume of 24 000 cm^3 at rtp]

[for lithium, $A_r = 7$]

(3)

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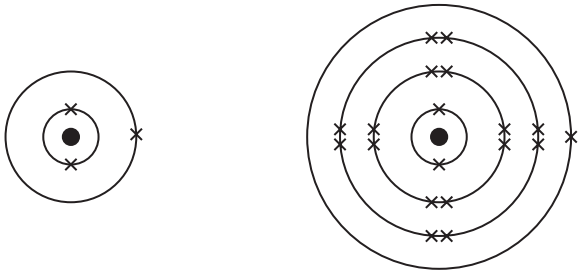
(b) Potassium is more reactive than lithium.

The diagram shows the electronic structure of an atom of lithium and an atom of potassium.



Lithium Potassium

(i) Give one observation that is different when a small piece of potassium, instead of lithium, is added to water.

(1)

(ii) Explain why potassium is more reactive than lithium.

Refer to the electronic structure of lithium and of potassium in your answer.

(3)

(Total for Question 4 = 11 marks)

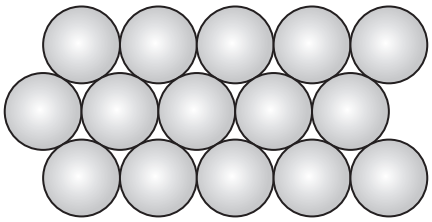
5 This question is about metals and metal compounds.

(a) The method used to extract a metal depends on the reactivity of the metal.

Explain which method is used to extract sodium metal from sodium chloride.

(2)

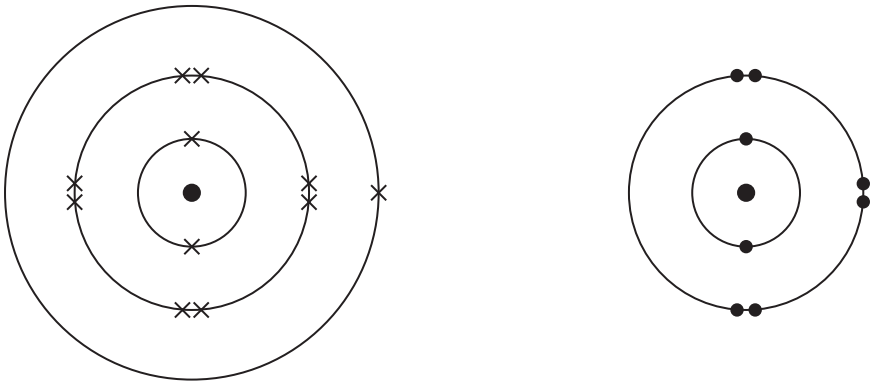
(b) The diagram shows the arrangement of particles in a pure metal.



Explain why pure metals are soft.

(2)

(c) The diagram shows the electronic structure of an atom of sodium and an atom of oxygen.



Sodium Oxygen

Describe, in terms of electrons, what happens when sodium reacts with oxygen.

(2)

(d) The table shows the melting points of sodium and sodium oxide.

	Melting point in °C
Sodium	98
Sodium oxide	1132

Explain why sodium and sodium oxide have different melting points.

In your answer you should refer to:

- the structures of sodium and sodium oxide
- the forces between the particles

(5)

(Total for Question 5 = 11 marks)

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6 A student does a titration to find the volume of phosphoric acid solution (H_3PO_4) needed to neutralise a sample of potassium hydroxide solution (KOH).

One of the products of the reaction is potassium phosphate.

This is the student's method.

- use a measuring cylinder to transfer 25 cm^3 of potassium hydroxide solution to a conical flask
- add two drops of an indicator
- fill a burette with phosphoric acid solution and record the initial reading on the burette
- add the acid to the conical flask
- record the final burette reading when the indicator changes colour

This is the equation for the reaction.

$$H_3PO_4(aq) + 3KOH(aq) \rightarrow K_3PO_4(aq) + 3H_2O(l)$$

(a) Explain two improvements to the student's method that would give more accurate results.

(4)

1 .....

.....

.....

.....

.....

2 .....

.....

.....

.....

.....

(b) The student repeats the titration correctly.

The potassium hydroxide solution has a concentration of 0.150 mol / dm^3.

The phosphoric acid solution has a concentration of 0.0400 mol / dm^3.

Calculate the volume, in cm^3, of phosphoric acid solution needed to neutralise 25.0 cm^3 of 0.150 mol / dm^3 potassium hydroxide solution.

Give your answer to **three** significant figures.

(4)

volume of phosphoric acid solution = ... cm^3

(c) Potassium phosphate solution reacts with calcium chloride solution.

One of the products is the insoluble solid, calcium phosphate.

(i) Complete the equation for the reaction.

(1)

$2K_3PO_4(aq)$ + ... $CaCl_2(aq)$ → $Ca_3(PO_4)_2(s)$ + ... $KCl(aq)$

(ii) The student reacts a solution containing 0.0400 mol of potassium phosphate with an excess of calcium chloride solution.

The student obtains 5.70 g of calcium phosphate.

Show that the percentage yield for the reaction is about 90%

[for $Ca_3(PO_4)_2$ $M_r = 310$]

(3)

(iii) Describe how the student can obtain a pure, dry sample of calcium phosphate from the mixture at the end of the reaction.

(3)

(Total for Question 6 = 15 marks)

7 This question is about ethanol, C_2H_5OH, which can be used as a fuel.

Ethanol can be produced by the fermentation of glucose solution.

(a) (i) Name the substance that is added that causes the fermentation of glucose solution.

(1)

.....

(ii) Which temperature is most suitable for fermentation?

(1)

☒ **A** 0 °C

☒ **B** 10 °C

☒ **C** 30 °C

☒ **D** 100 °C

(iii) Explain why fermentation is done in the absence of air.

(2)

.....

.....

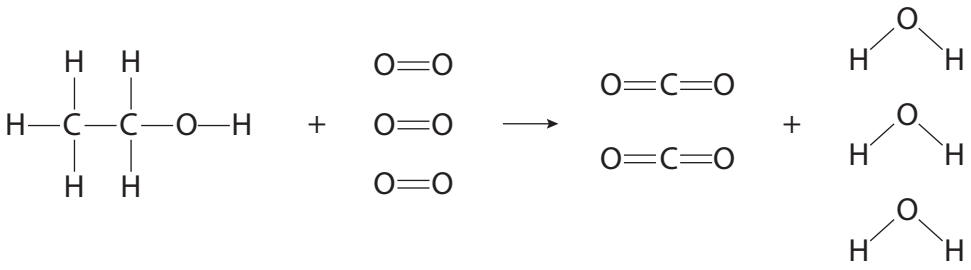
.....

.....

(b) This is the equation for the combustion of ethanol.

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

The equation shows the displayed formulae of the reactants and products.



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The table shows some bond energies.

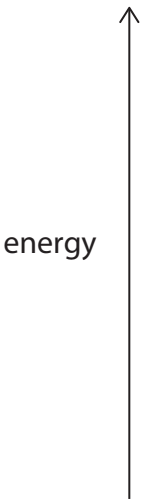
Bond	Bond energy in kJ / mol
C—H	414
C—C	346
C—O	358
O—H	463
O=O	498
C=O	804

(i) Use the bond energies to show that the molar enthalpy change, ΔH, is about −1300 kJ / mol.

(3)

(ii) Complete the energy level diagram for the reaction between C_2H_5OH and O_2

(3)



(iii) Explain, in terms of bonds broken and bonds made, why this reaction is exothermic.

(2)

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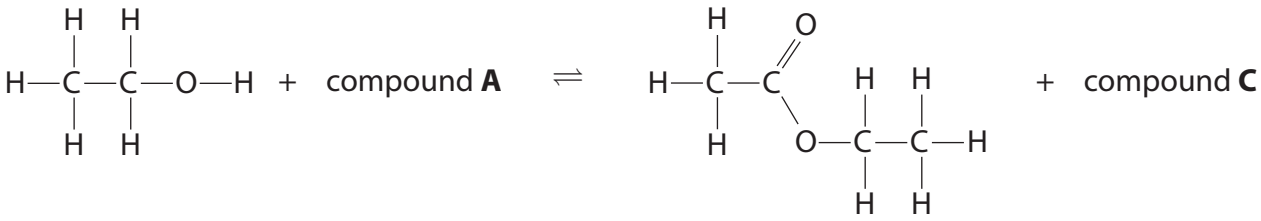
.....

(c) Ethanol reacts with compound **A** to produce ester **B** and compound **C**.

This is the equation for the reaction.



ester **B**

(i) Draw the displayed formula for compound **A** and for compound **C**.

(2)

compound **A**	compound **C**

(ii) Name ester **B**.

(1)

.....

(Total for Question 7 = 15 marks)

TOTAL FOR PAPER = 70 MARKS

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