LEVEL 3 CERTIFICATE / EXTENDED CERTIFICATE

APPLIED SCIENCE

ASC2: Applied Experimental Techniques
Report on the Examination

1775 (1776 & 1777)
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General

Summer 2019 was the third summer series entry opportunity for the Certificate Units.
A combination of centres, some entering for the first time, some resits, and those now in their second or third year of delivery of this course, was evident.

Some centres had taken advantage of the comprehensive Reports on the Examination published in previous series and, if necessary, had adjusted their approaches and marking to good effect.

In addition to the comments that follow, centres are recommended to read the reports previously published and available on the AQA website (in 'Secure Key Materials'), and which contain detailed comments and advice relating to the delivery and marking of this unit.

All centres are reminded of the requirement for internal standardisation (specification p136) and TOLs would contribute to that.

Please see: *https://www.aqa.org.uk/news/teacher-online-standardisation-tols*

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. In most cases, it was also clearly understood that the approaches adopted by learners should reflect fully the demands and expectations of a Level 3 qualification. However, some centres had underestimated the depth and breadth of the portfolio evidence expected, and were too generous in their assessments.

ASC2 covers elements of biology, chemistry and physics. Some centres deliver the course via three subject specialists, whilst others do not have this opportunity, and this is understood. Whichever delivery approach is adopted, effective internal standardisation and/or moderation processes must be in place to ensure validity of assessments.

Submission of coursework samples is variable. Centres are reminded of the following:

- The deadline for marks submissions via eSUBs is May 15th
- The sample should be posted to the moderator promptly
- Portfolios should be hole punched and treasury tagged (top left); no poly-pockets or folders or staples
- Only one copy of the Assessment Brief is needed
- The USF must be completed (centre name, number, candidate name, number, candidate and teacher signatures, UAR, total marks, confirmation and evidence of internal standardisation)
- Outcomes of internal standardisation and moderation must be consistent with the marks submitted via eSUBs
- Pages should be numbered
- Work should be printed, portrait format, correctly sequenced
- Any previous versions, drafts etc must be removed before submission
- Marks awarded on the UAR must be identical to the marks submitted via eSUBs and the UAR total is consistent with the number of 'ticks' in the grid
- A completed Witness Confirmation is enclosed with each portfolio submitted.

Examples of good practice seen at moderation included the following:

- Researched content from the Internet is reworded to demonstrate the candidates' own knowledge and understanding
- Any direct cut and paste (prose) content is suitably annotated and not given credit
- All sources are referenced
- Experimental work is carried out individually wherever possible. eg titrations, determination of resistivity
- Where any pair or group work is necessary, it must be confirmed that each individual has played a full part in all the experimental work and his/her own results are clearly identified so that …
- …. each individual's ability to follow the standard procedure and record their own results is clearly evident in all six relevant Pass performance outcomes (PO)
- Standard procedures (SP) have all been fully trialled by the centre so that learners achieve data consistent with Level 3
- No centre issued templates or scaffolding are used in portfolios, for instance for recording results or carrying out calculations
- Hand drawn lines of best fit to support learner understanding are evident,for instance in M2, P6, M9.

PO1: Demonstrate applied experimental techniques in biology

P1, M1, D1

The most common issue encountered is still that these three grading criteria each require both respiration and photosynthesis to be considered. It should also be remembered that M1 cannot be awarded if P1 is not met.

- P1 requires an <u>outline of uses</u> of physiological measurements of respiration (eg peak flow and lung capacity) and for photosynthesis, uses of measurements for improving yields and productivity
- M1 requires explanations of the scientific principles behind respiration and photosynthesis (see Unit content p46, 47 in the specification)
- D1 must be suitably detailed for Distinction level, and again, must cover both respiration and photosynthesis and how they are applied in a medical or commercial context
- Good portfolios usually include very detailed applications of peak flow, lung capacity and blood pressure in medical contexts and the use of BMR by sports physiologists
- Photosynthesis is usually linked to commercial applications in agriculture and horticulture and manipulation of factors in the context of improving crop yields and rates of growth
- Good approaches seen this year again made excellent use of graphs, tables and images in D1 to support and demonstrate the points made.

PO1a and PO1b

The centre issues a standard procedure for P2 that must be followed. This must measure the effect of one factor on rate of respiration. M2 needs formulas / calculations / graphical representations to be used in explaining the data recorded as part of P2. D2 involves the evaluation of the results and the SP used.

Varying temperature is the most common approach seen and most centres have now adjusted their procedures to allow a suitable range of data to be recorded.

Typical high scoring portfolios include the following:

- Measure rate of respiration of yeast (sometimes seeds/beans) at 5 or 6 different temperatures
- The temperatures chosen span the optimum
- Results pattern and optimum are as would be expected
- Rates are calculated (eg by volume of gas/time, or from gradients on a graph of results)
- A graph of rate v temperature is drawn
- The shape of the graph is explained with reference to reaction kinetics, collision rate, activation energy, enzyme action, active sites and denaturing
- The results are evaluated and anomalies and errors identified; methodology is evaluated.

P3 requires a standard procedure to investigate the Hill (light dependent) reaction and results to be recorded. This should be trialled by the centre to ensure it works. No calculations or conclusions are expected. M3 requires the <u>same</u> SP as used for P3 to be adapted for three different limiting factors. Most commonly seen was light intensity, wavelength of light, carbon dioxide (via varying concentrations of sodium hydrogen carbonate) and herbicides.

For M3:

- State the modifications required in each of the three cases and/or a new, adapted SP
- Explain the science behind how the adaptations work. eg applying the inverse square law for light intensity diminishing with increased distance; explaining how wavelength of light relates to the colours in the visible spectrum.

PO2: Demonstrate applied experimental techniques in chemistry

P4, M4

Volumetric analysis and colorimetry are outlined in terms of their basic principles and uses for P4.

M4 then requires explanations of the underlying science of the two techniques with specific reference to standard solutions, choice of indicators, and the Beer-Lambert Law.
The following details should be evident in portfolios:

Volumetric analysis
- The reaction, equation and stoichiometry (molar ratio)
- Choice of indicator, justification and explanation in terms of pH titration curves and end points
- The importance of using a standard solutions, examples and uses.

Colorimetric analysis

- The visible spectrum
- How a simple colorimeter is constructed and how it works
- Choice of filter or wavelength of incident light used, absorption curves and lambda max
- Absorbance (NB not transmission)
- The Beer Lambert Law and graphical representation
- Calibration and the nature of the abs v concentration graph
- Uses.

PO2a

Key content and outcomes that scored well for PO2a, volumetric analysis, covered the following:

- For P5, learners followed a suitable SP to:
    - Prepare a standard solution, for example sodium carbonate or sodium hydrogen carbonate
    - Carry out a titration, for example against hydrochloric acid of unknown concentration
    - Achieve titres of suitable values, typically 20 – 25 cm^3
    - Record all results to include mass of standard weighed out, volume of volumetric flask, volume pipetted, initial and final burette readings (to +/- 0.05).
        - Note: a completed witness confirmation and ra is needed to support the practical work.

- For M5, learners calculated:
    - The concentration of the standard solution from the mass they weighed out and the volume of the volumetric flask
    - The unknown concentration.

- For D3, learners researched titrimetric methods used in industry with particular reference to:
    - Use of auto-pipettes, auto-titrators, electronic end-point detection
    - The accuracy and precision of recording of the results that follows
    - The use of primary standards explained with suitable examples.

PO2b

Key content and outcomes that scored well for PO2b covered the following:

- For P6, learners followed a suitable SP to:
    - Use solution dilutions of a standard solution (eg copper (II) sulphate)
    - Prepare a suitable range of known concentrations
    - Select a suitable filter or choose a suitable wavelength
    - Correctly zero the colorimeter
    - Record absorbance values for all standards and the unknown
    - Plot a calibration graph
    - Use the calibration graph to determine the unknown concentration.

- For M6, learners:
    - Explained the choice of filter or wavelength in relation to the colour of the unknown and the visible spectrum. In the best portfolios they referred to a graph of abs readings v filter colour and determining λmax

- Described any anomalies in the data recorded
- Referred to the Beer-Lambert law and compared the expected line (straight line through the origin) with that achieved.

- For D4, learners:
    - Evaluated the outcome of the analysis of the data
    - Systematically considered all the stages in the procedures, the apparatus used and any errors or lack of precision that may have resulted
    - Considered the data recorded (solution dilutions, colorimeter readings) and its reliability through repeats, and precision of recording
    - Compared the outcome with the expected value and accounted for any discrepancies.

PO3: Demonstrate applied experimental techniques in physics

P7 and M7 were surprisingly weak in some submissions. Resistivity in particular was often poorly understood by learners, sometimes confused with resistance and lacking an explanation of its definition. Specific heat capacity (SHC) was usually better described/defined. However, both were poorly explained 'in relation to material properties'. It is essential to get P7 correct as, if weak, it usually followed that M7 was not met. M7 needs to concentrate on researched values of resistivity and SHC, and how these determine uses of materials in industry.

The following details should be evident in portfolios:

Resistivity
- The meaning and definition of resistivity and how resistivity relates to resistance
- How resistivity determines uses of materials
- How values of resistivity are linked to uses for a range of materials with high and low values
- How values of resistivity are linked to the uses of semi-conductors.

Specific Heat Capacity
- The meaning and definition of SHC
- Why different materials have different values
- How high and low values of SHC are linked to uses of materials
- Suitable examples including water.

PO3a

Key content and outcomes that scored well for PO3a covered the following:

- For P8, learners:
    - Followed a SP to measure resistivity
    - Recorded all results including the length and diameter of the wire
    - Used suitably precise equipment
    - Repeated readings at least three times.

- For M8, learners:
    - Calculated cross sectional area and resistance, and hence resistivity
    - Compared their results with (researched) industry standard values

  - Identified whether their result was in agreement with the industry standard
  - Identified and accounted for any anomalous readings and reasons why any differences arose.

- For D5, learners:
  - Researched industry standard methods of measuring resistivity such as 4 point probes
  - Described these methods, usually with diagrammatic support
  - Linked these methods to reduction of errors such as contact resistance
  - Considered the improved accuracy and precision of the recorded data that resulted.

PO3b

Key content and outcomes that scored well for PO3b covered the following:

- For P9, learners:
  - Followed a SP to measure the SHC of one material (usually a solid)
  - Recorded all results.

- For M9, learners:
  - Plotted a graph of temperature <u>change</u> v time (or energy supplied)
  - Calculated % errors in the measurements made and plotted error bars (for temperature change only) on the graph (Note: uncertainties in readings are acceptable in place of error bars)
  - Drew the line of best fit (NB this is often not a straight line throughout, especially at low and high temperatures)
  - Calculate SHC
  - Explain the graph in terms of heat transfer (heat gain v heat loss and how this may vary as temperature increases).

- For D6
  - Explain how the SP (NB that used previously in P9) could be adapted to measure the SHC for a material in a different phase, typically a liquid
  - Diagrams, adapted SPs, due regard for heat losses / insulation / materials used for apparatus, measurements recorded, are typically all part of good responses.

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

For P10, the answers tended to be either well done or very poorly done in respect of the risk assessments seen. This is an area that needs to be addressed by a number of centres and it does tend to affect the likelihood of equally weak RAs being submitted for the Extended Certificate units.

P10 has three outcomes which are assessed:

- The safe use of a range of practical equipment and materials (across all six experiments) is normally met, but does need supporting evidence from the centre via a Witness Confirmation for each learner
- The ability to identify hazards is judged from the learner written RAs cross-checked against the experiments carried out
- The ability to produce risk assessments for one experiment from each of PO1, PO2, PO3. These need to be suitably identified in the portfolio. [NB the remaining three RAs can be centre issued, and copies of each included in the sample.] All 6 RAs need to be evident.

Centres should note that a missing learner RA will lead to P10 not being available for credit.

The production of meaningful risk assessments remains an area which needs attention in a large number of centres, some across all three science areas, some in one or two.

- The approach to RAs needs to be coordinated across the three science areas, as some significant differences have been noted in this submission and in earlier ones too
- RAs should start with identification of materials (chemicals, micro-organisms, other materials and apparatus) including, for chemicals, relevant states and concentrations. 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 required or expected
- Further column entries should then consider control measures and PPE, disposal if relevant, and action on spillage/emergency or similar points.

RAs written in prose are not suitable and will not gain credit.

Mark Ranges and Award of Grades

Grade boundaries are available on the Results Statistics page of the AQA Website.