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)

## Tuesday 13 June 2023

Morning (Time: 1 hour 15 minutes)

Paper reference **4CH1/2C**

# Chemistry

**UNIT: 4CH1**
**PAPER: 2C**

**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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N:1/1/

P 7 1 9 5 2 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** Use the Periodic Table to help you answer this question.

(a) (i) Name the element with atomic number 14.

**(1)**

(ii) Name the element in Group 2 and Period 3.

**(1)**

(iii) Name an element that is a liquid at room temperature.

**(1)**

(iv) Give the electronic configuration of an atom of phosphorus.

**(1)**

(v) Give the formula of sodium sulfide.

**(1)**

(b) Explain, in terms of electron configuration, why neon is unreactive.

**(2)**

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

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**2** This question is about gases in the atmosphere.

(a) Which of these gases has the lowest percentage by volume in the atmosphere?

**(1)**

- ☒ **A** argon
- ☒ **B** carbon dioxide
- ☒ **C** nitrogen
- ☒ **D** oxygen

(b) When copper(II) carbonate is heated, copper(II) oxide and carbon dioxide form.

(i) What is the name of this type of reaction?

**(1)**

- ☒ **A** addition
- ☒ **B** decomposition
- ☒ **C** oxidation
- ☒ **D** substitution

(ii) Which colour change occurs when copper(II) carbonate is heated?

**(1)**

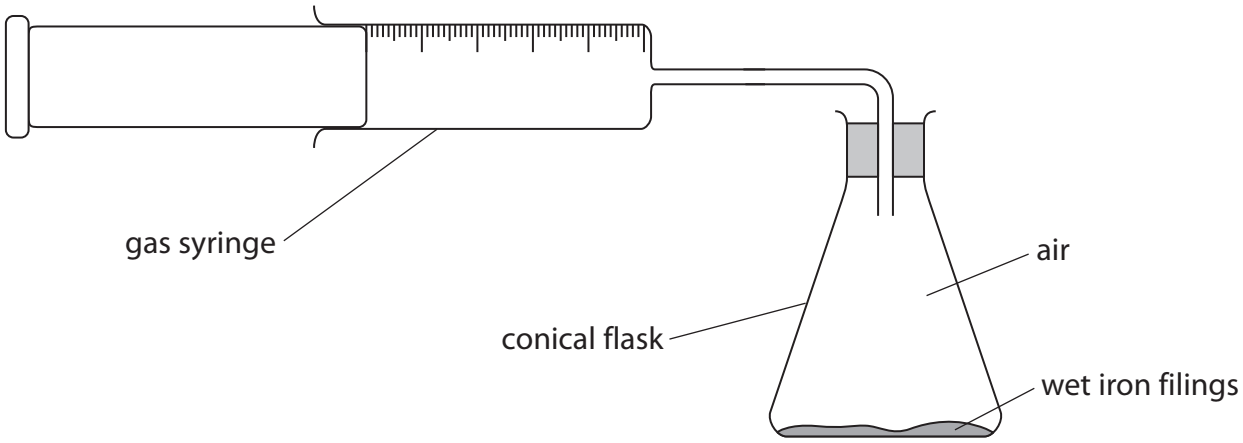
- ☒ **A** blue to black
- ☒ **B** blue to orange
- ☒ **C** green to black
- ☒ **D** green to orange

(iii) Give the chemical equation for this reaction.

**(1)**

.....

(c) A student uses this apparatus to find the percentage of oxygen in a sample of air.




The student leaves the apparatus until there is no further change in volume of gas in the syringe.

These are the student's results.

| | |
|---|---|
| volume of gas in flask and connecting tube in $cm^3$ | 280 |
| volume of gas in syringe at start in $cm^3$ | 100 |
| volume of gas in syringe at end in $cm^3$ | 27 |

Calculate the percentage of oxygen in the sample of air.

Give your answer to two significant figures.

**(4)**

percentage of oxygen = ..... %

(d) Explain why an increasing amount of carbon dioxide in the atmosphere is likely to cause a problem for the environment.

**(2)**

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**(Total for Question 2 = 10 marks)**

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**3** This question is about alcohols.

Ethanol can be manufactured using two different methods.

- hydration of ethene
- fermentation of glucose

This is the equation for hydration.

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

(a) Complete the equation for fermentation.

**(2)**

$C_6H_{12}O_6 \rightarrow$ ..... + .....

(b) The table gives some information about the two methods.

| | **Hydration** | **Fermentation** |
|---|---|---|
| **Reagents** | ethene and steam | aqueous glucose |
| **Catalyst** | | enzymes in yeast |
| **Temperature in °C** | 300 | |
| **Pressure in atmospheres** | | 1 |
| **Rate of process** | fast | slow |
| **Purity of product** | pure | impure |

(i) Complete the table by giving the missing information.

**(3)**

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(ii) Explain one advantage and one disadvantage of using fermentation rather than hydration to produce ethanol.

You should use information from the table to help your answer.

**(4)**

advantage

disadvantage

(c) Explain why fermentation needs to occur in the absence of air.

**(2)**

(d) Propanol has this percentage composition by mass.

C = 60.0%  H = 13.3%  O = 26.7%

(i) Show by calculation that the empirical formula of propanol is $C_3H_8O$.

**(3)**

(ii) Draw the displayed formula of propanol.

**(1)**

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

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**4** A student does a titration to find the concentration of potassium hydroxide solution.

This is the student's method.

- add 25.0 $cm^3$ of the potassium hydroxide solution to a conical flask
- add a few drops of methyl orange indicator to the conical flask
- fill a burette with dilute sulfuric acid and record the initial burette reading
- place the conical flask on a white tile
- add the acid from the burette to the mixture in the conical flask, swirling the flask continuously
- when the indicator changes colour at the end point, record the final burette reading

Repeat the titration to obtain concordant results.

(a) Give the name of the most suitable piece of apparatus to measure out 25.0 $cm^3$ of potassium hydroxide solution.

**(1)**

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(b) Give the colour of methyl orange in potassium hydroxide solution and in dilute sulfuric acid.

**(2)**

colour in potassium hydroxide solution

.....

colour in dilute sulfuric acid

.....

(c) State why the student places the conical flask on a white tile.

**(1)**

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(d) State why the student swirls the flask continuously.

**(1)**

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(e) State what is meant by the term **concordant results**.

**(1)**

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(f) The student finds that 15.00 $cm^3$ of sulfuric acid of concentration 0.180 mol / $dm^3$ neutralises 25.0 $cm^3$ of potassium hydroxide solution.

This is the equation for the reaction.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$$

Calculate the concentration of the potassium hydroxide solution.

**(3)**

concentration = ..... mol / $dm^3$

(g) This is the ionic equation for the reaction between an acid and an alkali.

$$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$$

Explain why the $OH^-$ ion is a proton acceptor in this reaction.

**(2)**

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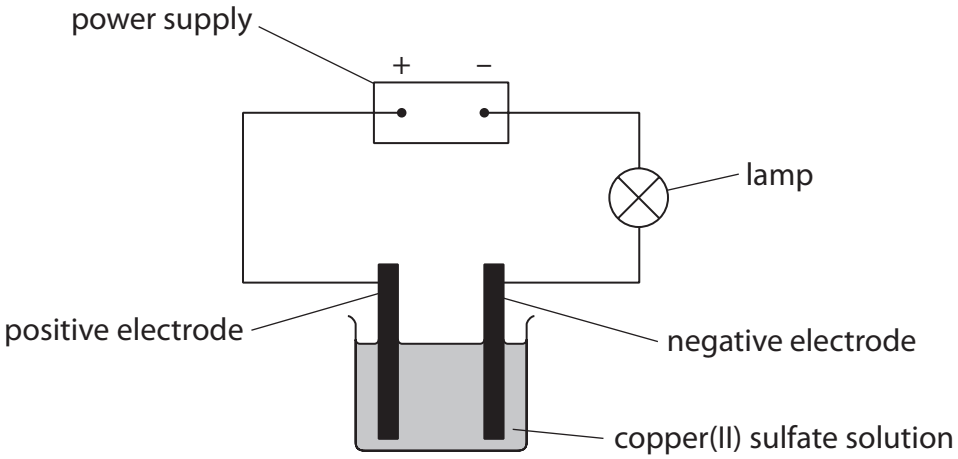
**(Total for Question 4 = 11 marks)**

**5** When copper(II) sulfate solution is electrolysed, copper forms at the negative electrode.

A student uses this apparatus to investigate the electrolysis of copper(II) sulfate solution.




(a) Describe how the student could test a sample of copper(II) sulfate solution to show that it contains copper(II) ions.

**(2)**

(b) Describe how copper metal forms at the negative electrode.

**(3)**

(c) State the appearance of the copper that forms on the negative electrode.

**(1)**

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(d) Oxygen forms at the positive electrode.

(i) Give a test for oxygen.

**(1)**

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(ii) Complete the half-equation for the formation of oxygen at the positive electrode.

**(2)**

$2H_2O \rightarrow$ ..... + ..... + .....

(iii) State why the formation of oxygen at the positive electrode is an oxidation reaction.

**(1)**

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**(Total for Question 5 = 10 marks)**

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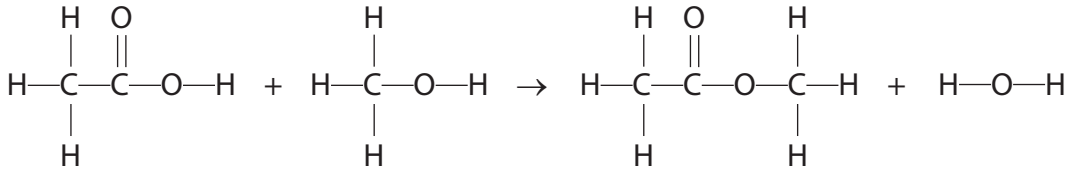
**6** Ethanoic acid reacts with methanol to form an ester.

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



(a) (i) Give the name of a suitable catalyst to increase the rate of this reaction.

**(1)**

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(ii) State how you would know that an ester has formed.

**(1)**

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(iii) Give the name of this ester.

**(1)**

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(b) The table shows the number of bonds in the reactants and the number of bonds in the products.

| **Bond** | C—H | C—C | C—O | C═O | O—H |
|---|---|---|---|---|---|
| **Number of bonds in reactants** | 6 | 1 | 2 | 1 | 2 |
| **Number of bonds in products** | 6 | 1 | 2 | 1 | 2 |

(i) State which two bonds need to be broken in the reactants.

**(1)**

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(ii) Explain why the enthalpy change in this reaction is approximately 0 kJ / mol.

**(2)**

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

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**7** Methane reacts with steam to form carbon monoxide and hydrogen.

This is the equation for the reaction.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +206 \text{ kJ / mol}$$

(a) State why carbon monoxide is poisonous to humans.

**(1)**

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(b) Explain the effect, if any, on the yield of hydrogen at equilibrium when a nickel catalyst is used.

**(2)**

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(c) The reaction conditions for this reaction are a temperature of 700 °C and a pressure of 5 atmospheres.

(i) The temperature of the reaction mixture is reduced to 600 °C, but the pressure is kept at 5 atmospheres.

Explain the effect on the yield of hydrogen at equilibrium.

**(2)**

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(ii) The pressure of the reaction mixture is reduced to 4 atmospheres, but the temperature is kept at 700 °C.

Explain the effect on the yield of hydrogen at equilibrium.

**(2)**

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(d) Calculate the volume, in $dm^3$, of methane gas at rtp needed to produce 6.6 tonnes of hydrogen gas.

[at rtp, molar volume = 24 $dm^3$ 1 tonne = $10^6$ g]

Give your answer in standard form.

**(4)**

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

**(Total for Question 7 = 11 marks)**

**TOTAL FOR PAPER = 70 MARKS**

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