Oxford Cambridge and RSA

AS Level Chemistry B

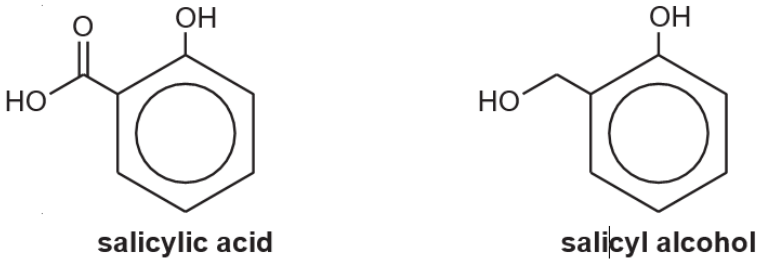
H033/01 Foundations of chemistry

Question Set 4

1

Willow bark contains salicin. Salicylic acid is obtained from willow bark by first hydrolysing the salicin to salicyl alcohol, which is a solid at room temperature.

The structures of salicylic acid and salicyl alcohol are shown in **Fig. 1.1**.



salicylic acid **salicyl alcohol**

Fig. 1.1

(a) Name the **two** types of hydroxyl group that are present in salicyl alcohol.

1 .....

2 .....

[2]

(b) Suggest laboratory reagents and conditions for converting salicyl alcohol to salicylic acid.

Reagents.....

Conditions.....

[2]

(c) Some students have an impure sample of salicyl alcohol. They wish to purify it by recrystallisation from water.

(i) Give the **first** step in the recrystallisation process. **[2]**

(ii) How would the students show that their recrystallised product was purer than the impure sample?

[1]

(d) The students make some predictions about salicyl alcohol.

They predict that salicyl alcohol will fizz with sodium carbonate solution.

They also predict that salicyl alcohol will dehydrate when heated over Al_2O_3 to give asubstance that will decolourise bromine water.

Comment on their predictions, giving chemical explanations.

[3]

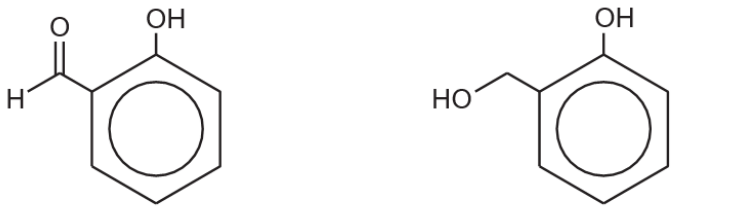
(e) **(i)** When salicyl alcohol reacts with concentrated hydrochloric acid, only one –OH groupreacts.

Write the formula of the product formed. **[1]**

(ii) Salicyl alcohol reacts with ethanoic acid in the presence of concentrated sulfuric acid.

Draw the **skeletal** formula of the product formed. **[1]**

(f) The boiling point of salicylaldehyde is 197 °C and the boiling point of salicyl alcohol is 267 °C.
The structures of salicylaldehyde and salicyl alcohol are shown in **Fig. 1.2**.

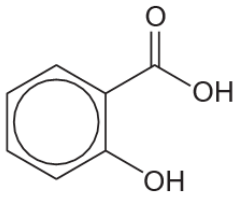


salicylaldehyde (197 °C) **salicyl alcohol** (267 °C)

Fig 1.2

Explain the difference in boiling points between salicylaldehyde and salicyl alcohol in terms of intermolecular bonds. **[2]**

2 Aspirin is a medicine that reduces fever and relieves pain.
Some students prepare a sample of aspirin from salicylic acid.



salicylic acid

(a) Before the students start the preparation, they test the salicylic acid with iron(III) chloride.What colour would they see? **[1]**

(b) The students then make aspirin by warming 6.0 g of salicylic acid with 10 cm^3 of ethanoicanhydride in the presence of concentrated sulfuric acid.

$HOOCC_6H_4OH + (CH_3CO)_2O \rightarrow HOOCC_6H_4OCOCH_3 +$ .....

salicylic acid ethanoic anhydride aspirin

(i) Balance the equation by writing the structural formula of the other product on the dotted line. **[1]**

(ii) The density of ethanoic anhydride is 1.1 g cm^{-3}.

Calculate the amount (in moles) of ethanoic anhydride used.

amount of ethanoic anhydride =……mol **[1]**

(iii) Which is in excess, the salicylic acid or the ethanoic anhydride?

[2]

(c) The students pour their hot solution into water and aspirin crystallises out as the water cools.

The students then look for a suitable solvent to recrystallise the aspirin.

(i) State the properties of a suitable solvent for recrystallisation

[1]

(ii) Name a method for testing the purity of the aspirin formed.

[1]

(d) After recrystallisation, the students obtained 3.1 g of aspirin.

What value for the percentage yield does this give?

yield =……..……..%

[2]

(e) Some other students make the liquid ester ethyl ethanoate.

Name the final stage in their purification of the ester.

[1]

(f) The students also carry out some tests on phenol, C_6H_5OH.

They find that it is not very soluble in water but fully dissolves when sodium hydroxide solutionis added.

A student says that this shows that phenol is acidic and thus it should fizz with sodiumcarbonate solution.

Comment on the student's statement.

[2]

3 Ethyl ethanoate, $CH_3COOC_2H_5$, is an ester with many uses, including removing the caffeine from coffee.

(a) Ethyl ethanoate can be made in the laboratory by the reaction shown below.

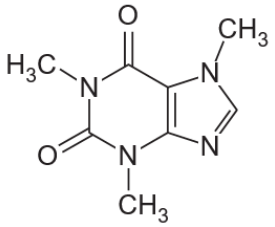
$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$

This reaction can reach dynamic equilibrium.

What can be said about the forward and back reactions once an equilibrium position has been reached?

[1]

(b) Ethyl ethanoate will dissolve caffeine since it has similar intermolecular bonds.



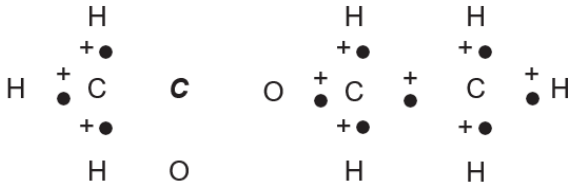
caffeine

(i) Caffeine contains some atoms that have greater electronegativity than carbon.

Explain the term *electronegativity.*

[1]

(ii) Complete the *'dot-and-cross'* diagram for ethyl ethanoate.



[1]

(iii) State and explain the bond angle around the ester group carbon (shown in bold) in the structure above.

[4]

(iv) Name the strongest intermolecular bond that can form between caffeine and ethyl ethanoate.

[1]

Total Marks for Question Set 4: 34