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|---|---|
| | |

Centre Number | Candidate Number

# Pearson Edexcel International GCSE (9–1)

## Monday 17 November 2025

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.
- 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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# The Periodic Table of the Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1<br>**H**<br>hydrogen<br>1 | | | | | | | | | | 4<br>**He**<br>helium<br>2 |
| 7<br>**Li**<br>lithium<br>3 | 9<br>**Be**<br>beryllium<br>4 | | | | | | | | | | | 11<br>**B**<br>boron<br>5 | 12<br>**C**<br>carbon<br>6 | 14<br>**N**<br>nitrogen<br>7 | 16<br>**O**<br>oxygen<br>8 | 19<br>**F**<br>fluorine<br>9 | 20<br>**Ne**<br>neon<br>10 |
| 23<br>**Na**<br>sodium<br>11 | 24<br>**Mg**<br>magnesium<br>12 | | | | | | | | | | | 27<br>**Al**<br>aluminium<br>13 | 28<br>**Si**<br>silicon<br>14 | 31<br>**P**<br>phosphorus<br>15 | 32<br>**S**<br>sulfur<br>16 | 35.5<br>**Cl**<br>chlorine<br>17 | 40<br>**Ar**<br>argon<br>18 |
| 39<br>**K**<br>potassium<br>19 | 40<br>**Ca**<br>calcium<br>20 | 45<br>**Sc**<br>scandium<br>21 | 48<br>**Ti**<br>titanium<br>22 | 51<br>**V**<br>vanadium<br>23 | 52<br>**Cr**<br>chromium<br>24 | 55<br>**Mn**<br>manganese<br>25 | 56<br>**Fe**<br>iron<br>26 | 59<br>**Co**<br>cobalt<br>27 | 59<br>**Ni**<br>nickel<br>28 | 63.5<br>**Cu**<br>copper<br>29 | 65<br>**Zn**<br>zinc<br>30 | 70<br>**Ga**<br>gallium<br>31 | 73<br>**Ge**<br>germanium<br>32 | 75<br>**As**<br>arsenic<br>33 | 79<br>**Se**<br>selenium<br>34 | 80<br>**Br**<br>bromine<br>35 | 84<br>**Kr**<br>krypton<br>36 |
| 85<br>**Rb**<br>rubidium<br>37 | 88<br>**Sr**<br>strontium<br>38 | 89<br>**Y**<br>yttrium<br>39 | 91<br>**Zr**<br>zirconium<br>40 | 93<br>**Nb**<br>niobium<br>41 | 96<br>**Mo**<br>molybdenum<br>42 | [98]<br>**Tc**<br>technetium<br>43 | 101<br>**Ru**<br>ruthenium<br>44 | 103<br>**Rh**<br>rhodium<br>45 | 106<br>**Pd**<br>palladium<br>46 | 108<br>**Ag**<br>silver<br>47 | 112<br>**Cd**<br>cadmium<br>48 | 115<br>**In**<br>indium<br>49 | 119<br>**Sn**<br>tin<br>50 | 122<br>**Sb**<br>antimony<br>51 | 128<br>**Te**<br>tellurium<br>52 | 127<br>**I**<br>iodine<br>53 | 131<br>**Xe**<br>xenon<br>54 |
| 133<br>**Cs**<br>caesium<br>55 | 137<br>**Ba**<br>barium<br>56 | 139<br>**La***<br>lanthanum<br>57 | 178<br>**Hf**<br>hafnium<br>72 | 181<br>**Ta**<br>tantalum<br>73 | 184<br>**W**<br>tungsten<br>74 | 186<br>**Re**<br>rhenium<br>75 | 190<br>**Os**<br>osmium<br>76 | 192<br>**Ir**<br>iridium<br>77 | 195<br>**Pt**<br>platinum<br>78 | 197<br>**Au**<br>gold<br>79 | 201<br>**Hg**<br>mercury<br>80 | 204<br>**Tl**<br>thallium<br>81 | 207<br>**Pb**<br>lead<br>82 | 209<br>**Bi**<br>bismuth<br>83 | [209]<br>**Po**<br>polonium<br>84 | [210]<br>**At**<br>astatine<br>85 | [222]<br>**Rn**<br>radon<br>86 |
| [223]<br>**Fr**<br>francium<br>87 | [226]<br>**Ra**<br>radium<br>88 | [227]<br>**Ac***<br>actinium<br>89 | [261]<br>**Rf**<br>rutherfordium<br>104 | [262]<br>**Db**<br>dubnium<br>105 | [266]<br>**Sg**<br>seaborgium<br>106 | [264]<br>**Bh**<br>bohrium<br>107 | [277]<br>**Hs**<br>hassium<br>108 | [268]<br>**Mt**<br>meitnerium<br>109 | [271]<br>**Ds**<br>darmstadtium<br>110 | [272]<br>**Rg**<br>roentgenium<br>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 Lanthanides (atomic numbers 58-71) and the Actinides(atomic numbers 90-103) have been omitted.***

***Cu and Cl have not been rounded to the nearest whole number.***

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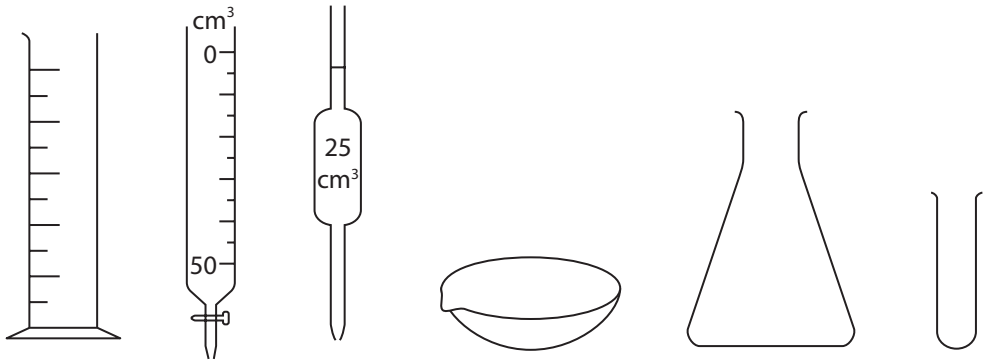
**Answer ALL questions.**

**1** The diagram shows some pieces of apparatus that can be used for different processes.

The pieces of apparatus are not to scale.




(a) Complete the table by placing ticks (✓) in each column to show if a piece of apparatus can be used for a process.

One tick has been done for you.

Each piece of apparatus can be used for one process, more than one process, or not at all.

**(5)**

| Letter | Process | | |
|---|---|---|---|
| | **titration** | **measures different volumes** | **evaporates solvent to produce crystals** |
| P | | | |
| Q | ✓ | | |
| R | | | |
| S | | | |
| T | | | |
| U | | | |

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(b) Give the letter for the piece of apparatus that is a burette.

**(1)**

.....

(c) Name the piece of apparatus labelled R.

**(1)**

.....

**(Total for Question 1 = 7 marks)**

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**2** This question is about the halogens.

(a) The table lists some halogens and their properties.

Complete the table by giving the missing information.

**(3)**

| Halogen | State at 25°C | Colour |
|---|---|---|
| fluorine | | pale yellow |
| chlorine | gas | |
| bromine | | brown |
| iodine | solid | dark grey |

(b) Suggest the state of astatine at 25 °C.

**(1)**

.....

(c) A sample of bromine atoms contains 42.0% bromine-79 and 58.0% bromine-81.

Calculate the relative atomic mass of this sample of bromine atoms.

Give your answer to three significant figures.

**(3)**

relative atomic mass = .....

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(d) A sample of chlorine contains 0.75 mol of $^{35}Cl$ atoms and 0.25 mol of $^{37}Cl$ atoms.

The table gives the relative molecular masses ($M_r$) of the different diatomic molecules of chlorine.

The table also gives the probability of having a molecule of $^{37}Cl^{37}Cl$ in this sample.

| **Molecule** | $^{35}Cl^{35}Cl$ | $^{35}Cl^{37}Cl$ **and** $^{37}Cl^{35}Cl$ | $^{37}Cl^{37}Cl$ |
|---|---|---|---|
| $M_r$ | 70 | 72 | 74 |
| **Probability** | | | $0.25 \times 0.25 = 0.0625$ |

(i) Calculate the probability of having a molecule with an $M_r$ of 70

**(1)**

probability = .....

(ii) Explain why the probability of a molecule having an $M_r$ of 72 is not 0.1875

**(2)**

.....

.....

.....

.....

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(e) Explain how displacement reactions involving halogens and halides provide evidence for the trend in reactivity in Group 7 of the Periodic Table.

Include examples of reactions in your answer.

**(5)**

**(Total for Question 2 = 15 marks)**

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**3** (a) Paint can be used to coat iron, which protects iron from rusting.

(i) Give the chemical name for rust.

**(1)**

(ii) Explain how painting prevents iron from rusting.

**(2)**

(b) Steel is made from iron and carbon.

Explain how the difference in malleability of pure iron and high-carbon steel affects the uses of these materials.

**(6)**

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(c) Zinc reacts with dilute sulfuric acid to produce zinc sulfate and hydrogen.

This is the equation for the reaction.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

A mass of 16 g of zinc reacts with an excess of sulfuric acid.

Calculate the maximum volume, at rtp, of hydrogen produced.

[for hydrogen at rtp, molar volume = 24 $dm^3$]

**(2)**

volume of hydrogen = ..... $dm^3$

(d) A solution of zinc sulfate is electrolysed to form zinc on the negative electrode.

(i) The ionic half-equation at the negative electrode is

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

Give a reason why this half-equation shows reduction.

**(1)**

.....

(ii) Complete the ionic half-equation for the reaction that could occur at the positive electrode.

**(1)**

..... $OH^-$ $\rightarrow$ ..... $O_2$ + ..... $H_2O$ + ..... $e^-$

(iii) A sample of the solution surrounding the positive electrode is tested with universal indicator.

Explain the final colour of the universal indicator.

**(2)**

.....

.....

.....

.....

**(Total for Question 3 = 15 marks)**

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**4** (a) Steam can be used to manufacture ethanol.

(i) Give the other reactant needed for this reaction.

**(1)**

(ii) State the pressure and catalyst used for this reaction to manufacture ethanol.

**(2)**

pressure

catalyst

(b) The glucose in grapes can be fermented to make ethanol.

(i) State the condition needed to prevent the formation of ethanoic acid.

**(1)**

(ii) Explain why fermentation needs to happen in the range of 30 °C to 40 °C.

**(2)**

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(c) Grapes also contain esters.

This is the structural formula of an ester.

$$CH_3COOCH_2CH_2CH_2CH_3$$

(i) Draw the displayed formula of this ester.

**(2)**

(ii) Deduce the name of the carboxylic acid and the name of the alcohol that react to form this ester.

**(2)**

carboxylic acid

alcohol

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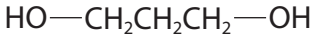
(d) These are the structural formulae of two monomers that are used to make a polyester.





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

**(1)**

.....

(ii) Draw the structure of the repeat unit of the polyester formed from the two monomers.

**(2)**

(iii) Identify the small molecule formed when these two monomers react together.

**(1)**

.....

**(Total for Question 4 = 14 marks)**

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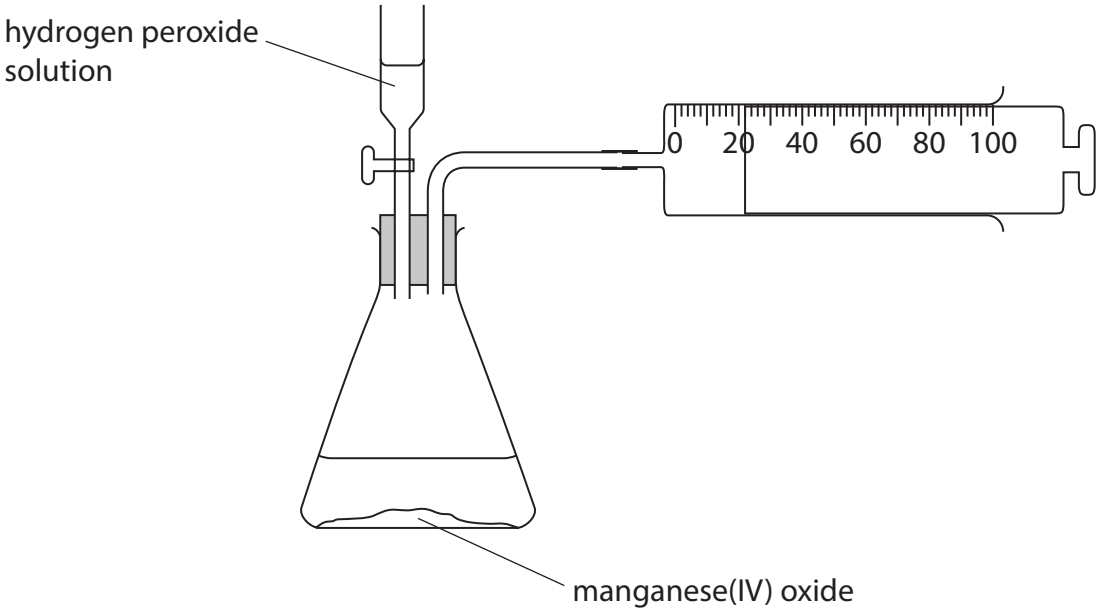
**5** A student uses this apparatus to investigate the decomposition of hydrogen peroxide solution.




This is the equation for the reaction.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

(a) Give a chemical test for the presence of water.

**(2)**

.....

.....

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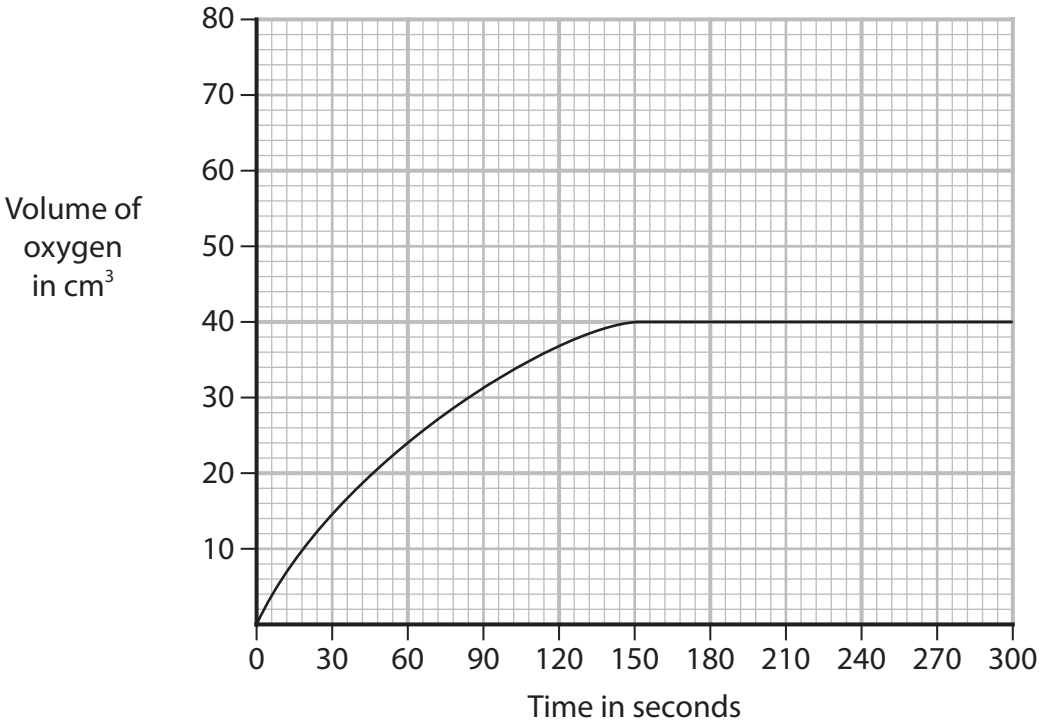
(b) In the first experiment the student uses hydrogen peroxide solution with a concentration of 0.020 mol / $dm^3$.

The graph shows the student's results.




In a second experiment, the student uses hydrogen peroxide solution with a concentration of 0.025 mol / $dm^3$.

All other conditions remain the same.

(i) On the grid, draw the curve you would expect the student to obtain from the second experiment.

**(2)**

(ii) On the grid, draw the curve you would expect the student to obtain for the second experiment carried out at a lower temperature.

**(2)**

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(c) Potassium iodide has been suggested as an alternative catalyst to manganese(IV) oxide.

Describe a method to show which catalyst is more effective for the decomposition of hydrogen peroxide.

**(5)**

**(Total for Question 5 = 11 marks)**

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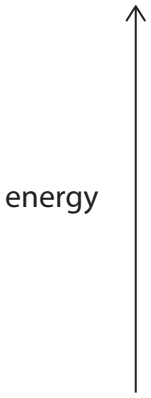
**6** The equation shows one of the possible substitution reactions that occurs during the reaction between methane and chlorine.

$$CH_3Cl + 3Cl_2 \rightarrow CCl_4 + 3HCl \qquad \Delta H = -339\,kJ/mol$$

(a) Complete the reaction profile diagram to show the levels of the reactants, the products and the activation energy, $E_a$.

**(3)**

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(b) The table gives some bond energies.

| **Bond** | C—H | Cl—Cl | H—Cl |
|---|---|---|---|
| **Bond energy in kJ / mol** | 414 | 242 | 431 |

Using information from the equation and the table, calculate the bond energy of the C—Cl bond.

**(5)**

C—Cl bond energy = ..... kJ / mol

**(Total for Question 6 = 8 marks)**

**TOTAL FOR PAPER = 70 MARKS**

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