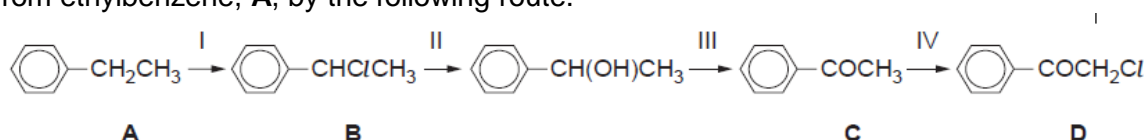
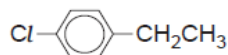


Q1 Chloroacetophenone (compound **D**, below) was formerly the most widely used tear gas, under the codename *CN*. It was used in warfare and in riot control. It can be synthesized from ethylbenzene, **A**, by the following route.



(a) Suggest reagents and conditions for step I.

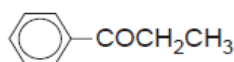
(b) Suggest reagents and conditions for converting ethylbenzene into compound **E**, an isomer of **B**.



E

(c) Draw the structure of the product obtained by heating ethylbenzene with KMnO_4 .

(d) Describe a test (reagents and observations) that would distinguish compound **C** from compound **F**.



F

reagents

observation with **C**

observation with **F**

(e) The efficiency of a tear gas is expressed by its 'intolerable concentration', I.C. The I.C. of the tear gas *CN* has been measured as 0.030 gm^{-3} of air.

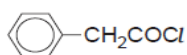
How many moles of chloroacetophenone need to be sprayed into a room of volume 60 m^3 in order to achieve this concentration?

(f) Residues of *CN* can be destroyed by hydrolysis with an aqueous alkali.

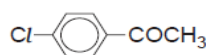


D

Compounds **G** and **H** are isomers of compound **D**.



G



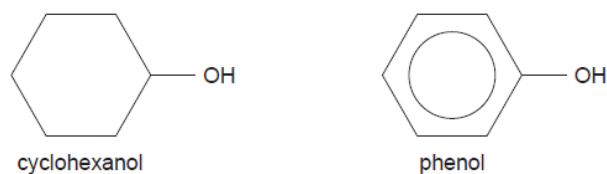
H

(i) Arrange the three isomers **D**, **G** and **H** in order of increasing ease of hydrolysis.

(ii) Explain the reasoning behind your choice.

(June 2003 Q4)

Q2 Cyclohexanol and phenol are both solids with low melting points that are fairly soluble in water.



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

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

(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 ₂ (aq)		

$I_2(aq) + OH^-(aq)$		
an excess of acidified $Cr_2O_7^{2-}(aq)$		

(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.

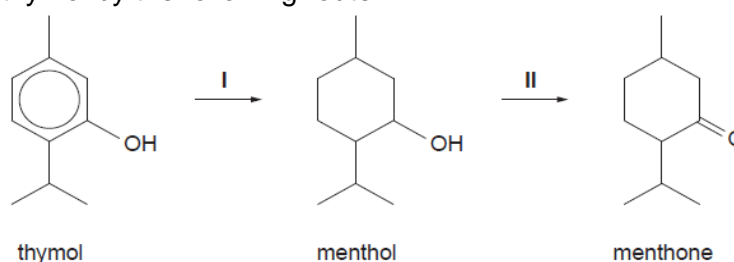
reagent

Observation with cyclohexanol

observation with phenol

(Nov 2009 P41 Q4)

Q3 Menthol and menthone, the main constituents of oil of peppermint, can be made synthetically from thymol by the following route.



(a) State the *type of reaction* of

• reaction I,

• reaction II.

(b) Suggest **one** test for **each** of the three compounds that would give a positive result with the stated compound but a negative result with **both** the other two compounds.

thymol

test

observation

menthol

test

observation

menthone

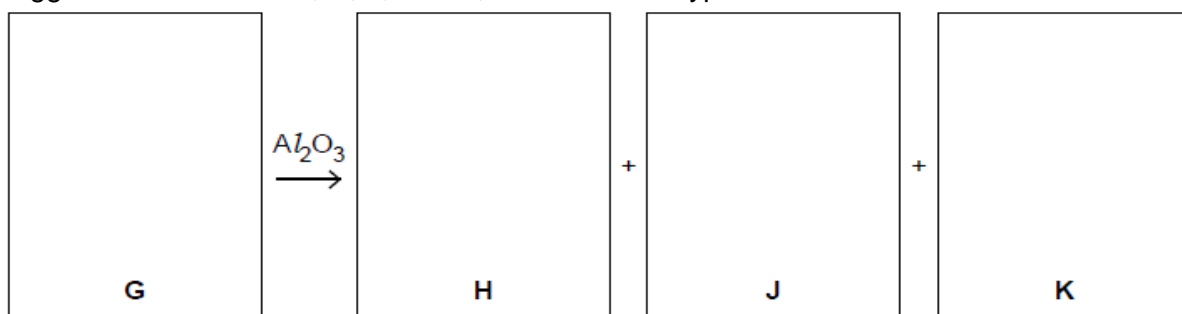
test

observation

(Nov 2010 P43 Q3)

(c) Treatment of compound **F** with NaBH_4 gives compound **G**, $\text{C}_4\text{H}_8\text{O}_3$. Heating **G** with Al_2O_3 gives a mixture of three isomeric unsaturated carboxylic acids **H**, **J** and **K**, $\text{C}_4\text{H}_6\text{O}_2$, two of which are stereoisomers of each other.

Suggest structures for **G**, **H**, **J**, and **K**, and name the type of stereoisomerism shown.

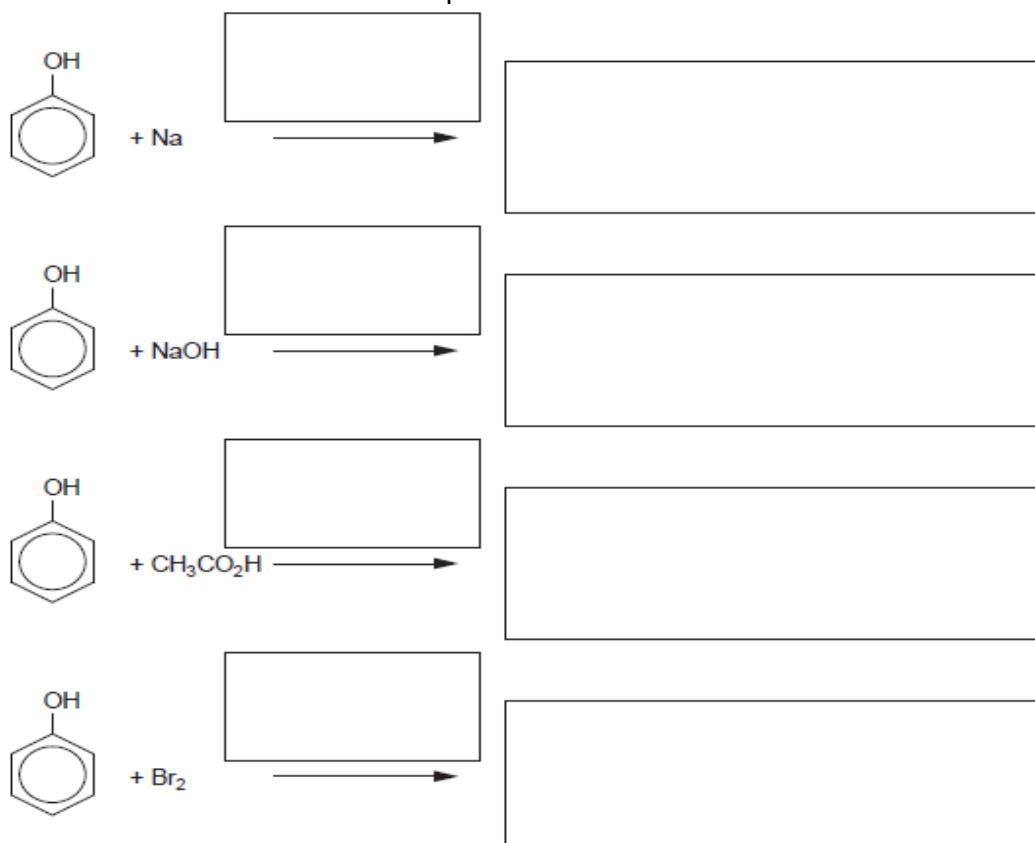


type of stereoisomerism
(June 2011 P41 Q6)

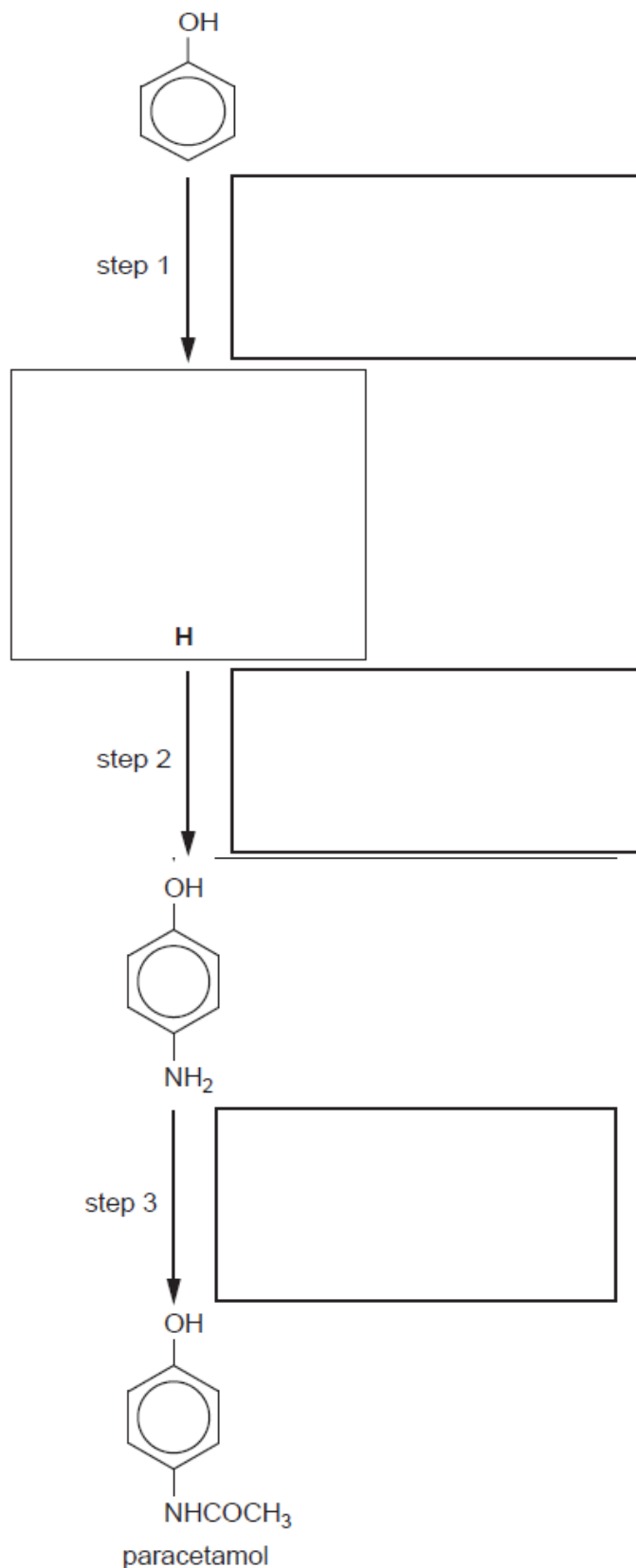
Q5 (a) Describe and explain how the acidities of ethanol and phenol compare to water.

.....
.....
.....

..... [4]
(b) Complete the following equations showing **all** the products of each of these reactions of phenol. Include reaction conditions where appropriate in the boxes over the arrows. If no reaction occurs write **no reaction** in the products box.



(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]

(June 2011 P42 Q5)