Phenol

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Hydroxy Compounds
Sub-Topic	Phenol
Paper Type	Theory
Booklet	Question Paper 1

Time Allowed: **65 minutes**

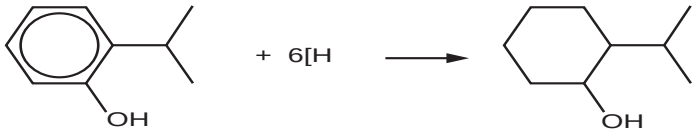
Score: **/54**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** Compound **B** is a component of several perfumes and flavourings. It can be obtained by the hydrogenation of compound **A**.
During the reaction, the hydrogen atoms all add onto the same side of the benzene ring.



A **B**

(i) Suggest reagents and conditions for this reaction.

.....

.....

[1]

(ii) Circle all the chiral atoms on the structure of **B** above. [1]

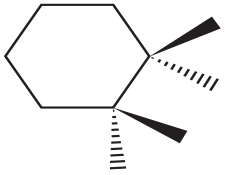
(iii) How many possible optical isomers are there with the same structural formula as **B**? [1]

.....

.....

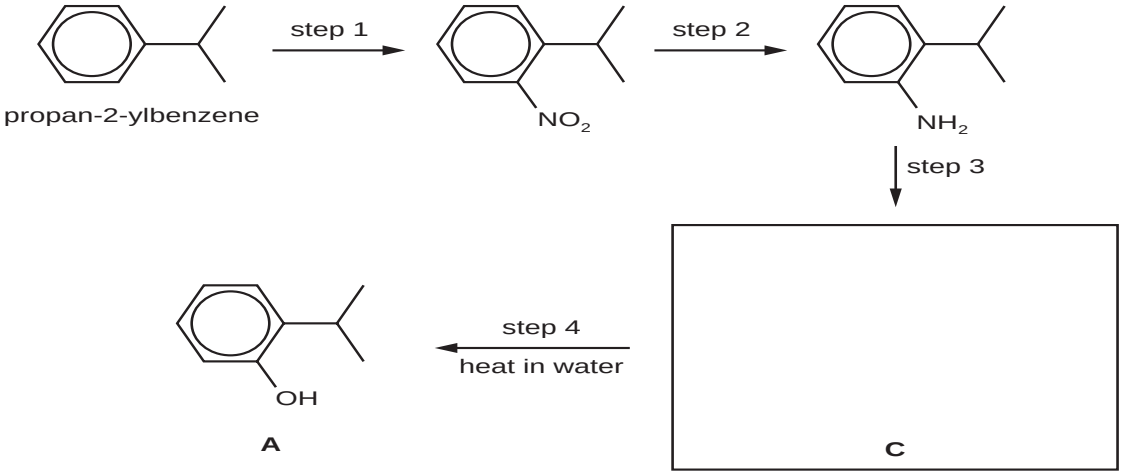
[1]

(iv) Complete the following part-structure to show the structure of one of the isomers of **B** that would be formed during the above reaction.



[1]

(b) Compound **A** can be obtained from propan-2-ylbenzene by the following route.



(i) Suggest the structure of the intermediate cation **C** and draw it in the box above. [1]

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

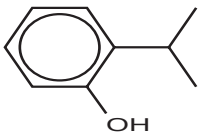
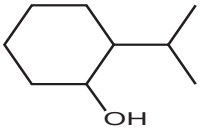
step 1 .....

step 2 .....

step 3 .....

[4]

(c) Suggest the structures of the organic products of the reactions between each of the compounds **A** and **B** and the following reagents. If no reaction occurs write 'no reaction' in the relevant box.

reagent	product with **A**, 	product with **B**, 
HBr		
Na		
NaOH(aq)		

[5]

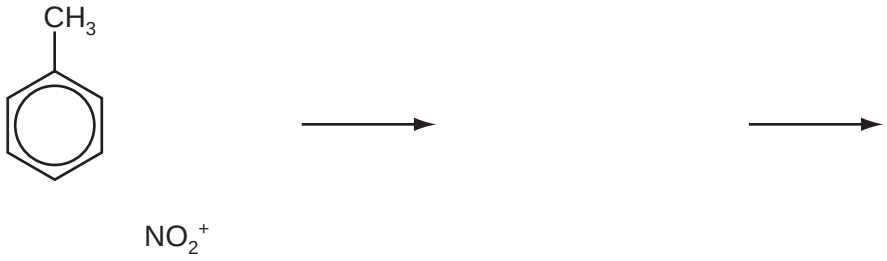
[Total: 14]

2 **(a)** Methylbenzene undergoes electrophilic substitution with nitronium ions, NO_2^+.
Nitronium ions are generated by the reaction between concentrated sulfuric acid and concentrated nitric acid.

(i) Construct an equation for the formation of nitronium ions, NO_2^+, by this method.

.....

(ii) Complete the scheme to show the mechanism for this reaction. Use curly arrows to show the movement of electron pairs.



[4]

(b) Describe and explain the relative acidities of chloroethanoic acid and ethanoic acid.

.....

.....

.....

(ii) Describe and explain the relative acidities of phenol and ethanol.

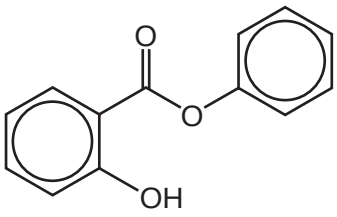
.....

.....

.....

[3]

(c) Phenyl 2-hydroxybenzoate is an antiseptic.



phenyl 2-hydroxybenzoate

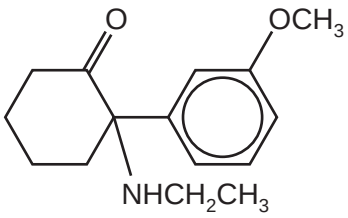
Complete the following table about the reactions of phenyl 2-hydroxybenzoate with the three reagents.

reagent	structure of product(s)		type of reaction
Na			
excess $Br_2(aq)$			
excess hot NaOH(aq)			

[6]

[Total: 13]

3 Methoxetamine is a derivative of the pharmaceutical drug, ketamine.



methoxetamine

(a) (i) What is the molecular formula of methoxetamine?

.....

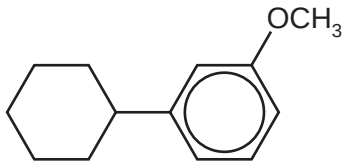
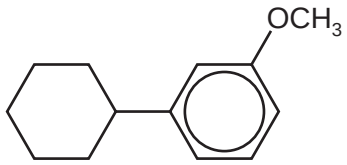
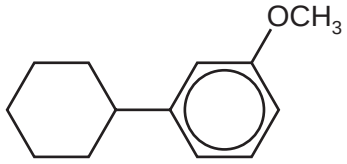
(ii) On the diagram above, **circle** any chiral centres that are present in methoxetamine.

(iii) Name **two** functional groups in methoxetamine, in addition to the aryl group.

.....

[4]

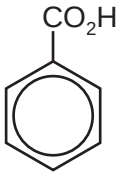
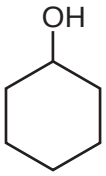
(b) In the table, complete the structure of each of the compounds formed when methoxetamine is reacted with the following reagents.
State the type of reaction in each case.

reagent	structure of product	type of reaction
(i) $LiAlH_4$		
(ii) $HCl(aq)$		
(iii) CH_3COCl		

[6]

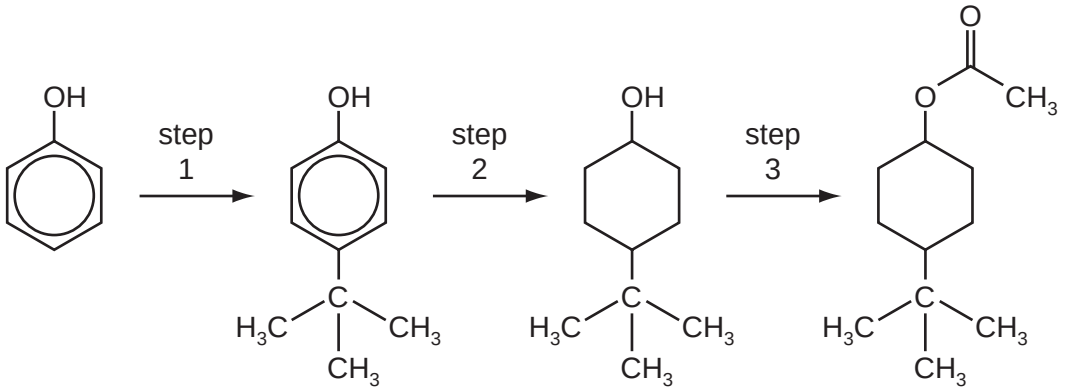
[Total: 10]

4 **(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_2O			
Na	H_2			
KOH(aq)	**x**			
Na_2CO_3(aq)	**x**			

[5]

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



A **B** **C**

(i) The only by-product of step 1 is HC*l*. 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 **A**	product with **B**
an excess of $Br_2(aq)$		
heat with HBr		
pass vapour over heated Al_2O_3		
heat with acidified $K_2Cr_2O_7$		

(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 **A**	observation with **B**

[7]

[Total: 17]