

**Monday 14 January 2013 – Afternoon**

**A2 GCE CHEMISTRY B (SALTERS)**

**F334/01** Chemistry of Materials

Candidates answer on the Question Paper.

**OCR supplied materials:**

- *Data Sheet for Chemistry B (Salters)* (inserted)

**Other materials required:**

- Scientific calculator

**Duration:** 1 hour 30 minutes




Candidate forename		Candidate surname	
--------------------	--	-------------------	--

Centre number						Candidate number				
---------------	--	--	--	--	--	------------------	--	--	--	--

**INSTRUCTIONS TO CANDIDATES**

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

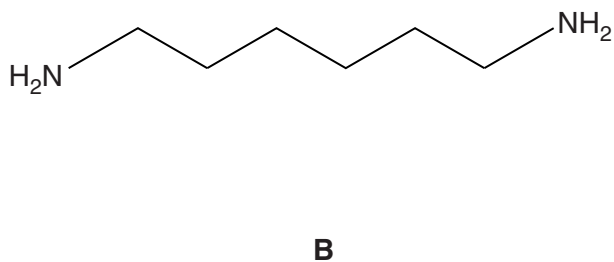
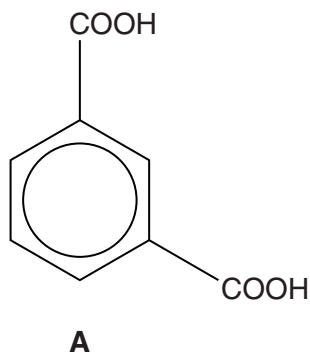
**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.  
This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry B (Salters)* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **90**.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

- 1 To combat the security problems of metal cutlery on aircraft, chemists have developed a polymer known as PPA. This polymer, a polyamide, is strong enough to replace stainless steel cutlery for in-flight use.

The following monomers, **A** and **B**, can be reacted to make PPA polymer.



- (a) (i) Use the formulae above to draw the structural formula of the repeating unit for PPA.

[2]

- (ii) On your diagram circle a secondary amide group.

[1]

- (iii) Name monomer **B**.

..... [2]

(b) Nylon-6 is also a polyamide.

Nylon-6 has six carbon atoms in its repeating unit and can be made from a single monomer having a straight carbon chain.

(i) Suggest a structural formula for this single monomer of nylon-6.

[1]

(ii) Name and explain the **type** of polymerisation reaction this monomer undergoes to form nylon-6.

.....  
.....  
..... [1]

(c) Polyamides have a high proportion of crystalline areas.

(i) Explain what is meant by *crystalline*.

.....  
..... [1]

(ii) PPA has more crystalline areas than nylon-6. This gives PPA a greater  $T_m$  than nylon-6.

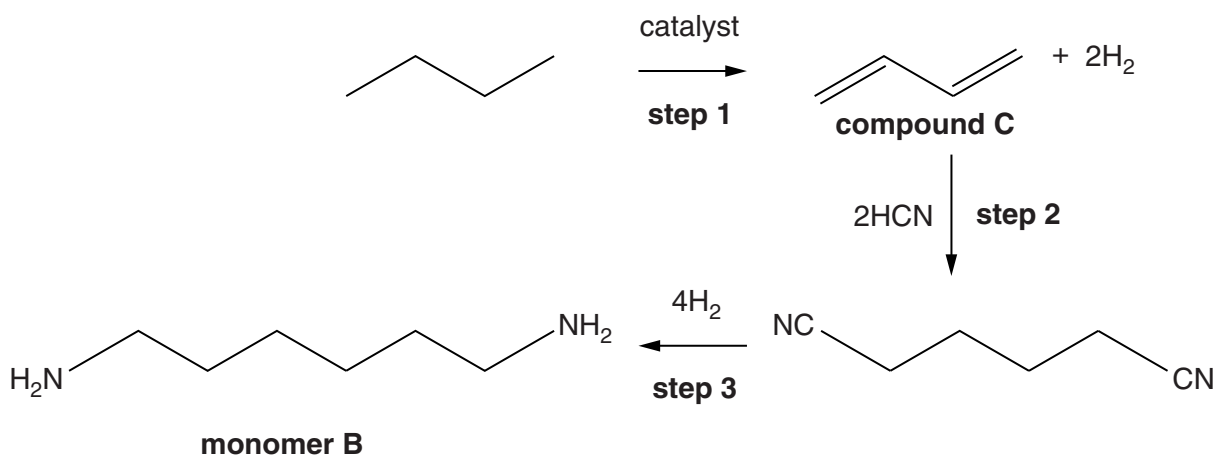
Explain this greater  $T_m$  in terms of the intermolecular bonding involved.

.....  
.....  
.....  
.....  
.....  
..... [3]

(iii) Name a process by which a nylon-6 fibre could be made more crystalline.

..... [1]

- (d) In the manufacture of PPA, monomer **B** can be made from butane by the following 3-step process.



- (i) For each step, name the type of reaction taking place by selecting a suitable word from the list below.

**addition      condensation      elimination      rearrangement      substitution**

**step 1** .....

**step 2** .....

**step 3** .....

[3]

- (ii) How does the hydrogen produced by **step 1** help to reduce the cost of the overall process?

.....

..... [1]

- (e) In some countries, compound **C** is synthesised by first converting ethanol into CH<sub>3</sub>CHO.

Give the reagents used in a laboratory to convert ethanol into CH<sub>3</sub>CHO.

..... [1]

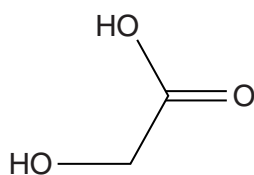
[Total: 17]

5  
**BLANK PAGE**

**Question 2 begins on page 6**

**DO NOT WRITE ON THIS PAGE**

- 2 Glycolic acid is widely used in cosmetic skin-care products. It is an odourless and crystalline solid that is very soluble in water.



glycolic acid

- (a) Describe and explain how part of the glycolic acid structure acts as an acid.

.....  
 .....  
 ..... [2]

- (b) The concentration of glycolic acid in a skin-care product is important. Any product containing over 10.0g of glycolic acid in 100cm<sup>3</sup> solution is classed as a hazardous material.

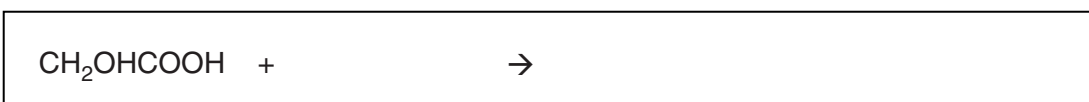
'Acnegone' is a solution of glycolic acid.

A student carries out an acid–base titration using a standard solution of NaOH to find out how much glycolic acid is in the *Acnegone* solution.

The student dilutes 14.0cm<sup>3</sup> of *Acnegone* with water to form 250cm<sup>3</sup> of solution.

25.0cm<sup>3</sup> of this solution reacts exactly with 16.0cm<sup>3</sup> of 0.250mol dm<sup>-3</sup> aqueous NaOH.

- (i) Complete the equation for the reaction of glycolic acid with sodium hydroxide.



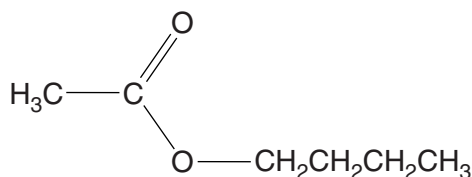
[1]

- (ii) Calculate the mass of glycolic acid in  $100\text{ cm}^3$  of *Acnegone* and state whether *Acnegone* should be classed as a hazardous product. Give your answer to an **appropriate** number of significant figures.

mass of glycolic acid = ..... g in  $100\text{ cm}^3$

is it classed as hazardous? ..... [6]

- (c) Carboxylic acids can be converted to esters. Esters, such as compound **D**, are often used in varnishes.



**compound D**

- (i) Name compound **D** and circle the ester group.

..... [2]

- (ii) **Name** the compounds you would heat under reflux with ethanoic acid to form compound **D**.

.....

..... [2]

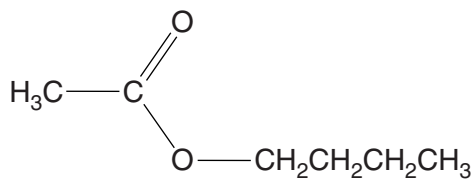
- (iii) Name the types of intermolecular bonds present in ethanoic acid and compound **D**.

ethanoic acid .....

.....

compound **D** .....

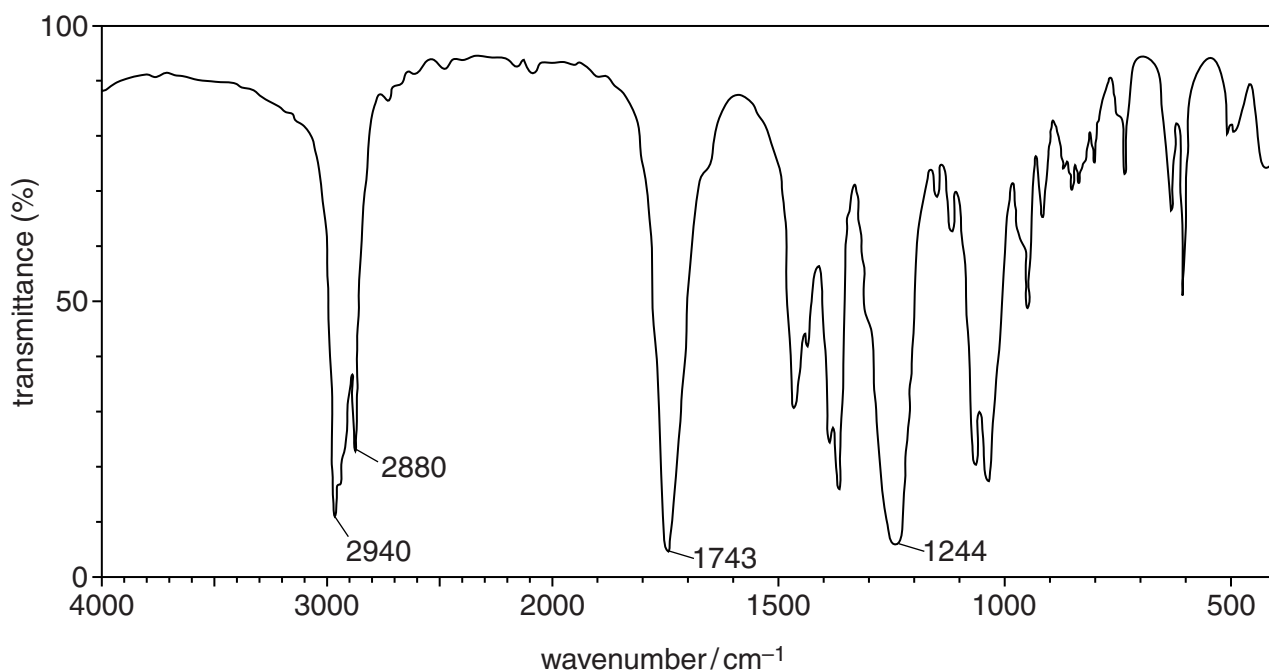
.....



compound **D**

- (d) A student attempts to synthesise compound **D** from ethanoic acid. The student distils off the product and runs an infrared spectrum and a mass spectrum on it.

The infrared spectrum is shown below.



- (i) Use the IR spectrum and your *Data sheet* to give **two** pieces of evidence to show that the product does not contain any starting materials.

.....

.....

.....

.....

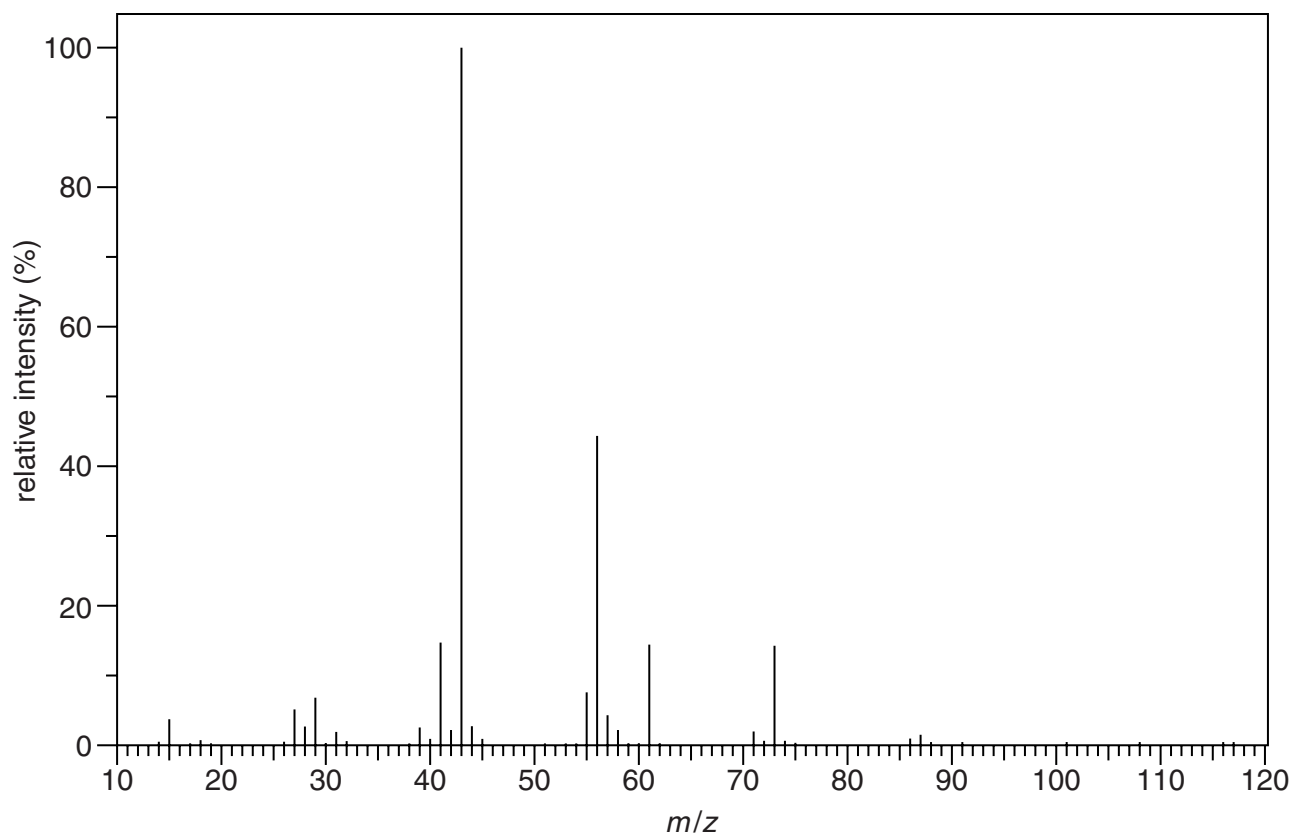
.....

.....

..... [2]



The mass spectrum of the ester is shown below.



(ii) Suggest formulae for the following:

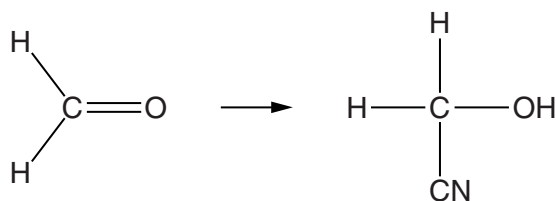
- the chemical species responsible for the peak at  $m/z$  73,
- the species **lost** from the molecular ion to form this chemical species.

Write your answers in the table below the working space.

	Formula
<b>Species which gives the peak at <math>m/z</math> 73</b>	
<b>Species lost from the molecular ion</b>	

[3]

- (e) Glycolic acid can be made from methanal. Methanal is first reacted with cyanide ions in aqueous solution to form a cyanohydrin.



- (i) Underline **two** of the following words which describe the mechanism of the reaction described above.

**addition**

**condensation**

**electrophilic**

**elimination**

**nucleophilic**

**radical**

**substitution**

[2]

- (ii) Describe the mechanism of the reaction using 'curly' arrows, bond polarities and relevant lone pairs of electrons.

[5]

[Total: 28]

3 DNA and proteins are polymers made up of long chains of monomer units. At one time proteins were considered more likely than DNA to transmit genetic data.

(a) (i) Name the monomer units in DNA and the components of which they are made.

.....  
 ..... [2]

(ii) Name the monomer units in proteins.

..... [1]

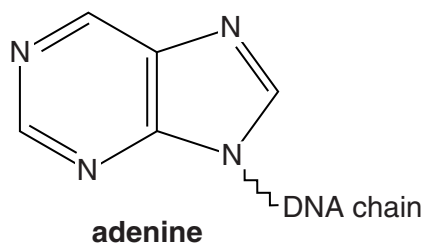
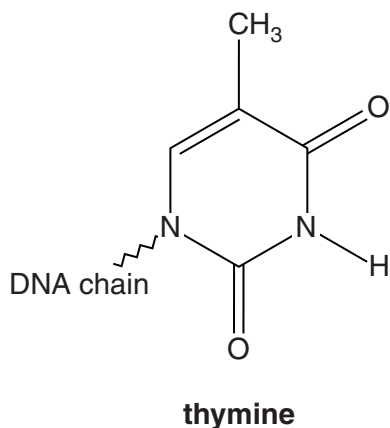
(iii) Suggest why scientists once thought that proteins were more likely to transmit genetic data.

.....  
 .....  
 .....  
 ..... [2]

(b) Hydrogen bonding is important in base pairing in DNA.

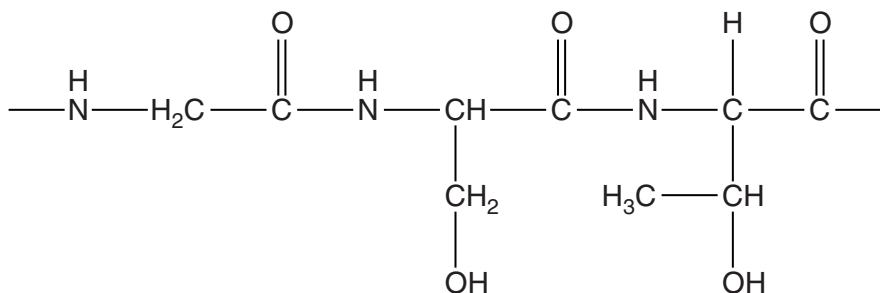
Complete the structure of adenine in the diagram below using your *Data Sheet*. Show how adenine hydrogen bonds with thymine.

Show any relevant lone pairs of electrons and partial charges.



[3]

(c) The diagram below shows part of the primary structure of an enzyme.



(i) On the diagram circle **two** chiral carbon atoms. [1]

(ii) Proteins are hydrolysed by refluxing with aqueous NaOH.

On the diagram above draw arrows pointing to the bonds that will break in the two **full** peptide links in the structure. [1]

(iii) Draw the structural formula of the complete ion formed by breaking **these** peptide links in **alkaline** solution.

[2]

(iv) As well as having a primary structure, enzymes also have secondary and tertiary structures.

What is meant by the *secondary structure* and the *tertiary structure* of an enzyme?

secondary.....

.....

tertiary.....

..... [2]

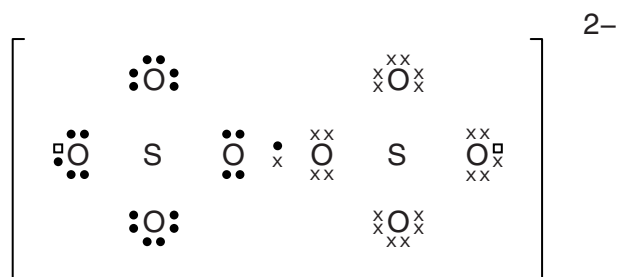
[Total: 14]

- 4 A common way of cleaning laboratory glassware is by dipping it in a bath containing acidified potassium dichromate(VI), often called chromic acid, which is a powerful oxidising agent. However, such use of compounds containing heavy metal ions is considered hazardous.

'Nochromix®' is a metal-free alternative to chromic acid. It consists of ammonium peroxodisulfate crystals. These are white crystals that are very soluble in water, forming a solution which can also act as a strong oxidising agent.

- (a) The diagram shows the arrangement of atoms in a peroxodisulfate ion,  $S_2O_8^{2-}$ .

- (i) Complete the diagram to show a 'dot-and-cross' representation of the peroxodisulfate ion.



▫ represents the extra electrons required to form the ion

[2]

- (ii) Give the formula of ammonium peroxodisulfate.

..... [1]

- (b) Use the data in the table below to decide which of the two oxidising agents,  $Cr_2O_7^{2-}/H^+$  and  $S_2O_8^{2-}$ , is the stronger under standard conditions.

Give your reasoning.

Half-reaction	$E^\circ/V$
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.33
$S_2O_8^{2-} + 2e^- \rightarrow 2SO_4^{2-}$	+2.01

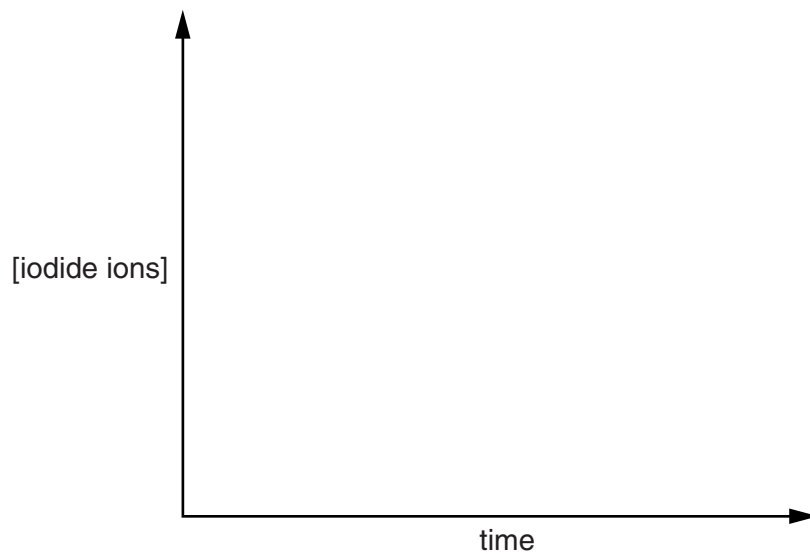
.....  
 .....  
 ..... [2]



(iii) The student converts the concentrations of iodine into concentrations of iodide remaining.

The student then uses a time–concentration graph to show that the reaction is first-order with respect to iodide ions.

Sketch a curve and indicate on the graph how the reaction can be shown to be first-order.



[3]

**Question 4 continues on page 16**

- (d) The student investigates whether transition metal ions would catalyse the reaction between  $\text{S}_2\text{O}_8^{2-}$  and  $\text{I}^-$  ions. The student uses the data in the table below to decide if the use of  $\text{Fe}^{3+}$  ions might speed the reaction up.

Half-reaction	$E^\ominus / \text{V}$
$\text{I}_2 + 2\text{e}^- \rightarrow 2\text{I}^-$	+0.54
$\text{Fe}^{3+} + \text{e}^- \rightarrow \text{Fe}^{2+}$	+0.77
$\text{S}_2\text{O}_8^{2-} + 2\text{e}^- \rightarrow 2\text{SO}_4^{2-}$	+2.01

- (i) Name the **type** of catalysis the student is investigating.

Give a reason for your answer.

.....  
 ..... [1]

- (ii) Complete the electron structures for  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ .

$\text{Fe}^{2+}$        $1\text{s}^22\text{s}^22\text{p}^6$  .....

$\text{Fe}^{3+}$        $1\text{s}^22\text{s}^22\text{p}^6$  .....

[2]

- (iii) Use the table of data to explain why adding  $\text{Fe}^{3+}$  ions to the mixture of  $\text{I}^-$  and  $\text{S}_2\text{O}_8^{2-}$  ions provides an alternative route for this reaction.

Include ionic equations for any reactions you describe.



*In your answer you should explain how the data from the table are linked to the reactions you describe.*

.....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 ..... [6]



(e) The student's results for the uncatalysed reaction are given below.

Experiment	$[\text{S}_2\text{O}_8^{2-}]$ / $\text{mol dm}^{-3}$	$[\text{I}^-]$ / $\text{mol dm}^{-3}$	Rate of formation of iodine, $\text{I}_2$ / $\text{mol dm}^{-3} \text{ s}^{-1}$
1	0.075	0.040	$2.0 \times 10^{-5}$
2	0.150	0.040	$4.0 \times 10^{-5}$
3	0.075	0.020	$1.0 \times 10^{-5}$

(i) Complete the rate equation for the reaction.

Rate =  $k \times$  [2]

(ii) Calculate the rate constant,  $k$ , for the reaction and give its units.

$k =$  ..... units ..... [3]

(iii) What would be the rate of **disappearance of  $\text{I}^-$**  in experiment 3?

..... [2]

[Total: 31]

**END OF QUESTION PAPER**

**ADDITIONAL ANSWER SPACE**

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines extending across the page, providing space for writing answers.

Lined writing paper with a vertical margin line on the left and horizontal dashed lines for writing.

A large area of the page is reserved for writing, featuring a vertical solid line on the left side and horizontal dotted lines extending across the page.



**Copyright Information**

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.