21 Organic synthesis

Organic chemistry is important for making new substances, not just looking at the reactions of functional groups.

This chapter deals with synthesis using those groups and compounds you have studied at AS Level. Chapter 36 deals with additional groups and compounds you will study for A Level work.

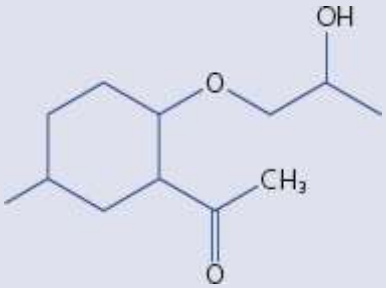
Identification of functional groups

For AS Level you need to be able to look at a molecule containing several functional groups from this part of the syllabus and identify what they are, then predict the properties and reactions of the compound based on these functional groups.

Perhaps the best way to show this is to look at an example.

WORKED EXAMPLE

Study compound X:



a Identify the functional groups it contains – with the exception of the –O– group.

b Predict how X would react with:

- **i** 2,4–dinitrophenylhydrazine
- **ii** acidified potassium manganate(VII) solution

iii alkaline aqueous iodine solution

Answers

a 2-alcohol/hydroxyl; ketone

b i It would form a yellow-orange precipitate of 2,4-dinitrophenylhydrazone.

ii The 2-alcohol group would be oxidised to a ketone, decolorising the manganate(VII) solution.

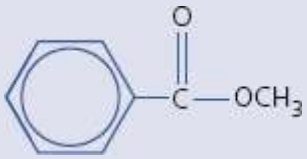
iii A yellow precipitate would form as the $CH_3CH(OH)$– group reacts.

Synthetic routes

The next part of this topic involves working out a multi-stage synthetic route to prepare a given compound based on the reactions you have come across in the AS material. You may also be asked to study a given synthetic route and asked for the type of reaction and reagents for each of the steps and to identify possible by-products.

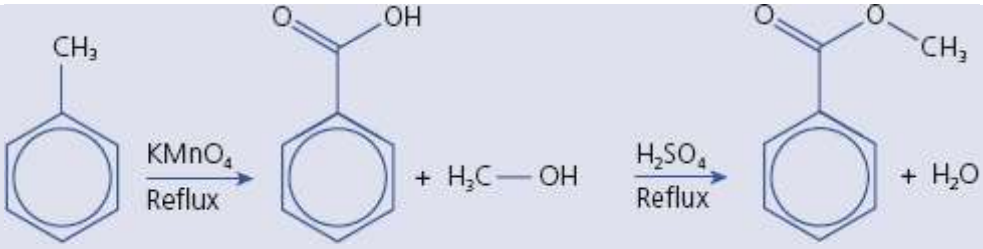
WORKED EXAMPLE

Compound Z is produced naturally in a number of plants. It can also be produced synthetically. It is used in fragrances and in foods and beverages.



Outline a route showing essential reagents and conditions to synthesise compound Z starting from methylbenzene (you can assume that the C_6H_5 ring is not oxidised).

Answers



Looking at the molecule you can clearly see the ester group in the middle. We know that an ester can be made by reacting an acid with an alcohol. Close inspection reveals that the acid must be from the group on the left (the fact that it contains a C_6H_5 ring is not important here).

That leaves us with methanol as the alcohol. So first we need to oxidise the CH_3 group to form the acid and then react it with methanol to form the ester.

Reagents and conditions for the oxidation are acidified manganate(VII) and reflux. Adding the acid form to ethanol needs acid conditions (dilute sulfuric acid) and refluxing again to give maximum yield.

REVISION ACTIVITY

Starting with ethene and ethanol, draw a reaction sequence to form ethyl propanoate, $CH_3CH_2COOCH_2CH_3$.

END OF CHAPTER CHECK

By now you should be able to:

- identify organic functional groups in a complex organic molecule and predict properties and reactions of the molecule
- devise a multi-step synthesis of an organic molecule using reactions from the syllabus
- analyse a synthetic route in terms of the type of reaction and reagents used or each step, and identify possible by-products

Analysis