LEVEL 3 CERTIFICATE / EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC5: Investigating Science
Report on the Examination

1775 (1776 & 1777)
June 2019

Version: 1.0

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General

Summer 2019 was the fourth submission opportunity for ASC5, Investigating Science. A range of investigation titles was evident, some more successful than others, and there was a mixture of centres submitting for the first time and others who had clearly had the opportunity to fine tune approaches, after feedback from previous series.

There are still issues apparent regarding the suitability of investigation titles and the nature of investigative work at this level, and the following should be considered:

- All aspects of the investigation should reflect the Level 3 nature of the Applied Science award
- ASC5, as with any other coursework unit, requires 60 GLH
- The suggested titles (Specification p90) should be followed as written and other approaches should be agreed by an NEA Adviser
- Some suggested factors are more demanding and higher level than others: centres must prioritise accordingly
- Typically, a minimum of three factors could allow access to the higher level criteria if completed fully and to an appropriate standard (Level 3)
- Restricting the number of factors is very likely to prevent access to most of the higher criteria
- Adopting practical work with a low level of demand (lower than Level 3) and/or a restricted coverage of the relevant scientific principles will, similarly, prevent access to many of the Merit and Distinction criteria.

The titles suggested in the specification were all used, although with varied success.

Some investigated fewer factors than documented, sometimes just one. Whilst others chose mainly low-level, simplistic experimental approaches which were well below Level 3 standards. In both cases, credit was immediately limited to lower criteria, and sometimes not even these were met.

- "Immobilised cells in bioreactors" was generally successful if a suitable range of factors affecting enzyme action and rates was investigated
- "Efficiency of electroplating using copper" is potentially a relatively low level investigation in terms of practical demand, but there are five factors listed in the specification that may affect electro-deposition rates, and the underlying theory must be based on the Faraday and its quantitative application
- "Electrochemical Cells" has proved to be successful in the past and provides opportunities for good Level 3 approaches and theory, eg application of the Nernst equation and redox potentials
- "Fermentation in the brewing industry" is possibly the most popular choice, but also potentially one of the weaker investigations in terms of practical approaches. The entry in the specification lists 5 factors to investigate (the Sample Assessment Brief suggests 3 but this is then widened in terms of practical approaches and techniques when ethanol content - ABV via specific gravity - colour and clarity are also included). At its simplest, submissions have investigated one factor, sometimes very inaccurately, and have effectively done no more than 1/6 of ASC2 practical work. Such an approach, often with <10 pages in the portfolio is very unlikely to secure even a basic pass mark.
- "Properties of shampoos" lists 5 factors, although there are others that would be suitable such as effect on hair dye and anti-microbial action for instance. Here, several factors are able to be brought up to L3 approaches such as a quantitative determination of viscosity

using Stokes Law, applying pH using GCE level definition, formula, effect of dilution/temperature, buffer action, calibration of pH meters, etc, cleansing effectiveness via careful gravimetric work. Simplistic approaches to foaming and oil-emulsification will add breadth, but not depth.

- "Response of LDRs" lists only two factors, but both can be brought up to a good L3 standard. Both intrinsic and extrinsic types should be investigated.
- "Output of a wind turbine" lists 3 factors and all should be investigated. However, here have been some very basic attempts at this investigation evident, well below L3, and poor marks resulted. It does require appropriate apparatus, and simplistic approaches that involve, for instance, cut out pieces of card and blue-tack are very likely to fail.
- "Factors that affect reaction time" is another "favourite" investigation. There are 4 factors listed in the Specification, and there are various real and virtual timers to trial. There are good links to background science in ASC4, although other sources and other relevant aspects of science should also be researched. Obtaining sufficient data in order to make valid conclusions is always a problem, and this has to be recognised and explained.

Alternative Investigations

Centres may choose their own investigations, but are strongly advised to contact their NEA Adviser well in advance of starting work. Full details of the intended investigation, likely aims, experimental methods/SPs, factors to vary, links to industry/commerce will be needed if an informed recommendation is to be made.

Centres should note that it is allowed for all students to follow the same investigation title. However, they must work independently, carry out their own research, obtain and record their own results, analyse, manipulate, conclude and evaluate, etc.

Investigations seen in the past, and that have sufficient potential if wisely implemented, include ones based within the following scientific areas:

- Micro-biology (eg a comparison of natural anti-microbials)
- Effectiveness of bleaches (eg concentrations, types, and dilution effects on microbial activity)
- Material properties such as tensile strength (comparisons of materials, effects of external agents).

Good investigations were characterised by:

- Comprehensive portfolios created with a firm understanding of the depth of treatment expected
- Extensive research and use of secondary sources
- Wide ranging approaches to all elements of the investigation
- Good levels of scientific knowledge and understanding consistent with level 3
- Appropriate practical methods producing accurate and reliable data
- Sensible marking by assessors who clearly understand the need for content at an appropriate level
- Clear centre annotation identifying where performance outcomes had been met and awarded.

Weak investigations which struggled to meet the Pass criteria were characterised by:

- Insufficient factors being investigated (sometimes only one) and/or choosing low-level approaches well below Level 3 expectations
- A lack of evidence documenting contact with the centre's NEA Adviser
- Less than 60glh used and/or below Level 3 (the two often went together)
- A portfolio of very few pages and little content (several at 10 sides and below were submitted)
- Limited and/or low-level research into scientific background
- Only one standard procedure identified, used or trialled (and sometimes issued, not researched)
- Restricted outcomes and levels of data recorded
- Little or no centre annotation to support award of marks.

Learners would benefit from guidance on the following at the outset:

- The levels of science expected and the depth of knowledge and understanding that should be demonstrated
- Using practical techniques of suitable levels of demand and avoiding GCSE level work (or even below)
- How to access sources which are not predominantly based on GCSE work (or below).

With the right decisions, appropriate investigations can meet all the criteria at a good level. However, it is possible for two investigations with the same title to be met at Distinction level or at below Pass level depending on the decisions made and approaches adopted.

To an extent, some credit may normally be available if investigative processes and procedures have been followed, but some criteria cannot be met for low level approaches, weak science and restricted, inaccurate or unreliable data.

PO1: Prepare for a scientific investigation

P1, M1, D1

These criteria involve progressively more detailed research and explanations of scientific principles across the performance outcomes grid. The principles to be covered concern all aspects of the investigation including:

- The scientific area concerned, and the underlying theories and principles
- The science related to the relevant procedures, techniques, possible approaches
- The science relating to the variables/factors to be investigated and/or controlled
- The need for a particularly detailed account of principles which also have to be related to commercial and industrial uses (D1).

Although not necessarily a pre-requisite, some investigations will have direct, extensive links to other areas of the specification, for instance "reaction time" and ASC4, and this gives an idea of the level of theory that is appropriate. In this example, relevant parts of "*the structure and function of the nervous system and brain*" and "*nerve impulses*" from ASC4 would provide a good high level basis for some of the scientific principles behind the investigation. In addition, further areas, relating to the standard procedures and factors/variables investigated or controlled, would also need to be considered.

P2, M2, D2

These criteria are also connected and provide a sequence from Pass to Merit to Distinction.

- P2 requires a plan, aims and researched standard procedures/techniques to be followed
- M2 records results/data from trials of the SPs identified in P1 – leading on to changes made to the SPs to be adopted
- D2 then requires a justification of the final SPs chosen and the accuracy, reliability and validity shown.

Whilst "practise techniques" are mentioned in the Unit content (p85), the main purpose is to "determine parameters". Trials are designed to identify the SPs to be used, and how variables are best controlled to give accurate, reliable data. Changes to the plan, including modifications of parameters – eg concentrations, times, etc as appropriate – need to be described.

In weaker portfolios, trials were usually very limited in scope as they were not aimed at trialling methodology and determining parameters. Subsequent modifications were not extensive, and often not present at all.

PO2: Carry out the investigation and record results

P3, M3

Across the entries for this series, risk assessments were poor, and sometimes very weak indeed. This is surprising as these learners will have already completed risk assessments for ASC2.

Learner generated RAs are needed for P3 and Control Measures are assessed for M3. Control Measures are often incorporated into the RA template and this is acceptable.

RAs are best recorded on a standard template (lengthy prose style RAs are not acceptable). Column headings of Equipment and Materials, Hazard, Risk, Control Measures, PPE, Action on Spillage, are required. Hazards and risks must be correct for the states and concentrations used and quoted in the RA.

P4

An Observation Record is required for each student to support the criterion "correctly follow SPs to use a range of practical equipment and materials safely".

Another issue that can arise, if a limited approach to the investigation is evident, is that learners may not "use a range of equipment" or be working at Level 3.

It is important that the SPs are present in portfolios together with the associated results in order that P4 can be judged in the context of the practical work carried out.

P5, M4, D3

For P5, data must be recorded to correct levels of precision (significant figures/decimal places) with correct units and adhering to normal conventions. This was not always seen, and absent units and/or incorrect conventions result in P5 not being met.

- It is assumed that all data recorded are the learner's own unless otherwise annotated
- Learners and assessors must sign the USF to confirm that all work is the candidate's own
- If any secondary data from other learners are included, these should be tabulated separately and annotated accordingly.

M4 assesses effectiveness of methods used to collect data. This is measured on the quality of the recorded data, precision of recording, anomalies, repeatability/concordancy, etc.

Questions to ask …..

- Are data complete / are sufficient data recorded?
- Are sample sizes adequate?
- Is the precision of recording appropriate?
- Are there any anomalies?
- Are the data repeatable, hence reliable?
- Are there any issues with accuracy?

D3 then considers the responses to these questions, and makes suggestions for improvements to the methodology and/or data collection.

PO3: Analyse results, draw conclusions and evaluation the investigation

P6, M5, D4

P6: Analysis of data could include suitable, simple calculations – eg means - and simple presentation of data using appropriate graphs and/or charts.

M5: Manipulation of data using appropriate methods usually incorporates mathematical changes, for instance calculating rates of fermentation, energy output from a wind turbine, viscosity using Stokes Law, time of fall in a ruler drop test. These modified outcomes can then be presented graphically in a more meaningful way. IT is expected to be used at some stage in the process, either in the manipulation steps (eg spreadsheet calculations) and/or at the graphical representation stage. *(The use of IT does have to be appropriate, and should enhance the ways in which data are manipulated and presented, remembering also that some Excel graphs are too simplistic, often with inappropriate lines of best fit, to be useful.)* A sometimes useful addition to manipulation of data would be the use of statistical methods, but it does have to be appropriate to the data set recorded and often, in ASC5, this is not the case.

D4: Discussion of the methods and formats used in the analysis in the context of the outcomes and their relevance to the original aims of the investigation. Justifications can also consider the methods used and what further information or outcomes are derived as a result of applying those methods.

P7, M6

P7 identifies sources of error and anomalous data. These errors can be systematic or random. Good approaches, seen from learners, were to:

- Identify qualitative errors and consider the methodology used
- Identify quantitative errors (in the readings taken/data recorded)
- Identify % errors in readings recorded (and comment on their values).

M6 then:

- Explains these sources of error and how they arose including reasons for anomalous data
- Explains how these sources of error can be minimised.

P8, M7, D5

P8 and M7 were particularly weak areas for most learners.

For P8, conclusions should be related to the original aims set out in P2 and should be based on the data recorded and analysed in P6/M5.

In M7, these conclusions based on primary data are compared with equivalent information (data) gained from secondary sources, such as researched expected outcomes and literature values if available. [Note: this was a weak aspect of many portfolios as candidates offered limited or no evidence of the comparison of conclusions drawn on primary data gathered by the learner, and those based on secondary data].

NB Using other learners' results as secondary data may be of limited value, and should not be seen as a substitute for extensive research and recording of relevant secondary data from reliable sources. Using other learners' results often appears pre-planned and "an easy way out" of proper research for related data from theory or from independent investigation outcomes.

D5, in many ways, 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 start point. The use of percentage errors can then lead to a comparison of the accuracy of the calculated outcomes with the overall error.

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

P9, M8, D6

P9: The report on the investigation is usually the portfolio and no separate mini-report is expected.

The presentation:

- Can be in various formats
- Should be designed for a suitable (identified) audience
- Should be appropriate for that audience
- Should contain text and images
- Should include results and a conclusion, which are clear and concise.

Note: Some PowerPoint presentations were seen with slides that were too "wordy" and not concise enough. Improvements are expected for future submissions and many learners would benefit from

guidance in the design and content of PowerPoint presentations. On the other hand, leaflets were used well for some investigations and audiences.

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

D1 assessed the relevant scientific principles and their relationship to industrial/commercial uses, and now D6 revisits these, but from the point of view of the relevance of the results and outcomes of the investigation to those industrial processes.

P10, M9

P10:

- Requires sources to have been used in research for PO1 and for secondary data for M7.
- Expects (just a basic version of) HRS to be used. For example, a numbered indication eg [12] in the body of the text and the reference listed in a footer or in a bibliography at the end.

M9:

- Requires the usefulness of the references to be evaluated and the references themselves to be validated.

Validation can consider a whole range of checks and ideas depending on the nature of the source. Approaches may include:

- Type of publication and 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.

Mark Ranges and Award of Grades

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