5 **(a)** Describe and explain the shape of benzene.

In your answer, include:

- the shape and bond angle in the ring
- the hybridisation of the carbon atoms
- how orbital overlap forms σ and π bonds between the carbon atoms in the ring.

.....

.....

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.....

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.....

.....

..... [4]

(b) Fig. 5.1 shows two reactions of benzoic acid.

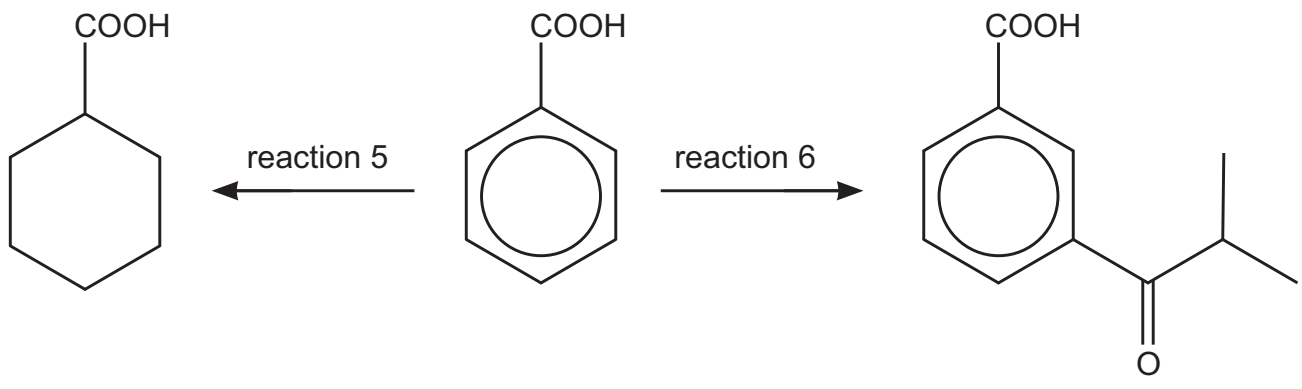

Fig. 5.1

(i) Suggest reagents and conditions for reaction 5 and for reaction 6 in Fig. 5.1.

reaction 5 .....

reaction 6 .....

[2]

(ii) State the type of reaction for reaction 5 in Fig. 5.1.

..... [1]

(c) In the electrophilic substitution of arenes, different substituents can direct to different ring positions.

(i) Describe the directing effect of the $-CH_2CH_3$ group.

Explain your answer.

.....

..... [1]

(ii) The alkylation of arenes uses a mixture of CH_3CH_2Br and $FeBr_3$ to generate the $CH_3CH_2^+$ electrophile.

Write an equation for the formation of the $CH_3CH_2^+$ electrophile.

..... [1]

(iii) Complete the mechanism in Fig. 5.2.

Include all relevant curly arrows and charges. Draw the structure of the organic intermediate.

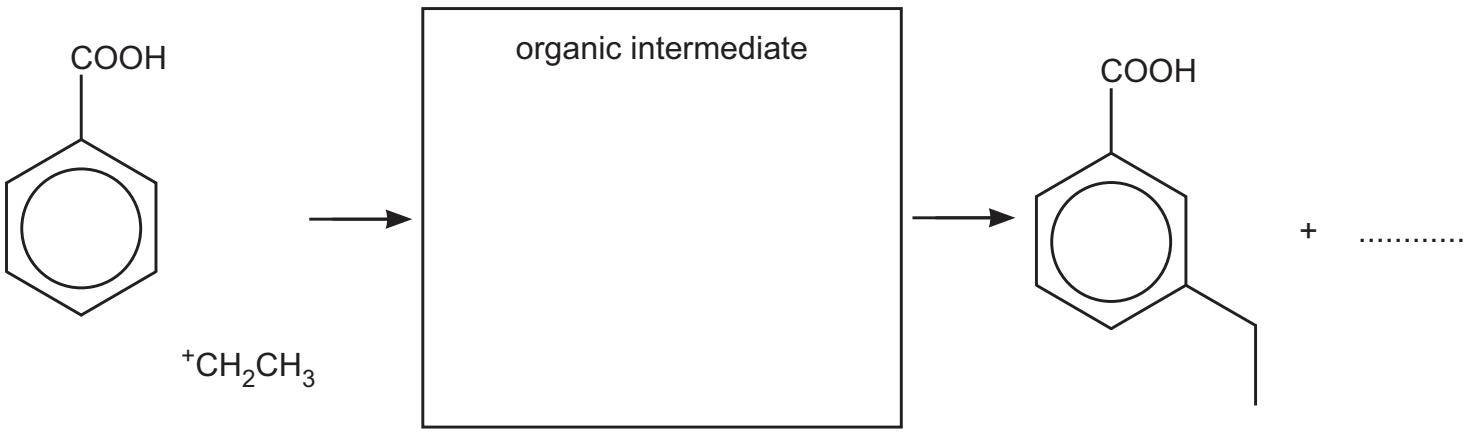

Fig. 5.2

[3]

(iv) Write an equation to show how $FeBr_3$ is regenerated after the reaction in Fig. 5.2.

..... [1]

[Total: 13]