GCSE Specification
Additional Applied Science
For exams June 2014 onwards
For certification June 2014 onwards
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Introduction

1.1 Why choose AQA?

We, AQA, are the United Kingdom’s favourite awarding body and more candidates get their academic qualifications from us than from any other awarding body. But why are we so popular?

We understand the different requirements of each subject by working with teachers. Our GCSEs:

- help candidates to achieve their full potential
- are relevant for today’s challenges
- are manageable for schools and colleges
- are easy for candidates of all levels of ability to understand
- lead to accurate results, delivered on time
- are affordable and value for money.

We provide a wide range of support services for teachers, including:

- access to subject departments
- training for teachers, including practical teaching strategies and methods that work, presented by senior examiners
- individual support for Controlled Assessment
- 24-hour support through our website and online with Ask AQA
- past question papers and mark schemes
- a wide range of printed and electronic resources for teachers and candidates
- free online results analysis, with Enhanced Results Analysis.

We are an educational charity focused on the needs of the learner. All our income is spent on improving the quality of our specifications, examinations and support services. We do not aim to profit from education, we want you to.

If you are already an AQA customer we thank you for your support. If you are thinking of joining us we look forward to welcoming you.
1.2 Why choose Additional Applied Science?

GCSE Additional Applied Science is one of many qualifications that AQA offers for Key Stage 4. AQA’s range, including GCSEs, Diplomas and Entry Level qualifications, enables teachers to select and design appropriate courses for all learners.

Additional Applied Science 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 GCSE Science course.

Additional Applied Science integrates the study of biology, chemistry and physics. This specification concentrates on particular disciplines of science and those scientists that work with them. It also allows candidates to develop some of the knowledge and skills used in these disciplines. Following the specification will introduce candidates to work-related learning and equip them with some of the skills they will need in the workplace or in further education or training. It will also empower candidates to take charge of their own learning and provide a range of teaching, learning and assessment styles to motivate candidates to achieve the best they can.

This specification has evolved from the current specification. Some changes have been required by regulations. In preparing this new specification we have taken advice from a wide group of teachers and organisations with an interest in science education.

In addition to this specification and the associated specimen papers, we offer a wide range of related support and resources for teachers, much of it free. This includes:

- Preparing to Teach meetings
- on-line schemes of work
- ideas for practical work including worksheets and technician guidance
- practice tests for homework
- our Enhanced Results Analysis service.

This support is accessible through a web-based portal called The Science Lab.

1.3 How do I start using this specification?

To ensure you receive all the teaching and examination material, it is important that the person responsible for making the decision to teach AQA GCSE Additional Applied Science informs both their Examinations Officer and AQA.

**Step One**

To confirm you will be teaching this specification please sign up to teach and complete the online form. You will then receive your free GCSE Sciences welcome pack(s) that contain teaching and support material.

**Step Two**

Inform your Exams Officer of your choice to ensure you receive all your examination material. Your Exams Officer will make sure that your centre is registered with AQA and will complete the Intention to Enter and Estimated Entries when required to do so.

If your centre has not used AQA for any examinations in the past, please contact our centre approval team at centreapproval@aqa.org.uk
1.4 How can I find out more?

You can choose to find out more about this specification or the services that AQA offers in a number of ways.

**Ask AQA**

You have 24-hour access to useful information and answers to the most commonly asked questions at aqa.org.uk/askaqa

If the answer to your question is not available, you can submit a query through Ask AQA for our team. We will respond within two working days.

**Speak to your subject team**

You can talk directly to the GCSE Sciences subject team about this specification either by e-mailing science-gcse@aqa.org.uk or by calling 08442 090 415.

**Teacher Support**

Details of the full range of current Teacher Support and CPD courses are available on our web site at http://web.aqa.org.uk/qual/cpd/index.php

There is also a link to our fast and convenient online booking system for all of our courses at http://coursesandevents.aqa.org.uk/training

**Latest information online**

You can find out more including the latest news, how to register to use Enhanced Results Analysis, support and downloadable resources on our website at aqa.org.uk
Specification at a Glance

Unit 1: Science at Work
Written paper – 1 hour
60 marks – 40%
Structured and closed questions
At least one question assessing Quality of Written Communication in a science context

Unit 2: How Scientists use Practical Techniques
90 marks – 60%
A Controlled Assessment based on two assignments chosen from those supplied by AQA each year:
- Investigating the work of scientists and how they use science.
- How scientists use evidence to solve problems.

For assessments and subject awards after June 2013 there is a requirement that 100% of the assessment is terminal.
Subject Content

3.1 Introduction

During this course candidates learn about some of the science used in specific areas in which scientists work. Candidates will learn about:

■ the use of standard procedures in the workplace
■ the importance of health and safety
■ how science helps in the understanding of health and fitness
■ how science helps in the development and use of materials for products
■ the work of food scientists and how they contribute to the production of food
■ how analytical scientists use techniques to detect and analyse different types of samples.

The subject content of this specification is presented in three sections:

■ the ideas behind How Science Works
■ the substantive content: Science at Work
■ the Controlled Assessment unit.

It is intended that How Science Works is integrated into the course, and delivered not only through the Controlled Assessment but also through the context of the content of Unit 1.

Assessment

Unit 1 is assessed by a 60 minute written paper, which is worth 40% of the overall marks for the specification.

In the written paper, questions will be set that examine application of knowledge and understanding gained in discussing, evaluating and suggesting implications of data and evidence in both familiar and unfamiliar situations. All applications will use the knowledge and understanding developed through the substantive content.

For the written paper, an equation sheet will be provided with equations that candidates may need in order to answer questions. Candidates will be expected to choose the appropriate information from the equation sheet to answer the question.

Throughout the course, candidates are expected to carry out practical and investigative work, covering the skills of investigation design, observation, measurement, data presentation and handling, drawing conclusions and evaluation. These skills will primarily be assessed in the Controlled Assessment in Unit 2, although questions in the written paper will also assess these skills.

Unit 2 is assessed by Controlled Assessment, which is worth 60% of the overall marks for the specification. Candidates will need to carry out two assignments from the list provided by AQA each year.

Tiering of subject content

In this specification, there is additional content for Higher Tier candidates. This is denoted in the subject content in bold type.
3.2 The ideas behind How Science Works

Ideas in science attempt to explain the world in which we live. It provides technologies that have had a great impact on our society and the environment. Scientists try to explain phenomena and solve problems using evidence. The data to be used as evidence must be reproducible, repeatable and valid, as only then can appropriate conclusions be made.

A scientifically literate person should, amongst other things, be equipped to question and engage in debate on the evidence used in decision-making.

The scientific terms used in this section are clearly defined by the Association for Science Education (ASE) in The Language of Measurement: Terminology used in school science investigations (ASE, 2010). Teachers should ensure that they, and their candidates, are familiar with these terms. Definitions of the terms will not be required in assessments, but candidates will be expected to use them correctly.

The reproducibility and the repeatability of evidence refer to how much we trust the data. The validity of evidence depends on these, as well as on whether the research answers the question. If the data is not reproducible or repeatable the research cannot be valid.

Obtaining evidence
Evidence must be approached with a critical eye. It is necessary to look closely at how measurements have been made and what links have been established. Scientific evidence provides a powerful means of forming opinions. A hypothesis is a proposal intended to explain certain facts or observations.

Observation
Observation is the link between the real world and scientific ideas. When we observe objects, organisms or events, we do so using existing knowledge. Observations may suggest hypotheses and lead to predictions that can be tested.

Designing an investigation
An investigation is an attempt to determine whether or not there is a relationship between variables. Therefore, it is necessary to identify and understand the variables in an investigation. The design of an investigation should be scrutinised when evaluating the validity of the evidence it has produced.

Making measurements
When making measurements we must consider such issues as inherent variation due to variables that have not been controlled, human error and the characteristics of the instruments used. Evidence should be evaluated with the repeatability and validity of the measurements that have been made in mind.

Presenting data
To explain the relationship between two or more variables, data may be presented in such a way as to make the patterns more evident. There is a link between the type of graph used and the type of variable represented. The choice of graphical representation depends upon the type of variable represented.

Using data to draw conclusions
The patterns and relationships observed in data represent the behaviour of the variables in an investigation. However, it is necessary to look at patterns and relationships between variables with the limitations of the data in mind in order to draw conclusions.

Evaluation
In evaluating a whole investigation, the repeatability, reproducibility and validity of the data obtained must be considered.
3.3 Unit 1 AAS1 Science at Work

Unit 1 is divided into six sections:

3.3.1 Following standard procedures
3.3.2 Health and safety at work
3.3.3 The use of science in maintaining health and fitness
3.3.4 The use of science to develop materials for specific purposes
3.3.5 The use of science in food production
3.3.6 The use of science in analysis and detection

Each section begins with an overview to put the content into clear and relevant contexts, emphasising why such knowledge is relevant to people today and why the work of the scientists concerned is important.

Teachers should use the sections entitled ‘Candidates need to understand that;’ to introduce candidates to the content and to encourage informed discussion around the subject covered.

The substantive content of each section is presented under the heading “Candidates need to:” as a series of numbered statements containing details of what candidates need to know and understand and what they will be assessed on.

At the end of each section there is a box highlighting areas where candidates will be expected to apply the knowledge and understanding they have gained in discussing, evaluating and suggesting implications of data and evidence (“How Science Works”).

Additional guidance, expansion of the content and clarification on what may be examined is given at the end of each section. Numbering in the additional guidance boxes corresponds with the numbering of the subject content above it.

The subject content is assessed by a 60 minute written paper, which is worth 40% of the overall marks for the specification.

Application of knowledge and understanding gained in discussing, evaluating and suggesting implications of data and evidence is also assessed in the written paper. Areas that could be covered are highlighted at the end of each section.

The content of Unit 1 directly links to the investigation and research that candidates will carry out in the Controlled Assessment unit (Unit 2).
3.3.1 Following standard procedures

Throughout this course candidates will learn that standard procedures are an important part of practice in science laboratories. They will learn about the importance of using ‘scientific methodology’ and following standard procedures, and how to use them correctly.

Candidates need to understand that:

When working in laboratories scientists follow standard procedures to obtain evidence.

In developing procedures, scientists will often start with an observation and make a hypothesis to explain their observation. They then test their hypothesis, with trials and experiments that can also be carried out by other people, to show why their data and results are correct.

A ‘standard procedure’ describes exactly how to carry out an experiment or procedure, and ensures that everyone who carries out a particular experiment does it in exactly the same way so that the results collected are consistent. For these reasons, standard procedures are very important in the scientific workplace and are used when monitoring and controlling processes and when making and analysing substances. Standard procedures are agreed within a company or organisation and may be agreed nationally or internationally.

Throughout this course, candidates need to be able to:

1. Explain the importance of using standard procedures to obtain evidence.
2. Read a procedure and check to see if there is anything they do not understand.
3. Set out their work area appropriately and collect together the equipment and materials needed.
4. Follow instructions one step at a time.
5. Select instruments of appropriate sensitivity and use them to make accurate observations or measurements.
6. Identify possible sources of error and repeat observations and measurements, when necessary, to improve reproducibility and repeatability.
7. Use evidence collected from their experimental work to make informed conclusions.
8. Present their evidence and conclusions in a suitable report that clearly communicates their findings to others.

Additional guidance

Whilst completing practical work throughout the course and their investigations for Unit 2, candidates should be able to use the principles of scientific methodology and follow standard procedures.

Candidates should appreciate that scientists start investigations by asking a question or recognising a problem. In order to answer the question or solve the problem scientists carry out research and make a hypothesis. They then test the hypothesis by doing experiments or tests. They analyse the evidence they obtain from the experiments and make conclusions from their analyses. Finally, they communicate their conclusions and the procedures they have followed to others.

Examination questions may also require candidates to give reasons for selecting appropriate instruments and to identify anomalous results from given data.
3.3.2 Health and safety at work

In this section, candidates will learn about the regulations that deal with health and safety in the workplace and about the importance of assessing and managing risk assessment and applying safe practice. Candidates will be expected to apply safe practices throughout the practical work they undertake during the course.

Candidates need to understand that:
Strict regulations control the way in which scientists work and behave in laboratories and other workplaces. Regulations are designed to protect the people who work in potentially hazardous environments. Both employers and employees have responsibilities for ensuring that these regulations are followed and that all work is carried out safely.

Candidates need to know:
1. That the Health and Safety at Work Act deals with occupational health and safety in the United Kingdom.
2. That the Health and Safety Executive (HSE) is the regulatory body responsible for the regulation of risks to health and safety in the workplace.
3. The commonly used hazard symbols (biohazard, dangerous for the environment, explosive, highly flammable, harmful/irritant, oxidising, radioactivity, electrical hazard and toxic).
4. The common safety signs used in workplaces (mandatory signs for eye protection, hand protection, breathing masks, ear protection; safe condition signs: first aid, eye wash, emergency shower and fire alarm point).
5. The common types of fire extinguishers (water, foam, powder and carbon dioxide) and which type of fire each should be used on.
6. How to carry out a health and safety check of their own working area.
7. How to carry out risk assessments for all practical activities undertaken during this course.

Additional guidance
7. Whilst completing practical work throughout the course and their investigation for Unit 2, candidates should be able to complete and use appropriate risk assessments.
3.3.3 The use of science in maintaining health and fitness

In this section candidates will learn about some of the science and techniques used by healthcare scientists who work in maintaining health and fitness.

Physiologists are interested in the health and fitness of the parts of the body involved in exercise. Nutritionists and diéticians help to optimise performance by controlling energy and nutrient intake.

This section should be delivered as far as possible in terms of the knowledge, understanding and skills that healthcare scientists (for example, sports physiologists, nutritionists, diéticians and physiotherapists) use to carry out their work.

3.3.3.1 Healthcare scientists

Candidates need to understand that:
Healthcare scientists play a vital role in the prevention, diagnosis and treatment of a huge number of medical conditions and in rehabilitation. Together with doctors and nurses, healthcare scientists include pharmacists, diéticians, physiotherapists and people involved in the coaching and training of sportsmen and women.

Candidates need to know:
1. At least two occupations in healthcare science.
2. The roles of at least two healthcare scientists.
3. The role of a fitness practitioner.

Additional guidance
Candidates may link this part of the specification with their Unit 2 report.
3.3.3.2 Exercise and the human body

Candidates need to understand that:
Healthcare scientists working in fields related to exercise and fitness need a detailed understanding of the organs and organ systems in the body and understand the need for personal fitness. Before healthcare scientists can advise on personal fitness, they need to be able to take baseline measurements of physiological changes that happen in the body before, during, and after exercise from a large number of people to build up a model of normal values. They can then compare these values with readings from individuals and use them to develop ways of improving fitness.

Candidates need to know:
1. The physiological changes that occur during exercise (linked to breathing and heart rate): increase in heart rate, increase in the volume of blood pumped with each beat, increase in the breathing rate and increase in the volume of each breath.

2. How to take baseline measurements of:
   (a) the heart rate (pulse) and the breathing rate at rest and during exercise, and how to monitor the recovery rate immediately after exercise
   (b) temperature
   (c) the vital capacity and tidal volume of the lungs using a spirometer and to be able to define these terms
   (d) the glucose content of blood and urine using a dip-stick method
   (e) the strength of a muscle using the grip test method

3. The parts of the thorax related to breathing (ribs, intercostal muscles, diaphragm, lungs, trachea, bronchi, bronchioles and alveoli), and be able to recognise these on a diagram.

4. How the structure of the thorax enables ventilation of the lungs.

5. The structure of the human cardiovascular system.

6. The function of the heart and lungs in providing glucose and oxygen to the muscles.

7. The word equation for aerobic respiration:
   \[ \text{glucose} + \text{oxygen} \rightarrow \text{carbon dioxide} + \text{water} (+ \text{energy}) \]

8. The formula equation for aerobic respiration:
   \[ C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O (+ \text{energy}) \]

9. That if insufficient oxygen is reaching the muscles, they use anaerobic respiration to obtain energy.

10. That anaerobic respiration is the incomplete breakdown of glucose and produces lactic acid.

11. That anaerobic respiration releases much less energy than aerobic respiration.

12. That ‘oxygen debt’ may occur in muscles due to the build up of lactic acid, which needs to be converted back to glucose.

13. That the thermoregulatory centre in the brain monitors and controls body temperature.
14. How humans maintain a constant body temperature:
   (a) by sweating (evaporation)
   (b) by the dilation of blood vessels that supply skin capillaries.

15. How humans maintain the correct amount of water in the body.

16. How blood glucose levels are controlled by the hormone insulin.

17. How blood glucose levels are controlled by the hormone glucagon.

18. That glycogen is the storage carbohydrate that is used when circulating blood glucose drops to a low level.

Candidates should be able to use scientific data to:
- calculate pulse and breathing rate.

Candidates should be able to use scientific explanations to:
- suggest suitable measurements to take in order to monitor physiological changes during exercise
- discuss the importance of taking accurate, repeatable and reproducible measurements.

Additional guidance

5. Candidates should be able to describe the structure of the heart and the pathway of the blood through the heart. They should be able to name the atria and ventricles and should understand how these structures function with valves to pump the blood.

Candidates should know the differences in both structure and function between the main blood vessels (arteries, veins and capillaries) and why a pulse can be felt in an artery. They should know the composition of the blood and the function of the red blood cells (carrying oxygen) and the plasma (carrying glucose).

7–12. Candidates should be able to explain aerobic and anaerobic respiration and the consequences of both types of respiration in terms of energy released (when extra energy is needed during vigorous exercise, lactic acid is produced). Higher Tier candidates also need to know that the lactic acid later needs to be converted back to glucose, incurring an ‘oxygen debt’.

8. Higher Tier only.

11. Higher Tier only.

12. Higher Tier only.

15. Control of fluid balance should be limited to the kidney maintaining a balance between water taken in and the water lost. Loss of water occurs in sweat, faeces, urine.

16. Candidates should know that if the blood glucose concentration is too high (following a meal), the pancreas releases insulin into the blood, which causes the liver to remove glucose from the blood and store it as insoluble glycogen.

17. Higher Tier only.
   Candidates also need to know that if the blood glucose concentration is too low (for example, during exercise) the pancreas releases glucagon, which causes the liver to convert glycogen back to glucose and release it into the blood.
3.3.3.3 Injuries to the human body

Candidates need to understand that:

Healthcare professionals who treat injuries need to know how the healthy body works so that they can use the information they obtain from examining injuries to decide on the best form of treatment.

Healthcare professionals who help to treat injuries include physiotherapists, who use various massaging and manipulation techniques to treat muscle, ligament and joint injuries. They may also advise on the design and supervision of exercise programmes following injury. Scientists use the principles of biomechanics to study the science of movement and biomaterials scientists can advise on appropriate materials and methods to use in creating artificial joints and limbs.

Candidates need to know:

1. That sports physiotherapists treat skeletal-muscular injuries.

2. That injuries may result in damaged ligaments, pulled or torn muscles, tendon rupture, torn cartilage, damaged joints, dislocation or fractured bones.

3. The functions of the skeleton in support, protection and allowing movement.

4. The antagonistic action of muscles in moving bones.

5. The role of muscles in moving bones, which act as simple levers.

6. That the turning or twisting effect of a force about a pivot is called its moment.

7. That moment can be calculated using the equation:

\[
\text{moment} = \text{force} \times \text{perpendicular distance to the pivot (metres, m)}
\]

8. The structure and function of a synovial joint and its parts (cartilage, synovial fluid and synovial membrane).

9. That worn or injured joints can be replaced by artificial joints made from appropriate materials.

Candidates should be able to use scientific data to:

- discuss the appropriateness of certain materials for artificial joints.

Candidates should be able to use scientific explanations to:

- evaluate issues arising from use of artificial joints and limbs.

Additional guidance

4. Candidates should know that a joint is where bones meet. Limbs are moved in different directions using joints. Tendons join muscle to bone, enabling movement. Ligaments join bone to bone, stabilising the joint.

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

8. Higher Tier only.

Candidates should know that in a synovial joint (for example, the knee), cartilage reduces friction, synovial fluid lubricates the joint and the synovial membrane produces the synovial fluid.
3.3.3.4 Nutrition for exercise and fitness

Candidates need to understand that:
The correct combination of carbohydrates, proteins, fats, vitamins, minerals and water is essential to maximise athletic performance. Nutritionists and dieticians analyse a person’s nutritional intake and use the results of their analyses, together with their knowledge of how the body uses nutrients, to advise on how to maximise the performance of the body during exercise.

Candidates need to know:
1. How the daily energy requirement for an individual depends on the mass of the individual (weight) and that this requirement increases during exercise.
2. Methods used to record dietary habits of individuals (24-hour dietary recall and diet diaries).
3. How to calculate:
   (a) Basic Energy Requirements (BER) (for every kg of body mass 5.4 kJ are required every hour).
   (b) Body Mass Index using the equation:
       \[ \text{BMI} = \frac{\text{mass (in kilograms, kg)}}{\text{height (in metres, m)}^2} \]
4. That Body Mass Index is an indicator of ideal weight.
5. That athletes increase their intake of complex carbohydrates (bread, pasta, rice) before competing to increase glycogen stores in the muscles.
6. That some athletes eat a diet high in protein to build muscle.
7. The terms ‘isotonic’, ‘hypertonic’ and ‘hypotonic’ as related to sports drinks.
8. The composition of isotonic sports drinks (water, glucose and electrolytes).

Candidates should be able to use scientific explanations to:
- compare a normally balanced diet with a diet used by a person competing in sport
- evaluate a range of different diets and comment on their suitability for athletes
- interpret BMI results.
2. Candidates should be able to analyse different diets and diet diaries and suggest suitable diets that may help athletes to achieve optimum athletic performance.

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

4. Candidates should also be aware of the limitations of the use of BMI and that it could lead to incorrect advice in certain circumstances. For example, a weightlifter is likely to be short and very heavy, because muscle weighs more than fat.

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

6. Candidates should be able to explain the purpose of high-protein diets and why and when these are used to achieve maximum performance.

8. Hypertonic drinks contain high levels of glucose and can be used to supplement carbohydrate intake. Hypotonic drinks contain little glucose and quickly replace fluids lost by sweating.
3.3.4 The use of science to develop materials for specific purposes

In this section, candidates will learn about some of the reasons why materials are chosen by materials scientists for particular purposes.

This section should be delivered as far as possible in terms of the knowledge, understanding and skills that materials scientists use to carry out their work.

3.3.4.1 Materials scientists

Candidates need to understand that:

Materials scientists are concerned with the design, manufacture and use of all classes of materials (including metals, ceramics, polymers and biomaterials), and with energy, environmental, health, economic and manufacturing issues related to materials. Materials scientists conduct research into the structures and properties of materials in order to obtain information that could be used to develop new products or enhance existing ones.

Products must be quality tested before going on sale to ensure that they comply with national and international standards and mandatory regulations that determine formulation, biological, chemical and physical properties, and that they are safe to use.

Candidates need to know:

1. That new products and materials are tested to assess quality and ‘fitness for purpose’.

2. The names of at least two organisations that are responsible for setting and testing product standards.

3. That products marketed in the European Community should carry the ‘CE’ Mark.

Additional guidance

2. Organisations that set standards for products include the British Standards Institute and the European Committee for Standardisation.

3. ‘CE marking’ is a process that applies to a wide variety of products and one which manufacturers located in the EU or importers of goods into the EU must complete.

Candidates may link this part of the specification with their Unit 2 report.
3.3.4.2 The properties and uses of materials

Candidates need to understand that:

Deciding which new materials to use to make a product requires a thorough understanding of the properties of the material and a detailed knowledge of materials science.

Materials scientists often use scientific models to represent the structure of a material. They sometimes undertake laboratory experiments to test a hypothesis that they have developed from a scientific model, such as a test for the tolerance of a material under tension or compression.

Candidates need to know:

1. The following terms, and how they are used to describe the properties of materials:
   (a) hardness
   (b) density
   (c) stiffness / flexibility
   (d) toughness / brittleness
   (e) compressive and tensile (breaking) strength
   (f) thermal conductivity
   (g) electrical conductivity.

2. That tensile strength is the ability to resist stretching and that compressive strength is the ability to resist crushing or squashing.

3. How to carry out tests on materials to determine the properties given above, plus resistance to corrosion (air and water).

4. How to recognise the parts of objects that are in tension or compression.

5. How to use the following relationships to compare materials:

   \[ \text{Density} = \frac{\text{mass}}{\text{volume}} \]

   \[ \text{Stress (N/cm}^2\text{)} = \frac{\text{force (in newtons, N)}}{\text{cross-sectional area (in cm}^2\text{)}} \]

   \[ \text{Hooke's Law: Force (N) = Constant (N/cm) } \times \text{ Extension (cm)} \]

6. The main types of materials (wood, metal, polymer, ceramic and composite).

7. The characteristic properties of metals (high tensile strength, thermal conductivity, flexibility and hardness).

8. That metals are malleable, can be hammered into shape and rolled into sheets.


10. That alloys are a mixture of two or more elements, of which at least one is a metal.

11. The characteristic properties of polymers (low density, flexibility and low thermal conductivity).
12. That thermoplastic polymers (for example, polyethene) are flexible and soften when heated, so are easy to mould and shape.

13. That altering the chain length and the amount of branching in a polymer affects the strength of forces between the chains and changes the melting point, density and strength of a polymer.

14. That thermosetting polymers (with strong cross-links between the chains that remain rigid once set) do not melt when heated and cannot be remoulded.

15. That ceramics are hard, brittle solids with very high melting points, low thermal conductivity and high resistance to chemical attack.

16. That composites are a combination of materials.

17. The properties of composites in terms of the properties of their components.

18. Examples of the types of material used for sports and medical equipment and transport.

19. The reasons for using different types of material in sports and medical equipment and in transport.

20. The advantages and disadvantages of synthetic materials compared with natural materials.

21. How different properties of materials are desirable for different purposes:

(a) low density
(b) smoothness
(c) high tensile strength
(d) thermal insulation
(e) flexibility
(f) shock-absorbency.

Candidates should be able to use scientific data to:

■ assess the suitability of materials for a particular purpose (by comparing properties)
■ compare the advantages and disadvantages of synthetic and natural materials.

Candidates should be able to use scientific explanations to:

■ suggest reasons why materials for specific purposes have changed over time.
**Additional guidance**

7. Candidates should be able to link properties of metals to the model of metallic bonding.

11. Candidates should be able to link the properties of polymers to the model of their bonding (compounds made up of large long-chained molecules with strong covalent bonds between the atoms in the chain and weaker forces of attraction between the chains).

12. Higher Tier only.

13. Higher Tier only.

14. Higher Tier only.

19. Some materials and examples of their uses include:

- **aluminium alloys** – used, for example, in aircraft frames, bicycle frames and tennis racquets
- **stainless steel** – used, for example, in exhaust systems, car trim/grilles, road tankers, ship containers, chemical tankers, surgical instruments, surgical implants, MRI scanners and golf clubs
- **titanium and its alloys** – used, for example, in the building of high-performance bicycle frames, aircraft frames and replacement hip joints
- **polymers** – materials for sports clothing, for example as the foam inner layer of cycle helmets
- **Kevlar** – a polymer used, for example, to increase the ability to absorb energy in, eg, tennis racquets and the shafts of golf clubs
- **Composites** – for example, laminated windscreens
- **carbon fibre** – a composite material used, for example, to make bicycle frames, racing dinghies/yachts, tennis rackets, badminton rackets, and the shafts of golf clubs
- **ceramics** – used, for example, as heat-resistant tiles on space shuttles and catalytic converters
- **carbon/ceramic** – a light, hard material used, for example, as brakes on racing cars.

Please note that this list is **not** exclusive.
3.3.5 The use of science in food production

The application of science and technology by agricultural scientists has increased food production throughout the developed world. In this section, candidates will learn about some of the science and techniques used by agricultural and food scientists, including microbiologists, in the production of food. Candidates will learn about how microorganisms can adversely affect human health but also how they can be used to benefit humans. They will also consider some economic and environmental aspects of food production.

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

3.3.5.1 Agricultural and food scientists

Candidates need to understand that:

The Food Standards Agency (FSA) is an independent food safety authority set up by an Act of Parliament in 2000 to protect the public’s health and consumer interests in relation to food. The FSA is responsible for the entire UK food industry from farming, food production and distribution to retail and catering.

The Department for Environment, Farming and Rural Affairs (Defra) has a responsibility for ensuring that the farming industry is thriving and that they produce a sustainable, healthy and secure food supply.

Candidates need to know:

1. That the work of agricultural and food scientists may include:
   (a) the study of farm crops and animals in order to develop new ways of improving their quality and quantity
   (b) the control of pests and weeds safely and effectively
   (c) the conservation of soil and water
   (d) the use of biotechnology to manipulate the genetic material of plants and crops to make them more productive or resistant to disease.

2. That agricultural and food scientists may be found in many different types of employment, including:
   (a) the food production and processing industries
   (b) research – to, for example, look for new food sources
   (c) sport, where they help athletes understand the links between their performance and what they eat and drink
   (d) analysis of food content to determine levels of vitamins, fat, sugar or protein, or searching for substitutes for harmful or undesirable additives such as nitrites.

3. That the FSA and Defra are regulatory authorities responsible for the safe production of the food we eat and that they also consider the ethical implications of food production.

4. The role of the regulatory authorities in the safe production of food.

Additional guidance

Candidates may link this part of the specification with their Unit 2 report.
3.3.5.2 Microorganisms and food safety

Candidates need to understand that:
Food poisoning is caused by the growth of microorganisms, usually bacteria, and by the toxins they produce when they grow. Microbiologists and Public Health Inspectors are responsible for monitoring the growth of bacteria in places where their presence causes harmful effects.

Candidates need to know:
1. Examples of bacteria that cause food poisoning (campylobacter, E.coli and salmonella).
2. Optimum conditions for the growth of bacteria (warmth, moisture and food source).
3. The common symptoms of food poisoning (stomach pains, vomiting and diarrhoea).
4. That food hygiene is concerned with the care, preparation and storage of food in order to prevent food poisoning.
5. How food preparation areas are kept free of bacteria:
   (a) good personal hygiene
   (b) wearing protective clothing
   (c) use of disinfectants on surfaces
   (d) using detergents to wash up
   (e) sterilisation using high temperatures or gamma rays
   (f) correct disposal of waste
   (g) control of pests such as insects and mice.
6. The ways in which the growth of bacteria can be slowed down or stopped:
   (a) refrigeration: slows down, but does not stop, the growth of bacteria
   (b) freezing: stops bacteria multiplying but does not kill them
   (c) heating: for example, ultra-heat treatment, where foods such as milk are heated to 132 °C for one minute and then rapidly cooled, which kills virtually all microorganisms and their spores
   (d) cooking: at the correct temperature kills microorganisms
   (e) drying: removes water so bacteria cannot digest and absorb the food source
   (f) salting: makes it impossible for bacteria to reproduce because they lose water from their cells by osmosis
   (g) pickling: the addition of vinegar to lower pH and inactivate most microorganisms.
7. How to carry out tests on food products to determine the level of bacteria in the food.
8. How to use aseptic techniques to swab areas to detect the presence of bacteria.
9. How to complete serial dilutions to make accurate bacteria counts.
10. How to make streak plates to identify the type of bacteria present.
Candidates should be able to use scientific explanations to:

■ discuss the problems of contamination of food products.

Additional guidance
Candidates should be able to describe and use standard laboratory techniques to detect the presence of bacteria and bacterial contamination in food.

3.3.5.3 Useful microorganisms in the production of food

Candidates need to understand that:
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.

Candidates need to know:
1. How bacteria, yeast and other fungi are used in food production (yoghurt, cheese, bread, beer and wine).

Candidates should be able to use scientific explanations to:

■ discuss the advantages of using microbes for food production.

Additional guidance
Candidates should be familiar with:

■ the use of bacteria to produce lactic acid in the production of yoghurt and cheese from milk
■ fermentation producing carbon dioxide gas, which makes dough rise
■ the use of yeast in fermenting sugar (maltose) to make beer and in fermenting the sugars in grape juice to make wine.
3.3.5.4 The use of organic and intensive farming in the production of food

Candidates need to understand that:
Agricultural scientists study how plants grow, determining which nutrients plants need. Two contrasting approaches to food production are intensive and organic farming.

Intensive farming produces large quantities of food cheaply and efficiently by maximising the growth of crops and farm animals. Agricultural scientists have produced artificial pesticides, herbicides and fertilisers using chemical reactions. These products allow food to be produced economically and are less labour intensive than using natural pesticides, herbicides or fertilisers.

Organic farming uses natural methods of producing crops and raising farm animals. Some consumers are willing to pay more for an organic product that has been produced in a more environmentally friendly way.

Candidates need to know:
1. That the work of agricultural and food scientists has resulted in:
   (a) intensification of farming practices – higher inputs are used to produce higher livestock or crop yields
   (b) technological and scientific developments in growing crops and rearing animals
   (c) better methods of storage, refrigeration and transportation of food.
2. That plants need the minerals nitrates, phosphates, potassium and magnesium, which they obtain from soil, for healthy growth.
3. That as crops grow they remove the essential nutrients from the soil and that these nutrients need to be replaced.
4. That by creating controlled environments, farmers can:
   (a) manage the inputs of light, temperature and ventilation to provide the best conditions for plant/animal growth
   (b) increase availability of carbon dioxide for photosynthesis
   (c) restrict animal movement to reduce energy loss in respiration.
5. The word equation for photosynthesis:
   \[
   \text{carbon dioxide + water} \rightarrow \text{glucose + oxygen}
   \]
6. How intensive farming increases crop yields by using artificial fertilisers, pesticides, herbicides and fungicides.
7. That artificial fertilisers consist of soluble chemical compounds (for example, ammonium nitrate) as a source of nitrogen, and can be made by neutralisation reactions.
8. That artificial fertilisers, pesticides, herbicides and fungicides are produced using chemical reactions that need to be controlled to make an economical product.
9. The factors that affect how quickly a chemical reaction occurs (concentration, temperature, use of catalysts and surface area), and be able to explain these in terms of collision theory.
10. The terms actual yield, theoretical yield and percentage yield, be able to use them correctly and be able to calculate these yields.
11. That some products are made using reversible reactions (e.g., ammonia: \( \text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3 \))

12. That in reversible reactions, the conditions affect the yield of the products.


14. How organic farming keeps animals under more natural conditions.

15. The advantages and disadvantages of both types of farming (food quality, cost, animal welfare, and effect on environment).

16. How to plan and assess how well a plant grows under various conditions.

Candidates should be able to use scientific explanations to:

- suggest the effect on the environment of the continued use of artificial fertilisers, pesticides, herbicides and fungicides and the effect of other factors associated with intensive farming
- discuss the ethics of food production and its distribution.

**Additional guidance**

3. Candidates should know that nutrients can be replaced by either natural (manure) or chemical fertilisers. They should also know why plants need certain nutrients, for example, nitrates for healthy leaf growth, phosphates for good root development, and potassium for a high fruit yield.

11. Higher Tier only. Candidates will be expected to write balanced chemical equations for the production of ammonia.

12. Higher Tier only. The understanding of reversible reactions should be limited to a qualitative treatment of the effects of temperature and pressure (the manufacture of ammonia for later use in fertiliser production such as ammonium nitrate).

13–15. Candidates should understand how controlled environments are used in intensive farming and be able to compare these with the techniques used in organic farming (for example, use of natural pests such as ladybirds or parasitic wasps and mechanical methods of weed control). Candidates should appreciate that if animals are kept warm, they will use less energy, and hence body weight, producing heat. If animals have good ventilation, they will keep healthy and a good food supply will promote growth. Animals farmed organically need more space, more time, and more labour to look after, and cost more to produce, but the animals may be better cared for.

16. Candidates should be able to describe and carry out an investigation to determine how well a plant grows under various conditions. An example would be to grow *Brassica rapa* or radishes using different nutrient conditions, light conditions or amounts of water and overcrowding.
3.3.5.5 The use of selective breeding and genetic engineering in the production of food

Candidates need to understand that:
Agricultural scientists have developed new methods of producing plants and animals with favourable characteristics. Both crops and livestock have been bred so that they produce more food or are more economical to harvest.

Candidates need to know:
1. That selective breeding allows agricultural and food scientists to:
   (a) choose the characteristics of the food item required
   (b) produce a more uniform crop (for example, in terms of size or harvesting time)
   (c) extend an organism’s tolerance range.

2. That selective breeding involves selecting the parents with desired traits, crossing them, selecting from their offspring and then repeating the process over several generations.

3. That genetic engineering involves the transfer of ‘foreign’ genes into the cells of animals or plants at an early stage in their development so that they develop with desired characteristics.

Candidates should be able to use scientific explanations to:
- discuss the economic, social and ethical issues concerning cloning and genetic engineering and suggest possible long-term evolutionary problems
- consider the impact of selective breeding and genetic engineering on the methods of food production over time.

Additional guidance
3. Higher Tier only.
Candidates will be expected to understand examples of the use of genetic engineering and to know some of the changes that can be made to an organism’s characteristics by genetic engineering.
3.3.6 The use of science in analysis and detection

One of the important tasks undertaken by scientists is the analysis and identification of chemical and biological substances. Analytical scientists are found in the manufacturing and pharmaceutical industries, in the healthcare and forensic services and in public protection. It is important that an analytical scientist works, records and interprets results accurately and performs the necessary tests and experiments safely.

Analytical scientists use scientific techniques to identify and to match substances and objects. This section should be delivered as far as possible in terms of the knowledge, understanding and skills that analytical scientists use to carry out their work.

3.3.6.1 Analytical scientists

Candidates need to understand that:
Analytical scientists answer questions and solve problems. The most important part of their work is to provide sufficient evidence that can be verified and used by others to confirm the answers to the questions and problems they investigate.

Analytical scientists use a variety of scientific procedures, mathematical principles, problem solving methods (including the use of complex instruments, chemical, biological, physical and microscopic examining techniques) to obtain and analyse evidence and consult reference literature to verify their work.

The work of analytical scientists includes:

- monitoring the production process of everything from food and drink to cosmetics and pesticides, ensuring that the quality of products is maintained
- determining the stability and quality of drugs and how they might be improved
- analysing body tissues and fluids to help medical staff diagnose disease
- analysing substances found at crime scenes to assist in criminal investigations
- monitoring and testing air, water and industrial waste.

Candidates need to know:
1. The importance of the work of analytical scientists working, for example, in forensic science, environmental protection (for example, Defra) healthcare (for example, public health laboratories) and in pharmaceuticals.

Additional guidance
Candidates may link this part of the specification with their Unit 2 report.
3.3.6.2 Analysing samples using qualitative chemical tests

Candidates need to understand that:
Qualitative analysis is an important aspect of the work of the analytical scientist. Chemical tests can be used to determine which substances are present in a sample.
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.

Candidates need to know:
1. The structure of an ionic compound: a giant lattice held together by strong forces of attraction between positively charged and negatively charged ions (for example, sodium chloride).
2. Why ionic compounds have high melting points.
3. That many substances obtained from living materials are organic compounds with covalent bonding.
4. The names of some simple covalent compounds, given their formulae, and the formula, given the name of the compound (CO₂, H₂O, C₂H₅OH, C₆H₁₂O₆).
5. That, although the covalent bonds between the atoms in a molecule are strong, the forces between the molecules are weak.
6. Why covalent compounds have low melting points and boiling points.
7. That flame tests are used to identify metal ions.
8. How to detect the presence of the metal ions Na⁺, K⁺, Ca²⁺ and Cu²⁺ using flame tests.
9. How to test the solubility of a compound in water.
10. How to remove solid matter to obtain a clear solution for use in further tests.
11. How to use universal indicator paper and pH meters to measure the pH of a solution.
12. How to use precipitation reactions to detect the presence of the non-metallic ions Cl⁻ and SO₄²⁻, and the metal ions Ca²⁺, Cu²⁺, Fe²⁺, Fe³⁺ and Pb²⁺.
13. How the CO₃²⁻ ion reacts with dilute hydrochloric acid and the positive result of this test.
14. How to test for carbon dioxide using limewater.
15. How to test for an alcohol (ethanol) using acidified potassium dichromate solution and how this reaction was used in the original breathalyser.
Candidates should be able to use scientific data to:

- determine whether an ionic compound is soluble in water
- determine the formula for an ionic compound
- suggest the name of a product resulting from 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 use scientific explanations to:

- suggest ways of improving the accuracy and reproducibility of the results obtained from tests on samples
- discuss the advances in breathalyser technology over time.

**Additional guidance**

Candidates need to be able to write word equations where appropriate.

**Higher Tier candidates need to be able to write balanced symbol equations where appropriate.**

1 and 2. Candidates should know that in ionic compounds the strong electrostatic attraction between ions of opposite charge gives the compounds a close regular structure. The strong force of attraction makes it difficult to separate the ions, which is why ionic compounds have a high melting point.

5 and 6. Candidates should know that atoms in covalent compounds share electrons and that these compounds are easy to boil and melt. This is because the bonds that hold the atoms together in a covalent compound are strong but the bonds that hold the molecules together are weak.
3.3.6.3 Analysing samples using quantitative techniques

Candidates need to understand that:
Analytical scientists use quantitative analysis to determine the amount of a substance present in a sample. Titration techniques can be used, for example, to determine the amount of acid in rainwater, lactic acid in milk and certain types of metal ions in polluted river water.

Candidates need to know:
1. That the relative atomic mass of an element is the mass of its atom relative to the mass of other atoms.
2. How to calculate the relative formula mass of a compound using the formula and the relative masses of the atoms it contains.
3. That the relative formula mass of a substance, in grams, is known as one mole of that substance.
4. How to calculate the masses of reactants and products from given balanced equations.
5. How to carry out titrations to determine the amount of substance in a sample.

Candidates should be able to use scientific data to:
- interpret results from analytical reports.

Candidates should be able to use scientific explanations to:
- suggest ways of improving the accuracy and reproducibility of the results obtained from titrations.

Additional guidance
Candidates need to be able to write word equations where appropriate.

Higher Tier candidates need to be able to write balanced symbol equations where appropriate.

5. Titrations should be limited to acid–base techniques (for example, to determine acid content of rainwater or the concentration of acid in vinegar).
3.3.6.4 Analysing samples using paper and thin-layer chromatography

Candidates need to understand that:
Chromatography is a technique that can be used to determine the number of components in a mixture. It can be used by analytical scientists to, for example, separate and compare samples of ink to obtain a match between the ink used in a particular pen with the ink used in a forged document.

Candidates need to know:
1. How coloured mixtures are separated using thin-layer and paper chromatography with both water and non-aqueous solvents.
2. That in chromatography substances are separated by the movement of a solvent (the mobile phase) through a medium (the stationary phase).
3. How to analyse a simple chromatogram produced by paper or thin-layer chromatography and use it to identify a substance in a mixture.
4. That chromatography depends on the relative attractions of molecules of a solute to the solvent and the medium.
5. Why different colours in the mixture are carried different distances by the solvent.
6. How to use the equation below to compare samples:

\[ R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}} \]

Candidates should be able to use scientific data to:
- identify and match samples from chromatograms.

Additional guidance
1 and 2. Candidates should be able to describe both paper and thin-layer chromatography techniques and should understand that separation of components in a mixture is caused by the substances that are more soluble in the solvent (the mobile phase) travelling faster. The component that is the most soluble in the mobile phase will move farthest up the paper.

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

4. Higher Tier only.
5. Higher Tier only.
3.3.6.5 Analysing samples using instrumental techniques

Candidates need to understand that:
Analytical scientists use more expensive and powerful electronic equipment than is available for use in the school laboratory. The equipment they use gives more accurate results, often using very small quantities of material. Examples of techniques used by forensic scientists include gas-liquid chromatography, mass spectrometry and infrared spectrometry.

The comparison microscope, polarising microscope and the electron microscope are also important tools used in, for example, the forensic science laboratory to compare samples.

Candidates need to know:
1. The distinctive features of bullets, fibres, seeds and soil that enable samples to be matched using results obtained from different types of microscope.
2. The distinctive features of pollen grains and layers of paint.
3. How to interpret simple traces obtained from gas-liquid chromatography, mass spectrometry and infrared spectrometry.
4. Why instrumental techniques provide more precise and reliable evidence than that obtained from simple laboratory experiments.

Candidates should be able to use scientific data to:
- decide whether observable features indicate a link between different samples and objects, for example, a suspect and the scene of a crime
- use traces from instrumental techniques to identify and match samples, for example, evidence with a possible suspect.

Candidates should be able to use scientific explanations to:
- discuss how the use of modern analytical techniques has changed the work of analytical scientists over time.

Additional guidance
1. Candidates need to know that measurements or distinctive features could be used to compare and analyse samples. For example, a bullet passing through the barrel of a gun picks up scratch marks. A test-fired bullet could be compared under a comparison microscope with a bullet from the crime scene to see if they have the same scratch marks. If the scratch marks line up it could prove that the gun fired the bullet.

   Fibres have distinctive features, which can be detected under the electron microscope – including, for example, colour, pattern and texture (wool has a pattern of surface scales and silk and most synthetic fibres have smooth surfaces).

2. Pollen grains are much smaller than seeds and the distinctive features of pollen grains include size, surface pattern and colour, which can be viewed with an electron microscope.

3. Higher Tier only.
   Experimental details of gas-liquid chromatography, mass spectrometry and infrared spectrometry are not required. Candidates will be expected to interpret traces to identify a match between an unknown and known substance.

4. Higher Tier only.
3.3.6.6 Analysing body fluids

Candidates need to understand that:
Blood typing can determine whether a bloodstain is human and to which blood group it belongs.

Samples of DNA can be extracted from blood, semen and saliva. When cut up into fragments and separated by electrophoresis, the DNA profile can be matched with great certainty to the DNA provided by, for example, a suspect of a crime. This technique can also be used to show whether or not people are related.

Candidates need to know:
1. The composition of blood (red blood cells, white blood cells, platelets and plasma).
2. The four main blood groups (A, B, AB and O).
3. That simple animal cells have a nucleus, cytoplasm and cell membrane.
4. That DNA is located in the nucleus of the cell.
5. That DNA is unique to the individual (except identical twins).
6. That children inherit their DNA from their parents.
7. That electrophoresis is used to identify DNA fragments.
8. That very small samples of material are required for electrophoresis.
9. How to interpret simple DNA profiles.
10. That DNA profiles can be compared and used to determine whether people are related or were at the scene of a crime.
11. Why DNA profiles in forensic investigations are of greater use than relying on evidence solely from blood groups.
12. How charged particles move in an electric field and how this movement can be used to separate them in order to produce a DNA profile.

Candidates should be able to use scientific data to:
- identify and match evidence from analysis of body fluids.

Candidates should be able to use scientific explanations to:
- discuss the ethical implications of storing DNA profiles.

Additional guidance

12. Higher Tier only.
Candidates should know that DNA is negatively charged when in an alkaline solution. In an electric field DNA fragments move towards the positive electrode. The smaller molecules of DNA move much faster than the larger ones and a DNA profile can be produced.
### 3.3.6.7 Analysing glass or plastic samples

**Candidates need to understand that:**

Different types of glass or plastic have different refractive indices. This enables fragments of glass and plastic to be compared and matched (for example, fragments found at a crime scene could be matched with fragments found on a suspect’s clothing or 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 $\frac{\sin i}{\sin r}$.

**Candidates need to know:**

1. How the refractive index of a glass fragment is determined using the oil immersion technique:
   - a small fragment of glass is immersed in a special oil on a microscope slide
   - as the oil is heated the refractive index of the oil changes and at a certain temperature the interface between the oil and glass will disappear
   - the temperature of the oil is used to work out the refractive index of the glass.

2. That when light enters a more dense medium it is refracted towards the normal, and that when it enters a less dense medium it is refracted away from the normal.

3. How to measure the refractive index of a glass block by measuring angles of incidence and refraction.

4. How to use the following equation to determine refractive index:

   $$\text{Refractive index} = \frac{\sin i}{\sin r}$$

   where $i$ is the angle of incidence and $r$ is the angle of refraction.

**Candidates should be able to use scientific data to:**

- identify and match different types of glass and plastic.
3.4 Unit 2 AAS2 How Scientists Use Practical Techniques

3.4.1 Introduction

This unit is assessed by Controlled Assessment. It is worth 60% of the marks for the award. The aim of this unit is for candidates to develop their own practical and analytical skills to solve problems, work safely and accurately and to understand the roles of scientists working in different disciplines.

The total number of marks available for this unit is 90.

In this unit, candidates will carry out two assignments:

- **Assignment 1** comprises research into the work of a scientist followed by a practical investigation based on one technique that such a scientist might use. The particular nature of the scientists in this assignment will be specified by AQA in the options given. Assignment 1 is worth 40 marks.
- **Assignment 2** is a practical investigation set in an applied context. It is worth 50 marks.

AQA expect that the assignments within this unit should take a total of approximately 45 hours to complete.

Each year, AQA will supply four options for each assignment for candidates to choose from. The investigations supplied by AQA will be based on, and will link directly to, the subject content of Unit 1.

It is expected that candidates will follow a practical and investigational approach throughout their course and appreciate that scientists and those who work with science are involved in many types of activity.

Access arrangements (see sections 4.5 and 5.4) can enable candidates with special needs to undertake this assessment.

For each assignment, candidates must complete at least one option although they may attempt any number of the four options supplied by AQA. For each assignment, the work that achieves the best mark should be submitted. The two options may be chosen from the same area of the specification, but teachers must ensure that candidates do not carry out the same technique in Assignment 2 as they have done in Assignment 1.

The documents provided by AQA for each assignment are:

- a list of task titles
- a set of Teachers’ Notes describing the investigation, suggesting applications, suggesting ways of contextualising the task for candidates and suggesting approaches to setting the practical
- notes for candidates on what they are expected to do.

3.4.2 Levels of control in task setting, task taking and task marking

Controlled Assessment is designed to address problems, such as plagiarism, recognised in coursework. For each subject, Controlled Assessment regulations from Ofqual stipulate the level of control required for task setting, task taking and task marking. The ‘task’ is what the candidate has to do; the ‘level of control’ indicates the degree of freedom allowed to teachers and candidates for different aspects of the ‘task’. For this unit, the ‘task’ is an investigation.

**Task setting – high control**

Each year AQA will provide a number of equivalent investigations for each assignment, set in appropriate contexts for candidates to complete. Centres should choose at least one investigation for each assignment which candidates should complete. It is permissible to complete more than one investigation and submit the best for moderation purposes.

**Task taking – medium control**

Research may be undertaken under limited supervision. This means that candidates need not be under the direct supervision of staff at all times. However, candidates are required to complete all of the work other than research under informal supervision. This means that the centre must ensure that:

- plagiarism does not take place
- any sources candidates use are clearly recorded
- each candidate’s preparation for the final production of the work is their own.
Supervision of candidates must ensure that they complete the tasks as set by AQA and as contextualised by the centre.

Teachers may provide limited guidance to candidates. Teachers may review candidates’ work and provide advice at a general level but must not provide detailed and specific advice on how the draft may be improved to meet the assessment criteria. The nature of any guidance provided and the details of any feedback given must be clearly recorded on the Candidate Record Form.

Candidates may be guided on the approach they might adopt but the outcome must remain their own. Likewise, feedback may summarise progress to date and propose suggested broad approaches for improvement but the detailed correction or annotation of work for feedback purposes is not allowed.

Candidates may work in small groups during their research and practical work, but each candidate must record and process the data then use it to make conclusions and evaluations individually.

Centres must ensure that the work of all candidates is collected at the end of each session and returned to candidates at the beginning of the next session.

Work may be either handwritten or word processed. Candidates using computers to write their report should not be allowed to take their work away on removable media such as memory sticks or CDs.

**Task marking – medium control**

AQA provide marking criteria and further guidance on how to mark the assignments for the unit (see sections 3.4.4–3.4.7). The criteria are common to all investigations.

AQA moderate your marking, in accordance with the procedures outlined in Section 7 of the specification.

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**3.4.4 Assignment 1: Investigating the work of scientists and how they use science**

Assignment 1 gives candidates the opportunity to find out about the work of a person who uses science in connection with healthcare, food, materials or in analysis of substances.

This assignment builds on the scientific knowledge and skills learnt by candidates in preparation for the examined unit (Unit 1). Candidates must research and carry out practical work in an applied context.

It is expected that the assignment should take approximately 10–15 hours to complete, including preparation, practical activity and research time.

Candidates need to appreciate that scientists have many different types of role in different types of organisation: they may classify things, obtain or make things, tackle specific problems, monitor and control changes. The more that scientists know about the materials and equipment they work with, the more effective they can be in their work.

Each year, AQA will provide a list of four types of scientist working within the following areas of the specification, all of which are linked to the subject content of Unit 1, and an outline for a practical investigation that illustrates a technique that a particular scientist may use in their work.

The particular kinds of scientist are:
1. a scientist working within the healthcare sector
2. a materials scientist
3. a scientist working with food
4. an analytical scientist.

Candidates will need to:
1. research the work of one of these scientists and prepare a report on their research
2. develop a hypothesis for a given investigation
3. carry out, using standard procedures, the investigation to collect evidence to test the hypothesis
4. analyse and draw conclusions from the data/evidence they obtain.

Teachers should contextualise the outline practical investigation and prepare a method and operating procedure for their candidates to follow. The practical technique should allow the candidate to understand the importance of, and appreciate the reasons for, using standard operating procedures.

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**3.4.3 Quality of Written Communication**

Candidates are expected to write their reports clearly, using good English and structuring the report in a logical and ordered way. The assessment of Quality of Written Communication (QWC) is included as an integral part of the assessment criteria. There are no discrete marks for QWC. The expectation is that in order to achieve the mark for the relevant criteria, candidates must have satisfied the QWC statement in each case.

The total number of marks available for this unit is 90.
Candidates will need to decide how they obtain information and the sources of information that are used. They may wish to use information from visits, questionnaires, the internet or CD-ROM.

Candidates will need to demonstrate skills associated with research and communication. They should be able to distinguish between relevant and irrelevant information and be able to structure their report appropriately. They should be reminded of the rules concerning plagiarism and that plagiarised work will receive no credit.

In their report for this assignment, candidates should:

- state the purpose of the type of organisation in which the scientist works
- state the purpose of the practical investigation they are undertaking
- give an account of the work of the scientist and link it to the scientific knowledge from the specification
- describe the qualifications required by this scientist to carry out their work
- explain how this scientist would use their practical skills and scientific knowledge to carry out the investigation
- state their hypothesis
- record their observations and results of their practical investigation appropriately
- analyse patterns and draw scientific conclusions from their results
- include a list of the resources that they have used in their research.

The report should demonstrate candidates’ skills in:

- research and processing secondary data
- making a hypothesis
- following standard operating procedures
- collecting and processing primary data
- analysing primary and secondary data.

Marks allocated to these areas are indicated in the table of marking criteria in Section 3.4.5.

Each of the marking criteria has statements for three levels of increasing demand. Generally, a candidate who satisfies a Level 2 (or 3) statement is also awarded the marks allocated to the Level 1 (or Levels 1 and 2) statements. In some cases, a ‘best-fit’ approach may be more appropriate in arriving at an overall mark for each strand.

The total number of marks for Assignment 1 is 40.
### 3.4.5 Marking criteria for Assignment 1

<table>
<thead>
<tr>
<th>Skill area</th>
<th>0 marks</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Assessment Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Research</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1A. Information on the organisation</td>
<td>No relevant content.</td>
<td>There is a statement of the purpose of the type of organisation in which the scientist works and of the investigation to be completed. Information is poorly organised and lacks a coherent structure, although it may contain some valid points.</td>
<td>There is a description of the purpose of the type of organisation in which the scientist works and of the investigation to be completed. Information shows some organisation and structure and contains some valid evidence.</td>
<td>There is an explanation of the type of organisation in which the scientist works and of the investigation to be completed in terms of the benefits to society. Information is logically organised and structured coherently, and is supported by a range of valid evidence.</td>
<td>3 AO1 3 AO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1–2 marks)</td>
<td>(3–4 marks)</td>
<td>(5–6 marks)</td>
<td></td>
</tr>
<tr>
<td>1B. Information on work of the scientist</td>
<td>No relevant content.</td>
<td>There is a brief account of the work of the scientist and at least one link to scientific knowledge from the specification.</td>
<td>There is a description of the work of the scientist and some relevant links to scientific knowledge from the specification are identified.</td>
<td>There is a detailed account of the work of the scientist, with clear links to scientific knowledge from the specification.</td>
<td>6 AO1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1–2 marks)</td>
<td>(3–4 marks)</td>
<td>(5–6 marks)</td>
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</tr>
<tr>
<td>1C. Qualification skills used by the scientist</td>
<td>No relevant content.</td>
<td>The qualifications required by the scientist are stated and at least one practical skill that is required to carry out the investigation is mentioned.</td>
<td>There is a description of the qualifications required by the scientist and how practical skills are used to carry out the investigation.</td>
<td>There is a description of the qualifications required by the scientist and an explanation of how practical skills and scientific knowledge are used to carry out the investigation.</td>
<td>3 AO1 3 AO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1–2 marks)</td>
<td>(3–4 marks)</td>
<td>(5–6 marks)</td>
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</tr>
<tr>
<td>1D. Sources of information</td>
<td>No relevant content.</td>
<td>A limited range of sources of information is given, some of which may have been provided to the candidate.</td>
<td>There is a record of using a range of identified sources of information, showing some degree of selection. The limitations of the data and conclusions that the scientist may recognise are given.</td>
<td>There is a bibliography containing a wide range or sources of information and the relevant information has been selected from this. Alternative strategies that the scientist may use to improve the data collected from the investigation are given.</td>
<td>5 AO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1 mark)</td>
<td>(2–3 marks)</td>
<td>(4–5 marks)</td>
<td></td>
</tr>
<tr>
<td>Skill area</td>
<td>0 marks</td>
<td>Level 1</td>
<td>Level 2</td>
<td>Level 3</td>
<td>Assessment Objective</td>
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<td>----------------------------------------</td>
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<td>------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>2. Making a hypothesis</td>
<td>No relevant hypothesis presented.</td>
<td>A vague hypothesis has been stated for the investigation, but it has little scientific foundation.</td>
<td>A hypothesis has been stated, which is relevant to the investigation.</td>
<td>A reasoned hypothesis with scientific justification has been given for the investigation.</td>
<td>3AO2</td>
</tr>
<tr>
<td></td>
<td>(1 mark)</td>
<td>(2 marks)</td>
<td>(3 marks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Following standard procedures and collecting data</td>
<td>No data collected or results presented.</td>
<td>The investigation has been carried out, but only vaguely following the standard operating procedure. Simple observations and measurements have been made and there is some attempt to record the results appropriately.</td>
<td>The investigation has been carried out, following the standard operating procedure with some guidance. Careful and accurate measurements and observations have been made and have been recorded in appropriate tables and graphs, with little guidance. Observations that it would be appropriate to repeat have been recognised.</td>
<td>The investigation has been carried out, independently following the standard operating procedure. Accurate and precise measurements and observations have been made throughout and have been independently recorded accurately and in appropriate tables and graphs. Reasons for repeating any measurements or observations have been given.</td>
<td>8AO2</td>
</tr>
<tr>
<td></td>
<td>(1–2 marks)</td>
<td>(3–5 marks)</td>
<td>(6–8 marks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Analysing data/evidence and drawing conclusions</td>
<td>No attempt made to identify patterns or manipulate the data and no conclusions given.</td>
<td>There is some attempt to identify patterns and carry out calculations. A vague explanation that the scientist may make in a report of the investigation is given. The conclusions show little logical structure or organisation.</td>
<td>Patterns within the data/observations have been identified and calculations carried out. Conclusions that the scientist may make in a report of the investigation are given, which are consistent with the evidence. The conclusions show some organisation and structure and relate directly to the evidence obtained.</td>
<td>Patterns within the data/observations are identified and explained and some expertise in manipulating the data to carry out calculations is demonstrated. Conclusions that the scientist may make, based on the evidence collected in a report of the investigation are given. The conclusions are clear and logical and relate directly to the evidence obtained, demonstrating a comprehensive scientific understanding.</td>
<td>3AO2 3AO3</td>
</tr>
<tr>
<td></td>
<td>(1–2 marks)</td>
<td>(3–4 marks)</td>
<td>(5–6 marks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
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</tbody>
</table>
Assignment 2: How scientists use evidence to solve problems

Assignment 2 gives candidates the opportunity to solve or respond to a scientific problem. Scientists 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 to solve a problem safely
- take part in research activities
- make measurements and observe changes correctly and accurately
- use particular scientific knowledge
- communicate and explain their findings to other people.

For this assignment, each year AQA will publish a list of four investigations based on, and linked directly to, the subject content of Unit 1. Candidates will need to use a range of practical skills and knowledge to carry out one investigation chosen from those supplied by AQA. The investigation should be considered as an integral part of the teaching programme.

When carrying out this assignment candidates will learn about:

- some techniques that may be used by different types of scientists
- the importance of hazard and risk
- 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 and other secondary sources
- interpreting results and drawing conclusions
- evaluating methods of data collection and considering the reliability of evidence
- presenting evidence.

This assignment may be carried out under informal teacher supervision.

We expect that the assignment should take approximately 25–30 hours to complete, including preparation time.

Preliminary work
In preparation for the assessment, teachers lead a discussion group with the candidates to outline the task, discuss the assessment criteria, discuss the technique to be used and illustrate the variety of equipment available.

Candidates should be left to themselves to plan the investigation and decide what variables they will study, the range interval and number of repeats they will take.

The teacher should show, and expect candidates to familiarise themselves with, the techniques(s) to be used in the investigation and with the equipment available to them.

As far as possible, there will be no restriction on the methods to be used.

At the end of the preliminary session, candidates need to research how the investigation would be used in a workplace context and should write their plan and risk assessment. This should take no more than one or two lessons (about 1½ hours). Work may be handwritten or word processed. Candidates’ work (including that done on removable media such as memory sticks or CDs) must be collected in at the end of the lesson and returned at the beginning of the next. The candidates’ completed plans and risk assessments should be made available for later use but must be kept securely between lessons then combined with the completed report for marking and moderation.

Practical work and data collection
The teacher may provide a method after the candidate has produced their own plan if the candidate’s plan is not adequate, uses equipment that cannot be sourced by the centre or is considered unsafe.

The practical work and data collection may be carried out under informal supervision during normal class time. Candidates may work individually or in groups during their practical work, but each candidate must record and process the data individually.

The method suggested in the Teachers’ Notes could be used, but this should not preclude centres from adapting this method to suit their own needs.

Instructions of a general nature may be given to candidates, but these must not be so prescriptive as to preclude candidates from making their own decisions.

During the investigation candidates should make and record observations with precision and accuracy; ICT may be used where appropriate or available. If working in groups, candidates must identify the data that has been collected under their own direction.

Candidates’ data/results, including work done on removable media such as memory sticks or CDs, must be collected by the teacher at the end of each lesson. Candidates must not be allowed to work on the
presentation or processing of their data between lessons.

We expect that the practical work will take place over a number of lessons. At the end of each lesson, candidates’ work (including any done on removable media) must be collected in and returned at the beginning of the next.

Writing the report

This work may be carried out under informal supervision during normal class time. Candidates must work individually to write up their findings, analyse their data and present their evaluations and conclusions.

Candidates should produce a report of their investigation in which they clearly:

1. describe the purpose of the investigation and plan how they will carry out their investigation, including selecting appropriate equipment
2. prepare a risk assessment for the investigation
3. record the data they have obtained appropriately
4. process the data and carry out calculations
5. analyse the data and make scientific conclusions based on their analysis
6. evaluate the investigation
7. explain how a scientist might use the results of the investigation in their workplace.

Marks allocated to these areas are indicated in the table of marking criteria in Section 3.4.7.

Each of the marking criteria has statements for three levels of increasing demand. Generally, a candidate who satisfies a Level 2 (or 3) statement is also awarded the marks allocated to the Level 1 (or Levels 1 and 2) statements. In some cases, a ‘best-fit’ approach may be more appropriate in arriving at an overall mark for each strand.

The total number of marks available for Assignment 2 is 50.
### 3.4.7 Marking criteria for Assignment 2

<table>
<thead>
<tr>
<th>Strand</th>
<th>0 marks</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Assessment Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Planning</strong></td>
<td></td>
<td>No plan presented.</td>
<td>The plan devised is basic, stating the purpose of the investigation and including some of the equipment needed, but overall lacks a coherent structure.</td>
<td>The plan devised clearly states the purpose of the investigation and includes precise details of all the equipment needed. It is logically organised, clearly written and well structured in a series of ordered steps that could easily be followed by another person.</td>
<td>3 AO1 3 AO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1–2 marks)</td>
<td>(3–4 marks)</td>
<td>(5–6 marks)</td>
<td></td>
</tr>
<tr>
<td><strong>2. Assessing and managing risk</strong></td>
<td></td>
<td>No evidence of risks having been identified.</td>
<td>Most of the relevant hazards involved with the investigation have been indentified together with associated risks.</td>
<td>The relevant hazards involved with the investigation have been identified, together with the appropriate associated risks.</td>
<td>8 AO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1–2 marks)</td>
<td>(3–5 marks)</td>
<td>(6–8 marks)</td>
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</tr>
<tr>
<td>Strand</td>
<td>0 marks</td>
<td>Level 1</td>
<td>Level 2</td>
<td>Level 3</td>
<td>Assessment Objective</td>
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</tr>
<tr>
<td>3. Collecting data/evidence</td>
<td>No data collected or results presented.</td>
<td>Basic observations have been made from first-hand evidence obtained during the investigation.</td>
<td>Rational, accurate observations have been made from first-hand evidence obtained during the investigation.</td>
<td>Rational, accurate, reliable observations have been made from the first-hand evidence gained during the investigation.</td>
<td>11AO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data is recorded in a simple form such as a two-column table (possibly with some errors, for example, incorrect/missing headings or units).</td>
<td>Data is recorded in a more complex form such as a table of three or more columns with few errors that adequately represents the data obtained.</td>
<td>Data is recorded in a sophisticated way, such as table of three or more columns, with correct units and headings, that represents the data obtained.</td>
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<tr>
<td></td>
<td></td>
<td>A simple bar chart or line graph has been constructed from scales provided.</td>
<td>There may be some inconsistency in recording of data in terms of number of significant figures.</td>
<td>There is consistency in recording data in terms of using an appropriate number of significant figures throughout.</td>
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<tr>
<td></td>
<td></td>
<td>Overall, recording of results has no coherent structure.</td>
<td>An appropriate graph or chart is constructed, from candidate's own scale chosen, but with some guidance on the type of chart or graph.</td>
<td>An appropriate chart or graph has been constructed independently, with no guidance given on scales.</td>
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<td></td>
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<td></td>
<td>Observations that it would be appropriate to repeat are recognised.</td>
<td>Anomalous results are indentified and an explanation given why it would be appropriate to repeat certain results.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Results are recorded in a structured way, although there may be some errors.</td>
<td>Results are recorded logically and clearly, with only minor errors.</td>
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<td></td>
<td></td>
<td></td>
<td>(1–3 marks)</td>
<td>(4–7 marks)</td>
<td>(8–11 marks)</td>
</tr>
<tr>
<td>Strand</td>
<td>0 marks</td>
<td>Level 1</td>
<td>Level 2</td>
<td>Level 3</td>
<td>Assessment Objective</td>
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<td>--------------------------------------------</td>
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<td>------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>4. Processing primary and secondary data/ evidence</td>
<td>No attempt made to identify patterns in the evidence or manipulate data.</td>
<td>Simple patterns have been identified within data/evidence with guidance.</td>
<td>Patterns within data/evidence have been identified and the quantitative relationship between two variables described where appropriate.</td>
<td>Patterns within data/evidence have been identified and clearly explained using, for example, linear, directly proportional or by describing a complex relationship where appropriate.</td>
<td>4AO2, 4AO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simple calculations (such as calculation of a mean from three results) have been carried out. Calculations are poorly organised, lack coherent structure and may contain errors.</td>
<td>Calculations (such as a mean from a set of at least three results) have been carried out to an appropriate number of significant figures.</td>
<td>The need to exclude any anomalous readings from the calculation has been recognised.</td>
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<tr>
<td>5. Analysing primary and secondary data/ evidence</td>
<td>No attempt to draw any conclusions from the data/evidence obtained.</td>
<td>Conclusions containing a vague statement of what the evidence shows are given. The conclusions show little logical structure or organisation. There is no reference to secondary data.</td>
<td>Conclusions, showing some organisation and structure, are given and relate directly to the evidence obtained.</td>
<td>Conclusions are clear and logical and relate directly to the evidence obtained (both primary and secondary), recognising its limitations.</td>
<td>6AO3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Some comparison with secondary data has been made and some suggestions made on how to increase the validity of the data.</td>
<td>The conclusions illustrate a comprehensive scientific understanding.</td>
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</tr>
<tr>
<td></td>
<td>(1–2 marks)</td>
<td></td>
<td>(3–4 marks)</td>
<td>(5–6 marks)</td>
<td></td>
</tr>
<tr>
<td>Strand</td>
<td>0 marks</td>
<td>Level 1</td>
<td></td>
<td></td>
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<td>------------------------------</td>
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<td>-------------------------------------------------------------------------</td>
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<td></td>
</tr>
<tr>
<td>6. Evaluating the practical activity</td>
<td></td>
<td>A basic evaluation of the practical activity and a simple suggestion for improvement are given.</td>
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<tr>
<td></td>
<td></td>
<td>Although there may be some valid points, there are significant errors and/or omissions in the use of technical terms, spelling, punctuation and grammar, leading to an overall lack of clarity.</td>
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<td></td>
<td></td>
<td>(1–2 marks)</td>
<td></td>
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<tr>
<td>7. Workplace context</td>
<td></td>
<td>A simple workplace application of the investigation is given.</td>
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<tr>
<td></td>
<td></td>
<td>There is not necessarily any scientific evidence.</td>
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<tr>
<td></td>
<td></td>
<td>(1 mark)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>An evaluation of the practical activity is given, describing the effectiveness of working methods and making some justified suggestions for improvement so that more reliable evidence can be obtained.</td>
</tr>
<tr>
<td>The evaluation contains a range of technical terms, although not all are used correctly and there are omissions and errors in spelling punctuation and grammar, leading to inconsistency and some lack of clarity.</td>
</tr>
<tr>
<td>(3–4 marks)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A reasoned and logical evaluation of the investigation is given, covering both strengths and weaknesses of working methods and including justified suggestions for improvement so that more reliable and precise evidence can be obtained.</td>
</tr>
<tr>
<td>The evaluation is clearly expressed, using technical terms correctly, and with few errors in spelling, punctuation or grammar.</td>
</tr>
<tr>
<td>(5–6 marks)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assessment Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>6AO3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total</th>
<th>50</th>
</tr>
</thead>
</table>

Subject Content

GCSE Additional Applied Science

for certification June 2014 onwards (version 1.0)

AQA
3.5 Mathematical and other requirements

Mathematical requirements

One learning outcome of this specification is to provide learners with the opportunity to develop their skills in communication, mathematics and the use of technology in scientific contexts. In order to deliver the mathematical element of this outcome, assessment materials for this specification contain opportunities for candidates to demonstrate scientific knowledge using appropriate mathematical skills.

The areas of mathematics that arise naturally from the science content in science GCSEs are listed below. This is not a checklist for each question paper or Controlled Assessment, but assessments will reflect these mathematical requirements, covering the full range of mathematical skills over a reasonable period of time.

Candidates are permitted to use calculators in all assessments.

Candidates are expected to use units appropriately. However, not all questions reward the appropriate use of units.

All candidates should be able to:

1. Understand number size and scale and the quantitative relationship between units.
2. Understand when and how to use estimation.
3. Carry out calculations involving +, -, x, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers.
4. Provide answers to calculations to an appropriate number of significant figures.
5. Understand and use the symbols =, <, >, ~.
6. Understand and use direct proportion and simple ratios.
7. Calculate arithmetic means.
8. Understand and use common measures and simple compound measures such as speed.
9. Plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes.
10. Substitute numerical values into simple formulae and equations using appropriate units.
11. Translate information between graphical and numeric form.
12. Extract and interpret information from charts, graphs and tables.
13. Understand the idea of probability.
14. Calculate area, perimeters and volumes of simple shapes.

In addition, Higher Tier candidates should be able to:

15. Interpret, order and calculate with numbers written in standard form.
16. Carry out calculations involving negative powers (only –1 for rate).
17. Change the subject of an equation.
18. Understand and use inverse proportion.
19. Understand and use percentiles and deciles.

Units, symbols and nomenclature

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

Scheme of Assessment

4.1 Aims and learning outcomes

GCSE specifications in Additional Applied Science should encourage learners to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. They should provide insight into and experience of how science works, stimulating learners’ curiosity and encouraging them to develop an understanding of science, its applications and its relationship with the world of work. Specifications should prepare learners to make informed decisions about further study and training opportunities in applied science and career opportunities.

GCSE specifications in Additional Applied Science must enable learners to:

- develop their knowledge and understanding of science and its applications
- develop their understanding of the benefits, drawbacks and risks of scientific developments for industry, the economy and society
- develop their understanding of the need for monitoring and regulation of the work of practitioners in science and science-related industries
- develop their awareness of risk factors and their ability to assess potential risks and manage them in practical and workplace contexts
- develop their understanding of the use of scientific protocols and standard procedures in the laboratory and the workplace
- develop their understanding of the scientific process
- develop their practical, problem-solving, enquiry and scientific modelling skills and understanding in laboratory, and work related contexts
- develop their understanding of the relationships between data, evidence and explanations and their ability to evaluate scientific methods, evidence and conclusions
- develop their communication, mathematics and technology skills in scientific contexts.
4.2 Assessment Objectives

The assessment units assess the following Assessment Objectives (AOs) in the context of the content and skills set out in Section 3 (Subject Content).

AO1 Recall, select and communicate their knowledge and understanding of science.

AO2 Apply skills, knowledge and understanding of applied contexts.

AO3 Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence.

Weighting of Assessment Objectives for GCSE Additional Applied Science

The table below shows the approximate weighting of each of the Assessment Objectives in the GCSE Additional Applied Science units.

<table>
<thead>
<tr>
<th>Assessment Objectives</th>
<th>Unit Weightings (%)</th>
<th>Overall weighting of AOs (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT 1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>AO1</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>AO2</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>AO3</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Overall weighting of units (%)</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

Quality of Written Communication (QWC)

In GCSE specifications that require candidates to produce written material in English, candidates must do the following:

- Ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear.
- Select and use a form and style of writing appropriate to purpose and to complex subject matter.
- Organise information clearly and coherently, using specialist vocabulary when appropriate.

In this specification QWC is assessed in Unit 1 by means of longer response questions. These questions are clearly indicated in the question paper. In these questions, candidates cannot obtain full marks unless they address the three bullet points above. In Unit 2, QWC is assessed throughout the Controlled Assessment task.
4.3 National criteria

This specification complies with:

- the Subject Criteria for GCSE Additional Applied Science including the rules for Controlled Assessment
- the Code of Practice
- the GCSE Qualification Criteria
- the Arrangements for the Statutory Regulation of External Qualifications in England, Wales and Northern Ireland: Common Criteria
- the requirements for qualifications to provide access to Levels 1 and 2 of the National Qualification Framework.

4.4 Previous Learning requirements

There are no previous learning requirements. However, any requirements set for entry to a course based on this specification are at your centre’s discretion.

4.5 Access to assessment: diversity and inclusion

GCSEs often need to assess a wide range of competences. This is because they are general qualifications designed to prepare candidates for a wide range of occupations and further study.

The revised GCSE qualification and subject criteria were reviewed to see whether any of the skills or knowledge needed by the subject presented a possible difficulty to any candidates, whatever their ethnic background, religion, sex, age, disability or sexuality. If there were difficulties, the situation was reviewed again to make sure that such tests of specific competences were only included if they were important to the subject. The findings were discussed with groups who represented the interests of a diverse range of candidates.

Arrangements are made for candidates with special needs to help them access the assessments as long as the competences being tested are not changed. Due to this, most candidates will be able to access any part of the assessment. Section 5.4 provides further details.
Administration

5.1 Availability of assessment units and certification

Ofqual’s revisions to the Code of Practice mean that from June 2014: assessments (both external assessments and moderation of controlled assessment) will only be available once a year in June with 100% of the assessment being taken in the examination series in which the qualification is awarded.

5.2 Entries

Please check the current version of Entry Procedures and Codes for up-to-date entry procedures. You should use the following entry codes for the units and for certification.

Unit 1 – AAS1 FP or AAS1 HP
Unit 2 – AAS2

GCSE Additional Applied Science certification – 4507

Candidates have to enter all the assessment units at the end of the course, at the same time as they enter for the subject award.

5.3 Private candidates

This specification is available to private candidates under certain conditions. Due to the Controlled Assessment, candidates must attend an AQA centre, which will supervise and mark the Controlled Assessment. Private candidates should write to us for a copy of Supplementary Guidance for Private Candidates.
5.4 Access arrangements, reasonable adjustments and special consideration

We have taken note of the equality and discrimination legislation and the interests of minority groups in developing and administering this specification.

We follow the guidelines in the Joint Council for Qualifications (JCQ) document: Access Arrangements, Reasonable Adjustments and Special Consideration: General and Vocational Qualifications. This is published on the JCQ website www.jcq.org.uk or you can follow the link from our website aqa.org.uk

**Access arrangements**

We can arrange for candidates with special needs to access an assessment. These arrangements must be made **before** the examination. For example, we can produce a Braille paper for a candidate with sight problems.

**Reasonable adjustments**

An access arrangement which meets the needs of a particular disabled candidate would be a reasonable adjustment for that candidate. For example, a Braille paper would be a reasonable adjustment for a Braille reader but not for a candidate who did not read Braille. The Disability Discrimination Act requires us to make reasonable adjustments to remove or lessen any disadvantage affecting a disabled candidate.

**Special consideration**

We can give special consideration to candidates who have had a temporary illness, injury or serious problem such as the death of a relative, at the time of the examination. We can only do this **after** the examination.

The Examinations Officer at the centre should apply online for access arrangements and special consideration by following the e-AQA link from our website aqa.org.uk

5.5 Examination language

We will only provide units for this specification in English.

5.6 Qualification titles

Qualifications based on this specification are:

- AQA GCSE in Additional Applied Science.
5.7 Awarding grades and reporting results

The GCSE will be graded on an eight-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.

We will publish the minimum raw mark for each grade, for each unit, when we issue candidates’ results. We will report a candidate's unit results to your centre in terms of uniform marks and qualification results in terms of uniform marks and grades.

For each unit, the uniform mark corresponds to a grade as follows.

### Unit 1
(maximum uniform mark = 80)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Uniform Mark Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>72–80</td>
</tr>
<tr>
<td>A</td>
<td>64–71</td>
</tr>
<tr>
<td>B</td>
<td>56–63</td>
</tr>
<tr>
<td>C</td>
<td>48–55</td>
</tr>
<tr>
<td>D</td>
<td>40–47</td>
</tr>
<tr>
<td>E</td>
<td>32–39</td>
</tr>
<tr>
<td>F</td>
<td>24–31</td>
</tr>
<tr>
<td>G</td>
<td>16–23</td>
</tr>
<tr>
<td>U</td>
<td>0–15</td>
</tr>
</tbody>
</table>

### Unit 2
(maximum uniform mark = 120)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Uniform Mark Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>108–120</td>
</tr>
<tr>
<td>A</td>
<td>96–107</td>
</tr>
<tr>
<td>B</td>
<td>84–95</td>
</tr>
<tr>
<td>C</td>
<td>72–83</td>
</tr>
<tr>
<td>D</td>
<td>60–71</td>
</tr>
<tr>
<td>E</td>
<td>48–59</td>
</tr>
<tr>
<td>F</td>
<td>36–47</td>
</tr>
<tr>
<td>G</td>
<td>24–35</td>
</tr>
<tr>
<td>U</td>
<td>0–23</td>
</tr>
</tbody>
</table>

We calculate a candidate’s total uniform mark by adding together the uniform marks for the units. We convert this total uniform mark to a grade as follows.

### GCSE Additional Applied Science
(maximum uniform mark = 200)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Uniform Mark Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>180–200</td>
</tr>
<tr>
<td>A</td>
<td>160–179</td>
</tr>
<tr>
<td>B</td>
<td>140–159</td>
</tr>
<tr>
<td>C</td>
<td>120–139</td>
</tr>
<tr>
<td>D</td>
<td>100–119</td>
</tr>
<tr>
<td>E</td>
<td>80–99</td>
</tr>
<tr>
<td>F</td>
<td>60–79</td>
</tr>
<tr>
<td>G</td>
<td>40–59</td>
</tr>
<tr>
<td>U</td>
<td>0–39</td>
</tr>
</tbody>
</table>
5.8 Grading and tiers

The Controlled Assessment is not tiered and the full range of grades A*-G is available to candidates for this unit.

For the other units, candidates take 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 paper receive the UMS score corresponding to their raw mark (i.e., they do not receive a UMS score 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.

5.9 Examination series

Candidates have to enter all the assessment units at the end of the course, at the same time as they enter for the subject award.

As a consequence of the move to linear assessment, candidates will be allowed to carry forward their controlled assessment unit result(s) following the initial moderation and aggregation during the lifetime of the specification.
Controlled Assessment administration

The Head of Centre is responsible for making sure that Controlled Assessment work is conducted in line with our instructions and JCQ instructions.

6.1 Authentication of Controlled Assessment work

To meet the requirements of the Code of Practice, we need the following.

- **Candidates** must sign the Candidate Record Form to confirm that the work they have handed in is their own.
- **Teachers and assessors** must confirm on the Candidate Record Form that the work marked is only that done by that candidate and was conducted in line with the conditions in the specification document (authentication declaration).
- **Centres** must give a mark of zero if candidates cannot confirm the work handed in for assessment is their own.

You should attach the completed Candidate Record Form for each candidate to his or her work. All teachers who have marked the work of any candidate entered for each component must sign the declaration that the work is genuine.

If you have doubts about signing the authentication declaration, you should follow these guidance points.

- If you believe that a candidate had additional assistance and that this is acceptable within the guidelines for the relevant specification, you should award a mark which covers only the candidate’s achievement without any help (you should sign the authentication declaration and give information on the relevant form).
- If you cannot sign the authentication declaration, the candidate’s work cannot be accepted for assessment.

If, during the external moderation process, there is no evidence that the work has been authenticated, we will award a mark of zero.

6.2 Malpractice

You should let candidates know about our malpractice regulations.

Candidates must not:

- submit work that is not their own
- lend work to other candidates
- give other candidates access to, or the use of, their own independently sourced research material (this does not mean that candidates cannot lend their books to another candidate, but that candidates should be stopped from copying other candidates’ research)
- include work copied directly from books, the internet or other sources without acknowledgement of the source
- hand in work typed or word-processed by someone else without acknowledgement.

These actions are considered malpractice, for which a penalty (for example being disqualified from the exam) will be applied.

If you suspect malpractice, you should consult your Examinations Officer about the procedure to be followed.

Where you suspect malpractice in Controlled Assessments after the candidate has signed the declaration of authentication, your Head of Centre must submit full details of the case to us at the earliest opportunity. The form JCQ/M1 should be used. Copies of the form can be found on the JCQ website www.jcq.org.uk

Malpractice in Controlled Assessments discovered prior to the candidate signing the declaration of authentication need not be reported to us, but should be dealt with in accordance with your centre’s internal procedures. We would expect you to treat such cases very seriously. Details of any work which is not the candidate’s own must be recorded on the Candidate Record Form or other appropriate place.
6.3 Teacher standardisation

We will hold standardising meetings for teachers each year, usually in the autumn term, for Controlled Assessment. At these meetings we will provide support in explaining tasks in context and using the marking criteria.

If your centre is new to this specification, you must send a representative to one of the meetings. If you have told us you are a new centre, either by sending us an Intention to Enter or an Estimate of Entry, or by contacting the subject team, we will contact you to invite you to a meeting.

We will also contact centres in the following cases:

- if the moderation of Controlled Assessment work from the previous year has shown a serious misinterpretation of the Controlled Assessment requirements
- if a significant adjustment has been made to a centre’s marks.

In these cases, you will be expected to send a representative to one of the meetings. If your centre does not fall into one of these categories, you can choose whether or not to come to a meeting. If you cannot attend and would like a copy of the written materials used at the meeting, you should contact the subject administration team at science-gcse@aqa.org.uk

It is likely that during the lifetime of this specification AQA will move to online teacher standardisation.

6.4 Internal standardisation of marking

Centres must have consistent marking standards for all candidates. One person must be responsible for ensuring that work has been marked to the same standard, and they need to sign the Centre Declaration Sheet to confirm that internal standardisation has taken place.

Internal standardisation may involve:

- all teachers marking some sample pieces of work and identify differences in marking standards
- discussing any differences in marking at a training meeting for all teachers involved in the assessment
- referring to reference and archive material, such as previous work or examples from our teacher standardising meetings.

6.5 Annotation of Controlled Assessment work

The Code of Practice states that the awarding body must make sure that teachers marking Controlled Assessments clearly show how the marks have been awarded in line with the guidance provided. For this specification, marking guidelines are provided by AQA and teachers must use these guidelines to annotate candidates’ work.

Annotation helps our moderators to see as precisely as possible where the teacher has identified that candidates have met the requirements of the marking guidelines.

Annotation includes:

- ticks and numbers showing how many marks have been awarded
- comments on the work that refer to the marking guidelines.
6.6 Submitting marks and sample work for moderation

The total mark for each candidate must be sent to us and the moderator on the mark forms provided, or electronically by Electronic Data Interchange (EDI) by the date given (see aqa.org.uk/deadlines/coursework_deadlines.php). Our moderator will contact you to let you know which pieces of work must be sent to them as part of the sample (please see Section 7.1 for more guidance on sending in samples).

6.7 Factors affecting individual candidates

You should be able to accept the occasional absence of candidates by making sure they have the chance to make up missed Controlled Assessments (you may organise an alternative supervised time session for candidates who are absent at the time the centre originally arranged).

If work is lost, you must tell us immediately the date it was lost, how it was lost, and who was responsible. Inform our Centre and Candidate Support Services using the JCQ form Notification of Lost Coursework JCQ/LCW form 15.

Where special help that goes beyond normal learning support is given, use the Candidate Record Form to inform us so that this help can be taken into account during moderation.

Candidates who move from one centre to another during the course sometimes need additional help to meet the requirements of a scheme of Controlled Assessment work. How this can be dealt with depends on when the move takes place. If it happens early in the course the new centre should be responsible for Controlled Assessment work. If it happens late in the course it may be possible to arrange for the moderator to assess the work as a candidate who was ‘Educated Elsewhere’. Centres should contact us by e-mailing science-gcse@aqa.org.uk as early as possible for advice about appropriate arrangements in individual cases.

6.8 Keeping candidates’ work

From the time the work is marked, your centre must keep the work of all candidates, with Candidate Record Forms attached, under secure conditions, to allow the work to be available during the moderation period or should there be an Enquiry about Results. You may return the work to candidates after the deadline for Enquiries about Results, or once any enquiry is resolved.

6.9 Grade boundaries on Controlled Assessment

The grade boundaries for the Controlled Assessment will be decided at the grade award meeting for each examination series and may, therefore, vary over time.
Moderation

7.1 Moderation procedures

Controlled Assessment work is moderated by inspecting a sample of candidates’ work sent (by post or electronically) from the centre to a moderator appointed by us. The centre marks must be sent to us and the moderator by the deadline given (see aqa.org.uk/deadlines/coursework_deadlines.php). Centres entering fewer candidates than the minimum sample size (and centres submitting work electronically) should send the work of all of their candidates. Centres entering larger numbers of candidates will be told which candidates’ work must be sent as part of the sample sent in for moderation.

Following the re-marking of the sample work, the moderator’s marks are compared with the centre marks to check whether any changes are needed to bring the centre’s assessments in line with our agreed standards. In some cases the moderator may need to ask for the work of other candidates in the centre. To meet this request, centres must keep the Controlled Assessment work and Candidate Record Forms of every candidate entered for the examination under secure conditions and they must be prepared to send it to us or the moderator when it is requested. Any changes to marks will normally keep the centre’s rank order, but where major differences are found, we reserve the right to change the rank order.

7.2 Consortium arrangements

If you are a consortium of centres with joint teaching arrangements (where candidates from different centres have been taught together, but where they are entered through the centre at which they are on roll), you must tell us by filling in the JCQ/CCA form Application for Centre Consortium Arrangements for Centre-assessed Work. You must choose a consortium co-ordinator who can speak to us on behalf of all centres in the consortium. If there are different co-ordinators for different specifications, a copy of the JCQ/CCA form must be sent in for each specification.

We will allocate the same moderator to each centre in the consortium and the candidates will be treated as a single group for moderation.

7.3 Procedures after moderation

When the results are published, we will give centres details of the final marks for the Controlled Assessment work.

We will return candidates’ work to you after the exam. You will receive a report, at the time results are issued, giving feedback on any adjustments that were made to your marks.

We may keep some candidates’ work for awarding, archive or standardising purposes and will inform you if this is the case.
Appendices

A Grade descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates who were awarded particular grades. The descriptions must be interpreted in relation to the content 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 Objectives overall (see Section 4). Shortcomings in some aspects of candidates’ performance in the assessment may be balanced by better performances in others.

Grade A

Candidates recall, select and communicate precise knowledge and detailed understanding of science and its applications and of the effects of science and its applications on society, industry, the economy and the environment. They demonstrate a clear understanding of why and how scientific applications, technologies and techniques change over time and the need for regulation and monitoring. They use a wide range of scientific, technical and mathematical terminology and conventions, symbols and techniques appropriately and consistently.

Candidates apply appropriate skills, including mathematical skills, knowledge and understanding effectively to a range of practical contexts and to explain applications of science. They apply a comprehensive understanding of practical methods, processes and protocols to plan and justify a range of appropriate methods to solve practical problems. They apply a range of observational, practical enquiry and problem solving skills to carry out procedures, investigate questions and test hypotheses effectively. They follow procedures and protocols consistently, evaluating and managing risk and working accurately and safely.

Candidates analyse and interpret critically a broad range of quantitative and qualitative information presented in a variety of forms. They reflect on the limitations of the methods, procedures and protocols they have used and the data they have collected and evaluate information systematically to develop reports and findings. They make reasoned judgements consistent with the evidence to develop substantiated conclusions.

Grade C

Candidates recall, select and communicate secure knowledge and understanding of the effects and risks of scientific developments and its applications on society, industry, the economy and the environment. They describe with reasons how scientific applications, technologies and techniques change over time. They use scientific, technical and mathematical terminology and conventions, symbols and techniques appropriately.

Candidates apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding in a range of practical and other contexts. They use models and scientific ideas to provide straightforward explanations of scientific applications. They plan and use appropriate methods and apply a variety of skills to address scientific questions and practical problems. They follow procedures, recognising and managing risk, to work safely and competently.

Candidates analyse, interpret and evaluate a range of quantitative and qualitative data and information. They recognise the limitations of evidence; undertake some evaluation and present reasons for argument. They draw conclusions consistent with their evidence.

Grade F

Candidates recall and communicate their limited knowledge and understanding of effects and risks of scientific developments and its applications on society, industry, the economy and the environment. They recognise simple inter-relationships between science and society. They demonstrate a limited understanding of how scientific applications, technologies and techniques change over time. They use a limited range of technical terms.

Candidates apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding in a limited range of practical and other contexts. They apply limited knowledge and ideas in different practical contexts. They identify simple links between evidence and explanations. Using a limited range of skills and techniques, they follow instructions to investigate scientific questions. They recognise a narrow range of risks and work safely.

Candidates interpret and evaluate some qualitative and quantitative data and information from a limited range of sources. They can draw elementary conclusions having collected limited evidence.
B  Spiritual, moral, ethical, social, legislative, sustainable development, economic and cultural issues, and health and safety considerations

We have taken great care to make sure that any wider issues (for example, spiritual, moral, ethical, social, legal, sustainable development, economic and cultural issues), including those relevant to the education of candidates at Key Stage 4, have been taken into account when preparing this specification. They will only form part of the assessment requirements where they are relevant to the specific content of the specification. In Section 3 (Subject Content), aspects of the wider issues that may be assessed are introduced with the phrases: ‘Candidates should be able to use scientific data to:’ and ‘Candidates should be able to use scientific explanations to:’. Additionally, health and safety considerations are addressed in the Controlled Assessment.

Environmental Education
We have taken the 1988 Resolution of the Council of the European Community and the 1993 Report ‘Environmental Responsibility: An Agenda for Further and Higher Education’ into account when preparing this specification and associated specimen units.

Avoiding Bias
We have taken great care to avoid bias of any kind when preparing this specification and specimen units.

European Dimension
We have taken the 1988 Resolution of the Council of the European Community into account when preparing this specification and associated specimen units.
C Overlaps with other qualifications

There are no overlaps with other GCSE Science qualifications.
The replacement of Key Skills with Functional Skills

The Key Skills qualifications have been replaced by the Functional Skills. However, centres may claim proxies for Key Skills components and/or certification in the following series: January, March and June 2012. The Administration Handbook for the Key Skills Standards 2012 has further details. All Examination Officers in centres offering AQA Key Skills and Wider Key Skills have been sent a letter outlining the details of the end dates of these subjects. Copies of the letters have also been sent to the Head of Centre and Key Skills coordinator. This is a brief outline of that information. It is correct as at August 2011 and replaces the information on the same subject found in other documents on the AQA website:

- **Key Skills Levels 1, 2 and 3 Test and Portfolio**
  The final opportunity for candidates to enter for a level 1, 2 or 3 Key Skills test or portfolio was June 2011 with the last certification in 2012.

- **Key Skills Level 4**
  The last series available to candidates entering for the Key Skills Level 4 test and portfolio was June 2010 with the last certification in the June series 2012.

- **Basic Skills Adult Literacy Levels 1 and 2, Adult Numeracy Levels 1 and 2**
  AQA Basic Skills qualifications will now be available until, at least, the June 2012 series.

### Funding

We have received the following advice on the funding of learners undertaking these qualifications:

- Currently the Skills Funding Agency funds Basic Skills in literacy and numeracy for adult, 19 plus, learners only. There are various support funds for learners aged 16–18 administered by the Young People’s Learning Agency (YPLA). These include EMA (until the end of the 2010/11 academic year), Care to Learn and discretionary learner support hardship funding for learners living away from home.

- This information is correct at the time of publication. If you would like to check the funding provision post-June 2011, please call the Skills Funding Agency helpdesk on 0845 377 5000.

### Wider Key Skills

The AQA Wider Key Skills qualifications are no longer available. The last portfolio moderation took place in June 2011.

Further updates to this information will be posted on the website as it becomes available.

GCSE Additional Applied Science
Specification
For exams June 2014 onwards
For certification June 2014 onwards

Qualification Accreditation Number: 600/0759/X

Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code will have only one grade counted for the purpose of the School and College Performance Tables. In the case of a candidate taking two qualifications with the same classification code that are of the same size and level, eg two full course GCSEs, the higher grade will count.

Centres may wish to advise candidates that, if they take two specifications with the same classification code, schools and colleges are very likely to take the view that they have achieved only one of the two GCSEs.

The same view may be taken if candidates take two GCSE specifications that have different classification codes but have significant overlap of content. Candidates who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

To obtain specification updates, access our searchable bank of frequently asked questions, or to ask us a question, register with Ask AQA: aqa.org.uk/ask-aqa/register

You can also download a copy of the specification and support materials from our website: sciencelab.org.uk/subjects for all your subject resources.