

Chemistry  
Paper 2C

Total Marks
-------------

Time: 1 hour 15 minutes plus your additional time allowance

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

Surname					
Other names					
Centre Number					
Candidate Number					

**YOU MUST HAVE**

**Calculator, ruler**

**YOU WILL BE GIVEN**

**Diagram Booklet, Periodic Table**

**INSTRUCTIONS**

**Answer ALL questions.**

**Answer the questions in the spaces provided – there may be more space than you need.**

**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 ☐.**

**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.**

**ADVICE**

**Read each question carefully before you start to answer it.**

**Try to answer every question.**

**Check your answers if you have time at the end.**

**Good luck with your examination.**

**Turn over**

**Answer ALL questions. Write your answers in the spaces provided.**

**1 Use the Periodic Table to help you answer this question.**

**(a) (i) Name the element with atomic number 14  
(1 mark)**

---

**(ii) Name the element with a relative atomic mass of 11  
(1 mark)**

---

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

---

**(continued on the next page)**

**1 continued.**

- (b) (i) Determine the number of neutrons in a phosphorus atom with mass number 31 (1 mark)**
- 

- (ii) State the electronic configuration of an aluminium atom. (1 mark)**
- 

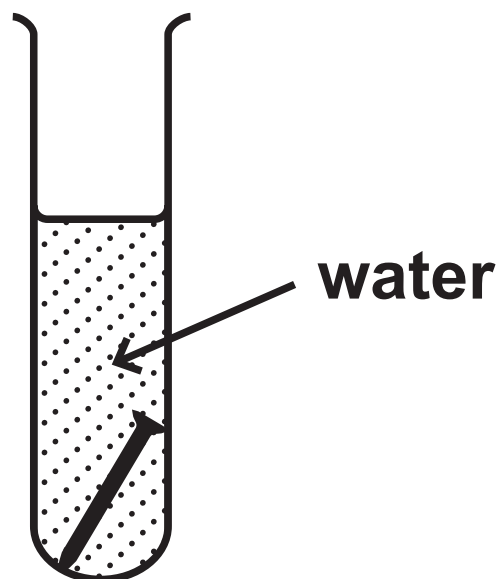
- (iii) State why neon is unreactive. (1 mark)**
- 
- 
- 

**(Total for Question 1 = 6 marks)**

---

**2 A student investigates the rusting of iron.**

- (a) She places an iron nail in a test tube of water and leaves it for several days.**



- (i) Predict the appearance of the iron nail after several days.  
(1 mark)**

---

---

- (ii) Name the main compound in rust.  
(1 mark)**

---

---

**(continued on the next page)**

**Turn over**

**2 continued.**

- (b) The student then sets up two more test tubes containing iron nails. Look at the diagram for Question 2(b) in the Diagram Booklet.**

**Explain why the iron nail in tube 1 and the iron nail in tube 2 do not rust.  
(4 marks)**

**tube 1** \_\_\_\_\_

---

---

---

---

---

---

**tube 2** \_\_\_\_\_

---

---

---

**(continued on the next page)**

**Turn over**

**2 continued.**

---

---

**(Total for Question 2 = 6 marks)**

---

**3 Look at the diagram for Question 3(a) in the Diagram Booklet. It shows the industrial equipment used to separate crude oil into fractions.**

**(a) (i) Give the name of the industrial equipment.  
(1 mark)**

---

---

**(ii) Give one use of the fuel oil fraction.  
(1 mark)**

---

---

**(iii) Give the names of fraction A and fraction F.  
(2 marks)**

**fraction A** \_\_\_\_\_

---

**fraction F** \_\_\_\_\_

---

**(continued on the next page)**

**Turn over**



**3 continued.**

- (b) One compound in the gasoline fraction is the alkane octane ( $\text{C}_8\text{H}_{18}$ ) and one compound in the kerosene fraction is the alkane dodecane ( $\text{C}_{12}\text{H}_{26}$ )**

**These two alkanes are covalently bonded and have simple molecular structures.**

- (i) Give the general formula for the alkanes.  
(1 mark)**

---

---

- (ii) Explain, in terms of their structures, why  $\text{C}_{12}\text{H}_{26}$  has a higher boiling point than  $\text{C}_8\text{H}_{18}$   
(3 marks)**

---

---

---

---

---

**3 continued.**

---

---

---

---

---

---

---

---

---

---

**(continued on the next page)**

**3 continued.**

**(c) Catalytic cracking can be used to convert the alkane  $C_{12}H_{26}$  into more useful products.**

**(i) Give the name of the catalyst used for catalytic cracking.  
(1 mark)**

---

---

**(ii) Complete the equation for this cracking reaction.  
(1 mark)**



**(Total for Question 3 = 10 marks)**

---

- 4 A student investigates the solubility of potassium nitrate in water. She measures the masses of potassium nitrate that dissolve in  $25\text{ cm}^3$  of water at different temperatures.**

**Look at the table for Question 4(a) in the Diagram Booklet. It shows the student's results. One of the results is anomalous.**

**Look at the grid for Question 4(a) in the Diagram Booklet.**

- (a) (i) Plot the results on the grid.  
(1 mark)**
- (ii) Draw a circle around the anomalous result.  
(1 mark)**
- (iii) Ignoring the anomalous result, draw a curve of best fit.  
(1 mark)**

**(continued on the next page)**

**4 continued.**

**(b) Suggest TWO possible mistakes that could have caused the anomalous result.  
(2 marks)**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**

**4 continued.**

- (c) Use your graph for Question 4(a) in the Diagram Booklet to find the maximum mass of potassium nitrate that dissolves in 25 cm<sup>3</sup> of water at 75 °C.**

**Show on your graph how you obtained your answer.**

**(2 marks)**

**mass = \_\_\_\_\_ g**

**(continued on the next page)**

**4 continued.**

- (d) Use your graph for Question 4(a) in the Diagram Booklet to calculate the solubility of potassium nitrate in g per 100 g of water at 25°C. (2 marks)**

**[1·0 cm<sup>3</sup> of water has a mass of 1·0 g]**

**solubility = \_\_\_\_\_ g per 100 g of water**

**(Total for Question 4 = 9 marks)**

---

**5 Ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , is a member of the homologous series of alcohols.**

**(a) Give two characteristics of a homologous series.  
(2 marks)**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**



**5 continued.**

**(b) When ethanol is heated with potassium dichromate(VI) and one other reagent, the ethanol is oxidised to ethanoic acid,  $\text{CH}_3\text{COOH}$**

**(i) Give the formula of the other reagent.  
(1 mark)**

---

---

**(ii) State the colour change that occurs during this oxidation reaction.  
(2 marks)**

from \_\_\_\_\_

to \_\_\_\_\_

**(iii) Look at the diagram for Question 5(b)(iii) in the Diagram Booklet. Draw the displayed formulae for ethanol and ethanoic acid in the boxes.  
(2 marks)**

**(continued on the next page)**

**Turn over**

**5 continued.**

**(c) Ethanol can be manufactured by two different methods.**

**Look at the table for Question 5(c)(i) in the Diagram Booklet. It gives some information about the two methods.**

**(i) Discuss the advantages and disadvantages of these two methods, using information from the table.**

**(6 marks)**

---

---

---

---

---

---

---

---

---

---

**(continued on the next page)**

**Turn over**

**5 continued.**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

**(continued on the next page)**

**Turn over**

**5 continued.**

**(ii) The word equation for the fermentation process is**

**glucose  $\longrightarrow$  ethanol + carbon dioxide**

**Look at the diagram for Question 5(c)(ii) in the Diagram Booklet. Complete the chemical equation for this reaction.**

**(1 mark)**

**(Total for Question 5 = 14 marks)**

---

**6 Look at the diagram for Question 6(a) in the Diagram Booklet. It shows how hydrogen gas and chlorine gas can be prepared in the laboratory by electrolysis of a concentrated solution of sodium chloride.**

**(a) (i) Give a test for hydrogen gas.  
(1 mark)**

---

---

---

**(ii) Give a test for chlorine gas.  
(2 marks)**

---

---

---

---

---

---

**(continued on the next page)**

**Turn over**

**6 continued.**

**(b) The ionic half-equation for the formation of chlorine at the positive electrode is**



**(i) State why this reaction is an oxidation reaction.  
(1 mark)**

---

---

---

**(ii) Give the ionic half-equation for the formation of hydrogen at the negative electrode.  
(1 mark)**

---

---

**(continued on the next page)**

**Turn over**

**6 continued.**

- (iii) State why it is safer to do this electrolysis in a fume cupboard.  
(1 mark)**

---

---

---

- (iv) Suggest why the volume of chlorine collected during this electrolysis is less than the volume of hydrogen collected.  
(1 mark)**

---

---

---

---

---

**(continued on the next page)**

**Turn over**

**6 continued.**

- (c) In the chemical industry, chlorine can be produced by the electrolysis of molten sodium chloride.**

**The overall equation for this reaction is**



- (i) Explain why sodium chloride needs to be molten rather than solid for electrolysis to occur.  
(2 marks)**

---

---

---

---

---

---

---

---

---

---



6 continued.

- (ii) Calculate the maximum volume, in  $\text{dm}^3$ , of chlorine gas at rtp that can be obtained from 23.4 tonnes of molten sodium chloride.  
(4 marks)

[1 tonne =  $10^6$  g]

[ $M_r$  of NaCl = 58.5]

[molar volume of chlorine at rtp =  $24 \text{ dm}^3$ ]

Give your answer in standard form.

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

(Total for Question 6 = 13 marks)

---

Turn over

- 7 A student does a titration to find the concentration of a solution of phosphoric acid.**

**He uses these pieces of apparatus X, Y and Z in his titration.**

**Look at the diagrams for Question 7(a) in the Diagram Booklet. Diagrams are not to scale.**

- (a) Give the names of X, Y and Z.  
(3 marks)**

**X** \_\_\_\_\_

\_\_\_\_\_

**Y** \_\_\_\_\_

\_\_\_\_\_

**Z** \_\_\_\_\_

\_\_\_\_\_

**(continued on the next page)**

**7 continued.**

**(b) What is the colour of phenolphthalein in phosphoric acid?  
(1 mark)**

☐ **A blue**

☐ **B colourless**

☐ **C pink**

☐ **D red**

**(continued on the next page)**

**7 continued.**

- (c) The student titrates  $25.0\text{ cm}^3$  of phosphoric acid with a solution of sodium hydroxide (NaOH).**

**Look at Table 1 for Question 7(c) in the Diagram Booklet. It shows the student's results.**

**Concordant results are those within  $0.20\text{ cm}^3$  of each other.**

- (i) Add ticks ( ✓ ) to Table 1 to show the concordant results.  
(1 mark)**
- (ii) Use your ticked results to calculate the mean (average) volume of NaOH added.  
(2 marks)**

**mean volume = \_\_\_\_\_  $\text{cm}^3$**

**(continued on the next page)**

**7 continued.**

- (d) Look at Table 2 for Question 7(d) in the Diagram Booklet. It shows the titration results of another student.**

**The equation for the reaction is**



- (i) Calculate the amount, in moles, of NaOH in 30·40 cm<sup>3</sup> of sodium hydroxide solution.  
(2 marks)**

**amount = \_\_\_\_\_ mol**

**(continued on the next page)**

**7 continued.**

- (ii) Calculate the amount, in moles, of  $\text{H}_3\text{PO}_4$  in  $25.0\text{ cm}^3$  of phosphoric acid.  
(1 mark)**

**amount = \_\_\_\_\_ mol**

- (iii) Calculate the concentration, in  $\text{mol/dm}^3$ , of the phosphoric acid.  
(2 marks)**

**concentration = \_\_\_\_\_  $\text{mol/dm}^3$**

**(Total for Question 7 = 12 marks)**

---

---

**TOTAL FOR PAPER = 70 MARKS**

**END**