APPLIED GENERAL L3

APPLIED SCIENCE

ASC/U Applied experimental techniques + Investigating Science + Microbiology + Medical Physics + Organic Chemistry

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General comments

There were many examples of good quality work in the samples submitted for moderation in summer 2023, and most centres had a clear understanding of the requirements of the specification and the performance outcomes.

In most centres, it was also clearly understood that the approaches adopted by students should reflect fully the demands and expectations of a Level 3 qualification. However, some centres had underestimated the depth and breadth of the portfolio evidence expected and were too generous in their assessments. As a result, some fell out of tolerance and marks were regressed.

Some centres had clearly taken advantage of the Teacher Online Standardisation materials (T-OLS) available online via Centre Services, although it did appear that others may not have accessed these useful materials.

All centres are reminded of the requirement for internal standardisation (specification p136) and use of T-OLS materials could contribute to department training in preparation for internal standardisation.

Centres are reminded of the following requirements:

- The deadline for summer marks submissions, via AQA Centre Services, is May 15th. The sample is generated immediately when the marks are submitted and should be posted to the moderator promptly.

- Only one copy of the Assignment Brief is needed per sample.

- Portfolios should be hole-punched and tagged, correctly sequenced, with pages numbers. Plastic wallets, folders, staples, and loose pages should be avoided as they significantly slow down the moderation process. Only the final version of the student's portfolio should be submitted. Any initial or draft work should be removed from portfolios before submission.

- The Unit Submission Form (USF) for each student should be attached to the front of the portfolio, complete with centre name, centre number, student name, candidate number, student and teacher signatures. On the reverse of the USF, the Unit Achievement Record (UAR) should include total marks and evidence of internal standardisation.

- Marks awarded on the UAR must be identical to the marks submitted to AQA by the centre and the UAR total must be consistent with the number of "ticks" in the grid.

- A completed Witness Confirmation should be included for each portfolio for ASC2, and an Observation Record should be included for ASC5 and ASC6.

Examples of good practice seen during moderation in Summer 2023 across all units:

- Centres submitting the required documentation including Centre Declaration Sheet, Unit Submissions Forms, Witness statements and Observation Records without being prompted by the moderator.

- Good communication from the centre regarding their assessment rationale, eg clear annotation on the students' portfolios, as to where and why assessment criteria have and have not been awarded. Providing this clear rationale can strengthen the chance of the centre's marks being supported by the moderator.

- Evidence of effective internal standardisation processes, to help identify misunderstandings in assessment criteria requirements and errors in administration.

- Researched content from the internet reworded to demonstrate the student's own knowledge and understanding. Any direct cut and paste content suitably annotated by the assessor and not given credit. All sources of information referenced.

- Experimental work carried out individually wherever possible. Where any pair or group work is necessary, it is confirmed that each individual has played a full part in all the experimental work and his / her own results are clearly identified. This ensures each individual can follow the standard procedure and record their own results.

- Standard procedures (SPs) for all experimental work fully trialled by the centre so that students achieve data consistent with Level 3 expectations.

- No centre-issued templates or scaffolding used in portfolios eg for recording results or carrying out calculations.

ASC2: Applied experimental techniques

General comments on ASC2

ASC2 provides opportunities for research, experimental work, risk assessment, analysis of results, drawing conclusions and evaluating outcomes, as well as exploring links to industry and commercial applications. It covers elements of biology, chemistry and physics and some centres deliver the course via three subject specialists. Others do not have this opportunity, and this is understood. Whichever delivery approach is adopted, effective internal standardisation processes should be robust to ensure validity of assessments.

PO1: Demonstrate experimental techniques in biology

The most common issue encountered is still that P1, M1 and D1 all require both respiration and photosynthesis to be considered. The uses of measurements of photosynthesis were sometimes neglected in comparison to those for respiration. It should also be remembered that M1 cannot be awarded if P1 is not met.

P1 requires an outline of uses of physiological measurements of respiration (eg peak flow and lung capacity), and photosynthesis (eg uses of measurements for improving yields and productivity).

M1 requires explanations of the scientific principles behind respiration and photosynthesis (see Unit content p46, 47 in the specification).

D1 must be suitably detailed for Distinction level and should cover both respiration and photosynthesis and how they are applied in a medical or commercial context. Good approaches make use of graphs, tables, and images in D1 to support and demonstrate the points made.

For respiration there should be detailed applications of peak flow, lung capacity and blood pressure in medical contexts and the use of BMR by sports physiologists. Photosynthesis is usually linked to commercial applications in agriculture and horticulture and manipulation of factors in the context of improving crop yields and rates of growth.

PO1a

Students who had achieved P2 followed a suitable SP to:

- Measure the effect of one factor on respiration.
- Varying temperature is the most common approach seen and most centres have adjusted their procedures to allow a suitable range of data to be recorded.

Students who achieved M2:

- Recorded results at 5 or 6 different temperatures (for yeast, seeds, or beans). Centres should remember that, where ethical constraints restrict the range of temperatures to be used, it follows that M2 is likely to not be met.
- Chose temperatures that spanned the optimum value and the pattern of results and optimum were as would be expected.
- Calculated rates of respiration (eg by volume of gas/time).

- Drew a graph of rate of respiration vs temperature.
- Explained the shape of the graph with reference to, for instance, reaction kinetics, collision rate, activation energy, enzyme action, active sites, and denaturing.

Students who achieved D2:

- Evaluated the results and the SP used.
- Identified anomalies and errors and made justified suggestions for improvements.

PO1b

Students who achieved P3 followed a suitable SP to:

- Investigate the Hill reaction (light dependent reaction).
- Record all results. No calculations or conclusions are expected.

Students who achieved M3:

- Adapted the same SP as used for P3 for three different limiting factors. Most commonly these limiting factors were light intensity, wavelength of light, carbon dioxide (eg varying concentrations of sodium hydrogen carbonate) and herbicides.
- Included and explained the science behind how the adaptations work (eg applying the inverse square law for light intensity diminishing with increased distance, explaining how wavelength of light relates to the colours in the visible spectrum).

PO2: Demonstrate applied experimental techniques in chemistry

Volumetric analysis and colorimetry are outlined in terms of their basic principles and uses for P4. M4 then requires explanations of the underlying science of the two techniques with specific reference to standard solutions, choice of indicators, and the Beer-Lambert Law. This section of research was generally completed better than that in PO1 or PO3. However, on occasion, the expected content had one or two aspects missing.

Volumetric analysis includes:

- The reaction, equation, and stoichiometry (molar ratio).
- Choice of indicator, justification, and explanation in terms of pH titration curves and end points.
- The importance of using a standard solution, examples and uses.

Colorimetric analysis includes:

- The visible spectrum.

- How a simple colorimeter is constructed and how it works.
- Choice of filter or wavelength of incident light used absorption curves and lambda max.
- Absorbance (NB not transmission).
- The Beer Lambert Law and graphical representation.
- Calibration and the nature of the absorbance vs concentration graph.
- Uses of colorimetric analysis.

PO2a

Students who achieved P5 followed a suitable SP to:

- Prepare a standard solution (eg sodium carbonate or sodium hydrogen carbonate) NB the choice of standard is important and inappropriate choices (eg NaOH) cannot be credited.
- Carry out a titration (eg against hydrochloric acid of unknown concentration).
- Achieve titres of suitable values, typically 20 – 25 cm^3.
- Record all results to include mass of standard weighed out, volume of volumetric flask, volume pipetted, initial and final burette readings (to +/- 0.05). Note: a completed Witness Confirmation and RA is needed to support the practical work.

Students who achieved M5:

- Calculated the concentration of the standard solution from the mass they weighed out and the volume of the volumetric flask.
- Calculated the unknown concentration.

Students who achieved D3 researched titrimetric methods used in industry with particular reference to:

- Use of auto-pipettes, auto-titrators, electronic end-point detection.
- The accuracy and precision of recording of the results that follows.
- The use of primary standards explained with suitable examples.

PO2b

Students who achieved P6 followed a suitable SP to:

- Use solution dilutions of a standard solution (eg copper(II) sulfate).

- Prepare a suitable range of known concentrations.
- Select a suitable filter or choose a suitable wavelength.
- Correctly zero the colorimeter.
- Record absorbance values for all standards and the unknown.
- Plot a calibration graph.
- Use the calibration graph to determine the unknown concentration.

Students who achieved M6:

- Explained the choice of filter or wavelength in relation to the colour of the unknown and the visible spectrum (and in the best portfolios, by referring to a graph of absorbance readings vs filter colour and determining λmax).
- Described any anomalies in the data recorded.
- Referred to the Beer-Lambert Law and compared the expected line (straight line through the origin) with that achieved.

Students who achieved D4:

- Evaluated the outcome of the analysis of the data.
- Systematically considered all the stages in the procedures, the apparatus used and any errors or lack of precision that may have resulted.
- Considered the data recorded (solution dilutions, colorimeter readings) and its reliability through repeats, and precision of recording.
- Compared the outcome with the expected value and accounted for any discrepancies.

PO3: Demonstrate applied experimental techniques in physics

P7 and M7 were surprisingly weak in some submissions, with resistivity in particular being often poorly understood by students and lacking an explanation of its definition. SHC was usually better described / defined. Both, however, were poorly explained “in relation to material properties”.

It is essential to get P7 correct as, if weak, it usually followed that M7 was not met. M7 needs to concentrate on (researched) values of resistivity and SHC, and how these determine uses of a range of materials in industry.

Resistivity includes:

- The meaning and definition of resistivity and how resistivity relates to resistance.
- How resistivity determines uses of materials.

- How values of resistivity are linked to uses for a range of materials with high and low values.
- How values of resistivity are linked to the uses of semi-conductors.

Specific Heat Capacity includes:

- The meaning and definition of SHC.
- Why different materials have different values.
- How high and low values of SHC are linked to uses of materials.
- Suitable examples including water.

PO3a

Students who achieved P8 followed a suitable SP to:

- Measure resistivity.
- Record all results including the length and diameter of the wire.
- Use suitably precise equipment.
- Repeat readings at least three times.

Students who achieved M8:

- Calculated cross sectional area and resistance, and hence resistivity.
- Compared their results with (researched) industry standard values.
- Identified whether their result agreed with the industry standard.
- Identified and accounted for any anomalous readings and reasons why any differences arose.

Students who achieved D5:

- Researched industry standard methods of measuring resistivity such as 4-point probes.
- Described these methods, usually with diagrammatic support.
- Linked these methods to reduction of errors such as contact resistance.
- Considered the improved accuracy and precision of recorded data that result.

PO3b

Students who achieved P9 followed a suitable SP to:

- Measure the SHC of one material (usually a solid).
- Record all results.

Students who achieved M9:

- Plotted a graph of temperature change vs time (or energy supplied).
- Calculated % errors in the measurements made and plotted error bars (for temperature change only) on the graph (Note: uncertainties in readings are acceptable in place of error bars).
- Drew the line of best fit (NB this is often not a straight line throughout, especially at low and at high temperatures).
- Calculated SHC.
- Explained the graph in terms of heat transfer (heat gain vs heat loss and how this may vary as temperature increases, Newton's Law of cooling will be relevant here).

Students who achieved D6:

- Explained how the SP (NB that used previously in P9) could be adapted to measure the SHC for a material in a different phase (typically, a liquid).
- Included diagrams, adapted SPs, due regard for heat losses / insulation / materials used.

PO4: Understand safety procedure and risk assessment when undertaking scientific practical work

The production of meaningful risk assessments (RAs) is important. Centres are advised to coordinate the production of RAs across all three areas of science so that students become familiar with a generic risk assessment template and can complete it independently for the required practical tasks.

Centres are reminded of the requirements of risk assessments for P10:

- Students should independently produce one risk assessment for each of PO1, PO2 and PO3.
- Centre-issued risk assessments for the other three practical tasks undertaken in ASC2 should be included.

- It should be clear to the moderator which risk assessments have been produced independently by the student and which have been centre-issued.

- Centres should note that a missing student RA will lead to P10 not being available for credit.

Guidance for the production of risk assessments:

- Risk assessment templates should be produced. RAs written in prose are not suitable and will not gain credit.

- RAs should start with identification of materials/equipment. Chemicals should include relevant states and concentrations. Equipment such as glassware can be grouped together as one entry to avoid repetition, as can any mains electrical equipment.

- Students must make it clear that they understand the difference between hazard and risk and assign these to the next two columns in the risk assessment template. The nature of the hazard should correctly reflect the state/concentration of the chemicals.

- A numerical approach to risk should not be undertaken.

- Further column entries should then consider control measures (including PPE and disposal if relevant) and action on spillage/emergency.

ASC5: Investigating science

General comments on ASC5

A range of investigation titles was evident in Summer 2023. Some centres make good use of (and are advised to use) the Student Worksheets: “ASC5 Investigations Task Overviews” (available on the AQA website). Teachers can print off the double-sided card for each investigation to produce a useful teaching aid which can be issued to students to support them in the conduct of their investigation. There are ten different investigations represented and each provides advice and information on how to approach the various assessment criteria.

Centres are reminded of the following requirements for ASC5:

- All aspects of the investigation should reflect the Level 3 nature of the Applied Science qualification.

- ASC5, as with any other coursework unit, requires 60GLH.

- The suggested titles represented in the “ASC5 Task Overviews” on the AQA Website should be followed as written.

- If centres wish to develop their own investigation, then they are advised to consult their NEA Adviser first. Full details of the intended investigation, likely aims, experimental methods / SPs, factors to vary, links to industry / commerce will be needed if an informed recommendation is to be made.

- Students can follow the same investigation title as others, but they must work independently, carry out their own research, obtain and record their own results, analyse, manipulate, conclude, and evaluate individually.

- Some suggested factors on the Task Overviews are more demanding and higher level than others. Centres must prioritise accordingly.

- Typically, a minimum of three factors, all at Level 3, could allow access to the higher-level criteria if completed fully and to an appropriate standard.

- Restricting the number of factors is very likely to prevent access to most of the higher criteria.

- Adopting practical work with low level demand and / or restricted coverage of the relevant scientific principles will, similarly, prevent access to most of the Merit and Distinction criteria.

Some students investigated fewer factors than documented, whilst others chose mainly low-level experimental approaches which were well below Level 3 standards. In both cases, credit was limited to lower criteria.

What students should consider before starting an ASC5 investigation:

- The levels of science expected and the depth of knowledge and understanding that should be demonstrated.

- Using practical techniques of suitable levels of demand and avoiding GCSE level work (or even below).

- How to access sources which are not predominantly based on GCSE work (or below).

- With the right decisions, appropriate investigations can meet all the criteria at a good level. However, it is possible for two investigations with the same title to be met at Distinction level or at below Pass level depending on the decisions made and approaches adopted.

- To an extent, some credit may normally be available if investigative processes and procedures have been followed, but some criteria cannot be met for low level approaches, weak science and restricted, inaccurate, or unreliable data.

Popular ASC5 investigations seen in Summer 2023:

Electrochemical Cells has proved to be successful in the past and provides opportunities for good Level 3 approaches and theory, eg application of the Nernst equation and redox potentials.

Fermentation in the brewing industry is a popular choice, but it can also be, potentially, one of the weaker investigations in terms of practical approaches. The entry in the specification lists 5 factors to choose from (the Task Overview suggests 3, but this is then widened in terms of practical approaches and techniques when ethanol content (ABV via specific gravity), colour and clarity are also included).

At its simplest, submissions have investigated one factor, sometimes very inaccurately and with limited outcomes and marks available.

Properties of shampoos lists 5 factors, although there are others that would be suitable such as effect on hair dye and anti-microbial action for instance. Here, several factors are able to be brought up to L3 approaches such as a quantitative determination of viscosity using Stokes' Law, applying pH using GCE level definition, formula, effect of dilution / temperature, buffer action, calibration of pH meters, etc., cleansing effectiveness via careful gravimetric work.
Simplistic approaches to foaming and oil-emulsification will add breadth, but not depth.

Output of a wind turbine lists 3 factors, and all should be investigated. This does require appropriate apparatus. Simplistic approaches that involve, for instance, cut out pieces of card and blue tack, are very likely to fail.

Factors that affect reaction time is another popular investigation, but not always for the right reasons. There are 4 factors listed in the specification, and there are various real and virtual timers to trial. There are good links to background science in ASC4, although other sources and other relevant aspects of science should also be researched.
Obtaining sufficient data in order to make valid conclusions is always a problem, and this has to be recognised and explained.

Good investigations were characterised by:

- Comprehensive portfolios created with a firm understanding of the depth of treatment expected.
- Extensive research and use of secondary sources.
- Wide ranging approaches to all elements of the investigation.
- Good levels of scientific knowledge and understanding consistent with Level 3.
- Appropriate practical methods producing accurate and reliable data.
- Sensible assessment by assessors who clearly understand the need for content at an appropriate level.
- Clear assessor annotation identifying where performance outcomes had been credited.

Weak investigations which often failed to meet Pass criteria were characterised by:

- Insufficient factors being investigated (sometimes only one) and / or choosing low-level approaches well below Level 3 expectations.
- Less than 60GLH spent on completing the unit.
- A portfolio of very few pages and very little content.
- Limited and / or low-level research into scientific principles/background.
- Only one standard procedure identified, used, or trialled (and sometimes issued, not researched by student).

- Restricted outcomes/data recorded.
- A lack of evidence of contact with the centre's NEA Adviser where "ASC5 Task Overviews" on the AQA Website had not been followed as written.

PO1: Prepare for a scientific investigation

P1, M1 and D1 involve progressively more detailed research and explanations of scientific principles across the performance outcomes grid.

The principles to be covered concern all aspects of the investigation including:

- The scientific area concerned, and the underlying theories and principles.
- The science related to the relevant procedures, techniques, possible approaches.
- The science relating to the variables/factors to be investigated and / or controlled.
- The need for a particularly detailed account of principles which also have to be related to commercial and industrial uses (D1).

Although not necessarily a pre-requisite, some investigations will have direct, extensive links to other areas of the specification, for instance reaction time and ASC4, and this gives an idea of the level of theory that is appropriate. In this example, relevant parts of the structure and function of the nervous system and brain and nerve impulses from ASC4 would provide a good high-level basis for some of the scientific principles behind the investigation.

In addition, further areas, relating to the standard procedures and factors / variables investigated or controlled, would also need to be considered.

P2, M2 and D2 are also connected and provide a sequence from Pass to Merit to Distinction:

- P2 requires a plan, aims, and researched standard procedures/techniques (plural) to be followed.
- M2 records results/data from trials of the SPs identified in P1 – leading on to changes made to the SPs to be adopted.
- D2 then requires a justification of the final SPs chosen and the accuracy, reliability and validity shown.

Whilst practise techniques are mentioned in the Unit content (p85) the main purpose is to determine parameters. Trials are designed to identify the SPs to be used, and how variables are best controlled to give accurate, reliable data. Changes to the plan, including modifications of parameters (eg concentrations, times, etc) need to be described.

In weaker portfolios, trials were usually very limited in scope as they were not aimed at trialling methodology and determining parameters. Subsequent modifications were not extensive, and often not present at all.

PO2: Carry out the investigation and record results

Risk assessments (P3) including control measures (M3) were often very poor. This is surprising as these students will have already completed risk assessments for ASC2. RAs are best recorded on a standard template (lengthy prose style RAs are not acceptable).

Appropriate column headings for a RA template are Equipment or Materials, Hazard, Risk, Control Measures, and Emergency Measures, are expected. Hazards and risks must be correct for the states and concentrations used and quoted in the RA.

A Teacher Observation Record is required for each student to support the award of P4 “correctly follow SPs to use a range of practical equipment and materials safely”.

Other issues that can arise are that students do not “use a range of equipment” or are not working at Level 3. It is important that the SPs are present in portfolios together with the associated results in order that P4 can be judged in the context of the practical work carried out.

For P5, data must be recorded to correct levels of precision (significant figures / decimal places) with correct units and adhering to normal conventions. This was not always seen, and absent units and / or incorrect conventions result in P5 not being met.

It is assumed that all data recorded are the student’s own unless otherwise annotated. Students and assessors must sign the USF to confirm that all work is the student’s own. If any secondary data from other students are included, these should be tabulated separately and annotated accordingly.

M4 assesses effectiveness of methods used to collect data. This is measured on the quality of the recorded data, size of samples, precision of recording, anomalies, repeatability / concordance, accuracy, etc.

D3 then considers the responses to these questions and makes suggestions for improvements to the methodology and/or data collection.

PO3: Analyse results, draw conclusions and evaluate the investigation

P6: Analysis of data could include suitable, simple calculations, eg means, and presentation of data using appropriate graphs and/or charts.

M5: Manipulation of data using appropriate methods usually incorporates mathematical changes, for instance calculating rates of fermentation, energy output from a wind turbine, viscosity using Stokes’ Law, time of fall in a ruler drop test. These modified outcomes can then be presented graphically in a more meaningful way.

IT is expected to be used at some stage in the process, either in the manipulation steps (eg spreadsheet calculations) and / or at the graphical representation stage. The use of IT does have to be appropriate and should enhance the ways in which data are manipulated and presented, remembering that some Excel graphs are too simplistic, often with inappropriate lines of best fit, to be useful.

A useful addition to manipulation of data would be the use of statistical methods, but this does have to be appropriate to the data set recorded and often this is not the case for ASC5.

D4 discusses the methods and formats used in the analysis in the context of the outcomes and their relevance to the original aims of the investigation. Justifications can also consider the analytical methods used and what further information or outcomes are derived as a result of applying those methods.

P7 identifies sources of error and anomalous data. These errors can be systematic or random. Good approaches seen include identifying qualitative errors (considering the methodology used), quantitative errors (in the readings taken/data recorded) and percentage errors in readings recorded (and comment on their values).
M6 then explains these sources of error and how they arose (including reasons for anomalous data) and how these sources of error can be minimised.

P8 and M7 were particularly weak areas for many students. For P8, conclusions should be related to the original aims set out in P2 and should be based on the data recorded and analysed in P6 and M5.

In M7, these conclusions based on primary data are compared with equivalent information (data) gained from secondary sources, such as researched expected outcomes and literature values if available.

Much work seen offered limited or no evidence of the comparison of conclusions drawn from primary data gathered by the student, and those based on secondary data. Using other students' results as secondary data may well be of limited value and should not be seen as a substitute for extensive research and recording of relevant secondary data from reliable sources.

D5 ties together the explanations in M6 and the review of outcomes in M7. A full evaluation of the outcomes and qualitative and quantitative errors is an essential start point. The use of percentage errors can then lead to a comparison of the accuracy of the calculated outcomes with the overall error.

PO4: Present the findings of the investigation to a suitable audience

P9: The report on the investigation is usually the portfolio and no separate mini report is expected. The presentation can be in various formats, designed for a suitable (identified) audience and appropriate for that audience. It should contain text and images, include results and a conclusion, which are clear and concise.

Some very poor PowerPoint presentations were seen with slides that needed to be more focussed and concise.

Many students would benefit from guidance in the design and content of PowerPoint presentations. A small number of centres did not include the presentations in the students' portfolios, and these had to be requested by the moderator, slowing down the moderation process.

M8 connects to M7 in terms of secondary data but also includes its use in other criteria such as P1, M1, and D1. M8 also has the additional expectation of use of correct scientific terminology throughout.

D1 assesses the relevant scientific principles and their relationship to industrial / commercial uses, and now D6 revisits these, but from the point of view of the relevance of the results and outcomes of the investigation to those industrial processes.

P10 requires sources to have been used in research for PO1 and for secondary data for M7. A basic version of Harvard Reference System is expected to be used. For example, a numbered indication in the body of the text and the reference listed in a footer or in a bibliography at the end.

M9 requires the usefulness of the references to be evaluated and the references themselves to be validated. Validation can consider a whole range of checks and ideas depending on the nature of the source. Considerations might include the type of publication, who published it and where, the purpose of the publication, the academic standing of the author, and likelihood of peer review.

ASC6a: Microbiology

General comments on ASC6a

Some excellent portfolios were seen in Summer 2023, with suitable high-level practical work which was not only complete but also logically ordered and presented. This followed through to the inclusion of good supporting evidence, data, images, etc for all experiments. High scores also reflected a consistent approach across all four POs and good levels of knowledge of the required content and approaches.

ASC6a contains more practical work than the other two optional units. PO1 (P3), PO2, and most of PO3 are all based on practical activities, and clarity and full supporting evidence, descriptions, results / data, photographs, images, etc are all very important.

An issue noticed by moderators was that PO4, as in previous years, was often a weaker section than any other. In some cases, this appeared to be a time issue, and in others it was seemingly due to the independent nature of the expected approach, based almost solely on individual research. Overall, PO4 can generate 6 marks - or almost 25% of the overall marks available - and this is potentially a very significant contribution to overall scores.

Examples of good practice seen during moderation of ASC6a:

- Observation Records were included for all practical work. These provided evidence that the student had followed the SP, applied the risk assessment, used aseptic technique, and recorded results correctly.

- Students provided a coherent set of results for all practical work, clearly demonstrating that the practical work had been completed.

- USF signatures of both the student and the teacher confirmed that the work submitted is the student's own independent work. If there was a degree of pair or group work, this was made clear.

PO1: Identify the main groups of microorganisms in terms of their structure

P1 and M1 were covered well by many students. Content was based on independent research and sourced material was adapted well by the students to target the criteria. In some cases, source material was not reworded to demonstrate the students' own knowledge and understanding, and this could not be awarded credit.

Good portfolios included labelled diagrams and detailed coverage for all three types of microorganism (akaryotes, prokaryotes and eukaryotes).

P2 should describe methods used to identify microorganisms to include Gram staining, light and electron microscopy, colony characteristics. Annotated diagrams and images from research will always add to the descriptions.

Good portfolios described all techniques well, whereas weaker attempts sometimes missed out a technique completely and/or included very little descriptive detail.
M2 continues from P2 and explains how all the techniques described are used and how they provide information that allows identification of the structures of microorganisms. In each case, good explanations will be accompanied by relevant images.

D1 requires a comparison of the different identification techniques listed in P2 and how they are used in biotechnological industries. It was clear that students did not always know what was required here and often underestimated the levels of detail expected at Distinction level.

Relevant industries and techniques may include food and beverage, pharmaceuticals, water, environmental, forensics and good portfolios included which industries use which identification techniques and for what.

Some excellent examples of independent research seen then went on to consider if there were other relevant techniques, for example those based on electrophoresis, DNA sequencing and mass spectrometry.

P3 is an experimentally based criterion. The evidence expected includes an SP and risk assessment for Gram staining correctly followed, an observation record, individual student results (eg photographic images), and conclusions drawn.

Weaker portfolios often failed to include evidence of outcomes and thus did not complete the experiment (which is to identify microorganisms).

PO2: Use aseptic techniques to safely cultivate microorganisms

P4 is achieved for producing risk assessments including preparation of sterile growth media, names of microorganisms used, cultivation of microorganisms, aseptic techniques, and safe disposal.

Centres should note that, without specific identification of the microorganisms used and full risk assessments associated with them, the RA will be considered to have important omissions and P4 should not be awarded.

Risk assessments in general are still a weak area for students in a range of centres. This follows through to the control measures which are assessed in M3. M3 should not be considered for credit if P4 is not awarded.

For P5 there should be at least two different types of microorganism (specification p101), and three different cultivation techniques used. Standard procedures for the preparation of the growth media and for all three cultivation techniques, including aseptic techniques and incubation, should be documented.

Evidence to support completion of the practical tasks should include an observation record and may include images or photographs.

For M4 an explanation of the principles behind the use of growth media and each of the three techniques is required. This remains a weak area for many students. It is suggested that M4 is included as in introduction to each of the experiments and then linked to a conclusion as to whether the purpose of the technique used has been achieved.

D2 requires an evaluation of each technique, referring to the results obtained, identification of errors or anomalies evident in the results and justified suggestions for improvement.

Evaluations and justifications are often a difficult area for many students, and this is applicable to all the units, but especially so here where a logical, ordered approach across all three techniques and their results is necessary.

Weaker portfolios were often not logical in their order and omissions of key information such as results were not uncommon.

PO3: Use practical techniques to investigate the factors that affect the growth of microorganisms

Ten different factors which promote or inhibit growth of microorganisms are listed in the Unit Content (page 97). P6 requires a range to be described, and portfolios should include a minimum of 5 or 6 although able students may go on to describe more. Insufficient factors or lack of detail may prevent credit for P6.

M5 requires evidence of practical work investigating three factors that affect growth. The three factors are drawn from the range considered in P6. D3 requires students to draw conclusions about how the factors affect growth.

Conclusions must be consistent with the recorded results. In order to then go on and provide evidence for other marking criteria in PO3, centres often combine the experiments investigating these three factors with other practical approaches. This avoids too many repeats of similar practical work.

The specification (p102) gives examples of approaches to this practical work (but there are alternatives).

Approaches to M5 should include:

- Use of a range of cultivation techniques (these can follow on from those used for P5).
- Use of at least two types of microorganism if carrying on from P5.
- Use of a range of counting or measuring techniques selected from measuring clear zones, viable counts, use of a haemocytometer, colorimetry, viral plaque assay.
- Serial dilutions can be used as part of the counting and measuring techniques or can be used in a separate activity such as the haemocytometer investigation).
- Standard procedures, RAs (centre issued).
- Observation records, evidence for completion of all 3 practicals including aseptic technique.
- Recorded results, images, photographic evidence.

Portfolio evidence was again variable across a range of centres, and some was particularly difficult to follow and had omissions. Students need sufficient direction to ensure all the evidence required for award of the various marking criteria is present.
Issues that arose included the following:

- Some results were absent or incomplete.
- Insufficient range of values of factors investigated for M5, leading to poor explanations and conclusions in D3.

- Graphs were produced based on minimal evidence.
- Some results were identical across all students, indicating group work, but there was no indication of individual contribution.
- The Observation Record should record any use of group or pair work and the individual's contribution. Centres should note that the signatures on the USF confirm independent work.

P7 requires the use of one suitable technique to count / measure microorganisms. This was most commonly a haemocytometer, and some good approaches and results were evident. There were some well-considered explanations of the use of haemocytometers in a small number of centres, with fully explained subsequent calculations.

However, success rates varied with the student's levels of understanding and explanations of the technique were sometimes very difficult to follow and had omissions. Diagrammatic support was sometimes weak or absent or not applied well and calculations were not explained in full and did not show understanding.

Viable counts were also a popular choice of technique and worked well for a number of centres. It is important that centres realise that measurement of clear zones is not a technique suitable for the award of P7 (measuring microorganisms).

In addition to, and in combination with, serial dilutions, the following techniques may be used:

- Viable counts on plates.
- Haemocytometer (direct counts).
- Colorimetry (to measure turbidity and so an indirect count).
- Measurement of clear zones (suitable for M5, D3 but not P7)
- Viral plaque assay.

For M6 explanations of the technique used were often not sufficiently detailed, as indicated above, and were based on incomplete understanding of the processes involved.

For counts of colonies, it would be appropriate to record all 'raw' data, rather than just state the number of live cells. The specification (p102) indicates that the total count should include viable and non-viable cells.

For D4 there should be an evaluation of the measuring and counting techniques used and suggestions for improvement. It is acceptable for students to leave this until all the required elements of PO3 have been completed, including P8 and M7.
The evidence for P8 includes the SP for the serial dilution practical task and any associated data. The Observation Record should confirm correct use of the SP and safe working.

M7 requires evidence of calculations of the number of microorganisms in the original sample used for the serial dilution. This should demonstrate an understanding of the calculations undertaken.

This was a weak area in many portfolios seen. Where student's calculations contained errors or had been scaffolded, it left the student with no idea as to what the calculations represented or why.

PO4: Identify the use of microorganisms in biotechnological industries

PO4 requires independent student research, suitably referenced, and targeting the relevant sections of the Unit Content and the PO grid. This appeared to be a weaker area for some students which may have been caused by time constraints, insufficient research, and lack of understanding of the assessment requirements.

For P9, students should describe the main features of both batch and continuous processes in biotechnologies, including diagrams, examples, and the scientific basis of the processes to support the descriptions.

For M8, students should explain the benefits of industrial fermenters or bioreactors with suitable examples to demonstrate their purpose and nature. Benefits might include scale, rates and costs including energy use. These can be linked to examples taken from a range of industries (see Unit Content p97).

M8 then leads into D5 where the emphasis is on the comparison of two specific industrial processes or techniques. At Distinction level, the two selected processes should be researched in detail, and similarities and differences discussed. It is very important that the microorganisms used in these two processes should be identified and the part played in each case described. This was a weak area for many, despite being very straightforward.

For P10, students choose two different industries from those listed in the Unit Content (p 97). Students research them in some detail, concentrating on naming the microorganisms used and describing the relevant industrial processes and techniques in each case.

This leads on directly to the content expected for M9, where the reasons why these processes benefit society can then be explained in detail. Weaker content seen is often too brief and does not explain benefits in detail or at the levels expected for Merit.

D6 can be based on a different biotechnological industry from those used in P10 and M9, but it does have to use microorganisms and genetic engineering, as stated in the marking criteria. The biotechnological industry must be clearly identified with the process and products or outcomes described.

The roles of the microorganisms and the genetic engineer are evaluated, including advantages, disadvantages, and other considerations such as legal restrictions, public opinion, and possible misconception.

ASC6b: Medical Physics

General comments on ASC6b

Some excellent portfolios were seen for ASC6b during Summer 2023 moderation. ASC6b remains a popular choice of optional unit. It should be noted, however, that centres should not choose this optional unit unless they are able to meet the practical requirements relating to radioactivity.

Examples of good practice seen during moderation of ASC6b:

- Practical work requirements relating to radioactivity were interpreted correctly.
- An Observation Record was included which provided the evidence that the student had followed the SP, applied the risk assessment, and recorded results correctly.
- Higher scoring portfolios seen, were based on extensive research. Research included medical applications of imaging, radiotherapy, tracers, optical fibres, and lasers, coupled with a sound understanding of the underlying physics.
- The best work was supported by an appropriate range of images, graphs, data, decay equations, and mathematical relationships.
- The ability to provide, explain, use equations, and apply quantitative support for the background theory also typified high scoring portfolios.

PO1: Understand imaging methods

P1, M1, D1 are linked via the underlying theory behind imaging methods and are sequential. Ultrasound and X-rays were the most common choices for the imaging techniques, but other techniques listed in the specification (p107) are acceptable. Diagrams that fully illustrate the apparatus used are included and described.

In the portfolios submitted, most students achieved P1 via descriptions of the underlying theory behind two imaging methods.

However, the weaker portfolios did not go on to provide good links between the theory and the way in which images are formed for M1. Suitable examples and appropriate images will always add to the descriptions.

D1 requires calculations to be performed. Relevant content includes:

- The use of $v = f\lambda$ to calculate and then compare properties of relevant wave forms.
- Using $E = hf$ to determine and compare photon energies.
- The calculation of reflection coefficient between two media (and its implications).

Just quoting relevant equations without applying them or using them to generate quantitative support for the theory will not achieve D1.

P2 and M2 may follow on directly from P1, although it is acceptable to select different imaging techniques, one suitable and one unsuitable, for this section. For P1 the selected condition is described, including its nature and site in the body and then one suitable and one unsuitable technique are identified.

For M2 there should be a comparison of the quality of the images for the two techniques, potential dangers to the patient of the unsuitable technique and lack of dangers for the suitable technique. This criterion is another where suitable images, well explained, enhance the portfolio evidence.

PO2: Understand radiotherapy techniques and the use of radioactive tracers

These three performance criteria are linked and sequential. If P3 is not met, M3 and D2 cannot be awarded, although this is likely to be the case anyway if the basic descriptions for P3 are not all present.

For P3 two radiotherapy techniques are chosen (see specification p108). One technique is implant based and one involves external therapy. There should be good levels of research evident enabling good descriptions of the two techniques. The disease linked with each technique should be stated and diagrams used to enhance the descriptions of the techniques.

Often, in weaker portfolios, the diagrams were not referred to nor used to enhance understanding. M3 goes on to explain how each technique is used to treat the relevant specified disease and how each chosen therapy is administered.

D2 then explains, compares, and contrasts the invasive nature of the two therapies chosen.
Good portfolios often tended to deal with P4 and M4 together, identifying each property of the selected radioisotope sequentially and explaining the importance of that property.

For P4 good portfolios included name, symbol, mass number, atomic number, the type of decay / radiation emitted, half-life, technique used and medical context.

M4 requires the decay equation, the part played by, and the importance of, the type of radiation emitted, half-life explained in the context of importance in radiotherapy and the physical half-life and biological half-life explained.

For D3, quantitative support (calculations) for the explanations includes the time taken for activity to fall to a level unsuitable for further use, calculation of effective half-life and photon energy.

P5, M5 and D4 relate specifically to the use of radioisotopes as tracers. Good portfolios often considered P5 and M5 together for the range of examples selected, which avoided rather disjointed reports which sometimes typified lower scoring examples.

For P5 there should be an outline of how tracers are used in associated medical contexts with a suitable range of examples (radioisotopes identified, common applications outlined). An outline of organ affinity, need for short half-life, and the type of radiation emitted, and detection are all included.

For M5 two isotopes used as tracers should be identified and the medical contexts in which they are used described, including purpose, type of illness and location in the body. Properties, decay equations, half-lives, organ affinity and properties linked to reasons why they are suitable for the use described are all included.
D4 requires detailed research and both isotopes identified for M5 must be considered. Graphical data should include decay curves. Determination or demonstration of half-life should be included

and values for physical half-life and biological half-life researched and evaluated via calculations of effective half-life.

P6 and M6 are good examples of where a detailed knowledge and understanding of the Unit Content is essential (see specification p108). This then has to be backed up by detailed research.

Some good examples of this were seen, although it was clear from some submissions that students had not always been prepared well in this respect.

High scoring portfolios included:

- Consideration of the dangers of radioactivity, comparison of alpha, beta, gamma.
- Precautions taken for both medical professionals and patients.
- Scientific principles behind the precautions taken.
- The effects of ionising radiation including meanings of stochastic, non-stochastic, somatic and heredity.

PO3: Demonstrate the ability to work with radioisotopes in the laboratory

A small number of centres approached this unit without the means to carry out the determination of half-life. An alternative which covers the same principles in terms of the use of data, is to perform experiments on half value thickness (eg for Co-60). This has the advantage of also allowing coverage of the various required practical elements.

An observation record should confirm the following practical aspects:

- safe working
- following procedures involving correct handling of radioisotopes
- correct precautions taken to ensure safety
- use of a Geiger counter
- measuring background radiation.

This evidence can be obtained via practical activities including a full protactinium half-life determination or an HVT determination for instance for Co-60 and a comparison of the penetration properties of alpha, beta, gamma radiation (specification p109).

It is also worth noting that just using a simulation does not provide all the evidence required for P7. Evidence for penetration for alpha, beta, gamma radiation is also required as part of M7.

If the full protactinium half-life determination or HVT are carried out, then these other experiments into penetration can, as the Assessment Amplification suggests p112, be done as a group, tutor demonstration or online.

M7 requires the results of the experiments to be related to the use of radioisotopes in medical treatments (radiotherapy and tracers). This will include the importance of half-life (physical, biological, effective), comparison of half-lives for a range of different radioisotopes and applications and the importance of penetrating power and its effect on uses of different isotopes.

D5 involves a summary of advantages and disadvantages of using alpha, beta and gamma radioisotopes in medical treatments. Some very good comparisons were seen, with some selecting a tabulated presentation which often worked well and was very comprehensive and detailed.

PO4: Understand the medical uses of optical fibres and lasers

P8 was met by most students and requires descriptions of how optical fibres are constructed and how they transmit light. This was generally well researched and descriptions and explanations appropriate. The inclusion of relevant diagrams and images, with appropriate reference made to them, always enhances the descriptions.

M8, similarly, was often well done, but there was a significant number whose reports were weaker as they tended to just state uses and not go on to explain how the optical fibres are actually used in treatments. Both diagnosis and treatment should be considered, and a range of examples included. As with many criteria, clear references to supporting diagrams and images enhance the content.

For P9 the experiment was generally very well done by students. Centres should remind students that the recording and use of results, correct tabulation, precision of recording and units, ray diagrams and calculations should all be included.

For P10 two medical conditions where laser light is used in treatment should be identified. Purely cosmetic uses are not acceptable. Centres are reminded that M9 will not be available if P10 is not met.

For M9 the report should cover both medical conditions from P10. The nature of the conditions to be treated, how the treatment is administered and the scientific principles behind the treatment (including the role played by the laser light in each treatment) should all be included.

For D6 a different medical condition (from those used in P10 and M9) can be identified, but it does have to be medical, not cosmetic, as mentioned above. A careful choice is essential as the medical condition chosen must be able to be treated in two ways, one via laser, one not.

Both advantages and disadvantages of each treatment need to be considered for the specified condition. Cataract surgery was a common choice, but there are others which fit the criteria equally well.

ASC6c: Organic chemistry

General comments on ASC6c

ASC6c introduces students to preparative organic chemistry and its importance in a range of applied contexts. The importance of yield, rates and purity of compounds resulting from organic synthesis is expected to be understood, and this is alongside their characterisation using spectroscopic techniques.

The key roles played by structure and isomerism in the uses and applications of organic compounds are also considered.

Examples of good practice seen during moderation of ASC6c:

- The PO1 reports fully represented the unit content but contained primarily just factual content and suitable examples: i.e. a source of reference.
- Students sourced and used relevant images, structures, formulae, and data.
- The two practical preparations (mostly aspirin and ethyl ethanoate) were completed well and enabled melting point and boiling point to be carried out.
- Observation Records were included which provided the evidence that the student had followed the SPs, applied the risk assessments, and recorded their own results.

PO1: Identify molecular structure, functional groups, and isomerism

As with all content in this unit, the scientific principles and examples must be targeted only at organic compounds. Inorganic examples gain no credit, and, in many ways, their inclusion is an indication of a weak approach to the Unit and lack of knowledge. This follows through to types of bonding in some cases.

There were some very good attempts at P1 seen, but also a small number of others with omissions. The key elements of this criterion are:

- Bonding, strong C-C bonds, ability to multiple bond, catenation.
- Use of the terms aliphatic, alicyclic, aromatic, arene, saturated and unsaturated, applied correctly to a range of examples.
- Structures and nomenclature for common functional groups, with a range of examples.
- Examples of structural, displayed, and skeletal formulae.

P2 was well researched and presented by many students, although referencing was weak in the majority of cases as has been reported in the past. It is important that all three techniques, IR, NMR, MS, are considered and at similar levels of detail.

The basic research needed for P2 leads to an outline of each of the three techniques and a (researched) spectrum for a named compound that illustrates typical output.
This then leads into M1 where descriptions of how spectra are obtained are needed, followed by an outline of the associated scientific principles.

Good portfolios included diagrams of the basic construction of each spectrometer with suitable annotation / labelling, explanation of the type of sample used and how each spectrometer works, and an outline description of how the spectral “peaks” are produced.

To then access D1, the spectra previously included for P2 (or additional alternatives) can be used. At Distinction level, this needs to be detailed in all three cases, with peaks assigned and linked to structural features of the compounds involved.

P3 was often met, but very weakly in a significant number of cases. It is important that students realise that the choice of group of compounds is very important. The group selected for P3 should allow access to M2 and D2. Alkanes, for instance, could not be used in M2.

For P3 a group of compounds with a common use or application is selected eg flavours, fragrances, liquid crystals, biofuels, painkillers, dyes (specification p126) but there are many more. This is not a functional group as uses would not necessarily be common to all. The choice made should allow access to M2 and D2. Common uses or applications of the members of the group and their structures are outlined.

M2 requires two of the group to be chosen from P3, and for the specified aspects of P1 to be applied in detail to these two. Structures, skeletal formulas, functional groups are identified, and correct IUPAC nomenclature used if possible (although complexity may prevent this and this is understood). Use of correct scientific terminology is expected throughout.

D2 requires students to explain why the structure and / or functional groups make them suitable for the specified use. Students aspiring to high marks need to be aware of D2 requirements when choosing the group, and this was not always the case.

Students should be able to identify the links between the use, the properties and the structure and explain how the structure affects the property. Examples might include consideration of structures of NSAIDs and COX-2 inhibitors, structures of fragrances / flavours and nasal and tongue receptors, and structures of dyes and effect on light absorption from the visible spectrum.

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.

D3 can follow on from either P4, M3 or P5, M4 depending on the compound chosen, and this is acceptable.

Students did not always target the required content well, and included too few examples of isomers, gave incorrect structures, and, in some cases, included inorganic examples.

For P4 and M3 good portfolios were based on a systematic approach which included an outline of each type of isomerism (specification p120) which included chain, functional group, positional geometric (cis / trans), correct structures (often downloaded images) and correct examples for each type of isomerism.

To go on and access M3, a more detailed explanation is needed in terms of bonding and structure. Detailed examples include explanations relating to straight chain and branch chain molecules, rearrangement of atoms to produce a different functional group, bonding of functional groups at different positions and restricted rotation around carbon-carbon double bonds.

Most portfolios seen met the requirements for P5, although examples linked to biochemical systems were not a strong point for some students. This followed through to M4, which also demonstrated weak understanding of what was required.

P5 requires an outline of optical isomerism demonstrating an understanding of asymmetric carbon, chiral centre, optical isomers (enantiomers), optical activity and racemic mixture.

For M4 good portfolios sometimes incorporated discussions of the importance of the three-dimensional structure of enantiomers and their relationship as non-superimposable mirror images into their work for P5, although it is more properly assessed here in M4. It was clear from good portfolios that students understood the importance of stereoisomerism in biochemical systems and how this is related to enzyme action and active sites.

These good portfolios demonstrated knowledge and understanding of the importance of stereoisomerism in biological systems, a range of optically active compounds (eg amino acids, sugars, proteins, enzymes), the nature of enzymes' active sites and why only one enantiomer may be active.

D3 can follow on from either P4, M3 or P5, M4. Thalidomide was a common choice and there is much information available to research. It does fit the criteria well, but a full description, as befits a Distinction criterion, is necessary.

The best examples had clearly been based on several sources and the combination of relevant content from each of them led to higher level accounts.

Other examples that would fit the descriptor well, and for which there is easily accessed information, include Naproxen (where one isomer is toxic and the other is a NSAID), various flavours and fragrances where enantiomers have different smells and tastes, and Aspartame sweetener (which has potential side-effects for one isomer).

PO2: Understand reactions of functional groups

P6 was unfortunately mis-read in some centres and portfolio content did not include all expected evidence. This should be as follows:

- For each of five functional groups, one example of a reaction is provided.
- Reagents, conditions, observations are given in each of the five cases.
- Equations are provided for each of the five reactions.
- Changes that occur to the functional groups are explained.

It is important that the choice of five reactions in P6 contains at least two which would fit M5, from alkenes reacting with aqueous bromine, aldehydes reacting with Benedict's, Fehling's or Tollens or alcohols reacting with carboxylic acids to give esters.

PO3: Prepare organic compounds

P7 was researched and completed well by some students. However, other students did not include all four "preparative techniques" listed in the unit content (specification p122), and yet more did not consider "purification techniques" (also specification p122). Others described all four, but did not give an example for each, and yet more had the wrong diagrams alongside the technique being described.

To a large extent, P7 and M6 are based on student research, but lab-based teacher demonstrations would help students understanding of the processes involved.

Diagrams or images of apparatus, a short explanation and an example of a preparation or extraction that uses each technique are required for; reflux, distillation, fractional distillation, and steam / water distillation. Purification methods of filtration under reduced pressure, recrystallization, and washing and separation of immiscible liquids should be included.

M6 needs a similar approach (diagrams, short explanations) and reference to the effects of impurities. As with P7, this is not difficult, but omissions of some of the required content were not uncommon. Content for M6 should demonstrate how melting points are measured (diagram or image, short explanation), how impurities affect melting points (depression of values and increased range), how boiling points are measured (diagram, short explanation) and how impurities affect boiling points (elevation of values).

For P8 there were some very good RAs in evidence, demonstrating good understanding of how to arrange the content, which headings to use, and complete and correct content. However, some students had not learnt lessons from ASC2 and its subsequent feedback, and some still do not fully understand the difference between hazard and risk. Making CLEAPSS hazcards available to students could help.

Please see the guidance on risk assessments in the ASC2 section of this report.

M7 should consider reasons why the method chosen is appropriate for students in a school laboratory setting. Consideration should include availability of reactants, timescale for the experiment, rate of reaction, use of catalysts, elevated temperature, yield, equilibrium, purification procedures and purity of the product.

D4 is based on research, and it is important that the industrial scale production is identified and described. Comparisons with the method used in the centre's laboratory can then be made in terms of the reaction, the reaction conditions, scale, rates, purification, and automation as relevant.

P9, M8 and D5 are all related to characterisation: identification and purity.

P9 was done well in most centres, although some students did not set out the calculations well or explain the stages. It is expected that masses of reactants, mass of purified product, and calculation of percentage yield are included, as well as boiling point or melting point, for each compound. Melting point is usually quoted as a range.

M8 requires a comparison of values obtained with literature values for melting and boiling points and expected percentage yields. These values are not necessarily easy to find, but it is important that students understand that most reactions have a yield significantly below 100% and this should be clear in the portfolio.
Students can then go on to explain that reactions may not go to completion in the timescale of the experiment, or that they 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, perhaps lower. How/why a number of students managed to get yields >100% is uncertain, although it does suggest that technique is an issue.

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).

D5 links back to D1 and is based on a researched spectrum for one of the compounds made. Characterisation here means “identification” of the compound based on the spectrum in the first instance, followed by a consideration of purity, again based on the spectrum (and where extra peaks might be seen if purity is low). It follows that the spectrum has to be described in terms of the main “peaks” present and how they can be assigned and related to specific aspects of the structure of the compound.

P10 requires two reports: one for each preparation. These were generally present in all portfolios. Looking back at previous POs, the standard procedures, equipment or apparatus used and outcomes (yield, m.pt / b.pt.) are already covered and do not have to be repeated in a separate section.

M9 follows on from M8 and conclusions should be drawn relating to the methods of preparation used. The best conclusions were reached for a systematic consideration of the expected outcomes for each of the two preparations, including whether the methods used produce good yields, whether the compounds were produced in a pure state, and the evidence to support the comments on yields and purity.

D6 can then cover the possible improvements that could be made to increase yield or purity. Consideration should be given to any relevant factors including 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, or alternative processes.

Overall, some excellent portfolios were seen, based on excellent research and a thorough understanding of the assessment criteria. The theory and the practical work will have been new to most students. However, many rose to the challenge and, with extensive research, some high-level practical work and appropriate support from the centre, a good proportion of high marks was in evidence.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

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 *(delete if appropriate)*

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