

Arenes

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Hydrocarbons
Sub-Topic	Arenes
Paper Type	Theory
Booklet	Question Paper 1

Time Allowed: 81 minutes

Score: /67

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

1 (a) Both chloroalkanes and acyl chlorides react with water, but only acyl chlorides fume in moist air.

(i) State which product causes the fumes in this reaction.

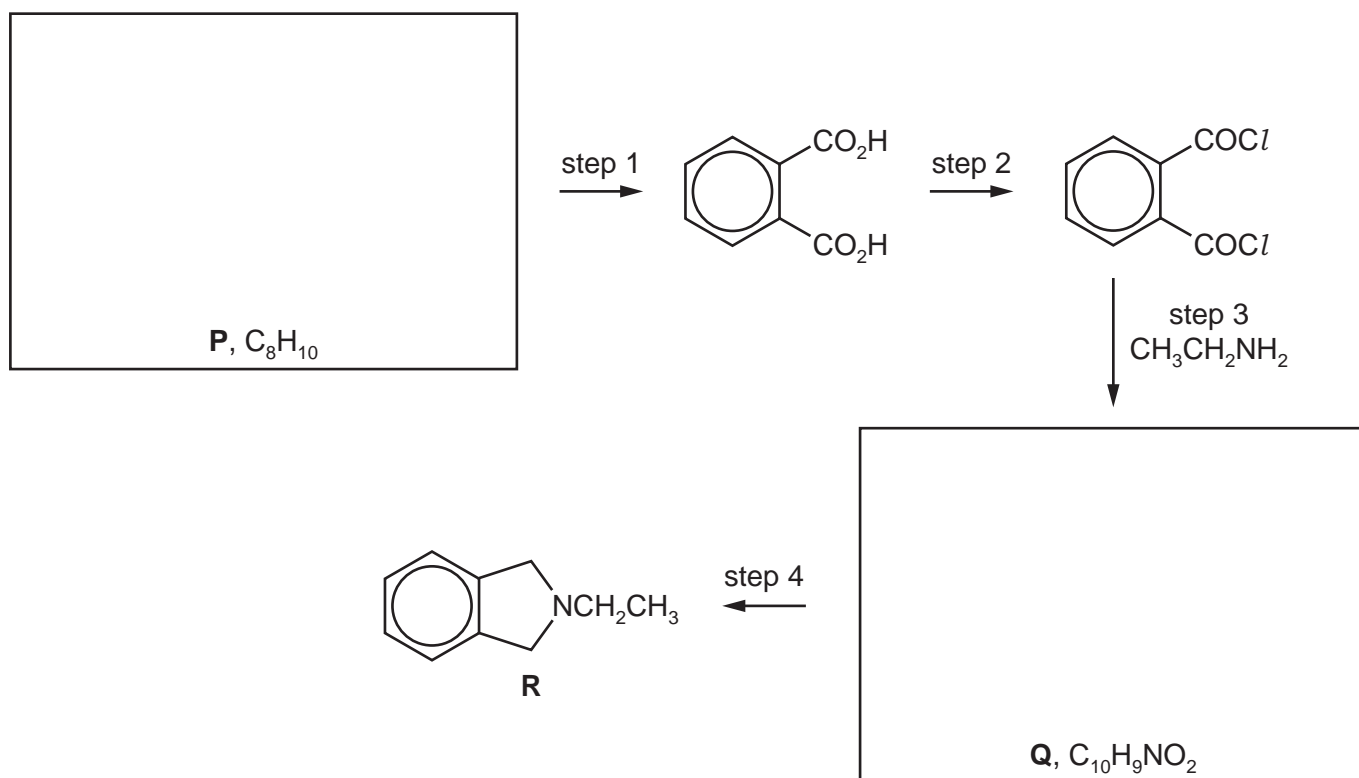
..... [1]

(ii) Explain why the reactivities of chloroalkanes and acyl chlorides differ.

.....

 [1]

(b) Compound R is a useful intermediate in the synthesis of pharmaceutical compounds. It can be made from compound P by the following route.



(i) Suggest structures for the starting material P and the intermediate Q. [2]

(ii) Suggest reagents and conditions for the following steps in the above scheme.

step 1

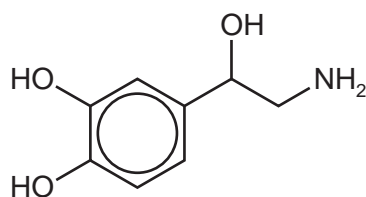
step 2

step 4

[3]

[Total: 7]

- 2 Noradrenaline is a hormone and neurotransmitter, which is released during stress to stimulate the heart and increase blood pressure.



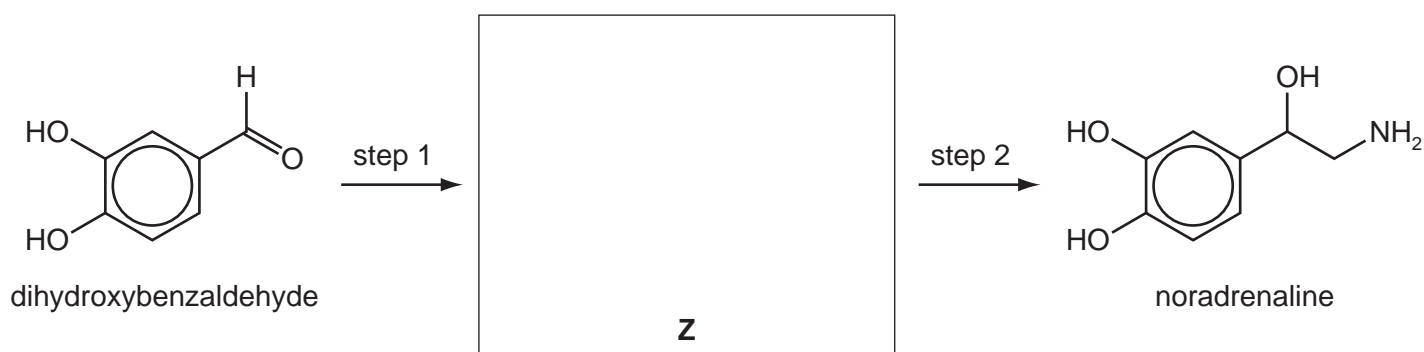
noradrenaline

- (a) State the **names** of **three** functional groups in the noradrenaline molecule.

.....

 [3]

- (b) Consider the following two-stage synthesis of noradrenaline from dihydroxybenzaldehyde.



- Draw the structure of the intermediate **Z** in the box.
- Suggest reagents for steps 1 and 2.

step 1

step 2

(ii) Dihydroxybenzaldehyde reacts with $\text{Br}_2(\text{aq})$.

- Describe what you would see during this reaction.

.....

- Draw the structure of the product.

[5]

(c) Draw the structures of the products when noradrenaline is reacted with

(i) dilute $\text{NaOH}(\text{aq})$,

(ii) dilute $\text{HCl}(\text{aq})$,

(iii) an excess of ethanoyl chloride, CH_3COCl .

[4]

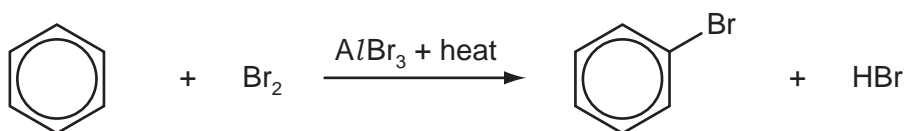
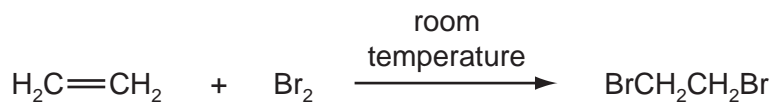
(d) Name the **new** functional groups formed in the reaction in (c)(iii).

.....

..... [2]

[Total: 14]

3 Both ethene and benzene react with bromine.



(a) What *type of reaction* is the reaction of bromine with

(i) ethene,

.....

(ii) benzene?

.....

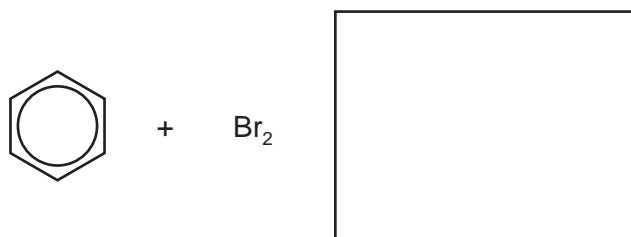
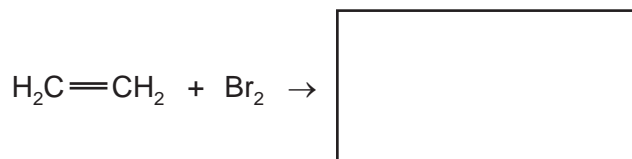
[1]

(b) Write an equation to show the formation of the electrophile during the reaction between bromine and benzene.

..... [1]

(c) Each of these reactions involves an intermediate.

(i) Draw the structure of the intermediate in each reaction.



(ii) Suggest why the product of the reaction between bromine and benzene, bromobenzene, is still unsaturated.

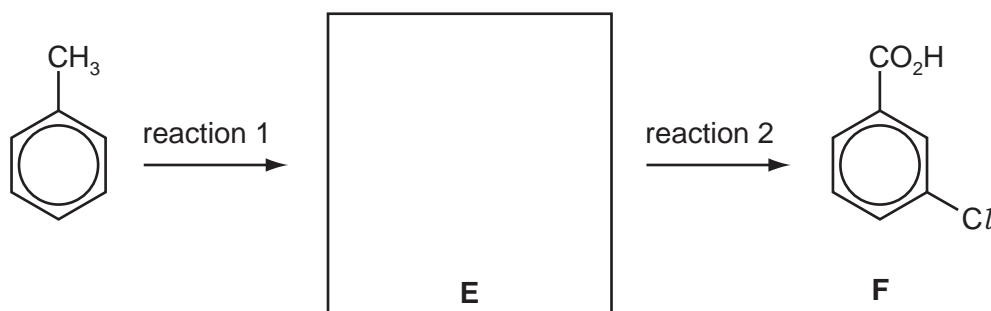
.....

[3]

- (d) When methylbenzene is nitrated, 4-nitromethylbenzene is formed, but when benzoic acid is nitrated, 3-nitrobenzoic acid is produced.

Consider the following synthesis of 3-chlorobenzoic acid, **F**, from methylbenzene. Use the information given above to suggest

- the structure of the intermediate **E**,
- the reagents and conditions needed for reactions 1 and 2.



reagents and conditions for reaction 1

.....

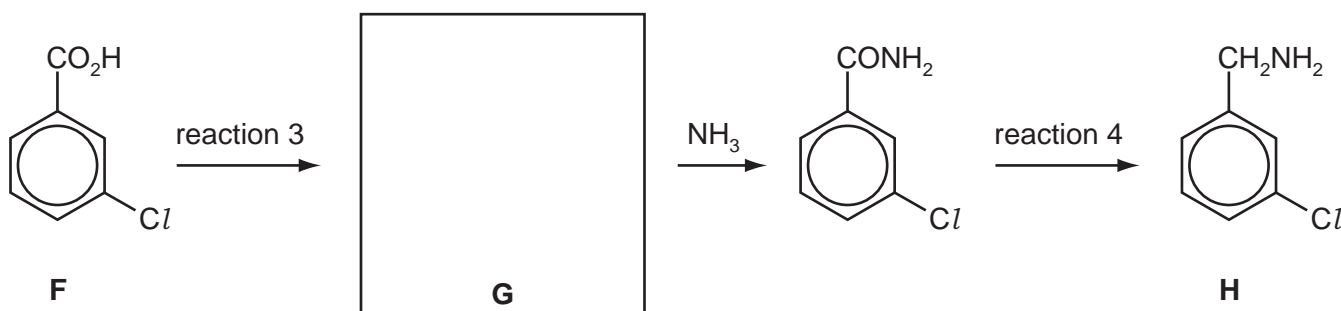
reagents and conditions for reaction 2

.....

[3]

- (e) Consider the following synthesis of 3-chlorophenylmethanamine, **H**, from **F**. Suggest

- the structure of the intermediate **G**,
- the reagents for reactions 3 and 4.



reagents for reaction 3

.....

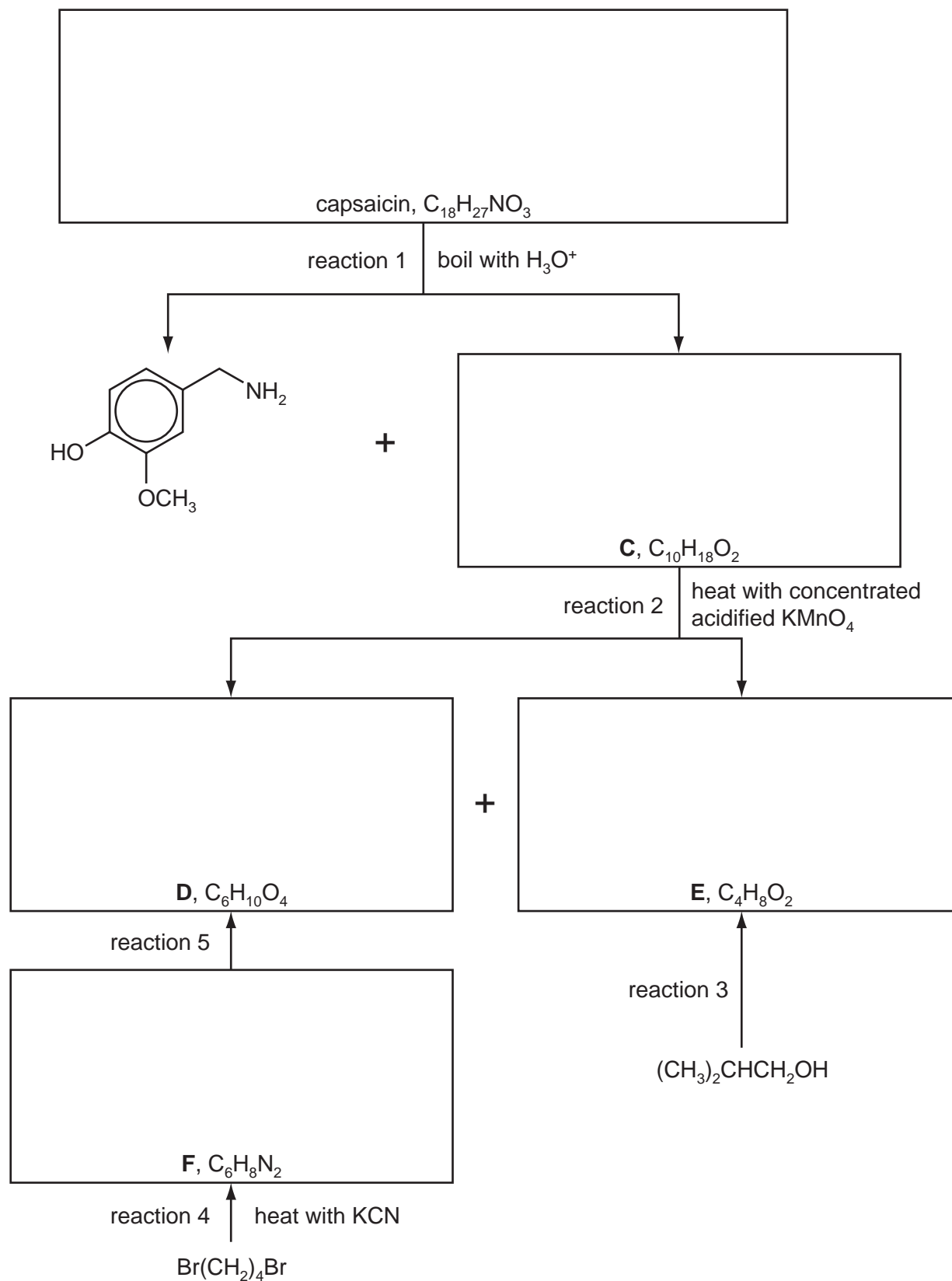
reagents for reaction 4

.....

[3]

[Total: 11]

- 4 The compound responsible for the hot taste of chilli peppers is capsaicin. Its molecular structure can be deduced by the following reaction scheme.



Compounds **C**, **D** and **E** all react with $Na_2CO_3(aq)$.

Answer the following questions.

- (a) Suggest reagents and conditions for reaction 3.

..... [1]

- (b) What *type of reaction* is reaction 4?

..... [1]

- (c) Suggest reagents and conditions for reaction 5.

..... [1]

- (d) Name the functional group in **C** that has reacted with hot concentrated acidified KMnO_4 .

..... [1]

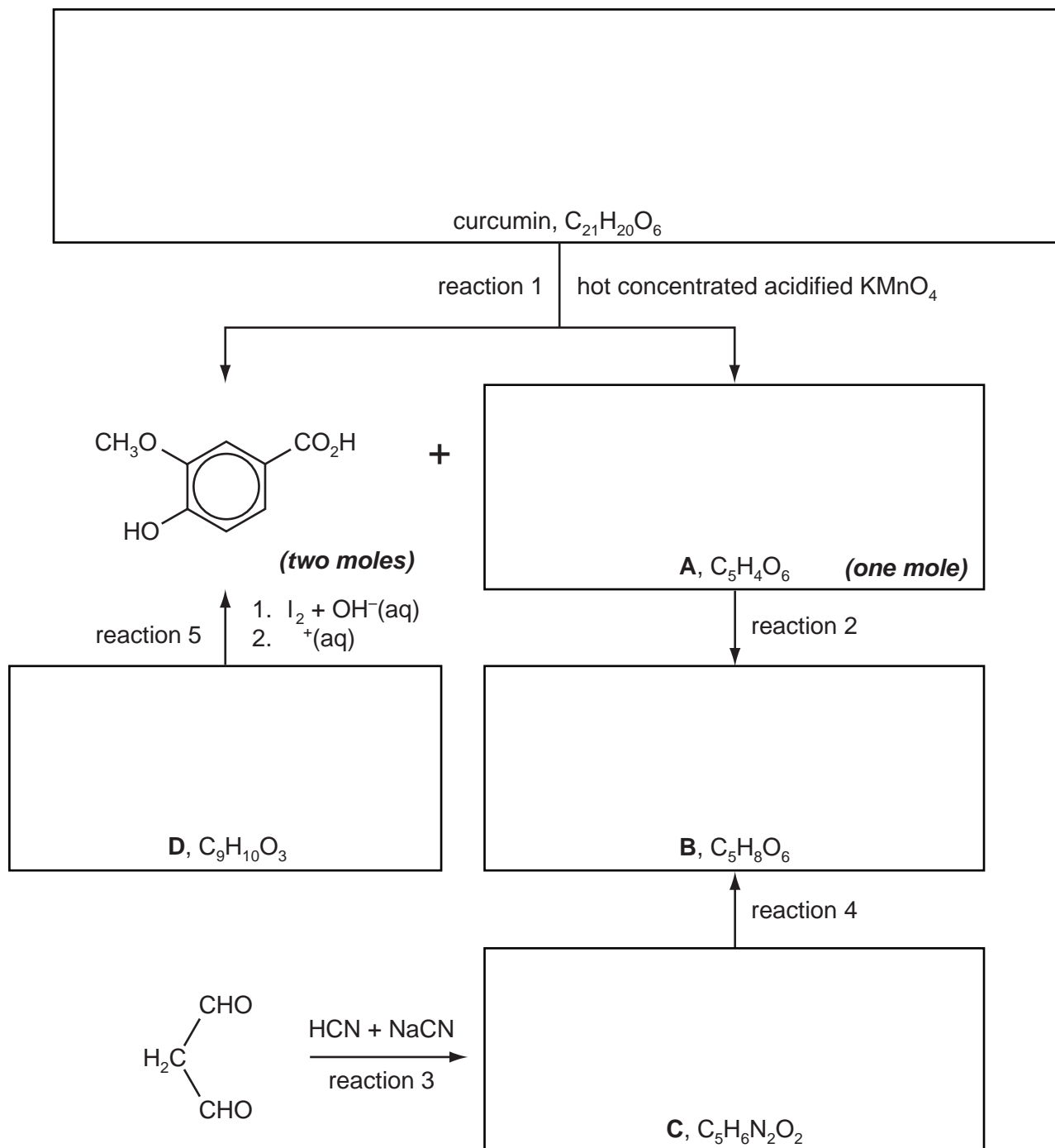
- (e) Suggest the name of the functional group in capsaicin that has reacted in reaction 1.

..... [1]

- (f) Work out structures for compounds **C–F** and capsaicin, and draw their structural formulae in the boxes opposite. [5]

[Total: 10]

- 5 The compound responsible for the yellow colour of the spice turmeric is curcumin. Its molecular structure can be deduced from the following series of reactions. The CH_3O – group that is present in curcumin may be regarded as unreactive.



Curcumin and compounds **A** and **D** all react with 2,4-dinitrophenylhydrazine reagent.

Compounds **A** and **B** effervesce with $\text{Na}_2\text{CO}_3(\text{aq})$, but curcumin, and compounds **C** and **D**, do not.

Curcumin reacts with $\text{Br}_2(\text{aq})$ and with cold dilute acidified KMnO_4

- (a) Name the functional group common to curcumin and compounds **A** and **D**.

.....

- (ii) Name the functional group common to compounds **A** and **B**.

.....

[2]

- (b) Suggest the structures of compounds **B**, **C** and **D**, and draw their structural formulae in the relevant boxes opposite.

- (ii) Suggest suitable reagents and conditions for reaction 4.

.....

[4]

- (c) Name the *type of reaction* for reaction 2.

.....

- (ii) Suggest a reagent for reaction 2.

.....

- (iii) Suggest the structure of compound **A**, and draw its structural formula in the relevant box opposite.

[3]

- (d) **Name** the functional group in curcumin that reacts with cold dilute acidified KMnO_4 .

.....

- (ii) **Name two** functional groups in curcumin that react with $\text{Br}_2(\text{aq})$.

.....


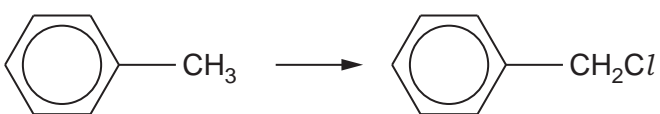
[2]

- (e) Suggest a structure for curcumin and draw its structural formula in the relevant box opposite.

[2]

[Total: 13]

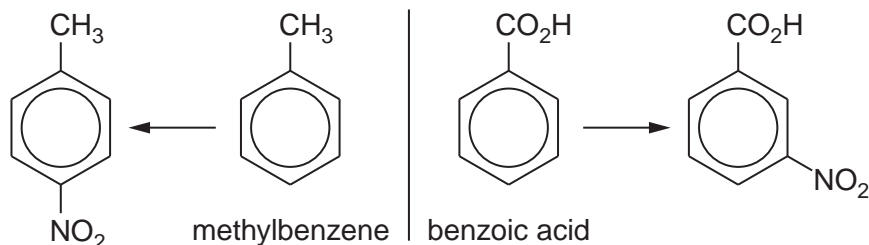
- 6 (a) There are several ways of introducing chlorine atoms into organic molecules. State the reagents and conditions necessary to carry out the following transformations.

transformation	reagents + conditions
$C_2H_4 \longrightarrow C_2H_5Cl$	
$C_2H_5OH \longrightarrow C_2H_5Cl$	
$C_2H_6 \longrightarrow C_2H_5Cl$	
$C_2H_4 \longrightarrow C_2H_4Cl_2$	
$CH_3CO_2H \longrightarrow CH_3COCl$	
	
	

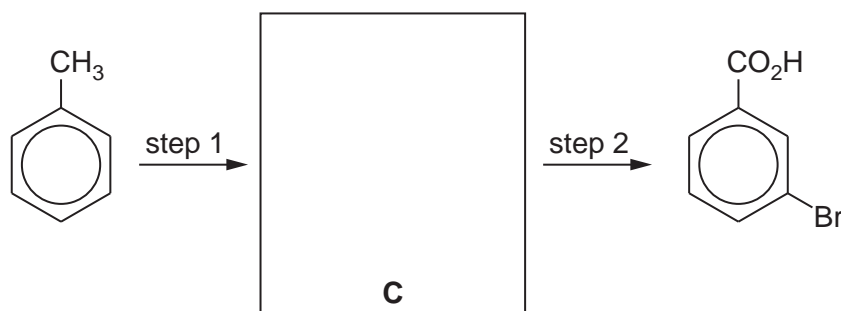
[6]

- (b) (i) When treated with concentrated $HNO_3 + H_2SO_4$ at $55^\circ C$, benzene produces nitrobenzene.
Outline the mechanism of this reaction. You should include all charges, and use curly arrows to represent the movement of electron pairs.

In aromatic substitution of monosubstituted benzenes, the orientation of an incoming group depends on the nature of the group already attached to the ring. For example, using the same reagents and conditions as in (i), methylbenzene and benzoic acid produce the following nitro compounds.



(ii) Using this information as an aid, suggest a structure for compound **C** in the following synthesis of 3-bromobenzoic acid.



(iii) Suggest reagents and conditions for steps 1 and 2.

step 1

step 2

[6]

[Total: 12]