LEVEL 3 CERTIFICATE AND EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC2: Investigating Scientific Techniques
Report on the Examination

TVQ01028 & TVQ01029
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General

Summer 2017 saw the first entry of ASC2 coursework portfolios. This followed the launch of the new, DfE approved, specification in the Summer of 2016, a series of Prepare to Teach meetings throughout 2016 and on into 2017, and a number of very well attended Teacher Standardisation meetings in the Spring of 2017. The entries for ASC2 were from a mixture of schools and colleges with previous knowledge and experience of the outgoing GCE Applied Science course and schools and colleges new to Level 3 applied courses of this type.

Many examples of high quality work were seen in the samples submitted for moderation, and schools and colleges assessments were often based on a clear understanding of the specification content and the Performance Criteria, together with an equally good understanding of the depth and breadth of treatment expected for a Level 3 subject. Many schools and colleges are to be congratulated for ensuring experimental work was suitable, that it worked well, and produced appropriate outcomes that allowed students to draw correct conclusions and go on to explain and evaluate the results when required to do so. However, there were examples of weaker experimental work in a small number of cases. Schools and colleges are urged to rethink approaches which are clearly below Level 3 in standard and/or outcomes, or did not meet the requirements of the specification (eg in P3 and P8: see below).

There were also a small number of schools and colleges where the up-to-date, approved specification was apparently not used. This may have impacted on the performance outcomes (PO) grid in one or two minor ways, although good accounts would always have scored well and there was no evidence from moderation that any schools and colleges marking which was based on the draft scheme had disadvantaged their students in this respect.

The most common problems with schools and colleges marking outcomes which were encountered at the moderation stage were as follows:

- Levels of understanding of the depth of knowledge expected to be evident in Level 3 portfolios (especially when Merit and Distinction outcomes are to be considered).
- Levels of understanding of the standards expected in experimental work (eg range of variables, accuracy of data, precision of recording, repeatability/concordancy).
- Standard procedures that had not been fully trialled and generated weak (inaccurate) data.
- Crediting un-reworded downloaded (cut and paste) content.
- Giving full credit when only part of a performance outcome is met.
- Awarding credit when a performance outcome statement has been amended by schools and colleges to suit their approach and students' answers, for example:
  - replacing the Hill reaction with another inappropriate experiment into photosynthesis
  - replacing a colorimetric analysis with a totally unrelated experiment
  - determining resistance, not resistivity.
- Accepting poor graphical skills and poor presentation of graphs.
- Giving credit for calculations when templates have been provided.

Where there are two or more teaching groups, it is essential that internal standardisation of the marking across the different assessors is rigorously carried out, and, in the majority of cases, this was clearly done well. Internal standardisation identifies assessors' misunderstandings in the application of the grading criteria so that these can be addressed before marks are submitted. If internal standardisation has not taken place and moderation identifies inconsistent marking, then the assessor who is out of tolerance will affect other assessors' marks as any subsequent regression analysis is carried out on the whole entry from the school or college.

Schools and colleges are also reminded that the award of Merit outcomes can usually only be made if the associated Pass has been met, and Distinctions need both the associated Pass and Merit to be met.

A variety of teaching and learning approaches were in evidence. But those that closely met the specification content, the PO grid and assessment amplification, all with a suitable level of demand for a Level 3 qualification and independent approaches by students, will always be the most successful.

The question of the levels of support and direction given to students in a small number of schools and colleges was an issue, and it was clear from the structure and content of some portfolios that the level of schools and colleges direction was too great. Cut and paste content cannot be credited unless it is reworded and presented in a way that demonstrates a student's own knowledge and understanding, and this would apply to work copied from any source including the Internet, a school or college's server, VLE, issued documents, etc. As has always been the case, downloaded diagrams, images, tables of data, chemical formulae and structures, equations and the like are allowed if suitably referenced. In ASC2, standard procedures (SPs) would be issued by the school or college and then implemented by students, and this, too, is accepted (NB every portfolio must contain full copies of all SPs used). What should not be seen are results tables which have been issued in template form, as the onus is on students' abilities to record their own results, to appropriate levels of precision, with correct units, and with sufficient repeats for the data to be considered to be reliable. If a student achieves poor results, these must still be recorded and then, if thought necessary, additional results may be issued in order that the student can go on to meet any associated Merit and Distinction with suitable data to interpret, analyse, evaluate as necessary. The minimum evidence will be a table constructed by the student, titles, units, repeats, etc, and with some comment indicating what happened and why, if data were not obtained.

Results recorded by the student are part of the assessment and will provide part of the evidence needed that s/he has followed the SP correctly. If data are combined across a number of student's results for good reason, then the contribution of each individual must be indicated via annotation within the portfolio. What is not acceptable is that students are allowed to work in pairs or groups when it is not essential, for instance titrations and determinations of resistivity. Tables of combined results should be the exception, not the rule, and identical results across all experiments and all students cannot be accepted, but were seen, without explanation, in a few rare instances. It is important that assessors make it clear via suitable annotation which results are the individual student's and, if present, the origins of any other data. In summary, it is each individual student's ability to follow the SP and to record results that is assessed in the 6 relevant Pass POs.

Administration, Paperwork and Presentation

The majority of schools and colleges provided all the required paperwork in support of the students' portfolio evidence, and followed the requirements for the submission of coursework. There were, however, instances when the USF was incomplete, and witness statements were either incomplete or missing entirely. For submission, the use of poly-pockets is not acceptable and neither is a loose leaf approach. Schools and colleges should combine all the evidence for PO1–PO4 and secure with a treasury tag to facilitate moderation and prevent loss of pages.

Some schools and colleges enclosed both an initial submission and the final submission, sometimes sequentially, sometimes interleaved. This approach can lead to issues in determining which content should be considered at moderation and which content, if any, is to be ignored. The ability to improve and resubmit is not being assessed and only the final version is important. Schools and colleges are urged to ensure that portfolios are presented in final version format and in a way that the moderator is presented only with work that is relevant and is not diluted by weaker content elsewhere. The use of lab books can be encouraged but please do not send these in as part of the evidence for moderation.

The vast majority of students produced portfolios which were well presented, correctly ordered and printed. A small minority included both printed and handwritten pages, which, whilst not unacceptable, is very rare and did appear to place limits on the content (and presentation and legibility were issues for some).

The inclusion of photographs of practical work can provide good evidence, but photographs of graphs do not and should be avoided. Graphical skills are assessed in some POs, but an indistinct photograph of a hand drawn graph, often at an angle, will not allow award of credit in many cases. Either the original graph should be included or a good quality flat-bed scan. Some Excel graphs also generate issues, sometimes connected with choices of axis scales, sometimes with problems associated with the line of best fit and the use of just the most basic plotting functions should be reconsidered.

Detailed Consideration of the Performance Criteria

PO1 Applied Experimental Techniques in Biology

P1, M1 and D1 are, in many ways, closely connected and a variety of approaches can lead to good scores and full coverage of these POs. A consideration of both respiration and photosynthesis is required and should include the following:

- An outline of the uses of measurements of the two processes (to include at least peak flow, lung capacity, yields and productivity in agriculture).
- The scientific principles of measurements, to include the equations, descriptions and factors affecting rate of respiration and rate of photosynthesis as indicated in the specification (pages 46 and 47), and the principles of the measurements of peak flow, lung capacity and blood pressure.
- Explanations of how physiological measurements are applied in medical contexts (such as diagnosis, monitoring treatment and recovery) and/or by sports physiologists and/or commercial uses relating to manipulation of factors affecting crop yield and productivity.

For the medical and sports physiologists' applications in D1, reference should be made to normal ranges for measurements and how abnormal data are interpreted and used. High scoring portfolios seen at moderation almost always made good use of diagrams, graphs, tables of data and images to support the written content. Students should be complimented on their research skills, selectivity of content and presentation of the complex scientific ideas involved.

P2, M2 and D2 assess different aspects of the experiment to investigate the effect of one factor on rate of respiration. This was done well in many schools and colleges and the most common approach was that of varying temperature and monitoring respiration of yeast or maggots or germinating seeds.

Schools and colleges should have an eye on M2 and D2 when deciding on the SP to use, as an explanation of the outcomes, based on science, of the experiment is needed. For instance, at least five temperatures across a suitable range will be needed if the graphical display of rate against temperature is to allow a full explanation of the temperature effects on the kinetics of this enzyme catalysed reaction.

Schools and colleges are reminded that Level 3 experimental approaches to data collection and recording are needed here, and collection of gas in a balloon or in a 100 ml measuring cylinder over water, or watching dough rise in a measuring cylinder, are not going to meet these requirements. Given the title of the experiment and the content of the PO grid, M2 requires the calculation of rate from the recorded data and its subsequent graphical analysis.

P3 and M3 study the Hill reaction, the light dependent reaction of photosynthesis. Schools and colleges must ensure that it is only the light dependent reaction that is studied and not some generalised, overall photosynthesis experiment. A small number of schools and colleges could not get the Hill reaction to work well, perhaps due to centrifuging issues, problems with temperature control, or using a DCPIP solution which is not freshly made up or is from old stock. There are various experimental approaches in the literature and moderators saw them used successfully many times (note: the accuracy of the outcomes is not assessed but the recording of the results obtained is, and the table of results with data, even if inaccurate – or observations in lieu if absolutely necessary - must be included).

M3 was not always well done and rather more detail (the modified SP, apparatus and its arrangement, readings to be taken, and also some scientific background) is expected. Explanations could be supported with diagrams of modified apparatus as this would aid the assessor's understanding of what is being proposed. Also very important is that the adaptations must be made to the SP used in the original experiment performed, not some unrelated and very different SP.

PO2 Applied Experimental Techniques in Chemistry

P4, M4 require both volumetric analysis and colorimetry to be considered. For titration, its types, uses in industry, and basic principles are needed for P4 as are the basic principles behind colorimetry, the construction of a colorimeter and how it is used, and some references to the visible spectrum and absorption of light. These ideas are then developed for M4, with, in particular, a consideration of pH titration curves and choice of indicators and an understanding demonstrated of standard solutions. For colorimetry, the ideas of serial or solution dilutions and measuring absorbance to create a calibration graph, which should be related to the Beer-Lambert Law, should be present. Schools and colleges should note that absorbance must be the focus, not transmission.

P5, M5 and D3 are all related to a standard titration exercise where the emphasis is on individual students carrying out the technique, from making up a standard solution through to performing the titration. A simple 1:1 molar ratio acid/base experiment will suffice, although some schools and colleges employed a more complex titration which might prove more difficult for some students.

Data should include that relating to the preparation of the standard solution (masses and volume of the volumetric flask) and SPs for this part of the experiment, and also the SP for the titration section must be present. Remembering this is Level 3, all raw data (including initial and final burette readings) must be recorded to the correct precision (± 0.05 for burette readings and titres) and concordancy should be achieved (two titres within 0.10 cm^3). Several schools and colleges accepted burette readings to only one decimal place, and a number of students seemed to record the volume of solution in the burette (eg 50.00 not 0.00 for instance): neither is acceptable, but is easily put right for future submissions. Some titrations had not been trialled and titres > 50.00 and some < 5.00 were seen – both have decreased accuracies.

The calculations should be clearly carried out without scaffolding or templates, and include both the preparation of the standard solution and the titration. Weighing out a set, calculated mass exactly, (eg 4.00 g sodium hydroxide), is unlikely to work accurately, and this is another simple mistake made by some students.

D3, as befits its Distinction status, will need good research skills and the ability to combine information from a number of sources. A range of industrial uses and the need for greater precision and accuracy should be discussed in detail. The use of auto-titrators and auto-pipettes coupled with the use of potentiometric probes and electrode systems to measure the end point are all relevant. Also required is a discussion, with examples, of the use of primary standards for a variety of different types of reaction, again with links to ensuring accuracy of outcomes.

For P6, a few schools and colleges used SPs where students had to measure transmission. This is bound to compromise the marks available when attempting to explain how the results relate to the Beer-Lambert Law in M6. Some schools and colleges have only very basic colorimeters, and whilst this is accepted and not an assessment problem, students still have to explain, for instance, the choice of filter based on some form of experimental data. This was understood by most and results were obtained and the limitations explained – what is important is that students are able to demonstrate the scientific background to the technique and the choices that have to be made, especially for M6.

It was noticed that a small number of schools and colleges provided SPs where the range of concentrations generated by serial/solution dilutions was inappropriate. Whilst it depends on the colorimeter used, absorbance values >1 often no longer comply with the Beer-Lambert Law. Concentration ranges should be reconsidered for future submissions to enable students to access M6 and D4 more easily and also to allow a more accurate choice of line of best fit. It is important that 0,0 (concentration, abs) is included as a point, that axes are not ‘broken’ or discontinuous, and the line of best fit is appropriately chosen for the data recorded.

PO3 Applied Experimental Techniques in Physics

P7 and M7 proved to be two of the performance objectives that students found to be the most demanding. Many seemed unclear in their minds about the distinction between resistance and resistivity, and, indeed, a number went on to discuss resistance in relation to material properties and also to determine only resistance experimentally.

For both resistivity and specific heat capacity, the levels of research into values for common materials and how these values affect their properties (P7) and uses in industry (M7) were often limited. Few extensive accounts were seen for this section and students should appreciate the need for more extensive research. Most realised that the specification makes reference to semi-conductors and had a rather brief, limited section on this important application of resistivity.

P8 was normally well done apart from those who did not measure the wire’s diameter (or record it) and calculated resistance, not resistivity. Sometimes, this was part of the SP included in the portfolio, sometimes not. When resistivity was calculated, higher-attaining students were able to go on in M8 to compare their value with a researched value for the industry standard, although the accuracy of the experimental outcomes was sometimes rather low and students found it difficult to account for anomalies in the data when these were very significant. Some also had difficulties in manipulating the units to obtain correct scientific notation and thus make a valid comparison of values.

D5 is a challenging task, but good accounts of methods that may be used in industry were seen, and the students clearly had good research skills and levels of understanding of this area of physics. The discussions of levels of accuracy and precision in industry were the most difficult and these might have been developed more.

P9 was generally done well, and very often based on standard apparatus for the determination of the specific heart capacity ie aluminium using a 1 kg block and an immersion heater. For M9, specific heat capacity was usually calculated correctly from the data recorded (via a variety of acceptable methods). However, the graphical work seen was often weak, with poor choice of axis scales, inappropriate error bars, and a poor choice of the line/curve of best fit in many cases. Lines of best fit were often poorly drawn, discontinuous (broken) and many students seemed determined to draw a straight line even when the points plotted suggested otherwise. As it was, only some students seemed to realise that they must plot temperature change against time and that the shape of the graph was not necessarily a straight line relationship throughout. It then followed that explanations of the graph were over-simplified and did not include the expected scientific explanations concerning heat transfer and heat loss. D6 was often well done, and the solid block/immersion heater approach was adapted for a liquid, heat losses considered and apparatus amended accordingly, and the data to be recorded considered. Those with a suitable diagram of the apparatus tended to find the descriptions easier.

Some schools and colleges allowed completely new methods and apparatus and these will not be accepted as the assessment in D6 is specifically testing students' abilities to adapt a SP, not research a new one. It might be the case that the original SP cannot be adapted for a liquid, in which case a full explanation of why there are problems with the adaptation of the previous method used, followed by a suitable replacement SP could be accepted. However, schools and colleges are encouraged to use a method in the first place that can subsequently be adapted to meet D6.

PO4 Understand Safety Procedure and Risk Assessment

P10 was a disappointing area of performance and does raise questions about safe practice if students are carrying out experiments but applying risk assessments that are incomplete or erroneous. The P10 assessment is based only on the three student generated risk assessments, one each for PO1, 2 and 3. The other three risk assessments can be issued by the school or college, but should be present in the portfolios and annotated accordingly.

Some students appear to not understand the concepts of 'hazard' and 'risk' which should be applied to each of the entries (named chemical, microorganism, procedure, apparatus, equipment, etc). For chemicals, state is important as is concentration for solutions, and separate entries for, say, $NaOH(s)$ and 0.1 M $NaOH(aq)$ would be required. The hazard associated with the entry is then stated and the risk considered. This can then be followed by a consideration of control measures and PPE, disposal and any other relevant comments. 'Glassware' can be considered as one entry, as can 'mains electrical equipment'.

Overall, the standard of this first submission of ASC2 portfolios was very impressive in many cases, and the hard work by schools and colleges in developing appropriate experimental approaches was clearly evident. Similarly, many students' hard work, which generated portfolios at the higher end of the mark range, was clear to see and equally impressive, combining excellent independent research and the application of scientific ideas and principles with experimental work that was carried out accurately and produced reliable results. In contrast, it was evident that some students may have experienced time constraints and did not achieve the levels of attainment of which they might be capable, but their current portfolios, although relatively low scoring, certainly provide the basis for improvement which will pay dividends when resubmitted.

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

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