

Chemistry
UNIT: 4CH1
PAPER: 2C

Total Marks

Tuesday 11 June 2024 – 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, ruler

YOU WILL BE GIVEN

Diagram Booklet, Periodic Table

INSTRUCTIONS

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 answer these questions.

- (a) (i) Give the name of the element with atomic number 16
(1 mark)**

- (ii) Give the name of the element with relative atomic mass 9
(1 mark)**

(continued on the next page)

1(a) continued.

**(iii) Give the name of the element in Group 3 and
Period 2
(1 mark)**

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

(continued on the next page)

1 continued.

- (b) Explain, in terms of electron configuration, why sodium is more reactive than lithium.
(3 marks)**

Answer space continues on the next page.

Turn over

1(b) continued.

(Total for Question 1 = 7 marks)

2 Structures made of iron can rust.

- (a) (i) Name the two substances that cause iron to rust.
(2 marks)**

1 _____

2 _____

- (ii) State a barrier method that prevents rusting.
(1 mark)**

(continued on the next page)

2 continued.

- (b) Explain how sacrificial protection prevents the rusting of iron.
(2 marks)**

(Total for Question 2 = 5 marks)

3 Look at the diagram for Question 3 in the Diagram Booklet. It shows the separation of crude oil into fractions.

**(a) Give the name of fraction A and the name of fraction F.
(2 marks)**

fraction A

fraction F

(continued on the next page)

3 continued.

(b) One of the fractions is kerosene.

**(i) Give one use of kerosene.
(1 mark)**

(continued on the next page)

3(b) continued.

**(ii) Describe how kerosene can be obtained from crude oil.
(3 marks)**

(continued on the next page)

Turn over

3 continued.

(c) Catalytic cracking is a process used to break down fractions containing long-chain molecules.

**(i) Give the name of the catalyst and the temperature used for catalytic cracking.
(2 marks)**

catalyst

temperature

(continued on the next page)

3(c) continued.

**(ii) Explain why catalytic cracking is useful.
(3 marks)**

Answer space continues on the next page.

Turn over

3(c)(ii) continued.

(Total for Question 3 = 11 marks)

- 4 The table shows the maximum mass of potassium nitrate (KNO_3) and the maximum mass of sodium nitrate (NaNO_3) that dissolves in 25 cm^3 of water at different temperatures.

Temperature in $^{\circ}\text{C}$	10	25	40	60	75
Mass of potassium nitrate in g	5	10	16	28	39
Mass of sodium nitrate in g	21	23	26	31	35

- (a) (i) On the grid for Question 4(a) in the Diagram Booklet, plot the data for potassium nitrate and for sodium nitrate.
(2 marks)
- (ii) On the grid for Question 4(a) in the Diagram Booklet, draw and label a curve of best fit for KNO_3 and for NaNO_3
(2 marks)

(continued on the next page)

4 continued.

- (b) The graph shows the temperature at which the maximum mass dissolved is the same for each solute.**

**Determine this temperature.
(1 mark)**

temperature = _____ °C

(continued on the next page)

4 continued.

- (c) Use your graph to calculate the solubility, in g per 100 g of water, of sodium nitrate at 30 °C.
(2 marks)**

[1·0 cm³ of water has a mass of 1·0 g]

solubility of sodium nitrate in g per 100 g of water =

(continued on the next page)

4 continued.

- (d) 25 cm^3 of a saturated solution of potassium nitrate is cooled from 50°C to 20°C .**

Use your graph to determine the mass, in grams, of potassium nitrate that crystallises.

**Show your working on the graph.
(3 marks)**

mass = _____g

(Total for Question 4 = 10 marks)

5 Methanol, CH_3OH , is the first 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) Methanol is heated with potassium dichromate(VI) and one other reagent.**

**The methanol is oxidised to methanoic acid,
HCOOH**

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

- (ii) Give the colour change that occurs during
the reaction.
(2 marks)**

from _____

to _____

- (iii) In the table for Question 5(b)(iii) in the
Diagram Booklet, draw the displayed formula
for methanol and for methanoic acid.
(2 marks)**

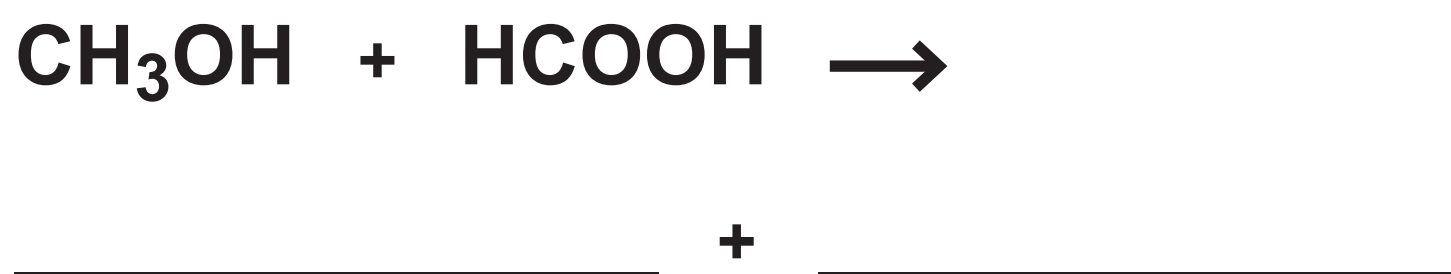
(continued on the next page)

Turn over

5 continued.

- (c) Methanol reacts with methanoic acid to form an ester.**

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



(continued on the next page)

5 continued.

**(d) The structural formula of an ester is
 $\text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3$**

**(i) What is the name of this ester?
(1 mark)**

☐ **A butyl ethanoate**

☐ **B butyl methanoate**

☐ **C ethyl butanoate**

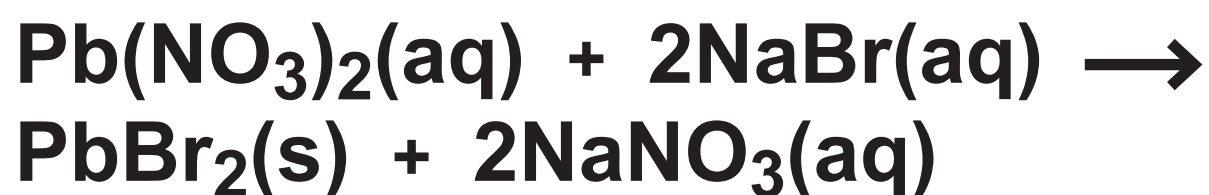
☐ **D methyl butanoate**

**(ii) Deduce the molecular formula of this ester.
(1 mark)**

(Total for Question 5 = 10 marks)

- 6 A scientist reacts lead(II) nitrate solution with sodium bromide solution.

This is the equation for the reaction.



- (a) Describe how the scientist could obtain a pure dry sample of lead(II) bromide (PbBr_2) from the reaction mixture.
(3 marks)

6 continued.

(b) The scientist reacts an excess of lead(II) nitrate solution with 25 cm^3 of sodium bromide solution of concentration 2.0 mol/dm^3

**(i) Show that the amount of sodium bromide used is 0.050 mol .
(1 mark)**

(continued on the next page)

6(b) continued.

- (ii) Show that the maximum theoretical mass of lead(II) bromide is approximately 9 g.
(2 marks)**

[for PbBr_2 $M_r = 367$]

(continued on the next page)

6 continued.

(c) Look at the diagram for Question 6(c) in the Diagram Booklet. The scientist electrolyses molten lead(II) bromide using this apparatus.

- (i) Explain why lead(II) bromide needs to be molten rather than solid for electrolysis to occur.
(3 marks)**

Answer space continues on the next page.

Turn over

6(c)(i) continued.

(continued on the next page)

6(c) continued.

(ii) The electrolyte is at a temperature of 400 °C.

**Explain a suitable material for the electrodes.
(2 marks)**

**(iii) Give the half-equation that occurs at the
negative electrode.
(1 mark)**

6 continued.

(d) Bromine forms at the positive electrode.

This is the half-equation for the reaction at the positive electrode.



**(i) State what is observed at the positive electrode.
(1 mark)**

**(ii) State why the half-equation represents an oxidation reaction.
(1 mark)**

(Total for Question 6 = 14 marks)

Turn over

7 This question is about hydrogen chloride (HCl).

Hydrogen chloride is a covalent compound.

- (a) State, in terms of electrostatic attraction, what is meant by a covalent bond.
(2 marks)**

(continued on the next page)

7 continued.

- (b) When hydrogen chloride gas is dissolved in an organic solvent, the hydrogen chloride remains a covalent molecule.**

When hydrogen chloride gas is dissolved in water, ions are formed.

**Explain what happens when dry blue litmus paper is dipped into separate samples of each solution.
(4 marks)**

Answer space continues on the next page.

Turn over

7(b) continued.

(continued on the next page)

7 continued.

(c) In the presence of ultraviolet radiation, hydrogen reacts with chlorine to form hydrogen chloride.

This is the equation for the reaction.



The table shows the bond energies.

Bond	H—H	Cl—Cl	H—Cl
Bond energy in kJ/mol	436	242	431

(i) Calculate the enthalpy change (ΔH), in kJ/mol, for the reaction.

Include a sign in your answer.

(3 marks)

$\Delta H =$ _____ kJ/mol

7(c) continued.

- (ii) Look at the diagram for Question 7(c)(ii) in the Diagram Booklet. Draw a reaction profile for the reaction.**

**Label the reactants, the products, ΔH and the activation energy (E_a).
(4 marks)**

(Total for Question 7 = 13 marks)

TOTAL FOR PAPER = 70 MARKS

END OF PAPER