LEVEL 3

# APPLIED GENERAL SCIENCE

ASC2: Applied Experimental Techniques
Report on the Examination

1775
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## General

January 2020 was the 6th entry opportunity for this Unit.

Some centres are very well established in regard to delivering and assessing this unit, and others had taken advantage of the various supporting documents and advice available to all centres. This includes:

- Reports on the Examination published after every Series
  - Most recent Reports are only available via AQA "Secure Key Materials"; others are on the AQA Website
- Teacher Online Standardisation materials (TOLS)
  - Online via eAQA at *https://www.aqa.org.uk/news/teacher-online-standardisation-tols*
- Advice via email from the centre's designated NEA Adviser
  - Contact advice.admin@aqa.org.uk for your Adviser's contact details if necessary
- Content Guide (based firmly on the Unit Content, Delivery Guidance, and Assessment Amplification in the Specification)
  - Available via centres' NEA Advisers

There were many examples of good quality work in the samples submitted for moderation and most centres had a clear understanding of the requirements of the Specification and the Performance Outcomes. They also understood that the approaches adopted by learners should reflect fully the demands and expectations of a Level 3 qualification.

Some centres had underestimated the depth and breadth of the portfolio evidence expected, and they were too generous in their assessments.

The Unit Content, Performance Outcomes and Grading Criteria for all the non-examined units do not change year on year. It follows that examples of good practice seen in high scoring portfolios vary 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 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 are fully trialled by centres before use and produce sufficient data suitable for analysis and evaluation
- Experimental work, especially titrations and determination of resistivity, is carried out individually
- Where combination of data across two or more learners is essential, this is annotated accordingly, and each learner is assessed on their own contribution and practical skills
- Each individual's ability to follow safely the standard procedure and record their own results is clearly evident for all six relevant Pass POs
- Photos of practical work to help support learner attainment may be included, but graphs and tables of results should be the originals

- Hand drawn lines of best fit to support learner understanding are evident (and often prove to be more appropriate and accurate than 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. Centres should ensure the following guidelines are adhered to.

- A fully completed USF (both sides) must be appended to the front of each portfolio
- A completed Witness Statement (as found in the Specification p142) is included with each portfolio
- One copy of the Assignment Brief (if used) is included in the submission
- One copy of each centre issued RA and SP are included
- 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, and poly-pockets and folders are not used
- A Centre Declaration Sheet is signed and enclosed with the sample to the moderator

**PO1: Demonstrate experimental techniques in biology**

P1, M1, D1

It is important that these three criteria are covered for <u>both</u> respiration and photosynthesis, but it continues to be a common way in which required content is absent from portfolios and assessors overmark one or more of these criteria.

- P1 requires an outline of the <u>uses</u> of physiological measurements of respiration <u>and</u> photosynthesis
    - Typically this includes 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 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.

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

In general terms, the most 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 a suitable range for the variable (most often temperature) and subsequent analysis and explanations in M2.
Ethical issues may prevent the wider ranges of temperature for some organisms, and this can affect outcomes for M2. Other factors are permissible, but are less commonly seen.

P2 does not require or expect a Q10 or RQ approach, and factors with just two or three “values” recorded cannot properly access M2.

Other suitable responses show an awareness of the following:

- M2 requires calculations of rate, graphical representation of rate v factor and explanations of the shape of the graph in terms of enzyme kinetics; explanations need to be at Level 3 standards
- D2 is unlikely to be met without a full, systematic evaluation of the methodology used, data, outcomes, and the qualitative and quantitative errors

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

This experiment was again successfully achieved in most centres, and the few that obtained no clear results seemed not to have trialled the experiment beforehand. There are several different approaches, including one with a link on the CLEAPSS website and also on YouTube, and several others easily accessed online.

The Hill reaction is the light dependent reaction, and it is this that must be investigated. Some learners missed out results for the “reaction” carried out in the dark, or did not identify that reaction in the results table, and so did not meet P3. Key points to ensure complete coverage of the criteria include:

- clear evidence that the learner has followed the SP and recorded results, even if negative, for P3
- for M3, the SP used in P3 is modified for each of the three other factors that could be investigated
- adaptations need to be explained with scientific support such as:
    - how distance and light intensity are related
    - how the colour 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. At Merit level, an appropriately detailed approach is expected with well-developed explanations relating to standard solutions and indicators. This would include specific reference to pH titration curves and a range of indicators, thus providing supporting reasons for the choice of indicator for the titration to be carried out. This was a weaker area for some learners, even though it links well with ASC1 content.

- P4 should have an <u>outline</u> 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 Unit Content p48)
- M4 develops the ideas behind the techniques and expects more detailed content and explanations of the scientific principles relating to:
  - a) standard solutions and their use, and the choice of indicators
  - b) the Beer-Lambert Law and its application to a calibration graph of abs 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 suitable titres, and this was not always the case. For titrations, it is expected that practical work is <u>carried out individually and results should be clearly unique to the learner</u>.

There was still a number of cases where it was evident there had been a misinterpretation in the way in which burette readings are taken, and how a standard solution is prepared.

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

- for P5, correct recording of all data including (i) mass data for the weighing related to the standard, (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
- M5 requires two calculations, one for the concentration of the standard solution based on the mass weighed out, and one for the titration
- 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 types of titration

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

Each learner must demonstrate the ability to use solution dilutions and record absorbance values (NB not transmission). Good work was apparent in many cases but some results were poor, probably due to incorrect zeroing of the colorimeter with an appropriate “blank”. In some cases, the SP generated too many values above abs = 1 when linearity is often no longer achieved, and this presented problems with the drawing of a line of best fit.

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 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 (this, however, was a weaker area for most learners)
- D4 demonstrated:
    - (i) a systematic consideration of the methodology and qualitative errors
    - (ii) an assessment of the data and percentage errors in the measurements recorded
    - (iii) a comparison with the expected or teacher value and an overall percentage error calculated

**PO3: Demonstrate experimental techniques in physics**

P7, M7

P7 required better 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
    - suitable examples of a range of different materials and links to the properties of those materials
    - consideration of both resistivity and SHC

- M7 requires:
- descriptions of how a <u>range of different values</u> 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 and 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 often for no apparent reason), and centres would do well to trial this experiment before use*.

- 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)
        - if learners wish to use swg conversions as a comparison, that is a good addition to the approach, and may later contribute to M8 and possibly D5
- M8 requires:
    - the resistivity to be calculated and then compared with a researched value for the industry standard data
    - any differences to be discussed
    - anomalies in the recorded data to be identified and accounted for via an evaluation of the methodology used

*Note: In some centres, 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
    - an approach that clearly demonstrates 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

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

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

Graphs were often poorly done by learners, and the requirement to plot temperature <u>change</u> was often missed. The 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 include the 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 and how it relates to the graphical evidence

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

P10

This has been reported on adversely for all previous submissions, and there are still many issues which arise, not only in learner generated RAs, but 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 annotated by the centre)
- the other 3 RAs can be centre issued, but must be present (one copy per sample is sufficient)
- the approach to RAs needs to be coordinated across the three science areas as some significant differences in standards and approaches have been noted in this submission and in the past
- RAs should start with identification of materials (chemicals, microorganisms, other materials, apparatus) 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
- 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 is not expected
- 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.

## Mark Ranges and Award of Grades

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