

Chemistry  
UNIT: 4CH1  
PAPER: 2C

Total Marks
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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					

## **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.**

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**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)**

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

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**(continued on the next page)**

**1(a) continued.**

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

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

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

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**(continued on the next page)**

**1 continued.**

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

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**(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 mark)**

☐ **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 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)**

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**(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.**

<b>volume of gas in flask and connecting tube in cm<sup>3</sup></b>	<b>280</b>
<b>volume of gas in syringe at start in cm<sup>3</sup></b>	<b>100</b>
<b>volume of gas in syringe at end in cm<sup>3</sup></b>	<b>27</b>

**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)**

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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.**



**(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)**

**(continued on the next page)**

**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**

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

**disadvantage**

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**(continued on the next page)**

**3 continued.**

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

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**(continued on the next page)**

**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<sub>3</sub>H<sub>8</sub>O.  
(3 marks)**

**(continued on the next page)**

**Turn over**

**3(d) continued.**

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

**(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  $25.0\text{ cm}^3$  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  $25.0\text{ cm}^3$  of potassium hydroxide solution.**  
**(1 mark)**
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**(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**

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**colour in dilute sulfuric acid**

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**(continued on the next page)**

**4 continued.**

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

**(1 mark)**

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

**(1 mark)**

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**4 continued.**

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

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

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



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

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

**4(f) continued.**

**concentration = \_\_\_\_\_ mol/dm<sup>3</sup>**

**(continued on the next page)**

**4 continued.**

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



**Explain why the  $\text{OH}^-$  ion is a proton acceptor in this reaction.**

**(2 marks)**

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

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- 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)**

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**5 continued.**

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

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**Turn over**

**5 continued.**

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

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- (d) Oxygen forms at the positive electrode.**

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

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**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)**

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

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**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)**

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

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

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**6 continued.**

**(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)**

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**6(b) continued.**

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

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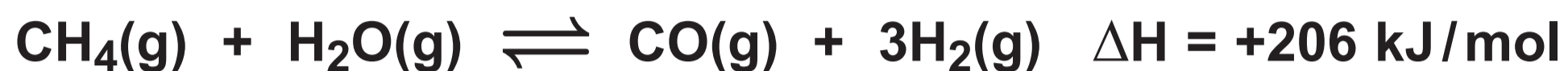
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**(Total for Question 6 = 6 marks)**

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

This is the equation for the reaction.



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

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(continued on the next page)

**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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**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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**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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7 continued.

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

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

Give your answer in standard form.

(4 marks)

volume of methane = \_\_\_\_\_  $\text{dm}^3$

(Total for Question 7 = 11 marks)

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TOTAL FOR PAPER = 70 MARKS

END OF PAPER