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ASSESSMENT and QUALIFICATIONS ALLIANCE

# General Certificate of Secondary Education

# Additional Applied Science 4863 2010

Special Features

- Clear statements about what candidates need to learn and do
- One assessment per Unit

Material accompanying this Specification

- Specimen Papers and Mark Schemes
- Teachers' Guide

# SPECIFICATION

This specification will be published annually on the AQA Website (www.aqa.org.uk). If there are any changes to the specification centres will be notified in print as well as on the Website. The version on the Website is the definitive version of the specification.

Further copies of this specification booklet are available from:

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# Background Information

## 1 Revision of GCSE Sciences – an Outcome of the DfES 14–19 Strategy

Following the publication of the DfES '14 – 19: Opportunity and Excellence' policy document, changes to the key stage 4 National Curriculum for England have been announced. One change is a new programme of study for KS4 Science (published Autumn 2004), and the consequent rewriting by QCA of the GCSE Criteria for Science. Further details of this are given in Section 1.1. Another change relevant to GCSE Science is a requirement to provide work-related learning for all students. This is described in the QCA document 'Changes to the key stage 4 curriculum – guidance for implementation from September 2004', and is discussed in Section 1.2. These changes have together necessitated the redevelopment of GCSE Science specifications by all awarding bodies for first teaching from September 2006.

### 1.1 Changes to the GCSE Criteria for Science

The new programme of study has been incorporated by QCA into the GCSE Criteria for Science. The revised Criteria outline the common characteristics and subject content for science GCSEs developed by all awarding bodies for first teaching from September 2006. The main points are as follows.

- There is a greater emphasis than before on the knowledge, skills and understanding of how science works in the world at large as well as in the laboratory.
- As a consequence there is an equal emphasis on knowing and understanding a body of scientific facts.
- There is a new single award GCSE Science incorporating all of the content in the programme of study.
- There is a new single award GCSE Additional Science, which, together with GCSE Science, allows progression to post-16 science courses.
- Alternative progression routes are available in the form of GCSE Biology, GCSE Chemistry and GCSE Physics, in addition to an applied science route leading to a new single award GCSE Additional Applied Science.
- There is provision for students wishing to follow an applied route from the outset of KS4 through a revised GCSE Applied Science (Double Award).

- Taken together, the three separate sciences cover the requirement to teach the new programme of study, as does the revised GCSE Applied Science (Double Award).
- Through these new specifications the opportunity exists for candidates to study GCSE Science and one or more of the separate science GCSE courses.

In parallel with the GCSE developments, a new Entry Level Certificate specification for Science is being produced. This covers the breadth of the programme of study but in less depth than required for GCSE Science.

Further details of the suite of specifications developed by AQA to meet these requirements are given in Section 4.2.

## 1.2 Changes to the KS4 Curriculum

### Requirement to teach programme of study

The revised programme of study for KS4 Science has been designed by QCA as a small core of content relevant to all students. It is a statutory requirement to teach the programme of study to all students at maintained schools. Since the start of teaching of the new specifications (September 2006), it has no longer been possible to apply for disapplication from this requirement for the purposes of extended work-related learning.

### Work-related learning

The removal of the provision for disapplication is linked to the statutory requirement for work-related learning for all students which was introduced in September 2004. With the greater emphasis in the revised programme of study on 'How Science Works', science teachers are enabled, if they wish, to make a larger contribution to work-related learning through the teaching of science.

## 1.3 Other Regulatory Requirements

### Key Skills

All GCSE specifications must identify, as appropriate to the subject, opportunities for generating evidence for the Key Skills of Application of Number, Communication, Information and Communication Technology, Working with Others, Improving own Learning and Performance, and Problem Solving. Details for this specification are given in Section 13.2.

### ICT

The subject content of all GCSEs must require candidates to make effective use of ICT and provide, where appropriate, assessment opportunities for ICT. Details of how the teaching of this specification can encourage the application and development of ICT skills are given in Section 9.2. However, ICT skills are not assessed by any component of this specification.

| | |
|---|---|
| Communication | All GCSE specifications must ensure that the assessment arrangements require that, when they produce extended written material, candidates have to:<br>• ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear<br>• present information in a form that suits its purpose<br>• use a suitable structure and style of writing.<br>Further details for this specification are given in Section 9.1. |
| Citizenship | Since 2002, students in England have been required to study Citizenship as a National Curriculum subject. Each GCSE specification must signpost, where appropriate, opportunities for developing citizenship knowledge, skills and understanding. Further details for this specification are given in Section 14.5. |
| Other issues | All specifications must identify ways in which the study of the subject can contribute to developing understanding of spiritual, moral, ethical, social and cultural issues, European developments, environmental issues, and health and safety. Further details for this specification are given in Sections 14.1, 14.2, 14.3 and 14.4. |
| Wales and Northern Ireland | There is no longer any additional material that centres in Wales or Northern Ireland have to teach in order to meet the different requirements of the National Curriculum in these countries.<br>Therefore, centres may offer any of the AQA specifications without the need to supplement the teaching required in order to meet additional statutory orders applying to students outside England. |

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

| GCSE Additional Applied Science |
|---|
| 4863 |

# 3 Availability of Assessment Units and Entry Details

## 3.1 Availability of Assessment Units

Assessments based on this specification are available as follows:

| | Externally Assessed Unit | Portfolio Moderation | | Qualification |
|---|---|---|---|---|
| | | Unit 1 | Unit 3 | |
| June | ✓ | ✓ | ✓ | ✓ |
| January | ✓ | ✓ | ✓ | ✓ |

## 3.2 Entry Codes

Normal entry requirements apply but the following information should be noted.

Each assessment unit has a separate unit entry code, as follows:

Unit 1 – AASC1
Unit 2 – AASC2F or AASC2H
Unit 3 – AASC3

These three units contribute to the subject award GCSE Additional Applied Science.

The Subject Code for entry to the GCSE Additional Applied Science is 4863.

## 3.3 Entry Restrictions

Each specification is assigned to a national classification code, indicating the subject area to which it belongs. Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The Classification Code for this specification is 1340.

The subject award GCSE Additional Applied Science has a common unit with GCSE Applied Science (Double Award). Unit 1 (Science in the Workplace) has exactly the same content in GCSE Additional Applied Science and GCSE Applied Science (Double Award). Therefore concurrent entries for GCSE Additional Applied Science and GCSE Applied Science (Double Award) will not be accepted.

## 3.4 Private Candidates

This specification is available for private candidates in the following situations:

- where candidates have already received results for the centre-assessed units, the externally assessed unit and entry for the qualification is available
- where a GCSE award has already been made, the centre-assessed unit results may be reused within twelve months if the externally assessed unit is being retaken. Private candidates should write to AQA for a copy of *"Supplementary Guidance for Private Candidates"*.

## 3.5 Access Arrangements and Special Consideration

AQA pays due regard to the provisions of the Disability Discrimination Act 1995 in its administration of this specification.

Arrangements may be made to enable candidates with disabilities or other difficulties to access the assessment. An example of an access arrangement is the production of a Braille paper for a candidate with a visual impairment. Special consideration may be requested for candidates whose work has been affected by illness or other exceptional circumstances.

Further details can be found in the Joint Council for Qualifications (JCQ) document:

*Access Arrangements and Special Consideration*
*Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations*
*GCE, AEA, VCE, GCSE, GNVQ, Entry Level & Key Skills*

This document can be viewed via the AQA website (www.aqa.org.uk)

Applications for access arrangements and special consideration should be submitted to AQA by the Examinations Officer at the centre.

## 3.6 Language of Examinations

All assessment will be through the medium of English. Assessment materials will not be provided in Welsh or Gaeilge.

# Scheme of Assessment

## 4 Introduction

### 4.1 National Criteria

This GCSE Additional Applied Science specification complies with the following:

- the Statutory Regulation of External Qualifications in England, Wales and Northern Ireland 2004, including the common criteria for all qualifications and the additional criteria for GCSE
- the GCSE Criteria for Science
- the GCSE, GCE and AEA Code of Practice April 2008.

### 4.2 Background

This GCSE Additional Applied Science specification is part of the AQA GCSE Science suite, which comprises:

GCSE Science A
GCSE Science B
GCSE Additional Science
GCSE Additional Applied Science (this specification)
GCSE Biology
GCSE Chemistry
GCSE Physics
GCSE Applied Science (Double Award)

A matching Entry Level Certificate specification for Science is also available.

The suite enables centres to offer a range of flexible progression routes from KS3 through KS4 Science to further studies.

### 4.3 Rationale for GCSE Additional Applied Science

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, Forensic 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 students to work-related learning and equip students with some of the skills they will need in the workplace or in further education or training. It will also empower students to take charge of their own learning and provide a range of teaching, learning and assessment styles to motivate students to achieve the best they can. The assessment comprises three units: two portfolio units and one externally assessed unit.

## 4.4 Other Specifications in the Suite

### GCSE Science A and GCSE Science B

Students can begin KS4 with a general science course based on either GCSE Science A or GCSE Science B. These are both single award qualifications. They cover all aspects of a good science education: evaluating evidence and the implications of science for society; explaining, theorising and modelling in science; and procedural and technical knowledge of science practice, though with an emphasis on the first aspect, namely, evaluating evidence and the implications of science for society. The weighting given to the procedural content in these specifications is higher than in the other general science specifications, and the substantive contexts lend themselves to engagement with the societal implications of scientific knowledge at a level which is appropriate to key stage 4. Both these specifications therefore provide the opportunity for all students to develop the science knowledge, understanding and skills needed for adult life, but they also give a good basis for further study of science.

These specifications have identical content, covering the whole programme of study for KS4 Science, with the subject areas of Biology, Chemistry and Physics presented separately so that they can be taught by subject specialists if this suits the staffing and/or teaching strategy in the centre. The assessment styles for Science A and Science B are different, though they share a common model for centre assessment. Students who are successful in GCSE Science could study a level 3 science qualification such as AS Science for Public Understanding, but would find progression to GCE Biology, Chemistry, Physics and Applied Science difficult without further preparation. Many will undertake a level 2 course such as GCSE Additional Science or GCSE Additional Applied Science before continuing to level 3 courses.

### GCSE Science A

The specific feature of this specification is that external assessment is available in 'bite-size' objective tests. Each of the three units, Biology 1, Chemistry 1 and Physics 1, is divided into two equal sections and each section is examined in a separate 30 minute test. The tests are available in November, March and June. The objective tests are available as paper-based and on-screen tests in centres.

### GCSE Science B

In contrast, GCSE Science B does not offer assessment through the 'bite-size' test route but has 45 minute written papers with structured questions. There is one paper for each of Biology 1, Chemistry 1 and Physics 1, available in January and June.

| | |
|---|---|
| GCSE Additional Science | This is another Additional Science route, which could be taken after or at the same time as GCSE Science A or B. This award together with an award in GCSE Science provides the nearest equivalent to the previous GCSE Science: Double Award. The content follows on from that of GCSE Science, and the centre assessment follows the same model as used for Science A and Science B. However, the emphasis of this specification, and the three separate sciences, GCSE Biology, Chemistry and Physics, is somewhat different. Whereas GCSE Science A and B emphasise evaluating evidence and the implications of science for society, these specifications have a greater emphasis on explaining, theorising and modelling in science.<br><br>There are three 45 minute written papers with structured questions, one paper for each of Biology 2, Chemistry 2 and Physics 2, available in January and June. Courses based on this specification form a firm basis for level 3 courses in the sciences such as AS and A Level Biology, Chemistry and Physics. |
| GCSE Biology, Chemistry, Physics | Each of these single award GCSEs would provide the basis for the study of the corresponding GCE Science. Like GCSE Additional Science, they emphasise explaining, theorising and modelling in science. Taken together they include the whole programme of study for KS4 Science, enabling the statutory requirement to be met. Students could take courses based on these specifications directly after KS3 Science. Alternatively, some students may prefer to take GCSE Science to provide a general background in KS4 Science, then specialise in one or more separate science(s). |
| GCSE Applied Science (Double Award) | Alternatively, students embarking on KS4 and wishing from the outset to specialise in a vocational approach to science can be offered GCSE Applied Science (Double Award). This is a qualification which has been developed from the previous GCSE Applied Science specification but, unlike its predecessor, it covers the whole programme of study for KS4 Science, enabling the requirement to teach the programme to be met (see Section 1.2). The assessment comprises four units: three portfolio units and one externally assessed unit. |
| ELC Science | Candidates who may not be ready to take GCSE Science at the same time as their contemporaries can study for the Entry Level Certificate in Science. This has the same breadth of content as GCSE Science, but less depth. Teaching for ELC Science can enable the requirement to teach the programme of study for KS4 Science to be met (see Section 1.2) and students can be taught alongside students preparing for GCSE Science (if they cannot be taught separately). Students who have succeeded in ELC Science can progress to GCSE Science. Assessment is through the completion of units of content with the success criteria being clearly focussed on skills rather than depth of knowledge. |

## 4.5 Prior Level of Attainment and Recommended Prior Learning

This key stage 4 GCSE specification builds on the knowledge, understanding and skills set out in the National Curriculum programme of study for Key Stage 3 science. While there is no specific prior level of attainment required for candidates to undertake a course of study based on this specification, a level of scientific literacy and numeracy skills commensurate with having followed a programme of study at key stage 3 is expected.

## 4.6 Progression

This qualification is a recognised part of the National Qualifications Framework. As such GCSE is a level 2 qualification and provides progression from key stage 3 to post-16 studies.

A course based on this specification provides a worthwhile course for candidates of various ages and from diverse backgrounds in terms of general education and lifelong learning. It will follow naturally from a course based on the programme of study for KS3 Science. From a GCSE Science course, followed by a GCSE Additional Applied Science course, students could progress to courses at level 3 such as GCE Applied Science and AS Science for Public Understanding. Students wishing to progress to level 3 courses in AS and A Level Biology, Chemistry and particularly Physics might need to undertake further study. This course also prepares students for other courses in the FE sector, including a range of NVQs, as well as employment.

# 5 Aims

A course based on this specification should encourage candidates to:

- develop their interest in, and enthusiasm for, science
- develop a critical approach to scientific evidence and methods
- acquire and apply skills, knowledge and understanding of how science works and its essential role in society
- acquire scientific skills, knowledge and understanding necessary for progression to further learning.

# 6 Assessment Objectives

The scheme of assessment will require candidates to demonstrate the abilities detailed under assessment objectives below in the context of the subject content in Sections 10–12.

## 6.1 Assessment Objective 1 (AO1)

Knowledge and understanding of science and how science works

Candidates should be able to:

a) demonstrate knowledge and understanding of the scientific facts, concepts, techniques and terminology in the specification

b) show understanding of how scientific evidence is collected and its relationship with scientific explanations and theories

c) show understanding of how scientific knowledge and ideas change over time and how these changes are validated.

## 6.2 Assessment Objective 2 (AO2)

Application of skills, knowledge and understanding

Candidates should be able to:

a) apply concepts, develop arguments or draw conclusions related to familiar and unfamiliar situations

b) plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem

c) show understanding of how decisions about science and technology are made in different situations, including contemporary situations and those raising ethical issues

d) evaluate the impact of scientific developments or processes on individuals, communities or the environment.

## 6.3 Assessment Objective 3 (AO3)

Practical, enquiry and data handling skills

Candidates should be able to:

a) carry out practical tasks safely and skilfully

b) evaluate the methods they use when collecting first-hand and secondary data

c) analyse and interpret qualitative and quantitative data from different sources

d) consider the validity and reliability of data in presenting and justifying conclusions.

# 7 Scheme of Assessment

## 7.1 Assessment Units

The Scheme of Assessment comprises three units: Unit 1 – *Science in the Workplace,* Unit 2 – *Science at Work* and Unit 3 – *Using Scientific Skills*

| Unit 1 – Science in the Workplace | | |
|---|---|---|
| Centre-Assessed | Portfolio | |
| 20% of the marks | | 25 marks |

The unit comprises a portfolio of work assessing the content in Section 10.

| Unit 2 – Science at Work | | |
|---|---|---|
| Externally Assessed | Written Paper | 1 hour |
| 40% of the marks | | 60 marks |

The unit comprises a written paper with short-answer questions. The questions assess the subject content in Section 11. The paper is available at Foundation and Higher Tier. All questions are compulsory.

| Unit 3 – Using Scientific Skills | | |
|---|---|---|
| Centre-Assessed | Portfolio | |
| 40% of the marks | | 40 marks |

The unit comprises a portfolio of work assessing the content in Section 12.

## 7.2 Weighting of Assessment Objectives

The approximate relationship between the relative percentage weighting of the Assessment Objectives (AOs) and the overall Scheme of Assessment is shown in the following table:

| Assessment Objectives | Unit Weightings (%) | | | Overall Weighting of AOs (%) |
|---|---|---|---|---|
| | Unit 1 | Unit 2 | Unit 3 | |
| AO1 | 12 | 23 | – | 35 |
| AO2 | 8 | 12 | 10 | 30 |
| AO3 | – | 5 | 30 | 35 |
| **Overall Weighting (%)** | 20 | 40 | 40 | **100** |

Candidates' marks for each assessment unit are scaled to achieve the correct weightings.

## 7.3 Tiering and Assessment

The portfolio units are not tiered. In Unit 2, the papers are tiered, with Foundation Tier being aimed at Grades C–G, and Higher Tier being aimed at grades A*– D. Questions for the Higher Tier will be more demanding, requiring higher level skills allowing candidates to access the higher grades.

The level of demand of questions depends on factors such as the nature of the underlying scientific concepts being tested, amount of cueing provided including the plausibility of distractors, the context/application in which the question in contained, whether the response required is directed or open, and the extent to which reference material must be used in order to respond. Consideration of such factors allows GCSE Science questions to be allocated to one of three levels of demand (low, standard and high). Foundation Tier papers contain low and standard demand questions, while Higher Tier papers contain standard and high demand questions.

## 7.4 Mathematical and Other Requirements

The knowledge and skills in mathematics which are relevant to science and which are given below will not be exceeded in making assessments in this specification. Candidates will not be prevented from demonstrating achievement in science by mathematics which is excessively demanding.

**FT and HT**

- The four rules applied to whole numbers and decimals
- Use of tables and charts
- Interpretation and use of graphs
- Drawing graphs from given data
- Reading, interpreting and drawing simple inferences from tables
- Vulgar and decimal fractions and percentages
- Scales
- Elementary ideas and application of common measures of rate
- Averages/means and the purpose for which they are used
- Substitution of numbers for words and letters in formulae (without transformation of simple formulae).

**HT only**

(in addition to the requirements listed above)

- Square and square root
- Conversion between vulgar and decimal fractions and percentages
- The four rules applied to improper (and mixed) fractions
- Expression of one quantity as a percentage of another; percentage change
- Drawing and interpreting related graphs
- Idea of gradient
- Transformation of formulae
- Simple linear equations with one unknown
- Elementary ideas and applications of direct and inverse proportion.

### Units, symbols and nomenclature

Units, symbols and nomenclature used in examination papers will normally conform to the recommendations contained in the following.

- *Signs, Symbols and Systematics – the ASE companion to 16-19 Science.* Association for Science Education (ASE), 2000. ISBN 0 86357 312 6
- *Signs, Symbols and Systematics – the ASE companion to 5-16 Science.* Association for Science Education (ASE), 1995 ISBN 0 86357 232 4

Any generally accepted alternatives used by candidates will be given appropriate credit.

### Data sheet and formulae list

Data sheets and formulae lists are **not** included with the question papers for this specification. Information of this kind should **not** be provided to candidates for use during the examination.

### Communication skills

AQA takes care that candidates are not prevented from demonstrating achievement in science by the use of language in question papers which is inappropriately complex and hinders comprehension. Similarly, while the assessment of communication is not a primary function of this specification, candidates are required to demonstrate scientific communication skills. These are described in Section 10.4.

In addition, candidates will have difficulty in scoring the marks for science in any of the written assessments if they do not:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
- present information in a form that suits its purpose
- use a suitable structure and style of writing.

In presenting their answers, candidates will also need to use scientific conventions (including chemical equations) and mathematical language (including formulae) accurately and appropriately to score all the available marks.

# Subject Content

## 8 Summary of Subject Content



## 9 Introduction to Subject Content

### 9.1 Communication Skills

Throughout their GCSE Additional Applied Science course, candidates should be encouraged to develop and improve their scientific communication skills.

These include:

- recalling, analysing, interpreting, applying and questioning scientific information or ideas
- using both qualitative and quantitative approaches
- presenting information, developing an argument and drawing a conclusion, using scientific, technical and mathematical language, conventions and symbols and ICT tools.

These skills will be developed through the activities that candidates undertake during their course. Appropriate use of communication skills will enable candidates to be successful in the written and portfolio assessments for this specification. Communication is specifically assessed in Unit 1 and is included in the portfolio of evidence for the unit.

## 9.2 ICT Skills

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.

**Whilst using ICT to support learning objectives it should be remembered that portfolios containing pages of notes printed from the internet or CD-ROMs as evidence will not be accepted.**

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# Unit 1
# *Science in the Workplace*

## 10.1 About this Unit

In this unit candidates find out about the types of people who work with science and use scientific skills. Candidates will also find out that those who work with science are very aware of the safety implications of their work. Candidates will need to use research skills to investigate:

- how science is used
- safe working in science.

Candidates will need to decide how they are going to obtain information and the sources of information that they use. They may wish to use, for example, information from visits, questionnaires, the internet or CD-ROMs.

## 10.2 Investigating how Science is Used

Vocational science is the science and skills used by people in a wide variety of jobs. Those with a major job role in science may classify things, obtain or make things, and monitor and control changes. The more scientists know about the materials and equipment they work with, the more effective they can be. Scientists tackle problems; sometimes straightforward, often complex. This requires employing scientific skills and knowledge, coupled with imagination and curiosity. However, there are many people who use science in their work, whom we do not think of as scientists. For some it is a significant part of their work (eg nurses, engineers); for others it plays a smaller part (eg photographers, chefs and gardeners).

**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.

**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 to be followed if an accident from these hazards happens.

## 10.3 Working Safely in Science

Scientific work can be dangerous, yet accidents among scientists are rare. This is because scientists are always aware of the hazards they deal with and of the need to work safely. Candidates must be able to work safely and prevent accidents in the laboratory or wherever they are doing their scientific work. Candidates must know what to do if an accident happens.

### Hazards and risks

Potential hazards in scientific workplaces, including school and college laboratories, include:

- careless behaviour
- not using equipment properly
- not using protective and safety equipment
- not following correct procedures
- the possible risks that may arise from:
  - chemical substances classified as toxic, flammable, corrosive, oxidising and irritant
  - microorganisms
  - utilities (gas and electricity).

It is important that candidates are aware that workplaces are governed by health and safety regulations.

**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.

### First aid

Common injuries in laboratories are heat burns and scalds, chemical burns, injury from breathing in fumes or swallowing chemicals, electric shock, cuts and damage to the eyes from particles or chemicals.

**For each of these injuries, candidates need to know:**

- the basic first aid to give
- the situations in which it would be dangerous to give first aid.

**Candidates need to find out:**

- why it is useful to have a first aid qualification
- the names of organisations that give training for first aid qualifications and how to contact these organisations.

### Fire prevention

In places of work, including schools or colleges, there are fire regulations. These regulations are to ensure that the numbers of casualties in fires are kept to a minimum. Although many people are killed or injured in fires each year, the vast majority occur in the home and only 6% of deaths and 10% of injuries occur in the workplace (*Fire Statistics United Kingdom 1999*: L. Watson, J. Gamble and R. Schofield). However, continued vigilance is essential if these figures are to be maintained or improved.

**Candidates need to know:**

- 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.

## 10.4 Assessment Evidence for Unit 1: *Science in the Workplace*

This unit is assessed entirely on evidence contained in candidates' portfolios of work.

Candidates need to produce a portfolio of evidence about workplaces that use science and how science and scientific skills are used in the workplace. Candidates will need to consider safety precautions in the workplace and compare these with the health and safety precautions in their school or college. Candidates should be able to use a variety of sources of information and present their findings in a clear and logical way.

**A candidate's portfolio of evidence should include the following:**

- a report of an investigation on workplaces that use scientific skills, describing the work of scientists or those who use scientific skills and how science is important in a wide variety of jobs
- a report of an investigation carried out into working safely in a scientific workplace and a comparison with the health and safety precautions in their school or college.

## Assessment Evidence Grid – Unit 1: *Science in the Workplace*

**Candidates need to produce** a portfolio of evidence about workplaces that use science and how science and scientific skills are used in the workplace. Candidates will need to consider safety precautions in the workplace and compare these with the health and safety precautions in their school or college. Candidates should be able to use a variety of sources of information and present their findings in a clear and logical way.

The portfolio of evidence should include the following:

- a report of an investigation on workplaces that use scientific skills, describing the work of scientists or those who use scientific skills and how science is important in a wide variety of jobs
- a report of an investigation carried out into working safely in a scientific workplace and a comparison with the health and safety precautions in their school or college.

| Stage 1 | Stage 2 | Stage 3 |
|---|---|---|
| **1A.** Candidates should be able to:<br>**1A.1** produce a simple study on a range of organisations that use science<br>**1A.2** state the products made or services provided<br>**1A.3** identify the jobs of those employed.<br>**1–3 marks** | **2A.** Candidates should be able to:<br>**2A.1** identify organisations as local, national or international<br>**2A.2** describe their location<br>**2A.3** describe the products made or services provided<br>**2A.4** describe the jobs and qualifications of the employees and how they use science<br>**2A.5** describe the types of skills scientists need in addition to their qualifications, and a range of careers that are available in science.<br>**4– 8 marks** | **3A.** Candidates should be able to:<br>**3A.1** produce an in-depth study of **one** particular organisation<br>**3A.2** explain its location<br>**3A.3** describe the products made or services provided and explain their importance to society<br>**3A.4** give a detailed account of the skills and qualifications needed by scientists who work there<br>**3A.5** describe the effect on the local environment of the organisation.<br>**9–11 marks** |
| **1B.** Candidates should be able to:<br>**1B.1** carry out research into working safely in the school or college laboratory, including:<br>– hazards and risks and their assessment<br>– first aid<br>– fire prevention.<br>**1–4 marks** | **2B.** Candidates should be able to:<br>**2B.1** carry out research into the issues of working safely in a workplace that uses science or scientific skills, including:<br>– hazards and risks and their assessment<br>– first aid<br>– fire prevention.<br>**5–8 marks** | **3B.** Candidates should be able to:<br>**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:<br>– hazards and risks and their assessment<br>– first aid<br>– fire prevention.<br>**9–11 marks** |

**Whilst completing this unit candidates will be assessed on the way that they research and communicate their evidence in their portfolio of work.**

| Stage 1 | Stage 2 | Stage 3 |
|---|---|---|
| **1C.** Candidates should be able to:<br>**1C.1** use a limited range of sources and information to present findings in their portfolio.<br>**1 mark** | **2C.** Candidates should be able to:<br>**2C.1** use a range of sources and information to present findings clearly in their portfolio.<br>**2 marks** | **3C.** Candidates should be able to:<br>**3C.1** identify and use a wide range of sources and information to present findings clearly and logically throughout their portfolio.<br>**3 marks** |

## 10.5 Guidance on Assessment

This unit is assessed entirely through evidence that candidates produce in their portfolios.

The descriptors in the Assessment Evidence Grid will allow teachers to determine levels of work appropriate for their candidates.

In general, when assessing portfolio work teachers should be aware of:

- an increasing breadth and depth of understanding
- an increasing ability to independently research for evidence.

**Stage 1** Candidates should undertake research into the safe working practices required in a scientific workplace. Research and planning skills will be limited and they will need help in such things as choosing a suitable range of organisations and identifying hazards and risks.

**Stage 2** In their research into health and safety issues candidates at this level should be able to use sources of information, gathered from outside the laboratory situation, some of which may have been suggested to them. They should be able to use information sources confidently and classify, for example, types of organisation using science given broad headings under which to work.

**Stage 3** Candidates should be able to suggest and locate sources of information for use in their health and safety research. Their work should demonstrate a clear understanding of the health and safety issues involved and they should be able to compare work done in school or college with their research gained from other sources. They should be able to select their own research material and be able to compile an in-depth report. They should be able to classify and compare aspects of scientific industry independently.

11

# Unit 2
# *Science at Work*

## 11.1 About this Unit

In this unit candidates will learn about some of the science used in three specific areas in which scientists work. Candidates will learn about the work of food scientists and how it contributes to a healthy diet. They will learn how scientists use forensic techniques to help solve crime. Candidates will also learn how science helps in the understanding of appropriate diet and fitness needed in sport and contributes to the design of sports equipment and clothing used for sport.

This unit links directly to the investigations that candidates will carry out in Unit 3. The areas that can be linked are shown in *italics* throughout this unit.

## 11.2 Food Science

The Food Standards Agency is the independent food safety watchdog set up by an Act of Parliament in 2000 to protect the public's health and consumer interests in relation to food. Food scientists and dieticians work within the Agency to promote good eating habits and to ensure that our food is safe and that it is labelled correctly.

In this section candidates will learn about some of the science and techniques used by food scientists and dieticians to help us maintain a healthy body and a healthy lifestyle. The role of a dietician is to study individuals' diets, record individuals' food consumption and nutritionally analyse their intake. They then make recommendations on how individuals can eat a healthier diet. A healthy diet contains lots of fruit and vegetables. It is based on starchy foods such as wholegrain bread, pasta and rice and is low in fat (especially saturated fat), salt and sugar.

Candidates will learn about how microorganisms can affect health and how they can be used to benefit humans. They will also consider some economic and environmental aspects of food production.

### Food nutrients and their functions

**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 the following nutrients:
  - carbohydrates: energy providers
  - saturated and unsaturated fats: insulation, energy provision, a viable source of the fat-soluble vitamins (A, D, E and K), protection of vital organs (eg kidneys)
  - proteins: repair of body tissues, growth and energy

- the function of the following vitamins:
  - A: healthy eyesight, keeps mucous membranes free from infection
  - B: release of energy from carbohydrate foods, nerve functions
  - D: healthy teeth and bones, absorption of calcium and phosphorus
  - K: aids the clotting of blood
  - C: maintenance of the immune system, absorption of iron, maintenance of skin and linings of the digestive system
- the function of the following minerals:
  - iron: helps the body to manufacture haemoglobin, which is responsible for transporting oxygen around the body
  - calcium: for healthy teeth and bones
  - phosphorus: aids release of energy from food
  - zinc: for enzyme action and wound healing
- the symptoms of any deficiencies of vitamins within the human body:
  - A: inability to adjust to dim light, dry skin and mucous membrane
  - B: anaemia, mouth sores, nerve cell degeneration
  - C: bleeding gums, poor healing of cuts and wounds, weakening of blood vessels
  - D: weak teeth and bones, which may deform through excess body weight
- examples of foods that are good sources of these nutrients
- 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.

### Food additives

There are three reasons for the use of food additives: to improve taste, to improve appearance and to increase shelf life. The nature and quantity of food additives is strictly regulated and all additives have been given an 'E' number.

**Candidates need to know and understand:**

- the function of and examples of the following additives:
  - antioxidants (vitamin C)
  - flavouring and flavour enhancers (monosodium glutamate)
  - colourings (tartrazine)
  - preservatives (benzoic acid)
  - sweeteners (aspartame)
  - thickeners (starch)
- 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).

### Food labelling and food testing

Foods are often composed of more than one nutrient. Food analysts test the composition of individual foods and combinations of foods in order to ensure that accurate nutritional information is given on food labels.

**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
- *carry out qualitative food tests for starch, fat, protein, reducing sugar and acidity*
- *carry out quantitative tests on food and food supplements:*
  - *moisture content by evaporation*
  - *suspended matter by filtration*
  - *acidity of a product by titration*
  - *vitamin C content of food*
  - *iron content of food supplements.*

**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.

### Useful microorganisms in the production of food

Microorganisms such as bacteria, yeast and other fungi play an important part in the production of some foods and drinks. Microbiologists study these living organisms to see what factors favour their growth and how their growth can be controlled to produce useful products eg bread, yoghurt, beer, wine and cheese.

**Candidates need to be able to:**

- describe the use of bacteria, yeast and other fungi in food production (bread, wine, beer, yoghurt and cheese).

## Microorganisms and food safety

Food poisoning is caused by the growth of microorganisms, usually bacteria, and by the toxins they produce when they grow. Hygiene and quality control staff in industry and Public Health Inspectors are responsible for controlling the growth of bacteria in places where the presence of bacteria causes harmful effects.

**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, detergents, 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 the presence of bacteria*
- *complete serial dilutions to do an accurate bacterial count*
- *make streak plates to identify the types of bacteria present.*

## Organic and intensive farming

Two contrasting approaches to food production are organic and intensive farming. Intensive farming produces large quantities of food cheaply and efficiently by maximising the growth of crops and farm animals. Some consumers are willing to pay more for a product that has been produced in a more environmentally friendly way.

**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.*

## 11.3 Forensic Science

Forensic science uses scientific techniques to identify and match substances and objects. Most of the work of the Forensic Science service is done to help police investigate crimes but forensic methods can also be used for other purposes, eg to study archaeological specimens, to investigate the cause of an industrial accident or to show whether or not people are related. Many types of materials and objects need to be investigated, so a wide variety of methods is used. The results often have to be used as evidence in a court of law, so accuracy and reliability are very important.

In this section candidates will learn about some of the science and techniques used by forensic scientists.

### Collecting evidence from the crime scene

As a scientific investigation, forensic work begins with the careful observation and recording of materials found at the crime scene. Before any laboratory tests can be carried out, samples need to be collected and labelled without introducing any contamination.

**Candidates need to be able to:**

- describe how to avoid the contamination of evidence at a crime scene by:
  - restricting access
  - wearing protective clothing
  - using appropriate methods of sampling, storage and recording
- *describe how to take appropriate samples from large quantities of materials*
- *describe how to collect and record the following types of forensic samples:*
  - *broken glass*
  - *fibres*
  - *soil*
  - *fingerprints*
  - *blood.*

**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.

Marks and impressions left at the scene of a crime may be recorded using plaster of Paris, plasticine or by taking a photograph. A comparison can be made with tools, tyres and the soles of shoes owned by a suspect. Fingerprints can be revealed and lifted from various types of surfaces and compared with known prints.

**Candidates need to be able to:**

- *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*
- recognise the three distinctive types of fingerprint pattern (loop, arch, whorl)
- *make measurements to enable a comparison of crime scene marks and impressions with real objects.*

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

- 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

The melting point and boiling point of a substance and its behaviour when it is dissolved in water depend on its structure and bonding. The characteristic behaviour of a substance enables it to be identified.

Qualitative analysis is an important aspect of the work of the forensic scientist. Chemical tests can be used to determine which substances are present in a sample.

**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.

**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.

**Candidates need to be able to:**

- 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.*

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

- 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.

Chromatography is a technique that can be used to separate and compare samples of ink.

**Candidates need to be able to:**

- *describe the separation of coloured mixtures using thin layer and paper chromatography with both water and non-aqueous solvents*
- explain why different colours in a 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.

Forensic scientists use more expensive and powerful equipment than is available for use in the school laboratory. This equipment gives more accurate results, often using very small quantities of material. The comparison microscope, the polarising microscope and the electron microscope are important tools used in the forensic science laboratory to compare samples.

**Candidates need to be able to:**

- *describe the distinctive features of fibres, bullets, seeds and soil that enable samples to be matched.*

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

- 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.

Blood typing can determine whether a blood stain is human and the blood group to which it belongs. Samples of DNA can be extracted from blood, semen and saliva. DNA can be cut up into fragments and separated by electrophoresis, and the DNA profile of the material from a crime scene can be matched with great certainty to the DNA provided by a suspect. This technique of DNA profiling can also be used to show whether or not people are related.

**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.

Fragments of glass and plastic found at a crime scene can be matched with fragments attached to a suspect's clothing or fitted to a vehicle involved in a road traffic offence. The refractive index of a glass fragment is found by noting its disappearance when it is immersed in oil with the same refractive index. The refractive index of blocks of glass or plastic can be obtained by measuring the angle of incidence and the angle of refraction and calculating $\sin i / \sin r$.

**Candidates need to be able to:**

- 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.

### Using databases

Dental and medical records, vehicle records held on the DVLC database, insurance company records of valuable items, fingerprint and DNA databases and police records of descriptions of missing persons are examples of databases that are useful in forensic investigations. If a match can be found in a database this increases the probability of a positive identification and a mismatch may be equally important to eliminate a suspect from the police inquiry.

**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.

### Interpreting and presenting evidence

Having carried out investigations in the laboratory, a forensic scientist must prepare a report and may have to stand up in court to present their evidence. The facts must be stated clearly in a logical order. The conclusions drawn from the facts must be explained and justified.

**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.

## 11.4 Sports Science

The role of the sports scientist is to improve the performance of athletes competing in a wide variety of sporting competitions. Sports physiologists are interested in the health and fitness of the parts of the body involved during exercise. Nutritionists and dieticians help to optimise performance by controlling energy and nutrient intake. Materials scientists develop new materials for clothing and sports equipment and study their properties and the effect of the forces that act upon them during exercise.

Success in sport depends on a wide range of factors, including:

- the fitness of the body in order to perform during stressful situations
- the energy and nutrient intake before exercise
- the effectiveness of sports equipment and clothing used for training and competing
- the skill level of the athlete
- the ability of an athlete to concentrate and focus in a competitive situation.

In this section candidates will learn about some of the science and techniques used by sports physiologists, nutritionists and materials scientists.

## Exercise and the human body

Athletes are focused on improving their performance through fitness training. Sports physiologists have a detailed understanding of the organs and organ systems in the body; they help athletes to develop a personal fitness programme that meets their individual needs.

**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).

Before sports physiologists can advise an athlete on an appropriate fitness programme they need to take baseline measurements of physiological changes that happen in the athlete's body before, during and after exercise.

**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.

Sports nutrition

The correct combination of carbohydrates, proteins, fats, vitamins, minerals and water is essential to optimise athletic performance. Sports nutritionists and dieticians study the nutrient intakes of athletes and provide nutritional advice to maximise the performance of the body during exercise.

**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:* $\frac{weight}{height^2}$
- 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.

## Materials for sport

Materials scientists are constantly researching, developing and testing new materials to see if they can help to improve the performance of an athlete. They analyse the effect of forces such as friction and air resistance on the material used for clothing and the ability of the material to absorb excess moisture, to help maintain the temperature of the body or to encourage blood flow around the body. They design and test sports equipment made from materials that have the correct combination of properties.

**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, racquets, 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.

## 11.5 Assessment

This unit will be assessed by written examination, which is tiered into Foundation and Higher papers. Both tiers will reflect the full content of the Unit. Questions for the Higher Tier will be more demanding, requiring higher level skills allowing candidates to access the higher grades. The questions will be based on and will reflect, as far as possible, the work of scientists involved in food science, forensic science and sports science.

12

# Unit 3
# *Using Scientific Skills*

## 12.1 About this Unit

Scientists and those who work with science are involved in many types of activity. Some scientists may make products such as medicines; many others carry out investigations as part of their work. Whilst carrying out investigations, those employed in science-based jobs may have to:

- plan how to carry out an investigation
- take part in research activities
- make measurements and observe changes correctly and accurately
- use particular scientific knowledge
- communicate and explain their findings with other people.

In this unit candidates will use a range of practical skills, and knowledge gained in Unit 2, in **one** vocational option:

- Food Science

**or**

- Forensic Science

**or**

- Sports Science

to carry out an investigation and report and explain their findings.

When carrying out this investigation candidates will learn about:

- some techniques used by food scientists, forensic scientists or sports scientists
- the purpose of each technique and how it works
- the use of simplified techniques in their own investigations
- the importance of working safely and accurately when collecting first-hand data
- the collection of data from databases
- interpreting results and drawing conclusions
- evaluating methods of data collection and considering the reliability of evidence
- presenting evidence.

## 12.2 Food Science

A food scientist uses scientific knowledge to study foods and food components, either for research purposes or in a manufacturing industry. In the manufacturing area, food scientists concern themselves with analysing food product quality and safety, creating new food products and investigating new manufacturing methods.

Food scientists could be involved in:

- applying scientific methods to keep food fresh, safe and attractive
- researching ways of producing food more quickly and cheaply
- working in quality assurance and food safety – for example, checking types and numbers of microorganisms
- checking food quality, for example the amount of gas in a carbonated drink or vitamins in a drink or the physical properties of food, such as its density
- formulating food supplements and their effect on health.

**In this vocational option, candidates need to:**

- carry out **one** investigation which relates to food or components that may be found in food or food supplements.

**Candidates should produce a report of their investigation which:**

- describes the purpose of the investigation
- includes a plan and risk assessment for the investigation
- draws conclusions from, and evaluates, the investigation
- explains how a food scientist might use the results of the investigation.

Possible investigations could include:

- investigating the effect of nutrients on the growth of a food product
- a comparison of the amount of iron present in different iron tablets
- a comparison of the vitamin C content of various commercial fruit juices
- the qualitative and quantitative analysis of a fruit drink (detection of starch, glucose, sucrose and protein molecules, and estimation of moisture content, suspended matter and acidity)
- the effect of different conditions on bacterial growth
- the determination and use of the iodine number to compare the degree of saturation of fats and oils in our diet.

## 12.3 Forensic Science

Forensic scientists work closely with the police and are sometimes required to go to a crime scene – such as a murder or fire. Forensic science covers a wide range of science subjects; the main function of the forensic scientist is to provide impartial, scientific evidence for use in courts of law.

This evidence will often come from investigations carried out in forensic science laboratories and could include:

- identification and comparison of textile fibres
- identification and comparison of plant and animal materials – including hair
- analysis of blood and urine samples for their drug or alcohol content in relation to driving offences
- analysis of chemical substances found at a crime scene
- examination of paint and glass fragments using physical and chemical methods including microscopy.

**In this vocational option, candidates need to:**

- carry out a forensic investigation, which will include a number of tests and techniques for comparing and matching samples in order to indicate the probability of a 'suspect' being linked to a crime. Candidates should remember that a match does not necessarily prove that a suspect has committed a crime.

**Candidates should produce a report of their investigation which:**

- describes the purpose of the tests
- includes a plan and risk assessment for the tests
- draws conclusions from, and evaluates, the complete investigation
- explains how a forensic scientist might use the results of the investigation to indicate the probability of a 'suspect' being linked to a crime.

Where appropriate, candidates should describe:

- how the samples for the tests are collected
- how the samples for the tests are prepared.

Having carried out their investigations in the laboratory, candidates should prepare a report to present their evidence and conclusions. The conclusions drawn from the facts should be explained and justified. Any evidence that does not fit the conclusions should also be included, if appropriate. Evidence could include actual objects from the crime scene, photographs or drawings, fingerprints or plaster casts as well as experimental evidence, eg chromatograms.

Techniques used in the investigation should include a number of the following:

- testing the solubility of a substance in water or organic solvents
- using universal indicator paper to measure the pH of a solution
- using reactions and flame tests to detect the presence of, eg, $Na^+$, $K^+$, $Ca^{2+}$, $Cu^{2+}$, $Fe^{2+}$, $Fe^{3+}$, $Pb^{2+}$, $Cl^-$, $SO_4^{2-}$, $CO_3^{2-}$ ions
- testing for ethanol using acidified potassium dichromate solution
- using chromatographic techniques to separate coloured mixtures and colourless samples
- the examination of surface details such as scratch patterns or cross-sections of paint layers using microscopy
- comparing samples of, eg, types of clothing, fibre, hair or small seeds using microscopy
- determining the refractive index of small samples of glass and plastics
- revealing and examining fingerprints on different surfaces
- taking, examining and measuring plaster casts of footprints and tyre tracks.

## 12.4 Sports Science

People working in sports science are often involved in health and fitness and deal with those parts of the body involved in sport and exercise activities. Success in sport depends on the body being prepared to achieve a high level of performance. Sports scientists interested in the performance and skills of athletes will often study the physiological changes of athletes during intense training and offer advice on maintaining personal fitness.

Sports scientists could be involved in:

- the development of fitness programmes
- monitoring the changes that take place in the body during and after exercise
- the development of an appropriate diet for those involved in particular sports.

Sports and materials scientists may also be interested in developing sports equipment or clothing and will investigate the properties of new materials and the forces that act on these materials as an athlete competes at the highest level. Scientists need to choose the best materials for the job, so must think about which properties are needed and which materials have the most suitable properties.

Sports and materials scientists could be involved in:

- the investigation of grip
- the investigation of the physical properties of materials
- the investigation of wear, weathering and corrosion on different materials.

**In this vocational option, candidates need to:**

- carry out **one** scientific investigation in which they:

  **either**

  devise, apply, monitor and evaluate a personal fitness plan for a particular sport or purpose

  **or**

  investigate the appropriateness of materials that could be used in sport for a particular purpose.

**In either case, candidates should produce a report of their investigation which:**

- describes the purpose of the investigation
- describes how the investigation is connected with a particular sport
- includes a plan and risk assessment for the investigation
- draws conclusions from, and evaluates, the investigation
- explains how a sports scientist might use the results of the investigation.

Investigations and practical activities for the fitness plan might include:

- identification of baseline measurements such as height, weight, BMI, heart rate, ventilation rate, total lung capacity and the tidal volume, and monitoring these physiological changes during exercise
- the calculation of recovery rate after aerobic exercise
- developing specific diets for those taking part in a particular sport and calculating their energy requirements
- analysis of the effect of training on an athlete's reaction time.

Investigations and practical activities for the appropriateness of materials used in sport may include:

- a study of the effect of frictional forces on different materials
- analysis of the absorbency and insulating properties of different materials
- testing the tensile strength of different materials
- testing the resistance to wear of different materials
- analysing the effect of weathering and chemical corrosion of different materials
- how density affects the uses of different materials.

## 12.5 Assessment evidence for Unit 3: *Using Scientific Skills*

This unit is assessed entirely on evidence contained in the portfolio of work.

Candidates need to produce a portfolio of evidence, which should contain a report of **one** practical investigation set in a vocational context covering **either** food science **or** forensic science **or** sports science.

Candidates should:

- 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 conclusions
- evaluate the investigation and explain how the findings could be used and applied.

## Assessment Evidence Grid – Unit 3: *Using Scientific Skills*

**Candidates need to produce** a portfolio of evidence, which should contain a report of **one** practical investigation set in a vocational context covering **either** food science **or** forensic science **or** sports science.

Candidates should:

- 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 draw conclusions
- evaluate the investigation and explain how the findings could be used and applied.

| Stage 1 | Stage 2 | Stage 3 |
|---|---|---|
| **1A.** Candidates should be able to:<br>**1A.1** give a simple vocational application of the practical investigation.<br>**1 mark** | **2A.** Candidates should be able to:<br>**2A.1** describe a vocational application of their practical investigation.<br>**2 marks** | **3A.** Candidates should be able to:<br>**3A.1** research and explain the vocational significance of their practical investigation.<br>**3–4 marks** |
| **1B.** Candidates should be able to:<br>**1B.1** produce a simple plan for the investigation with guidance<br>**1B.2** carry out a risk assessment for the investigation, given clear guidelines.<br>**1–2 marks** | **2B.** Candidates should be able to:<br>**2B.1** produce a plan which, with little guidance, would enable the investigation to be carried out by another person<br>**2B.2** carry out a risk assessment for the investigation, given some guidelines.<br>**3–4 marks** | **3B.** Candidates should be able to:<br>**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<br>**3B.2** independently carry out a risk assessment for the investigation.<br>**5–6 marks** |
| **1C.** Candidates should be able to:<br>**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.<br>**1–3 marks** | **2C.** Candidates should be able to:<br>**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.<br>**4–7 marks** | **3C.** Candidates should be able to:<br>**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.<br>**8–12 marks** |

## Assessment Evidence Grid – Unit 3: *Using Scientific Skills* (continued)

| Stage 1 | | Stage 2 | | Stage 3 | |
|---|---|---|---|---|---|
| **1D.** | Candidates should be able to: | **2D.** | Candidates should be able to: | **3D.** | Candidates should be able to: |
| **1D.1** | use the data/information collected to draw some simple conclusions. | **2D.1** | use and process the data/information collected to make conclusions. | **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. |
| | **1–3 marks** | | **4–6 marks** | | **7–10 marks** |
| **1E.** | Candidates should be able to: | **2E.** | Candidates should be able to: | **3E.** | Candidates should be able to: |
| **1E.1** | give a simple evaluation of the practical activity. | **2E.1** | give an evaluation of the practical activity and suggest an improvement to their method | **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 |
| | | **2E.2** | suggest how their findings could be used in the vocational setting. | **3E.3** | suggest and explain how their findings could be used in the vocational setting. |
| | **1–2 marks** | | **3–4 marks** | | **5–8 marks** |

## 12.6 Guidance on Assessment

This unit is assessed entirely through evidence that candidates produce in their portfolios. The descriptors contained in the Assessment Evidence Grid allow the determination of appropriate levels of work. It is assumed that candidates will progress through Stage 1 and Stage 2 and finally to Stage 3 as appropriate. In general, when assessing portfolio work teachers should be aware of:

- an increasing breadth and depth of understanding
- an increasing ability to plan an investigation and independently research for evidence
- an increasing ability to organise and carry out experimental work in the laboratory
- an increasing coherence and ability to analyse, record and evaluate research and laboratory work
- an increasing independence and originality in candidates' work.

**Stage 1** Candidates at this level will show some limited confidence but will need considerable guidance from a member of staff in producing appropriate plans, risk assessments and 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 comment on 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** Practical work should give a clear indication that candidates have carefully and independently planned and anticipated any problems that may occur. Candidates should be able to work independently when selecting appropriate equipment and producing risk assessments for their investigations. Candidates should appreciate the need to repeat experiments where results are obviously incorrect. They should be able to complete calculations and rearrange standard formulae when required. Candidates 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.

# Key Skills and Other Issues

## 13 Key Skills – Teaching, Developing and Providing Opportunities for Generating Evidence

### 13.1 Introduction

The Key Skills Qualification requires candidates to demonstrate levels of achievement in the Key Skills of *Application of Number, Communication* and *Information and Communication Technology*.

The units for the 'wider' Key Skills of *Improving own Learning and Performance, Working with Others* and *Problem Solving* are also available. The acquisition and demonstration of ability in these 'wider' Key Skills is deemed highly desirable for all candidates, but they do not form part of the Key Skills Qualification.

Copies of the Key Skills Units may be downloaded from the QCA website (http://www.qca.org.uk/keyskills).

Copies of the Key Skills specification may be downloaded from the AQA website (www.aqa.org.uk).

### 13.2 Teaching, Developing and Providing Opportunities for Generating Evidence

Areas of study and learning that can be used to encourage the acquisition and use of Key Skills, and to provide opportunities to generate evidence, are signposted in the tables below. Key Skills signposting indicates naturally occurring opportunities for the development of Key Skills during teaching, learning and assessment. Candidates will not necessarily achieve the signposted Key Skill through the related evidence.

## Application of Number Level 1

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **N1.1** Interpret information from **two** different sources. At least **one** source must include a table, chart, graph or diagram. | – | ✓ | ✓ |
| **N1.2** Carry out and check calculations to do with:<br>a. amounts or sizes<br>b. scales or proportion<br>c. handling statistics. | – | ✓ | ✓ |
| **N1.3** Interpret results of your calculations and present your findings – in two different ways using charts or diagrams. | – | ✓ | ✓ |

## Application of Number Level 2

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **N2.1** Interpret information from a suitable source. | – | ✓ | ✓ |
| **N2.2** Use your information to carry out calculations to do with:<br>a. amounts or sizes<br>b. scales or proportions<br>c. handling statistics<br>d. using formulae. | – | ✓ | ✓ |
| **N2.3** Interpret the results of your calculations and present your findings. | – | ✓ | ✓ |

## Communication Level 1

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **C1.1** Take part in either a **one-to-one** discussion or a **group** discussion. | ✓ | ✓ | ✓ |
| **C1.2** Read and obtain information from at least **one** document. | ✓ | ✓ | ✓ |
| **C1.3** Write **two** different types of documents. | ✓ | – | ✓ |

## Communication Level 2

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **C2.1a** Take part in a group discussion. | ✓ | ✓ | ✓ |
| **C2.1b** Give a talk of at least four minutes. | ✓ | ✓ | ✓ |
| **C2.2** Read and summarise information from at least **two** documents about the same subject. Each document must be a minimum of 500 words long. | ✓ | ✓ | ✓ |
| **C2.3** Write **two** different types of documents each one giving different information. One document must be at least 500 words long. | ✓ | – | ✓ |

## Information and Communication Technology Level 1

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **ICT1.1** Find and select relevant information. | ✓ | ✓ | ✓ |
| **ICT1.2** Enter and develop information to suit the task. | ✓ | ✓ | ✓ |
| **ICT1.3** Develop the presentation so that the final output is accurate and fit for purpose. | ✓ | ✓ | ✓ |

## Information and Communication Technology Level 2

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **ICT2.1** Search for and select information to meet your needs. Use different information sources for each task and multiple search criteria in at least one case. | ✓ | ✓ | ✓ |
| **ICT2.2** Explore and develop the information to suit the task and derive new information. | ✓ | ✓ | ✓ |
| **ICT2.3** Present combined information such as text with image, text with number, image with number. | ✓ | ✓ | ✓ |

**Improving own Learning and Performance Level 1**

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **LP1.1** Confirm your targets and plan how to meet these with the person setting them. | ✓ | ✓ | ✓ |
| **LP1.2** Follow your plan, to help meet targets and improve your performance. | ✓ | ✓ | ✓ |
| **LP1.3** Review your progress and achievements in meeting targets, with an appropriate person. | ✓ | ✓ | ✓ |

**Improving own Learning and Performance Level 2**

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **LP2.1** Help set targets with an appropriate person and plan how these will be met. | ✓ | ✓ | ✓ |
| **LP2.2** Take responsibility for some decisions about your learning, using your plan to help meet targets and improve your performance. | ✓ | ✓ | ✓ |
| **LP2.3** Review progress with an appropriate person and provide evidence of your achievements. | ✓ | ✓ | ✓ |

**Working with Others Level 1**

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **WO1.1** Confirm you understand the given objectives, and plan for working together. | ✓ | – | ✓ |
| **WO1.2** Work with others towards achieving the given objectives. | ✓ | – | ✓ |
| **WO1.3** Identify ways you helped to achieve things and how to improve your work with others. | ✓ | – | ✓ |

**Working with Others Level 2**

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **WO2.1** Plan work with others. | ✓ | – | ✓ |
| **WO2.2** Work co-operatively towards achieving the identified objectives. | ✓ | – | ✓ |
| **WO2.3** Review your contributions and agree ways to improve work with others. | ✓ | – | ✓ |

**Problem Solving Level 1**

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **PS1.1** Confirm with an appropriate person that you understand the given problem and identify different ways of tackling it. | ✓ | ✓ | ✓ |
| **PS1.2** Confirm with an appropriate person what you will do and follow your plan for solving the problem. | ✓ | ✓ | ✓ |
| **PS1.3** Check with an appropriate person if the problem has been solved and how to improve your problem solving skills. | ✓ | ✓ | ✓ |

**Problem Solving Level 2**

| What you must do … | Signposting of Opportunities for Generating Evidence in Subject Content | | |
|---|---|---|---|
| | **Unit 1** | **Unit 2** | **Unit 3** |
| **PS2.1** Identify a problem, with help from an appropriate person, and identify different ways of tackling it. | ✓ | ✓ | ✓ |
| **PS2.2** Plan and try out at least one way of solving the problem. | ✓ | ✓ | ✓ |
| **PS2.3** Check if the problem has been solved and identify ways to improve problem solving skills. | ✓ | ✓ | ✓ |

# 14 Spiritual, Moral, Ethical, Social, Cultural and Other Issues

## 14.1 Spiritual, Moral, Ethical, Social and Cultural Issues

The study of science can contribute to an understanding of spiritual, moral, ethical, social and cultural issues. The following are examples of opportunities to promote candidates' development through the teaching of Science.

### Spiritual

Through candidates sensing the natural, material and physical world they live in, reflecting on their part in it, exploring questions such as when life starts and where life comes from, and experiencing a sense of awe and wonder at the natural world. Sections 11.2, 11.3, 11.4, 12.2, 12.3 and 12.4 are relevant.

### Moral and Ethical

Through helping candidates see the need to draw conclusions using observation and evidence rather than preconception or prejudice, and through discussion of the implications of the uses of scientific knowledge, including the recognition that such uses can have both beneficial and harmful effects. Exploration of values and ethics relating to applications of science and technology is possible. Sections 10.2, 10.3, 11.2, 11.3, 11.4, 12.2, 12.3 and 12.4 are relevant.

### Social

Through helping candidates recognise how the formation of opinion and the justification of decisions can be informed by experimental evidence, and drawing attention to how different interpretations of scientific evidence can be used in discussing social issues. Sections 10.2, 10.3, 11.2, 11.3 and 11.4 are relevant.

### Cultural

Through helping candidates recognise how scientific discoveries and ideas have affected the way people think, feel, create, behave and live, and drawing attention to how cultural differences can influence the extent to which scientific ideas are accepted, used and valued. Sections 11.2, 11.3 and 11.4 are relevant.

## 14.2 European Dimension

AQA has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen papers.

There are opportunities in this specification to relate the study of topics to wider European or global contexts. In particular, a broader European context could be used in relation to Sections 10.2, 10.3, 11.2, 11.3 and 11.4.

## 14.3 Environmental Issues

AQA has taken account of the 1988 Resolution of the Council of the European Community and the Report *Environmental Responsibility: An Agenda for Further and Higher Education* 1993 in preparing this specification and associated specimen papers.

This specification allows responsible attitudes to environmental issues to be fostered. In particular, environmental issues can be considered in relation to Sections 11.2, 11.3 and 11.4.

## 14.4 Health and Safety

This specification will encourage the development of a sense of responsibility for the health and safety of the self and others. More general teaching requirements about health and safety are as applicable to science as to other subjects. Examples can be found in Sections 10.2, 10.3, 12.2, 12.3 and 12.4.

When working with equipment and materials, in practical activities and in different environments, including those that are unfamiliar, candidates should be taught:

- about hazards, risks and risk control
- to recognise hazards, assess consequent risks and take steps to control the risks to themselves and others
- to use information to assess the immediate and cumulative risks
- to manage their environment to ensure the health and safety of themselves and others
- to explain the steps they take to control risks.

Centres are reminded of requirements to make their own risk assessments under COSHH regulations in relation to the many materials and processes involved in the teaching of this subject.

## 14.5 Citizenship

This specification allows treatment of aspects of citizenship through the contribution made to candidates' moral, ethical, social and cultural development (see Section 14.1), through opportunities to teach about the European dimension (see Section 14.2) and through opportunities to promote an understanding of, and responsible attitudes towards, environmental issues (see Section 14.3).

## 14.6 Avoidance of Bias

AQA has taken great care in the preparation of this specification and associated specimen papers to avoid bias of any kind.

## 14.7 Use of Organisms

Nothing in this specification requires candidates or teachers to kill animals. Live animals brought into the laboratory for study should be kept unstressed in suitable conditions and should, wherever possible, be returned unharmed to their habitats. Studies of animals and plants in their habitats should aim at minimal disturbance.

# Centre-Assessed Units

## 15 Guidance on Setting Centre-Assessed Units

### Portfolio Advisers

Advisers will be available to assist centres with any matters relating to portfolio units. Details will be provided when AQA knows which centres are following the specification.

Advice will normally be given in response to telephone or e-mail enquiries but will be restricted to:

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

Advisers do not mark work.

## 16 Supervision and Authentication

### 16.1 Supervision of Candidates' Work

Candidates' work for assessment must be undertaken under conditions which allow the teacher to supervise the work and enable the work to be authenticated. If it is necessary for some assessed work to be done outside the centre, sufficient work must take place under direct supervision to allow the teacher to authenticate each candidate's whole work with confidence.

### 16.2 Guidance by the Teacher

The work assessed must be solely that of the candidate concerned.

Internal assessors must record, on the Candidate Record Form, full details of the nature of any assistance given to individual candidates that is beyond that of the teaching group as a whole, but within the parameters laid down by the specification. Any assistance given must be taken into account when assessing candidates' work.

### 16.3 Unfair Practice

At the start of the course, the supervising teacher is responsible for informing candidates of the AQA regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of portfolio unit work to be submitted for assessment, and must understand that to present material copied directly from books or other sources without acknowledgement will be regarded as deliberate deception. Centres must report suspected malpractice to AQA. The penalties for malpractice are set out in the AQA regulations.

### 16.4 Authentication of Candidates' Work

Both the candidate and the teacher are required to sign declarations confirming that the work submitted for assessment is the candidate's own. The teacher declares that the work was conducted under the specified conditions, and records details of any additional assistance.

# 17 Standardisation

### 17.1 Standardising Meetings

Annual standardising meetings will usually be held in the autumn term. Centres entering candidates for the first time must send a representative to the meetings. Attendance is also mandatory in the following cases:

- where there has been a serious misinterpretation of the specification requirements
- where the nature of portfolio unit tasks set by a centre has been inappropriate
- where a significant adjustment has been made to a centre's marks in the previous year's examination.

Otherwise attendance is at the discretion of centres. At these meetings support will be provided for centres in the development of appropriate portfolio unit tasks and assessment procedures.

### 17.2 Internal Standardisation of Marking

The centre is required to standardise the assessment across different teachers and teaching groups and within and across units to ensure that all work at the centre has been judged against the same standards. If two or more teachers are involved in marking units, one teacher must be designated as responsible for internal standardisation. Common pieces of work must be marked on a trial basis and differences between assessments discussed at a training session in which all teachers involved must participate. The teacher responsible for standardising the marking must ensure that the training includes the use of reference and archive materials such as work from a previous year or examples provided by AQA. The centre is required to send to the moderator the Centre Declaration Sheet, duly signed, to confirm that the marking of portfolio work at the centre has been standardised. If only one teacher has undertaken the marking, that person must sign this form.

A specimen Centre Declaration Sheet appears in Appendix B.

# 18 Administrative Procedures

## 18.1 Recording Assessments within each Unit

The candidates' work must be marked according to the assessment criteria. Teachers should keep records of their assessments during the course in a format which facilitates the complete and accurate submission of the final overall assessments at the end of the course on the Candidate Record Forms.

Candidate Record Forms are available on the AQA website in the Administration area. They can be accessed via the following link http://www.aqa.org.uk/admin/p_course.php. The exact design may be modified before the operational version is issued and the correct year's Candidate Record Forms should always be used.

## 18.2 Submitting Marks and Sample Work for Moderation

For each portfolio unit a mark for each candidate must be submitted to AQA by the date specified. Centres will be informed which portfolio units are required to be submitted in the samples to the moderator.

## 18.3 Factors Affecting Individual Candidates

Teachers should be able to accommodate the occasional absence of candidates by ensuring that the opportunity is given for them to make up missed assessments.

Special consideration should be requested for candidates whose work has been affected by illness or other exceptional circumstances. Information about the procedure is issued separately.

If work is lost, AQA should be notified immediately of the date of the loss, how it occurred, and who was responsible for the loss. AQA will advise on the procedures to be followed in such cases.

Where special help that goes beyond normal learning support is given, AQA must be informed so that such help can be taken into account when assessment and moderation take place.

Candidates who move from one centre to another during the course sometimes present a problem for a scheme of internal assessment. Possible courses of action depend on the stage at which the move takes place. If the move occurs early in the course the new centre should take responsibility for assessment. If it occurs late in the course it may be possible to accept the assessments made at the previous centre. Centres should contact AQA at the earliest possible stage for advice about appropriate arrangements in individual cases.

## 18.4 Retaining Evidence

The centre must retain the work of candidates, with Candidate Record Forms attached. These must be kept under secure conditions, from the time they are assessed, to allow for the possibility of an enquiry about results. The work may be returned to candidates after the issue of results provided that no enquiry about results is to be made which will include re-moderation of the work in the portfolio unit(s). If an enquiry about results is to be made, the work must remain under secure conditions until requested by AQA.

# 19 Moderation

## 19.1 Moderation Procedures

Moderation of the portfolio work is by inspection of a sample of candidates' work by a moderator appointed by AQA. The centre's marks must be submitted to AQA by the specified date. The moderator will normally inspect the work either by visiting the centre or by receiving the sample by post.

Following the re-marking of the sample work, the moderator's marks are compared with the centre marks to determine whether any adjustment is needed in order to bring the centre's assessments into line with standards generally. In some cases it may be necessary for the moderator to call for the work of other candidates. In order to meet this possible request, centres must have available the work and Candidate Record Form of every candidate entered for the examination and be prepared to submit it on demand. Mark adjustments will normally preserve the centre's order of merit, but where major discrepancies are found AQA reserves the right to alter the order or merit.

## 19.2 Post-Moderation Procedures

On publication of the GCSE Applied Science results, the centre is supplied with details of the final marks for the portfolio units.

Where moderation is not by a visit the candidates' work is returned to the centre after the examination. At the same time as the issue of results the centre receives a report form giving feedback on the appropriateness of the tasks set, the accuracy of the assessments made, and the reasons for any adjustments to the marks.

Some candidates' work may be retained by AQA for archive purposes.

# Awarding and Reporting

## 20 Grading, Shelf-Life and Re-Sits

### 20.1 Qualification Titles

The qualification based on this specification has the following title: AQA General Certificate of Secondary Education in Additional Applied Science.

### 20.2 Grading System

The qualification will be graded on an 8-point grade scale: A*, A, B, C, D, E, F and G. Candidates who fail to reach the minimum standard for grade G will be recorded as U (unclassified) and will not receive a qualification certificate.

### 20.3 Grading of Unit Results and Subject Awards

The achievement of each candidate on each unit is reported as a grade on the scale A*–G and as a UMS (Uniform Mark Scale) score.

UMS scores are related to grades as follows:

| | **Range of UMS scores** | | |
|---|---|---|---|
| **Unit 1** | **Unit 2** | **Unit 3** | **Grade** |
| 72–80 | 144–160 | 144–160 | A* |
| 64–71 | 128–143 | 128–143 | A |
| 56–63 | 112–127 | 112–127 | B |
| 48–55 | 96–111 | 96–111 | C |
| 40–47 | 80–95 | 80–95 | D |
| 32–39 | 64–79 | 64–79 | E |
| 24–31 | 48–63 | 48–63 | F |
| 16–23 | 32–47 | 32–47 | G |
| 0–15 | 0–31 | 0–31 | U |

The relationship of raw marks to UMS scores is determined separately for each unit, and where appropriate for each tier (see Section 20.4), through the awarding procedures for each series. This allows for any variation in the demand of the assessments between series to be taken into consideration. Raw marks that represent the minimum performance to achieve a grade are chosen, and these boundary marks are assigned the minimum UMS score for the grade. Between boundaries interpolation is used to relate raw marks to UMS scores.

When a candidate is entered for a subject award, the grade for the qualification is obtained by adding together the UMS scores for the units that contribute to the subject award, and using the following relationship between total UMS score and grade:

| Range of total UMS scores | Grade |
|---|---|
| 360–400 | A* |
| 320–359 | A |
| 280–319 | B |
| 240–279 | C |
| 200–239 | D |
| 160–199 | E |
| 120–159 | F |
| 80–119 | G |
| 0–79 | U |

## 20.4 Grading and Tiers

The centre-assessed units are not tiered and the full range of grades A*–G is available to candidates for these units.

For Unit 2, candidates must be entered for either the Foundation Tier or the Higher Tier. For candidates entered for the Foundation Tier, grades C–G are available. For candidates entered for the Higher Tier, A*–D are available. There is a safety net for candidates entered for the Higher Tier, where an allowed grade E will be awarded if candidates just fail to achieve grade D. Candidates who fail to achieve a grade E on the Higher Tier or grade G on the Foundation Tier will be reported as unclassified.

For the tiered unit, candidates cannot obtain a UMS score corresponding to a grade that is above the range for the tier entered. Therefore the maximum UMS score for candidates on a Foundation Tier paper is 111. In other words, they cannot achieve a UMS score corresponding to a grade B. Candidates who just fail to achieve grade E on the Higher Tier receive the UMS score corresponding to their raw mark, ie they do not receive a UMS mark of zero.

During the awarding procedures the relationship between raw marks and UMS score is decided for each tier separately. Where a grade is available on two tiers, for example grade C, the two raw marks chosen as the boundary for the grade on the two tiers are given the same UMS score. Therefore candidates receive the same UMS score for the same achievement whether this is demonstrated on the Foundation or the Higher Tier assessments.

Individual assessment unit results will be separately reported.

| | | |
|---|---|---|
| 20.5 | Shelf-life of Unit Results | The shelf-life of individual unit results, prior to certification of the qualification, is limited only by the shelf-life of the specification. |
| 20.6 | Re-Sits | Each assessment unit may be re-taken an unlimited number of times within the shelf-life of the specification. The best result will count towards the final award. |
| 20.7 | Minimum Requirements | Candidates do not have to achieve a grade G or better on every unit to achieve overall qualification certification. Candidates will be graded on the basis of work submitted for assessment. |
| 20.8 | Awarding and Reporting | This specification complies with the grading, awarding and certification requirements of the GCSE, GCE and AEA Code of Practice April 2008, and will be revised in the light of any subsequent changes in future years. |

# Appendices

## A Grade Descriptions

The following grade descriptors indicate the level of attainment characteristic of the given grade at GCSE. They give a general indication of the required learning outcomes at each specified grade. The descriptors should be interpreted in relation to the content and assessment evidence requirements outlined in the specification; they are not designed to define that content.

The grade awarded will depend in practice upon the extent to which the candidate has met the assessment evidence requirements overall. Shortcomings in some aspects of the assessment may be balanced by better performance in others.

**Grade A** Candidates demonstrate a detailed knowledge and understanding of science content and how science works, encompassing the principal concepts, techniques, and facts across all areas of the specification. They use technical vocabulary and techniques with fluency, clearly demonstrating communication and numerical skills appropriate to a range of situations.

They demonstrate a good understanding of the relationships between data, evidence and scientific explanations and theories. They are aware of areas of uncertainty in scientific knowledge and explain how scientific theories can be changed by new evidence.

Candidates use and apply their knowledge and understanding in a range of tasks and situations. They use this knowledge, together with information from other sources, effectively in planning a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

Candidates describe how, and why, decisions about uses of science are made in contexts familiar to them, and apply this knowledge to unfamiliar situations. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They choose appropriate methods for collecting first-hand and secondary data, interpret and question data skilfully, and evaluate the methods they use. They carry out a range of practical tasks safely and skilfully, selecting and using equipment appropriately to make relevant and precise observations.

Candidates select a method of presenting data appropriate to the task. They draw and justify conclusions consistent with the evidence they have collected and suggest improvements to the methods used that would enable them to collect more valid and reliable evidence.

**Grade C** Candidates demonstrate a good overall knowledge and understanding of science content and how science works, and of the concepts, techniques, and facts across most of the specification. They demonstrate knowledge of technical vocabulary and techniques, and use these appropriately. They demonstrate communication and numerical skills appropriate to most situations.

They demonstrate an awareness of how scientific evidence is collected and are aware that scientific knowledge and theories can be changed by new evidence.

Candidates use and apply scientific knowledge and understanding in some general situations. They use this knowledge, together with information from other sources, to help plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

They describe how, and why, decisions about uses of science are made in some familiar contexts. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They carry out practical tasks safely and competently, using equipment appropriately and making relevant observations, appropriate to the task. They use appropriate methods for collecting first-hand and secondary date, interpret the data appropriately, and undertake some evaluation of their methods.

Candidates present data in ways appropriate to the context. They draw conclusions consistent with the evidence they have collected and evaluate how strongly their evidence supports these conclusions.

**Grade F** Candidates demonstrate a limited knowledge and understanding of science content and how science works. They use a limited range of the concepts, techniques and facts from the specification, and demonstrate basic communication and numerical skills, with some limited use of technical terms and techniques.

They show some awareness of how scientific information is collected and that science can explain many phenomena.

They use and apply their knowledge and understanding of simple principles and concepts in some specific contexts. With help they plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem, using a limited range of information in an uncritical manner. They are aware that decisions have to be made about uses of science and technology and, in simple situations familiar to them, identify some of those responsible for the decisions. They describe some benefits and drawbacks of scientific developments with which they are familiar and issues related to these.

They follow simple instructions for carrying out a practical task and work safely as they do so.

Candidates identify simple patterns in data they gather from first-hand and secondary sources. They present evidence as simple tables, charts and graphs, and draw simple conclusions consistent with the evidence they have collected.

# B Record Forms

Candidate Record Forms and Centre Declaration Sheets are available on the AQA website in the Administration area. They can be accessed via the following link http://www.aqa.org.uk/admin/p_course.php

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# Overlaps with Other Qualifications

## Specifications covering the Programme of Study

Many of the specifications in the AQA GCSE Sciences suite described in Section 4.2 cover the programme of study for KS4 Science, and there is therefore significant overlap between them. This specification has very little overlap with the general suite of specifications; however, it does have a common Unit 1 with GCSE Applied Science (Double Award).

The entry restrictions in Section 3.3 reflect this overlap.

## Relationship to Other Subjects

Some of the knowledge, skills and understanding included in this specification may also be encountered by candidates following courses leading towards other subject qualifications. This is a feature of National Curriculum provision and means that the specification can complement other subjects and enable candidates to consolidate their learning. Some overlap exists with the following GCSE subjects:

- Human Physiology and Health
- Environmental Science