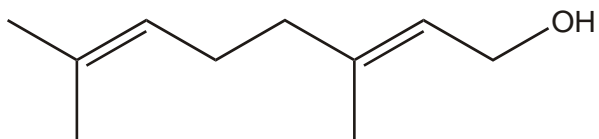


## Carbonyls and carboxylic acids

1.



geraniol

Mild oxidation of geraniol gives an aldehyde **Y**.

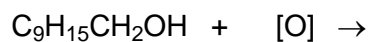
(i) Draw the skeletal formula of aldehyde **Y** below.



aldehyde **Y**

[2]

(ii) Complete the equation for the oxidation of geraniol to aldehyde **Y**.

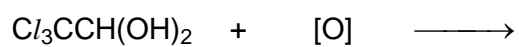


[2]

[Total 4 marks]

2. Chloral hydrate is broken down in the body after several hours. One reaction is oxidation to trichloroethanoic acid.

Complete the equation for this reaction below.



[Total 1 mark]

3. Cinnamaldehyde can be reduced using sodium borohydride, NaBH<sub>4</sub>.

(i) State which functional group reacts with the sodium borohydride.

.....

[1]

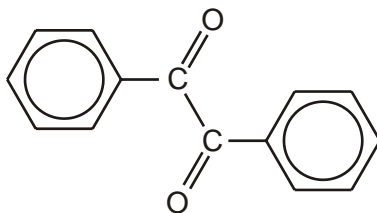
(ii) Complete and balance the equation for this reaction.



[1]

[Total 2 marks]

4. The reducing agent, NaBH<sub>4</sub>, is used widely in organic chemistry. One example is for the reduction of diphenylethanedione, C<sub>14</sub>H<sub>10</sub>O<sub>2</sub>, shown below.



**diphenylethanedione**

(i) Draw a displayed formula to show the structure of the organic product that would be formed by reducing diphenylethanedione with excess NaBH<sub>4</sub>.

[1]

(ii) Complete and balance the equation for this reaction, using [H] to represent the reducing agent.



[1]

[Total 2 marks]

5. But-2-enal,  $\text{CH}_3\text{CH}=\text{CHCHO}$ , is a pale yellow, flammable liquid with an irritating odour.

- (a) (i) Describe a simple chemical test that would show that but-2-enal is an aldehyde.

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[2]

- (ii) Explain why this test gives a different result with aldehydes than it does with ketones.

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[1]

- (b) But-2-enal also reacts with sodium borohydride,  $\text{NaBH}_4$ .

- (i) Identify the organic compound formed in this reaction.

.....

[1]

- (ii) State the type of chemical reaction occurring.

.....

[1]

- (c) Precautions must be taken to prevent but-2-enal catching fire.

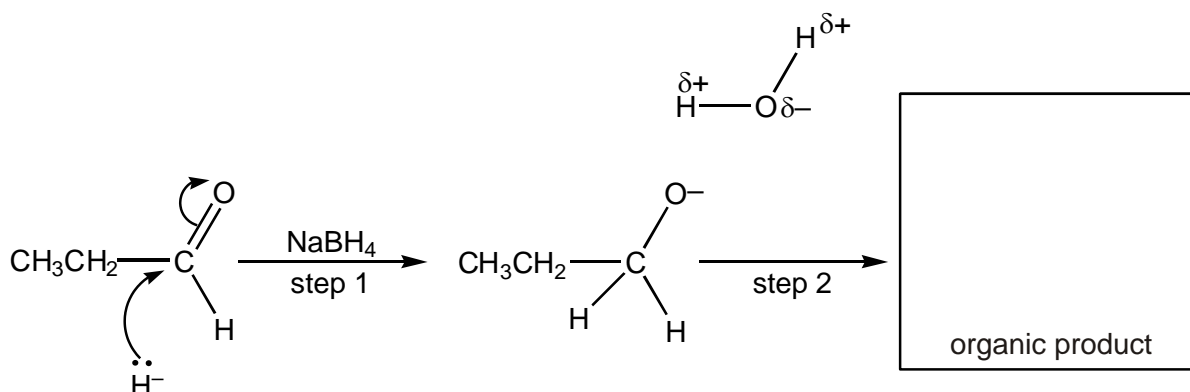
Construct a balanced equation for the complete combustion of but-2-enal,  $\text{C}_4\text{H}_6\text{O}$ .

[1]

[Total 6 marks]

6. Propanal,  $\text{CH}_3\text{CH}_2\text{CHO}$ , can be used in the synthesis of organic compounds.

$\text{CH}_3\text{CH}_2\text{CHO}$  reacts with  $\text{NaBH}_4$  in a nucleophilic addition reaction. The nucleophile can be represented as a hydride ion,  $\text{H}^-$ . A mechanism for the reaction is shown below.



- (i) Add 'curly arrows' to the mechanism to show how the intermediate reacts with the water molecule in **step 2**.

[2]

- (ii) Draw the structure of the organic product in the box above.

[1]

- (iii) What is meant by the term *nucleophile*?

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[1]

- (iv) Describe, in words, exactly what is happening to the electron pairs and bonds in **step 1** of the mechanism above.

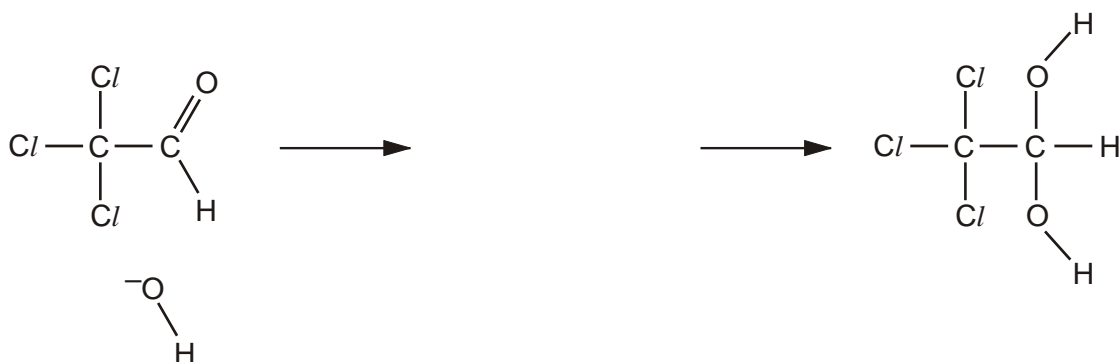
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[3]

[Total 7 marks]

7. (a) The reaction of trichloroethanal with water is a nucleophilic addition reaction. It can be catalysed by small amounts of hydroxide ions,  $\text{OH}^-$ .

Complete the diagram below to suggest a mechanism for this reaction. Show all the relevant dipoles and curly arrows.



[5]

- (b) The recommended adult dose of chloral hydrate as a sedative is 250 mg, three times a day.

Calculate the mass of **trichloroethanal** you would need to react with water to make one week's supply of chloral hydrate for an adult, assuming a 60% yield.

$M_r$ : chloral hydrate, 165.5; trichloroethanal, 147.5

mass of trichloroethanal = ..... g

[3]

[Total 8 marks]

8. In this question, one mark is available for spelling, punctuation and grammar.

Tollens' reagent can be used to identify the aldehyde group in cinnamaldehyde,  $\text{C}_6\text{H}_5\text{CH}=\text{CHCHO}$ .

- Describe how you would make Tollens' reagent and carry out this test in the laboratory.
- Explain what happens to both the Tollens' reagent and the cinnamaldehyde in this reaction. Identify the organic product.

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[7]

Quality of Written Communication. [1]

[Total 8 marks]