Cambridge Assessment International Education

Interactive

Interactive Example Candidate Responses
Paper 42 (May/June 2016), Question 6

Cambridge International AS & A Level Chemistry 9701

Version 1.0

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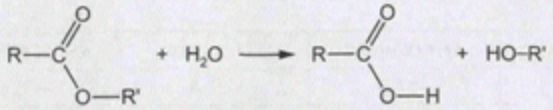
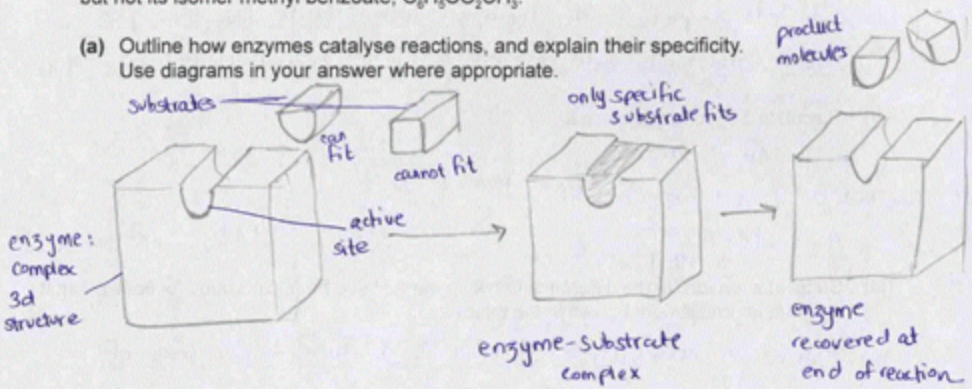
HIGH | MIDDLE | LOW

6 Esterases are enzymes that hydrolyse esters.



Enzymes can be quite specific in the structures of the substrates they act upon. For example, an esterase isolated from the mould *Aspergillus niger* will hydrolyse phenyl ethanoate, $CH_3CO_2C_6H_5$, but not its isomer methyl benzoate, $C_6H_5CO_2CH_3$.

(a) Outline how enzymes catalyse reactions, and explain their specificity. Use diagrams in your answer where appropriate.



Enzymes are biological catalysts. They reduce the activation energy for a reaction by providing an alternative pathway for reaction. Now ~~when~~ many more substrate molecules have the Ea required and reaction rate increases. Enzymes are highly specific, with an active site only certain substrates can fit into. An enzyme-substrate complex is formed, the product is made and enzyme is recovered unchanged

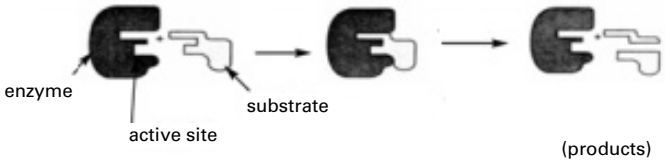
[3]

Your Mark

6(a) ☐

6(b)(i) ☐

6(b)(ii) ☐

Q6	Mark scheme
(a)	*essential mark* M1 the reactants / substrate has a **shape** complementary / **specific** to **active site** – can be awarded from a labelled diagram as below or diagrams showing this specificity clearly *any two of* M2: reactants / substrate binds to / fits into the active site of the enzyme M3: (Interaction with site) causes a specific bond to be weakened, (which breaks) **or** lowers activation energy M4: forms an E-S complex M5: products released from enzyme / active site **labelled diagrams**  **[3]**
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EXAMINER COMMENTS | MARK SCHEME

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(b) Sample bottles of each of the isomers phenyl ethanoate and methyl benzoate have lost their labels and so have been named isomer **A** and isomer **B**.

(i) The carbon-13 NMR spectra of isomers **A** and **B** contain the following peaks.

isomer A	isomer B
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The identity of the compound responsible for each spectrum can be deduced by studying the chemical shifts (δ) of the peaks in the spectra.

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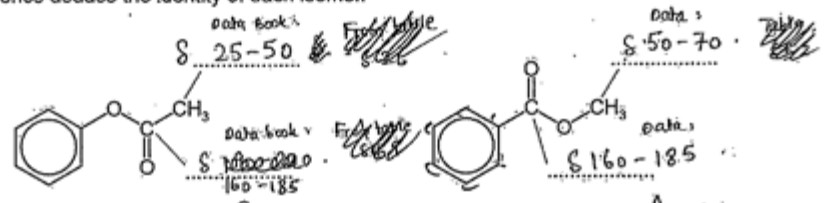

phenyl ethanoate is isomer B methyl benzoate is isomer A

[2]

(ii) These two isomers are difficult to distinguish chemically.

Describe a method of converting them to suitable products in step 1 which can then be tested in step 2.
You should state the reagents and conditions for each step, and any observations you would make.

step 1 Hydrolyse with dil. HCl and heat. A phenol and a benzoic acid will result

step 2 React with Br_2(aq) compounds. The phenol will form a white ppt precipitate of tribromophenol and decolourise. The benzoic acid will not. So phenyl ethanoate will be the white ppt compound parent.

[3]

[Total: 8]

Your Mark

6(a) ☐

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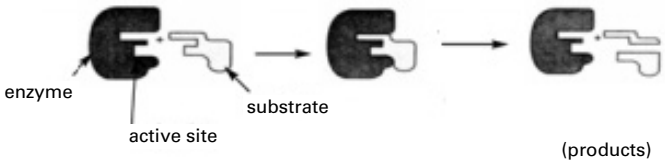
(a)	*essential mark* M1 the reactants / substrate has a **shape** complementary / **specific** to **active site** – can be awarded from a labelled diagram as below or diagrams showing this specificity clearly *any two of* M2: reactants / substrate binds to / fits into the active site of the enzyme M3: (Interaction with site) causes a specific bond to be weakened, (which breaks) **or** lowers activation energy M4: forms an E-S complex M5: products released from enzyme / active site **labelled diagrams**  **[3]**
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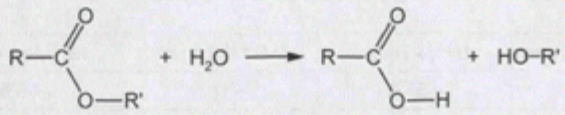

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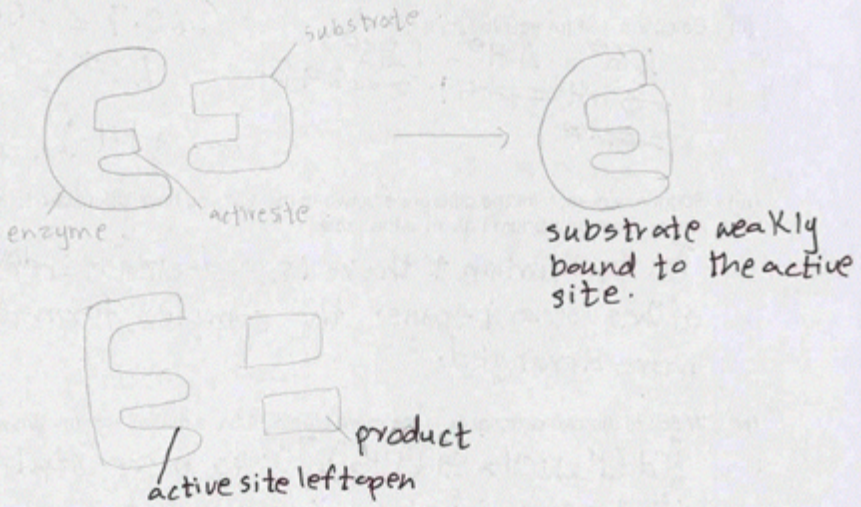

The enzymes have an active site with a specific three-dimensional shape which is complementary to the substrate. The substrate weakly binds to it and is converted to product after which the active site is left open for another substrate molecule. [3]

Your Mark

6(a)

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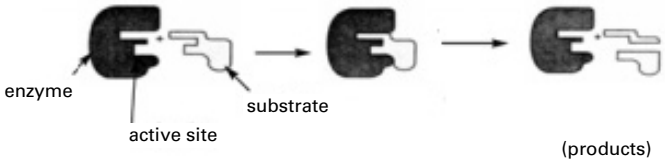
(a)	*essential mark* M1 the reactants / substrate has a **shape** complementary / **specific** to **active site** – can be awarded from a labelled diagram as below or diagrams showing this specificity clearly *any two of* M2: reactants / substrate binds to / fits into the active site of the enzyme M3: (Interaction with site) causes a specific bond to be weakened, (which breaks) **or** lowers activation energy M4: forms an E-S complex M5: products released from enzyme / active site **labelled diagrams**  **[3]**
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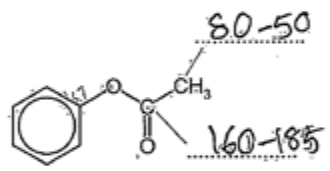

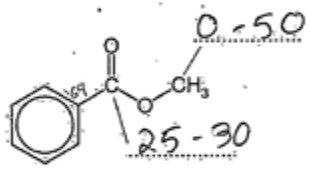

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[2]

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step 1 Add a ~~carboxylic acid~~ NaOH (aq) to it. It will lead to the formation of phenol

step 2 Phenol can be tested with aq. Bromine it will form a white ppt.

[3]

Your Mark

6(a) ☐

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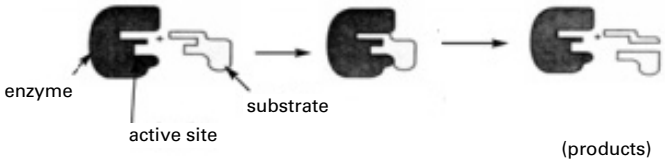
(a)	*essential mark* M1 the reactants / substrate has a **shape** complementary / **specific** to **active site** – can be awarded from a labelled diagram as below or diagrams showing this specificity clearly *any two of* M2: reactants / substrate binds to / fits into the active site of the enzyme M3: (Interaction with site) causes a specific bond to be weakened, (which breaks) **or** lowers activation energy M4: forms an E-S complex M5: products released from enzyme / active site **labelled diagrams**  **[3]**
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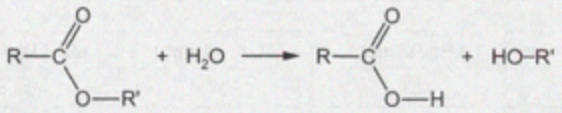

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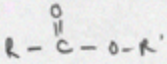

Enzymes have a specific site called active site, which provides adsorption for specific reactant only. They act as a catalyst and speed up the esterification. [3]

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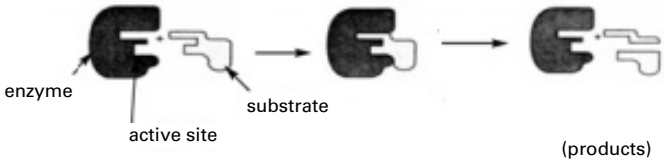
(a)	*essential mark* M1 the reactants / substrate has a **shape** complementary / **specific** to **active site** – can be awarded from a labelled diagram as below or diagrams showing this specificity clearly *any two of* M2: reactants / substrate binds to / fits into the active site of the enzyme M3: (Interaction with site) causes a specific bond to be weakened, (which breaks) **or** lowers activation energy M4: forms an E-S complex M5: products released from enzyme / active site **labelled diagrams**  **[3]**
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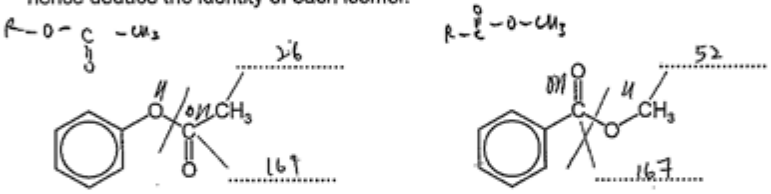

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step 1 ~~Use concentrated hydrochloric acid~~ Hydrolysis is used to produce 2 different products for each compound. Dilute $H^+(aq)$ and heat under reflux.

step 2 Use $I_2(aq) + NaOH(aq)$. The products of Isomer B from step 1 will give yellow precipitate as positive result.

[3]

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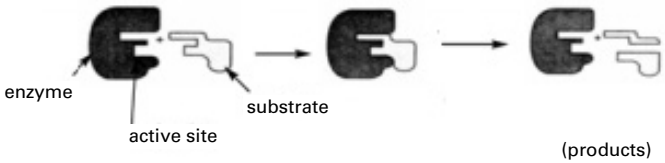
(a)	*essential mark* M1 the reactants / substrate has a **shape** complementary / **specific** to **active site** – can be awarded from a labelled diagram as below or diagrams showing this specificity clearly *any two of* M2: reactants / substrate binds to / fits into the active site of the enzyme M3: (Interaction with site) causes a specific bond to be weakened, (which breaks) **or** lowers activation energy M4: forms an E-S complex M5: products released from enzyme / active site **labelled diagrams**  **[3]**
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EXAMINER COMMENTS

MARK SCHEME

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