Paper Reference(s)   4CH1/2C
Pearson Edexcel International GCSE (9−1)

# Chemistry
UNIT: 4CH1
PAPER: 2C

**Tuesday 13 June 2023 – Morning**

**Time: 1 hour 15 minutes**

**In the boxes below, write your name, centre number and candidate number.**

| Surname | |
|---|---|
| Other names | |
| Centre Number | |
| Candidate Number | |

Y71952A

**Pearson**

**YOU MUST HAVE**

**Calculator**

**YOU WILL BE GIVEN**

**Diagram Booklet, Periodic Table**

**INSTRUCTIONS**

**If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).**

**Answer ALL questions.**

**Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – 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.

A periodic table is provided as a separate insert.

There may be spare copies of some diagrams.

## 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.

**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 mark)

_____

_____

(continued on the next page)

**1(a)** **continued.**

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

_____

_____

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

_____

_____

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

_____

_____

**(continued on the next page)**       **Turn over**

**1(a)** **continued.**

    **(v) Give the formula of sodium sulfide.**
          **(1 mark)**

_____

_____

**(continued on the next page)**

**1 continued.**

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

_____

_____

_____

_____

_____

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

**Turn over**

2   This question is about gases in the atmosphere.

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

☐ A   argon

☐ B   carbon dioxide

☐ C   nitrogen

☐ D   oxygen

(continued on the next page)

1   continued.

(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 mark)

☐ A addition

☐ B decomposition

☐ C oxidation

☐ D substitution

(continued on the next page)

**Turn over**

**2(b)** **continued.**

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

☐ **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 mark)**

_____

_____

**(continued on the next page)**

**2    continued.**

(c) Look at the diagram for Question 2(c) in the Diagram Booklet. 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 |

(continued on the next page)

**2(c)** continued.

Calculate the percentage of oxygen in the sample of air.

Give your answer to two significant figures.
(4 marks)

Answer space continues on the next page.

**2(c)** **continued.**

**percentage of oxygen =**

_____**%**

**(continued on the next page)**

2    continued.

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

_____

_____

_____

_____

_____

_____

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

**Turn over**

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.

$$C_2H_4 + H_2O \longrightarrow C_2H_5OH$$

(a) Look at the equation for Question 3(a) in the Diagram Booklet. Complete the equation for fermentation.
(2 marks)

(b) Look at the table for Question 3(b) in the Diagram Booklet. It gives some information about the two methods.

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

**Turn over**

3(b)   continued.

(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 marks)

Answer space continues on the next page.

advantage

_____

_____

_____

_____

_____

**3(b)(ii)   continued.**

**disadvantage**

_____

_____

_____

_____

_____

**(continued on the next page)**

**3** **continued.**

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

_____

_____

_____

_____

_____

**(continued on the next page)**

**Turn over**

**3    continued.**

(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 marks)

Answer space continues on the next page.

**3(d)(i)   continued.**

**(continued on the next page)**

**3(d)** **continued.**

(ii) **Draw the displayed formula of propanol.**
(1 mark)

(Total for Question 3 = 15 marks)

**Turn over**

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

(continued on the next page)

**Turn over**

**4 continued.**

Repeat the titration to obtain concordant results.

(a) Give the name of the most suitable piece of apparatus to measure out $25\cdot0\,cm^3$ of potassium hydroxide solution. (1 mark)

_____

_____

**(continued on the next page)**

**Turn over**

**4    continued.**

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

**colour in potassium hydroxide solution**

_____

_____

**colour in dilute sulfuric acid**

_____

_____

**(continued on the next page)**

**4    continued.**

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

_____

_____

_____

**(d) State why the student swirls the flask continuously.
(1 mark)**

_____

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_____

**(continued on the next page)**

**Turn over**

**4    continued.**

(e) **State what is meant by the term CONCORDANT RESULTS.**
**(1 mark)**

_____

_____

_____

(f) **The student finds that $15 \cdot 00 \, cm^3$ of sulfuric acid of concentration $0 \cdot 180 \, mol/dm^3$ neutralises $25 \cdot 0 \, cm^3$ of potassium hydroxide solution.**

**This is the equation for the reaction.**

**$2KOH \ + \ H_2SO_4 \ \longrightarrow \ K_2SO_4 \ + \ 2H_2O$**

**Turn over**

**4(f)   continued.**

**Calculate the concentration of the potassium hydroxide solution.
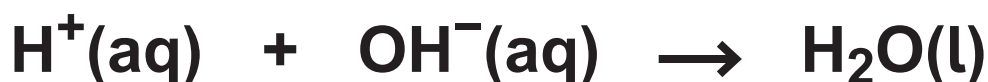(3 marks)**

**Answer space continues on the next page.**

**4(f)   continued.**

**concentration =** _____

**mol / dm$^3$**

**(continued on the next page)**

**4 continued.**

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

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

**Explain why the $OH^-$ ion is a proton acceptor in this reaction.**
**(2 marks)**

_____

_____

_____

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_____

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

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

Look at the diagram for Question 5 in the Diagram Booklet. 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 marks)

_____

_____

_____

_____

_____

5    continued.

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

Answer space continues on the next page.

_____

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_____

_____

_____

_____

_____

**5(b)   continued.**

_____

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_____

**(c) State the appearance of the copper that forms on the negative electrode. (1 mark)**

_____

_____

**(continued on the next page)**

**Turn over**

5   continued.

   (d) Oxygen forms at the positive electrode.

      (i)   Give a test for oxygen.
            (1 mark)

_____

_____

_____

(continued on the next page)

**5(d)** **continued.**

(ii) **Look at the half-equation for Question 5(d)(ii) in the Diagram Booklet. Complete the half-equation for the formation of oxygen at the positive electrode.**
**(2 marks)**

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

_____

_____

_____

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

**Turn over**

6   Ethanoic acid reacts with methanol to form an ester.

Look at the equation for Question 6 in the Diagram Booklet. It 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 mark)

_____

_____

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

_____

_____

_____

(continued on the next page)     Turn over

**6(a)** continued.

(iii) Give the name of this ester.
(1 mark)

_____

_____

(b) Look at the table for Question 6(b) in the Diagram Booklet. It shows the number of bonds in the reactants and the number of bonds in the products.

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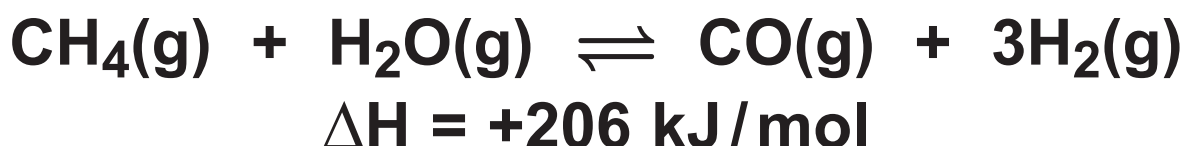(1 mark)

_____

_____

(continued on the next page)

**Turn over**

**6(b)** **continued.**

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

_____

_____

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_____

_____

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

**Turn over**

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

This is the equation for the reaction.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$
$$\triangle H = +206 \ kJ/mol$$

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

_____

_____

_____

(continued on the next page)

**Turn over**

**7** **continued.**

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

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_____

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_____

**(continued on the next page)**

7    continued.

(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 marks)

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Turn over

7(c) continued.

(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 marks)

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(continued on the next page)

**Turn over**

**7    continued.**

(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 marks)

Answer space continues on the next page.

**Turn over**

**7(d)   continued.**

**volume of methane =**

_____ **dm$^3$**

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

**TOTAL FOR PAPER = 70 MARKS**
**END OF PAPER**