

# Phenol

## Question Paper 2

<b>Level</b>	International A Level
<b>Subject</b>	Chemistry
<b>Exam Board</b>	CIE
<b>Topic</b>	Hydroxy Compounds
<b>Sub-Topic</b>	Phenol
<b>Paper Type</b>	Theory
<b>Booklet</b>	Question Paper 2

**Time Allowed:** 69 minutes


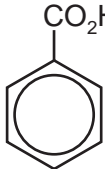
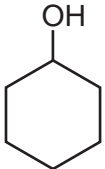
**Score:** /57

**Percentage:** /100

**Grade Boundaries:**

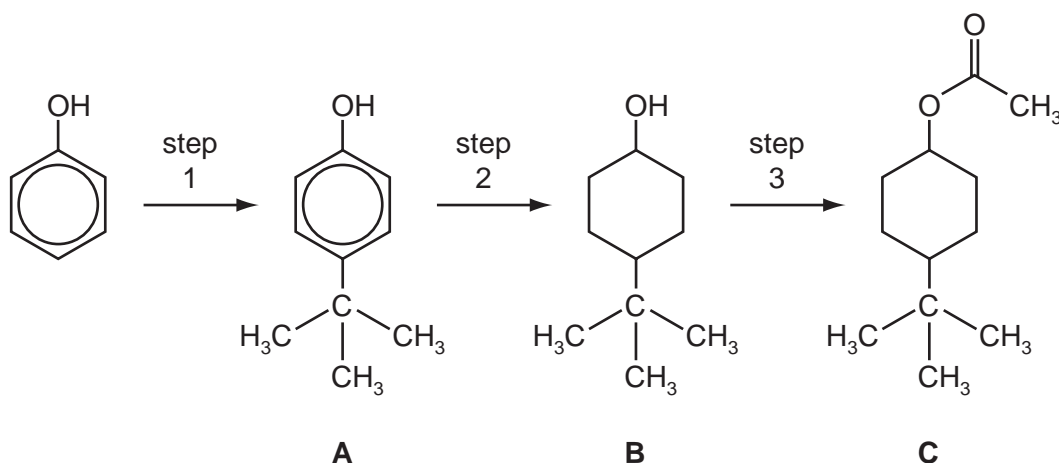
A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

- 1 (a) A series of experiments is carried out in which the reagent shown at the top of the column of the table is mixed, in turn, with each of the reagents at the side. Complete the following table by writing in each box the formula of any gas produced. Write **x** in the box if no gas is produced. The first column has been completed as an illustration.

	H <sub>2</sub> O			
Na	H <sub>2</sub>			
KOH(aq)	<b>x</b>			
Na <sub>2</sub> CO <sub>3</sub> (aq)	<b>x</b>			

[5]

- (b) Compound **C** is responsible for the pleasant aroma of apples. It can be prepared from phenol by the following 3-step synthesis.



- (i) The only by-product of step 1 is HCl. Suggest the reagent that was used to react with phenol to produce compound **A**.

.....

- (ii) What *type of reaction* is occurring in step 2?

.....

- (iii) What reagents and conditions are required for step 3?

.....

- (iv) State the reagent and conditions needed to convert **C** back to **B**, the reverse of step 3.

.....

[5]

- (c) (i) Either compound **A** or compound **B**, or both, react with the following reagents. For each reagent draw the structure of the organic product formed with **A**, and with **B**. If no reaction occurs, write 'no reaction' in the relevant box.

reagent and conditions	product with <b>A</b>	product with <b>B</b>
an excess of Br <sub>2</sub> (aq)		
heat with HBr		
pass vapour over heated Al <sub>2</sub> O <sub>3</sub>		
heat with acidified K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub>		

- (ii) Choose **one** of the above reactions to enable you to distinguish between **A** and **B**.

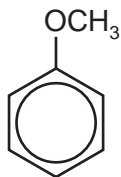
State below the observations you would make with each compound.

reagent	observation with <b>A</b>	observation with <b>B</b>

[7]

[Total: 17]

- 2 (a) Methoxybenzene reacts with  $\text{Br}_2(\text{aq})$  in a similar manner to phenol.



methoxybenzene

- (i) Draw the structural formula of the product of the reaction between methoxybenzene and an excess of bromine.

- (ii) Suggest a chemical reaction you could use to distinguish between methoxybenzene and phenol. State the reagent, describe the observations you would make, and give an equation for the reaction.

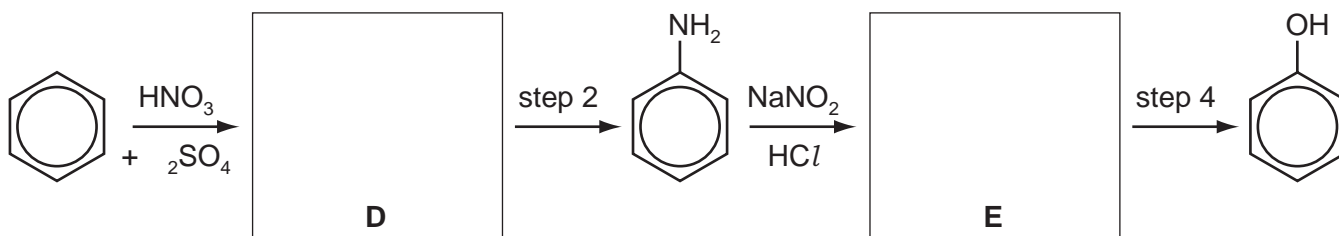
reagent .....

observation .....

equation

[4]

- (b) Phenol can be synthesised from benzene by the following route.



- (i) Suggest structures for compounds **D** and **E** and draw them in the boxes above.

- (ii) Suggest reagents and conditions for

step 2, .....

step 4. ....

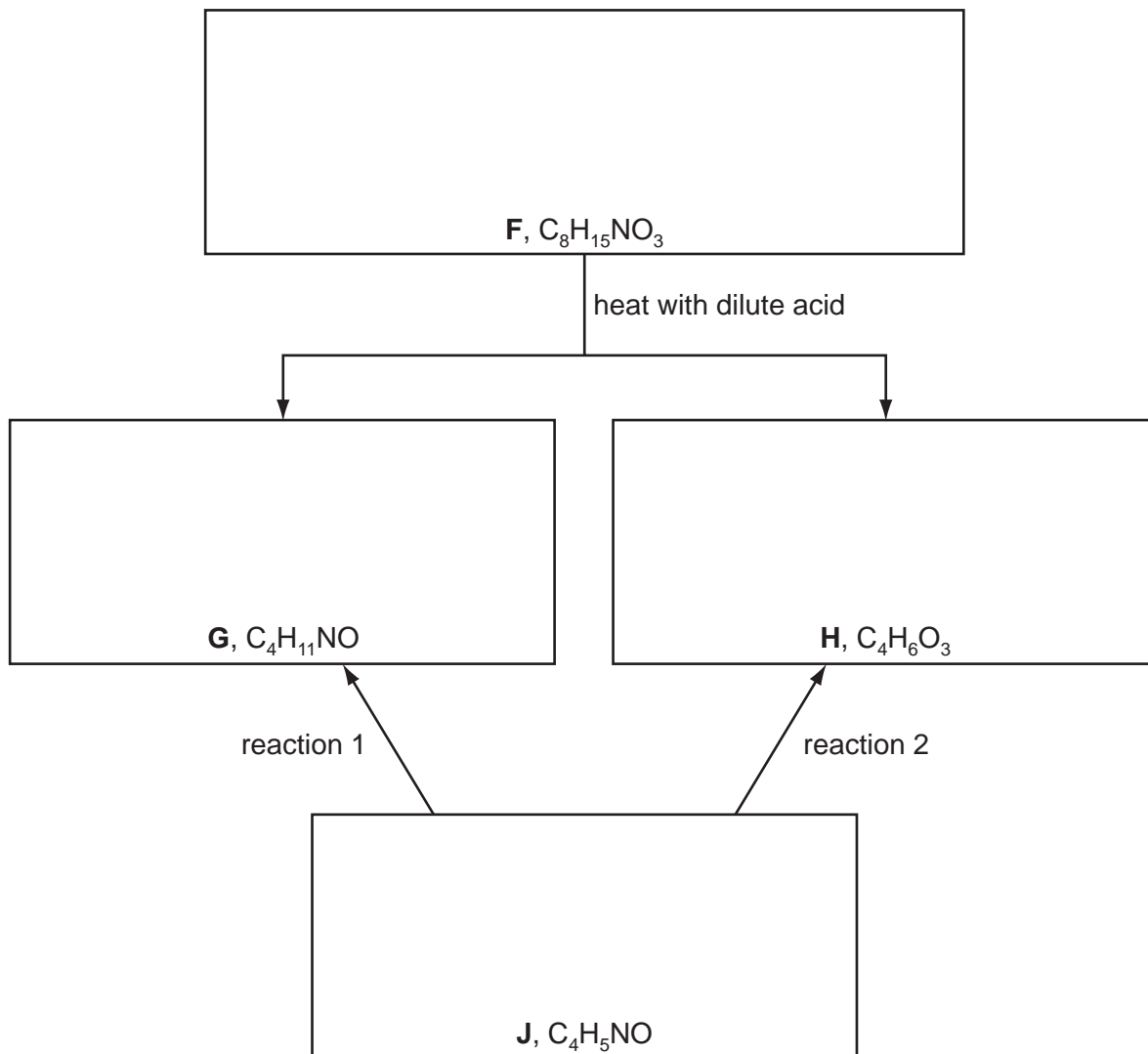
[4]

(c) The following chart shows some reactions of compound **F** which is a neutral compound.

**G** forms a salt with dilute  $\text{H}_2\text{SO}_4$ , whereas **H** forms a salt with  $\text{NaOH}(\text{aq})$ .

Both **G** and **H** can be obtained from compound **J** by separate one-step reactions (reaction 1 and reaction 2 below).

All four compounds **F**, **G**, **H** and **J** form a yellow precipitate with alkaline aqueous iodine.



(i) Suggest structures for **F**, **G**, **H** and **J**, and draw them in the boxes above.

(ii) Suggest reactants and conditions for

reaction 1, .....

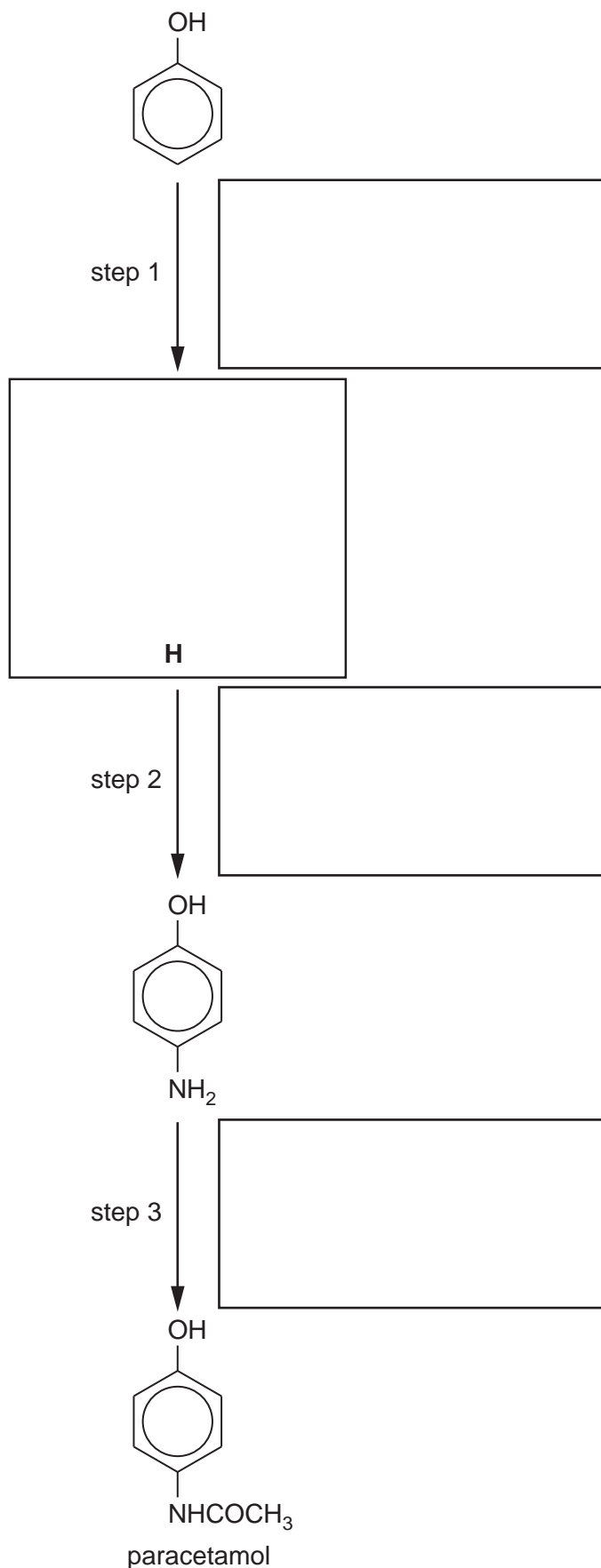
reaction 2. ....

[6]

[Total: 14]



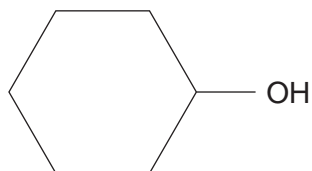
- (c) The analgesic drug paracetamol can be synthesised from phenol by the following route. Suggest reagents and conditions for the each of three steps, and suggest the structure of the intermediate **H**. Write your answers in the boxes provided.



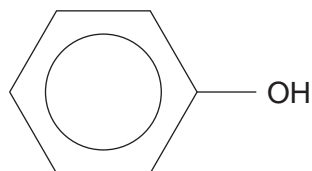
[4]

[Total: 13]

- 4 Cyclohexanol and phenol are both solids with low melting points that are fairly soluble in water.



cyclohexanol



phenol

- (a) Explain why these compounds are more soluble in water than their parent hydrocarbons cyclohexane and benzene.

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

- (b) Explain why phenol is more acidic than cyclohexanol.

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



- (c) For **each** of the following reagents, draw the structural formula of the product obtained for **each** of the two compounds. If no reaction occurs write **no reaction** in the box.

reagent	product with cyclohexanol	product with phenol
Na(s)		
NaOH(aq)		
Br <sub>2</sub> (aq)		
I <sub>2</sub> (aq) + OH <sup>-</sup> (aq)		
an excess of acidified Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> (aq)		

[7]

- (d) Choose **one** of the above five reagents that could be used to distinguish between cyclohexanol and phenol. Describe the observations you would make with each compound.

reagent .....

observation with cyclohexanol .....

observation with phenol .....

[2]

[Total: 13]