

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

(i) Describe the directing effect of the $-\text{NO}_2$ group. Explain your answer.

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

(ii) The nitration of arenes uses a mixture of concentrated HNO_3 and concentrated H_2SO_4 to generate the NO_2^+ electrophile.

Write an equation for the formation of the NO_2^+ electrophile.

..... [1]

(b) Carbon-carbon bond formation is an important reaction in organic synthesis.

Fig. 8.1 shows the synthesis of compound **Q** from benzene in two reaction steps.

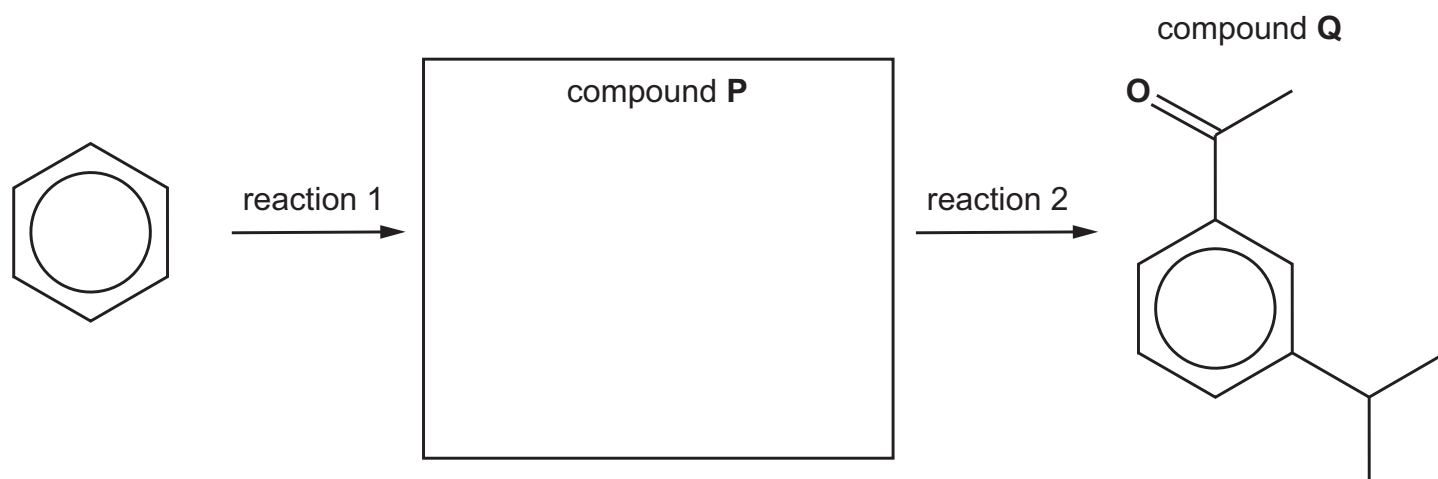


Fig. 8.1

(i) Draw the structure of compound **P** in the box in Fig. 8.1.

[1]

(ii) Suggest reagents and conditions for reactions 1 and 2 in Fig. 8.1.

reaction 1

reaction 2

[2]

(c) Separate samples of $\text{C}_6\text{H}_5\text{Br}$ and $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$ are added to warm $\text{AgNO}_3(\text{aq})$.

State the expected observations, if any. Explain your answer.

$\text{C}_6\text{H}_5\text{Br}$ with $\text{AgNO}_3(\text{aq})$

$\text{C}_6\text{H}_5\text{CH}_2\text{Br}$ with $\text{AgNO}_3(\text{aq})$

explanation

.....

.....

.....

[3]

(d) Acyl bromides, RCOBr , react readily with H_2O .

The mechanism of this reaction is similar to that of the reaction of H_2O with acyl chlorides, RCOCl .

(i) Name the mechanism of this reaction.

..... [1]

(ii) Complete the mechanism in Fig. 8.2 for the reaction of RCOBr with H_2O .

Include all relevant lone pairs of electrons, curly arrows, charges and dipoles.

Draw the structure of the intermediate.

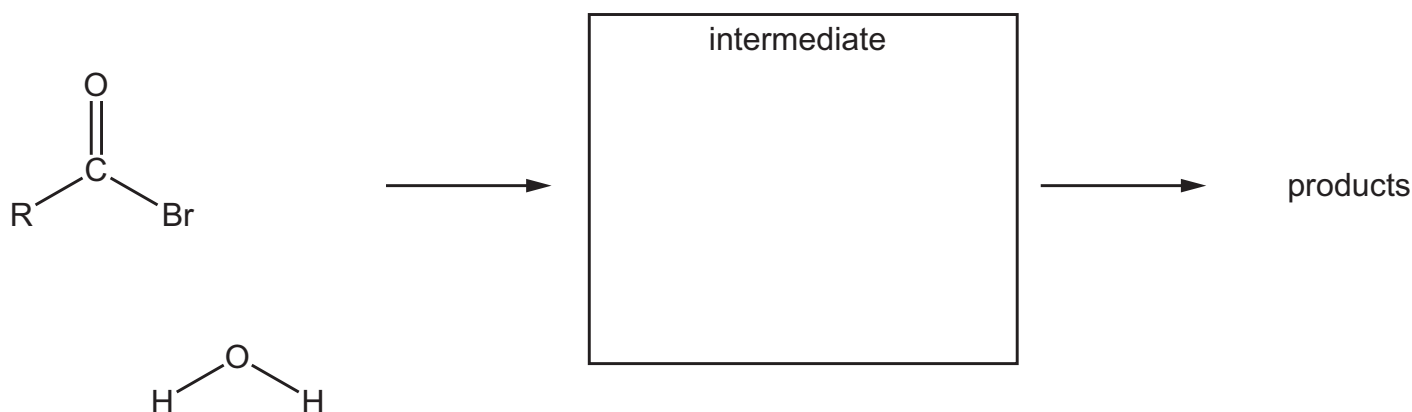


Fig. 8.2

[4]

[Total: 13]

- 7 (a) State the relative acidities of bromoethanoic acid, BrCH_2COOH , chloroethanoic acid, ClCH_2COOH , ethanoic acid, CH_3COOH and ethanol, $\text{CH}_3\text{CH}_2\text{OH}$.

Explain your answer.

.....		
most acidic		least acidic
.....		
.....		
.....		
.....		
.....		
.....		
.....		

[4]

- (b) Fig. 7.1 shows the reaction of methylbenzene and ethanedioic acid with KMnO_4 .

Predict the major carbon-containing product for each of these reactions.

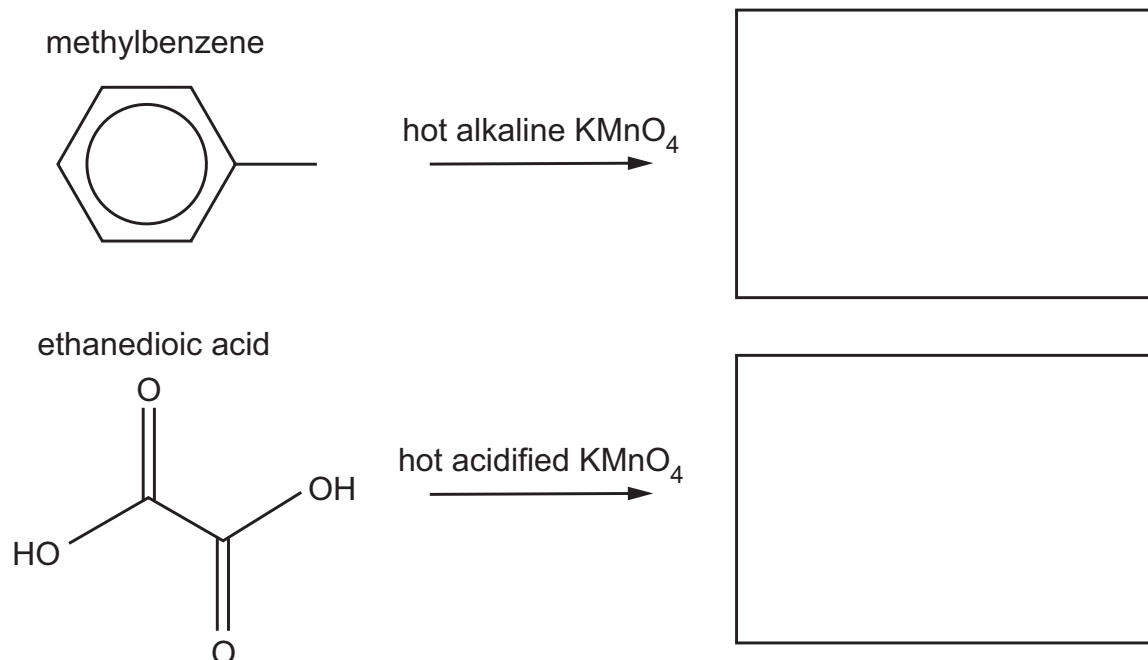
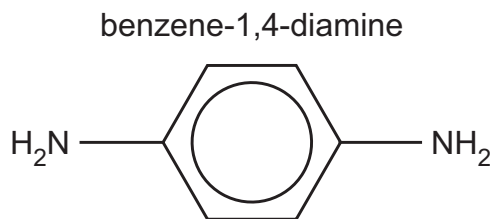


Fig. 7.1

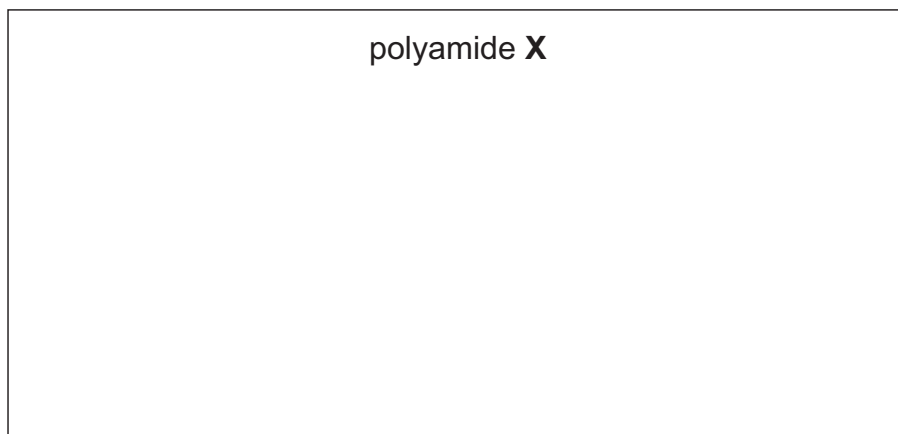
[2]

(c) Polyamide **X** can be synthesised from ethanedioic acid and benzene-1,4-diamine.



(i) Draw the repeat unit of polyamide **X** in the box.

The new functional group formed should be shown displayed.



[2]

(ii) Benzene-1,4-diamine can be formed by reduction of 1,4-dinitrobenzene.

Complete the equation for this reduction.

[H] represents one atom of hydrogen from a reducing agent.



[1]

(d) Fig. 7.2 shows the two-step synthesis of the azo compound **W**.

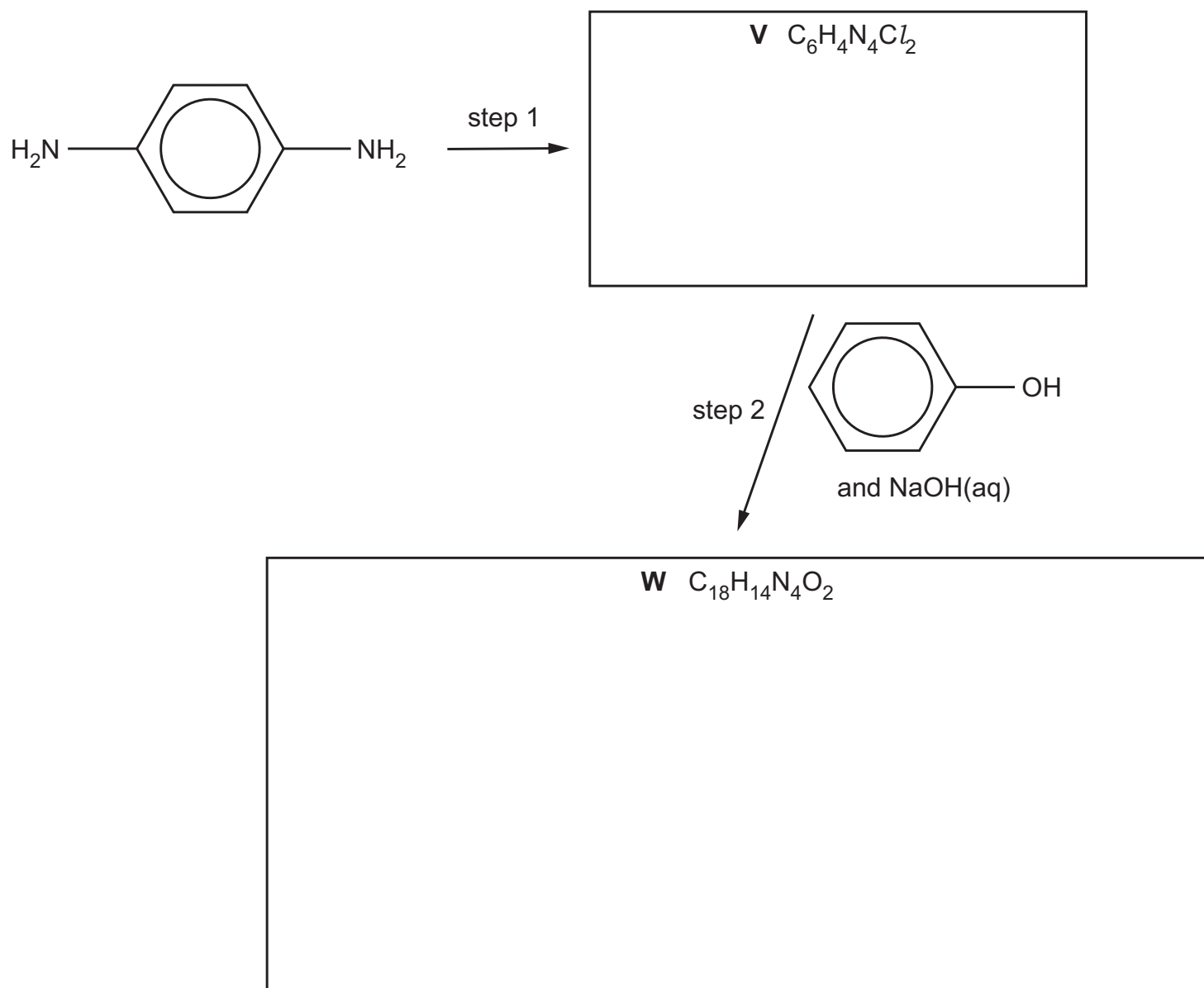


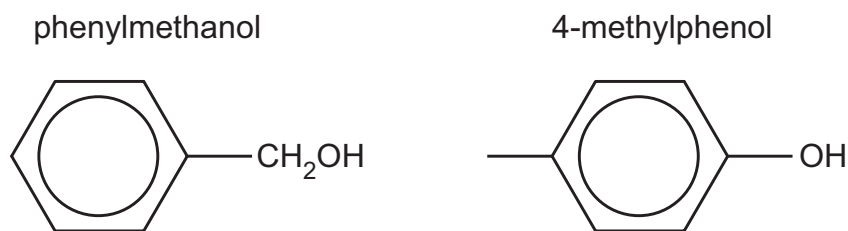
Fig. 7.2

- (i) Suggest structures for compounds **V** and **W** and draw them in the boxes in Fig. 7.2. [2]
- (ii) Give the reagents and conditions for step 1.

..... [1]

[Total: 12]

7 Phenylmethanol and 4-methylphenol are isomers.



(a) Complete Table 7.1 to show the relative acidities of benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$), phenylmethanol, 4-methylphenol and water.

Explain your answer.

Table 7.1

most acidic ↓ least acidic	name of compound

explanation

.....

.....

.....

.....

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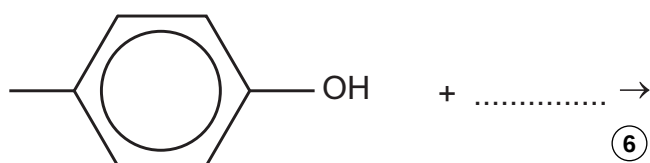
.....

.....

[4]

(b) 4-methylphenol reacts readily with sodium.

Complete the equation for this reaction.



- (c) Under certain conditions, ethane-1,2-diol, $\text{HOCH}_2\text{CH}_2\text{OH}$, reacts with propane-1,3-dioic acid, $\text{HOOCCH}_2\text{COOH}$, to form different organic products, as shown in Fig. 7.1.

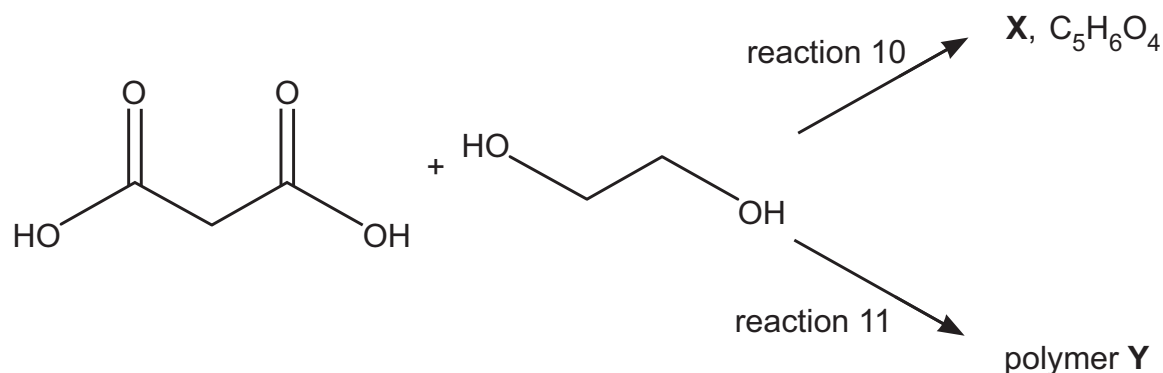


Fig. 7.1

- (i) **X** does **not** react with Na metal.

Draw the structure of the organic product **X**, $\text{C}_5\text{H}_6\text{O}_4$, shown in Fig. 7.1.

[1]

- (ii) Reactions 10 and 11 in Fig. 7.1 are different types of reaction.

Name the type of reaction for reaction 10 and for reaction 11.

reaction 10

reaction 11

[1]

- (iii) Draw a section of polymer **Y** showing only **one** repeat unit.

The new functional group formed should be displayed.

[2]