LEVEL 3 EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC6c: Organic chemistry
Report on the Examination

1775 (1777)
June 2018

Version: 1.0

Further copies of this Report are available from aqa.org.uk

General

The central aim of this unit is to introduce students to preparative organic chemistry and its importance in a range of contexts including industrial and biochemical examples. The key roles played by structure and isomerism in the uses and applications of organic compounds are also considered.

To a large extent, students completed the practical preparations relatively well, especially as they were techniques new to them and based on some demanding practical approaches. Purifications were not always done as well however, and this was reflected by some quite inaccurate melting and boiling points and yields very much higher than expected, some in excess of 100%.

For the initial, introductory POs, some struggled with presentation issues, some with covering all the required content, some with both. This was often an organisational issue, for instance the lack of an assignment brief that indicated suitable approaches and content. Also clearly evident was that the ability to research and use (incorporate) relevant material, images, structures, formulae and data was very poor in some centres. This was rather unexpected from a generation with so many years of experience of ICT based work through the Key Stages.

All the work throughout the portfolios is expected to be word processed and all manner of diagrams, formulae, equations, structures, incorporated. With the more complex examples of molecules, this would be essential. For diagrams of apparatus and equipment, images from the Internet are the obvious way forward, and spectra, similarly, will be downloaded. All this should have appropriate acknowledgements and referencing.

As indicated in the specification (Assessment amplification, p126) various performance criteria can be met with concise reports which can be a ‘revision guide’, posters, Powerpoint slides or similar formats. The important point is that these fully represent the unit content, but contain primarily just factual content with suitable examples: ie a source of reference or ‘aide memoir’.

P01: Identify molecular structure, functional groups and isomerism

P1

As with all content in this unit, the scientific principles and examples must be targeted only at organic compounds. There were some very good portfolios seen, but also others with omissions and / or poor presentation.

The key elements of this criterion are:

- bonding, strong C-C bonds, ability to multiple bond, catenation
- use and examples of the terms aliphatic, alicyclic, aromatic, arene, saturated and unsaturated
- structures and nomenclature for common functional groups
- examples of structural, displayed and skeletal formulae.

P2, M1, D1

P2 was done well by many learners, with good research relating to the three techniques evident. Referencing was, however, not a strong point. An outline of each of the three techniques and a (researched) spectrum for a named compound to illustrate typical output for each is all that is needed.

This then leads into **M1** where a brief description of the underlying science of the technique is required. More able students did this very well, usually following the pattern of:

- diagram of the basic construction of each spectrometer
- explanation of the type of sample used
- an outline description of how the spectral 'peaks' are produced.

Weaker portfolios tended to have some omissions in this section, for instance descriptions for one of the three techniques, or not attempting to explain how the spectra are generated.

If P2 and M1 were completed well, students then found **D1** accessible. They can use the spectra previously included for P1 or alternatives, and the key idea is to interpret the spectrum by assigning the main peaks to the structural features of the compound in the sample.

P3, M2, D2

P3 was often met, but quite weakly in a number of cases. Too many students interpreted 'group' in this context to mean 'functional group', instead of choosing a group of compounds with common uses or applications. The examples given in the specification (p126) — flavours, fragrances, liquid crystals, biofuels, painkillers, dyes etc — allow the proper approach and, importantly, also allow access to M2 and D2. Too many chose 'alcohol', and ran out of uses common to all after just two examples.

M2 requires two of the group to be chosen, and for the specified aspects of P1 to be applied in detail to these two:

- structures
- skeletal formulae
- functional groups
- use of correct scientific nomenclature.

For **D2**, explaining why the structure and/or functional groups make them suitable for the specified use requires students to make links between the use, the properties and the structure. Some good attempts for painkillers were seen, and flavours/fragrances also provide interesting research opportunities in terms of nasal and tongue receptors.

P4, M3 and P5, M4, D3

The portfolio content regarding isomerism is split into two sections in order that optical isomerism can be treated separately and its importance in biochemical systems developed in more detail.

Some learners did not target the required content well, and included non-specific examples of structures, and even inorganic examples in some cases.

A systematic approach with an outline of each type of isomerism and examples of each (names, structures) is needed. Images/structures can be downloaded, but they have to be correct organic compounds. Some portfolios did not cover all the required types of isomerism, and P4 could not be credited.

To go on and access M3, a more detailed explanation is needed in terms of bonding and structure, including, for instance, restricted rotation around a carbon-carbon double bond.

P5 needs an outline of optical isomerism, which was met by most, but some struggled to give examples of compounds that are optically active and occur naturally in biochemical systems.

This then leads into M4 which proved to be more difficult for some, with little discussion evident relating to the importance of optically active compounds and the nature of enzyme catalysed reactions, for instance. One detailed example is then needed to complete M4. (See Assessment amplification p126).

To access D3, a detailed account of one compound that is biologically active is needed, explaining its benefits and/or detrimental effects in a medical, commercial or industrial application. Thalidomide was a common choice, although research was not always complete in terms of whether it was taken as an enantiopure drug or as a racemic mixture. Other suitable examples are given on p126 in the specification.

PO2: Understand reactions of functional groups

P6, M5

P6 should have been a straightforward PO, but some learners did not target five functional groups and, instead, considered several reactions of the same group. For each of the five chosen functional groups, the following are needed for P6:

- name of the functional group
- type of reaction, reagents and conditions
- observations eg colour change
- equation for a specific example.

For **M5**, two of the reactions from P6 are identified as ones which could serve as a qualitative test for the functional group. Simple examples, including observations/outcomes, such as the following would suffice:

- Alkenes reacting with bromine water
- Aldehydes reacting with Benedicts, Fehlings or Tollens
- alcohols reacting with carboxylic acids to give esters.

PO2 gives opportunities for practical work or demonstrations to illustrate these simple ideas and reinforce knowledge.

PO3: Prepare organic compounds

P7, M6

P7 was done very well by some students, with diagrams / images of apparatus, a short explanation and an example of a preparation or extraction that uses each technique:

- reflux
- distillation
- fractional distillation
- steam / water distillation.

Some students, however, used incorrect apparatus images and/or missed out one of the techniques. Another common omission was the example of a preparation that uses the technique. This suggests that practical examples, for instance simple demonstrations in the lab, had not been seen by some students, and this also explained their lack of understanding of what the technique is used for and how it works.

M6 needs a similar approach (diagrams, short explanations) for melting point and boiling point determinations to assess purity. The effect of impurities on melting points (depression) and boiling points (elevation) was weakly understood by some and omitted by others. The comparison between pure samples with sharp melting points and impure samples with a melting point range was rarely made.

P8, M7, D4

Regarding **P8**, risk assessments which are correct and complete are clearly a very important feature of organic preparations, and many portfolios had good examples of these. Some students, however, had not learnt lessons from ASC2, and did not understand hazard or risk, and they did not complete RAs appropriately.

A template with the following would be sufficient if completed accurately:

- name of material (including state, concentration where relevant, apparatus, etc)
- hazard identified (eg ‘corrosive’)
- risk identified (a numerical approach is not needed)
- PPE, control measures
- action on spillage, emergency, and disposal.

Note that ‘glassware’ should be a single entry, as should ‘mains electrical equipment’.

The most common examples of preparations / extractions used include:

- Aspirin
- Ethyl ethanoate
- Limonene.

M7 should consider reasons why the method chosen is appropriate. Areas to consider include:

- availability of reactants
- timescale for the experiment, rate of reaction, use of catalysts, elevated temperature
- yield, equilibrium
- purity of the compound / purification procedures.

D4 is based on research and it is important that the industrial scale production is considered. A good starting place would be a flow diagram for the industrial process. Comparisons with the method used in the centre lab can then be made in terms of the reaction, the conditions, scale, rates, purification, and automation as relevant.

P9, M8, D5

These three criteria are all related to characterisation (ie identification) and purity. **P9** involves calculating percentage yields and measuring melting or boiling point. These were generally done well but with the exception of boiling point which was often mistaken for a distillation temperature or range. The following are expected as evidence for P9:

- masses of reactants and of the purified product
- calculation of % yield for each compound prepared
- boiling point or melting point for each compound (melting point is usually quoted as a range).

and for **M8**:

- literature values for melting / boiling points
- expected % yield (from research*).

The comparison of values in M8 is taken further in M9 where overall conclusions regarding the methodologies used in the preparations are drawn (see below).

*These are not necessarily easy to find, but a realisation that most reactions have a yield <<100% is important. Reactions may not go to completion in the time scale used or are reversible. Purity is important and purification stages will also inevitably reduce yields. Typical yields for esterifications may be in the range 50-70% for instance. How/why a number of students managed to get yields >100% is uncertain, although it does suggest that technique is an issue and the product was very impure.

D5 links back to D1, and is based on a researched spectrum for one of the compounds made. Characterisation here effectively means 'identification' in the first instance, and then considering purity subsequently. What is it? Is it pure? What impurities may be present?

The spectrum has to be described in terms of the peaks present and how they can be assigned and related to specific aspects of the structure of the compound.

- Researched tables of data (absorption frequencies) and explanations relating to the fingerprint region (for infrared spectra).
- Assigning major peaks in the mass spectrum to structural features of the compound.
- Identifying the groups responsible for the peaks and splitting in the nmr spectrum.

This is then extended to suggesting peaks that might be present if impurities are present, for example unreacted reagents, water, solvent, and products of side reactions, as relevant. An example would be OH stretching frequency for unreacted acid/alcohol in the ester IR spectrum.

P10, M9, D6

P10 requires two reports: both must be present for award of credit.

M9 follows on from M8 and conclusions should be drawn relating to the methods of preparation used.

- Do the methods used produce good yields?
- What evidence is there?
- Are the compounds produced pure?
- What evidence is there?

D6 can then cover the possible improvements that could be made to increase yield or purity. There are many areas, and students should understand that only some areas listed below may be applicable:

- reaction (reflux) time
- steam distillation times
- loss of product during reflux or distillation
- excess reagents to improve yields
- catalysts
- reversible reactions
- alternative reagents
- purification stages, loss of product, removal of impurities
- drying stages
- alternative processes.

Overall, some excellent portfolios were seen. However, others did appear not to reflect the 60glh expectation for the unit as a whole and some areas were rushed and incomplete.

As mentioned previously, presentation was an issue for some, but the most common cause for not awarding credit was the lack of attention to the detailed requirements for each performance criterion. In some cases, students seemingly ran out of time as deadlines approached, and several performance criteria in PO3 were not attempted.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.
UMS conversion calculator