LEVEL 3 CERTIFICATE AND EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC2: Applied Scientific Techniques
Report on the Examination

1775 (1776 & 1777)
June 2018

Version: 1.0

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General

June 2018 was the third entry opportunity for this Unit. A combination of colleges entering for the first time, some resits, and those now in their second year was evident.

Some colleges had taken advantage of the comprehensive Reports* on the Examination published in Summer 2017 and Spring 2018 and, if necessary, had adjusted their approaches and marking to good effect.

*In addition to the comments that follow, Colleges are recommended to read these two reports previously published and available on the AQA website, both of which contain detailed comments and advice relating to the delivery and marking of this unit.

There were again many examples of good quality work in the samples submitted for moderation. Most colleges had a clear understanding of the requirements of the specification and performance outcomes. Equally important was that the approaches employed reflected fully the demands and expectations of a Level 3 qualification.

Examples of good practice seen in high scoring portfolios include the following:

- Portfolios reflect the requirements of the Unit Content and also take the Assessment Amplification and Delivery Guidance into account.
- Content (including recorded data from experiments) is the learner's own, no direct downloads, no inappropriate group practical work.
- Experimental work such as titrations and determination of resistivity is carried out individually.
- Where combination of data across two or more learners is essential, this is annotated accordingly.
- Each individual's ability to follow the standard procedure and record their own results is clearly evident in all six relevant Pass POs.
- Where the college identifies direct cut and paste, credit is not awarded for the relevant sections.
- Standard procedures are fully trialled by colleges before use and produce data suitable for analysis and evaluation.
- No college issued templates or scaffolding are used in portfolios, for instance for recording results or carrying out calculations.
- A fully completed USF is appended to the front of each portfolio.
- A completed witness statement is included with each portfolio.
- One copy of the assignment brief (if used) is included in the submission.
- Copies of college issued risk assessments and standard procedures are included.
- After internal re-submissions, portfolios submitted for moderation are the final versions only and do not have various versions of the same content. Similarly, additions are correctly placed.

- For resits after new work has been added by the learner, the portfolios submitted do not contain work which is no longer to be assessed.
- Photos of practical work to help support learner attainment may be included, but graphs and tables of results are the originals.
- Hand drawn lines of best fit to support learner understanding are evident (and often more appropriate than computer generated lines).
- Submissions are free of poly-pockets and use treasury tags to secure portfolios.

PO1: Demonstrate experimental techniques in biology

P1, M1, D1

For credit to be considered, each of these criteria must cover both respiration and photosynthesis. The most common issue that arose was the absence of content relating to the uses of measurements of photosynthesis both in P1 and D1. It should also be remembered that M1 cannot be awarded if P1 is not met.

- **P1** requires an <u>outline</u> of physiological measurements of peak flow and lung capacity and their uses: contexts could include diagnosis of relevant diseases and monitoring recovery. For photosynthesis, uses of measurements for improving yields and productivity must be explained.
- **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 <u>detailed</u> and should concentrate on how physiological measurements of respiration are applied in medical contexts and/or by sports physiologists. Also required is a consideration of commercial applications of measurements of photosynthesis relating to manipulation of factors to improve yields and productivity.
- Appropriate content for D1 (respiration) would include normal / abnormal values and ranges, and how these are interpreted. Good approaches seen this year again made excellent use of graphs, tables and images to support and demonstrate the points made.

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

The most successful approaches 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 range for the variable, and subsequent analysis and explanations in M2. For learners who are likely to access Merit level or beyond, it is important that the standard procedure adopted for P2 allows that access.

- **P2** does not require a Q10 or research question approach and factors with just two "values" cannot properly access M2. Investigating maggots or woodlice may also place limitations on using suitable ranges of variables.
- **M2** requires calculations of rate, graphical representation of rate v factor and explanations of the shape of the graph in terms of enzyme kinetics.
- **D2** expects evidence of a systematic evaluation of the methodology used, data recorded and outcomes. Are the results accurate? Do the outcomes reflect those expected? What qualitative and quantitative errors are there? Are there any anomalies? Is repeatability evident? What ethical issues apply?

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

This experiment is successfully achieved in most colleges, but a small number found that no clear results were obtained. There are several different approaches, including one with a link on the CLEAPSS website and also successful versions on YouTube.

- **P3** requires the <u>light dependent</u> reaction of photosynthesis to be investigated. Other reactions do not gain credit. Clear evidence that the learner has followed the standard procedure and recorded results (even if negative) is all that is needed.
- **M3** requires the standard procedure already used in P3 to be modified to allow three other factors to be investigated. Adaptations need to be explained and diagrams of modified apparatus will often help in some cases. Scientific explanations of, for instance, (i) how distance and light intensity are related, (ii) how the colour of gels or filters are related to wavelength, (iii) how a range of carbon dioxide concentrations is achieved using sodium hydrogen carbonate also add to the overall scientific content of this section.

PO2: Demonstrate experimental techniques in chemistry

P4, M4

For these criteria to be met, both volumetric analysis and colorimetry must be considered. P4 was met by almost all learners with the basic principles outlined and some uses identified. M4 requires explanations of the scientific principles behind both techniques and specific consideration of standard solutions, the choice of indicators and the Beer-Lambert Law.

- **P4** should have an <u>outline</u> reference to a) (i) types of titration, (ii) use of standard solutions, (iii) end points, indicators, equivalence/mole ratios; and b) (i) absorption of light from the visible spectrum by coloured compounds, the basic construction of a colorimeter and how it works
- **M4** develops the ideas behind a) standard solutions and their use in determining unknown concentrations and the choice of indicators with specific reference to pH titration curves and the reaction to be carried out for P5; b) the Beer-Lambert Law and its application to a calibration graph of abs v concentration

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

The expectation is that the standard procedure is issued by the college. Learners' risk assessments must have states and concentrations included for chemicals in order that they can correctly identify the hazard involved: most colleges now ensure that this is the case, but some very weak attempts are still evident. For titrations, it is expected that practical work is carried out individually. Results should be clearly unique to the learner.

For D3, it was reassuring to see more learners researching the ways in which titrations are carried out in industry, although there are still those who interpret this criterion in terms of just reiterating the uses of the technique (ie P4 repeated) as opposed to <u>how</u> it is used / carried out.
Good practice as seen in high scoring portfolios includes the following:

- For **P5**, correct recording of all data including (i) mass of standard weighed out, (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, (v) clear, learner designed tables, no templates
- **M5** requires two calculations, one for the concentration of the standard solution based on the mass weighed out, and one for the titration (and an absence of templates or scaffolding)
- **D3** can be approached from a comparison of apparatus – auto-pipettes, auto-titrators, sensors/electrodes – with standard laboratory glassware. Explanations of how these work and are used were researched and explained well and images often added clarity to learners' responses. A comparison of the resolution or precision of recording and overall accuracy could then follow. The properties of primary standards and their use was also considered, with the best accounts going on to give examples for a number of types of titration.

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

Colleges varied in their approaches to the colorimetry, but a majority followed the sample assignment brief and achieved good results. Each learner must demonstrate the ability to prepare standard solutions and perform solution dilutions, and this needs to be clearly annotated by the college. This then carries through to obtaining absorbance results individually (identified in the portfolio), although combining group results to achieve a range of concentrations is permissible.

There was only a very small number of colleges where transmission was mistakenly recorded and, unfortunately, a similar number where a correctly working colorimeter was not available. Good work was apparent in many cases and was typified by the following.

- For **P6**, a suitable range of concentrations was selected, prepared, and absorbance values recorded. The range was selected with the likely outcome for the unknown in mind, allowing accurate graphical work to find the unknown concentration. Correct zeroing of the colorimeter with an appropriate blank was clearly carried out for each sample. Readings were recorded individually without college issued templates. A graph of abs v concentration is drawn and a correct line of best fit drawn. The abs value for the unknown is clearly recorded, and the unknown concentration determined from the graph.
- For **M6**, the explanation of how the choice of filter was made is supported by data or a suitable graph of abs v wavelength. Inconsistencies/anomalies in abs data are identified from the calibration graph and how well the line and data fit the Beer-Lambert Law is explained.
- **D4** demonstrated a systematic consideration of the methodology and qualitative errors, and also an assessment of the data and percentage errors in the measurements made. A comparison with the expected value is made and overall percentage error calculated.

PO3: Demonstrate experimental techniques in physics

P7, M7

Some learners struggled with P7 through not understanding that resistance and resistivity are different and / or by not relating resistivity and SHC to material properties. P7 required better research, selection and presentation of content than was sometimes seen, and this followed through to M7 as well. Suitable approaches to these two criteria included the following.

- **P7** could be started with a definition, including relationships, symbols, formulae, units and an explanation. Suitable examples of values for a range of different materials followed and links to the properties of those materials are made. This is repeated for each of the terms, resistivity and SHC.
- **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. Tables of data covering high, low and intermediate values will be needed and cross referenced to those materials being discussed. Semi-conductors should be included in the discussions for resistivity as should water for SHC.

PO3(a) Resistivity: P8, M8, D5

The majority of learners completed the practical determination of resistivity, although the accuracy of the methods employed was low in some cases (and for no apparent reason), and colleges would do well to trial this experiment before use. There is a requirement to record results for P8, and this must include the diameter of the wire recorded in several places along its length. If they wish to use swg conversions as a comparison, that is a good addition to the approach, and may later contribute to D5.

- **P8** is awarded for following the standard procedure and recording results. Appropriate precision of recording and repeats should be evident.
- **M8** will need the resistivity to be calculated and then compared with a researched value for the industry standard data. Where there are differences, these should be discussed and any anomalies in the recorded data identified and accounted for via an evaluation of the methodology used. Unfortunately some experimental values were orders of magnitude away from industry standards making comparisons difficult.
- **D5** requires significant research into methods and equipment used in industry to achieve more accurate and valid outcomes. Precision of recording of data using industry standard equipment, meters, measurement of dimensions of samples, can be discussed as can the issues with contact resistance and methods of reducing that resistance. Gold plated connectors, 4 point collinear probes, Kelvin sensing, Kelvin bridge, are all areas for comment and the different types of measurement – bulk / volume, sheet resistivity measurements have also been compared in some good examples.

PO2(b) Specific heat capacity: P9, M9, D6

Most colleges used a solid 1 kg block of, for instance, aluminium that is specifically designed for SHC determination. There is no need to investigate a range of different solids, nor does the SHC of water have to be found experimentally, and the time would be better spent on ensuring calculations were correct and M9 and D6 were completed to a high standard. The % error for M9 needs to consider the errors in the measurements made and the overall % error compared with the data book value. The error bars expected on the graph can be uncertainties in the temperature measurements, although these were often omitted. Graphs were often poorly done by learners, and a majority still do not appreciate that it is temperature <u>change</u> that should be plotted against time (or energy in some cases).

- **P9** is awarded for following the standard procedure and recording results. Results should be recorded with appropriate levels of precision and correct units.
- **M9** requires, in addition to the points mentioned above, an explanation of the shape of the graph. This should be in terms of heat transfer, heat loss / cooling effects and the balance between the two. Good portfolios may notice a non-linear section to the line initially, followed by a straight line, and then a tailing off of temperature rise at higher temperatures. The best responses will go on to discuss Newton's Law of cooling.
- **D6** expects the original method (eg for aluminium) to be adapted for a material in a different phase (eg water). Responses relating to liquid aluminium did not score well! It is not necessary to carry out the determination of SHC for water.

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

P10

This has been reported on adversely for the two previous submissions, May 2017 and January 2018. It does not seem to have improved this year however, but this may be to do with the number of first time submissions. It is an area which needs attention in a large number of colleges and moderators hope for and expect to see improvements in 2019.

- 3 risk assessments must be learner generated, one for each of PO1, PO2, PO3.
- The other 3 risk assessments can be college issued, but must be present (one copy is sufficient per sample).
- The approach to risk assessments s needs to be coordinated across the three science areas as some significant differences have been noted in this submission and in earlier ones too.
- Risk assessments should start with identification of materials (chemicals, microorganisms, other materials) and, where relevant, their state and concentration. Apparatus should also be included, but “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. The nature of the hazard should correctly reflect the state / concentration of the chemicals.
- A numerical approach to risk is not expected.
- Further column entries should then consider control measures and PPE, disposal if relevant, and action on spillage/emergency or similar points.
- Risk assessments s written entirely in prose are not suitable and are unlikely to gain credit.

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.