version 1.0

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Secondary Education

Additional Applied Science 2008

TEACHERS' GUIDE

Further copies of this booklet are available from:

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Background Information

1 Introduction

1.1 Purpose

This Teachers' Guide has been produced to help teachers in their preparation for the delivery of AQA GCSE Additional Applied Science and should be read in conjunction with the specification. The specification is available in hard copy, and may be downloaded from the AQA website (http://www.aqa.org.uk). Specimen papers for Unit 2, portfolio guidance and standardisation materials are also available.

1.2 Curriculum

The course has been developed as an alternative to the other GCSE Science courses available at key stage 4 and provides a different approach in teaching, learning and assessment style. The context of this course is in terms of 'what scientists do' and the skills that they use. As such, the course emphasises the applied and vocational nature of science and provides opportunities for the study of science in real situations.

As with all other single award science courses, this specification is designed to be delivered in approximately 20% of curriculum time. The content is presented as a clear, coherent and detailed specification targeted at the candidate. The specification clearly indicates to candidates what they have to know, learn, find out and be able to do.

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Specification at a Glance
Additional Applied Science

This specification is one of a suite of GCSE Science specifications offered by AQA. The specification leads to a single award GCSE Additional Applied Science. Unit 1 is common with GCSE Applied Science (Double Award). The award has three assessment units.

There are two tiers of assessment for Unit 2: Foundation (G–C) and Higher (D–A*). The centre-assessed units are not tiered.

GCSE Additional Applied Science	
Unit 1 ***Science in the Workplace***	
Centre-Assessed	20% of total marks 25 marks
A portfolio of evidence including two reports	
Unit 2 ***Science at Work***	
Written Paper 1 hour	40% of total marks 60 marks
Unit 3 ***Using Scientific Skills***	
Centre-Assessed	40% of total marks 40 marks
A portfolio of evidence including one report	

GCSE Additional Applied Science
4863

3 The Additional Applied Science GCSE

3.1 Introduction

This is a single award GCSE, separate from and generally taken after GCSE Science A or B by those candidates who wish to specialise in a vocational approach after the general science course.

This specification considers some of the knowledge required by particular scientists and the type of work and investigations that they may undertake in their work. It exemplifies some procedural and investigational activities that Food Scientists, Forensic Scientists and Sports Scientists undertake. The important contribution of science and scientific skills in the workplace is provided by the opportunity to study the work of scientists outside the school or college environment. Following this specification will introduce candidates to work-related learning and equip them with some of the skills they will need in the workplace or in further education or training. It will also empower candidates to take charge of their own learning and will provide a range of teaching, learning and assessment styles that will motivate them to achieve the best they can.

The assessment comprises three units: two portfolio units and one externally assessed unit.

3.2 Key Skills

All GCSE specifications must identify, as appropriate, opportunities for generating evidence on which candidates may be assessed in the 'main' Key Skills of *Communication*, *Application of Number* and *Information and Communication Technology* at the appropriate level(s). Also, where appropriate, specifications must identify opportunities for developing and generating evidence for addressing the 'wider' Key Skills of *Working with Others*, *Improving own Learning and Performance* and *Problem Solving*.

Section 13 of the specification shows Key Skills opportunities within each unit.

3.3 Use of ICT

In addition to the Key Skill of ICT, the National Curriculum requires that students should be given opportunities to apply and develop their ICT skills through the use of ICT to support their learning. Where appropriate, candidates should make effective use of ICT skills within their study of Applied Science.

Candidates should be given opportunities to support their work by being encouraged to:

- find things out from a variety of sources, selecting and synthesising the information to meet their needs
- develop their ideas using ICT skills to amend and refine their work and enhance its quality and accuracy
- exchange and share information, both directly and through electronic media
- review, modify and evaluate their work, reflecting critically on its quality, as it progresses
- understand the importance of databases in forensic science.

Examples of opportunities in Additional Applied Science for the use of ICT skills follow.

Candidates could:

- use multimedia sources to see things that cannot readily be observed at first hand, eg in vocational applications of scientific skills such as forensic techniques throughout the course
- use dataloggers in investigations, eg in Unit 3
- use the internet to find information about vocational applications of food, forensic and sports science
- use spreadsheets for modelling or data analysis resulting from the investigations undertaken in Unit 3
- use software simulations to enhance their learning in Unit 2, eg in sports science.

It should be noted that pages of notes printed from the internet or CD-ROMs will not be accepted as portfolio evidence, and will be ignored in the moderation process.

3.4 Citizenship

Since 2002, students in England have been required to study citizenship as a National Curriculum subject. Section 14 of the specification signposts opportunities for developing citizenship knowledge, skills and understanding.

3.5 Spiritual, Moral, Ethical, Social, Cultural, Environmental, Health and Safety and European Issues

All specifications must identify ways in which the study of the subject can contribute to an awareness and understanding of these issues.

Please refer to Section 14 of the specification for the relevant details.

3.6 Examining 'How Science Works'

Some of the ideas contained in 'How Science Works' will be examined in Unit 2 by providing candidates with appropriate data or text to interpret or comment on.

The parts of the specification where this is likely to take place are listed below.

Food nutrients and their functions

Candidates should be able to use data, theories and explanations to:

- comment on the nutritional value of food
- consider the impact of marketing, fast food and lifestyle on diet and health.

Food labelling and food testing

Candidates should be able to use data, theories and explanations to:

- evaluate qualitative and quantitative analysis of food
- consider the social and economic impact of information about the long-term harmful effects of eating certain types of food or food containing certain types of additive.

Microorganisms and food safety

Candidates should be able, when provided with appropriate information, to:

- consider the problems of contamination of food products which have led to product recalls or health scares.

Organic and intensive farming

Candidates should be able to assess the applications and implications of science when:

- comparing the advantages and disadvantages of both types of farming (food quality, cost, animal welfare, effect on environment).

Collecting evidence from the crime scene

Candidates should be able to use data, theories and explanations to:

- suggest why an inappropriate collection or sampling technique may lead to uncertainty about the validity and reliability of evidence
- suggest which measurements or distinctive features could be used to make a comparison
- state whether there is a possible match between two different samples using distinctive marks or impressions.

Analysing evidence from the crime scene

Candidates should be able to use data, theories and explanations to:

- state whether an ionic compound is soluble in water
- write the formula for an ionic compound
- name the product of a precipitation reaction
- draw conclusions about the identity of substances when given the results of a series of chemical tests

- describe the distinctive features of pollen grains and layers of paint
- suggest why instrumental techniques provide more precise and reliable evidence than that obtained from simple laboratory experiments
- state whether observable features indicate a link between a suspect and the scene of a crime
- interpret data and state whether there is a high probability that a suspect is linked to the scene of a crime
- draw conclusions from the results of blood tests and DNA profiling.

Candidates should be able to assess the applications and implications of science when:

- suggesting ways to improve the accuracy and reliability of the evidence being collected.

Interpreting and presenting evidence

Candidates should be able to use data, theories and explanations to:

- draw conclusions based on the facts and state whether, on the basis of the evidence, a suspect may have been present at a crime scene or may have committed a crime.

Exercise and the human body

Candidates should be able to use data, theories and explanations to:

- suggest suitable measurements to take in order to monitor physiological changes during exercise
- explain the importance of taking accurate and reliable measurements
- calculate pulse and breathing rate.

Sports nutrition

Candidates should be able to assess the applications and implications of science when:

- comparing and contrasting a normally balanced diet with that for a person competing in sport
- comparing and contrasting a range of different diets and suggest their suitability for an athlete.

Materials for sport

Candidates should be able to use data, theories and explanations to:

- select appropriate materials for sports clothing, equipment and footwear and be able to explain why the different properties are important.

Scheme of Assessment

GCSE Additional Applied Science is assessed by means of a combination of external assessment and centre assessment (portfolio evidence). Each unit is assessed by one method only.

4 External Assessment

4.1 Introduction

The following unit is assessed externally by a written examination:

- Unit 2: Science at Work

  Foundation Tier 1 hour **or**

  Higher Tier 1 hour

First examination is available in January 2008.

Each written paper consists of a number of compulsory questions based on the unit content, and will allow candidates to apply the knowledge, understanding and skills they have gained from teacher-designed activities and assignments. Many of the questions will be written with a vocational context, expecting candidates to apply their science to that context. The context will be based on, and will reflect as far as possible, the work of scientists involved in food science, forensic science and sports science of their work.

All papers are presented as question and answer booklets, are set and marked by AQA and are available in January and June each year.

4.2 Guide to Command Words in GCSE Additional Applied Science

The command words and phrases used in examination papers are there to inform candidates of the style of answer required. Ignorance of the meanings of one or more of these command words or phrases could lose a candidate marks. The list below provides the meanings to many of the most frequently used command words and phrases.

Many questions are best asked as direct questions prefaced by the words 'What?', 'Why?' or 'Where? So commonplace are these words and so varied the context in which they might be used that no attempt has been made to define them.

AQA's guiding principle in producing its examination papers is to set questions that are clear and unambiguous. While instructions will normally be taken from the list that follows, AQA reserves the right to substitute alternative expressions if it is felt that they make the meaning of the question clearer.

Calculate / Work out	The candidate must produce a numerical answer.
Compare	The candidate needs to describe the similarities and/or differences in sets of data.
Complete	The candidate needs to enter the answer in the spaces provided in a diagram, table, sentence, etc.
Describe	The candidate must state in words, or as diagrams, the important points of the topic.
Draw a bar chart	• Where the axes are labelled and scaled, the candidate needs to plot as bars a series of values. • Where the axes are labelled and not scaled, the candidate needs to add scales and to plot as bars a series of values.
Draw a graph	• Where the axes are labelled and scaled, the candidate needs to plot as points a series of values, and then to draw a straight or curved line appropriate to the relationship between the points. • Where the axes are labelled and not scaled, the candidate needs to add scales, to plot as points a series of values, and then to draw a straight or curved line appropriate to the relationship between the points
Explain	The candidate should apply reasoning to the recall of theory. (This command word will **not** be used if the required answer is no more than a list of reasons.)
Evaluate	Candidates should use the information supplied in the form of articles, graphs and/or experimental results within a given context, to consider the evidence for and against and draw conclusions.
Give a reason (how/why)	The candidate should give a reason that is an application of scientific knowledge based on the recall of content stated in the specification.
Give/Name/State/Write down	A concise answer is required without supporting evidence.
List	Candidates should give a series of concise answers, each answer being written one after the other.
Predict	The candidate must give a concise answer, without supporting evidence, and should produce their answer by making logical links between various pieces of information.
Sketch a graph	The candidate needs to draw a graph indicating a trend or pattern without the need to first plot a series of points.
Suggest	There is no unique answer: candidates are expected to base their answers on scientific knowledge and/or principles.
Use the information	Candidates should base their answers on information provided within the context of the question.
Use your understanding/ ideas of .....to	Candidates should frame their answers around a scientific concept.
What is meant by	The candidate should give a definition, together with some relevant comment on the significance or context of the question.

4.3 Further Requirements

Unit 2 of the specification also contains sections entitled *'Candidates should be able to use data, theories and explanations to'*. These sections of the specification will be assessed by supplying data or 'science media stories'/short case studies, which candidates will need to interpret. Candidates will be expected to use the information to evaluate, give reasoned scientific explanation or to argue a rational case.

4.4 Written Papers

Two tiers of entry are available for the written paper for Unit 2:

- Foundation Tier, targeted at grades C–G
- Higher Tier, targeted at grades A*–D.

Care should be taken to ensure that candidates are entered for the appropriate paper.

The final grades for the award obtained by the candidate are determined by the total UMS score achieved in the three units. Although the maximum UMS for the Foundation Tier is 111, it is possible for candidates entered for the Foundation Tier paper to achieve overall grades above C if they perform well in the centre-assessed units. See pages 64–65 of the specification for further information on UMS scores.

Both the Foundation and the Higher Tier papers are 1 hour long, with a maximum of 60 marks. Approximately 30–35% of the questions are common to both tiers. The remaining 65–70% of the marks on the Foundation Tier paper are targeted at the less able candidates (E, F and G). On the Higher Tier paper approximately 50% of questions are targeted at the more able candidates (A*, A and B).

The common elements of these papers may appear as:

- complete common questions
- part common questions
- common questions that have been extended on the Higher Tier paper to test candidates' deeper understanding and application of topics.

There is no specific Higher Tier content in the specification. Questions set at the 'higher demand' will be more demanding, thus allowing candidates to reach the higher grades.

As the tier of entry for the written examination does not restrict the overall grade awarded for the completed course, it is important to correctly target the entry of individual candidates for these papers. Centres should think carefully before entering borderline grade C/D candidates for the Higher Tier paper.

5 Portfolio

5.1 Introduction

The following units are centre assessed:

- Unit 1: Science in the Workplace
- Unit 3: Using Scientific Skills

First moderation of portfolio units will be in January 2008. Subsequently, moderation of portfolio units will be available twice each year, in January and June.

5.2 Support for Coursework

Portfolio Advisers

Each centre is allocated a Portfolio Adviser. Portfolio Advisers will answer telephone or email queries and may look at an example of marked work to give guidance on the standard if a centre is in difficulties.

The advice that a Portfolio Adviser gives will be restricted to:

- issues related to the carrying out of assignments
- standards of marking
- administrative issues
- discussion of feedback from moderators.

Portfolio Advisers cannot prime mark any work.

Portfolio Advisers are all moderators. They will not moderate work from centres that they advise.

Standardisation meetings

Annual meetings will usually be held in the autumn term, at venues around the country. At these meetings teachers will have the opportunity to discuss the portfolio requirements, will be given examples of possible approaches and will receive instruction on the application of the portfolio criteria.

New centres **that have registered** with AQA will be invited automatically to these meetings. Attendance in the first year of the examination is compulsory.

5.3 Annotation of Scripts

Paragraph 5.16 of the GCSE, GCE, VCE, GVNQ and AEA Code of Practice 2006/7 states: '*The awarding body must require internal assessors to show clearly how credit has been assigned in relation to the criteria defined in the specification … The awarding body must provide guidance on how this is to be done.*'

This annotation will enable the moderator to see as precisely as possible where the teacher considers that the candidate has met the criteria in the specification.

It is suggested that teachers refer to the mark descriptors for each unit, using the codes as given in the assessment grid for each unit – for example, 1A.1, 3B.2, etc.

Annotation should show clearly:

- what guidance a candidate has been given
- any ephemeral evidence provided by the candidate to the teacher in order to justify the awarding of a particular mark; eg in Unit 3, selecting and preparing laboratory equipment (3C.1)
- those areas of the work that provide the evidence for the award of a particular mark
- any witness statement that is included in the student portfolio; eg in Unit 3 whether guidance was given in carrying out risk assessment (3B.2).

Any information or guidance provided to candidates (eg data provided for analysis) **must** accompany work that is submitted for moderation. Where secondary evidence is used, candidates must quote the appropriate references.

Work could be annotated by one of the following methods:

- key pieces of evidence flagged throughout the work by annotation either in the margin or in the text
- summative comments on the work, referencing precise sections in the work. Optional progress record forms are provided on pages 69–70 to help in tracking candidates' progress.

5.4 Authentication of Candidates' Work

Paragraph 5.13 of the GCSE, GCE, VCE, GNVQ and AEA Code of Practice 2006/7 states: '*The awarding body must require centres to obtain from each candidate a signed declaration that authenticates the coursework they produce as their own. A mark of zero or absent must be recorded if a candidate cannot provide confirmation of the authenticity of the coursework produced*.'

AQA will not accept coursework marks if the work is not authenticated. Centres are asked to bear this in mind when submitting marks, and where work is not authenticated, zero or absent should be recorded on the Centre Mark Sheets. Centres should ensure that all Candidate Record Forms are signed before candidates go on study leave and should check that all work submitted to the moderator has signed forms attached.

5.5 Moderation Procedures

Paragraph 5.20 of the GCSE, GCE, VCE, GVNQ and AEA Code of Practice 2006/7 states: *'To ensure that standards are aligned within and across centres, the awarding body must moderate the marks submitted by each centre against the specified assessment criteria.'*

Moderation is carried out by an AQA moderator, who will undertake detailed scrutiny of all the work of a sample of candidates from each centre. On the basis of this inspection, it will be decided whether to:

- accept the centre's assessments
- adjust the assessments to bring them into line with national standards
- ask for a further sample

ask for the work of all candidates or request the centre to reassess or internally standardise their marks.

Normally, a centre's judgement about the order of merit will be accepted. However, if major discrepancies are discovered, AQA reserves the right to alter the order of merit and to inform the centre accordingly.

5.6 Explanation of Terminology

Portfolio of evidence

A portfolio of evidence is a collection of evidence to show that the candidate has completed the set tasks to the appropriate standard for the award of the mark given. The form of the evidence can be:

- written work from the candidate
- photographic, audio or video recording of candidate activity
- statements from the teacher/assessor, detailing observations of the candidate performing tasks or relating conversations with the candidate.

Vocational context

This refers to evidence that should have a particular relevance to the use of science in a manner that candidates can appreciate in society, eg the production of useful materials and products such as drugs, plastics, foodstuffs, dyes, burglar alarms, etc.

Scientific workplace

This refers to any workplace that uses scientific knowledge, techniques, skills, principles and ideas. These may be major users of science, such as the chemical industry, but are likely to include smaller users of science such as photographers, chefs and gardeners.

Simple calculations	Simple calculations are calculations that involve the basic rules of addition, multiplication, subtraction and division. Candidates would normally be expected to use these rules in equations, eg to process data and make conclusions (Unit 3, 2D.1). At a higher level, candidates would be expected to manipulate data and rearrange equations and formulae.

5.7 Developing Assignments and Tasks in Applied Science

An assignment or task should:

- be clear in its demands and related to a vocational context, demonstrating the use of science or scientific skills
- match the learning being developed
- provide opportunities for producing the evidence required to meet the criteria as appropriate and reflect the demands of the specification
- provide opportunities for higher grades to be achieved as appropriate.

Assignments could be:

- targeted at a particular stage in Unit 1 (designed to contain a series of activities targeted at particular ability levels)
- integrated across the stages within each strand, eg in health and safety in Unit 1
- targeted across units by developing skills and understanding.

The assignment should:

- be clearly titled
- give clear, detailed information/instructions, for candidates, with a clear expected outcome, as the criteria give no credit for the method. Where a task sheet for each assignment is used, a copy should be included in the candidate's portfolio
- allow candidates to follow standard procedure throughout all their experimental work (the standard procedure may be given as part of the task sheet)
- contain advice on what work is expected to meet the criteria and therefore encourage candidates to recognise the strengths of their own work
- where appropriate, contain the background material that candidates will need to complete the work (graphs, reports, tables, etc)
- specify how candidates have to work
- involve various styles of learning (questioning, discussion, research, etc)

- provide opportunities for staff review and feedback to candidates. Candidates may redraft assignments following guidelines given at the review stage
- contain strict deadlines.

The internally assessed work should be seen as an integral part of the course and treated as normal work. It should not be seen as an extra 'bolt on' in addition to the normal scheme of work (see the Scheme of Work on pages 52–65). Ideally, candidates should be encouraged to build their portfolios regularly, with work completed as part of the programme.

Contents of the portfolio

As well as the candidate's work, the portfolio should contain:

- a copy of the assignment outline or task. This is particularly important as it helps to put the assignment or task into context for moderation and internal standardisation purposes
- teacher annotation using the codes from the assessment grid. An example in Unit 3 would be 1B.2 ('carry out a risk assessment for the investigation, given clear guidelines')
- observation evidence by those assessing the work, eg records that a candidate has selected appropriate laboratory equipment, worked safely, and completed risk assessments with guidance, etc
- any feedback sheets used by staff during assignment review
- the final assessment decision and records to show how the decision was reached
- index and numbered pages.

Types of evidence

Types of evidence that the Applied Science portfolio could contain include:

- reports – as a result of experimental work or other research
- job descriptions – as a result of work in Unit 1
- presentations – evidence from candidates to, for example, the whole class group
- questionnaires – as a result of interviews undertaken, eg in Unit 1
- charts – eg flow chart to illustrate a process
- diagrams, observations, surveys, notes or graphs – as a result of work undertaken in the laboratory or when visiting business or industry to research, for example, health and safety, working with scientific skills or investigating a vocational context to illustrate work done in the laboratory
- leaflets – produced by candidates as an alternative to a written report (eg to illustrate first aid in the laboratory or workplace)

- posters – produced by candidates as an alternative to a written report (eg to illustrate careers in science)
- conclusions – made as a result of experimental work
- evaluations of experimental work
- photographs as evidence of products produced, electronic devices made, etc
- audio recordings – eg of interviews candidates have carried out as part of their research
- assessor evidence – witness sheets providing ephemeral evidence
- feedback records – as a result of assessor review.

Use of templates

Some centres may find it useful to give their candidates templates to use in their portfolios to ensure a consistency of approach. These may be of help in:

- recording risk assessment
- making observations of candidates selecting appropriate equipment
- recording that a candidate undertook tasks following appropriate standard procedures and following correct health and safety guidelines
- providing particular help for lower ability candidates (eg the provision of writing frames, etc)
- providing support in the use of calculations (eg in Unit 3).

Generally, templates are not suitable for candidates who are assessed as working at Stage 3 (although they may be accepted in the case of risk assessments). Candidates working at this level would normally be expected to work more independently, without the structure of templates or writing frames.

5.8	Guidelines to Successful Assessment	• Treat assessment as part of the course, built into the Scheme of Work and completed as a part of the normal programme. • Build the candidates' portfolios regularly throughout the course. • Set deadlines for work to be completed and keep to them to ensure consistency and fairness. • Ensure that assignments or tasks will generate sufficient evidence. • Do **not** accept material downloaded from the internet or CD-ROMs as evidence. • Ensure that there are sufficient opportunities within the assignments or tasks to meet the criteria. • Ensure that candidates understand the assessment grid. • Assess the work against the criteria set throughout the course, not just on the 'odd occasion'.
5.9	Administrative Procedures to Support Assessment	• Ensure that all the Candidate Record Forms are signed before candidates go on study leave and check that all work submitted for moderation has signed forms attached. • Annotate work clearly in order to identify where the evidence is, how it has been matched to the criteria in a strand and the level it has attained. Ideally, annotations should be on the work itself using the codes from the assessment grids – eg 2B.2 ('carry out risk assessment for the investigation, given some guidelines') in Unit 3. However, a separate record card may be used if this is considered more appropriate. • Train candidates to identify where they think criteria have been met and to undertake some form of self-assessment. • Include any record cards and assignment sheets in the final portfolio. Remember that a moderator must be able to find the evidence easily. • Keep paperwork to a minimum and encourage candidates to keep their own record of progress whilst building their portfolio. • Evaluate existing procedures and good practice in either the centre or the department, as these are often easily modified for the Applied Science programme. • All pieces of work contributing to the final mark for each candidate need to be made available for moderation and kept at the centre until the October following the final award.

5.10 Awarding Marks: Unit 1

Stage 1 Candidates should undertake research into the safe working practices in the school or college laboratory. They should include details concerning hazards and risks, fire prevention and first aid in order to obtain maximum marks.

It should be noted that in the statement 'a range of organisations that use science' **a range** refers to **a minimum of three** organisations. (Three marks can be awarded for three named organisations where candidates have stated the products made or services offered together with the types of job undertaken by the employees.)

Stage 2 Candidates should undertake research into the safe working practices in an alternative workplace, preferably outside the school or college environment to allow a meaningful comparison at Stage 3. Candidates should include details concerning hazards and risks, fire prevention and first aid in order to obtain maximum marks.

In the study of a range of organisations, 2A.1–2A.5 refer to the organisations considered at Stage 1. The careers in science criterion may be based on these organisations or may be focused on an alternative scientific vocational area in which the candidate is interested.

Stage 3 At this level candidates make a comparison between the health and safety procedures in a workplace and those in their school or college. The comparison should use the same headings as Stage 1 and Stage 2 (ie hazards and risks, first aid and fire prevention) in order to obtain maximum marks.

Candidates need to write a report about one of the organisations used at Stage 1 and Stage 2. Although a visit to the organisation is not essential, it would help candidates to write their report if a visit had taken place.

Skill Area A: The Use of Science in the Workplace

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1–3	1A.1 produce a simple study on a range of organisations that use science 1A.2 state the products made or services provided 1A.3 identify the jobs of those employed.	↓
2	4–8	2A.1 identify organisations as local, national or international 2A.2 describe their location 2A.3 describe the products made or services provided 2A.4 describe the jobs and qualifications of the employees and how they use science 2A.5 describe the types of skills scientists need in addition to their qualifications, and a range of careers that are available in science.	
3	9–11	3A.1 produce an in-depth study of **one** particular organisation 3A.2 explain its location 3A.3 describe the products made or services provided and explain their importance to society 3A.4 give a detailed account of the skills and qualifications needed by scientists who work there 3A.5 describe the effect on the local environment of the organisation.	

- Base this activity on local organisations, if possible, as this will be more relevant for candidates.
- This activity could be a literature survey, although candidates will find visits to, and contacts with, local industry and business more relevant.
- In Stage 1 and Stage 2, the 'range' of organisations should be **at least three**.
- The Stage 3 criteria refer to **one** of the organisations used at Stage 1 and Stage 2.
- Criteria 1A.1 to 2A.5 may be awarded 1 mark each.
- At Stage 3, if both criterion 3A.2 and criterion 3A.3 are met then 9 marks may be awarded. Criteria 3A.4 and 3A.5 attract one mark each.

Skill Area B: Working Safely in the Workplace

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1–4	1B.1 carry out research into working safely in the school or college laboratory, including: – hazards and risks and their assessment – first aid – fire prevention.	
2	5–8	2B.1 carry out research into the issues of working safely in a workplace that uses science or scientific skills, including: – hazards and risks and their assessment – first aid – fire prevention.	
3	9–11	3B.1 carry out research into the issues of working safely in a scientific workplace and compare these with the school or college laboratory, including: – hazards and risks and their assessment – first aid – fire prevention.	

- Work should reflect the specification in the areas of:
  - hazards and risks
  - first aid
  - fire prevention.
- To complete each stage of this report and obtain maximum marks candidates must address each of the above categories, although greater emphasis could be placed on one of the areas.
- To reach stages 2 and 3 candidates should consider an alternative workplace or workplaces. At Stage 3 they should appreciate the similarities with the school/college situation.
- At Stage 1, 1 mark may be awarded for some basic research, and then 1 mark given for each of the three categories.
- A candidate cannot obtain a mark of 5 or above unless he or she has included a report on a scientific workplace other than the school laboratory.
- At Stage 2 candidates may be awarded 5 marks for basic research on the issues. One further mark may be added for each of the three categories, to take the total to 8.
- To achieve marks of 9 or above the report **must** include a comparison of the similarities and differences between the school/college and a workplace. Comparison in each of the categories will take the marks through 9, 10 and 11.

Hierarchy

In Unit 1 marks should be awarded hierarchically; for example, all Stage 1 marks **must** be achieved before any Stage 2 marks can be awarded, and all Stage 2 marks **must** be achieved before Stage 3 marks can be awarded.

If all criteria are achieved within a stage, then the maximum mark for that stage can be awarded.

However, if a candidate completes the Health and Safety study in the workplace without completing the study in the school or college then the maximum mark that he or she may achieve is 4.

Compensatory marking

In Unit 1, if a candidate has missed up to a maximum of two criteria at Stage 1 or Stage 2 this may be compensated by work completed at the stage above. In such cases the maximum mark that may be awarded is the maximum mark allowable at the lower stage.

Where compensatory marking is used this should be justified to the moderator on the Candidate Record Form and by comments on the candidate's work.

Arrangements for incomplete Unit 1 portfolio work

Candidates who do not submit work for 'The Use of Science in the Workplace' should be awarded zero for that strand. Similarly, candidates who submit no work for 'Working Safely in the Workplace' should be awarded zero for that strand.

Annotation

To aid both internal standardisation and final moderation of portfolio work it is recommended that candidates' work is annotated using the codes in the assessment evidence grid.

Authentication of candidates' work

Teachers are reminded that candidates must sign the Candidate Record Forms to authenticate the work as their own independent work, and that each portfolio should have a signed form attached.

If any Candidate Record Forms received by the moderator have not been signed by the candidate, the moderator will write to the centre to request a new form with the candidate's signature. If no signature is forthcoming then that candidate will be awarded a mark of zero / absent.

Skill Area C: Research and Communication of Evidence

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1	1C.1 use a limited range of sources and information to present findings in their portfolio	
2	2	2C.1 use a range of sources and information to present findings clearly in their portfolio	
3	3	3C.1 identify and use a wide range of sources and information to present findings clearly and logically throughout their portfolio.	

- A candidate's ability to research and communicate is assessed within Unit 1 using the grid above.
- This is the only unit where research and communication is assessed. Compensatory marking is not appropriate in this instance.

5.10 Awarding Marks: Unit 3

Candidates must complete **one** investigation, as listed in the assessment evidence requirements. It is anticipated that the investigation will be set in a vocational context. The suggested approach is that candidates are given a 'brief' from a client for the investigation. They should prepare a report based on their investigations and direct their report back to the client with results, conclusions, evaluations and recommendations. Further details may be found on pages 48–51.

Stage 1 At this level candidates will show some limited confidence but will need considerable guidance from a member of staff in producing appropriate plans, risk assessments and in selecting equipment. Results will meet the basic requirement of the activity. Candidates should be able to make a simple judgement and evaluation of their findings linked to the overall purpose of the activity and demonstrate an awareness of the vocational application of the activity in the context of food, forensic or sports science.

Stage 2 Candidates should be able to demonstrate some independence in their work but may seek clarification when planning, selecting equipment and producing risk assessments where necessary. Candidates should begin to interpret data collected as a result of their experimenting and be able to make comment about the validity of the data in the context of the activity. They should be able to undertake calculations and obtain correct values. Candidates should be able to begin to recognise the limitations of their procedures and suggest an improvement that may be adopted to collect more reliable data. They should be able to describe the application of the activity and suggest how their findings might be used in the context of food, forensic or sports science.

Stage 3 The evidence should give a clear indication that candidates have carefully and independently planned their investigation and have anticipated any problems that may occur. Candidates should be able to work independently when selecting appropriate equipment and producing risk assessments for their investigations. They should appreciate the need to repeat experiments where results are obviously incorrect and be able to make an appropriate comment. Candidates should be able to complete calculations and rearrange standard formulae when required. They should be able to evaluate their work and give clear, reasoned conclusions to their research and experimenting. They should be able to research and clearly explain the significance of the investigation, and explain how their findings might be used in the context of food, forensic or sports science.

Skill Area A: Vocational Application

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1	1A.1 give a simple vocational application of the practical investigation.	
2	2	2A.1 describe a vocational application of their practical investigation.	
3	3–4	3A.1 research and explain the vocational significance of their practical investigation.	

- At Stage 1 candidates simply need to state the purpose of their investigation.
- At Stage 3 candidates would be expected to research the type of organisation that would use similar techniques and the purpose for which they would use them. In order to gain 4 marks candidates should have some evidence of their own research in their portfolio.

Skill Area B: Planning and Risk Assessment

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1–2	1B.1 produce a simple plan for the investigation with guidance 1B.2 carry out a risk assessment for the investigation, given clear guidelines.	
2	3–4	2B.1 produce a plan which, with little guidance, would enable the investigation to be carried out by another person 2B.2 carry out a risk assessment for the investigation, given some guidelines.	
3	5–6	3B.1 independently produce a plan, described in a series of well-ordered steps, which would clearly enable the investigation to be carried out by another person 3B.2 independently carry out a risk assessment for the investigation.	

Planning

- Plans should be considered as 'statements of intent' (ie how the investigation will be carried out). At Stage 1 it may be considered appropriate to provide candidates with a structured framework within which to work.

Risk assessments

- Risk assessments should be comprehensive and include all relevant risks in the activity, including the use of general laboratory equipment.
- To achieve Stage 3, a candidate's risk assessments must be comprehensive as well as being done independently (sources of research such as 'Hazcards' are acceptable).
- Giving a candidate an example to follow (eg the completion of one horizontal row including a substance to be assessed, the hazard, risk and control measure) may be considered as 'some guidelines' (Stage 2).
- 'Clear guidelines' (Stage 1) could be considered as the above, plus supplying all the materials/activities to be 'risk assessed'.
- An assessor comment stating the level of guidance is essential in helping the moderator to assess the pieces of work.
- **Note: templates are appropriate at all stages.**

Skill Area C: Selecting Equipment and Recording Information

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1–3	1C.1 select, with guidance, appropriate equipment for the investigation and use it safely to carry out the plan to collect and record some data/information.	
2	4–7	2C.1 select, with little guidance, appropriate equipment for the investigation and use it correctly and safely to carry out the plan to collect and record data/information accurately in a suitable format.	
3	8–12	3C.1 independently select appropriate equipment for the investigation and use it correctly and safely to carry out the plan to collect and record data/information accurately and precisely in a suitable format, repeating measurements if necessary.	

- At Stage 1 candidates should be able to select, with guidance, appropriate equipment (1 mark) and use it (1 mark) to obtain and record some results (1 mark).
- At Stage 2 candidates should be able select equipment with little help and use it to obtain some results. To obtain 7 marks candidates should clearly record their results in tables or other suitable format. Tables should have appropriate headings and results the appropriate number of decimal points. Observations should include the appropriate descriptive detail (eg 'a precipitate' without mention of colour is not sufficient).
- At Stage 3 the recording of results should be accurate and consistent to obtain 11 marks. In cases where repeats are not necessary, candidates should make a suitable comment to explain why. A candidate may be awarded 12 marks if he or she recognises the need to repeat results.

Skill Area D: Processing Information and Drawing Conclusions

Stage	Marks	Candidates should be able to:		Increasing demand of activity
1	1–3	1D.1	use the data/information collected to draw some simple conclusions.	
2	4–6	2D.1	use and process the data/information collected to make conclusions.	
3	7–10	3D.1	use and accurately process the data/information obtained, and data/information obtained from other sources, to draw and present well-structured and accurate conclusions.	

- At Stage 1 candidates should be able to briefly state what they have found out for 1 mark. Reference, in a simple conclusion, to the observations made or data collected enables 3 marks to be awarded.
- At Stage 2 candidates should be able to process data using simple calculations such as averages and percentages. Where appropriate, graphs should be completed and lines of best fit drawn for 6 marks (in cases where it is not appropriate to carry out calculations the conclusions made should contain an appropriate account of all observations made before 6 marks may be awarded). Conclusions should be detailed and contain a reasoned analysis of the data collected and processed or observations made (6 marks).
- To reach Stage 3 the processed data should be accurate and consistent (eg appropriate number of decimal points throughout) and candidates should have worked independently. Conclusions should be well structured and logically presented as independently made (8 marks). Candidates should be able to verify their data and observations using secondary sources and make reference to these in their conclusions to merit 10 marks.

Skill Area E: Evaluation and Explanation

Stage	Marks	Candidates should be able to:	Increasing demand of activity
1	1–2	1E.1 give a simple evaluation of the practical activity.	↓
2	3–4	2E.1 give an evaluation of the practical activity and suggest an improvement to their method 2E.2 suggest how their findings could be used in the vocational setting.	
3	5–8	3E.1 review their work, and present a logical evaluation of its strengths and weaknesses 3E.2 suggest improvements to their method that would allow the collection of more accurate, precise and reliable evidence 3E.3 suggest and explain how their findings could be used in the vocational setting.	

Evaluating

- Basic comments about how well the experiment went and how 'good or not' the results were are not worth more than 2 marks (Stage 1). A comment such as 'my experiment work went well' is not worth any marks: even at Stage 1 candidates need to make any comments specific to the activity.
- Generally, to access marks at Stage 2 and Stage 3, candidates should explain how results could be improved.
- The suggestion for an improvement at Stage 2 should be accompanied with a reason to obtain 3 marks. Very little credit should be given for simple suggestions such as 'repeat it' or 'work more carefully' that are given without qualification.
- At Stage 3 candidates should be able to discuss the strengths and weaknesses of the technique or their method of completing the investigation. At this level a description of the improvements that could made and how these would allow the collection of more reliable data should be expected to obtain 5 marks.

The vocational setting

- At Stage 2 candidates should be able to relate their findings to the vocational setting of their investigation by writing their report in the appropriate context (eg back to the client) to obtain the fourth mark.
- At Stage 3 candidates should be able to suggest (7 marks) and explain how their findings could be used by the client (8 marks).

Hierarchy	As in Unit 1, marks should be awarded hierarchically; for example, all Stage 1 marks should be awarded before any Stage 2 marks may be awarded. If all the criteria for a stage are achieved then the maximum mark for that stage may be awarded. The total mark submitted for Unit 3 is calculated by adding together the best marks awarded for each of the skill areas A–E.
Compensatory marking	Generally, if a candidate has failed to complete a criterion or part of a criterion at Stage 1 or Stage 2 this may be compensated by work completed at the stage above. In such cases the maximum mark that may be awarded is the maximum mark allowable at the lower stage. Where compensatory marking is used this should be justified to the moderator on the Candidate Record Form for the unit and by annotation on the candidate's work.
Total marks for the unit	Candidates should complete **one** investigation. The total mark for the unit is determined by adding together the marks awarded for each strand A–E.
Arrangements for incomplete Unit 3 portfolio work	If the work required for Unit 3 is missing, the mark for the unit is zero. The Candidate Record Form for the unit must be completed for each candidate. An optional record form is given on page 70, which centres may use to track progress.
The use of worksheets and templates	The use of writing frames and templates is acceptable at Stage 1. However, candidates who are working at Stage 2 are expected to be beginning to work in a more unstructured environment, and at Stage 3 candidates should be able to work without the formalised structure of writing frames and templates.
Annotation	To aid both internal standardisation and final moderation of portfolio work it is recommended that candidates' work is annotated using the codes in the assessment evidence grid.
Authentication of candidates' work	Teachers are reminded that candidates must sign the Candidate Record Forms to authenticate the work as their own independent work, and that each portfolio should have a signed form attached. If any Candidate Record Forms received by the moderator have not been signed by the candidate, the moderator will write to the centre to request a new form with the candidate's signature. If no signature is forthcoming then that candidate will be awarded a mark of zero / absent.

Course Organisation

6 Delivery of the Course

6.1 Guidance on Delivery for Unit 1

This unit is designed to be delivered discretely. Parts of the unit may form a good introduction to the course. Alternatively, sections of the unit may be used as part of a work experience programme that candidates undertake at the end of Year 10 or at the beginning of Year 11.

This guidance should be used in conjunction with the statements of what candidates need to be able to do and what candidates need to find out and with the assessment criteria for Unit 1.

Investigating How Science is Used

Candidates will need guidance in their decision on what constitutes a workplace where science is used. They will also need to be aware of the skills required of different types of scientific worker. This could be achieved by, for example, brainstorming exercises in the first instance. Candidates should also be aware of the types of career that are available in science and where scientific skills are used. Where possible, they should experience first hand a 'workplace that uses science'.

Candidates need to be aware of the scientific work carried out in various organisations, for example:

- pharmaceutical company
- civil engineering company
- quality control laboratory
- product development laboratory – such as food
- hospital laboratory
- environmental monitoring consultancy
- agricultural/horticultural development company.

Scientific skills may also be found in such places as hairdressing salons, breweries, garages and water purification units.

Candidates will need to consider **at least three** organisations and to achieve at Stage 3 should look in more detail at one of these organisations.

Links to the scientific workplace or to a workplace that uses scientific skills could be achieved through:

- links with or visits to local organisations or businesses that use science as part of their work. This may form a focus for the work experience or shadowing programme for some candidates
- vocational activity within school or college
- the use of speakers as an integral part of the delivery programme
- using literature produced by organisations (this may be obtained via the internet)
- the use of professional organisations
- the use of a careers service
- the use of work experience providers (eg Trident)
- the local 'Education Business Partnerships'
- the Learning and Skills Council
- local Chamber of Commerce Training and Enterprise.

Some useful resources (in addition to the websites of national and local organisations) may be found at:

- http://www.futurevu.com
- http://www.gcseinappliedscience.com
- http://www.vocationallearning.org.uk

Working Safely in Science

This topic could be used as a general introduction to the course and to working in the laboratory. Candidates should be aware of the importance of working safely, not only in their own laboratory environment but also in a wider vocational context. The 'wider context' could include any scientific workplace and, ideally, should be from one of the organisations studied in 'Investigating how Science is used'.

Candidates should know that it is necessary to adopt safety procedures and carry out risk assessments for all practical work. They should also appreciate the importance placed on risk assessment in the scientific workplace. Candidates will need to appreciate the importance of safety regulations by finding out about hazard and risk limitation.

It is important that candidates are able to recognise the similarities and differences in the approach to health and safety within their school or college environment and in a named workplace.

The teaching and learning strategy will need to be structured in order to allow each candidate to learn the underpinning knowledge and concepts in the study of laboratory hazards and safety. This may involve formal teaching as well as allowing individual research activities.

Candidates are not expected to study health and safety regulations in depth, but they should be aware of the provision and purpose of common regulations, such as:

- Management of Health and Safety at Work Regulations
- COSHH Regulations
- Electricity at Work Regulations (portable appliance testing).

Candidates should be aware of the first aid techniques used when treating the conditions listed on page 25 of the specification, but it is not intended that they become proficient 'first aiders' as a result of undertaking the Additional Applied Science programme. Local branches of St John Ambulance and the Red Cross are often willing to assist in the delivery of first aid programmes in schools and may be able to offer some additional certification if this is considered desirable within the teaching programme.

Candidates should be taught the basic requirements of fire safety in order to appreciate the use and action of different types of extinguisher. The local fire service is often willing to assist schools by arranging visits and/or demonstrations.

Ideally, candidates' assignments should be structured under the headings given in the assessment criteria for the unit.

Further information and resources may be found at:

- http://www.cleapss.org.uk
- http://www.sserc.org.uk
- http://www.ase.org.uk
- http://www.sja.org.uk
- http://www.redcross.org.uk
- http://www.firstaid.org.uk

Research and Communication

A maximum of three marks is available for the quality of communication skills and expertise in researching and using the researched material.

It should be remembered that material simply downloaded from the internet may not be credited as evidence. Candidates may refer to such information and, if they include it in their portfolio, should produce it as an appendix.

6.2 Guidance on Delivery for Unit 2

Unit 2 will be assessed by external examination. However, its delivery should not be separated from the delivery of Unit 3 as the specification for Unit 2 contains a number of italicised sections that could be used as a basis for practical work and the investigation in Unit 3.

The examination will mainly test candidates' knowledge and understanding of science and how science works (AO1) and their ability to apply their skills, knowledge and understanding (AO2). However, the examination will also test candidates' practical, enquiry and data handling skills (AO3).

The information presented in this section is intended to indicate the breadth and depth of treatment required and should be used in conjunction with the content contained within the specification. The depth of knowledge required will be roughly the same as for a similar GCSE science topic. Where appropriate, questions will be set in a vocational context and reflect the knowledge, skills and understanding that food, forensic and sports scientists need in order to carry out their work.

Sections of the Unit 2 specification that refer to the use of data, theories and explanations, or which refer to the applications and implications of science, will be examined by asking candidates to respond to information provided in the form of tables, charts or text.

Questions in both tiers of the examination will assume that candidates have studied science at key stage 3, although key stage 3 content will not be directly assessed.

There is no assumption that candidates will have completed the key stage 4 programme of study before starting this course.

Food Science

This section should be delivered as far as possible in terms of the knowledge, understanding and skills that food scientists (including nutritionists, dieticians, food analysts, agricultural scientists and those working in public health) use to carry out their work.

Food nutrients and their functions

Candidates should know that the body requires a healthy diet consisting of a balance of carbohydrates, proteins, fats, vitamins, minerals and fibre. They should also be able to describe the use of these dietary components.

Carbohydrates can be complex (eg starch and glycogen) or simple (eg glucose). Simple carbohydrates are used for energy in the process of respiration.

Candidates should appreciate that fats can be either saturated (eg animal fats, butter and lard) or unsaturated (eg plant oils such as sunflower, rape seed and olive oils). They are used as an energy store, for example under the skin and around the kidneys where they also provide insulation and protection.

In addition to growth and repair, protein is needed for the production of body chemicals such as hormones and enzymes. Proteins cannot be stored in the body, so excess protein is broken down in the liver and turned into glycogen for use as energy. Good sources of protein are meat, fish, eggs, milk, seeds and lentils.

Candidates should know that minerals and vitamins have particular roles in the body and that lack of vitamins can cause deficiency diseases. Examples of deficiency diseases include:

- vitamin A – night blindness
- vitamin B – anaemia
- vitamin C – scurvy
- vitamin D – rickets.

In addition to describing the purpose of minerals and vitamins, candidates should be able to give examples of their sources. For example:

- vitamin A is found in fish liver oils, liver, butter, margarine and carrots
- vitamin B is found in yeast extract, liver, eggs and vegetables
- vitamin C is found in fresh fruit, particularly citrus fruits such as orangesvitamin D is found in liver, butter and cheese
- vitamin K is found in green vegetables
- iron is found in red meat, liver, eggs and green vegetables
- calcium is found in dairy products, fish, bread and vegetables
- phosphorus is found in fresh vegetables and dairy products
- zinc is found in seafood, meat (beef, liver, turkey and dark meat of chicken) or dairy products.

Candidates should realise that too much of certain foods can be just as dangerous as too little – for example:

- too much fat can lead to blocked arteries and heart attacks
- too much salt can cause high blood pressure
- too much sugar can lead to diabetes.

Candidates should realise that different people require different amounts of energy (for example, a manual worker would need a greater energy intake than an office worker; women who are pregnant require more energy than non-pregnant women; generally men require more than women).

Weight reducing diets are rarely successful unless accompanied by a lifestyle change (eg taking more exercise and only eating when you feel hungry).

Candidates should appreciate that a high consumption of energy providing foods can lead to weight gain, with increased risks of heart attack, joint damage, diabetes and varicose veins.

Whilst appreciating the advantages of 'fast food', candidates should also realise the disadvantages (eg frequently such foods have high fat and salt content and low fibre content).

Food additives

Candidates should appreciate that substances are added to food in order to change it some way. For example:

- antioxidants are added to fatty foods to stop them becoming rancid and to protect vitamins in the food from being destroyed
- flavourings, including herbs and spices, and flavour enhancers stimulate the taste buds to make food taste stronger
- colourings are used to make food more attractive
- preservatives protect the food against microbes and prevent them spoiling the food; this increases the shelf life, and helps protect against food poisoning
- sweeteners are used in low-calorie foods and foods for people with diabetes.
- Candidates should appreciate that some people are allergic to permitted additives and that other additives may cause hyperactivity.

Food labelling and food testing

Candidates should be able to analyse nutritional labels on a variety of food products including cereals, squashes and canned foods. They will need to know how to carry out the following qualitative food tests and should be able to recall a positive result:

- starch, using iodine
- fats, by rubbing a sample of the food into filter paper and leaving to dry
- protein, using the Biuret test
- reducing sugar, using Benedict's solution and heating in a water bath (candidates should be aware of the safety aspect of using a water bath rather than heating directly)
- acidity, using litmus paper or universal indicator solution.
- Candidates should be able to determine the moisture content, amount of suspended matter, acidity, vitamin C and iron content of, for example, commercial fruit juice using standard laboratory techniques and tests. (Vitamin C content can be tested using DCPIP. The fruit juice is added to the DCPIP a drop at a time until the DCPIP loses its colour; the iron content of a food supplement can be estimated using potassium permanganate.)

Useful microorganisms in the production of food

Candidates should be able to describe the use of microorganisms in the production of bread, wine, beer, yoghurt and cheese, and the process and conditions under which each product is made. In particular, candidates should be aware of the conditions that can influence the growth of microorganisms (temperature, acidity, moisture and type of food).

They should be familiar with:

- the use of yeast for making bread (fermentation produces carbon dioxide gas, which makes dough rise)
- the use of yeast in fermenting sugar (maltose) to make beer and the sugars in grape juice to make wine
- the use of bacteria to produce lactic acid in the production of yoghurt and cheese from milk.

Microorganisms and food safety

Candidates should appreciate that food hygiene is concerned with the care, preparation and storage of food in order to prevent food poisoning.

They should know how food preparation areas can be kept free of bacteria by, for example:

- personal hygiene
- wearing protective clothing
- using disinfectant chemicals on surfaces
- using detergents to wash up
- sterilisation of equipment using high temperatures or gamma rays
- the correct disposal of waste and control of pests.

Candidates should appreciate how the growth of bacteria can be slowed down or stopped:

- refrigeration, which slows down, but does not stop, the growth of bacteria
- freezing, which stops bacteria multiplying but does not kill them
- heating (eg ultra heat treatment where foods such as milk are heated to 132°C for one minute and then rapidly cooled), which kills virtually all microorganisms and their spores
- cooking food at the correct temperature to kill microorganisms
- drying, which removes water so bacteria cannot digest and absorb the food
- salting food, which makes it impossible for bacteria to reproduce because they lose water from their cells by osmosis
- pickling, which involves the addition of vinegar to lower pH and inactivate most microorganisms.

Candidates should be able to describe and use standard laboratory techniques to detect the presence of bacteria and bacterial contamination in food. They should be able to describe and use the technique of serial dilution in order to carry out an accurate bacterial count. They should also be able to make and describe the use of streak plates to identify types of bacteria.

Organic and intensive farming

Candidates should appreciate the problems farmers face in trying to achieve the maximum amount of produce for the maximum profit.

They should understand that nutrients need to be replaced in the soil by either natural fertilisers (manure) or chemical fertilisers (NPK).

They should know why plants need certain nutrients, for example:

- nitrates for healthy leaf growth
- phosphates for good root development
- potassium for fruit.

They should also know that different crops will require these nutrients in different proportions – for example, a crop of tomatoes will require a high-potassium fertiliser.

Candidates should be able to describe and carry out an investigation to determine how well a plant grows under various conditions. An example would be to grow *Brassica rapa* or radishes using different nutrient conditions, light conditions or amounts of water and overcrowding. (Sach's solutions may be used to compare the need for various minerals.)

Candidates should understand how the use of artificial fertilisers, pesticides, herbicides, fungicides and controlled environments are used in intensive farming and be able to compare these with the techniques used in organic farming (eg use of natural pests such as ladybirds or parasitic wasps and mechanical methods of weed control).

Candidates should appreciate that animals farmed intensively are usually housed in a controlled environment, where heating, lighting, food and ventilation can all be controlled for maximum growth of the animals. They should appreciate that if animals are kept warm they will not use up energy, and hence body weight, producing heat. If animals have good ventilation they will keep healthy and a good food supply will keep them growing larger. Animals farmed organically need more space, more time and more labour to look after and cost more to produce, but the animals' welfare is better cared for.

Forensic Science

This section should be delivered as far as possible in terms of the knowledge, understanding and skills that forensic scientists (forensic technicians and Scenes of Crime Officers [SOCOs]) use to carry out their work.

It is important that candidates know and understand the sequence of a forensic investigation, as given in the table below.

Stage in the forensic investigation	**Important features**
1 – Examination of the scene	Precise observation and recording
2 – Collection of samples	Labelling and logging of collected samples
3 – Analysing /testing samples	Accuracy, reliability of test, avoiding contamination
4 – Interpreting results	What are the factual conclusions? What can be deduced from the facts?
5 – Preparing the report	Reports must be accurate and precise
6 – Presenting the evidence in court	Evidence often indicates probability rather than proof

Collecting evidence from the crime scene

Candidates should appreciate the importance of preserving the scene of a crime in order to record it. They will need to know the various means of recording the scene such as digital and conventional, photography and sketches. They should appreciate the reason for restricting access to authorised persons only (the addition or removal of vital evidence) and how this is achieved.

When collecting evidence from the scene of a crime the Scenes of Crime Officers (SOCOs) wear special clothing to avoid contaminating the evidence. The clothing includes all-in-one body suits, gloves, overshoes, hairnets, masks and caps.

Candidates need to know the procedure for collecting samples (collect sample → place in evidence bag → seal bag → label → send to laboratory for analysis). Great care has to be taken to make sure that the samples are not contaminated and that they are clearly labelled to make sure that they are not misplaced. Poor collection techniques or mishandling may lead to evidence presented in court being rejected.

Candidates will need to know the methods that are used for collecting the following samples:

- fingerprints – candidates should know the various techniques for revealing, lifting and storing fingerprints (both visible and latent) from both porous and non-porous surfaces, using methods involving dusting, ninhydrin and superglue. They should be familiar with the three basic fingerprint patterns (loops, arches and whorls) and the minute points that distinguish one print from another. They will be expected to examine fingerprints and identify possible matches. They should understand that fingerprints are unique and never change. They should be aware of the National Automated Fingerprint Identification System (NAFIS)
- fibres and hairs – using tweezers or sticky tape
- blood – using a sterile swab, cotton bud or a knife to scrape samples of dried blood
- broken glass or plastic – using tweezers or sticky tape
- plant seeds and pollen – samples that are visible to the naked eye are collected using tweezers, smaller grains of pollen are lifted using sticky tape
- soil – using a small trowel or a spatula.

Evidence lifted using sticky tape will be first mounted on card before placing in an evidence bag and labelling.

Candidates should be able to describe how to use Plaster of Paris at the scene of a crime for recording impressions made by footwear and vehicle tyres. They should also be aware that materials such as silicone rubber or plasticine can be used for making a cast of tool mark impressions or other implements used to commit a crime.

Analysing evidence from the crime scene

Candidates need to be aware of the variety of chemical tests that can be carried out to determine what substances are present in a sample.

Candidates should know that in ionic compounds the strong electrostatic attraction between ions of opposite charge gives the compound a close regular structure. The strong force of attraction makes it difficult to separate the ions, which is why ionic compounds have a high melting point.

They should know that atoms in covalent compounds share electrons and that these compounds are easy to boil and melt. This is because the bonds that hold the atoms together in a covalent compound are strong but the bonds that hold the molecules together are weak.

Candidates should be able to carry out and describe the use of the following chemical tests in forensic analysis:

- flame tests (to identify metal ions)
- pH testing, including the use of pH meters
- precipitation reactions (for identifying chloride ions using silver nitrate; sulfate ions using barium chloride; metal ions using sodium hydroxide)
- the reaction of carbonate ions with dilute hydrochloric acid, and testing for the carbon dioxide evolved in a positive test
- the use of acidified potassium dichromate to test for ethanol, including a description of the use of this reaction in the original breathalyser
- testing for glucose using Benedict's solution.

Candidates should be able to prepare a sample for analysis and understand that in some cases filtering may be required to separate soluble and insoluble samples.

Chromatography can be used to separate components of a mixture in a forensic investigation (eg to check a sample of ink on a forged document). Forensic technicians may be asked to identify the compounds present in a mixture or to compare different samples to see if they are the same.

Candidates should be able to describe both paper and thin layer chromatography techniques and should understand that separation of components in a mixture is caused by the substances that are more soluble in the solvent (the mobile phase) travelling faster. The component that is the most soluble in the mobile phase will move farthest up the paper.

Candidates should appreciate that the thin layer technique provides the opportunity to use a range of non-aqueous solvents.

Candidates need to be able to describe use of the comparison microscope, the polarising microscope and the electron microscope.

- The comparison microscope is used to compare samples. It joins two microscopes together and splits the view in the eyepiece between them. The technique is valuable for comparing bullets, fibres or paint fragments. Candidates need to know that measurements or distinctive features could be used to compare and analyse samples. For example, a bullet passing through the barrel of a gun picks up scratch marks. A test-fired bullet could be compared under a comparison microscope with a bullet from the crime scene to see if they have the same scratch markings. If the scratch marks line up it proves that the firearm fired the bullet.
- A polarising microscope could be used to compare rock samples.
- An electron microscope could be used to analyse glass fragments found on a suspect.

- Pollen grains are much smaller than seeds and the distinctive features of pollen grains include size, surface pattern and colour, which can be viewed with an electron microscope.
- Fibres have distinctive features, which can be detected under the electron microscope – including, for example, colour or pattern, or texture (wool has a pattern of surface scales, silk and most synthetic fibres have smooth surfaces).
- Soil at a crime scene is important when it has been moved, either deliberately or accidentally, during criminal activity. The identification of the minerals present, and their proportions, can be used to locate the original location of the soil. Crystals can also be identified using a polarising microscope, pH can be measured and, by passing the sample through a nest of sieves, the size of particles in the soil can be identified. It is important to realise that soil evidence is a challenge because it is usually a mixture of soils picked up from a variety of places. Shoes, for example, are regularly in contact with different soil samples from different places.

Candidates should be aware that DNA contains phosphate, which is negatively charged when in an alkaline solution. They need to know that in an electric field DNA fragments move towards the positive electrode. The smaller molecules of DNA move much faster than the larger ones and a DNA profile can be produced. DNA profiles can be compared and used to determine whether people are related or were at the scene of a crime. Candidates should know why the use of DNA profiles in forensic investigations is of greater use than relying on evidence solely from blood groups.

Glass may be useful evidence in a wide variety of cases, for example, hit and run, burglaries and assault. When glass is in a liquid that has the same refractive index, the glass becomes invisible. A small piece of glass is immersed in a special oil on a microscope slide. As the oil is heated the refractive index of the oil changes and at a certain temperature the interface between the oil and glass will disappear. The temperature of the oil is used to work out the refractive index of the glass.

Using databases	Candidates should able to give methods used in recording the observation of witnesses, such as artists' impressions, identikit and electronic methods. They should be familiar with the databases that are commonly used in forensic investigations and that a match may help in the forensic process or, indeed, that a mismatch may help to eliminate a suspect from an enquiry. They should be familiar with the types of information held on: • the DVLC database, including name of the owner of the vehicle, licence number, make and model of vehicle, colour of vehicle, engine, capacity and engine number • police records, including previous convictions, photographs, DNA profiles and fingerprints (the National Automated Fingerprint Identification System holds 8.2 million sets of prints and 1.2 million marks from crime scenes; crime scene officers are able to collect fingerprints from suspects using digital photography and match them up with the database in seconds) • medical and dental records.
Interpreting and presenting evidence	Candidates should be able to analyse evidence and study the facts presented to them to determine if a suspect may have been present at a crime scene or may have committed the crime.
Sports Science	This section should be delivered as far as possible in terms of the knowledge, understanding and skills that sports scientists (eg sports physiologists, nutritionists, dieticians and materials scientists) use to carry out their work.
Exercise and the human body	Candidates should be able to describe the structure of the heart and the pathway of the blood through the heart. They should be able to name the atria and ventricles and should understand how these structures function with valves to pump the blood. Candidates should know the differences in both structure and function between the main blood vessels (arteries, veins and capillaries) and why a pulse can be felt in an artery. They should know the name of the main artery (aorta), and the main vein (vena cava). They should know the composition of the blood and the function of the red blood cells (carrying oxygen) and the plasma (carrying glucose). Candidates should be able to describe the physiological changes that occur during exercise to deliver the extra oxygen needed: • the heart rate increases • the volume of blood pumped with each beat increases • the breathing rate increases • the volume of each breath increases. They should know how to measure these changes before, during and after exercise. Candidates should be able to name the parts of the thorax (including ribs, rib muscles, diaphragm, lungs, trachea, bronchi, bronchioles and alveoli), explain how ventilation occurs and understand the pressure changes involved. Candidates should know that gases can easily diffuse through the alveoli in the lungs.

Candidates will need to be able to use word and symbol equations in an explanation of aerobic and anaerobic respiration and should be able to explain the consequences of both types of respiration in terms of energy released (when extra energy is needed during vigorous exercise, lactic acid is produced that later needs to be converted back to glucose, incurring an 'oxygen debt').

Candidates should be familiar with and understand the term 'homeostasis' and should know the role of the kidney in maintaining water balance.

Candidates should know that humans maintain a constant body temperature, and how it is monitored and controlled by the thermoregulatory centre in the brain. They should appreciate that:

- this centre is able to increase or decrease the amount of sweating, which cools the body by evaporation
- this centre can cause blood vessels in the skin to dilate, increasing the blood flow and the amount of heat lost from the skin
- this centre can also cause blood vessels in the skin to constrict, decreasing the blood flow and the amount of heat lost.

Candidates should know how blood glucose levels are monitored and controlled by cells in the pancreas:

- if the blood glucose concentration is too high (following a meal), the pancreas releases insulin into the blood, which causes the liver to remove glucose from the blood and store it as insoluble glycogen
- if the blood glucose concentration is too low (eg during exercise) the pancreas releases glucagon, which causes the liver to convert glycogen back to glucose and release it into the blood.

Candidates should be familiar with the structure of the arm (including radius, ulna, tendons, ligaments, biceps and triceps), and should be able to describe the action of antagonistic muscles (biceps and triceps).

Sports nutrition

Food nutrients and their functions have been covered in the section on food science (pages 35–39). This section deals with the differences in diets relating to body mass and the amount and type of exercise carried out. Candidates should be able to analyse different diets and diet diaries and suggest suitable diets that may help athletes to achieve optimum athletic performance.

There are many different diary methods in use but two common ones are 24-hour dietary recall and 3-day or 7-day diet diaries.

Candidates should be able to explain the purpose of high protein and high carbohydrate diets and why and when these are used to achieve maximum performance. They should also be aware of the disadvantages of a high carbohydrate diet.

In describing isotonic sports drinks candidates should be able to explain what isotonic means and how isotonic drinks differ from hypertonic and hypotonic drinks:

- hypertonic drinks contain high levels of glucose and can be used to supplement carbohydrate intake
- hypotonic drinks contain little glucose and quickly replace fluids lost by sweating.

Candidates should be able to calculate Basic Daily Energy Requirement (BER) and Body Mass Index (BMI) and to interpret the data obtained. They should be able to use the data in terms of the advice that nutritionists may offer particular types of athletes.

Candidates should also be aware of the limitations of the use of BMI, and that it could lead to incorrect advice in certain circumstances. For example, a weight lifter is likely to be short and very heavy, because muscle weighs more than fat. Such a person's BMI could show them as 'obese', or even 'clinically obese', but they would actually have very little fat tissue.

Materials for sport

The emphasis in this section should be on the properties of materials and how these properties can be used in a sports context.

Candidates need to know the characteristic properties of metals, polymers and ceramics and should be able to relate these properties to their use in a sport context.

- Metals are strong and hard, they make excellent structural materials, they are malleable and can be hammered into shape and rolled into sheets.
- Polymers are compounds made up of large long-chained molecules with strong covalent bonds between the atoms in the chain and weaker forces of attraction between the chains. **Thermoplastic** polymers (eg polyethene) are flexible and soften when heated, so are easy to mould and shape. Candidates also need to be able to explain how altering the chain length and the amount of branching affects the strength of forces between the chains and changes the melting point, density and strength of the polymers. They should know that **thermosetting** polymers (with strong cross-links between the chains remain rigid once set) do not melt when heated and cannot be remoulded.

- Ceramics are hard, brittle solids with very high melting points and poor thermal conductivity. They are resistant to chemical attack. Ceramics often form a major material used in the brake pads of racing cars.
- Candidates should appreciate the advantages of using a composite material in that it combines the properties of the component materials.

Candidates should be aware of the materials used to make sports equipment and should be able to compare modern designs with designs from the past. They should know how the characteristics of materials make them suitable for particular uses (eg carbon fibre materials are used for bicycle frames because of the low density and strength). They should be aware of the use of modern materials (such as 'fast skin' in swimming, 'sports wool' used for shirts and socks and phase change materials) and their advantages over the more traditional materials.

Candidates should be aware of the different fabrics used in the construction of various items of sports clothing, including footwear, swimming costumes and sports shirts. Candidates should be able to:

- select suitable fabrics for different purposes
- compare the advantages and disadvantages of synthetics (eg polyester and lycra) with those of natural materials such as cotton and leather
- match the property of a material to its purpose for sports clothing and be able to practically investigate these properties.

Such properties include tensile strength, thermal insulation, density, friction, resistance to weathering and corrosion and absorbency in terms of moisture and shock.

Candidates should be able to appreciate that friction may be an advantage in sporting equipment (eg in footwear) but can also be a disadvantage (for example, when considering aerodynamic shapes). They should know which types of surface are likely to give a lot of friction.

Candidates will be expected to use data supplied to evaluate the properties of different materials and to suggest appropriate materials for particular uses.

6.3 Guidance on Delivery for Unit 3

In Unit 3 candidates are required to complete **one** report based on food science, forensic science or sports science. Centres are advised, however, to complete more than one investigation and submit the best for final moderation. This would allow candidates to become acquainted with the demands of the assessment scheme. All investigations are assessed using the same assessment evidence grid.

The information presented in this section should be used in conjunction with the content and the assessment criteria for Unit 3 in the specification.

Unit 3 may be delivered discretely, although its delivery will be more effective if it is integrated into the overall scheme of work for Units 1 and 2.

The specification for Unit 2 contains some italicised sections. Although this material may be tested in the Unit 2 examination it could also form the basis of the investigation in Unit 3. The idea is that candidates learn both knowledge and skills in Unit 2, which they then use in the Unit 3 investigation.

The Unit 3 investigation may be composed of a number of smaller investigations where appropriate. The Scheme of Work on pages 52–65 suggests where the material from this could be integrated into the overall teaching programme.

The content of Unit 3 is based on the skills needed by Food Scientists, Forensic Scientists or Sports Scientists. To satisfy the demands of the assessment it is imperative that candidates appreciate the vocational significance of their investigation. The delivery of the unit should therefore centre on the purpose and use of a particular investigation in a vocational context or theme (see strands A and E of the assessment grid; specification pages 48 and 49). The suggested approach is that candidates receive a 'brief' from a 'client' for the investigation. The report resulting from the investigation should then be directed back to the 'client'.

Candidates should be able to:

- explain the vocational application of the investigation
- produce a plan and complete a risk assessment
- select appropriate equipment and carry out the plan, collecting and recording relevant information
- process the information and make appropriate conclusions
- evaluate their investigation and explain how their findings could be used and applied.

Candidates should be able to appreciate the vocational application and purpose of the problem they have been given to investigate. Before beginning any investigation a scientist will plan how it is to be completed and candidates should produce evidence that they have completed a similar process. Candidates should appreciate the importance of carrying out risk assessments (link with Unit 1) and

therefore should be able to complete a risk assessment template for each investigation (or part investigation where the investigation takes the form of a number of smaller investigations). They should be allowed access to appropriate information in order to complete the risk assessment.

To progress from Stage 1 through to Stage 3 candidates should demonstrate their ability to work more independently in selecting equipment, carrying out their investigation and collecting and recording their results.

The final report should be presented in a format that addresses the problem posed by the 'client' (ie written to the client). The report should contain all relevant observations and conclusions and an evaluation of the investigation. Candidates should be aware of the purpose of evaluation, ie to appraise the success (or otherwise) of their investigation. They should also assess the value of their work in terms of its use in their chosen science.

This investigation forms 40% of the marks for the award, and the complexity of the task set should reflect this. The specification contains examples of the types of investigation and technique that may form a basis of the activity but the list is far from exhaustive and other examples may be used. Examples of contexts for the investigations are given below.

Food Science

The investigation should be set using a 'food' scenario. For example:

You are a food analyst working for your local 'trading standards' authority. Trading standards are investigating the contents of a range of fruit juices following complaints about an 'acid' taste in the juice made by one particular manufacturer. You have also been asked to comment on the amount of solids and moisture content (water) of the juices.

In this case candidates should use a number of standard laboratory techniques to complete the investigation. The investigation could be extended to include other constituents of the juices, such as vitamin C, etc.

In their report, candidates should be able to compare their results and make some recommendations in answer to the problem.

Forensic Science

The investigation should be set in a forensic context, the emphasis of which should be based on comparing and matching samples to indicate the probability of a suspect being linked to a crime. It is important that candidates realise that a match does not necessarily prove that there is a link. A mismatch can often disprove the link. The more matches found the stronger the possibility of a link.

Candidates should be given a 'crime' scenario in order that they may use a number of techniques in their investigation. The scenario should allow candidates to use a number of practical techniques in the overall investigation. For example:

Scenes of Crime Officers were called to a stately home where a robbery had taken place. Entry was made by breaking a window at the back of the house. Some paintings and jewellery were missing. After the crime scene was sealed off, some evidence was collected and sent to the forensic laboratory for analysis:

- *some small pieces of broken glass*
- *a white powder collected from the crime scene*
- *an impression of a vehicle tyre-mark left in some soil at the back of the house. Some of the surrounding soil was also sent to the laboratory for analysis.*

A white van was later found abandoned. There were some glass splinters embedded in the upholstery of the front seats. A suspect was arrested and glass fragments were found in some of his clothing. A different sample of white powder was recovered from the shoes of the suspect.

Teachers may wish to set up mini databases to allow candidates access to further information. Candidates should be encouraged to bear in mind the sequence used in a forensic investigation and to discuss the correct method of collecting appropriate evidence.

Following their investigation, candidates need to appreciate the difference in their report between the scientific facts discovered as a result of their investigations and the conclusions that may be drawn as far as the crime is concerned. They should be encouraged to draw together various aspects of their investigations and consider whether or not the various pieces of evidence contribute to a proposed theory about the crime.

Sports Science

Candidates have a choice of investigation. They may either complete a fitness programme or investigate materials that could be used in sport or sports equipment. In either case, candidates should be allowed to use a number of techniques in order to reach a satisfactory outcome.

One suggestion for the context of the fitness programme is given below.

You are a fitness trainer and have been asked to design a fitness programme for a group of 15–16-year-old candidates who have applied to be members of a national sports team. Fitness will determine those finally selected for the team.

In this case, candidates should decide what measurements to take (eg breathing rate, pulse rate, vital capacity) over what period of time and decide on the process of monitoring. The final report should be based on the outcome of the programme and offer a recommendation for selection to the team. NB – This type of investigation should not be undertaken without first consulting a qualified person.

The context for an investigation of sports equipment might be:

You are a materials scientist and have been asked by a sportswear manufacturer to compare the use of possible materials in a piece of sports kit (trainers, swimwear, etc).

Candidates will need to plan which properties they are going to investigate (eg grip, density, tensile strength, absorbency, weathering). In their final report back to the manufacturer they should use their results to make a reasoned recommendation in answer to the problem posed. Other factors, which cannot be investigated in the laboratory, could be included (eg cost).

7 Scheme of Work

7.1 Introduction

The AQA Scheme of Work for GCSE Additional Applied Science is intended as an overview for teachers to check and prepare their own schemes of work and lesson plans.

The Scheme of Work is neither exhaustive nor prescriptive; it is one suggested scheme among many others available. It is envisaged that teachers will tailor the scheme to use within their own centres, for example by adding their own preferred activities and resources. Factors that should be considered when doing this include:

- resources available in the centre
- number of teachers delivering the course
- location of centre and type of work places available in the area
- type of student on the course.

Note: There are no 'Learning Objectives' that are assessed only in the Higher Tier paper.

It has been assumed that most centres will deliver this course primarily in Year 11, having first delivered a GCSE 'core science' course. Centres are strongly advised that, in order to complete the course, teaching of the programme should begin immediately following any GCSE 'core science' examinations that students will have taken towards the end of Year 10.

In this suggested scheme of work the course content is divided into 18 teaching modules, based primarily on the examined unit (Unit 2). The first two modules are based on Unit 1. The majority of modules 3–18 have natural links to Unit 3, which are indicated in the scheme of work. Using this approach, the entire course may be covered.

Centres are strongly encouraged to deliver the course as an integrated programme and not as individual units. By delivering the course in this way the assessment of the practical investigation tasks in Unit 3 may take place as part of the overall teaching programme and need not be treated as a discrete unrelated exercise.

Centres are also encouraged to deliver the course in terms of *'What scientists do'* and '*The way that they do it'*, together with the skills, knowledge and understanding required.

Within the tasks undertaken in Unit 3, candidates are assessed on some laboratory skills, which may be developed over a period of time. These skills are concerned with:

- planning
- risk assessment
- collecting, recording and using data and observations to make conclusions
- evaluating.

Candidates put the investigation into an appropriate context by:

- describing its purpose in relation to the particular vocational option selected
- explaining how a particular type of scientist may interpret and use the results of their investigation.

Centres may wish to consider an introduction to the course using modules 1 and 2. This approach may be useful for those who wish to use the January moderation period for at least one unit.

Although modules 3–18 follow the order of the specification it is not necessary to deliver them in this order. Some centres may wish to consider using the January moderation period for the Unit 3 portfolio work, in which case Unit 2 should be delivered in an order that would allow for this. However, centres are strongly advised to allow students perhaps to complete more than one investigation in Unit 3 so that they can develop fully the skills required.

In this Scheme of Work, criteria from Unit 1 and Unit 2 have been taken from the specification and are listed in the 'Learning Objectives' column. There are no separate learning objectives for Unit 3.

WORKING SAFELY IN SCIENCE		
Module	**Learning Objectives**	**Notes**
Module 1: Health and safety in science	**Candidates need to find out about:** • health and safety checks in the workplace • risk assessments for activities performed in the workplace • what can be done to prevent accidents from hazards in a scientific workplace • emergency procedures followed if an accident from these hazards happens. **Candidates need to be able to:** • identify hazard warning signs • identify biological, chemical and physical hazards, including radioactive substances, and their associated risks • follow health and safety procedures • understand the use of risk assessments. **Candidates need to find out:** • about the safety measures employed for handling radioactive materials and the procedures adopted to ensure that people who work with radioactive materials are not exposed to unacceptable risk • about how unwanted or waste materials, including radioactive substances, are disposed of safely • why it is useful to have a first aid qualification • the names of organisations which give training for first aid qualifications and how to contact these organisations. **Candidates need to know:** • the basic first aid to give in the case of: heat burns and scalds, chemical burns, breathing in fumes and swallowing chemicals, electric shock, damage to eyes by particles or chemicals • the situations in which it would be dangerous to give first aid • what must be done if they hear a fire alarm or smoke alarm • what must be done if they find a fire • how fire doors function • why different types of fire extinguisher (water, carbon dioxide, dry powder, foam, a fire-blanket) are used on different types of fire • about the use of automatic sprinkler systems.	Modules 1 and 2 form the entire content of **Unit 1** and could form an introduction to the course at the end of Year 10. They could: • contribute to part of a work experience programme • make use of any student employment • be delivered in conjunction with a specific area of the course. Whilst it would be preferable to use vocational areas associated with units 2 and 3 (ie food science, forensic science or sports science) this is not essential and should not be viewed as either a restriction or a necessity

Module	Learning Objectives	Notes
Module 2: Investigating science at work	**Candidates need to:** • identify local, national and international businesses and service providers that use science • identify and describe the types of scientific activity that are carried out • describe the importance of the activity to society or the community • find out where organisations are located and why • put the employees into one of three classes: major, significant and small users of science • identify the job titles and qualifications of the people who perform them • find out what skills are used by the people employed • find out what skills scientists need in addition to their qualifications • find out what careers are available in science and science-related areas.	

FOOD SCIENCE

Module	Learning Objectives	Notes
Module 3: What is the purpose of nutrients in food?	**Candidates need to know:** • that the human body requires a variety of nutrients in order to carry out the vital functions of life: respiration, movement, growth and repair of body tissue • the function of carbohydrates, saturated and unsaturated fats, proteins • the function of vitamins A, B, C, D and K • the function of the minerals iron, calcium, phosphorus and zinc • symptoms of any deficiencies of vitamins within the human body: A, B, C and D • examples of foods that are good sources of nutrients.	
Module 4: What do food scientists consider a healthy diet?	**Candidates need to know:** • the health risks of eating too much saturated fat, sugar and salt (heart disease, diabetes and high blood pressure in later life) • the importance of fibre in the diet • the importance of controlling the overall energy intake (energy requirements of different individuals, dieting). **Candidates should be able to use data, theories and explanations to:** • comment on the nutritional value of food • consider the impact of marketing, fast food and lifestyle on diet and health.	This will be tested in **Unit 2** by providing information (as data or text) to interpret.

FOOD SCIENCE		
Module	Learning Objectives	Notes
Module 5: Why do food manufacturers use additives?	**Candidates need to know:** • the function of and examples of additives: antioxidants, flavourings and flavour enhancers, colourings, preservatives, sweeteners, thickeners • some advantages of using additives (improved taste, appearance and shelf life) • some disadvantages of using additives (toxic nature of some preservatives, hyperactivity linked to tartrazine).	
Module 6: How does a food analyst test the quality of our food?	**Candidates need to be able to:** • interpret food labels, including 'sell by' dates, quantities and energy values of nutrients and other components of food including food additives	Best treated by using real labels for candidates to interpret. Could form the starting point for a **Unit 3** food science investigation.
	• *carry out qualitative food tests for starch, fat, protein, reducing sugar and acidity* • *carry out quantitative tests on food and food supplement: moisture content, suspended matter, acidity, vitamin C content, iron content.*	*These techniques could be used as part of a food science investigation for the **Unit 3** portfolio. The complete analysis and comparison of a range of foodstuffs (eg a range of fruit juices) could form a major investigation.*
	Candidates should be able to use data, theories and explanations to: • evaluate qualitative and quantitative analysis of food • consider the social and economic impact of information about the long-term harmful effects of eating certain types of food or food containing certain types of additive.	Will be tested in **Unit 2** by providing information (as data or text) to interpret. Some parts of a **Unit 3** investigation may also include these skills.

FOOD SCIENCE		
Module	Learning Objectives	Notes
Module 7: How do food scientists use and control microorganisms in our food?	**Candidates need to be able to:** • describe the use of bacteria, yeast and other fungi in food production (bread, wine, beer, yoghurt and cheese). **Candidates need to know:** • examples of bacteria that cause food poisoning (campylobacter, E. coli, salmonella) • optimum conditions for the growth of bacteria (warmth, moisture, food source) • the common symptoms of food poisoning (stomach pains, vomiting, diarrhoea) • how food preparation areas are kept free of bacteria (personal hygiene, disinfectants, detergent, sterilisation, disposal of waste, control of pests eg insects, mice) • some examples of the ways in which the growth of bacteria is slowed down or stopped (refrigeration, freezing, heating, drying, salting, pickling). **Candidates should be able, when provided with appropriate information, to:** • consider the problems of contamination of food products which have led to product recalls or health scares. **Candidates need to be able to:** • *carry out tests on food products to determine the level of bacteria in the food* • *use aseptic techniques to swab areas to detect presence of bacteria* • *complete serial dilutions to do accurate bacterial count* • *make streak plates to identify the types of bacteria present.*	Will be tested in **Unit 2** by providing information (as data or text) to interpret. *These tests and techniques could be used as part of a food science investigation for the **Unit 3** portfolio.*

FOOD SCIENCE		
Module	Learning Objectives	Notes
Module 8: Which type of food production is better for us?	**Candidates need to:** • understand that as crops grow they remove essential nutrients from the soil and that these nutrients need to be replaced • know that plants need the minerals nitrates, phosphates, potassium and magnesium, which they obtain from soil, for healthy growth • describe how intensive farming increases crop yields by using artificial fertilisers, pesticides, herbicides and fungicides • describe how intensive farming increases meat production by using controlled environments (eg hens, pigs) • describe how organic farming uses the alternative methods of natural fertilisers, natural pesticides and mechanical methods of eliminating weeds in crop production • describe how organic farming keeps animals under more natural conditions. **Candidates should be able to assess the applications and implications of science when:** • comparing the advantages and disadvantages of both types of farming (food quality, cost, animal welfare, effect on environment). **Candidates need to be able to:** • *plan and assess how well a plant has grown under various conditions.*	Will be tested in **Unit 2** by providing information (as data or text) to interpret. *Could be used to form a major investigation for the **Unit 3** portfolio.*

FORENSIC SCIENCE		
Module	**Learning Objectives**	**Notes**
Module 9: How does the Scenes of Crime Officer record, collect and store evidence?	**Candidates need to be able to:** • *describe how to avoid the contamination of evidence at a crime scene* • *describe how to take appropriate samples from large quantities of materials* • *describe how to collect and record forensic samples: broken glass, fibres, soil, fingerprints, blood* • *describe a suitable technique to make a permanent record of a mark or impression found at the scene of a crime* • *describe a suitable technique to reveal, lift and store a fingerprint left by a suspect at the scene of a crime* • *make measurements to enable a comparison of crime scene marks and impressions with real objects* • recognise the three distinctive types of fingerprint pattern (loop, arch, whorl). **Candidates should be able to use data, theories and explanations to:** • suggest why an inappropriate collection or sampling technique may lead to uncertainty about the validity and reliability of evidence • suggest which measurements or distinctive features could be used to make a comparison • state whether there is a possible match between two different samples using distinctive marks or impressions.	*These techniques could be used as part of a forensic investigation for the **Unit 3** portfolio.* Will be tested in **Unit 2** by providing information (as data or text) to interpret. Candidates may also use supplied data to compare and match in their **Unit 3** portfolio.

FORENSIC SCIENCE		
Module	**Learning Objectives**	**Notes**
Module 10: How do forensic scientists use chemical tests?	**Candidates need to be able to:** • describe the structure of ionic compounds as consisting of a giant lattice held together by strong forces of attraction between positively charged and negatively charged ions (eg sodium chloride) • explain why ionic compounds have high melting points • recall that many substances that are obtained from living materials are organic compounds with covalent bonding • name some simple covalent compounds, given their formulae, and state the formula, given the name of the compound (carbon dioxide – CO_2, water – H_2O, ethanol – C_2H_5OH, glucose – $C_6H_{12}O_6$) • understand that, although the covalent bonds between the atoms in a molecule are strong, the forces between the molecules are weak • explain why covalent compounds have low melting points and boiling points • *describe how to detect the presence of Na^+, K^+, Ca^{2+} and Cu^{2+} ions using flame tests* • *describe how to test the solubility of a compound in water* • *describe how to obtain a clear solution for use in further tests* • *describe the use of universal indicator paper to measure the pH of a solution* • *describe the use of precipitation reactions to detect the presence of Ca^{2+} , Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Cl^- and SO_4^{2-} ions* • *describe the reaction of CO_3^{2-} ions with dilute acid* • *describe the test for carbon dioxide using limewater* • *describe the test for ethanol using acidified potassium dichromate solution and outline the use of this reaction in the original breathalyser* • *describe the test for glucose using Benedict's solution* • *describe the separation of coloured mixtures using thin layer and paper chromatography with both water and non-aqueous solvents* • explain why different colours in the mixture are carried different distances by the solvent and how this observation can be used to match the mixture with known samples or identify the substances present in the mixture.	*These tests could be used as part of a forensic investigation for the **Unit 3** portfolio.* *This technique could be used as part of a forensic investigation for the **Unit 3** portfolio.*

FORENSIC SCIENCE		
Module	**Learning Objectives**	**Notes**
Module 10 (continued)	**Candidates should be able to use data, theories and explanations to:** • state whether an ionic compound is soluble in water • write the formula for an ionic compound • name the product of a precipitation reaction • draw conclusions about the identity of substances when given the results of a series of chemical tests. **Candidates should be able to assess the applications of science when:** • suggesting ways to improve the accuracy and reliability of the evidence being collected.	Will be tested in **Unit 2** by providing information (as data or text) to interpret. Candidates may also use these skills in their **Unit 3** portfolio. Candidates will also be expected to use the skills of evaluation in their **Unit 3** portfolio.
Module 11: How do forensic scientists use biological tests?	**Candidates need to know and understand:** • the composition of blood (red blood cells, white blood cells, platelets, plasma) • the four main blood groups: A, B, AB and O • that DNA is located in the nucleus of the cell • that DNA is unique to the individual (except identical twins) • that children inherit their DNA from their parents • how charged particles move in an electric field and how this movement can be used to separate them (eg in order to produce a DNA profile). **Candidates should be able to use data, theories and explanations to:** • draw conclusions from the results of blood tests and DNA profiling.	Will be tested in **Unit 2** by providing information (as data or text) to interpret. This type of data could be supplied for candidates to interpret in their **Unit 3** investigation.

FORENSIC SCIENCE		
Module	**Learning Objectives**	**Notes**
Module 12: How do forensic scientists use physical tests?	**Candidates need to be able to:** • *describe the distinctive features of fibres, bullets, seeds and soil that enable samples to be matched* • *describe how light is refracted at a glass surface* • *describe the procedure to measure the refractive index of a glass block* • describe how the refractive index of a glass fragment is determined. **Candidates should be able to use data, theories and explanations to:** • describe the distinctive feature of pollen grains and layers of paint.	*These techniques could be used as part of a forensic investigation for the **Unit 3** portfolio.* Will be tested in **Unit 2** by providing information (as data or text) to interpret.
Module 13: How do forensic scientists use databases?	**Candidates need to be able to:** • give a method to record a witness description (artist impression, identikit) • describe the type of information stored in the databases used in forensic investigations • explain how databases can be searched to find possible matches or to exclude a suspect from an investigation.	
Module 14: How do forensic scientists interpret tests and evidence?	**Candidates should be able to use data, theories and explanations to:** • suggest why instrumental techniques provide more precise and reliable evidence than that obtained from simple laboratory experiments • state whether observable features indicate a link between a suspect and the scene of a crime • interpret data and state whether there is a high probability that a suspect is linked to the scene of a crime • draw conclusions based on the facts and state whether, on the basis of the evidence, a suspect may have been present at a crime scene or may have committed a crime.	Will be tested in **Unit 2** by providing information (as data or text) to interpret. In the **Unit 3** report resulting from their investigation candidates must be able to demonstrate that they can interpret forensic data correctly. Their conclusions should not only be scientific, resulting from investigations, but also state if these conclusions would prove the guilt of a suspect.

SPORTS SCIENCE		
Module	Learning Objectives	Notes
Module 15: How does the 'fit' body work?	**Candidates need to be able to:** • describe the structure of the human cardiovascular system • describe the function of the heart and lungs in providing glucose and oxygen to the muscles • describe the physiological changes that occur during exercise (linked to breathing and heart rate) • describe how the structure of the thorax enables ventilation of the lungs • describe how respiration may be aerobic or anaerobic depending on the availability of oxygen, and that 'oxygen debt' may occur in muscles • describe how humans maintain a constant body temperature (by sweating and changing the diameter of capillaries) • explain why humans need to maintain the correct amount of water in the body (water loss through urine and sweat) • describe how the blood glucose levels are controlled (by the hormones insulin and glucagon) • describe the antagonistic action of muscles (biceps and triceps).	
Module 16: What baseline measurements does a sports scientist use?	**Candidates should be able to take baseline measurements of:** • *the heart rate (pulse) and the breathing rate at rest/during exercise and how to monitor the recovery rate immediately after exercise* • *the vital capacity and tidal volume of the lungs using a spirometer* • *the glucose content of blood and urine using a dip-stick method* • *the strength of a muscle using the grip test method.* **Candidates should be able to use data, theories and explanations to:** • suggest suitable measurements to take in order to monitor physiological changes during exercise • explain the importance of taking accurate and reliable measurements • calculate pulse and breathing rate.	*These measurements could be used as part of a sports science investigation for the **Unit 3** portfolio.* Will be tested in **Unit 2** by providing information (as data or text) to interpret. In planning for the **Unit 3** report, candidates may wish to suggest suitable measurements and discuss the importance of reliability and accuracy.

SPORTS SCIENCE		
Module	**Learning Objectives**	**Notes**
Module 17: How does the sports nutritionist help improve athletic performance?	**Candidates need to be able to:** • describe how the daily energy requirements for an individual depend on the mass of the individual (weight) and that these requirements increase during exercise • explain that Body Mass Index is an indicator of ideal weight • describe methods used to record dietary habits of individuals (24 hour dietary recall and diet diaries) • *calculate:* – *basic daily energy requirements (BER) (for every kg of body mass 1.3 Kcal are required every hour)* – *Body Mass Index (weight/height$^{2)}$* • explain why athletes increase their intake of complex carbohydrates (bread, pasta, rice) before competing (increase glycogen stores in the muscles) • explain why some athletes eat a diet high in protein (build muscles) • describe the composition of isotonic sports drinks (water, glucose and electrolytes). **Candidates should be able to assess the applications and implications of science when:** • comparing and contrasting a normally balanced diet with that for a person competing in sport • comparing and contrasting a range of different diets and suggest their suitability for an athlete.	*These calculations could be used as part of a sports science investigation for the **Unit 3** portfolio.* Will be tested in **Unit 2** by providing information (as data or text) to interpret.

SPORTS SCIENCE		
Module	Learning Objectives	Notes
Module 18: Why is the choice of material important in sports equipment?	**Candidates need to be able to:** • explain why sports clothing (including footwear) needs to be lightweight, durable and comfortable • explain why friction is important in the design of sports equipment (grip on soles of shoes, aerodynamics of cycle helmet) • give examples of materials (wood, metal, polymer, ceramic, composite) used to make sports equipment (eg clubs, rackets, bicycle frames, protective equipment) • give the characteristic properties of metals (high tensile strength, thermal conductivity, flexibility, hardness) • give the characteristic properties of polymers (low density, flexibility, low thermal conductivity) • give the characteristic properties of ceramics (high melting point, low thermal conductivity) • explain the properties of composites in terms of the properties of their components • give examples of different types of materials (natural: cotton, leather) (synthetic: polyester, lycra) used for sports clothing • describe the advantages and disadvantages of synthetic materials compared with natural materials • *describe how different properties of materials are desirable for different clothing and equipment:* – *low density for increasing speed* – *smooth for aerodynamic shapes* – *high tensile strength for materials providing support* – *thermal insulation to help maintain body temperature* – *large surface area for cooling* – *flexibility for comfortable equipment and clothing* – *shock absorbent materials for footwear.* **Candidates should be able to use data, theories and explanations to:** • select appropriate materials for sports clothing, equipment and footwear and be able to explain why the different properties are important.	*These properties could be used to test a range of sports clothing and equipment to find the best materials, to form a major sports science investigation for the **Unit 3** portfolio. As a result of their investigation candidates should be able to give scientific reasons for the selection of appropriate materials.* Will be tested in **Unit 2** by providing information (as data or text) to interpret.

8 Resources

8.1 Introduction

AQA is working in partnership with Nelson Thornes, who are producing a range of teaching materials to support the new GCSE Additional Applied Science course:

- Students' book
  ISBN 074879655X
- Teacher's book
  ISBN 0748796800
- Revision guide
  ISBN 0748783210
- e-science
  ISBN 0748796568
- Test & Assessment
  ISBN 0748796606

For further information, visit the AQA Website (http://www.aqa.org.uk)
or the Nelson Thornes website (http://www.nelsonthornes.com).

8.2 Forensic Science

Crime Scene Investigation: Methods and Procedures

Ian Pepper

Paperback, 192 pages (2004)

Publisher: Open University Press

ISBN: 0335214908

Crime Scene to Court: The Essentials of Forensic Science

P.C. White (Editor)

Paperback, 470 pages (2004)

Publisher: The Royal Society of Chemistry

ISBN: 0854046569

The Forensic Casebook: The Science of Crime Scene Investigation

N.E. Genge

Paperback, 320 pages (2003)

Publisher: Ballantine

ISBN: 0345452038

The Forensic Science Project

http://www.bergen.org/EST/Year5/

Activities and projects designed to help students master the background theories and concepts of forensice science, then to carry out investigations to get the feel of being a real forensic scientist.

8.3 Food Science

University of Reading Food Law Pages

http://www.fst.rdg.ac.uk/foodlaw/label/index.htm

A useful introduction to UK food labelling regulations, including images of labels to illustrate the legal requirements.

Food Standards Agency

http://www.foodstandards.gov.uk/hea/index2.html

Interactive games and teachers' resources on food hygiene.

Institute of Food Science & Technology

http://www.ifst.org

5 Cambridge Court

210 Shepherds Bush Road

London W6 7NJ

Tel: 020 7603 6316

Fax: 020 7602 9936

email: info@ifst.org

Information on a wide range of topical issues. Their special schools website (http://www.foodtechcareers.org) contains careers information, a list of resource material for teachers and a series of experiments illustrating sciences within the food context.

The Food Foundation

http://www.fooddirectory.co.uk

Database of sources to support schools in areas of food and drink.

Food and Drink Federation

6 Catherine Street

London WC2B 5JJ

Tel:020 7836 2460

Fax: 7379 0481

- http://www.foodlink.org.uk

  guide to food safety

- http://www.foodfuture.org.uk

  examines current issues on the use of technology in food production

- http://www.foodfitness.org.uk

  practical advice on eating and lifestyle.

British Soft Drinks Association

http://www.liquidsmeanlife.org.uk

Teachers notes, fact sheets and activities designed to meet the National Curriculum requirements for Food Technology and Science

8.4 Sports Science

BBC World Service

http://www.bbc.co.uk/worldservice/sci_tech/features/science_of_sport

General information on the use of science in training techniques and modern materials used in sports kit.

Exploratorium

http://www.exploratorium.edu/sports/

Useful material linking science to specific sports and fitness.

Lucozade Sport – Science and Nutrition Centre

http://www.lucozadesport.com

http://www.thelssa.com

Useful sports science and nutrition information.

A Optional Progress Record Forms

Unit 1: Science in the Workplace

Investigating How Science is Used		Working Safely in Science		Research and Communication	
Criterion	**Notes**	**Criterion**	**Notes**	**Criterion**	**Notes**
1A.1		**1B.1**		**1C.1**	
1A.2					
1A.3		**2B.1**		**2C.1**	
2A.1					
2A.2		**3B.1**		**3C.1**	
2A.3					
2A.4			(Max. 11)		(Max. 3)
2A.5					
3A.1					
3A.2					
3A.3					
3A.4					
3A.5					
	(Max. 11)				

Unit 3: Using Scientific Skills

Criterion	Notes	Criterion	Notes	Criterion	Notes
A: Vocational Application					
1A.1		**2A.1**		**3A.1**	
				Mark:	(Max. 4)
B: Planning and Risk Assessment					
1B.1		**2B.1**		**3B.1**	
1B.2		**2B.2**		**3B.2**	
				Mark:	(Max. 6)
C: Selecting Equipment and Recording Information					
1C.1		**2C.1**		**3C.1**	
				Mark:	(Max. 12)
D: Processing Information and Drawing Conclusions					
1D.1		**2D.1**		**3D.1**	
				Mark:	(Max. 10)
E: Evaluation and Explanation					
1E.1		**2E.1**		**3E.1**	
		2E.1		**3E.2**	
				3E.3	
				Mark:	(Max. 8)