

Additional Applied Science A

Twenty First Century Science Suite

OCR GCSE in Additional Applied Science A J632

Foreword to the Second Edition

This Second Edition of the OCR GCSE Additional Applied Science A specification has been produced to correct minor errors found in the original edition (published in Dec 2005). There are no changes to actual content or the scheme of assessment. Centres should note however the grade descriptions in Appendix A have now been replaced with the correct versions.

Section 6.10 has been updated (amended in April 2008).

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Vertical black lines indicate a significant change to the previous printed version. Changes can be found on page 76.

1 About this Qualification

1.1 About the Twenty First Century Science Suite

The Twenty First Century Science suite comprises six specifications which share common material, use a similar style of examination questions and have a common approach to skills assessment. The qualifications available as part of this suite are:

GCSE Science A (J630) which emphasises scientific literacy – the knowledge and understanding which students need to engage, as informed citizens, with science-based issues. As with other courses in the suite, this qualification uses contemporary, relevant contexts of interest to students, which can be approached through a range of teaching and learning activities.

GCSE Additional Science A (J631) which is a concept-led course developed to meet the needs of students seeking a deeper understanding of basic scientific ideas. The course focuses on scientific explanations and models, and gives students an insight into how scientists develop scientific understanding of ourselves and the world we inhabit.

GCSE Additional Applied Science A (J632) which meets the needs of students who wish to develop their scientific understanding through authentic, work-related contexts. The course focuses on procedural and technical knowledge that underpins the work of practitioners of science and gives students an insight into what is involved in being a practitioner of science.

GCSE Biology A (J633)
GCSE Chemistry A (J634)
GCSE Physics A (J635) each of which provides an opportunity for further developing an understanding of science explanations, how science works and the study of elements of applied science, with particular relevance to professional scientists.

This suite is supported by the Nuffield Curriculum Centre and The University of York Science Education Group.

1.2 About this Additional Applied Science Specification

This booklet contains OCR's GCSE specification in Additional Applied Science for teaching from September 2006 and first certification in June 2008.

This specification, together with GCSE Science A (J630), aims to provide candidates with the scientific understanding needed to progress to further studies of science, should they choose to undertake them. It offers the perspective of the practitioner by focussing on practical competencies in contexts where the results clearly matter.

- It is pre-vocational in the sense that candidates will explore how science underpins a range of science-related work places.
- It builds upon and develops the range of the GCSE Science A modules by exploring the ways in which science is applied to the areas of activity.

Candidates should develop a greater understanding of:

- procedural and technical knowledge;
- what is involved in being a practitioner/technician of science;
- application of science in authentic work-related contexts.

The specification content has two distinctive features.

- There is a choice of modules, each of which is based on a study of how an important part of science is applied in contemporary life.
- Activities are included which develop a range of practical competencies (such as following standard procedure and problem solving) in work-related contexts.

Candidates take **three** units from Units 1 to 6 **and** Unit 7.

Unit	Unit Code	Title	Duration	Weighting	Total Mark
1	A324	AP1 Life Care	45 mins	16.7%	36
2	A334	AP2 Agriculture and Food	45 mins	16.7%	36
3	A325	AP3 Scientific Detection	45 mins	16.7%	36
4	A335	AP4 Harnessing Chemicals	45 mins	16.7%	36
5	A326	AP5 Communications	45 mins	16.7%	36
6	A336	AP6 Materials and Performance	45 mins	16.7%	36
7	A337	Additional Applied Science A – Work-related Portfolio	-	50%	96

1.3 Qualification Titles and Levels

This qualification is shown on a certificate as OCR GCSE in Additional Applied Science.

This qualification is approved by the regulatory authorities (QCA, ACCAC and CEA) as part of the National Qualifications Framework (NQF).

Candidates who gain grades G to D will have achieved an award at Foundation Level (Level 1 of the NQF).

Candidates who gain grades C to A* will have achieved an award at Intermediate Level (Level 2 of the NQF).

1.4 Aims

The aims of this GCSE specification are to encourage candidates to:

- demonstrate that they can carry out specific scientific procedures and understand that the results matter;
- acquire a coherent body of scientific knowledge, and the skills needed to apply this in new and changing situations in a range of domestic, industrial and environmental contexts;
- apply knowledge and understanding of scientific facts, methods, tests and trials to provide data, deliver a product or solve problems;
- show that they understand the social, economic and environmental contexts and values in which science is applied and that they appreciate the need for monitoring and regulation of science in practice;
- plan and carry out a test of the suitability of a particular material, procedure, or device, considering and evaluating critically their own data and that obtained from other sources, and using ICT where appropriate;
- select, organise and communicate information clearly and logically, using appropriate scientific terms and conventions, and using ICT where appropriate;
- interpret and evaluate scientific data from a variety of sources;
- use electronic (internet, CD ROMs, databases, simulations etc.) and/or more traditional sources or information (books, magazines, leaflets etc.) to research the application of science by people at work in a specific context.

1.5 Prior Learning/Attainment

Candidates who are taking courses leading to this qualification at Key Stage 4 should normally have followed the corresponding Key Stage 3 programme of study within the National Curriculum.

Other candidates entering this course should have achieved a general educational level equivalent to National Curriculum Level 3, or a distinction at Entry Level within the National Qualifications Framework.

2 Summary of Content

The content of this specification is written in modules. Each candidate must be assessed on three modules.

Each module is designed to be taught in approximately one and a half terms, (in 10% of the candidates' curriculum time).

Module AP1: Life Care

- People and organisations
- Baseline assessment
- Diagnosis and action plans
- Treatment and aftercare
- Underlying skills and knowledge

Module AP2: Agriculture and Food

- The agricultural and food industries
- Growing plants for food
- Animal farming for food
- Biotechnology and food
- Quality, value and sustainability

Module AP3: Scientific Detection

- The need for scientific evidence
- Imaging
- Chromatography and electrophoresis
- The use of colour in analysis
- General principles of evidence

Module AP4: Harnessing Chemicals

- The chemical industry
- Making useful chemicals
- Planning, controlling and costing chemical synthesis
- Formulations and effectiveness
- Underlying principles

Module AP5: Communications

- The communications industries
- Electronic circuits and systems
- Wireless communications
- Digital communications
- Underlying skills and knowledge

Module AP6: Materials and Performance

- People and organisations
- Mechanical behaviour of materials
- Electrical, thermal and acoustic behaviour of materials
- Optical behaviour of materials
- Underlying skills and knowledge

3 Content

Layout of Module Content

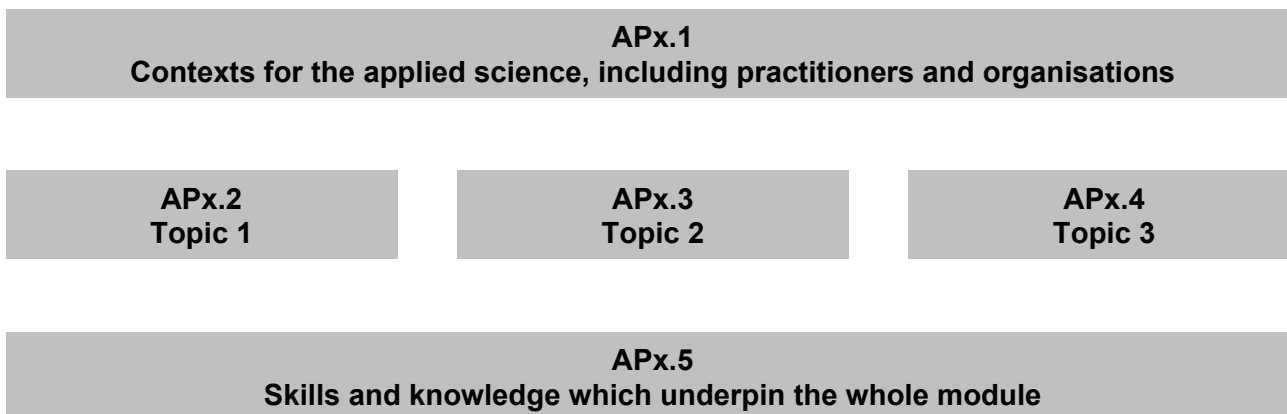
Each module starts with a synopsis. The synopsis provides a brief rationale for the module, some contexts in which the module could be taught and an outline of the main areas of study within the module. Some information is given about how the content of the module is related to the content of GCSE Science A (J630), although candidates are not expected to have completed GCSE Science A beforehand.

Some symbols and fonts are provided to give teachers additional information, expressed in abbreviated form, about the way in which the content is linked to other parts of the specification, and the table below summarises this information.

Abbreviation	Explanation and guidance
	These content statements will only be assessed on Higher Tier papers.
ⓘ	Advisory notes for teachers to clarify depth of cover required.

The content of each module is designed such that the first section (APx.1) gives an overview and relevance to the candidate. The following three sections (APx.2, APx.3 and APx.4) provide the details and techniques, and the last section (APx.5) draws the module together, linking ideas, common themes and underlying principles.

Teachers are strongly advised to develop a teaching scheme of work which appropriately integrates these sections in their chosen context.



MODULE AP1: LIFE CARE – OVERVIEW

Practitioners of many types play important roles in the maintenance of personal and public health. Their work involves collecting and analysing reliable information about the way in which our bodies are working. Decisions affecting health are taken at many levels: personal, national and international.

In this module candidates explore the importance of collecting, analysing and interpreting data, and of monitoring progress in fitness, treatment and care programmes. A scheme of work for this module should present these ideas in more than one context. Opportunities exist to use the following contexts, if desired, but teachers are free to use contexts relevant to their locality and experience:

- Preventative care;
- Primary health care;
- Sport and fitness training;
- Emergency treatment;
- Ante and post natal care.

The module (sections Ap1.2 – 1.4) covers three stages common to all fitness, treatment and care programmes. Within each stage there is a cluster of techniques and procedures. Some lend themselves to practical work by the candidate. Others lend themselves to information gathering from secondary sources. Candidates should study these techniques within relevant contexts.

AP1.1 People and organisations

AP1.2 Baseline assessment

AP1.3 Diagnosis and action plans

AP1.4 Treatment and aftercare

AP1.5 Underlying skills and knowledge

The module builds on the science of human health covered in the GCSE Science A course, especially:

- B1 You and your genes
- B2 Keeping healthy
- B3 Life on Earth
- C3 Food matters

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science and technology, for example:

- assessing and monitoring physical fitness;
- analysing the data collected in different medical imaging techniques.

Use of ICT in teaching and learning can include:

- video sequences to show GP referral, hospital diagnosis and treatment;
- using an animation that shows the functioning of the heart;
- video sequences to show the assessment of physical fitness;
- use of the internet to find out about people who apply science in their work.

MODULE AP1: LIFE CARE

AP1.1 People and organisations

There are many people and organisations involved in life care. Effective life care requires a co-ordinated effort between all involved. Organisations operate locally, nationally and internationally. Their work, and that of the people that work in them, is regulated to ensure high standards of service.

1. recall two examples of local organisations that provide health care and fitness facilities for the community;
 2. describe the provision offered by two local organisations that provides health care or enhances fitness;
 3. describe features of a national health service (makes health care available to all citizens; can provide specialist care not available locally, monitor national trends, plan suitable health care, and allocate resources where and when they are needed; **but has to manage tensions between different services, spending on administration as well as practitioners and facilities directly serving the public**).
-

Many practitioners help people to maintain and improve their health and fitness. They respond to emergencies, provide treatment and aftercare for people. Health information sources are important.

4. recall two examples of the title and role of health or fitness practitioner;
 5. understand the advantages of regular contact between health or fitness practitioners and their patients or clients;
 6. understand the importance of education and public information about health;
 7. **explain why, despite the expense of health education and public information programmes, these may be cost effective in the long term.**
-

MODULE AP1: LIFE CARE

AP1.2 Baseline Assessment

Health or fitness practitioners often begin by taking a detailed medical history of a person. This helps them to decide what further tests may be needed.

1. recall factors in the person's medical or lifestyle history that should be disclosed before treatment begins or before an exercise regime is started (limited to symptoms, current medication, alcohol or tobacco consumption, general level of physical activity, family medical history, previous treatments);
2. understand why this information is needed;
3. **understand why the risk to a patient must be assessed before any diagnostic test is carried out.**

A number of basic tests are commonly used to determine a person's state of health and/or fitness.

4. describe how basic information is collected in an initial health or fitness assessment (pulse rate, temperature, blood pressure, height, body mass, aerobic fitness, gender, age);
5. calculate and interpret body mass index data;
6. recall the equipment used to measure a person's pulse, temperature (clinical thermometer, liquid crystal and electronic sensor), blood pressure (sphygmomanometer and electronic sensor);
7. understand why personal medical or fitness information must be recorded, stored and made available to other people on the health or fitness practitioner team.

Doctors often require more detailed information about a patient's condition. This may involve haematology, microbiology, biochemistry or medical imaging techniques. Some tests are more expensive to carry out than others.

8. recall that samples (blood, urine, **saliva, tissue sections, faeces, pus**) are taken for analysis;
9. describe how a blood sample is taken;
10. recall that urine samples can be tested for the presence of nitrite (bacteria), protein or glucose and for pregnancy (**presence of the hormone hCG**);
11. recall the advantages and disadvantages of using test sticks for testing urine;
12. recall that the functioning of the heart can be studied using electrocardiograms (ECGs) (interpretation of ECGs not expected);
13. understand that medical imaging techniques are non-invasive methods of seeing inside the body and can provide both structural and functional information;
14. recall one medical use for each of
 - X-ray imaging;
 - ultrasound;
15. **recall one medical use for each of CT, PET and MRI scans.**

MODULE AP1: LIFE CARE

AP1.3 Diagnosis and action plans

Life care involves dialogue and decision making. A person decides if their health and/or fitness differs from accepted norms or their expectations. The health or fitness practitioner uses evidence to diagnose the state of the person's health.

1. interpret information on pulse rate, temperature, blood pressure, height and body mass;
 2. recall one possible cause for each of the following symptoms:
 - higher than average pulse rate (for example exercise, panic attack, anxiety, heart disorder);
 - weak pulse (for example low blood pressure, shock, heart disorder);
 - higher than average temperature (for example infection, heat stroke);
 - lower than average temperature (for example hypothermia);
 3. recall two examples of diagnoses that can be obtained from examination of
 - urine;
 - blood samples;
 4. interpret simple medical images obtained using X-rays and ultrasound.
-

Based upon a diagnosis of the situation, the health or fitness practitioner proposes a course of action and seeks the person's agreement before proceeding.

5. understand that treatments often have side effects and that these are weighed against the benefits gained;
 6. understand that there is often more than one way to achieve an agreed target (enhanced fitness, cure, recovery, rehabilitation);
 7. recall an example to illustrate the difference between treating the symptoms and curing the problem;
 8. understand that all treatments carry some risk;
 9. understand the need for medical patients to give informed consent.
-

Health and fitness practitioners often have to prioritise their actions when many people are involved. In emergency care, the injured must be sorted according to the seriousness of their condition. In general, decisions must be taken about the most effective and efficient use of resources.

10. understand how patients are prioritized for emergency treatment;
 11. describe how a hospital or health and fitness centre manages its facilities to ensure their most effective and efficient use;
 12. **understand how cost and availability of treatments may influence the decision making process.**
-

MODULE AP1: LIFE CARE

AP1.4 Treatment and aftercare

Once a diagnosis or physical assessment has been made, a treatment or aftercare programme is devised. It is implemented and the progress of the person is monitored.

1. describe briefly one example each of (a) surgery, (b) exercise regime, (c) diet, **(d) drug therapy and (e) public health campaign** that is used to improve health or fitness;
 2. describe the role of the physiotherapist in treatment of skeletal-muscular injury;
 3. describe a set of exercises that would be carried out to treat one skeletal-muscular injury.
-

Once a course of treatment or fitness training is underway, it needs to be monitored. Decisions need to be made as to whether the programme is having the desired effect. Sometimes a programme is modified in the light of the person's progress towards the desired goals.

4. describe briefly (a) one example of monitoring a person's progress during treatment or fitness training, and (b) one example of monitoring after treatment or fitness training is complete;
 5. understand why accurate record-keeping during treatment or fitness training is essential;
 6. understand that any assessment of progress needs to take into account the accuracy of the monitoring technique and the reliability of the data obtained;
 7. recall two examples of reasons for modifying a programme before it has been completed.
-

MODULE AP1: LIFE CARE

AP1.5 Underlying skills and knowledge

It is most helpful if health and fitness practitioners have some specific personal qualities.

1. describe elements of good practice, including abilities to
 - develop a detached yet personal relationship with the client;
 - make judgements when clients statements and evidence conflict;
 - recognise the importance of team work;
 - consider the whole person, including family, workplace and community contexts;
 2. understand personal qualities required (empathy, patience, tact, a manner which encourages confidence and trust);
 3. understand the need for effective communication skills (able to ask questions, to listen, to explain, to seek clarification by reinterpreting client statements).
-

In order to correctly assess the health of the person and suitability of their treatment, health and fitness practitioners need to understand how the human body functions.

4. name and locate the parts of the heart (limited to left and right atria and ventricles and valves);
 5. understand how the structure of the blood vessels is related to their function;
 6. name and locate the parts of the human breathing system (limited to ribs, intercostal muscles, diaphragm, lungs, trachea, bronchus, bronchioles and alveoli);
 7. understand how the structure of these parts is related to their function;
 8. recall the composition of blood (red blood cell, white blood cell and platelets);
 9. recall the general structure (limited to skull, vertebral column, radius, ulna, humerus, femur, tibia, fibula, clavicle, scapula, pelvis, ribs and sternum) and function of the human skeleton (protection, support and attachment of muscles);
 10. describe the relationship between ligaments, tendons, muscles and bones;
 11. describe the general structure and function of the female reproductive system (including changes during pregnancy and birth);
 12. describe the body's response to changes in temperature (temperature receptors in the skin, changes in blood flow through skin capillaries, sweating, shivering);
 13. describe the function of the kidneys.
-

MODULE AP2: AGRICULTURE AND FOOD – OVERVIEW

In this module, candidates study plants, animals and microorganisms as sources of food. They learn how people apply their knowledge and skills on farms, in market gardens, at breweries and in biotechnology companies.

Advances in scientific knowledge have brought about marked changes in farming practice and horticulture. Biotechnology has developed new processes and products to complement the traditional methods of brewing and dairying. Breeding of organisms is now more of a science. Conditions in which organisms produce optimum yields are now better known and understood. Products are also tested vigorously to investigate their suitability and ensure our safety.

The module covers techniques associated with reproducing and growing organisms, improving productivity and testing food products. It develops skills needed to produce foods safely from the products of growth. Techniques involving plants and microorganisms lend themselves to practical work by the candidates. Techniques involved in breeding and growing farm animals lend themselves to information gathering from secondary sources. Wherever possible, candidates should study relevant procedures and techniques in authentic contexts.

The module raises issues of ethical and economic value touching on animal welfare and sustainable agriculture.

AP2.1 The agricultural and food industries

AP2.2 Growing plants for food

AP2.3 Animal farming for food

AP2.4 Biotechnology and food

AP2.5 Quality, value and sustainability

This module offers opportunities to apply science from the GCSE Science A course, especially:

- B1 You and your genes
- B2 Keeping healthy
- P2 Radiation and life
- C3 Food matters

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science and technology, for example:

- gathering and storing data;
- selecting and presenting data in a variety of forms to explore patterns and trends;
- automatic monitoring and control of the conditions for growing organisms.

Use of ICT in teaching and learning can include:

- still images in presentations to show stages in a range of processes in agriculture and food processing;
- video sequences to show standard procedures and other working practices on farms, in food processing plants and in laboratories;
- the internet to gather information for Work-related reports and when planning suitability tests.

MODULE AP2: AGRICULTURE AND FOOD

AP2.1 The agricultural and food industries

British farmers care for more than 75% of the total UK land area of the UK and produce nearly 70% of the food we eat in this country.

1. recall one example each to show that products from organisms include:
 - gathered harvests (where the whole organism survives), such as milk, wool, fruits and nuts and extracellular protein from microorganisms;
 - whole organism harvests (where the organism is used or consumed), such as meat, farm crops, and food from microorganisms);
 - the use of organisms for tasks such as the supply of fuels for transport, environmental management, waste treatment and food processing.
 2. interpret information about the main sectors of agriculture in the UK and about work done by people in these sectors including
 - arable growing crops for human and animal consumption and for non-food uses (such as biofuels);
 - beef cattle, sheep and pigs for meat and other products such as wool and leather;
 - dairy cattle for milk and milk products;
 - poultry for meat and eggs;
 - horticulture for vegetables, salads, fruit, flowers and plants;
 3. understand that the chain of food production includes every stage of growing, transporting, processing, storing and delivering food from farm or factory to home;
 4. recall two uses of biotechnology to produce food.
-

Large numbers of people work for organisations responsible for regulating agriculture and food. Regulation is important for public health and safety as well as to protect the environment.

5. recall the purposes of regulating agriculture and food production for public health and safety, animal welfare and environment protection;
 6. recall two examples of organisations which are responsible for regulation (for example DEFRA and the Food Standards Agency);
 7. understand the need for enforcement officers to monitor the food chain (for example environmental health practitioners and factory inspectors);
 8. recall **and explain** the role of two examples of organisations which support a part of the food industry, carry out research and promote its products (for example the Milk Development Council, British Potato Council, Meat and Livestock Commission, ADAS).
-

MODULE AP2: AGRICULTURE AND FOOD

AP2.2 Growing plants for food

People working in modern agriculture and horticulture apply scientific principles at every stage of breeding, propagating, growing and harvesting crops. Others apply science to develop optimum conditions for storing and processing food and other plant products.

- recall one example of each type of food from plants and its source
 - food for farm animals such as grass, hay, silage;
 - food for people such as potatoes, lettuce, apples;
 - food ingredients such as flour, sugar, vegetable oils.
- recall one example of each type to show that plants are grown for other purposes
 - materials such as wood, paper;
 - fibres and fabrics such as cotton, linen;
 - biofuels such as alcohol, biodiesel.
- recall the main stages in the life-cycle of flowering plants limited to pollination, fertilisation, production of seed/fruit, dispersal of seed/fruit, germination of seed;
- recall the conditions for seed germination;
- interpret data about germination rates;
- recall the key characteristics of growing media, (limited to water supply, source of nutrients, pH) and support for the plants (limited to soil, composts and hydroponics);
- recall the word equation for photosynthesis;
- interpret data showing the effect on the rate of photosynthesis of the availability of light, water, carbon dioxide and nutrients from the growing medium;**
- recall limiting factors for photosynthesis (light, temperature, carbon dioxide);**
- understand how the conditions can be controlled to increase the growth of crops in the protected cultivation (for example in glasshouses or polytunnels);
- recall and compare the use of chemicals and predator organisms for protecting crops from insect pests in glasshouses;
- understand that crop yields can be measured using wet mass (for example potatoes, peas) **or dry mass** (for example tea, cereal grains);
- interpret data on crop yields;
- describe how large numbers of genetically identical plants can be produced by
 - taking cuttings;
 - tissue culture.
- interpret information about the stages in the processing of a food product made from plant material (for example sugar, flour, vegetable oil).

MODULE AP2: AGRICULTURE AND FOOD

AP2.3 Animal farming for food

Farmers use a range of approaches to rearing animals. These range from more traditional, organic methods to intensive forms of production. Farmers can apply science to encourage growth and high yields of the required products.

1. recall one example of each type of useful product from farm animals and its source
 - food such as meat, eggs, milk and dairy products;
 - textiles such as wool and leather;
 - fertilizers such as manures and bonemeal.
2. recall that animals can be reared using organic or intensive farming methods;
3. understand that intensive farming methods may raise ethical issues concerning animal welfare;
4. recall that the main factors affecting animal growth are temperature, shelter, food, water, pests and disease;
5. interpret data about animal growth and product yield.

Animal reproduction and breeding programmes make extensive use of science and technology.

6. recall the main stages in sexual reproduction in mammals (limited to formation of gametes, fertilisation, internal development and birth followed by growth and development);
7. describe the techniques used in artificial insemination of farm animals, (limited to selection of animals, collection of sperm, storage of sperm, timing of sperm insertion);
8. **understand that hormones can be used to control the timing of reproduction in animals;**
9. recall the advantages of artificial insemination;
10. describe how productivity can be improved by using selective breeding;
11. explain how embryos from selected females can be collected and implanted in surrogate mothers;
12. interpret information about the stages in the production and processing of a food product from animals from field to fridge.

MODULE AP2: AGRICULTURE AND FOOD

AP2.4 Biotechnology and food

Traditional and modern biotechnologies are widely used to produce food and drink. Microorganisms can be harnessed to produce good food but they can also lead to food spoilage and food poisoning.

1. recall one example of each type of useful product made from (or with the help of) microorganisms
 - alcohol for drinks or fuel;
 - food such as bread, cheese, yoghurt, mycoprotein;
 - enzymes such as chymosin for making cheese;
2. recall that microorganisms include yeasts, bacteria and viruses;
3. recall that some microorganisms cause disease (**pathogens**);
4. recall that microorganisms can spoil many products by feeding on them and contaminating them with their waste products;
5. understand the importance of aseptic techniques to ensure the sterile conditions necessary for the cultivation of specific microorganisms.

Controlling the conditions of growth is very important when culturing microorganisms on a large scale. Producers use batch or continuous methods of production depending on the nature of the microorganisms and the products.

6. **recall the main stages of population growth in cultures of microorganisms;**
7. interpret data on the population growth of microorganisms (for example colony counts, turbidity, biomass);
8. **recall advantages and disadvantages of batch and continuous cultures;**
9. **describe how a fermenter is used to produce large quantities of microorganisms;**
10. recall word equations for aerobic and anaerobic respiration (for example in yeast or lactobacilli);
11. recall one example of anaerobic fermentation and one example of aerobic fermentation in food production or processing;
12. interpret information about the stages in the processing of a food product made with microorganisms (for example bread, cheese, yoghurt, yeast extract or mycoprotein).

The food industry uses products from genetically modified organisms. GM microorganisms can produce both food ingredients and enzymes used in food processing.

13. recall an example of the use of genetic modification of a microorganism to produce a useful product;
14. **recall that DNA is the genetic material of all organisms;**
15. **recall that each gene codes for a particular protein;**
16. **understand that genes can be cut out of the DNA of one organism and inserted into the DNA of another organism;**
17. understand that the genetically modified (GM) organism produces the protein of the introduced gene.

MODULE AP2: AGRICULTURE AND FOOD

AP2.5 Quality, value and sustainability

Food and other products from organisms must be checked to ensure that they are fit and safe for use. The agriculture and food industries operate in a market place that is partly driven by consumer preferences but which is also influenced by government funding. People involved in agriculture also have to consider the environmental impact of their activities and adopt sustainable methods.

1. recall the importance of testing in ensuring the quality and safety of food and other products;
 2. distinguish between testing techniques
 - qualitative (for example mineral deficiency in plants, end of fermentation in brewing, visual inspection of crop, colour of dyes, visual inspection of food);
 - semi-quantitative (for example whole cereal grains, pH paper for soil acidity, indicators for presence of bacteria);
 - quantitative (for example pH meter/soil test kits, hydrometer for alcohol level in brewing, percentage seed germination, colorimeter for food dyes, determining carbohydrate and protein levels in cereal grains).
 3. interpret data on the effects of poor storage, transport, preparation and cooking of food;
 4. understand that suppliers of products from organisms operate in a market where price is determined by supply and demand but also affected by government intervention (for example subsidies);
 5. understand the importance of marketing products;
 6. understand that achieving a quality mark means that the product has reached certain standards (for example egg stamps, soil association recognition);
 7. appreciate that a quality mark adds market value;
 8. interpret data about sustainable agriculture intended to
 - protect and improve soil quality;
 - reduce dependence on non-renewable resources, such as fuel and synthetic fertilizers and pesticides,
 - lessen harmful effects on safety, wildlife, water quality and other environmental resources.
-

MODULE AP3: SCIENTIFIC DETECTION – OVERVIEW

Collecting and analysing reliable scientific evidence plays a fundamental role in many important decisions made on a personal, local, national and international level.

In this module, candidates explore the importance of scientific evidence in a variety of contexts. Opportunities exist to use the following contexts, if desired, but teachers are free to use contexts relevant to their locality and experience:

- law enforcement;
- environmental protection;
- consumer health and safety;

The module covers three categories of method for collecting evidence. Within each category there is a cluster of techniques and procedure, some of which lend themselves to hands-on experience by candidates while others can be studied using secondary sources. Candidates should explore these techniques in a relevant context.

Ap3.1 The need for scientific evidence

Ap3.2 Imaging

Ap3.3 Chromatography and electrophoresis

Ap3.4 The use of colour in analysis

Ap3.5 General principles of evidence

The module provides opportunities to apply science from the GCSE Science A course, especially:

- C1 Air quality;
- C2 Material Choices;
- P2 Radiation and Life;
- C3 Food Matters.

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science and technology, for example:

- the integral role of ICT in scientific instrumentation;
- gathering and storing data;
- selecting and presenting data in a variety of forms for analysis and evaluation.

Use of ICT in teaching and learning can include:

- still images with diagrams in presentations to show analytical techniques used in law enforcement, environmental monitoring and consumer protection.
- video sequences to show standard procedures and other working practices in laboratories and in the field;
- the internet to gather information for work-related reports and when planning suitability tests.

MODULE AP3: SCIENTIFIC DETECTION

AP3.1 The need for scientific evidence

The work of 'scientific detectives', or public analysts, contributes to law enforcement, environmental protection and consumer protection.

1. recall one example each of the roles of people with scientific expertise who are employed in law enforcement, environmental protection and consumer protection. (for example, crime scene investigators, environmental protection officers, public analysts);
 2. interpret information about the work of organisations responsible for gathering scientific data used for law enforcement, environmental protection and consumer protection (for example, Forensic Science Service, Environment Agency and the Food Standards Agency).
-

Good laboratory practice is essential to producing reliable evidence.

3. understand why public laboratories have a system of accreditation (for example reliability);
 4. understand that reliability can be increased by using a system of common practice and procedures;
 5. understand the purpose of proficiency tests;
 6. understand why good laboratory practice depends on
 - adherence to health and safety regulations;
 - regular maintenance and checking of equipment and instruments;
 - training and continuing professional development of staff.
-

MODULE AP3: SCIENTIFIC DETECTION

AP3.2 Imaging

Visual examination is a relatively low-tech method that can give quick results where the need for fine detail is not necessary for identification or measurement.

1. recall that images can be recorded in different ways, to include
 - written descriptions;
 - drawings;
 - photographs;
 - videos.
 2. identify important features of an image;
 3. compare similar images to decide whether there is an acceptable match;
 4. recall how to use a linear scale and estimate the reading taken between graduations;
 5. calculate areas;
 - 6. read a Vernier scale;**
 - 7. explain why a calculated area has a greater uncertainty than the measured lengths.**
-

More detail can be obtained using a light microscope.

8. identify the main functional parts of a compound light microscope and recall their purpose;
 9. understand that light microscopy provides greater detail by increasing the magnification and the resolution of the image;
 10. calculate magnifying power given the magnification of the eyepiece and the objective lenses;
 11. recall how a temporary slide is prepared for microscope examination;
 12. interpret a given unfamiliar drawing, sketch or photograph from a light microscope, together with a scale by:
 - describing the main features;
 - counting numbers of different features;
 - making measurements of distances and lengths;
 - using illustrations of reference samples to interpret the image;
 - 13. understand the term resolving power and use it to describe the limitations of light microscopy;**
 - 14. understand the term depth of field with reference to images from a light microscope.**
-

MODULE AP3: SCIENTIFIC DETECTION

AP3.2 Imaging

Even greater detail can be obtained using an electron microscope, but at a cost.

15. recall that an atom consists of a tiny positive nucleus surrounded by negative electrons;
 16. recall that an electron microscope uses a beam of electrons instead of light;
 17. interpret a given unfamiliar electron micrograph, together with a scale by
 - describing the main features;
 - counting numbers of different features;
 - making measurements of lengths;
 - using illustrations of reference samples to interpret the image.
 18. understand that the use of electron microscopes is limited by the presentation and preparation of samples;
 19. recall that an electron microscope shows greater detail because it has greater magnification **and greater resolving power**;
 20. **understand the meaning of depth of field with reference to images from a scanning electron microscope.**
-

MODULE AP3: SCIENTIFIC DETECTION

AP3.3 Chromatography and electrophoresis

Chromatography is a useful technique for analysing unknown mixing. Paper and thin layer chromatography are inexpensive techniques but have limited uses.

1. understand that in chromatography, substances are separated by the movement of a solvent (the mobile phase) through a medium (the stationary phase);
2. recall that substances move between the mobile and stationary phases;
3. recall that some compounds dissolve well in water while others are more soluble in solvents other than water (non-aqueous solvents);
4. **understand that chromatography depends on the relative attractions of molecules of a solute to the solvent and the medium;**
5. understand the use of standard reference materials in chromatography;
6. interpret paper and thin-layer chromatograms qualitatively;
7. **use the equation:**
$$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$$
8. **understand the advantages of thin layer chromatography when compared with paper chromatography;**
9. **understand why some chromatograms need to be developed (to show the presence of colourless substances).**

Gas chromatography (gc) is used to separate complex mixtures. It has greater separating power than paper or thin-layer chromatography.

10. recall that gc can produce quantitative data from very small samples of gases, liquids and volatile solids;
11. **understand how lc separates the components in a mixture (because they differ in their solubilities in the stationary or mobile phases);**
12. **recall two examples of the use of gc;**
13. **recall the choice of chromatographic technique is influenced by the separating power, sensitivity and limits of detection;**
14. **interpret chromatograms and tables of relative retention times.**

Electrophoresis is particularly useful for separating and identifying biological molecules, such as DNA fragments.

15. recall that electrophoresis can be used for scientific detection to include identifying DNA fragments;
16. recall that electrophoresis can be used on small biological samples;
17. recall two examples of the use of DNA profiling;
18. **understand how electrophoresis separates components in a mixture (because their particles carry charges, positive particles move to the negative electrode and negative particles towards the positive electrode);**
19. **understand that particles separate during electrophoresis because they differ in their size and the magnitude of their charge.**

MODULE AP3: SCIENTIFIC DETECTION

AP3.4 The use of colour in analysis

Traditional and modern biotechnologies are widely used to produce food and drink. Microorganisms can be harnessed to produce good food but they can also lead to food spoilage and food poisoning.

1. recall the colours of litmus to show if a solution is acid or alkali as an example of a qualitative test;
2. recall the use of Universal Indicator solution as an example of a semi quantitative test;
3. interpret given data on the use of indicator solutions to determine pH (no recall expected);
4. recall the use of colour test kits in medical diagnosis, limited to diabetes by clinticks and pregnancy by pregnancy test kits;
5. interpret data on the use of test kits (no recall expected).

A colorimeter will give quantitative data. By using standard reference solutions, scientists can measure the concentration of a coloured chemical in a solution.

6. understand that colorimeters can be used to produce quantitative results;
7. recall that colorimeters measure the intensity of a colour;
8. understand how colorimeters can be used to find the concentration of coloured chemicals:
 - pass light through a pure, colourless solvent and set the meter to zero;
 - plot data to produce a calibration graph;
 - use a calibration graph and given data to work out the concentration of a solution;
9. **understand differences in the techniques of colour matching and colorimetry in terms of**
 - **measurement uncertainty;**
 - **the range of concentrations that can be determined;**
 - **limits to the determination of concentration (sensitivity).**

MODULE AP3: SCIENTIFIC DETECTION

AP3.5 General principles of evidence

Candidates should be able to comment on scientific evidence in terms of handling a sample, the use of standard procedures and the objective evaluation of findings.

1. recall stages in the collection, storage and preparation of samples for analysis:
 - collect representative samples;
 - prevent change or deterioration to samples;
 - avoid contamination of samples;
 - avoid tampering of samples;
 2. understand the use of standard procedures for analysis and testing:
 - the use of standard reference materials for the calibration of measuring equipment and instruments;
 - the use of formulae and calibration graphs to manipulate data;
 - the recording of the standard operating procedure used and the outcomes achieved;
 - the presentation of data in the form of tables, graphs and drawings;
 3. understand the objective evaluation of findings:
 - identification of outliers in data;
 - explanations of significance of findings;
 - **assessment of uncertainties (systematic and random errors);**
 - whether conclusions are valid and justifiable;
 4. recall the advantages and disadvantages of different measuring methods and instruments (limited to light microscopy, electron microscopy, methods of chromatography, colour matching and colorimetry).
-

MODULE AP4: HARNESSING CHEMICALS – OVERVIEW

The chemical industry uses a wide variety of raw materials to create many different products. People have direct experience of the chemicals in consumer products such as cleaning and decorating materials, flavours and perfumes, plastics and fibres. However many chemicals are supplied to other industries to make into other products.

In this module, candidates explore the importance of chemicals and chemical processes. Opportunities exist to use the following contexts, but teachers are free to use contexts relevant to their locality and experience:

- small scale formulation (such as in a hospital dispensary);
- analysis and testing in laboratories (for quality, health and safety);
- manufacture and processing of consumer products (such as food, cosmetics, cleaning agents, paints, dyes);
- manufacture of pure fine and intermediate chemicals;
- manufacture and formulation of performance chemicals (such as pharmaceuticals, flavours, fragrances, photographic chemicals);
- large scale manufacture of bulk chemicals.

The module covers a cluster of techniques and procedures, some of which lend themselves to hands-on experience by candidates, while others can be studied using secondary sources.

Candidates also learn about the regulations and practices designed to protect individuals and the environment from the possible harmful effects of the use of chemicals.

AP4.1 Chemicals and why we need them

AP4.2 Making useful chemicals

AP4.3 Planning, controlling and monitoring chemical synthesis

AP4.4 Formulations and effectiveness

AP4.5 Underlying principles

The module provides opportunities to apply science from the GCSE Science A course, especially:

- C1 Air Quality;
- C2 Material choices;
- P2 Radiation and Life.
- C3 Food Matters

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science and technology, for example:

- logging data, storing it and displaying it in a variety of formats for analysis and evaluation;
- monitoring and controlling of manufacturing processes.

Use of ICT in teaching and learning can include:

- video clips to show standard procedures and other working practices;
- video sequences to illustrate chemical manufacture and formulation on a large scale;
- data loggers to investigate factors affecting the rates of chemical changes;
- the internet to gather information for work-related reports and when planning suitability tests.

MODULE AP4: HARNESSING CHEMICALS

AP4.1 The chemical industry

Everything is made of chemicals. Some chemicals occur naturally in the inorganic world and in living things. Useful chemicals (ones that can be converted into products we need) must be extracted and purified. These include inorganic chemicals and organic chemicals. A vast range of other chemicals are manufactured from these starting materials.

1. understand the terms 'inorganic' and 'organic' as they apply to chemicals;
2. recall that most inorganic compounds are obtained from never-lived (rocks, minerals and ores) sources;
3. recall that organic compounds are obtained from living (plants, animals) or non-living (crude oil, coal, natural gas) sources;
4. recall two examples each of substances obtained from living, non-living and never-lived sources.

The chemical industry makes a big contribution to the UK economy. The chemical industry synthesises chemicals on small, medium and large scales according to their value. Some chemicals are produced on a large scale (bulk chemicals, e.g. ammonia, sulfuric acid, sodium hydroxide, phosphoric acid) and some on a smaller scale (fine or speciality chemicals, e.g. drugs, agrochemicals, food additives, fragrances).

5. recall and use the terms 'bulk' (made on a large scale) and 'fine' (made on a small scale) in terms of the chemical industry;
6. recall examples of chemicals made on a large scale (ammonia, sulfuric acid, sodium hydroxide, phosphoric acid) or small scale (drugs, food additives, fragrances);
7. interpret information about the sectors and the production of chemicals in the chemical industry (bulk and fine) (no recall expected);
8. interpret information about the work done by people who make chemicals or formulate chemical products;
9. understand that new chemical products are the result of an extensive programme of research and development (for example new medical drugs);
10. understand that governments have strict regulations to control chemical processes as well as the storage and transport of chemicals to protect people and the environment;
11. recall that, in the UK, the Health and Safety Executive (HSE) is responsible for the regulation of risks to health and safety arising from the extraction, manufacture and use of chemicals.

Growing concern about the need to develop a more sustainable economy means that the chemical industry is carrying out much research and development so that their processes will in future move to a greater use of renewable resources, use less energy, maximise yields while producing less waste (i.e. improved atom economy), and find ways of using or recycling the wastes that are produced.

12. understand how the concept of sustainability applies to the chemical industry (greater use of renewable resources, using less energy, maximising yields, producing less waste);
13. understand the contribution that catalysts can make to making processes more sustainable;
14. interpret information on a given chemical process in terms of sustainability issues (no recall expected).

MODULE AP4: HARNESSING CHEMICALS

AP4.2 Making useful chemicals

Chemicals are made on a laboratory scale for the purposes of research and development. Chemists involved in synthesis use a range of techniques to work with chemicals, including: transferring solids, liquids and gases; weighing; measuring volumes of liquids and gases; heating and cooling; mixing; refluxing.

1. identify glassware used to measure out and transfer chemicals (measuring cylinder, pipette, burette and graduated flask) and glassware in which chemical reactions can be carried out (flask, beaker);
2. identify pieces of common laboratory equipment (balance, heating mantle, hot water bath, immersion heater, heating/cooling coil, magnetic stirrer and flea);
3. recall how to transfer chemicals (liquid and solid) from one container to another with minimum loss.

One way chemists make an insoluble chemical is to mix two solutions. Reaction takes place and the product precipitates. It is filtered, washed and dried. These reactions are usually instant.

4. understand the terms: 'soluble', 'insoluble', 'solution', 'solute', 'solvent', 'precipitation', 'precipitate', 'filtration' and 'filtrate';
5. understand the steps in the procedure for making an insoluble salt by mixing two solutions;
6. recall two examples of insoluble chemicals that can be made by reacting two solutions;
7. **interpret given information on solubility to predict chemicals that can be made by precipitation;**
8. identify the components of a filtration process, the filtrate and insoluble residue;
9. understand why it is necessary to wash a filtered precipitate;
10. write word **and symbol equations** for the formation of insoluble chemicals from two soluble chemicals.

A soluble chemical can be made by reacting an excess of an insoluble chemical with a solution. The reaction mixture is filtered to remove excess of the insoluble chemical. The solid product is obtained by crystallisation from the filtrate.

11. understand the terms: crystallisation, evaporation, residue;
12. understand the steps in the procedure for making a soluble salt by reacting an insoluble chemical with an acid in solution;
13. recall how to evaporate a solution;
14. understand how the size of crystals obtained often depends on the rate of evaporation;
15. write word **and symbol equations** for the formation of soluble salts made by reacting an insoluble metal, metal oxide, metal hydroxide or metal carbonate with a soluble acid in solution.

MODULE AP4: HARNESSING CHEMICALS

AP4.2 Making useful chemicals

Another way that a soluble chemical can be made is by reacting two solutions and crystallising a solid product. These reactions are instant. The reaction must be monitored to see when sufficient quantities of reactants have been mixed.

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16. understand the steps in the procedure for making a soluble salt by neutralising an acid with an alkali;
 17. recall how complete reaction can be monitored when neutralising an acid with an alkali;
 18. write word **and symbol equations** for the formation of soluble salts by neutralising acids with alkalis.

Some reactions take place without water as the solvent. Esters can be made by heating an alcohol and a carboxylic acid under reflux. The product is a liquid and is obtained by distillation from the reaction mixture.

-
19. recall the meaning of the terms aqueous and non-aqueous as applied to solvents;
 20. recall how esters can be made by reacting an alcohol with a carboxylic acid;
 21. understand the words 'reflux', 'distillation', 'distillate';
 22. identify the components of a reflux set-up;
 23. **write a word equation for the reaction between an alcohol and carboxylic acid to make an ester.**
-

MODULE AP4: HARNESSING CHEMICALS

AP4.3 Planning, controlling and costing chemical synthesis

It is important to choose the optimum method of preparation of a chemical. This includes consideration of yields, costs, energy requirements, disposal or recycling of side products. Some chemicals can be made in a single step process. Others require more than one step (multi-step synthesis).

1. understand the factors that influence the choice of a synthetic route (yields, costs, energy requirements, disposal or recycling of side products);
2. understand the terms: exothermic and endothermic;
3. understand the need for energy efficiency (limited to opportunities for recycling 'waste' heat).

Optimum methods of preparation need a suitable rate of reaction. The rate of a reaction depends on particle size, temperature and concentration of the solution. Catalysts provide an important means of controlling the rate of reactions.

4. understand the term: rate of chemical reaction;
5. recall methods for following the rate of a reaction;
6. recall **and understand in terms of particles** how the rate of reaction depends on:
 - the particle size of an insoluble chemical;
 - the concentration of a solution of the soluble chemical;
 - and the temperature of the reaction mixture;
7. understand the term: catalyst;
8. interpret results from experiments that investigate the rates of reactions (including results shown as graphs or charts).

A variety of issues must be addressed when transferring a laboratory synthesis to an industrial scale.

9. understand the issues that must be addressed when a laboratory preparation is scaled up to industrial plan (type of vessel, method of transferring liquids, method of mixing, method of heating or cooling, method for separating the product, method for removing impurities);
10. **understand the advantages and disadvantages of producing chemicals by a continuous process or a batch process.**

Chemical substances are available in various degrees of purity. The purity of a chemical required for a manufacturing process depends on the eventual use of the manufactured product.

11. understand the terms: technical, laboratory, analytical; in the context of chemical substances;
12. understand that the cost of purchasing a chemical depends on its degree of purity;
13. understand why the purity of chemicals used in a manufacturing process depends on the eventual use of the product;
14. interpret data on the cost of chemical substances in a laboratory or manufacturing process.

MODULE AP4: HARNESSING CHEMICALS

AP4.4 Formulations and effectiveness

Most of the products we use in our homes are complex mixtures of chemicals. They are made by mixing the ingredients according to a fixed formula (this is called a formulation). Each chemical in the mixture has a definite purpose. Many of the chemical products we use are solutions.

1. recall how to prepare a solution of a specified concentration;
2. understand that $1 \text{ ml} = 1 \text{ cm}^3$ and $1 \text{ litre} = 1000 \text{ ml}$;
3. calculate the mass of solute in a given volume of a solution of known concentration when working in concentration units in g/litre , g/cm^3 **and parts per million (ppm)**.

Most food products and drinks, paints, cosmetics, medicines, some adhesives and other chemical products consist of one substance very finely dispersed in another.

4. recall that an emulsion consists of one liquid finely dispersed in another;
5. recall two examples of consumer products that are emulsions;
6. recall the need for emulsifying agents when making an emulsion from two liquids that do not mix;
7. recall that a suspension consists of a solid dispersed in a liquid and be able to give two examples of suspensions;
8. recall two examples of useful solid mixtures;
9. interpret information on the composition and use of given formulations.

The effectiveness of chemicals, both pure and formulations must be tested as part of the quality control process. Standard tests are used. Some are company-specific, national or internationally recognised tests.

10. recall the purposes of tests on product formulations (limited to quality assurance, consumer protection, conformity to national and international standards);
11. interpret the results of tests on product formulations;
12. understand why there are national and international standards for testing;
13. interpret data on uses of manufactured chemicals and formulations (no recall expected).

MODULE AP4: HARNESSING CHEMICALS

AP4.5 Underlying principles

A pure chemical has distinct chemical properties. Chemists often classify chemicals according to reactions they have in common, e.g. acids, bases, oxidisers, reducers. They also classify chemicals according to the 'reactive' parts of a chemical, e.g. inorganic chemicals such as oxides (acidic and basic), chlorides, sulfates, carbonates, nitrates and organic chemicals such as alcohols and carboxylic acids. Chemists always work safely.

1. recall symbols for chemical elements (limited to the elements with these symbols C, Ca, Cl, Mg, H, K, N, Na, O, S, Zn);
2. understand how chemical formulae are used to show the numbers of each atom present in a compound;
3. understand the use of word and **balanced symbol equations** to represent chemical reactions;
4. recall the chemical formula for hydrochloric acid, sulfuric acid, and nitric acid;
5. **recall formulae for oxides, hydroxides and salts (chlorides, carbonates, sulfates, nitrates) (limited to the compounds with these formulae: CO_2 , H_2O , CaO , MgO , ZnO , Ca(OH)_2 , KOH , Mg(OH)_2 , NaOH , NaCl , KCl , CaCl_2 , Na_2CO_3 , MgCO_3 , CaCO_3 , ZnCO_3 , MgSO_4 , Na_2SO_4 , ZnSO_4 , NaNO_3 , KNO_3);**
6. recall the characteristic properties of acids (limited to pH, reactions of acids with metals, metal oxides and hydroxides, carbonates);
7. recall that alkalis dissolve in water to give solutions with a pH above 7 and neutralise acids to form salts;
8. understand the term: functional group, in organic compounds;
9. recognise hydrocarbons, alcohols and carboxylic acids from their chemical formulae;
10. recall and use the hazchem symbols for harmful, irritant, toxic, corrosive, oxidising, and highly flammable.

Chemists measure the yield of a chemical. The efficiency of the preparation is given by the percentage yield.

11. calculate the yield from experimental data;
12. **calculate the theoretical yield, given appropriate data (the equation and the relative formula masses);**
13. calculate the percentage yield;
14. **calculate relative formula mass (given the formula and relative atomic masses).**

MODULE AP5: COMMUNICATIONS – OVERVIEW

Systems which process and transmit signals are widely used in entertainment, personal and mass communications. They have become an integral part of very many people's lives. Global communications have dramatically changed production, politics and national cultures.

In this module, candidates explore a variety of communications technologies. Opportunities exist to use the following contexts, if desired, but teachers are free to use the contexts relevant to their facilities and experience:

- warning and surveillance systems;
- broadcast radio and television;
- fax and email communications;
- home entertainment systems.

The module covers knowledge and skills relevant to manufacturing, installing, using and servicing communications systems. The emphasis is on techniques and procedures, many of which lend themselves to hands-on experience by pupils while some can be studied using secondary sources. Candidates should explore these techniques in a relevant context. They will need access to cameras, computers and facilities for electronics assembly and testing.

Ap5.1 The communications industries

Ap5.2 Electronic circuits and systems

Ap5.3 Wireless communications

Ap5.4 Digital communications

Ap5.5 Underlying skills and knowledge

In these contexts, candidates also learn about underlying principles, regulations, procedures and safety features of electronic systems.

The module provides opportunities to apply science from the GSCE Science A course, especially

- P2 Radiation and life;

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science and technology, for example:

- digital encoding of images, text and numerical data and the subsequent multi-media processing that this enables;
- its role in global production chains for communication hardware and software;

Use of ICT in teaching and learning can include:

- using computer simulations to construct virtual circuits and test their behaviour;
- gaining familiarity with waveforms using a virtual oscilloscope;
- using peripheral interface controller (PICs);
- use of the internet to find out about people who apply science in their work.

MODULE AP5: COMMUNICATIONS

AP5.1 The communications industries

Communications industries include manufacturers; retailers and servicing centres; recording, broadcasting and telecommunications companies.

1. give two examples each of electronic technologies which increase the quality (for example hearing aid), quantity (for example mobile phone) or distance (for example international TV broadcasts) of human communications, and describe the effects of their examples on everyday lives;
2. understand that governments regulate communications industries by:
 - licensing the use of a part of the electromagnetic spectrum;
 - creating markets for competing telecommunications firms;
 - agreeing standard protocols for messages.

Many practical criteria constrain the design and manufacture of communications systems. Consumers need to compare their own requirements with manufacturers' product specifications.

3. recall key factors in a product specification, (limited to: range of functions; range of controls; image or sound quality; power output; type of power source; size; weight; network coverage; recyclable components; cost);
4. describe how the process of determining a specification involves consideration of the acceptable cost; likely customers; available technology; current fashion; expected lifetime; profit margin;
5. compare product specifications for similar communications systems (for example mobile phone, intercom, radio receiver) and evaluate them against given criteria (for example cost, reliability, energy use);
6. understand that powering communications systems from batteries allows them to be portable and independent of the mains supply;
7. explain the advantages of powering communications systems from the mains supply.

Communications industries employ technically-trained staff. Managers must deploy staff and equipment effectively to monitor and control a complex system.

8. give two examples of people with different technical expertise who are employed in the communications industries;
9. describe the major parts of a live outside broadcast system and explain how it is managed: (TV cameras, microphones, editing suite, transmitter, satellite, ground-based TV transmitter, domestic TV receiver)

Regulations and standard procedures are used to protect the health and safety of individuals while assembling, installing, operating or servicing electrical and electronic equipment. Electrical and electronic equipment also has built-in safety features.

10. recall the relevant BSI and EC safety symbols (limited to those in appendix G);
11. identify electrical hazards in a given situation, assess risk and suggest ways of controlling the risk;
12. understand how double insulation, over-current devices (e.g. fuses, trip switches) and **earth leakage devices** make electrical and electronic systems safe (technical details of the devices are not required).

MODULE AP5: COMMUNICATIONS

AP5.2 Electronic circuits and systems

Block diagrams are widely used to break complex communications systems into simpler units, making the whole system easier to understand. The simplest systems can be represented by only three blocks.

1. draw block diagrams to represent the following communications systems: telephone, television and fax;
2. give two examples of simple signalling systems, identifying the input, processor and output stages, and describing the function of each part; (for example microphone→amplifier→loudspeaker, telephone→exchange→telephone, scanner→CPU→printer).

Most communications systems are based on electrical and electronic circuits. Standard language and symbolic representation is needed to discuss these systems with others.

3. understand the difference between block and circuit diagrams;
4. recall the circuit symbols (in appendix F) for the following components: fixed resistor, variable resistor, battery of cells, switch, wire, microphone, loudspeaker, buzzer, LDR, LED, amplifier, integrated circuit, photodiode, thermistor, fuse, earth, junction, transformer, diode, capacitor;
5. draw circuit diagrams, using the symbols in appendix F, for components in series and parallel.

Calculations are often required to match components with their use in a circuit.

6. use the equation $I = V/R$ to calculate the current in a component with resistance R ;
7. use the equation $P = VI$ to calculate the heating power of a component;
8. understand that components have maximum ratings for power, voltage and current;
9. **understand how resistors can be used to limit the current in components;**
10. **recall the behaviour of currents at a junction;**
11. **recall that voltages add up to the supply voltage in a series circuit.**

MODULE AP5: COMMUNICATIONS

AP5.3 Wireless communications

Microwaves and radio waves are used for short and long distance wireless communications.

1. understand the function of the following blocks in a radio communications system: microphone, modulator, transmitter aerial, receiver aerial, tuner, demodulator, amplifier, loudspeaker;
 2. understand that an amplifier increases the amplitude of an alternating voltage;
 3. **understand that bandwidth is the range of frequencies required to represent a signal;**
 4. use the words signal, carrier and modulate to describe how radio waves carry signals;
 5. **understand how frequency and amplitude modulation enable radio waves to carry signals;**
 6. **describe amplitude and frequency modulation of radio waves with sketches of voltage-time graphs.**
-

The wavelength of a radio wave determines how it can be used in a communications system.

7. recognise the range of frequencies associated with radio (medium wave 1.5 MHz - 500 kHz, long wave 300 Hz - 150 Hz) and VHF 90 MHz - 110 MHz), terrestrial TV (about 600 MHz), Wi-fi/Bluetooth frequencies (about 2.4 GHz), mobile phones and satellite communications (about 10 GHz);
 8. understand why radio receivers have to be tuned to the broadcast frequency;
 9. recall different types of aerial and give two examples of their uses, limited to:
 - simple dipole for 360° reception;
 - dish receivers for satellites;
 - ferrite rod in radio receivers;
 10. **use the equation $c = f\lambda$ to calculate wavelengths or frequencies of radio waves;**
 11. **understand that radio waves are diffracted by an aperture comparable to or smaller than their wavelength;**
 12. understand that radio waves can be absorbed and reflected;
 13. understand that radio waves which arrive at a detector by different paths can interfere and cancel.
-

MODULE AP5: COMMUNICATIONS

AP5.4 Digital communications

Information often enters and leaves communications systems in analogue form, but there are advantages of fidelity and cost in transmitting the information in digital form.

1. understand that an analogue signal can have any value, but a digital signal is limited to discrete values (a range of fixed values);
2. understand the advantages of analogue communications: transmitters and receivers can be simple; true representation of original signal possible;
3. understand the disadvantages of analogue communications: information always distorted and degraded; difficult to compress or encrypt;
4. understand the advantages of digital signals: transferred with little loss of quality; can accommodate a range of digital devices so multimedia is a possibility; can be manipulated;
5. understand the disadvantages of digital signals: complex circuitry is needed at transmitter and receiver; involves distortion as not all values are possible.

Signals are often sent down communication links in digital form to improve signal-to-noise ratio. Digital formats also offer other advantages for security, processing and storage.

6. understand that signals are carried
 - in copper wires by electric current;
 - in optical fibres by light and infrared;
 - by radio waves with a range of frequencies;
7. give two examples each of communication systems linked by copper wire, optical fibre and radio waves, and explain why that type of link is used;
8. give two examples of how messages (for example email, telephone) are routed through a communications network using a block diagram, describing the likely form of the signal at each stage (digital/analogue);
9. give two examples of storing information electronically (for example floppy disc, CD-ROM, memory stick, flash card).

Converting analogue signals into digital format requires compromise. Once a signal is in digital format, it can be manipulated in a variety of ways using software.

10. describe how digital signals are created by sampling;
11. understand the terms word, bit, bit rate, byte, binary, sample rate;
12. give two examples of signal encryption for security (e.g. internet shopping, encoding of premium rate TV channels, mobile phone communication, wireless computer networks, espionage, crime), and explain their importance;
13. **understand compression of digital signals as a way of reducing the quantity of data sent;**
14. understand how the use of programmable electronic systems reduces the cost of digital communications through economies of scale;
15. **understand the term signal-to-noise ratio (dB not required).**

MODULE AP5: COMMUNICATIONS

AP5.5 Underlying skills and knowledge

Communication involves transferring information between people.

1. understand that communications are based on shared visual symbols (for example hazard symbols), sounds (for example alarms) and codes (for example Morse code), and give two examples of each;
 2. understand the following terms: data transmission rate, error rate, range, encoding and decoding.
-

Communications systems are made by connecting together electronic units.

3. recall that any electronic system can be represented by a connected set of blocks; each block represents a process, arrows joining blocks show flow of information;
 4. describe the functions of input, output and **processor** devices in a system;
 5. interpret flow charts (symbols given in appendix J) and simple data sheets to select devices for appropriate use in communications systems.
-

Transmission of pictures and video is becoming increasingly important.

6. understand that a picture can be represented by rows of pixels making up a frame;
 7. understand how to calculate the video bit rate from the word size required for a pixel, the number of pixels in a frame and the refresh rate;
 8. **understand the reasons for compressing video information and its effect on the quality of the received image.**
-

Instruments are used to detect malfunctioning blocks in a communications system.

9. understand how voltage is measured with a voltmeter;
 10. understand how to use an oscilloscope to measure amplitude and frequency of a time-varying signal;
 11. **understand that signals between blocks can be measured and compared with the expected signal.**
-

MODULE AP6: MATERIALS AND PERFORMANCE – OVERVIEW

Daily life depends on modern materials. Manufacturers are constantly seeking to satisfy ever greater demands – for longer-lasting body implants, lighter-weight computers, cars that are more energy-efficient. Often it is a combination of properties that makes a material suitable for a particular job.

In this module, candidates explore the design and testing of materials and artefacts. Opportunities exist to use the following contexts, if desired, but teachers are free to use contexts relevant to their locality and experience:

- improving sports performance
- children’s toys
- materials used on stage and screen
- building materials
- repairing the human body

The module covers techniques associated with measuring and improving performance of solid materials. Most lend themselves to practical work by the candidate. Some lend themselves to information gathering from secondary sources. Candidates should study relevant procedures and techniques in authentic contexts.

Ap6.1 People and organisations

Ap6.2 Mechanical behaviour of materials

Ap6.3 Electrical, thermal and acoustic behaviour of materials

Ap6.4 Optical behaviour of materials

Ap6.5 Underlying skills and knowledge

In context, candidates also learn about regulations and practices designed to protect individuals and the environment from performance failures in materials, under test or in use.

The module provides opportunities to apply science from the GCSE Science A course, especially:

- C2 Material choices;
- P2 Radiation and life;

ICT Opportunities

This module offers opportunities for illustrating the use of ICT in science and technology, for example:

- collecting, storing and displaying as charts and graphs, data on a variety of material properties;

- how the internet can be used to provide data on material properties for designers and end-users;
- control and programming of stage lighting effects.

Use of ICT in teaching and learning can include:

- data logging to investigate mechanical, electrical, acoustic, optical or thermal properties of materials;
- video sequences to show industrial testing of the mechanical properties of turbine blades;
- use of the internet to find out about people who apply science in their work.

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.1 People and organisations

People working in industrial, research or standards organisations require a good knowledge of materials and their properties.

1. recall two examples of people who need significant knowledge of materials and their properties for their job;
 2. interpret given information about the working, forming and joining of materials to make artefacts;
 3. match the main criteria used to select materials (particular properties, durability, cost, environmental impact, aesthetic appeal) against specific uses.
-

Regulations and standard procedures are used to protect the health and safety of individuals while testing or using materials and artefacts.

4. understand the need for product standards (limited to consideration of safety, quality and consistency);
 5. recall two examples of organisations that set product standards and their marks (for example the British Standards Institution (BS), the European Committee for Standardisation (CE), the International Organisation for Standards (ISO));
 6. recall two examples to illustrate the fact that artefacts are designed with safety margins;
 7. recall two examples of practitioners whose job it is to enforce standards (for example trading standards officer, building control surveyor).
-

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.2 Mechanical behaviour of materials

The mechanical properties of thousands of materials are tested, with reliable results published in reference books and on websites.

1. distinguish between loading in compression and tension;
2. understand the following terms used to describe mechanical properties:
 - stiffness/flexibility;
 - toughness/brittleness;
 - compressive and tensile (breaking) strength;
 - hardness;
 - density;applied to everyday materials and used to create artefacts (for example houses, tin cans, spectacles).
3. describe, with the aid of a diagram, how to compare stiffness in a school laboratory (Young modulus is not required);
4. describe, with the aid of a diagram, how to measure compressive or tensile strength in a school laboratory;
5. **use a force-extension graph to calculate the energy stored in a stretched sample and predict the extension for a given force;**
6. **use appropriately the equation $F = kx$;**
7. understand that materials exhibit both elastic and plastic behaviour and distinguish between them;
8. use force-extension graphs to predict elastic and plastic behaviour;
9. understand that a metal 'alloy' is a solid solution;
10. understand the benefits of using alloys over pure metals (limited to hardness, tensile strength, corrosion resistance, melting point);
11. understand that composite materials have one material embedded in another (for example fibres in a matrix);
12. give two examples of the uses of composite materials.

The mechanical behaviour of a structure can improve on the performance of a material from which its parts are made, typically reducing density and increasing strength and stiffness.

13. understand that an artefact can be made more rigid by changing its
 - shape or thickness of components;
 - materials;
 - structure.
14. **give two examples of artefacts whose materials are selected for matching mechanical behaviours (for example clothing which must change shape as wearer moves);**
15. **give two examples of artefacts whose materials are selected for complementary mechanical behaviours (for example force-spreading outer shell and energy-absorbent lining for a cycling helmet).**

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.2 Mechanical behaviour of materials

Some artefacts use materials that must carry, or respond to, forces that change.

16. recall that velocity is the rate of change of distance in a particular direction;
 17. recall that momentum is proportional to both mass and velocity ;
 18. understand that if a resultant force acts on an object, it causes a change in momentum in the direction of the force;
 19. explain qualitatively how $Ft = \text{change in momentum}$ applies to devices that improve road safety (limited to seat-belts, car crumple zones, cycle and motorcycle helmets);
 - 20. interpret $F - t$ graphs and solve quantitative problems using $Ft = m (v-u)$;**
 21. recall two examples of materials used in devices that improve road safety, describing how their mechanical properties are important.
-

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.3 Electrical, thermal and acoustic behaviour of materials

The materials used in many everyday artefacts are selected for their electrical and thermal properties.

1. understand that samples of materials can be described by their
 - electrical conductance;
 - thermal conductance;
 - thermal expansion;
 2. describe, with the aid of a diagram, how to measure:
 - thermal expansion;
 - **electrical conductance, $G = I/V$;**
 3. understand why different materials at the same temperature can feel warm or cold.
-

Many artefacts require parts to be made from different materials, each with appropriate electrical and thermal properties.

4. understand the choice of materials used in making simple electrical fittings (limited to mechanical and electrical properties);
 5. understand that thermal conductance determines the selection of materials used in an artefact or structure (for example. cookware, building materials);
 6. **give two examples of artefacts whose materials are selected for matching thermal behaviours (for example in a camera body);**
 7. **give two examples of artefacts whose materials are selected for complementary thermal behaviours (for example a bimetal switch in a flasher unit).**
-

Having to live and sleep in noisy surroundings, or to work near loud music or noisy machinery, damages physical and mental health. In some environments it is essential to use materials that absorb sound or vibrations.

8. understand the relationship between the pitch of a sound and the frequency of the vibration causing it;
 9. understand the relationship between the loudness of a sound and the vibration causing it;
 10. understand that the sensitivity of the ear depends on frequency and that the ear is most sensitive to sounds at about 2000 Hz (2 kHz);
 11. understand that the decibel scale describes sound intensity and that it is not a linear scale;
-

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.3 Electrical, thermal and acoustic behaviour of materials

Having to live and sleep in noisy surroundings, or to work near loud music or noisy machinery, damages physical and mental health. In some environments it is essential to use materials that absorb sound or vibrations.

12. recall that
 - a sound that increases by 10 decibels doubles in loudness;
 - the sound level of normal conversations is about 60 dB;
 - sound intensities above 85 dB can cause temporary hearing loss;
 - prolonged exposure to loud sounds can induce tinnitus and permanent hearing loss;
 - sound intensity above 130 dB causes pain;
 13. recall two methods and materials used to reflect or absorb sound in buildings (for example. acoustic ceiling tiles, double glazed windows, underlay used with carpeted or laminated floors);
 14. **understand why low frequency sounds cause more problems in buildings than high frequency sounds;**
 15. recall two methods and materials used to isolate vibrations so that they are not carried by rigid structures (for example mounting machinery on springs, or supporting floors with fluid-filled dampers).
-

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.4 Optical behaviour of materials

Materials can be fabricated with a wide range of optical properties. In many applications, the testing of optical properties is essential.

1. Understand the following terms :
 - transparent;
 - reflective;
 - translucent;
 - opaque;
 - refraction;
2. **understand that the amount of refraction at a material's surface depends on its refractive index;**
3. understand that the use of glass in artefacts depends on its optical and other properties;
4. recall two examples of a specialised glass and relate their properties to uses (for example toughened glass, infra-red reflectory glass, self-cleaning glass, lead glass, tinted glass, photochromic glass);
5. **understand why the glass used for optical fibres must have high purity;**
6. **discuss the relevant properties of materials commonly used for contact lenses (for example gas permeable, transparent, easily sterilised and stick to tears);**
7. recall two examples of the use of mirrors (for example in optical instruments, architecture, in amusements).

The optical properties of some polymers make them a suitable material for lenses. High performance cameras are generally made of glass with special coatings.

8. identify converging and diverging lenses by understanding how their action depends on their shape **and the refractive index of the material from which they are made;**
9. describe the action of a convex lens on parallel rays of light from a distant object, using a ray diagram and the terms focus, image, focal plane, focal length and power (in Dioptres);
10. use these terms to describe images - real/virtual, inverted/upright, smaller/larger/same size - in relation to the eye, a camera, a projector, a magnifying glass;
11. from a given diagram, identify the main parts of a simple camera (lens, shutter, aperture, focal plane, viewfinder);
12. **understand that moving a distant object towards a lens:**
 - **moves the image beyond its focal length;**
 - **increases the size of the image;****so to keep the image in focus: a camera lens moves towards the object; an eye lens becomes thicker.**
13. recall that camera lenses are coated so that they transmit more light.

MODULE AP6: MATERIALS AND PERFORMANCE

AP6.5 Underlying skills and knowledge

Materials scientists, engineers and technicians use standard operating procedures and evaluate their findings objectively.

1. present and interpret data in the form of tables, graphs and drawings;
 2. use given formulae to manipulate data;
 3. identify outliers in data;
 4. evaluate conclusions from data.
-

Solid materials are classified by their properties. The internal structure of a material determines its property.

5. recall the main classes of materials (metals and alloys, polymers, ceramics, woods and wood products, composites);
 6. recognise, **or suggest**, examples of each class of material;
 7. describe the properties of metals (good conductors of heat and electricity, shiny, stiff, ductile, malleable);
 8. describe the properties of ceramics (insulators of heat and electricity, stiff, brittle);
 9. describe the properties of polymers (insulators, often flexible, often plastic);
 - 10. understand that the mechanical properties of materials are affected by temperature.**
-

Artefacts must be tested against their performance specifications. Many artefacts require a combination of properties and this can be accomplished in various ways.

11. relate properties (above) to appropriate uses of metals, polymers, ceramics (including glasses) and composites;
 12. interpret information about the properties of materials to assess the suitability of these materials for particular purposes;
 - 13. recall two examples to explain how composite materials can combine the useful properties of different types of materials while avoiding some of their drawbacks;**
 - 14. recall two examples to explain why it is often a combination of properties that makes a material suitable for a particular job.**
-

4 Scheme of Assessment

4.1 Units of Assessment

GCSE Additional Applied Science A (J632)

Unit 1: AP1 Life Care (A324)

16.7% of the total GCSE marks
45 minutes written paper
36 marks

This question paper:

- is offered in Foundation and Higher Tiers;
- focuses on module AP1;
- uses structured questions throughout (there is no choice of questions);
- assesses knowledge and understanding of the specification and application of that knowledge and understanding.

Unit 2: AP2 Agriculture and Food (A334)

16.7% of the total GCSE marks
45 minutes written paper
36 marks

This question paper:

- is offered in Foundation and Higher Tiers;
- focuses on module AP2;
- uses structured questions throughout (there is no choice of questions);
- assesses knowledge and understanding of the specification and application of that knowledge and understanding.

Unit 3: AP3 Scientific Detection (A325)

16.7% of the total GCSE marks
45 minutes written paper
36 marks

This question paper:

- is offered in Foundation and Higher Tiers;
- focuses on module AP3;
- uses structured questions throughout (there is no choice of questions);
- assesses knowledge and understanding of the specification and application of that knowledge and understanding.

Unit 4: AP4 Harnessing Chemicals (A335)

16.7% of the total GCSE marks
45 minutes written paper
36 marks

This question paper:

- is offered in Foundation and Higher Tiers;
- focuses on module AP4;
- uses structured questions throughout (there is no choice of questions);
- assesses knowledge and understanding of the specification and application of that knowledge and understanding.

Unit 5: AP5 Communications (A326)

16.7% of the total GCSE marks
45 minutes written paper
36 marks

This question paper:

- is offered in Foundation and Higher Tiers;
- focuses on module AP5;
- uses structured questions throughout (there is no choice of questions);
- assesses knowledge and understanding of the specification and application of that knowledge and understanding.

Unit 6: AP6 Materials and Performance (A336)

16.7% of the total GCSE marks
45 minutes written paper
36 marks

This question paper:

- is offered in Foundation and Higher Tiers;
- focuses on module AP6;
- uses structured questions throughout (there is no choice of questions);
- assesses knowledge and understanding of the specification and application of that knowledge and understanding.

Unit 7: Work-related Portfolio (A337)

50% of the total GCSE marks
(*Standard Procedures 6 x 2%,
Suitability Test 1 x 21%,
Work-related Report 1 x 17%*)
96 marks

This unit comprises **three** elements:

- following a standard procedure (two per module, each worth 2%);
- testing the suitability of a material or device for a particular purpose (one only, worth 21%);
- work-related reports (one only, worth 17%) relating the module content to the application of science by people at work in a specific context.

The portfolio is assessed by teachers, internally standardised, then externally moderated by OCR.

For Units 1 - 6:

- Candidates are required to express some of their answers using extended writing;
- Foundation Tier papers will assess only the Learning Outcomes as printed in the Teaching Modules in normal type. Higher Tier papers will assess **all** the Learning Outcomes as printed in the Teaching Modules, including those in **bold**;
- The Foundation and Higher tier papers of each unit will be timetabled on the same day, and will commence at the same time. The papers timetabled simultaneously will contain common questions, or part questions, targeting the overlapping grades C and D.

4.2 Unit Options

Candidates must be entered for one option in each of **three** units chosen from Units 1 to 6. They must also be entered for Unit 7, Work-related Portfolio.

4.3 Tiers

Units 1 to 6 are set in one of two tiers: Foundation Tier and Higher Tier. Foundation Tier papers assess Grades G to C and Higher Tier papers assess Grades D to A*. An allowed grade E may be awarded on the Higher Tier components. Candidates are entered for either the Foundation Tier or the Higher Tier using option codes F and H. Unit 7 (Work-related Portfolio) is not tiered.

Candidates may enter Units 1 to 6 at different tiers, so for example, a candidate may take A324F, A334F and A325H.

4.4 Assessment Availability

There are two examination sessions each year, in January and June.

	Unit 1 (A324)	Unit 2 (A334)	Unit 3 (A325)	Unit 4 (A335)	Unit 5 (A326)	Unit 6 (A336)	Unit 7 (A337)
January 2007	-	-	-	-	-	-	-
June 2007	✓	-	✓	-	-	✓	-
January 2008	✓	✓	✓	✓	✓	✓	-
June 2008	✓	✓	✓	✓	✓	✓	✓

After June 2007, Units 1 to 6 will be available in the January and June sessions. The Work-related Portfolio, Unit 7, will only be available in the June session.

The Foundation and Higher tier papers covering the same unit will be timetabled on the same day, and will commence at the same time. The papers timetabled simultaneously will contain common questions, or part questions, targeting the overlapping grades C and D.

4.5 Assessment Objectives

The Assessment Objectives describe the intellectual and practical skills which candidates should be able to demonstrate, in the context of the prescribed content. Candidates should demonstrate communication skills, including ICT, using scientific conventions (including chemical equations) and mathematical language (including formulae).

Assessment Objective 1 (AO1): Knowledge and understanding of science and how science works

Candidates should be able to:

- demonstrate knowledge and understanding of the scientific facts, concepts techniques and terminology in the specification;
- show understanding of how scientific evidence is collected and its relationship with scientific explanations and theories;
- show understanding of how scientific knowledge and ideas change over time and how these changes are validated.

Assessment Objective 2 (AO2): Application of skills knowledge and understanding

Candidates should be able to:

- apply concepts, develop arguments or draw conclusions related to familiar and unfamiliar situations;
- plan a scientific task, such as a practical procedure, testing an idea, answering a question or solving a problem;
- show understanding of how decisions about science and technology are made in different situations, including contemporary situations and those raising ethical issues;
- evaluate the impact of scientific developments or processes on individuals, communities or the environment.

Assessment Objective 3 (AO3): Practical, enquiry and data-handling skills

Candidates should be able to:

- carry out practical tasks safely and skillfully;
- evaluate the methods they use when collecting first-hand and secondary data;
- analyse and interpret qualitative and quantitative data from different sources;
- consider the validity and reliability of data in presenting and justifying conclusions.

Weighting of Assessment Objectives

Assessment Objectives	Weighting
AO1: Knowledge and understanding	29.8%
AO2: Application of knowledge and understanding, analysis and evaluation	36.9%
AO3: Enquiry	33.3%

The relationship between the components and the assessment objectives of the scheme of assessment is shown in the following grid.

	Assessment Objective Weightings by Unit			
	AO1	AO2	AO3	Total
Units 1 - 6	23.5%	26.5%	-%	50%
Portfolio	6.3%	10.4%	33.3%	50%
Overall	29.8%	36.9%	33.3%	100%

All figures given are for guidance only and have a tolerance of $\pm 3\%$.

4.6 Quality of Written Communication

Candidates are expected to:

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

Candidates' quality of written communication will be assessed in Element 2 Suitability Test, and Element 3 Work-related Report, of the Work-related Portfolio.

5 Internal Assessment

5.1 Assessing Skills

Rationale

The internally assessed unit aims to develop candidates' practical scientific competencies in a range of contexts that candidates may well encounter in their working or everyday lives. In addition, it is intended that these will equip candidates with the competencies necessary to embark on science related vocational courses.

Introduction

The Work-related Portfolio accounts for 50% of the marks for this specification. Skills are assessed by teachers, internally standardised, and then externally moderated.

Unit of Assessment	Title	Weighting	Total Mark
A337	Work-related Portfolio: - Standard Procedures (6 x 2%) - Suitability Test (1 x 21%) - Work-related Report (1 x 17%)	50%	96

5.2 Marking Internally Assessed Work

Arrival at Strand Marks

The method of marking the skills assessment is the same across this Science suite.

The award of marks is based on the professional judgement of the science teacher, working within a framework of descriptions of performance. Within each strand, each line in the marking grids represents a different aspect of performance. For each of these, a series of four descriptions of performance illustrates what might be expected for candidates working at different levels.

Marking decisions should be recorded on marking grids. A master copy is provided in the skills assessment guidance booklet. The completed grid serves as a cover-sheet for the work if it is required for moderation.

Candidates may not always report their work in a particular order. So, evidence of achievement in a strand may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each strand in turn.

Within any one strand, each aspect should be considered in turn. A tick on the grid should be used to indicate the performance statement that best matches the work.

Where the maximum mark is 8, intermediate marks 1, 3, 5 or 7 can be used where performance exceeds that required by one statement, but does not adequately match that required by the next higher statement (e.g. if the work significantly exceeds what is required for 4 marks, but does not

reach the standard for 6, then the tick should be placed on the dividing line between the 4 and 6 mark boxes).

Where a decision is based partly on the teacher's observation of the candidate at work, the work should be annotated to record this at an appropriate point on the report.

In some cases, in order to allow credit for the widest possible variety of activities, an aspect of performance is represented by two (or more) rows of mark descriptors. In such cases, where a row is not relevant or appropriate for a particular activity, it should be left blank and excluded from the 'best-fit' marking judgement and the more appropriate alternative row used.

When each aspect of the performance within a strand has been assessed in this way, the pattern of achievement is interpreted by a 'best-fit' judgement to give a mark for that strand.

This method of marking can be applied even where there is a wide variation between performance in different aspects. Thus, weak performance in one aspect need not depress marks too far if other aspects show better performance.

Element 1: Standard Procedures

Many industries use standard procedures to ensure that results are of good quality and reliable, often to meet legal requirements for quality control. Candidates of all abilities can take pleasure in mastering a skill so that it is repeatable and reliable.

Candidates should demonstrate the ability to follow six standard procedures across the three chosen modules (two per module).

To successfully complete each standard procedure, candidates must:

- follow instructions, step by step
- work safely, observing safety procedures;
- make and record observations/measurements;
- use an appropriate degree of accuracy.

Typically standard procedures will be carried out and assessed in a single lesson

Each assessed standard procedure should involve more than just single step or measurement to be assessed against four criteria. Candidates should be given 0 or 1 for each criteria.

The award of marks is based on the professional judgement of the science teacher, working within the performance criteria.

The criteria should be considered in turn. A tick should be used to indicate a successful match.

When each criteria has been assessed in this way, the marks should be added together to give a total out of 4.

Marking Criteria	1 mark each
a Follows instructions, step by step, without guidance	
b Works safely, observing safety procedures and hazard warnings	
c Makes observations/takes measurements	
d Observations/measurements made to an appropriate degree of accuracy	
Total	out of 4

Marking decisions should be recorded on marking grids. A master copy is provided in the coursework guidance booklet.

Appropriate standard procedures include:

- Measuring the vital signs;
- Assessing aerobic fitness;
- Taking skinfold measurements;
- First Aid procedures;
- Testing the freshness of milk;
- Testing barley seeds for starch and sugar;
- Measuring gluten in flour;
- Culturing bacteria or yeast;
- Preparing a microscope slide;
- DNA extraction;
- Soil testing techniques;
- Chromatography of plant pigments;
- Fingerprinting techniques;
- Qualitative tests for ions;
- Making a soluble salt;
- Measuring chemical reaction rates;
- Making an emulsion;
- Constructing a simple circuit on breadboard;
- Programming a PIC chip;
- Sending messages by Morse Code;
- Setting up and using an oscilloscope to measure a signal;
- Comparing thermal conductance of two materials;
- Comparing stiffness of different materials;
- Finding the focal length of a simple lens.

Element 2: Suitability Test

In commerce or industry it is often necessary to decide the most suitable material to use for a specified purpose, or the most effective way to carry out a test, or the best equipment to use. This requires first an understanding of the context, and the criteria which will define 'suitability', then devising an investigation that will reveal how well the criteria are met. Thus, science knowledge and understanding, practical competency and an understanding of the work-related context are brought together to complete a suitability test.

There are opportunities for candidates to demonstrate the ability to test the suitability of a material, procedure or a device for a particular purpose across all three Applied modules undertaken. These tests will require a more extended time allocation than the Standard Procedures.

Candidates are required to test the suitability of materials, procedures or devices for a particular purpose. Emphasis should be placed on the scientific principles relating to the testing procedure.

Tests carried out by the candidates can be of three types:

- testing one **material** or comparing more than one **material** for a particular purpose, e.g., comparing two materials, for instance, the quality of signal transfer by copper wire with and without earth shielding (Ap5 Communications);
- comparing different **procedures** for a particular purpose, e.g., the suitability of paper and thin-layer chromatography for a particular purpose (Ap3 Scientific Detection);
- testing the suitability of a **device** for a particular purpose, e.g., testing a device used for malting to see whether it malts barley satisfactorily (Ap2: Agriculture and Food).

The work will be assessed under five headings or aspect of performance, with a mark of 0 to 8 awarded in each.

Candidates will be assessed on their ability to:

- describe the relevant properties or characteristics;
- follow or devise a suitable approach;
- collect reliable data;
- evaluate the suitability of the material, procedure or device;
- communicate through a structured report.

Candidates may carry out as many tests as the centre wishes to use, any or all of which can be assessed. The final assessment total for the candidate will be the mark for the highest scoring test.

Marking Criteria – Suitability Test

Aspect of Performance	Mark			
	2	4	6	8

Strand A Purpose of the test

(a) The use or purpose of the material, procedure or device to be tested, related to its workplace context.	Makes some reference to its use or purpose.	Gives a limited description of both its use and some aspect of the workplace context.	Gives a reasonable description of both its use and some aspect of the workplace context.	Gives a detailed description of both its use and relevant aspects of the workplace context.
(b) The criteria for 'suitability' of the material, procedure or device	Gives some description of its desirable properties or characteristics.	Gives a full description of its desirable properties or characteristics.	Gives a full description of its desirable properties or characteristics, explaining why at least one of these is necessary	Gives a full description of its desirable properties or characteristics, explaining why these are necessary.

Strand B Carrying out an appropriate test

(a) Student autonomy & independence	The approach is based on specific, task-related structured worksheets with further guidance from the teacher at most stages.	The approach is closely defined by the teacher, and is carried out with further guidance at several points during the testing.	The approach is closely defined by the teacher, but is carried out with little further guidance.	The approach is defined by the candidate from a more general brief, and then carried out independently.
(b) Complexity and appropriateness of the test	Carries out a simple measurement or comparison task.	Carries out a task of limited complexity.	Skilfully carries out a complex task.	Skilfully carries out a complex task, explaining how it relates to the criteria for 'suitability'.

Aspect of Performance	Mark			
	2	4	6	8

Strand C Collecting data or observations

(a) Recording the data	Partially records data or observations in a given format.	Fully records data or observations in a given format.	Devises own format and correctly records data or observations including all units of measurement.	Devises own format and correctly records data or observations to an appropriate degree of precision.
(b) Range and quantity of data or observations	Data or observations are limited in amount, covering only part of the relevant range.	An adequate amount or range of data or observations.	An adequate amount and range of data or observations, with repeats or checks for reliability.	Data or observations collected cover the relevant range, with values well-chosen across the range.
(c) Quality of data	Data generally of low quality.	Data of variable quality, with some operator error apparent.	Data generally good quality – adequately precise and reliable.	Data has a high level of precision and reliability.

Strand D Evaluation of suitability

(a) Conclusion about suitability, drawn by appropriately linking data or observations to the purpose of the test, and awareness of any limits to the conclusions.	Draws some conclusion, but data or observations not linked back to the purpose of the test.	Draws a correct conclusion from individual results or simple pattern in results, by linking these to the purpose of the test.	Draws a correct conclusion from overall pattern of results, by linking clearly to the purpose of the test.	Draws a correct conclusion from overall pattern of results by linking clearly to the purpose of the test. Discusses any limitations, such as range over which it is suitable.
(b) Evaluation of testing procedure used	Makes a relevant comment about how the data was collected.	Comments on any problems associated with the apparatus and techniques used.	Suggests improvements to apparatus or techniques, with little practical detail.	Describes in detail and explains improvements to apparatus or techniques.

Aspect of performance	Mark			
	2	4	6	8

Strand E Quality of scientific communication

(a) The structure and organisation of the report	The report has little or no structure or coherence, or follows a structure provided by worksheets.	The report has an appropriate sequence or structure.	Information is effectively organised, with contents listing of key elements and page numbering.	Considerable care has been taken to present the information clearly to a chosen audience.
(b) General quality of communication	Uses little or no relevant technical or scientific vocabulary.	Use of appropriate vocabulary is limited.	Uses an adequate scientific vocabulary.	Makes full and correct use of scientific vocabulary achieve effective communication.

Appropriate suitability tests include:

- comparing the suitability of different devices for measuring body temperature;
- comparing different methods of measuring blood glucose;
- comparing different ways of measuring a person's physical capabilities, such as strength, power, or flexibility;
- testing a growth media such as soil, peat-based compost, peat-free compost for seed germination rate;
- comparing different types of flour by measuring their gluten content and/or the quality of bread made from them;
- testing a device which measures the hardness of a tomato;
- identifying features of a sample using the naked eye and a light microscope;
- comparing different solvent systems with paper chromatography to separate the dyes in ink;
- comparing the effectiveness of either an active ingredient or a formulation for its specified purpose e.g. antacids to neutralize acids, or acids used to remove limescale;
- comparing the quality of signal transfer with and without earth shielding;
- comparing the frequency response for different types of microphones or loudspeakers;
- testing an electrical or electronic product against its specification;
- testing the tensile strength of fishing line;
- comparing the transmission of light or infra-red radiation through glass and Perspex acrylic;
- comparing the thermal expansion of two metals.

Element 3: Work-related Report

This task provides an opportunity for candidates to research authentic contexts in which science is applied. At the core of their report is a description of the nature of the work carried out. They should aim to focus on specific aspects of workplace practice, and make links to relevant scientific knowledge from one of the six Applied modules.

Writing this report requires several skills associated with scientific communication:

- collecting information and acknowledging sources;
- structuring a report appropriately;
- making effective use of visual material to convey information and ideas.

Candidates will be assessed on their ability to:

- select and use information sources;
- describe the workplace;
- make links to relevant scientific knowledge and understanding;
- produce a coherent report to present findings.

Marking Criteria – Work-related Report

Aspect of Performance	Mark			
	2	4	6	8

Strand A Information sources

(a) Initiative in collecting information	Information given is restricted to that provided by the original stimulus materials	Information from a few additional sources is provided, although some may be irrelevant or inappropriate.	Relevant information is collected, from a variety of sources including a practitioner and/or workplace.	Uses relevant information carefully selected, from a variety of sources including a practitioner and/or workplace.
(b) Reference to sources	Sources of information not identified	Sources are identified by incomplete or inadequate references	Sources are identified clearly but in limited detail	References to sources are clear and fully detailed
(c) Identification of source of particular information	-	Direct quotations are rarely indicated as such	Direct quotations are generally acknowledged	Direct quotations are appropriately used and acknowledged.

Aspect of Performance	Mark			
	2	4	6	8

Strand B Description of workplace

(a) Description the expertise of an individual, or a working group, with the vocational qualifications and personal qualities required	Gives an account which is superficial or lacks detail or focuses on only one aspect	Gives a partial account of the expertise of an individual, or a working group, with the vocational qualifications or personal qualities required	Describes the expertise of an individual, or a working group, with the vocational qualifications or personal qualities required	Gives a clear account which explains the relevance to the work of the vocational qualifications and personal qualities required
(b) Description of the nature of the work, its purpose and place in the wider organisation	Gives an account which is superficial or lacks detail or focuses on only one aspect	Gives a partial account of the work, its purpose and place in the wider organisation	Gives an account of the work and describes its purpose and place in the wider organisation	Gives a full account of the work and explains its purpose and place in the wider organisation
(c) Understanding of the financial or regulatory context in which the work is done (e.g. health and safety regulations).	Makes a link between one financial or regulatory factor and the work.	Identifies one relevant example of the impact of a financial or regulatory factor on the work.	Describes one example of the impact of a financial or regulatory factor on the work.	Explains one example of the impact of a financial or regulatory factor on the work.

Strand C Scientific knowledge and skills applied

(a) Scientific knowledge and understanding applied in the workplace	Makes a link between the work and one example of scientific knowledge.	Identifies scientific knowledge involved in the work described.	Describes scientific knowledge involved in the work.	Describes scientific knowledge and explains how it underpins the work described.
(b) Technical skills applied in the workplace	Makes a link between the work and one example of a technical skill	Identifies a relevant example of a technical skill applied in the workplace	Describes an example of a technical skill applied in the workplace	Describes and explains an example of a technical skill applied in the workplace

Aspect of performance	Mark			
	2	4	6	8
Strand D Quality of presentation				
(a) The structure and organisation of the report	The report has little or no structure or coherence, or follows a structure provided by worksheets.	The report has an appropriate sequence or structure	Information is effectively organised, with contents listing of key elements and page numbering	Considerable care has been taken to present the information clearly to a chosen audience.
(b) Use of visual means of communication (charts, graphs, pictures etc).	There is little or no visual material to support the text.	Visual material is simply decorative, rather than informative.	Visual material is used to convey information or illustrate ideas.	Visual material is used appropriately to convey information or illustrate ideas.
(c) General quality of communication	Spelling, punctuation and grammar are of generally poor quality. Little or no relevant technical or scientific vocabulary is used.	Use of appropriate vocabulary is limited. Spelling, punctuation and grammar are of very variable quality.	Appropriate scientific vocabulary is used. Spelling, punctuation and grammar are generally sound.	There is full and effective use of relevant scientific terminology. Spelling, punctuation and grammar are almost faultless.

Work-Related Report topics need to allow coverage of the work of the people involved and their qualifications. Appropriate topics include:

- one part of the National Health Service e.g. local hospital pathology department, health centre or surgery
- the work of a physiotherapist at a football club
- production on a local farm, nursery, market garden or garden centre
- veterinary practices
- visit to a brewery or maltings
- chemical analysis used in a context such as a council environmental health department, the enforcement of food standards
- one aspect of forensic science in practice
- the work of a person using chemicals on a big or small scale, e.g. beauty care or hairdressing, swimming pool maintenance
- factory formulation of paints
- visit to a chemical plant or oil refinery
- production or sales of communications equipment
- the management of a TV outside broadcast such as a sporting event, music festival
- visit to a local optician
- the way that materials are formed, worked or joined by a firm that manufactures some material or product

Arrival at the Final Mark Submitted

The marks achieved in all three elements should be added together to give a total mark for the Work-related Portfolio.

Element	Number of assessments	Total marks per assessment	Total marks for Element
Standard Procedures	6	4	24
Suitability Test	1	40	40
Work-Related Report	1	32	32
Total for Work-related Portfolio (for form MS1)			Total mark out of 96

Coursework Assessment Forms will be provided for centres to summarise each candidate's portfolio. The final total marks out of 96 should be submitted to OCR on Form MS1 by 15 May in the year of entry for Unit A337. These forms are produced and despatched at the relevant time based on entry information provided by the Centre.

All assessed work which has contributed to candidates' final totals must be available for moderation.

5.3 Regulations for Internally Assessed Work

Supervision and Authentication of Work

OCR expects teachers to supervise and guide candidates who are undertaking work that is internally assessed. The degree of teacher guidance will vary according to the kind of work being undertaken. It should be remembered, however, that candidates are required to reach their own judgements and conclusions.

When supervising internally assessed tasks, teachers are expected to:

- offer candidates advice about how best to approach such tasks;
- exercise supervision of work in order to monitor progress and to prevent plagiarism;
- ensure that the work is completed in accordance with the specification requirements and can be assessed in accordance with the specified mark descriptions and procedures.

Coursework should, wherever possible, be carried out under supervision. However, it is accepted that some tasks may require candidates to undertake work outside the Centre. Where this is the case, the Centre must ensure that sufficient supervised work takes place to allow the teachers concerned to authenticate each candidate's work with confidence.

Candidates will require guidance in their choice for their case study and some of the work is likely to be carried out individually and independently without direct supervision. Teachers will need to take steps to ensure that the work presented for assessment accurately reflects each candidate's individual attainment.

Production and Presentation of Internally Assessed Work

Candidates must observe certain procedures in the production of internally assessed work.

- Any copied material must be suitably acknowledged.
- Where work is based on the use of secondary data, the original sources must be clearly identified.
- Each candidate's assessed work submitted for moderation should be stapled together at the top left hand corner and have a completed cover sheet as the first page.

Annotation of Candidates' Work

Each piece of assessed coursework should be annotated to show how the marks have been awarded in relation to the mark descriptions.

The writing of comments on candidates' work provides a means of dialogue and feedback between teacher and candidate and a means of communication between teachers during internal standardisation of the portfolio.

However, the main purpose of annotating candidates' work is to provide a means of communication between teacher and moderator, showing where marks have been awarded and why they have been awarded.

Annotations should be made at appropriate points in the margins of the script of all work submitted for moderation. The annotations should indicate where achievement for a particular skill has been recognised.

It is suggested that the minimum which is necessary is that the 'shorthand' mark descriptions (for example, Ea8) should be written at the point on the script where it is judged that the work has met the mark description.

Moderation

All internally assessed work is marked by the teacher and internally standardised by the Centre. Marks are then submitted to OCR by a specified date, after which moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard of the award of marks is the same for each Centre and that each teacher has applied the standards appropriately across the range of candidates within the Centre.

It is the responsibility of the Centre to carry out effective internal standardisation to ensure that similar standards are applied by each teacher involved in the assessment. The Moderator will require a written statement describing how internal standardisation has been carried out within the Centre.

External moderation will be by postal sample selected by the Moderator.

The sample will represent performance across the whole ability range from the Centre. The sample of work which is presented to the Moderator for moderation must show how the marks have been awarded in relation to the mark descriptions.

Separate cover sheets are required for each element of the candidate's work in the sample submitted for moderation.

Minimum Requirements for Internally Assessed Work

If a candidate submits no work for this internally assessed unit, then the candidate should be indicated as being absent from that unit on the mark sheets submitted to OCR. If a candidate completes any work at all for an internally assessed unit, then the work should be assessed according to the criteria and mark descriptions and the appropriate mark awarded, which may be zero.

6 Technical Information

6.1 Making Unit Entries

Please note that centres must be registered with OCR in order to make any entries, including estimated entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Centres should be aware that a minimum of ten candidates for summer examinations is normally required.

Unit Entry Options

Within Units 1 to 6 candidates must be entered for either the Foundation Tier or the Higher Tier option. It is not necessary for candidates to enter at the same tier in every unit. Candidates may, if they wish, attempt papers at both tiers, but not in the same examination session, since the papers will be timetabled simultaneously.

Entry Code	Option Code		Component to be taken
A324	F	01	AP1 Life Care Foundation
	H	02	AP1 Life Care Higher
A334	F	01	AP2 Agriculture and Food Foundation
	H	02	AP2 Agriculture and Food Higher
A325	F	01	AP3 Scientific Detection Foundation
	H	02	AP3 Scientific Detection Higher
A335	F	01	AP4 Harnessing Chemicals Foundation
	H	02	AP4 Harnessing Chemicals Higher
A326	F	01	AP5 Communications Foundation
	H	02	AP5 Communications Higher
A336	F	01	AP6 Materials and Performance Foundation
	H	02	AP6 Materials and Performance Higher
A337		01	Work-related Portfolio

Candidate entries must be made by 21 October for the January session and by 21 February for the June session.

6.2 Making Qualification Entries

Candidates must be entered for certification code J632 to claim their overall GCSE grade.

If a certification entry is not made, no overall grade can be awarded.

A candidate who has completed all the units required for the qualification may enter for certification either in the same examination session (within a specified period after publication of results) or at a later session.

First certification will be available in June 2008 and every January and June thereafter.

Certification cannot be declined.

6.3 Grading

GCSE results are awarded on the scale A*-G. Units are awarded a* to g. Grades are awarded on certificates. Results for candidates who fail to achieve the minimum grade (G or g) will be recorded as unclassified (U or u).

In unitised schemes candidates can take units across several different sessions. They can also re-sit units or choose from optional units where available. When working out candidates' overall grades OCR needs to be able to compare performance on the same unit in different sessions when different grade boundaries have been set, and between different units. OCR uses uniform marks to enable this to be done.

A candidate's uniform mark is calculated from the candidate's raw mark. The raw grade boundary marks are converted to the equivalent uniform mark boundary. Marks between grade boundaries are converted on a pro rata basis.

When unit results are issued, the candidate's unit grade and uniform mark are given. The uniform mark is shown out of the maximum uniform mark for the unit e.g. 31/50.

Results for each unit will be published in the form of uniform marks according to the following scales.

	Unit Grade								
	a*	a	b	c	d	e	f	g	u
Units 1 to 6	50-45	44-40	39-35	34-30	29-25	24-20	19-15	14-10	10-0
Unit 7	150-135	134-120	119-105	104-90	89-75	74-60	59-45	44-30	29-0

Higher tier candidates may achieve an "allowed e". Higher tier candidates who miss a grade e will be given a uniform mark in the range f to u but will be graded as 'u'.

Candidates' uniform marks for each module are aggregated and grades for the specification are generated on the following scale.

Qualification Grade								
A*	A	B	C	D	E	F	G	U
300-270	269-240	239-210	209-180	179-150	149-120	119-90	89-60	59-0

The candidate's grade will be determined by this total mark. Thus, the grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performance in others. Candidates achieving less than the minimum mark for grade G will be unclassified.

6.4 Result Enquiries and Appeals

Under certain circumstances, a centre may wish to query the grade available to one or more candidates or to submit an appeal against an outcome of such an enquiry. Enquiries about unit results must be made immediately following the series in which the relevant unit was taken.

For procedures relating to enquires on results and appeals, centres should consult the OCR *Handbook for Centres* and the document *Enquiries about Results and Appeals – Information and Guidance for Centres* produced by the Joint Council. Copies of the most recent editions of these papers can be obtained from OCR.

6.5 Shelf-Life of Units

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the qualification.

6.6 Unit and Qualification Re-sits

Candidates may re-sit any unit an **unlimited** number of times.

For each unit the best score will be used towards the final overall grade.

Candidates may enter for the full qualification an unlimited number of times.

6.7 Guided Learning Hours

GCSE Additional Applied Science requires 120 guided learning hours in total.

6.8 Code of Practice/Subject Criteria/Common Criteria Requirements

These specifications comply in all respects with the revised *GCSE, GCE, VCE, GNVQ and AEA Code of Practice 2005/6*, the subject criteria for GCSE Additional Applied Science and *The Statutory Regulation of External Qualifications 2004*.

6.9 Arrangements for Candidates with Particular Requirements

For candidates who are unable to complete the full assessment or whose performance may be adversely affected through no fault of their own, teachers should consult the Access Arrangements and Special Consideration Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations. In such cases advice should be sought from OCR as early as possible during the course.

6.10 Prohibited Qualifications and Classification Code

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

The classification code for this specification is 0028.

7 Other Specification Issues

7.1 Overlap with other Qualifications

This specification has been developed alongside GCSE Science A, GCSE Additional Science A, GCSE Biology A, GCSE Chemistry A and GCSE Physics A.

7.2 Progression from these Qualifications

GCSE qualifications are general qualifications which enable candidates to progress either directly to employment, or to proceed to further qualifications.

Many candidates who enter employment with one or more GCSEs would undertake training or further part-time study with the support of their employers.

Progression to further study from GCSE will depend upon the number and nature of the grades achieved. Broadly, candidates who are awarded mainly grades G to D at GCSE could either strengthen their base through further study of qualifications at Level 1 within the National Qualifications Framework or could proceed to Level 2. Candidates who are awarded mainly grades C to A* at GCSE would be well prepared to broaden their base through further study of qualifications at Level 2 or to proceed to appropriate qualifications at Level 3 within the National Qualifications Framework. Candidates intending to proceed to qualifications in the sciences at Advanced Level (Level 3 in the National Qualifications Framework) should have completed courses in both GCSE Science A and GCSE Additional Science A or GCSE Additional Applied Science A.

7.3 ICT

In order to move on to more advanced study of science, candidates need to be confident and effective users of ICT. This specification provides candidates with a wide range of appropriate opportunities to use ICT in order to further their study of Science.

Opportunities for ICT include:

- gathering information from the Internet and CD-ROMs;
- gathering data using sensors linked to data-loggers or directly to computers;
- use of videos clips to show standard procedures in the workplace and the applications of science at work
- using spreadsheets and other software to process data;
- using animations and simulations to visualise scientific ideas;
- using software to present ideas and information on paper and on screen..

The examples listed in the table below show some points in the specification where opportunities might more easily be found.

Particular opportunities for the use of ICT are highlighted in the introductions to the modules.

7.4 Citizenship

Since September 2002, the National Curriculum for England at Key Stage 4 has included a mandatory programme of study for Citizenship.

Core science is designed as a science education for future citizens which not only covers aspects of the Citizenship programme of study but also extends beyond that programme by dealing with important aspects of science which all people encounter in their everyday lives.

Citizenship Programme of Study

Opportunities for Teaching the Issues during the course

Section 1: Knowledge and understanding about becoming informed citizens

The work of parliament, the government and the courts in making and shaping the law

AP1.1 –Features of a national health service.
AP2.1 – the role of government ministries and regulatory authorities that monitor and control the food chain.
AP3.1 – The role of scientific evidence in law enforcement.
AP5.1 – Regulation of communications industries.

How the economy functions, including the role of business and financial services

AP2.5 – Quality assurance and marketing and the economic context in which farmers operate.
AP4.1 – The scale and economic importance of the chemical industry.

The media's role in society, including the internet, in providing information and affecting opinion

AP5.2 – The commercial production of a communications system.

The rights and responsibilities of consumers, employers and employees

Work-related Report
AP3.1 The role of scientific evidence in consumer protection.
AP6.2 – British standard tests for mechanical properties.

The issues and challenges of global interdependence and responsibility, including sustainable development and Local Agenda 21

AP2.3 – Animal welfare issues.
AP2.5 – Principles underpinning sustainable agriculture
AP3.2 – Use of observation and analysis for environmental monitoring.
AP4.5 – Research and development in the chemical industry to develop 'green' processes.

Section 2 : Enquiry and communication

Researching the practice of science by analysing information from different sources, including ICT-based sources, showing an awareness of the use and abuse of statistics	Work-related Report and Suitability Test.
Expressing, justifying and defending orally and in writing a personal opinion about the practice of science	AP1.2 – Data kept on personal records in a health or fitness organisation. AP2.2 – Debating the relative merits of intensive and organic farming.
Contributing to group and class discussions	AP3.1 - Participating in a simulated scene-of-crime investigation.

Section 3: Developing skills of participation and responsible action

Consider and evaluate views that are not their own	Coursework: Work-related Portfolio.
Participating in science-based school and community activities	Coursework: Work-related Portfolio.

7.5 Key Skills

These specifications provide opportunities for the development of the Key Skills of *Communication*, *Application of Number*, *Information Technology*, *Working with Others*, *Improving Own Learning and Performance* and *Problem Solving* at Levels 1 and/or 2. However, the extent to which this evidence fulfils the Key Skills criteria at these levels will be totally dependent on the style of teaching and learning adopted for each unit.

The following table indicates where opportunities *may* exist for at least some coverage of the various Key Skills criteria at Levels 1 and/or 2 for each unit.

Level	Communication	Application of Number	IT	Working with Others	Improving Own Learning and Performance	Problem Solving
1	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓

7.6 Spiritual, Moral, Ethical, Social, Legislative, Economic and Cultural Issues

A number of Subject Criteria which feature in this specification have a significant cultural influence on how people think about themselves and their environment. Also in this specification, candidates gain more insight into the reliability and significance of scientific data.

Issue	Opportunities for Teaching the Issues during the Course
The commitment of scientists to publish their findings and subject their ideas to testing by others.	AP2 – The role of the Food Standard Agency in commissioning and publishing research into food safety. AP3 – Proficiency tests to accredit the performance of analytical laboratories.
The range of factors which have to be considered when weighing the costs and benefits of scientific activity.	AP2.3 – The use of artificial insemination and hormones to control animal reproduction. AP5.4 – Implications of limited possibilities for servicing electronic equipment. AP6.5 – Explain how composite materials can combine useful properties and assess the suitability of these materials.
The ethical implications of selected scientific issues.	AP1.3 – Assisted reproduction techniques. AP2.3 – Animal welfare and the five freedoms. AP3.1 – The implications of analytical results for people’s freedom under the law and freedom to take part in sport.
Scientific explanations which give insight into human nature	AP1.2 – Questionnaire on lifestyle history.
Scientific explanations which give insight into everyday experiences	AP3.1 – Health and safety. AP4.4 – Formulation of effective and safe consumer products. AP5.1 – Identify electrical hazards.
Scientific explanations which give insight into the local and global environment	AP5.3 – Criteria used to site mobile telephone masts. AP2.1 – The agriculture and food industries. AP1.3 – Treatments often have side effects and these are weighed against the benefits gained.

7.7 Sustainable Development, Health and Safety Considerations and European Developments

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

Issue	Opportunities for Teaching the Issues during the Course
Environmental issues	
Managing wastes from manufacturing industry	AP4.5 – Understanding the impact of making chemicals on a large scale and the need to reduce wastes.
Food and agriculture	AP2.3 – The environmental impact of alternative approaches to animal husbandry. AP2.4 – Using microorganisms to produce food and drinks.
Use and disposal of materials	AP4.3 – Disposing of and recycling products of from the chemical industry.
Detection of pollutants	AP2.4 – Tests for bacterial contamination of milk. AP3.2/3/4 – Use of analytical techniques to detect pollutants. AP4.2 – Methods of making pure chemicals.
Health and Safety issues	
Safe practice in the laboratory	Coursework – Standard procedures.
Health and disease	AP1 – Life Care. AP2.2 – Safe culturing of microorganisms and the importance of aseptic techniques. AP4.2/3/4 – Methods of making and formulating drugs and medicines.
Safety in motor vehicles and other forms of transport	AP2 – Crumple zones and car safety design. AP6.4 – Glass in automobiles.
The purity of food, water, consumer products and medical drugs.	AP2.2/3/4 – Stages in the preparation of a pure food product. AP4.3 – Purity of chemicals.

OCR has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen assessments. European examples should be used where appropriate in the delivery of the subject content.

Although this specification does not make specific reference to the European Dimension it may be drawn into the course of study in a number of ways. The table below provides some appropriate opportunities.

Issue	Opportunities for Teaching the Issues during the Course
The importance of the science-based industry to European economies	This features in all modules in ways appropriate to the context.
The role of national and international regulatory authorities in setting standards of quality, health and safety and environmental protection	This features in all modules in ways appropriate to the context.

7.8 Avoidance of Bias

OCR has taken great care in preparation of these specifications and assessment materials to avoid bias of any kind.

7.9 Language

These specifications and associated assessment materials are in English only.

7.10 Support and Resources

The University of York Science Education Group (UYSEG) and the Nuffield Curriculum Centre have produced resources specifically to support this specification. The resources will comprise:

- candidates' texts;
- candidates' work books;
- teacher guide with suggested schemes of work and candidate activity sheets (in customizable format);
- technician guide;
- ICT resources (for example, animations, video clips, models and simulations);
- assessment materials;
- a website for teachers and candidates.

The resources are published by Oxford University Press. Further information is available from:

Customer Services: Telephone: 01536 741068
Fax: 01536 454579
email: schools.orders@oup.com

Support is also available from the OCR GCSE science website www.gcse-science.com where centres should register their intention to offer this qualification. Registering on this site provides access to a teachers' forum and local support networks.

Appendix A: Grade Descriptions

Grade F

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

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

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

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

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

Grade C

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

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

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

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

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

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

Grade A

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

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

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

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

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

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

Appendix B: Requirements Relating to Mathematics

During the course of study for this specification, many opportunities will arise for quantitative work, including appropriate calculations. The mathematical requirements which form part of the specification are listed below. Items in the first table may be examined in written papers covering both Tiers. Items in the second table may be examined only in written papers covering the Higher Tier.

Both Tiers

add, subtract, multiply and divide whole numbers

recognise and use expressions in decimal form

make approximations and estimates to obtain reasonable answers

use simple formulae expressed in words

understand and use averages

read, interpret, and draw simple inferences from tables and statistical diagrams

find fractions or percentages of quantities

construct and interpret pie-charts

calculate with fractions, decimals, percentage or ratio

solve simple equations

substitute numbers in simple equations

interpret and use graphs

plot graphs from data provided, given the axes and scales

choose by simple inspection and then draw the best smooth curve through a set of points on a graph

Higher Tier only

recognise and use expressions in standard form

manipulate equations

select appropriate axes and scales for graph plotting

determine the intercept of a linear graph

understand and use inverse proportion

calculate the gradient of a graph

Appendix C: Physical Quantities and Units

It is expected that candidates will show an understanding of the physical quantities and corresponding SI units listed below and will be able to use them in quantitative work and calculations. Whenever they are required for such questions, units will be provided and, where necessary, explained.

Fundamental physical quantities

Fundamental Physical Quantities	
Physical quantity	Unit(s)
length	metre (m); kilometre (km); centimetre (cm); millimetre (mm)
mass	kilogram (kg); gram (g); milligram (mg)
time	second (s); millisecond (ms)
temperature	degree Celsius ($^{\circ}\text{C}$); kelvin (K)
current	ampere (A); milliampere (mA)

Derived Quantities and Units	
Physical quantity	Unit(s)
area	cm^2 ; m^2
volume	cm^3 ; dm^3 ; m^3 ; litre (l); millilitre (ml)
density	kg/m^3 ; g/cm^3
force	newton (N)
speed, velocity	m/s; km/h
energy	joule (J) ; kilojoule (kJ); megajoule (MJ)
momentum	kg m/s
power	watt (W); kilowatt (kW); megawatt (MW)
frequency	hertz (Hz); kilohertz (kHz)
gravitational field strength	N/kg

Appendix D: Health and Safety

In UK law, health and safety is the responsibility of the employer. For most centres entering candidates for GCSE examinations this is likely to be the Local Education Authority or the Governing Body. Teachers have a duty to co-operate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful microorganisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment.

A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of Safety in Science Education. For members, the CLEAPSS guide, Managing Risk Assessment in Science offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

- Safety in Science Education, DfEE, 1996, HMSO, ISBN 0 11 270915 X;
- Topics in Safety 3rd edition, 2001, ASE ISBN 0 86357 316 9;
- Safeguards in the School Laboratory, 10th edition, 1996, ASE ISBN 0 86357 250 2;
- Hazcards, 1995 with 2004 updates, CLEAPSS School Science Service*;
- CLEAPSS Laboratory Handbook, 1997 with 2004 update, CLEAPSS School Science Service*;
- CLEAPSS Shorter Handbook (CLEAPSS 2000) CLEAPSS School Science Service*;
- Hazardous Chemicals, A manual for Science Education, (SSERC, 1997) ISBN 0 9531776 0 2.

*Note that CLEAPSS publications are only available to members or associates.

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual Centre then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely.

The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc.

There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

When candidates are planning their own investigative work the teacher has a duty to check the plans before the practical work starts and to monitor the activity as it proceeds.

Appendix E: Explanation of Terms Used in Module Content

All the Ideas-about-Science are expressed in terms of what the candidates know, understand or can do, and are prefixed by 'Candidates should' which is followed by statement containing one or more 'command' words.

This appendix, which is not intended to be exhaustive or prescriptive, provides some guidance about the meanings of these command words.

It must be stressed that the meaning of a term depends on the context in which it is set, and consequently it is not possible to provide precise definitions of these words which can be rigidly applied in all circumstances. Nevertheless, it is hoped that this general guidance will be of use in helping to interpret both the specification content and the assessment of this content in written papers.

Command words associated with scientific knowledge and understanding (AO1)

Candidates are expected to remember the facts, concepts, laws and principles which they have been taught. Command words in this category include Learning Outcomes beginning:

recall...., ...state...; ...recognise...; ...name...; ...draw...; ...test for...; ...appreciate... ; describe...

The words used on examination papers in connection with the assessment of these Learning Outcomes may include:

Describe...; List...; Give...; Name...; Draw...; Write...; What?...; How?...; What is meant by..?

e.g. 'What is meant by the term 'catalyst' ?'

'Name parts A, B and C on the diagram.'

Command words associated with interpretation, evaluation, calculation and communication (AO2)

The command words include:

...relate...; ...interpret...; ...carry out ...; ...deduce...; ..explain...; ...evaluate...;
...predict...; ...use...; ...discuss...; ...construct...; ...suggest...; ...calculate...;
...demonstrate...;

The use of these words involves the ability to recall the appropriate material from the specification content and to apply this knowledge and understanding.



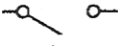


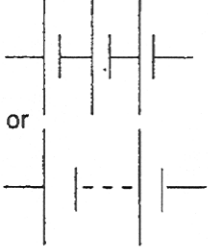


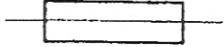

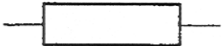


Questions in this category may include the command words listed above together with Why...? Complete... Work out... How would you know that...? Suggest...

e.g. 'Use the graph to calculate the concentration of the acid.'

'Explain why it is important for these materials to be recycled.'

'Suggest two reasons why some people are concerned about the use of these artificial flavours in foods.'

Appendix F: Electrical Symbols

junction of conductors		ammeter	
switch		voltmeter	
primary or secondary cell			
battery of cells	<p>or</p> 	indicator or light source	
power supply			
fuse		motor	
fixed resistor		generator	
variable resistor			

Appendix G: Safety Symbols



emergency stop



first aid point



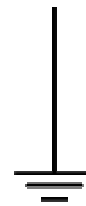
electrical shock hazard – 230 V



BSI kitemark



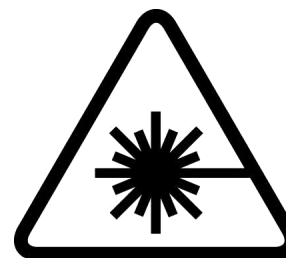
double insulated



earth or ground



danger



laser

