

1. Nov/2022/Paper\_41/No.7

(a) The structure of compound **P** is shown in Fig. 7.1.

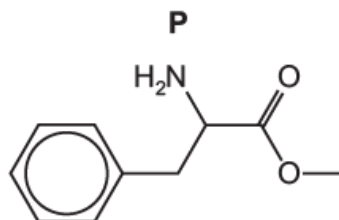


Fig. 7.1

(i) **P** is optically active.

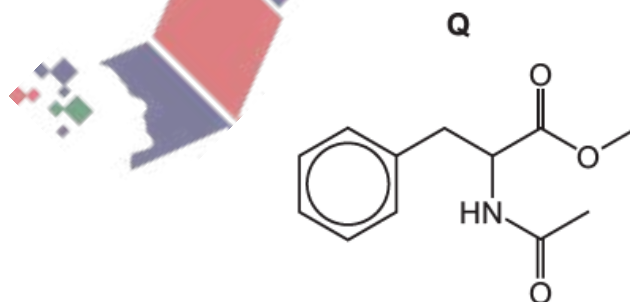
Use an asterisk (\*) to identify all chiral carbon atoms on the structure of **P** in Fig. 7.1. [1]

(ii) Plane polarised light is passed through a pure sample of one enantiomer of **P**. This is then repeated with a pure sample of the other enantiomer of **P**.

Describe the results of these two experiments, stating the similarities and differences of the results.

.....  
 .....  
 ..... [2]

(b) **P** can be used to make compound **Q** in a single step reaction.



(i) Give the structural formula of the compound that is added to **P** to make **Q** and give the formula of the other product of this reaction.

compound added to **P** .....

other product .....

[1]

- (ii) When an ester is treated with  $\text{LiAlH}_4$  in dry ether the ester linkage is cleaved by the addition of four hydrogen atoms and two alcohols are produced.

Draw the structures of the compounds formed when **Q** is treated with an **excess** of  $\text{LiAlH}_4$  in dry ether.

[3]

- (iii) Compare the relative basicities of compound **P**, compound **Q** and phenylamine.

..... < ..... < .....

least basic  most basic

Explain your answer.

.....

.....

.....

.....

[3]

- (c) **P** can be used to make compound **R** in a two-step reaction, shown in Fig. 7.2.



Fig. 7.2

- (i) Identify the reagents and conditions used for the two steps of the reaction.

step 1 .....

step 2 .....

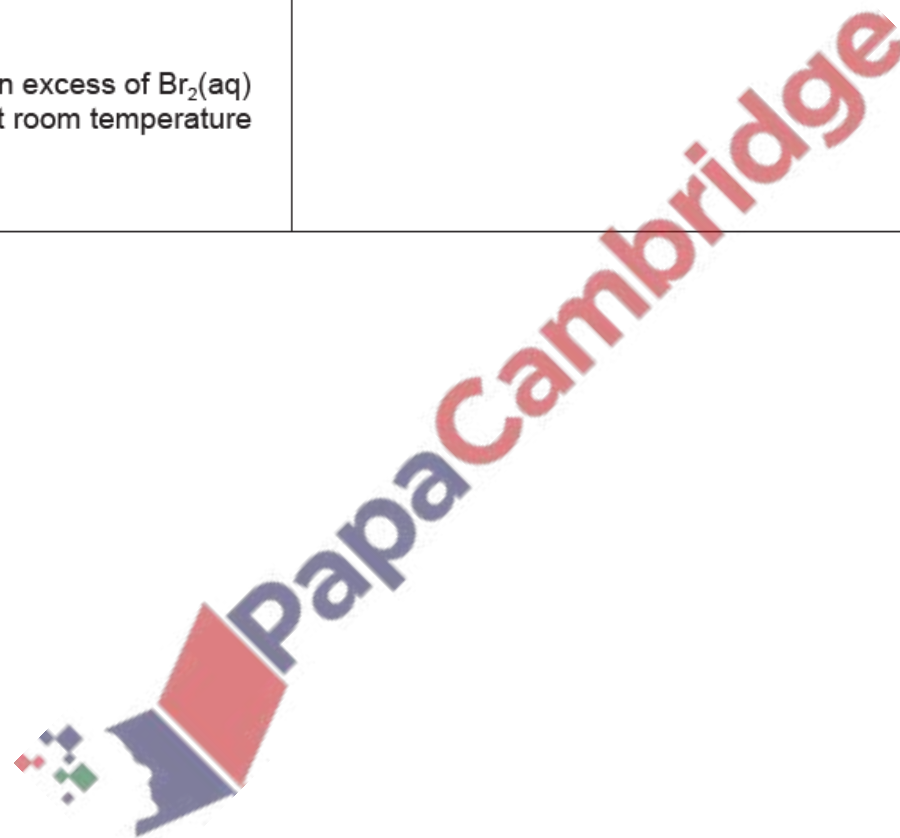
[2]

- (ii) Complete Table 7.1 by drawing the structures of the organic products formed when **R** is treated separately with the reagents given.

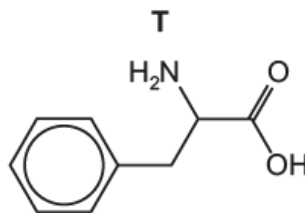
Table 7.1

reagent	product
$\text{HNO}_2(\text{aq})$ at $4^\circ\text{C}$	
an excess of $\text{Br}_2(\text{aq})$ at room temperature	

[2]



(d) P can be used to produce compound T.



(i) In aqueous solution, T has a property called an isoelectric point.

Explain what is meant by isoelectric point.

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

(ii) T can polymerise under suitable conditions. No other monomer is involved in this reaction.

Draw a section of the polymer chain formed that includes three T monomers. Identify the repeat unit on your diagram.

PapaCambridge

[2]

[Total: 17]



(c) Chlorobenzene and chloroethane have different reactivities in nucleophilic substitution reactions.

(i) Identify a suitable reagent to illustrate this difference in reactivity.

The reagent chosen should give **visibly** different results with chlorobenzene and chloroethane.

..... [1]

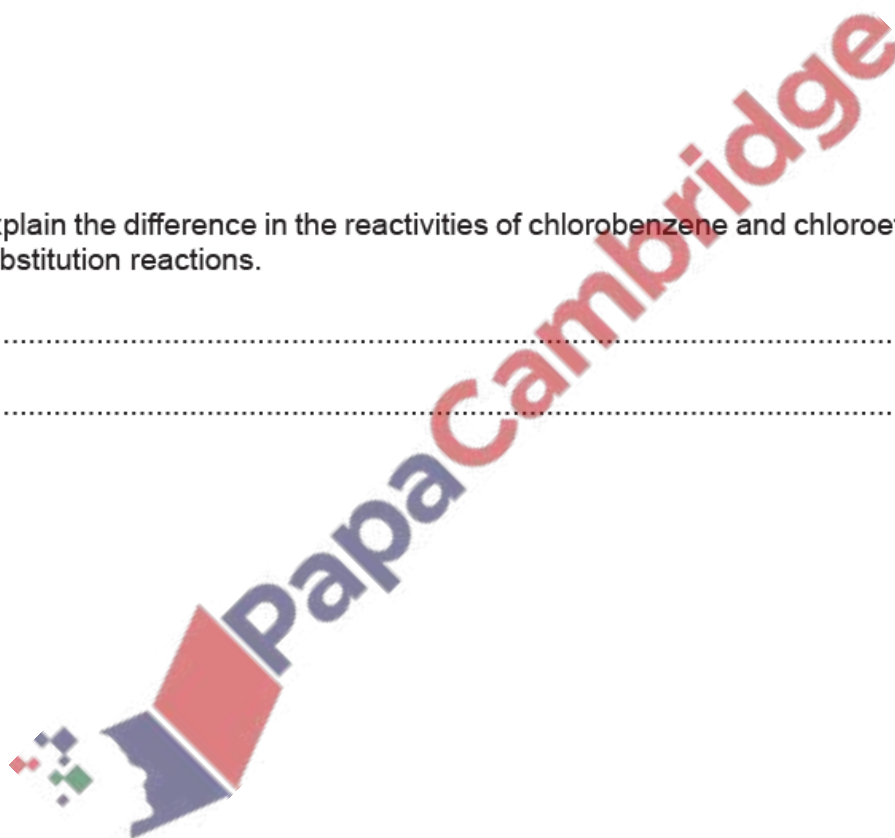
(ii) Write equations to describe any reactions that occur.

[1]

(iii) Explain the difference in the reactivities of chlorobenzene and chloroethane in nucleophilic substitution reactions.

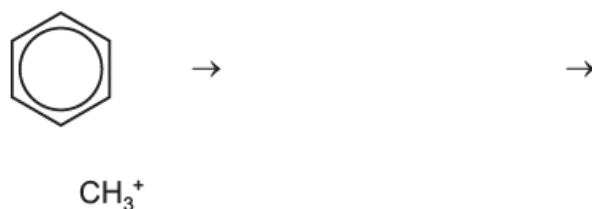
.....  
..... [1]

[Total: 8]





- (iii) Describe the mechanism for the reaction between benzene and the  $\text{CH}_3^+$  electrophile. Include all relevant curly arrows and charges.



[3]

- (iv) Identify a suitable reagent to oxidise methylbenzene to benzoic acid,  $\text{C}_6\text{H}_5\text{COOH}$ .

Write an equation for this reaction using [O] to represent one atom of oxygen from the oxidising agent.

reagent .....

equation .....

[2]

- (v) Methylbenzene and benzoic acid are both nitrated with a mixture of concentrated nitric acid and sulfuric acid to give mononitrated products. The structural formulae of these products are  $\text{CH}_3\text{C}_6\text{H}_4\text{NO}_2$  and  $\text{HOCC}_6\text{H}_4\text{NO}_2$  respectively.

Draw the structures of these two products.



[1]



(c) A reaction scheme is shown in Fig. 7.2.

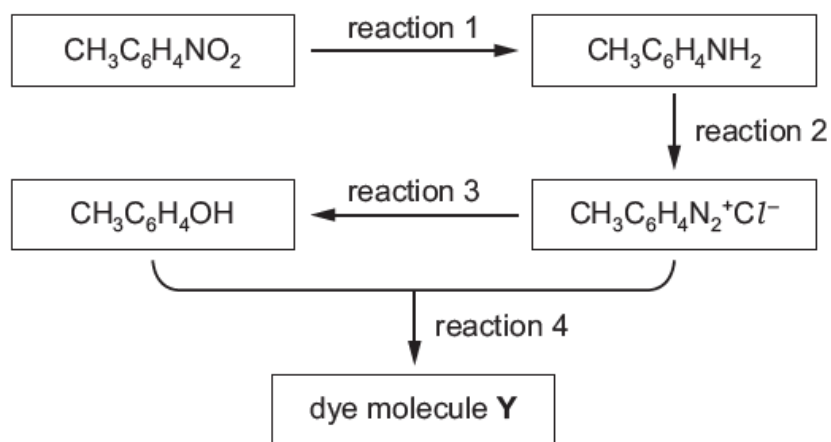


Fig. 7.2

- (i) Describe the reagents and conditions to produce  $\text{CH}_3\text{C}_6\text{H}_4\text{N}_2^+\text{Cl}^-$  from  $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$  in reaction 2.

reagents .....

conditions .....

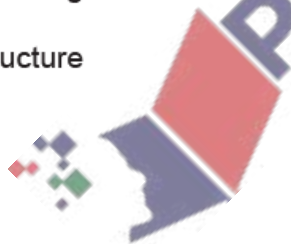
[1]

- (ii) Describe how  $\text{CH}_3\text{C}_6\text{H}_4\text{OH}$  can be produced from  $\text{CH}_3\text{C}_6\text{H}_4\text{N}_2^+\text{Cl}^-$  in reaction 3.

..... [1]

- (iii) Draw the structure of the dye molecule Y formed when  $\text{CH}_3\text{C}_6\text{H}_4\text{N}_2^+\text{Cl}^-$  and  $\text{CH}_3\text{C}_6\text{H}_4\text{OH}$  react together in reaction 4. Describe the conditions for this reaction.

structure



conditions .....

[2]

[Total: 15]