APPLIED GENERAL

APPLIED SCIENCE

1775/ASCU: ASC2/ASC5/ASC6a/ASC6b/ASC6c
Report on the Examination

1775 (1776 & 1777)
January 2022

Version: 1.0

General

January 2022 was the first opportunity for submission of portfolio coursework since January 2021.

With the levels of disruption and loss of teaching time experienced by all centres over the previous year, it is not surprising that overall entries were again lower than in pre-COVID times, although it is reassuring that there was an increase in entries compared to January 2021.

As noted last year, ASC2 entries appeared to be less affected than other portfolio units, and were at higher levels than ASC5. ASC6 entries were low as is usual for January submissions and most centres submit portfolio coursework for ASC6a, 6b and 6c in the Summer.

Many centres are very well established in regard to delivering and assessing the internally assessed portfolio units, and had taken advantage of the various supporting documents and advice available to all centres. These include:

(i) **Content Guides** (previously available from NEA Advisers*) These were updated to a new 2021/2 version and contain additional information and advice relating specifically to the effects of COVID-19 on the delivery of the portfolio units. In particular, there is guidance for where centres may amend approaches in light of COVID-19 related restrictions on teaching time and, in some cases, restricted access to laboratories. *The **Content Guides** for all ASC/U portfolio based units are on eAQA within the Secure Key Materials section.

(ii) **“Changes for 2022”** These are available on the AQA website, and they reinforce the additions made to the Content Guides. They can be found at: https://www.aqa.org.uk/subjects/science/applied-general/science/changes-for-2022

The accompanying note at https://filestore.aqa.org.uk/resources/science/AQA-1775-ASC2-GD.PDF headed “Grade Descriptors” reinforces the changes as they apply to ASC2.

(iii) New **Teacher Online Standardisation (TOLS) materials** for 2022 have also been added recently and are available online via eAQA or at: https://www.aqa.org.uk/news/teacher-online-standardisation-tols

(iv) The **NEA Adviser scheme,** which has continued “as normal” throughout the past year, remains available to all centres. Please note that advice is available only via email in order that a record can be kept of all questions and responses. If a centre is unaware of this resource then please contact advice.admin@aqa.org.uk for your NEA Adviser’s contact details.

(v) Specifically for ASC5, Investigating Science, a new resource was made available in 2021. This is entitled **“Student worksheets: ASC5 Investigation Task Overviews”** and can be found at https://filestore.aqa.org.uk/resources/science/AQA-1775-SW-ASC5-ITO.PDF or via the AQA website (on the Applied Science Teaching Resources page). These Task Overviews have a general introduction to ASC5 Investigations and 2 page overviews for ten common investigation titles.

Introduction to January 2022 Submissions and Moderation

As in previous years, there were many examples of good quality work in the samples submitted for moderation. A large majority of centres had a clear understanding of the requirements of the Specification and the Performance Outcomes, and they also understood that portfolio submissions should reflect the demands and expectations of a Level 3 qualification.

However, a small number of centres underestimated the depth and breadth of the portfolio evidence expected, or, in the case of teachers new to the qualification, had misinterpreted the requirements of some performance criteria. Where this was repeated several times across the range of criteria, it was likely that assessments would fall out of tolerance and marks would be regressed. [Note: Tolerance for all NEA Units remains at +/-2]

The Unit Content, Performance Outcomes and Grading Criteria for all the non-examined units do not change year on year. However, for 2022, as indicated above, there is some additional explanation of approaches to the delivery of practical work.

Examples of good practice seen in high scoring portfolios vary very little from Series to Series. The key approaches identified in previous reports are reproduced here, and will prove useful and informative for new centres, and also serve to reinforce approaches in existing centres.

- Portfolios reflect the requirements of the Specification Unit Content and also take the Assessment Amplification and Delivery Guidance into account
- Content (including recorded data from experiments) is the learner's own, with no direct downloads and no inappropriate group practical work
- No centre issued templates or scaffolding are used in portfolios
- Standard procedures for required practicals are fully trialled by centres before use and produce sufficient data suitable for analysis and evaluation enabling learners to access the associated Merit criteria
- Experiments are carried out individually where appropriate, for example titrations and determination of resistivity.
- Where combination of data across two or more learners is essential, this is annotated accordingly, and each learner is assessed on their own contribution, recording of data and practical skills
- **For 2022 only** (unless later extended), each individual's ability to follow the standard procedure, work safely, and record their own results is clearly evident for at least one experiment in each of PO1, PO2 and PO3
    - Where a teacher demonstration, video stream or simulation is used in order to generate data for the second experiment in PO1, PO2, PO3, learners should demonstrate that they fully understand the stages in the procedures used and that they <u>record their own data</u>
- Photos of practical work to help support learner attainment may be included, but graphs and tables of results should be the originals
- For graphs, learner drawn lines of best fit to support his/her understanding are evident (and often prove to be more appropriate and accurate than many computer generated lines).

Administration: Whilst many centres ensured that all the correct paperwork, forms, and supporting information were all present and correct, there are occasions when submissions are incomplete in this respect. Centres should ensure the following guidelines are adhered to.

- A fully completed Unit Submission Form (both sides) must be appended to the front of each portfolio
- A completed Witness Statement for ASC2 or Observation Record for ASC5 (as found in the Specification p142, 143) is included with each portfolio.
- Similar Observation Records to that for ASC5 should accompany ASC6a/b/c portfolios.
- One copy of the Assignment Brief (if used) is included in the submission
- One copy of each centre issued RA and SP are included if these are not included in portfolios
- After internal re-submissions, portfolios submitted for moderation are the final versions only
- For retakes after new work has been added by the learner, the portfolios submitted do not contain work which is no longer to be assessed
- Submissions use treasury tags to secure portfolios
- Poly-pockets and folders are not used
- A Centre Declaration Sheet is signed and enclosed with the sample to the moderator
- Only one set of centre issued tasks is included in the overall sample.

ASC2 Applied Experimental Techniques: Report January 2022

PO1: Demonstrate experimental techniques in biology

P1, M1, D1

It is very important that P1, M1 and D1 include relevant information and content for **both** respiration and photosynthesis.

P1 continues to be a common area where required content is absent from portfolios, and centre assessors do sometimes award marks when, in fact, the required portfolio evidence is incomplete.

- P1 requires an outline of the <u>uses of physiological measurements</u> of respiration <u>**and**</u> photosynthesis
    - typically this includes outlines of peak flow and lung capacity for respiration and improving yields and productivity for photosynthesis
- M1 is concerned with scientific principles underlying the measurements, the equations, descriptions of the two processes, the factors affecting them, and the principles of peak flow, lung capacity and blood pressure [Specification p46, 47]
- D1 needs to be extensive and detailed and should concentrate on:
    - the application of various physiological measurements of respiration in medical contexts and/or by sports physiologists, for example normal/abnormal values and ranges and how these are interpreted
    - commercial applications of measurements of photosynthesis relating to manipulation of factors to improve yields and productivity.

Good approaches continue to make excellent use of researched graphs, tables and images to support and demonstrate the points made, especially in M1 and D1.

Note: Where one of the two required areas of content, is missing from P1, this cannot be awarded. It follows that, if P1 is not met, M1 cannot be awarded even if the portfolio content is at an appropriate level. This follows on to D1, which cannot be awarded if either or both P1 and M1 are not met.

PO1(a) Rate of Respiration: P2, M2, D2

Successful approaches again seen here involved the investigation of the effect of temperature on the rate of respiration of yeast or germinating seeds. This then allowed an appropriate number of values and, importantly, a suitable range for the chosen variable (most often temperature). Subsequent analysis and explanations in M2 can then follow.

P2 does **not** require or expect a Q10 or RQ approach, and factors with just two or three "values" recorded will be unable to properly access M2. If the effect of temperature is followed, then a sufficiently wide range should be selected so that the resulting graph and explanation for M2 can follow.

Suitable responses show an awareness of the following:

- M2 requires calculations of rate, graphical representation of rate v chosen factor, and explanations of the shape of the graph in terms of enzyme kinetics (which should include reasons for the initial increase in rate as well as the subsequent decrease due to enzymes denaturing)
- Explanations of the graph need to be at Level 3 standards
- The graph itself is part of the assessment for M2, and should be presented clearly and at a suitable size; computer generated graphs can often fall short of the standards expected
- D2 is unlikely to be met without a full, systematic evaluation of the methodology used, data, outcomes, and the qualitative and quantitative errors associated with the recorded data.

PO1(b) The light dependent reaction in photosynthesis (the Hill reaction): P3, M3

This experiment was again successfully achieved in most centres, although some approaches were too complex and learners seemed unaware that the emphasis for P3 is very much on the light dependent (Hill) reaction.
There were some instances of centres expanding the coverage of potential factors instead of concentrating on just the light dependent (Hill) reaction, and this did appear to confuse learners and thereby affected approaches to P3.
There are several different approaches that are acceptable, including one with a link on the CLEAPSS website and also others which can be accessed online.

The requirements for M3 were sometimes misunderstood by centres, and learners were not briefed on the type of coverage needed. Key points to ensure complete coverage of the criteria include:

- Clear evidence that the learner has understood the SP and recorded results for P3
- For M3, the SP used in P3 is modified for each of the selected three other factors that could be investigated
- Adaptations need to be explained with scientific support such as:
  - how distance and light intensity are related via the inverse square law
  - how the colours of gels or filters are related to wavelength and the visible spectrum
  - how a range of carbon dioxide concentrations is mimicked using, for instance, sodium hydrogen carbonate

- how heat shields are used where appropriate.

PO2: Demonstrate experimental techniques in chemistry

P4, M4

Both volumetric analysis and colorimetry must be considered for P4, and portfolios should include basic principles and uses for each technique.

P4 should have an outline reference to:

- a) (i) types of titration, (ii) standard solutions, (iii) end points, indicators
- b) (i) absorption of light from the visible spectrum by coloured compounds, (ii) the basic construction of a colorimeter and how it works
- c) uses of the techniques (see Specification Unit Content p48)

This was a weak area for some learners, and was far from complete, even though it links well with ASC1 content.

At Merit level (M4), an appropriately detailed approach is expected with well-developed explanations of the use of (i) standard solutions and (ii) indicators in volumetric analysis. This would be expected to include:

- details of standard solutions, what they are, why they are used, suitable examples and properties
- specific reference to pH titration curves for different types of acids and alkalis
- a consideration of a range of different indicators and their application, linked to the pH titration curves, thereby providing supporting reasons for the choice of indicator for the titration to be carried out.

For colorimetry in M4, the Beer-Lambert Law should be stated and explained, together with a typical graph of absorbance v concentration.

PO2(a) Volumetric analysis: P5, M5, D3

The SP may be issued by the centre but should have been trialled to ensure it gives titres in a suitable range, and this was not always the case. For titrations, it is expected that practical work is carried out individually and results should be clearly unique to the learner.

There are still centres/learners who misinterpret the way in which the standard solution is prepared or which compounds are suitable to use as standards.

Good practice as seen in high scoring portfolios includes the following:

- P5 shows correct recording of all data including (i) mass data (for theweighing related to the standard) and the volume of the volumetric flask used, (ii) titration data to include initial and final burette readings and titres, (iii) correct tabulation and units, (iv) correct precision of recording – burette readings to +/-0.05 (note: this was not understood by students or assessors in a number of centres)

- M5 requires two calculations, one for the concentration of the standard solution based on the mass weighed out and the volume of the volumetric flask used, and one for the titration leading to the concentration of the unknown
- D3 requires:
    - a detailed comparison of apparatus (eg auto-pipettes, auto-titrators, sensors/ electrodes used to identify end points) with standard laboratory glassware, and a consideration of the resolution or precision of recording and overall accuracy
    - the properties of primary standards and their use, including examples for a number of different types of titration.

PO2(b) Colorimetric analysis: P6, M6, D4

Each learner must demonstrate the ability to use solution dilutions and record accurate absorbance values. Good work was apparent in many cases but some results were poor, most often due to incorrect zeroing of the colorimeter with an appropriate "blank". In some cases, the SP generated too many absorbance values above abs = 1 when linearity is often no longer achieved, and this presented problems with the drawing of a line of best fit. The centre should ensure appropriate trials of the standard procedure are carried out and that suitable results can be achieved before issue to learners.

Good practice includes:

- For P6, a suitable range of concentrations is used and absorbance values recorded, including the unknown; the unknown concentration is clearly determined from the graph
- For M6, the explanation of how the choice of filter was made is supported by data and/or a suitable graph of abs v wavelength, leading to a consideration of:
    - inconsistencies/anomalies in abs data that are identified from the calibration graph
    - how well the line and data fit the Beer-Lambert Law is explained (as in previous years, this remains a weaker area for most learners)
- D4 demonstrates:
    - (i) a systematic consideration of the methodology and qualitative errors
    - (ii) levels of precision used in recorded data
    - (iii) an assessment of the data with percentage errors in the measurements recorded
    - (iv) a comparison with the expected or teacher value and an overall percentage error calculated.

PO3: Demonstrate experimental techniques in physics

P7, M7

P7 requires better levels of research and selection of content than was often seen in some centre submissions, and this followed through to M7 as well. Suitable approaches to these two criteria included the following:

- P7 starts with a definition and goes on to include:
    - relationships, symbols, formulae, units and an explanation of both resistivity and SHC
    - explanations of how resistivity and SHC are related to properties of different materials
- M7 requires:
    - Descriptions of how a range of different values of resistivity and SHC are linked to, and determine the uses of, materials in industry
    - Researched data covering high, low and intermediate values for each of resistivity and SHC
    - Cross-referencing values to those materials being discussed
    - Semi-conductors to be included in the discussions for resistivity (see Specification p50), and water for SHC (also p50).

PO3(a) Resistivity: P8, M8, D5

Learners generally completed the practical determination of resistivity, although the accuracy of the methods employed was low in some cases (and often for no apparent reason). As with any experiment, centres should trial standard procedures before use by learners.

- P8 requires that the (issued) SP is followed and results are recorded. NB this must include the diameter of the wire (typically recorded in several places along its length)
- M8 requires:
    - the resistivity to be calculated and then compared with a researched value for the industry standard data
    - any differences between experimental and standard data should be discussed
    - anomalies in the recorded data to be identified and accounted for via an evaluation of the methodology used.

Note: It was again noticed that, in some centres, experimental values were orders of magnitude away from industry standards making comparisons difficult. Careful trialling of the SP issued to learners is essential.

- D5 requires significant research into methods and equipment used in industry to achieve more accurate and valid outcomes
- The approach should clearly demonstrate Level 3 understanding of the relevant science and an appropriate breadth of content, for instance:
    - precision of recording of data, issues with contact resistance and methods of reducing it, gold plated connectors, 4 point collinear probes / Kelvin sensing / Kelvin bridge
    - bulk /volume / sheet resistivity measurements have also been compared in some good examples seen.

PO3(b) Specific heat capacity: P9, M9, D6

Most centres used a solid 1kg block of, for instance, aluminium, specifically designed for SHC determination. The % error for M9 needs to consider the errors in the measurements made and the overall % error, calculated by learners, can then be compared with the data book value. It is an acceptable alternative for the “error bars” on the graph to be uncertainties in temperature measurements. However, error bars were sometimes omitted entirely or were inappropriate or incorrect.

Graphs were often poorly done by learners, and the requirement to plot temperature **change** was often missed. The correct use of axis scales was also an issue in some cases.

- P9 is met if the (issued) SP is followed and all results are recorded
- M9 requires, in addition to the points mentioned above, an explanation of the shape of the graph in terms of heat transfer, heat loss/cooling effects and the balance between the two
    - good portfolios generally demonstrate the non-linear section to the line initially, followed by a straight line, and then a tailing off of rate of temperature rise at higher temperatures
    - the best responses will go on to discuss Newton’s Law of Cooling and how it relates to the graphical evidence.

For D6, it is important for the suggested standard procedure (to measure SHC of a material in a different phase) is an adaptation of that used in P9. A diagram that shows the adapted apparatus is also key content. The explanations of the adaptations can then follow and be applied to the new standard procedure.

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

P10
As with all previous submissions, there are still many issues which arise in learner generated RAs, (and also in some centre issued ones).

Points for centres to note and, importantly, to share with learners include:

- 3 RAs must be learner generated, one for each of PO1, PO2, PO3 (appropriately labelled as learner RAs in the portfolio)
- The other 3 RAs can be centre issued, but must be present (one copy per sample is sufficient)
- The approach to RAs should be be coordinated across the three science areas, PO1, PO2, PO3, as some significant differences in standards and approaches have been noted in this series and also in the past
- RAs should start with identification of materials (chemicals, microorganisms, other materials, apparatus, etc) and, where relevant, their state and concentration, name, type
- “Glassware” can be one entry as can “mains electrical equipment”
- Learners must make it clear that they understand the difference between hazard and risk and assign these to the next two columns
- Where relevant, the nature of the hazard should correctly reflect the state/concentration of the chemicals, both of which must be considered as essential information to be included

- A numerical approach to risk should not be used
- Further column entries should then consider control measures and PPE, disposal if relevant, and action on spillage/emergency or similar points
- RAs written entirely in prose are not suitable or appropriate and are very unlikely to gain credit.

Note: CLEAPSS Student Safety Sheets are a good resource and provide much detail for a large range of types of experiment and materials.

ASC5 Investigating Science: Report January 2022

A number of centres submitted portfolios for ASC5, and all had studied Electrochemical Cells. This is often considered to be a "good choice" as the investigation can readily be brought up to Level 3 standards in terms of the background science researched, applications relating to commerce and industry, and, importantly, wide ranging practical work. That said, achieving good sets of results can be demanding for some, especially if apparatus and materials available in the centre are not extensive and/or inaccurate.

For the portfolios sampled, a range of outcomes was in evidence, with only a very small number of portfolios below Pass level. Overall, more examples than has sometimes been the case in the past reached Merit and Distinction levels. Some of the ideas involved are quite complex, for instance using the Nernst Equation and manipulating and applying redox potentials.

PO1 Prepare for a Scientific Investigation

- P1 is achieved with appropriate research evident and an <u>outline</u> of the relevant science
- M1 expects <u>explanations</u> of the relevant scientific principles (based on more extensive research)
- D1 requires a <u>detailed</u> account (with no significant omissions of relevant principles) <u>and</u> links made to commercial and industrial uses.

For P1, M1 learners carried out research into electrochemical cells, how they are constructed and how they work. These scientific ideas are outlined for P1 and the principles explained for M1. Typical content in the higher scoring portfolios included a consideration of the following, and links to values of cell EMFs, although the latter was sometimes less evident:

- electrode/redox potentials and redox potential series
- how simple cells are constructed
- purpose and nature of the salt bridge
- half-cell reactions and overall cell reactions
- factors that may/may not affect the voltage output
- the metal electrodes and salt solutions used
- size and shape of electrodes
- effect of temperature, concentration.

Note: The importance of using a high resistance voltmeter is seldom mentioned and these may not be available in centres. They would, however, be a sensible additional area of comment/explanation and a useful pre-cursor to a consideration of errors in PO3.

P1 and M1 were completed well by most learners, but, for D1, only high scoring learners showed a good understanding of the scientific principles and provided a detailed account including a consideration of the Nernst Equation, the variables involved, and application of redox potentials. They also researched commercial and industrial types of cells/batteries and their uses. Recent developments in commercial uses and applications such as large scale battery storage facilities and car power systems were not evident however.

For P2, M2, D2, the emphasis is very much on planning how the investigation will identify the overall aims, the best standard procedures to be used, and how accurate the data will be. This area was less well completed in some centres, generally due to not considering the three criteria in a logical, detailed way.

- P2 requires (i) a written plan for the investigation, (ii)details of the standard procedures/techniques to be trialled and (iii) aims of individual tasks
- M2 requires evidence of (i) trials of the standard procedures/techniques, (ii) recorded trial data or outcomes leading to (iii) changes made to the plan in light of the results of the trials
- D2 requires (i) the standard procedures/techniques chosen to be justified (based on the trial outcomes) and (ii) a consideration of that chosen procedure's accuracy, reliability and validity.

P2 and M2 can each be broken down into three sections, and these need to all be considered sequentially. Aims were not always clearly presented and trialling was a weaker area in some centre submissions.

PO2:Carry out the investigation and record results

- P3 effectively means that a full risk assessment must be written, including hazards and risks
- M3 expects explanations relating to the control measures taken
- P4 requires learners to follow standard procedures, to use a range of equipment and materials safely.

These were achieved by almost all learners. Then following directly on…..

- P5 requires that data are recorded in appropriate ways using correct conventions and units
- M4 needs learners to assess the effectiveness of methods used to collect data
- D3 is concerned with justifying suggestions for improvements that could be made to the methods of data acquisition.

These criteria, and in particular M4 and D3, are often found to be more difficult by learners and all but the highest scoring portfolios had very little evidence to show for these criteria.

PO3: Analyse the data obtained using appropriate methods, draw conclusions, and evaluate the investigation

- P6 requires evidence of data analysis using appropriate methods
- M5 is given for manipulation of data using appropriate methods and IT
- D4 requires the methods and formats used to analyse and manipulate data to be justified.

The Pass and Merit criteria were usually met by learners, and graphical analysis including the use of IT was the normal way forward. Apart from some high scoring portfolios, D4 was seldom attempted.

- P7 requires sources of error and anomalous data to be identified
- M6 follows on directly from P7 requiring explanations of the sources of error, reasons for anomalous data and explanations of how they might be minimised.

Whilst P7 was met by most, only high scoring learners tended to achieve M6, and this is clearly an area where centres should consider giving clear guidance of what is required.

- P8 requires conclusions to be drawn

- M7 expects a review of the use of both primary and secondary data
- D5 then provides an overall evaluation of the outcomes of the investigation.

Only high scoring learners tended to provide evidence beyond P8. D5, in particular, was seldom met.

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

- P9 is awarded for evidence of the report on the investigation, a presentation to a suitable audience and inclusion of the results and a conclusion
- M8 expects evidence of making reference to secondary data and using correct scientific terminology throughout
- D6 requires learners to identify the relevance of investigation and results to relevant industrial processes.

The portfolio of evidence is the report, and the presentation is usually (but not always) based on PowerPoint slides with appropriate evidence included in the portfolio. Again, only high scoring learners seemed able to move beyond Pass level, and centre advice would undoubtedly help in this respect.

- P10 is awarded if the portfolio included recorded sources of information which support research and conclusions. The Harvard Reference System should be used
- M9 requires sources to be evaluated in terms of usefulness and validity.

It is appreciated that descriptions of what is involved in Harvard Referencing can sometimes vary, and moderators would not penalise learners if relevant sources and information are present in situ or in a list at the end. M9 is seldom seen apart from in very high scoring portfolios, although it does appear that time may be running short for most learners at this stage of the process and with submission looming.

Student worksheets: ASC5 Investigation: Task Overviews

A new resource was published on the AQA Applied Science website over the past year and is available on the Teaching Resources page at: https://www.aqa.org.uk/subjects/science/applied-general/science/teaching-resources

The direct link to the worksheets is at: https://filestore.aqa.org.uk/resources/science/AQA-1775-SW-ASC5-ITO.PDF

After a general introduction to the delivery of ASC5 Investigations, there are a number of 2 page Student Worksheets which centre on overviews of the various tasks involved for each of:

- Investigate the factors that affect the efficiency of electroplating
- Investigate electrochemical cells
- Investigate the factors that affect fermentation in the brewing industry
- Investigate the use of immobilised cells in bioreactors
- Investigate the responses of light dependent resistors
- Investigate the properties of commercially available bleaches
- Investigate the properties of modern shampoos
- Investigate the factors that affect reaction time

- Investigate the factors that affect the output of a wind turbine
- Investigate the factors that affect tensile strength

ASC6a/b/c Microbiology, Medical Physics, Organic Chemistry

As is normally the case for January, entries for ASC6 Units are very small, and most centres submit these units in the following Summer.

The ASC6a and ASC6b January entries were both from well-established and experienced centres which have a clear understanding of the portfolio content required and of the approaches to practical work that allow the relevant criteria to be met. For both units, a range of centre marks was in evidence and all could be supported at moderation: this included a number of portfolios in each case which achieved very high marks in the Distinction range.

Mark Ranges and Award of Grades

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