



## EXAM PAPERS PRACTICE

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Level: CIE AS and A Level (9701)

Subject: Chemistry

Topic: CIE Chemistry

Type: Topic Question

2002



1583

Chemistry CIE AS & A Level  
To be used for all exam preparation for 2025+

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# CHEMISTRY

# AS and A

This to be used by all students studying CIE AS and A level Chemistry (9701) But students of other boards may find it useful

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**Question 1.**

- (a) Three nitrogen containing molecules, ammonia,  $\text{NH}_3$ , phenylamine,  $\text{C}_6\text{H}_5\text{NH}_2$  and *N*-methylethylamine,  $\text{CH}_3\text{CH}_2\text{NHCH}_3$ , are drawn below respectively in Fig. 1.1.

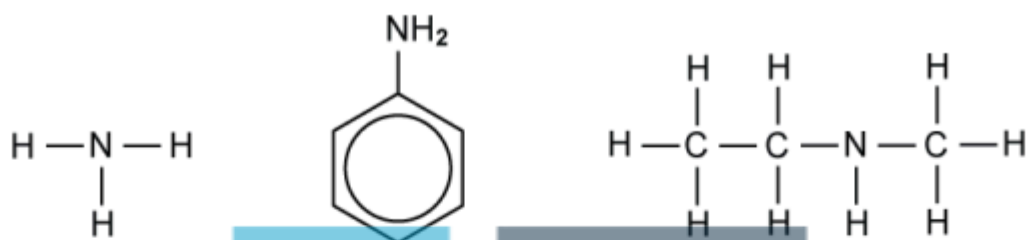


Fig. 1.1

- i) List the three amine molecules drawn in Fig. 1.1 in order of increasing base strength.

[1]

- ii) Explain your answer to part (b) (i).

[6]

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(7 marks)



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- (b) Phenylamine,  $C_6H_5NH_2$  shown in Fig. 1.1 in part (a) can be produced from nitrobenzene,  $C_6H_5NO_2$ .

Name the type of reaction and suggest suitable reagents and conditions for this conversion.

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(3 marks)

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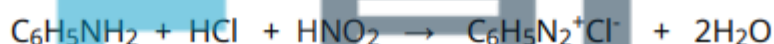


- (c) Azo dyes are organic compounds, which are largely used in the treatment of textiles and leather products, as well as in food. Phenylamine,  $C_6H_5NH_2$ , can be used in the manufacture of azo dyes.

The manufacturing process is outlined below.

### Step 1

Phenylamine is dissolved in HCl to produce a diazonium salt. A diazonium salt contains two nitrogen atoms joined together by a triple bond. The reaction for this process is as follows:



### Step 2

This solution is then slowly added to an alkaline solution of a phenol coupling agent to form the dye.

- i) The diazonium salt,  $C_6H_5N_2^+Cl^-$ , is an unstable compound. Suggest a condition that could be added to ensure that the salt would not break down during the reaction.

[1]

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ii) Draw the structure of the diazonium salt formed in **Step 1**, showing the displayed formula of the nitrogen containing group.

[1]

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(2 marks)



- (d) Phenol,  $C_6H_5OH$ , is an aromatic organic compound which is also crucial in the manufacture of azo dyes.

The final step of the azo dye production involves pairing up the diazonium salt with a phenol compound as a coupling agent.

Suggest a structure for the azo dye if the coupling agent used is 2,6-dimethylphenol.

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(2 marks)

**Question 2.**

- (a) 4-methylphenylamine is a useful compound in the manufacture of azo dyes. It can be manufactured from methylbenzene in two stages.

Draw the structure of the intermediate required to manufacture 4-methylphenylamine.

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- (b) State the reagents and conditions required to manufacture the intermediate in part (a).

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(2 marks)



- (c) The final stage for the preparation of 4-methylphenylamine involves the intermediate being heated under reflux in the presence of concentrated hydrochloric acid and a tin catalyst.

Explain why sodium hydroxide is also required in this step.

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(2 marks)

**Question 3.**

- (a) The azo dye 4-hydroxyazobenzene,  $C_{12}H_{10}N_2O$ , can be produced from phenylamine as shown in Fig. 3.1.

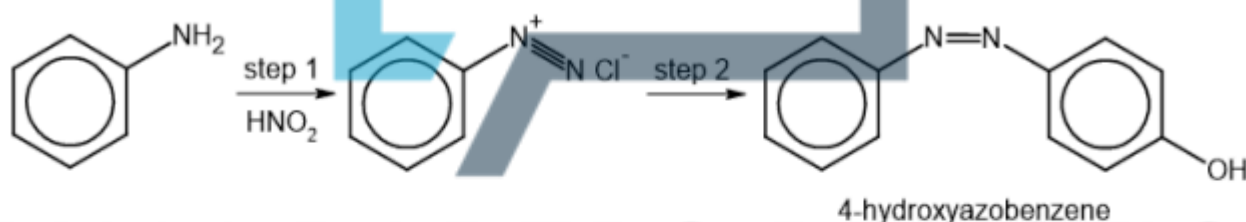


Fig. 3.1

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- i) Give the reagents and conditions for the formation of nitric(III) acid.

[2]

- ii) Write an equation for the reaction that takes place in step 1.

[1]

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(2 marks)



- (b) Step 2 is the coupling reaction of benzenediazonium chloride to form 4-hydroxyazobenzene.

Identify the other reagent involved in this coupling reaction.

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(1 mark)

- (c) An analogue of the azo dye methyl orange is shown in Fig. 3.2. It is an azo dye formed by a similar reaction to 4-hydroxyazobenzene.

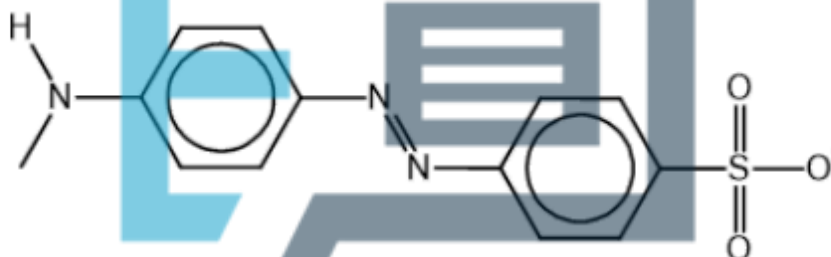


Fig. 3.2

Give the name of the secondary amine used to form the structure in Fig. 3.2.

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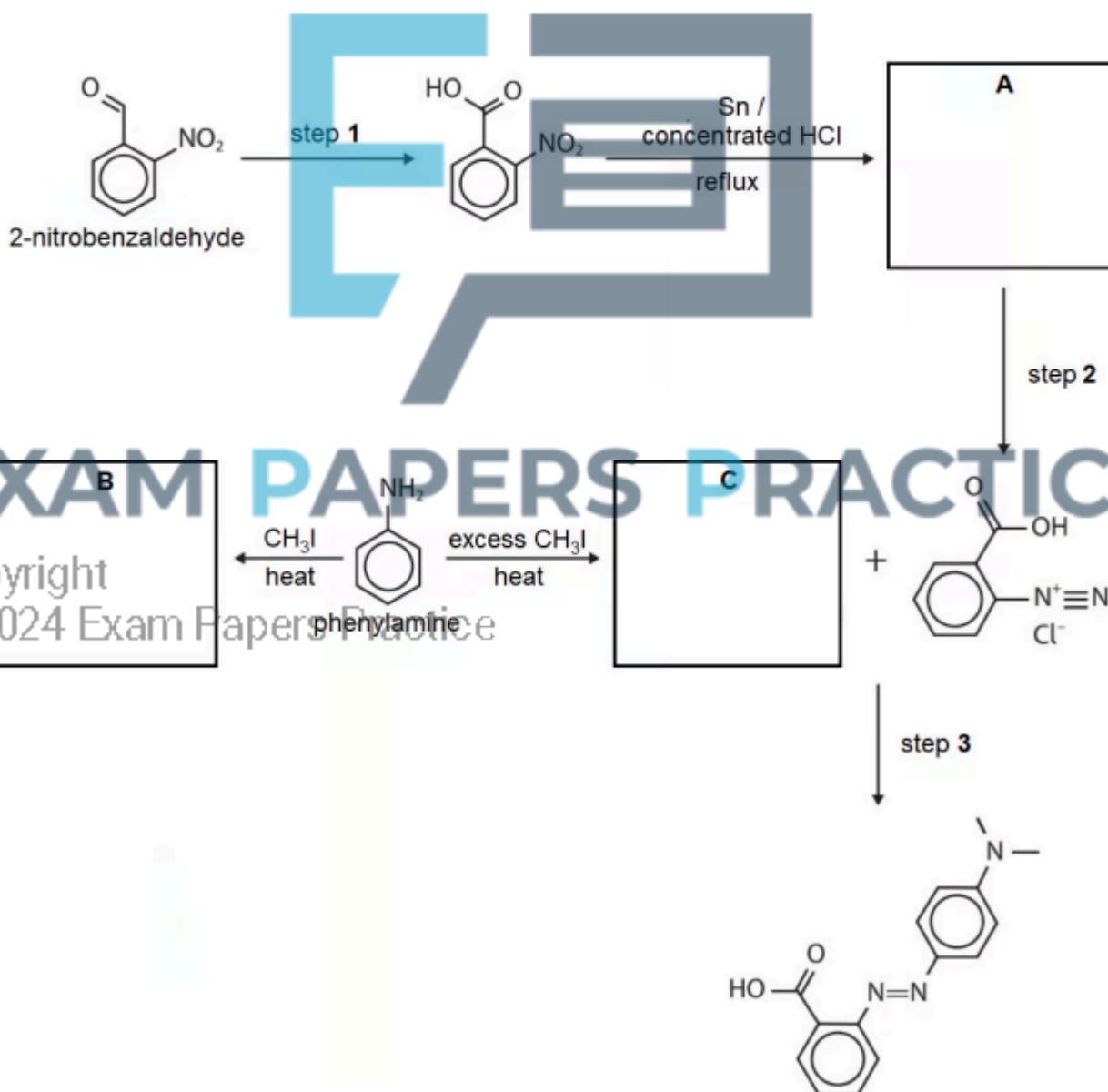
(1 mark)

**Question 4.**

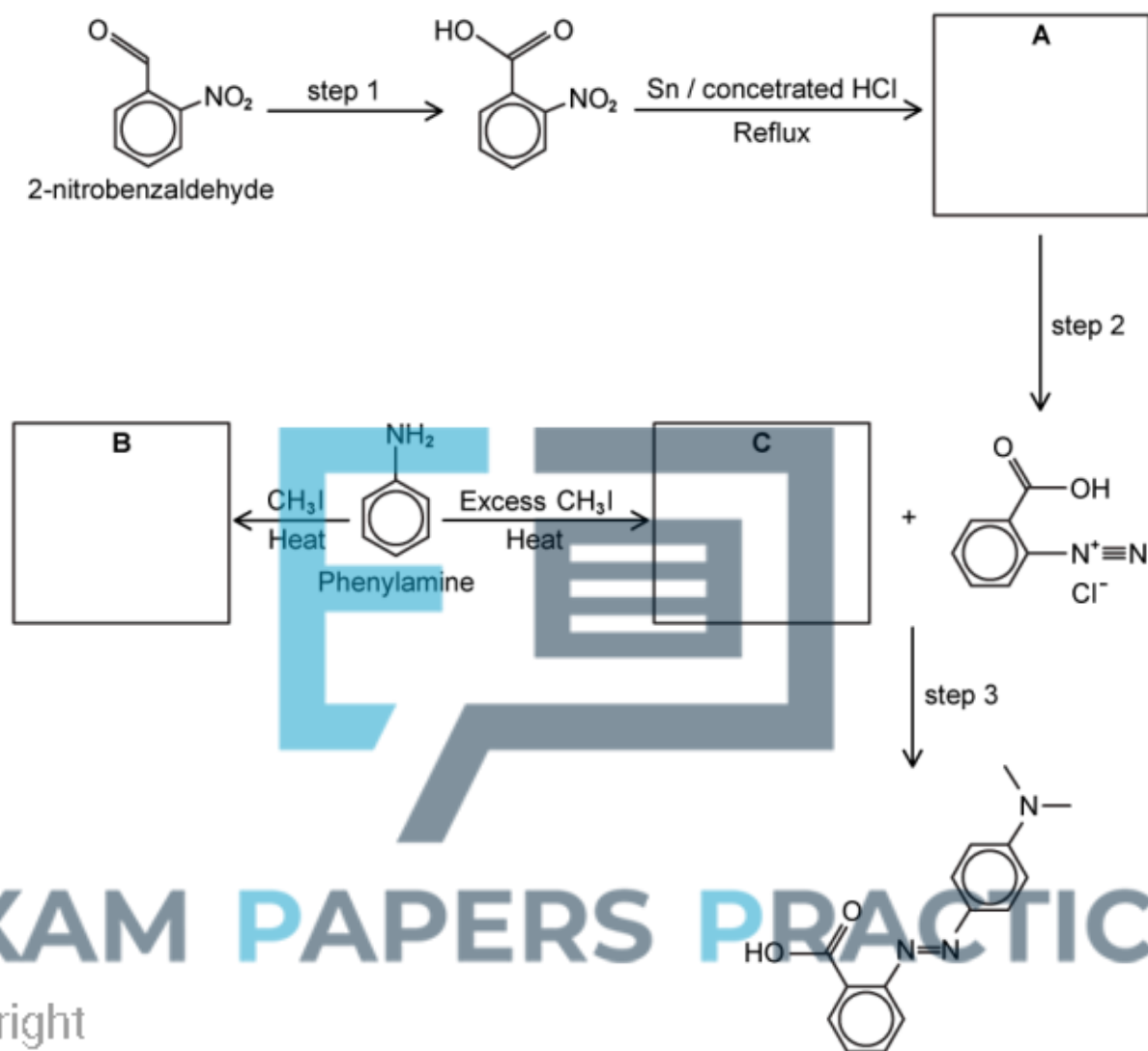
- (a) Organic molecules are an important source of colour both in the natural world and in a wide range of industrial applications.

Azo dyes are synthetic compounds that do not occur naturally. They can be used to colour textiles such as cotton.

The acid-base indicator methyl red is an azo dye that can be produced from 2-nitrobenzaldehyde and phenylamine as shown in Fig. 1.1.







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Fig. 1.1



- i) Suggest reagents and conditions for steps **1** and **2** of the synthesis.

step 1 .....

step 2 .....

[3]

- ii) Draw the structure of compound **A** in the box.

[2]

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(b) When heated, phenylamine can react with iodomethane to form compounds **B** and **C**.

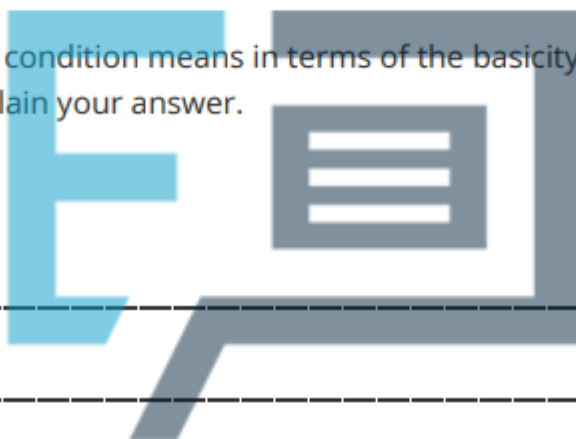
- i) Draw a mechanism for the formation of the *N*-methylphenylamine iodide salt of compound **B** from the reaction of phenylamine and iodomethane. Include all necessary curly arrows and charges.

[2]

- ii) Compound **C** requires an excess of iodomethane to form.

Suggest what this condition means in terms of the basicity of phenylamine and compound **B**. Explain your answer.

[3]



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(5 marks)

- (c) Suggest why the temperature used in steps **2** and **3** should be kept as close to 5 °C as possible.

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(2 marks)



- (d) Indigotin, shown in Fig. 1.2 is a naturally occurring compound that is used to dye denim a blue colour.

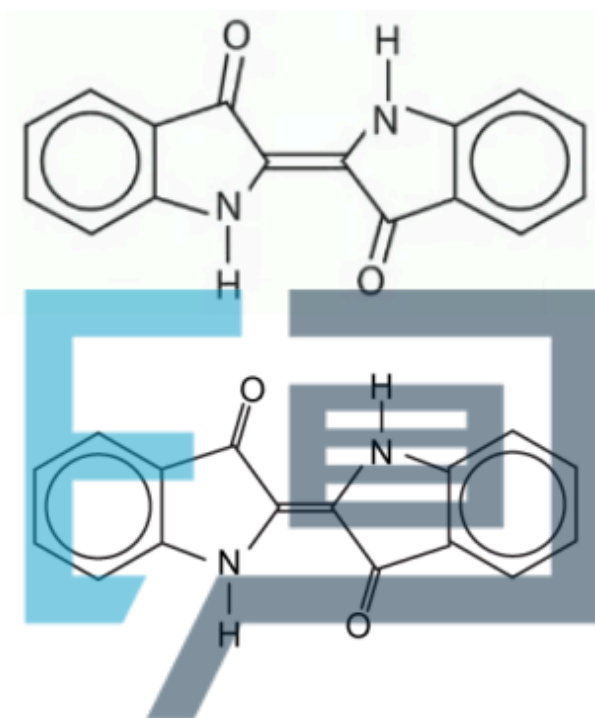


Fig. 1.2

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It can be synthesised from 2-nitrobenzaldehyde and propanone in aqueous sodium hydroxide.

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- i) Complete the equation for this reaction, shown in Fig. 1.3.

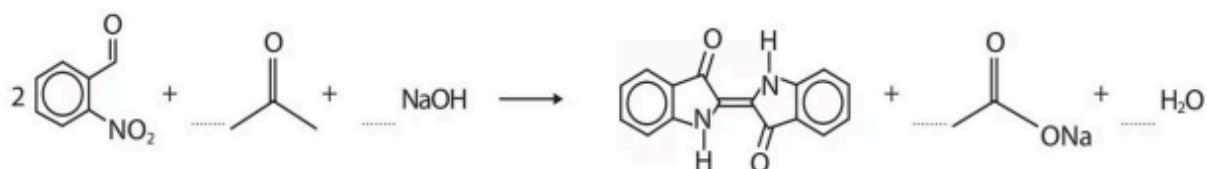
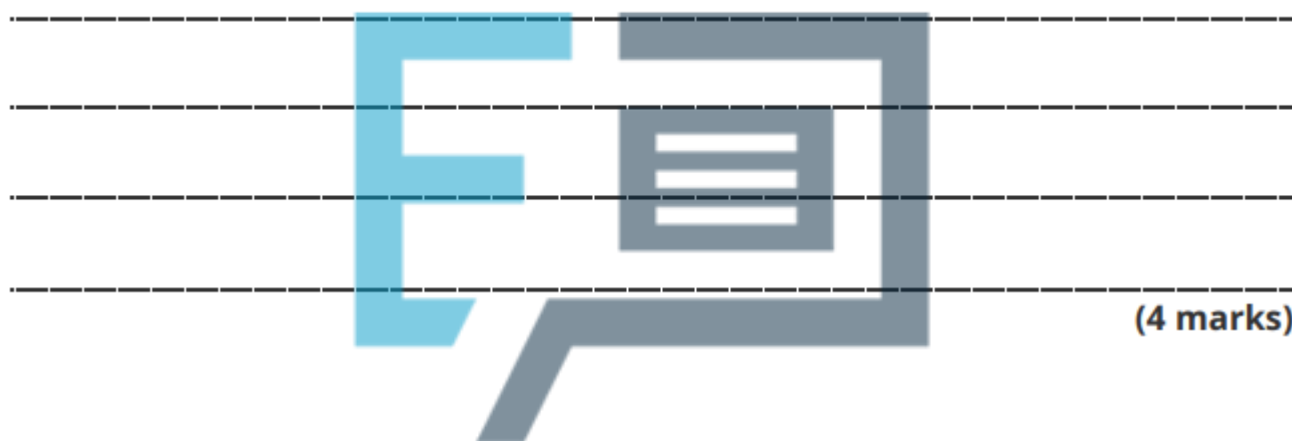


Fig. 1.3

[1]

- ii) Calculate the mass of 2-nitrobenzaldehyde required to make 12.0 g of indigotin from this reaction with a percentage yield of 82.0%.

[3]



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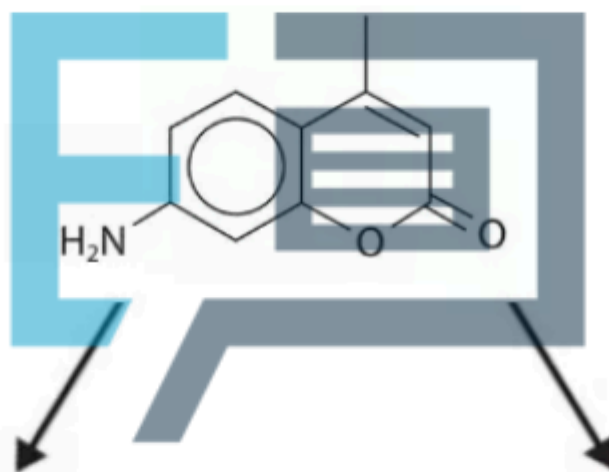
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- (e) Coumarin 440 is a dye that occurs naturally in plants but can be synthesised in the laboratory. It is used to generate blue light in lasers.

Coumarin 440 is hydrolysed with **excess** sodium hydroxide to form the **organic** compound **D** in Fig.1.4.

Coumarin 440 is condensed with ethanol chloride to form the **organic** compound **E** in Fig.1.4.



**D**

**E**

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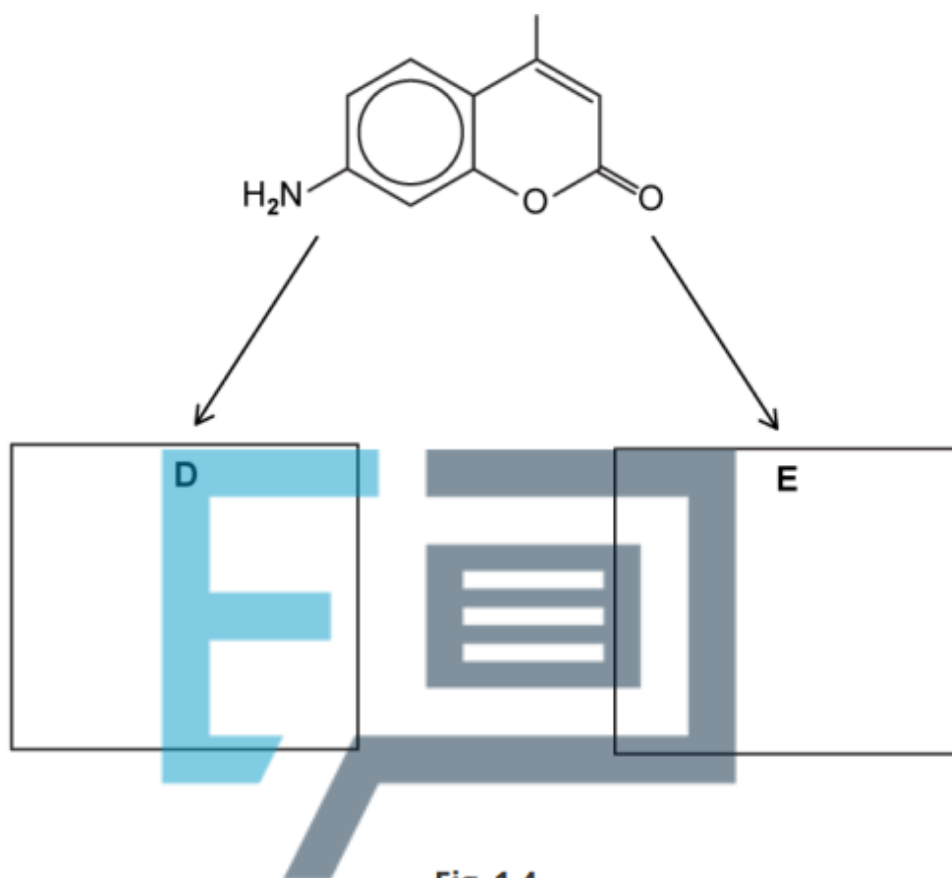


Fig. 1.4

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Draw the structures of compounds D and E in the boxes.

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(3 marks)