

# Carboxyl groups

## Question Paper

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|------------|---|
| Level      | Pre U   |
| Subject    | Chemistry                                     |
| Exam Board | Cambridge International Examinations          |
| Topic      | Carboxyl groups-Higher functional group level |
| Booklet    | Question Paper                                |

**Time Allowed:** 28 minutes

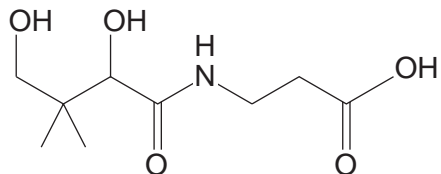
**Score:** /23

**Percentage:** /100

**Grade Boundaries:**

1. Pantothenic acid, vitamin B<sub>5</sub>, is a water-soluble vitamin needed to form coenzyme-A (CoA), and it is critical in the metabolism and synthesis of carbohydrates, proteins and fats.

The skeletal formula of pantothenic acid is shown.



- (a) Name fully all the functional groups present in a molecule of pantothenic acid.

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..... [4]

- (b) Give the structures of the organic products that would be formed if pantothenic acid was

(i) hydrolysed by reaction with aqueous acid,

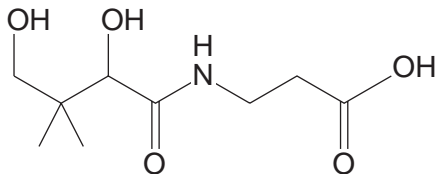
[2]

(ii) reacted with sodium metal.

[2]

- (c) Pantothenic acid is a chiral molecule and the full name of the biologically active form includes the prefixes *R* and (+).

- (i) Draw a circle around the chiral carbon in the molecule of pantothenic acid shown.



[1]

- (ii) Explain the meaning of each of the prefixes in the name *R*-(+)-pantothenic acid.

(+) .....

.....

*R* .....

.....

.....

.....[3]

- (d) The value of the acid dissociation constant,  $K_a$ , for pantothenic acid is  $3.98 \times 10^{-5}$ , whilst that for propanoic acid is  $1.32 \times 10^{-5}$ .

- (i) Calculate the pH of a  $0.20 \text{ mol dm}^{-3}$  solution of pantothenic acid.

pH = .....[3]

- (ii) The inductive effect can be used to account for the difference in the acid dissociation constants of pantothenic acid and propanoic acid. Explain why.

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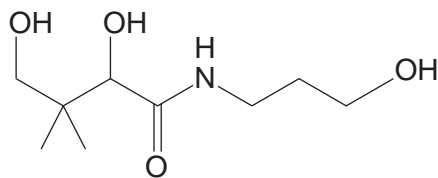
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.....[3]

- (e) A derivative of pantothenic acid, pantothenol, is a more stable form of the vitamin. It is often used in multivitamin supplements as it is converted to pantothenic acid in the body. Its structure is shown.



The structural formula of pantothenol is  $\text{HOCH}_2\text{C}(\text{CH}_3)_2\text{CHOHCONH}(\text{CH}_2)_3\text{OH}$  and its molecular formula is  $\text{C}_9\text{H}_{19}\text{NO}_4$ .

- (i) With reference to the idea of functional group level, explain what type of reaction is involved in the conversion of pantothenol into pantothenic acid.

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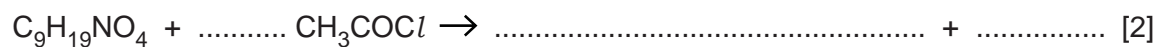
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- (ii) Give the structural formula of the organic product of the reaction of pantothenol with ethanoyl chloride.

[1]

- (iii) Complete and balance the equation below for the reaction of pantothenol with ethanoyl chloride, using **molecular formulae** for the products.



[Total: 23]