LEVEL 3
APPLIED GENERAL SCIENCE

ASC5: Investigating Science
Report on the Examination

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General

It is important with retakes that learners understand that original portfolio content (which may have been incomplete or incorrect) is not retained un-necessarily when it is replaced or superseded by new, additional work.

As with all Applied Science coursework units, ASC5 is a 60glh unit and portfolio content should also reflect the Level 3 nature of the award. These parameters are especially important with ASC5 as they will have a clear impact on decisions made relating to approaches to investigations, levels of research, experimental work and factors studied.

There is no change to the Unit Content or to the Performance Outcome criteria which require evidence of learners' abilities to:

- prepare for a scientific investigation
- carry out the investigation and record results
- analyse results, draw conclusions, and evaluate the investigation
- present the findings to a suitable audience

The investigations reported in the January 2020 portfolio submissions included several of those suggested in the specification including:

- Electrochemical cells
- Fermentation
- Properties of shampoos
- Reaction time
- Light dependent resistors

These sometimes have quite different approaches by centres, and, as a result, the moderation team saw investigations which were completed with varying degrees of success and at different levels of sophistication.

Some learners pitched the investigation at too low a level, with experimental approaches that fell short of Level 3 expectations and demand. However, most learners were able to achieve credit for following the basic aspects of investigative procedure at Pass criteria levels.

In contrast, there were also some high scoring portfolios with excellent approaches to investigations and content to match. As in previous series, these were characterised by:

- comprehensive portfolios created with a firm understanding of the depth of treatment expected
- excellent research and use of secondary sources leading to good levels of scientific knowledge and understanding consistent with Level 3 standards
- broad approaches to the investigation reflecting a suitable choice of a range of factors to investigate
- appropriate practical methods for a Level 3 investigation, producing accurate and reliable data
- high level analysis, manipulation and evaluation of data

- sensible marking by assessors who clearly understood the need for content at an appropriate level
- clear centre annotation identifying where performance outcomes had been met and awarded

Whilst most of the investigations submitted would have had the potential to allow access to all the criteria, some were limited by the narrowness of the approach adopted and less than 60glh applied. In general, these were typified by:

- limited research into the scientific background
- few variables/factors considered or investigated (sometimes only one)
- variables/factors chosen but which were then investigated in a simple way and with low level apparatus and inherently inaccurate techniques
- only one standard procedure identified, used or trialled (and sometimes issued, not researched)
- restricted outcomes and levels of data recorded
- less than 60glh devoted to the investigation and so limited practical work

Learners would benefit from guidance on the following:

- the depth of knowledge and understanding that should be demonstrated
- using practical techniques with suitable levels of demand and avoiding simple GCSE level work (or even below)
- how to access sources and identify techniques which are not predominantly based on just GCSE level work or below
- which factors to investigate that best allow access to higher levels of practical work, analysis, calculations and Level 3 theory

PO1: Prepare for a scientific investigation

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

- P1 is achieved with appropriate research evident and an outline of the relevant science
- M1 expects explanations of the relevant scientific principles (based on more extensive research)
- D1 requires a detailed account (with no significant omissions of relevant principles) and links made to commercial and industrial uses
- It is important that the research includes:
  - science relating to the factors to be investigated
  - science relating to factors which have to be controlled during the investigation

Often, if the levels of science are appropriate at this stage, much of the rest of the investigation falls more easily into place.

However, if the science is too narrow and/or low level, it is likely that so will be the rest of the investigation. Examples of weaker or limited approaches include:

- "Reaction Time", but without identifying and discussing the necessity to control all the many variables that may apply: age, gender, practice, caffeine, fatigue, etc …
- "Fermentation in the Brewing Industry", but without planning to use brewers' yeast strains and not following experiments through to conclusions with appropriate commercial links (eg specific gravity and ABV)
- "Electrolytic Cells", but without considering Electrode/Redox Potentials or the Nernst Equation
- "Electrolytic Cells", but with very low level apparatus and a lack of understanding of which factors are important and which should have no effect on the outcomes
- "Properties of Shampoos" but avoiding the investigation of factors that demonstrate higher practical skills and scientific theory for example:
    - viscosity determination using Stokes Law
    - pH including a consideration of the effects of dilution and temperature
    - cleansing ability *

*cleansing ability is sometimes confused with anti-microbial action by learners, but the latter, although not listed in the Specification, would also be a very suitable factor to investigate

P2, M2, D2
These criteria are also connected and move on sequentially from Pass to Merit to Distinction.

P2 requires a clear, well defined plan to be produced including:
- researched standard procedures/techniques to be followed
- potential alternative methods/techniques/procedures for comparison in trials
- aims / purposes of the tasks (objectives)

M2 requires:
- details of trials carried out and recorded trial results
- changes/modifications made to methods, parameters, range of variables (based on results from trials)

D2 requires the techniques chosen to be justified in terms of accuracy, reliability and validity.

In weaker portfolios, trials were usually limited in scope and not specifically aimed at trialling potential methodologies or at identifying subsequent modifications.

PO2: Carry out the investigation and record results

P3, M3

Risk assessments are still a weak area for many. Some were complete, correct, included concentrations where applicable, and demonstrated a clear understanding of Hazard and Risk. However, others were poor, and some were very weak.

NB: CLEAPPS Student Safety Sheets remain a suitable source of information and are available to all at http://science.cleapss.org.uk/Resources/Student-Safety-Sheets/

P4
This is awarded for following the standard procedures and also for using "a range of practical equipment and materials".

Centres should remind learners that their portfolio evidence needs to include copies of all SPs followed. A completed centre Observation Record is also essential if the moderator is to support centre marks.

P5, M4, D3

For P5:

- data must be recorded with:
  - correct levels of precision (significant figures/decimal places)
  - correct units and using normal conventions
- it is assumed that all data recorded are the learner's own:
  - NB: learners and assessors sign the USF to confirm this
  - all secondary data should be tabulated separately and annotated accordingly

M4 assesses effectiveness of the methods used and learners sometimes need guidance as to what is expected for this criterion. Questions to ask and so points to consider include the following:

- are data sufficient, complete and suitable for analysis?
- is the precision of recording appropriate?
- are the data repeatable/reliable?
- are the data accurate?

D3 considers the responses made in M4 and makes suggestions for:

- improvements that would lead to more accuracy, reliability, etc., and considering…
  - improvements to the methodology employed
  - alternative equipment and apparatus
  - alternative techniques

PO3: Analyse results, draw conclusions and evaluate the investigation

P6, M5, D4

The ability of learners to access these performance outcomes varied significantly and, in some cases, was also very much related to the experimental approaches used and data recorded. Some weaker portfolios generated data which gave little opportunity for calculations or further analysis (and in other cases, the opportunities were there, but not taken up).

- P6 (Analysis) should include suitable calculations and analysis of data using graphs and charts as appropriate
- M5 requires data to have been manipulated and that methods used, including IT, are appropriate
- Examples may include manipulation of data associated with or involving:
  - reaction time from ruler drop data
  - rates of reaction for fermentation, enzyme action
  - statistical analysis

- viscosity of shampoos
- variation of pH with temperature and dilution
- E^o values and Nernst equation
- ABV from specific gravity
- energy/power generated by wind turbines
- resistance of LDR
- power generated by wind turbines

- Suitable uses of IT could include, where relevant:
  - graphical analysis
  - generation of charts
  - use of (non-trivial) spreadsheet formulae
  - statistical analysis

NB: The use of IT does have to be appropriate, and should enhance the ways in which data are manipulated and presented, and so allow conclusions to be drawn later (in P8). Learners should be aware that some Excel graphs are too simplistic, often with inappropriate lines of best fit.

- D4 should consider the methods/formats used in the analysis and manipulation of data and how they are relevant to the original aims of the investigation
- learners can then go on to justify the methods/formats used in terms of the further information they provide

P7, M6

P7 is often completed well by most learners who identify sources of error and anomalies in the data they have recorded. Key areas include an understanding that:

- errors may be qualitative, based on the methodology used, and quantitative, based on levels of precision of recording and accuracy of the methods and apparatus used
- anomalous data should be clearly identified

M6 is more challenging for many learners. The portfolio evidence for this criterion should:

- explain the sources of error identified in P7 and how they arise
- give reasons for the anomalous data identified in P7
- explain how anomalies can be minimised eg in terms of the instruments and methodologies used, number of repeats

P8, M7, D5

P8 requires conclusions to be drawn based on the data obtained

M7 follows on from P8:

- conclusions drawn from each task (factor) should be compared with equivalent information (values, data) gained from secondary sources
- this may be linked to:
  - the use made of secondary sources at the planning stage
  - more information researched at this stage of the investigation

- secondary data should be researched and/or produced by using researched formulae and relationships for example:
  - reaction time data from on-line experiment reports and articles
  - application of E^o values and the Nernst equation
  - ABV values obtained commercially
  - optimum conditions used in commercial brewing
  - commercial data relating to shampoos
  - data relating to the use of immobilised cells
  - data relating to properties of LDRs
- Note: Using other learners' results as secondary data may well be of limited value as they may all use similar techniques and apparatus and have similar errors and outcomes. Other learners' results 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 starting point. This can be linked to a consideration of the methodologies used, and how they may have affected the outcomes and their accuracy.

The use of percentage errors can then lead to a comparison of the accuracy of the calculated outcomes with expected values in the context of the overall error.

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

P9, M8, D6

- the report on the investigation for P9 is effectively the portfolio
- the presentation can be in various formats, it should be designed for a suitable audience, and should be appropriate for that audience
- the presentation should contain text and images and include results and conclusions
- evidence of the presentation must be included in the portfolio of evidence, for example
  - a printed version of Powerpoint slides
  - a leaflet
  - a copy of a scientific magazine article
  - a downloaded copy of a learner constructed webpage

Note: Many learners would benefit from guidance in the design and content of Powerpoint presentations: some seen for this Series and also in the past have been very poor, not least in the tendency to fill most slides with prose. On some occasions, leaflet or booklet based presentations have been used well for some investigations and audiences.

- M8 connects to M7 in terms of secondary data, and could also potentially cover its use in other POs such as P1, M1, and D1
- M8 also has the additional expectation of the use of correct scientific terminology throughout

D1 is, in part, concerned with relating researched science to industrial/commercial uses. D6 revisits these potential links, but from the point of view of the relevance of the results and outcomes of the investigation to industrial processes.

P10, M9

P10 is relatively simple to achieve, assuming sources have been used in research. The portfolio should show evidence of:

- recording of sources used for research and to support conclusions
- use of HRS

Note: It is expected that only a relatively simplified version of HRS need be used, such as numbered references (eg [12]) in the body of the text, and the references listed in a footer or in a bibliography at the end. Some also correctly use references in the body of the text, which is also acceptable.

M9 requires consideration of:

- "usefulness" of the sources used and
- "validation" of those sources

Note:

- approaches for "validation" may include reference to the following as appropriate:
  - type of publication, who published it and where
  - purpose of the publication
  - academic standing of the author
  - advertising / Government / academic / commercial / industrial/ pressure group …..
  - peer review / editorial control / adopted textbook / book reviews / citations / cross referencing
- learners sometimes mis-understand what is required for "validation of sources" and centre input may be needed in the initial stages

Footnote: Centres who wish to seek more information concerning best approaches to investigations and/or to what is expected for individual performance outcomes can:

- contact their NEA Adviser for advice
- consider the TOLS materials on the secure AQA website
- consider feedback reports from previous submissions
- consider the Content Guide (available from NEA Advisers on request)

Note: The Content Guide is essentially an overall view of "good practice" and is firmly based on a combination of the Unit Content, the Assessment Amplification and the Delivery Guidance, all of which are in the Specification. That said, it is the Unit Content, the Performance Outcomes and the Level 3 / 60glh nature of the qualification that remain the basis for assessment and for moderation.

Mark Ranges and Award of Grades

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