Version 1.0

General Certificate of Education (A-level) Applied
June 2011

Applied Science SC16

(Specification 8771/8773/8776/8777/8779)

Unit 16: Ecology, Conservation and Recycling

Report on the Examination

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Set and published by the Assessment and Qualifications Alliance.

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Registered address: AQA, Devas Street, Manchester M15 6EX.

Principal Moderator's Report, June 2011

Centres are again to be congratulated overall in preparing students well for the units in this award, and, as in previous years, some very high quality work has been produced, enabling candidates to gain good grades.

During moderation, a large number of portfolios are sampled to ensure that standards are maintained and that grades awarded are appropriate and commensurate with the evidence seen.

As a result of examining a wide range of portfolios, some general issues became apparent, where centres and their candidates could approach work differently or more appropriately in order to gain maximum success.

Centres may like to consider their own approaches to the following areas; these are not listed in order of priority or significance since each may or may not contribute to outcomes, depending on current centre practice.

1) Use of the Specification

This may seem a very obvious thing to say but it would seem some candidates show insufficient awareness of the detail of the unit requirements in the specification. The text of the specification describes what students are required to know, understand and undertake. The assessment of portfolios is based on the assessment grids for the unit and again there are required aspects which should be covered. Where candidates cover more aspects than are required (which can sometimes have a detrimental effect on the quality of work produced in the **required** areas) or miss required areas out, this can significantly affect marks awarded.

Hence it is absolutely essential that those responsible for constructing course or unit delivery plans read the specification very carefully, along with the related assessment grids, and ensure that all aspects are covered by candidates. It is also important that candidates are made fully aware of what they are required to cover for the unit and what evidence is required in portfolios to support this. This compliance with unit requirements seems obvious, but each year some candidates demonstrate they are not fully aware of specification requirements based on the evidence seen in portfolios.

Published materials may be used to support delivery of this course and some of these are very good sources of information and ideas. However, centres must be warned that the specification requirements over-ride any published material and careful checking and selection of material is essential. Work must be selected which meets candidates' abilities and meets specification requirements, and so simply following a published book is inappropriate.

At the end of the specification are generic grade descriptors for the requirements of A and E grade standards. Centres should consider these in relation to their own assessments of candidates' work, in conjunction with the grade boundaries for the units which are published annually in this report, and also in relation to their own school data on predicted student achievement.

2) Terminology used

Accuracy
'Accuracy' is a reference to how close the measured or experimentally determined value of a parameter is to the true value. The true value may be obtained from data books, scientific literature and the like, or, if appropriate, a teacher-determined value could be used as the reference.

Precision
In carrying out experimental work, it is important that the measuring instruments selected are the most appropriate to the task, and lead to readings that can be recorded to suitable levels of precision which, at the same time, keep the percentage errors in the readings to a minimum. Precision is related to the smallest scale division (and occasionally to half a scale division e.g. burette readings) on the measuring instrument used and has implications for the number of significant figures used in the readings taken.

When averaging a number of readings it is inappropriate to record the average value to more significant figures than those used in the original readings.

Precision is also relevant in calculations, especially the final quoted answer. Some candidates seem to have a poor understanding of this and simply copy down their calculator displays, often to far too many significant figures. In other cases, incorrect rounding can lead to final answers being quoted to too few significant figures.

Reliability
Reliability is the extent to which the measurements of a quantity remain consistent over repeated measurements of the same quantity under identical conditions.
An experiment is reliable it if yields consistent results of the same measurement; for instance, concordant titres and consistent repeat values of zones of inhibition.

The results of an investigation may be considered reliable if they can be repeated. If other scientists get the same results, then the results of the initial investigation are more likely to be reliable. The reliability of data within a single investigation can be improved by carrying out repeat measurements.

Repeatability and Reproducibility
Repeatability of results or work refers to the same procedure being carried out by the same person using the same equipment in the same laboratory and getting the same result – if this happens, the experiment is repeatable.
Reproducibility of results or work refers to the same procedure being undertaken by a different person, in a different laboratory with different equipment but yet obtaining the same result.

Validity
Data are only valid if the measurements that have been made are affected by a single **independent variable** only. They are not valid if the investigation is flawed and **control variables** have been allowed to change or there is observer bias. Conclusions are only valid if they are supported by valid and **reliable** data measured to an appropriate level of **precision**.

(When considering the validity of sources of information, this is a reference to the likelihood that the source used for the information is judged to be one that many would feel they could trust as being an accepted source of information, because it is from a well known and probably long-established authority in the field.)

3) Use of the Portfolio Adviser

The portfolio adviser appointed to a centre is there to help in any query linked to portfolio work or specification requirements. There is *no requirement* to contact the adviser but where a centre tutor or assessor has concerns about delivery of a unit it is best to seek outline guidance about approaches to a unit before starting it, then to put an outline proposal to the adviser for **brief** consideration. Emailed documents are probably best following an initial email enquiry or phone call. Similarly, when assessing completed units it is best to contact the advisor, if it is felt necessary, after making a few trial assessments before seeking help, so that problems can be addressed rather than discussing generic issues.

Portfolio advisers are not in a position to over-mark large numbers of portfolios from centres to 'check' marking. Centres should remember that the adviser is namely that – an adviser – they can explain how to tackle things but cannot guarantee success. That depends on how well the centre and its candidates act on the advice given and the quality or responses candidates make to the work. Centres should not worry about contacting their centre adviser, they are there to help, and a quick email can easily sort out a problem.

4) Preview or student proposals and monitoring of work.

Two areas where centres could improve some aspects of student work are previewing initial plans and interim monitoring of work. Previewing candidates' planned approaches may avert inappropriate work and potential omissions in the early stages of portfolio construction. Similarly, brief monitoring of work during early and mid-stage production can also prevent problems later. This could, for instance, identify inappropriate organisations for SC01, the inclusion of downloaded material, a lack of research in required areas, omissions of aspects of study required by the assessment objectives, and so on.

5) Format of portfolios

AQA does not specify how portfolios should be constructed. However, experience has shown the following points will be of use to candidates:

a) Construction to match specification unit layout aids coverage of the required aspects of study by candidates.
b) Use of sub-headings to match sub-sections in a unit also aids coverage and location of work.
c) Over-large portfolios are problematic. They often take students far too long to produce, make initial marking by the centre assessor very time consuming and make moderation over-long. Production of large portfolios to some extent demonstrates an inability of the candidate to decide what is and is not important and is often a measure of the candidates' Quality of Written Communication (QWC) skills. Double spaced printing, excessive 'white-space' and single sided work also makes portfolios larger than they need be. However, it is also important that portfolios are well laid out and legible, not micro-print or very dense text. There is a middle way: neat, clear, layout with sufficient content to meet requirements but not so large that relevant material becomes buried in masses of text.
d) It would be very helpful if candidates fully checked their portfolios before submission. Many have duplicated pages by including old and revised sections: to read a page and then find a second revised copy can be frustrating. Similarly, pages out of sequence or inverted also show poor care and attention to details by candidates.
e) Plastic A4 wallets (polypockets), whilst keeping work tidy, make moderation awkward and time consuming. It is best to secure portfolio pages by treasury tags.

f) It was noted this year and in previous years that many candidates do not clearly tabulate raw data from experimental work. A significant number do not make good use of the correct units in tables or on graphs or other display methods. Sometimes conclusions do not match the evidence in the portfolio.

6) Calculations

Many units require candidates to undertake calculations. Candidates should make clear in their portfolios what they are planning to calculate, the formula or formulae to be used should be *briefly* explained and then appropriate data used from experimental work. It should be clear where the numbers used have come from; sometimes moderators are at a loss to see where new numbers have come from. Stages in calculations should be made clear. Some centres provide help-sheets or scaffolding forms for calculations. Whilst these are a great help for some candidates to overcome problems with mathematical work, marks should be awarded appropriately for such work. It should be remembered that more able candidates could have marks limited by giving too much help in this way since they cannot demonstrate autonomy and skill if they have been told exactly what to do. As mentioned previously, the appropriate use of significant figures in calculated values also demonstrates candidates' appreciation of the significance of numbers and their meaning.

7) Autonomy and group work

In some units, group work may be appropriate, especially in SC16 where team work is usual and results are collected for all to use or share. However it is also important that candidates have opportunities to demonstrate their own skills in use of techniques. Inorganic analysis, titrations, preparations, etc. should all be through individual work. A whole group having exactly the same set of titration results, would be considered unusual at GCE level and judgements of skill and autonomy cannot be made fairly. If it is essential to use group data then it is very important for each student to indicate his/her own contributions to the joint effort.

Autonomous working means that candidates, having had the work explained to them, are able to progress relatively unaided. They are still 6th form students and still need to be taught – autonomy does not mean they are left to their own devices, it means that once they have been told what is required, they can progress with relatively little help other than normal teaching.

8) Evaluation

Many candidates do not find this area easy. Some demonstrate confusion – writing the standard procedure in the past tense with comments is not an evaluation.
The purpose of evaluation is to look back at what was undertaken and to consider those aspects which may have presented problems and have possibly contributed to errors in findings. Lack of apparatus or broken equipment are centre problems and, whilst significant and a barrier to student progress, should not feature in an evaluation. (It is expected that candidates will be provided with all the appropriate equipment in sufficient quantities and in working order, that all chemicals and solutions are in the correct concentration or quantities and that sufficient time and laboratory access are provided to undertake their work. Candidates are expected to manage their own time and equipment, etc., but the fundamental requirements for their work should not be a problem for them).

Evaluations should consider the qualitative and quantitative errors associated with the methodology used and measurements made, and this should be in the context of an assessment of the accuracy of the experimental outcomes. The precision of recorded data and its reliability should also be considered. During this section it may be appropriate to consider the effect of variation in results using appropriate statistical methods.

However, candidates should be alert to the appropriate use of statistics in their evaluation. Standard deviation calculations on small numbers of values are pointless, and to calculate values and then not relate them to the experimental results and conclusion is also pointless. Where appropriate, candidates may also wish to calculate errors in equipment and in measurements taken. Many centres encourage candidates to calculate percentage errors but then candidates make little or even no use of the values that have been found, indicating a failure of candidates to appreciate what they have calculated and its significance. (This aspect of evaluation may be included in the data section of the portfolio and be linked to conclusions).

It must be remembered that these detailed mathematical procedures may help able candidates to incorporate further analysis of findings and their impact on conclusions and possible access to higher mark bands. However, for candidates whose mathematical skills may be less well developed, such calculations may detract from other aspects of their work and could actually limit marks. Centres should consider when it is appropriate to encourage candidates to embark on this area of work.

9) Reports

There are two sets of reports all centres should read carefully.

a) One is the set of feedback reports to the centre for each unit they submitted, which are issued at the same time as the results are published. These reports highlight strengths and weaknesses in the last entry and also explain the reasons for any changes in marks that have been found necessary to ensure marking is in line with the accepted AQA standard for each unit. These reports are really very important. It is unfortunate that some centres do not seem to read these (or if they read them take no apparent action) since the same mistakes continue to be made.

b) The second set of reports is that found in the overall examination report for all units and all examined units (this report) which is available on the AQA website at the time of publication of examination results. This report details the overview nationally of each examination component and is a valuable source of information for future entries.

There follows an overview of the Assessment Objectives for this award and then comments on each unit individually.

General Assessment Objective Issues

AO1

The portfolio evidence should encompass all the required elements of study and content detailed in the specification. It is imperative that candidates are aware of the specification's requirements regarding:

- the evidence expected within the portfolio
- the areas where candidates need to demonstrate knowledge and understanding.

Where there are differences between the coverage expected and the actual portfolio evidence provided, then the latter cannot be considered to be comprehensive, extensive or complete, which are typical mark band 4 terms.

For instance, in SC03, the specification requires portfolios to show evidence of (amongst many other ideas) the uses of the analytical techniques, the preparation of standard solutions and the usefulness of combustion reactions; these are common omissions and/or weak areas.

In SC15, the specification gives an extensive list of the aspects of work in the pathology departments that must be considered and in SC10, the list of experimental work required is equally clear.

Other units all have corresponding indications of the extent of portfolio evidence expected and the areas where research is to be carried out. The extent to which knowledge and understanding is demonstrated by candidates can be compared with that required by the specification and matched to the appropriate descriptor in the assessment grids. In SC07, for instance, secondary sources used in research must be checked and validated for mark band 3 and mark band 4, and the necessity for health and safety issues to be considered and a full description of those issues appear in mark band 4, both being frequent weak areas across many centres.

AO2

This Assessment Objective essentially covers the application of scientific knowledge and understanding, and whilst the exact nature of the application may vary from unit to unit, it does encompass calculations (in all units apart from SC01), the application of principles such as bond enthalpies (SC03), food spoilage and preservation (SC04), balanced equations and structures of organic compounds, and types of organic reactions (SC06), quantitative physical relationships (SC10) and ecological survey techniques (SC16).

In calculations, it is each candidate's abilities that are assessed and group work is totally inappropriate in this respect, as is the use of centre directed methods, proformas or tables, etc. Whilst it is expected that the relevant calculation methods are taught and practised, the actual portfolio evidence should be the candidate's own work if marks in the higher mark bands are to be considered. In SC07, for instance, mark band 3 and mark band 4 assume that calculations are independently attempted. Some minor errors in calculations would limit marks as well. It is essential that centre assessors check all calculations (and, please, annotate accordingly, as correct or incorrect).

Precision is also an important factor in calculations, particularly in the precision of the final calculated answer where incorrect or inappropriate rounding should be penalised. The use of correct units is another factor to be considered and penalties applied where necessary. Centres should also note that the performance descriptors for the A/B boundary at A level (pp 185-189 of 2011 specification) indicate that candidates “carry out complex calculations, obtaining correct solutions to an appropriate degree of accuracy”. This should be taken into account, for instance, in deciding approaches to SC07 investigations, and subsequently in awarding marks.

AO3(i) and AO3(ii) (Not assessed in SC01)

The levels of the need for teacher involvement in the practical work are part of the assessment grids, and it is expected that centres will annotate portfolios accordingly (as shown by # in the assessment grids). Teacher observations relating to the levels of safe and skilful working, the correct application of standard procedures and risk assessments, should also be recorded. The resulting marks for these aspects of AO3(i) will generally be supported by moderators unless the portfolio evidence contradicts the teacher's assessment. The most common example of this would be where the recorded results indicate that skilful working had not taken place, but there are also occasions where an assessment of 'safe working' and 'adhering to risk assessments' can be compromised by portfolio evidence that includes inappropriate, incomplete or erroneous risk assessments.

Whilst each unit has its own emphasis in AO3(i) and (ii), the clear, logical recording of data, measurements, observations, etc. is common to all, as are the ideas of precision, accuracy and reliability.

It is encouraging that many candidates are aware of the need to present data clearly, to the appropriate levels of precision and with the correct units, but, equally, there are significant numbers of portfolios seen which do not even record all raw data (for instance initial and final burette readings); this is often a centre-wide issue. Similarly, problems with the precision of recording are often centre-based and, despite many previous indications via the annual reports on the examination and feedback to centres, these problems are still relatively common. Examples of typical areas where precision may be weak include titrimetric work (SC03, SC07, and SC12), temperature readings (SC03), and measurement of zones of inhibition in microbiological work (SC07, SC12, and SC16). Whilst the more common problems involve a lack of precision, there are also examples seen of data recorded to apparently too high levels of precision.

There is also a significant degree of variation across the range of centres in terms of the likely errors associated with the practical work that they provide for their students, and this impinges directly on the quality of results obtained and the marks subsequently available in this AO. Tiny titres (around just 1 or 2 cm^3) clearly have large percentage errors, especially if read to just 0.1. In the same way, very small zones of inhibition (a few mm) and small temperature rises (measured only to the nearest degree) are also likely to have large percentage errors associated with them.

Repeats, recognition of anomalies, the calculation of appropriate means, concordance, and a lack of variation or consistency in data are all areas which are very important when assessing the evidence in AO3(i) and a minority of centres seem not to be aware of the significance of such approaches and outcomes in A level practical work. The idea that the candidates' final answers should be accurate (when compared with the expected / data book / literature / teacher-determined values) is also not considered by some assessors and clearly inaccurate outcomes are not marked appropriately. Unfortunately, it is clear that some very inaccurate student results are sometimes due to errors in making up solutions and a lack of standardisation of those solutions by the centre.

The level of demand of the practical activity is another area that must be considered in this AO. Where the practical work and the results obtained fall short of being 'extensive', 'comprehensive', and 'complete', then marks in mark band 4 will not be appropriate and, depending on the overall lack of demand, depth and breadth, it may be that marks in mark band 1 or mark band 2 will be the best that can be achieved (e.g. in a low level, GCSE-style SC07 investigation).

It is important to reiterate here that the portfolio evidence provides the basis for the mark awarded and, where that evidence is absent, a moderator will find it difficult, if not impossible, to support a high centre mark. Where methods, SPs or other information have to be researched, then this research must be explicit in the portfolio.

As stated above, each unit has its own emphasis in AO3 and the aspects of study assessed do vary, with AO3(ii) for a given unit having some particular strands that may not be common to other units. It is essential that candidates are fully aware of the exact requirements for the unit being studied and that they ensure that they provide portfolio evidence accordingly. However, a common aspect that does challenge most candidates and that is present in most units is the area of evaluation, sometimes leading to modifications to products or methods. Here, it is unlikely that candidates will do well without centre input and teaching. All too often, candidates simply consider their own practical inexperience and often reinforce the ideas that skill levels are very low (and, unfortunately, inconsistent with the high marks awarded by the centre). What is needed in most units is a consideration of the accuracy of the result (see above) followed by a detailed discussion of the quantitative and qualitative errors in the practical work. On this basis, any required modifications will follow quite logically and will provide a foundation in science.

In consideration of marking Assessment Objectives, it must be remembered that as a rule of thumb, approximately 2/3 of the marks (40 of the 60) available are for AO3, which is essentially the practical aspects of the unit (SC01 has no AO3). Hence practical work makes a very significant contribution to the marks a candidate gains and is expected to be of high quality in order to gain high marks. AO1 and 2 contribute approximately 1/3 of the unit marks and whilst this is a required and significant part of the unit, it nevertheless reflects the emphasis that should be placed on the work in units.

SC16 – Ecology, Conservation and Recycling

As in previous years, there were some excellent reports of ecological surveys in evidence across a range of possible habitats. Much, of course, depends on the habitat chosen and the time of year when the survey was carried out, and this remains a problem for some centres and their candidates. Equally important is the time allocation for the survey. A small number of candidates did seem to be constrained by this and were unable to collect sufficient data.

The habitat selected and the survey carried out should be consistent with the need to produce extensive biotic data which are used to develop estimates of populations and distributions of organisms/species. Appropriate abiotic data should also be obtained which can then be used to explain these populations and distributions. The data also have to be used to develop food chains and webs and allow energy flows to be considered. A minority of candidates produced so few data that the requirements of the specification and assessment grids could not be met and this usually resulted from the habitat selected and/or the time of year when the survey was carried out. In order to discuss the distribution of organisms in relation to abiotic data it is really important to be able to compare differences between areas. It is not necessary – indeed it is important not to – undertake surveys in two completely different environments.

However, to provide some evidence to support ideas for distributions, it is important to examine different areas in the same habitat. For example, shaded and open areas of grassland, fast and slow or virtually static fresh water, exposed and sheltered shores, low-water/high water zones of the seashore, a transect across sand dunes with a range of changing abiotic conditions. Changing abiotic factors can then be linked to changing species populations. Random quadrats in a single area of similar organisms can certainly allow populations to be estimated but the abiotic factors cannot easily be linked to distributions, other than to describe the status quo.

The origins of the data recorded were not always made clear by the candidate or the centre assessor, and, often, it appeared that secondary data predominated and that the survey was little more than cursory.

The conservation section was frequently well done with a good (often local) habitat selected that has been subject to damage over a period but is now completely re-established or is in the process of being conserved. With the habitat as the central theme, candidates often produced high level work. A more general approach, global problems and studies where the habitat has not been made the central idea often do not generate high marks, so a very careful selection is key.

Work on recycling frequently appears as a lower priority section and is frequently brief. There are three key ideas for this section:

1. What is the local authority policy and practice on refuse collection/recycling? How is this linked to government policies and initiatives?

2. The selection of a chosen material which is recycled by the local authority – what is the "waste-stream" for this material. How is it collected, processed and eventually re-used in some way? Where does it go, who does it and what happens to it?

3. An A2 level consideration of the science behind the recycling process, the economic aspects of the recycling process and the environmental impact of re-processing.

UMS conversion calculator: www.aqa.org.uk/umsconversion