

Annexes for the Market View Report for The Diploma in Science

QD8

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These Annexes are aligned to the Market View research report produced for the Diploma in Science Diploma Development Partnership as part of supplementary information requested, but are not contained within the Market View report as they detail specifics relating to individual Awarding Bodies - which is not permissible for the Market View report itself.

Annex 1 - Alternative 16-18 Qualifications

International Baccalaureate (IB)

This is an international qualification offered by 2,075 schools in 125 countries, including more than 100 UK schools. Standards and curricula are overseen by the International Baccalaureate Organisation (IBO) in Switzerland.

In any one year around 80% of candidates pass the programme which is a single qualification rather than a series of separate subjects as for the A Level system..

Most UK universities, including Oxford and Cambridge, accept the IB as equivalent to A-levels and Scottish Highers (see *Equivalence in the UK*, below).

Overall IB structure

There are three programmes:

- ❖ The Diploma Programme (DP) for students aged 16 to 19
- ❖ The Middle Years Programme (MYP) for students aged 11 to 16
- ❖ The Primary Years Programme (PYP) for students from 3 to 12

The (level 3) Diploma Programme covers subjects divided into six groups:

Group 1

Language 1 + literature in candidate's native language

Group 2

Language 2 - one or more foreign languages, taught to five grades of fluency

Group 3

Individuals & societies - humanities & social sciences

Group 4

Experimental sciences (see below for detailed listing)

Group 5

Maths & computer science - four levels of maths & an elective computer science course

Group 6

The arts & electives - music, theatre, visual arts, film, dance

Students take one subject from each of groups 1-5 and an additional subject from 1-4 and 6. A minimum of three subjects must be taken at Higher Level and the rest of Standard Level.

Other course requirements:

Extended Essay (EE) - a 4,000 paper on a topic of the candidate's choice.

Theory of Knowledge (ToK) - Discusses how the student is able to know something.

Creativity, Action, Service (CAS) - designed to counterbalance the academic content of the rest of the programme, CAS requires students to spend at least 150 hours over the course of the two-year programme participating in different activities that develop them creatively, physically and socially.

Marks are awarded from 1 to 7 in each subject, with 7 being the highest, and up to three additional points may be awarded depending on the results of the EE and ToK essays. The maximum possible point total in the Diploma Program is 45. In order to receive an International Baccalaureate Diploma, candidates must receive at least a 1 in all subjects, with a minimum of 24 points overall.

The UCAS tariff determines that a score of 30 IB points is equivalent to 419 UCAS points and is roughly equivalent to 3 A-grades at A Level and 1 A-grade at AS Level.

The maximum score of 45 IB points is equivalent to 768 UCAS points and is roughly equivalent to 6 A-grades at A Level and 1 B-grade at AS Level.

The IB qualification should not be confused with other “baccalaureates”, such as:

Baccalauréat Générale - the French level 3 high school qualification

French International Baccalaureate - the international version of the French high-school qualification

European Baccalaureate - which is awarded to students at the fourteen European Schools, jointly controlled by the European Union and member states. In the UK, there is just one such school, Culham European School in Oxfordshire. The European Baccalaureate examines in 10 subjects.

AQA Baccalaureate - see below

Welsh Baccalaureate Qualification - see below

Scottish Science Baccalaureate - announced in June 2008 and due for introduction in 2009

Science content

The IB’s Group 4 subjects, entitled **Experimental Sciences**, include:

- Biology
- Chemistry
- Physics
- Environmental Sciences
- Design Technology
- Ecosystems and Societies (currently only a pilot programme available at certain schools, counting as a Group 3 or Group 4 subject).

According to the IB's structure, all candidates must take at least one Group Four subject. However, taking three subjects from any one group is impossible, which rules out the possibility of taking three sciences.

Group 4 subjects can be studied at Standard Level (SL), for students who do not see themselves undertaking further science study after leaving the programme, or Higher Level (HL) for students who may go on to careers in science-based fields.

SL students spend around 150 hours on Group 4 subjects, while HL students spend 240 hours, although both numbers are merely recommendations and are not necessarily enforced. Around one quarter of this time is devoted to practical work in the laboratory.

Each Group 4 subject has its Subject Specific Core (SSC), i.e. material taught at both the standard and higher levels. Students sitting the Higher Level examination study the Additional Higher Level (AHL) material. There is also a list of options for each subject from which two are chosen. Ideally, students choose the options based on their own abilities and preferences, but in practice the options are usually chosen by the school (based on the school's scientific facilities and the teacher's discretion).

Assessment of a Group 4 subject comprises the following:

- ❖ Internal assessment of the practical work (24%)
- ❖ Paper 1 multiple choice questions on the SSC (20%)
- ❖ Paper 2 free response questions on the SSC (32% at SL, 36% at HL)
- ❖ Paper 3 free response questions on the options (24% at SL, 20% at HL)

At the Standard Level, the examinations are respectively 45 minutes, 1 hour and 15 minutes, and 1 hour long. At the Higher Level, they are 1 hour, 2 hours and 15 minutes, and 1 hour and 15 minutes long. Calculators are not permitted for Paper 1, but they (as well as a provided formula booklet and periodic table) are permitted for papers 2 and 3.

Cambridge Pre-U

This new qualification was launched by University of Cambridge International Examinations (i.e. the Cambridge exam board) in September 2008, largely in response to the perceived “dumbing down” of A levels.

It has been formally recognised by over fifty British universities and is currently offered by more than fifty schools.

Since it is a two-year course, its first holders will qualify in 2010.

Overall Pre-U structure

The Cambridge Pre-U is a diploma-type qualification, rather than modular like A-levels, and does not have any compulsory principal subjects as the IB does.

Students have a free choice of three Principal Subjects out of 26 (these include Biology, Chemistry, Physics, Maths and Further Maths).

Additional subjects may be taken, though not incorporated into the Diploma. In addition to the three Principal Subjects, an Independent Research Project and a Global Perspectives portfolio must both be completed for the award of the Pre-U Diploma.

The curriculum is linear and assessment is carried out at the end of the course. Assessment results in one of three classes (pass, merit and distinction) and nine grades, the top grade being equivalent to what is intended to be above A* at A level.

Science content

The Pre-U may be structured to be totally science-based, or to include no science subjects at all¹. Science is taught as three separate subjects.

¹ See <http://www.cie.org.uk/qualifications/academic/uppersec/preu/subjects>

Chemistry: there are four exams, the final one of which is a practical, lasting two hours 15 minutes and counting for 15% of the total Chemistry marks.

Physics: experimental and investigative skills count for 15% of the total Physics marks.

Biology: students are expected to spend 20% of their course time performing practical work. The practical component of the exam counts for 15% of the total Biology marks.

AQA Baccalaureate

This new qualification, approved by QCA in March 2008, is intended to demonstrate depth and breadth of study, as well as independent learning and personal development.

Overall AQA Bacc structure

The AQA Bacc consists of four key elements:

- ❖ At least three A-levels (grade E or above)
- ❖ AS-level in General Studies, Critical Thinking or Citizenship (grade E or above)
- ❖ Extended Project
- ❖ Enrichment Activities

Like the Cambridge Pre-U, the AQA Bacc is awarded at Pass, Merit and Distinction levels. The level awarded is dependent on the grades achieved for the Extended Project and the A-levels.

Science content

As with the Welsh Baccalaureate, any science content in the AQA Baccalaureate derives from the A-level element.

AS/A Level GCE in Applied Science

This is the science option of the vocationally focussed GCE's,

introduced in 2005 as a restructured version of the Vocational Certificates of Education (VCE's).

These qualifications are intended to be at the same level as academic A Levels and to prepare students for science related degree courses or further training whilst in employment. Applied GCE's are also available in business and art and design.

Overall GCE structure

The GCE in Applied Science qualification is available in Single and Double Award at both AS and A Level. The Single Award Advanced Subsidiary and the Double Award Advanced Subsidiary qualifications consist of three and six AS level units respectively. The Single Award Advanced Level comprises three AS units and three A Level units, with Double Award Advanced Level comprising six AS units and a further six A Level units.

The Single Award AS and A Level in applied science are equivalent to one GCE AS Level and one GCE A Level respectively. The Double Award AS and A Level in applied science are equivalent to two GCE AS and A Levels respectively.

Science content

The 14 units available are a mixture of options and compulsory depending on the award (Single or Double) being taken. The content of the units differs between awarding bodies incorporating a range of applied subjects relating to each main strand of science. For example sports science, medical physics, forensic science and organic chemistry are all options available to learners.

Welsh Baccalaureate Qualification (WBQ)

The Welsh Baccalaureate Qualification (WBQ) was piloted from 2003 and its extension across Wales began in 2007.

Structure

There are three levels: Foundation, Intermediate and Advanced; Advanced is equivalent to A-level and Level 3.

It is currently available at Intermediate and Advanced levels, running alongside GCSEs and A-levels. The Foundation level is being offered as part of a pilot scheme running from 2006-09

The WBQ combines personal development skills with existing qualifications like A-levels, NVQs and GCSEs to make one wider award.

63% of WBQ students passed the qualification in 2006, compared with a 97% pass-rate in A-level subjects.

The WBQ offers vocational qualifications within its framework, which the IB Diploma does not

Approved by the Qualifications and Curriculum Authority, but not universally recognised (or at least welcomed) by UK universities

The qualification consists of two parts:

Core consisting of four components:

- Key Skills
- Wales, Europe and the World
- Work-related Education
- Personal and Social Education

Options including courses/programmes currently offered, e.g. GCSE, VGCSE, AS/A levels, VCE (Vocational A levels), NVQ, BTEC

At Advanced level, the *Core* includes:

- Three Key Skills at level 3
- Three Key Skills at level 2

Acceptable Advanced level *Options* include any one of the following:

- NVQ Level 3
- BTEC National Certificate at pass level
- Two A-levels at grade A-E or equivalent

There is no WBQ exam. The Core element is demonstrated through a portfolio of evidence, and the Options are other qualifications, which have their own assessment methodology.

Science Content It is possible to achieve the WBQ with no science content at all. The Core - which distinguishes the Welsh Baccalaureate from other qualifications - does not, in itself, have any science content, so that must come from the Options, which, for most candidates, will mean A-levels.

[Bio-Medical Admissions Test \(BMAT\)](#)

This is an aptitude test used as part of the admissions process for Medicine, Veterinary Medicine or Physiological Sciences in some universities in the UK. It does not result in a qualification.

Universities that use it include Oxford University (for Medicine and Physiology), the University of Cambridge (for Medicine and Veterinary Science), University College London (for Medicine), the Royal Veterinary College (Veterinary Science) and Imperial College London.

Annex 2 - A Review of the Specifications and Assessment of Current Science Qualifications

Introduction

This Annex looks at the current biology, chemistry and physics qualifications available at levels 1 to 3 of the National Qualifications Framework.

The aim is to examine the broad content, assessment and grading structure of the qualifications against which the Diploma in Science will be expected to compete.

The paper is split into 3 sections:

- ❖ Level 1 and 2 Qualifications
- ❖ Level 3 Qualifications
- ❖ Summary

After a brief introduction, each section looks at physics, chemistry and biology qualifications (or, where appropriate, those elements in the qualification) in turn.

Section one focuses on the GCSE qualifications available from various awarding bodies, as these constitute the main competition for level one and two Diplomas. After outlining the most important qualifications and pathways available to learners at these levels, the section goes on to consider physics, chemistry and biology qualifications with examples from GCSE science, additional science, applied science, additional applied science and standard single science GCSE courses.

Section two looks at GCE AS/A Levels, as these are the most popular qualifications competing against the Advanced Diploma in Science at Level 3. Examples of available qualifications from a range of awarding bodies are considered first, and then, as in section one, the remainder of the section looks in more detail at the physics, chemistry and biology subject groups.

Finally, the summary provides a short overview of the main characteristics of the various qualifications available across the levels.

Level 1 and 2 Qualifications

Until recently, learners at levels 1 and 2 could cover the National Curriculum Key Stage 4 science requirement by following one of three GCSE science pathways. The first, and most common was to take a ‘double award’ combined science qualification, worth the equivalent of two normal GCSEs. The second option, and most demanding option, was to take ‘triple science’, three single science GCSEs in the traditional subjects of Physics, Chemistry and Biology. Finally, it was also possible to cover the National Curriculum requirement by taking a single combined science GCSE, but this was strongly discouraged on the grounds that it was an inadequate preparation for further science study.

The publication of *Beyond 2000: Science Education for the Future* (a report of the deliberations of a group of eminent scientists, science educationalists, and teachers on how the science curriculum could be improved) the Awarding Body OCR partnered the Nuffield Curriculum Centre and the Science Education Group at the University of York to produce a new suite of GCSE science qualifications, known as 21st Century Science.

These GCSEs are based on combining GCSE science with ‘Additional’ and ‘Additional Applied’ GCSEs for learners with, respectively, academic or applied inclinations. The courses are modular, meaning that the ‘Additional’ science can then be supplemented with further units to make up the three traditional single science GCSEs if required.

The new GCSEs were piloted in 2003-6, and found to be very successful with learners and teachers. This success strongly informed revisions to the Key Stage 4 curriculum made in 2006.

After 2006, the individual science GCSEs remained available, enabling academically oriented learners to take triple science - sometimes referred to as separate sciences (the study of biology, chemistry and physics) with successful candidates gaining 3 GCSE grades.²

However, the new curriculum provides a wider range of alternative pathways for learners when choosing their science options at levels 1 and 2.

Learners can take either GCSE Applied Science (double award), worth two GCSEs, or take GCSE Science with one of five further GCSEs (one of two additional subjects or one of physics, chemistry and biology³) to gain 2 GCSE grades.

Alternatively BTEC First and Introductory Certificates and Diplomas and OCR Nationals Science also provide work-related alternatives to the science GCSE’s.

The diagram below, illustrates the routes available.

² GCSE Science is not taken separately as the content is covered in the Triple Science course

³ Other GCSEs are available such as Astronomy but this paper will focus on the three main strands of Physics, Chemistry and Biology.

Four Routes to GCSE

GCSE Science (1 GCSE) and one of:	GCSE Additional Science (1 GCSE) GCSE Additional Applied Science (1 GCSE) GCSE Physics (1 GCSE) GCSE Chemistry (1 GCSE)
Triple Award:	GCSE Physics (1 GCSE) GCSE Chemistry (1 GCSE) GCSE Biology (1 GCSE)
GCSE Applied Science (Double Award) (2 GCSEs)	
One of:	BTEC Introductory Certificate in Applied Science BTEC Introductory Diploma in Applied Science BTEC First Certificate in Applied Science BTEC First Diploma in Applied Science OCR Nationals Science Level 2

Awarding bodies have each developed their own suites of qualifications to meet the new criteria and the pathways above. However, because the 21st Century Science physics, chemistry and biology GCSEs were formally evaluated, these have also been given specific consideration in the following sections.

Physics

GCSE Science A (AQA)

AQA's GCSE Science A qualification is a single GCSE covering the KS4 programme of study.

GCSE Science B is also available. This is the same specification but is assessed through written papers whereas science A is assessed through objective tests.

Content

The physics content is delivered in one unit split into two modules.

- Physics 1a Energy and Electricity
- Physics 1b Radiation and the Universe

There is also a centre-assessed unit to be completed in any of the contexts of the three strands.

The content ensures ‘how science works’⁴ is integrated and delivered in the context of the modules.

E.g. *Heat transfer - evaluate the ways heat is transferred in and out of bodies, in contexts including, all bodies emit and absorb thermal radiation and the hotter a body is the more it radiates.*⁵

Assessment

The assessment objectives and their weighting are;

- 36% knowledge and understanding of science and how science works
- 44% application of skills knowledge and understanding
- 20% practical, enquiry and data handling skills

75% of the GCSE is externally assessed by objective tests comprising matching and multiple choice questions worth 25% in each science strand.

The centre assessed unit is worth 25% of the GCSE, consisting of an Investigative Skills Assignment, which is normal class practical work followed by an externally set, internally assessed test taking 45 minutes and a Practical Skills Assessment judged by the teacher on practical skills used throughout the duration of the course.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE Additional Science (Edexcel)

GCSE Additional Science is part of Edexcel’s 360 Science suite of qualifications.

Equivalent to one GCSE this builds on the content learnt in the GCSE science part of the suite. When taken together learners gain two full GCSE’s.

Content

The physics content is delivered in one unit consisting of four topics.

They are;

- As fast as you can
- Roller Coasters and relativity
- Putting radiation to use
- Power of the atom

Topic content is structured around questions entitled ‘have you ever wondered?’ such as ‘*how does a jet ski work?*’⁶

⁴ How Science Works, sometimes referred to as science process has been incorporated into level 1-3 science education to reflect the changing needs of learners by providing a more appropriate balance between science process and factual learning.

⁵ AQA GCSE Science A specification, 2010, <http://www.aqa.org.uk/qual/pdf/AQA-4461-W-SP-10.PDF>

This aims to engage more learners by using everyday contexts related to how science works.

Assessment

The assessment objectives and their weighting are;

- 20-40% knowledge and understanding of science and how science works
- 30-55% application of skills knowledge and understanding
- 20-40% practical, enquiry and data handling skills

Edexcel's 360 Science suite incorporates a flexible approach to internal and external assessment.

40% of the course is compulsory internal assessment. 10% is covered by the assessment of practical skills throughout the course with 10% based on assessment activities on how science works in the context of the units in each strand.

The remaining 60% is structured through a choice of two out of three assessment routes in each of the strands worth 10% each.

The internal centre-devised assessment is based on learner's skills, knowledge and understanding to analyse scientific data and the applications and implications of science.

Alternatively learners can take an externally assessed multiple choice tiered test or an externally assessed structured tiered examination paper. Learners must choose two of these three routes in relation to physics for a total of 20%.

This system allows the course to be 70% internal assessment 30% external assessment or 40% internal assessment 60% external assessment or a mixture of the two.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE in Applied Science (Double Award) (WJEC)

The double award in applied science is an alternative way to achieve two full GCSE science grades.

The course is based on the science used in everyday life and a variety of jobs, aimed at introducing learners to the science sector and preparing them for further study on a vocational course in science or employment in a science related industry.

The course is interdisciplinary in nature dealing with aspects of working with science safely, practical tasks and using science.

Content

⁶ Edexcel 360 Science GCSE Additional Science specification, http://360science.edexcel.org.uk/VirtualContent/95173/UG018535_Science_2101new.pdf

The course is split into 3 units;

- Unit 1 Developing scientific skills
- Unit 2 Science in society
- Unit 3 Science at work

Unit 1 deals with working safely in science and carrying out practical tasks. In terms of physics this is covered by ‘investigating materials’⁷ which looks at electrical and other physical properties in applied contexts.

Unit 2 looks at the materials and living organisms that scientists work with. ‘Energy, electricity and radiations,’ surface and atmosphere of the Earth’ and ‘the solar system’ provide the physics content.

Unit 3 asks how science can be used to the benefit of industry and society. The physics content looks at electric and electronic devices.

Assessment

The assessment objectives and their weighting are;

- 33.3% knowledge and understanding of science and how science works
- 33.3% application of skills knowledge and understanding
- 33.3% practical, enquiry and data handling skills

Each unit is worth 33% with Units 1 and 3 internally assessed and Unit 2 externally assessed.

Unit 1 is based on a portfolio including a report of an investigation carried out into working safely in science and evidence of a range of skills carried out in applied contexts in each science strand. In physics this is electrical and other physical properties.

Unit 2 is a one hour fifteen minute test based on the content of the unit as a whole.

Unit 3 is also based on a portfolio, indicating how science is used for the benefit of society. In physics terms this includes an assignment on science in the workplace and a report on making and assessing the effectiveness of two devices, electrical and/or electronic.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE Additional Applied Science (AQA)

Additional applied science is an alternative to additional science, and can be taken with GCSE science to give two full GCSE’s.

The course builds on the work in GCSE science using vocational relevance and contexts focussed on the skills and knowledge used by scientists in the workplace.

Currently, additional applied science is only available in the AQA and OCR science suites.

⁷ WJEC GCSE in Applied Science (Double Award) specification, 2010 <http://www.wjec.co.uk/uploads/publications/2700.pdf>

Content

The course is split into three units;

- Unit 1 Science in the workplace
- Unit 2 Science at work
- Unit 3 Using scientific skills

Unit 1 is interdisciplinary and based on how science is used at work and how to use science safely.

Units 2 and 3 are interdisciplinary and split into three main areas of food science, sports science and forensic science.

Physics content is found in each including reflection of light, the importance of friction in sports clothing and particle composition of different types of food.

Assessment

The assessment objectives and their weighting are;

- 35% knowledge and understanding of science and how science works
- 30% application of skills knowledge and understanding
- 35% practical, enquiry and data handling skills

Units 1 and 3 are both internally assessed and worth 20% and 40% respectively, with Unit 2 externally assessed through a one hour written paper worth 40% of the GCSE, based on scientists work in food science, sports science and forensic science.

Unit 1 is assessed through a portfolio including two reports, one each on workplaces that use scientific skills and carrying out scientific work safely.

Unit 3 is a portfolio based on a report on one practical investigation set in a vocational context of food science, sports science or forensic science.⁸

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE in Physics (Edexcel)

This is Edexcel's standard GCSE in physics which can be taken with GCSE science to provide two GCSE's or with biology and chemistry as part of the triple science programme.

Content

The content is based on three units, with units 1 and 2 taken from the GCSE science and additional science GCSE's respectively.

Unit 3 is a further unit developed specifically for the subject. This builds on the content from Units 1 and 2 to help students develop their questioning, analytical and evaluative skills alongside core practical skills.⁹

Unit 1 and 2 include content on electricity, charge, the stars, speed,

⁸ AQA Additional Applied Science GCSE specification, 2010, <http://www.aqa.org.uk/qual/pdf/AQA-4863-W-SP-10.PDF>

⁹ Edexcel GCSE in Physics homepage, <http://360science.edexcel.org.uk/home/what-is-360science/gcse-bio-che-phy/>

movement, radiation and power.

The specialist physics unit is based on particles in action and medical physics.

Assessment

The assessment objectives and their weighting are;

- 20-40% knowledge and understanding of science and how science works
- 30-55% application of skills knowledge and understanding
- 20-40% practical, enquiry and data handling skills

Edexcel's 360 Science suite incorporates a flexible approach to internal and external assessment.

50% of assessment comprises compulsory routes. 30% internal assessment is based on two activities on Unit 1 and 2 worth 10% each, with a remaining 10% on a practical skills assessment.

20% external assessment is based on two multiple choice tiered tests on Unit 1.

The second 50% of the GCSE is flexible. 20% is a choice of two assessments based on unit 2, either a multiple choice test, structured examination paper or centre devised internal assessment. The remaining 30% is made up of a structured examination or centre devised internal assessment on the specialist extension unit.

The grading scale used is A*, A, B, C, D, E, F, and G.

21st Century Science Physics A (OCR)

Physics A is the physics strand of OCR's 21st Century Science suite of GCSE qualifications.

It is available as a single GCSE alongside GCSE science or as part of the triple science programme as one of three separate GCSE's.

Overall Structure

The qualification is made up of seven modules numbered P1 to P7, assessed through four units. Students must take Units 1, 2 and 3 and either 4 or 5.

- Physics A Unit 1 comprises modules P1 to P3, the physics modules from the 21st Century Science GCSE qualification
- Physics A Unit 2 comprises modules P4 to P6, the physics modules from the 21st Century Science GCSE Additional Science qualification
- Physics A Unit 3 is module P7, a Further Science¹⁰ module taken in conjunction with the above to complete the full GCSE grade

¹⁰ Further Science is the group of 3 modules in each of Physics, Chemistry and Biology, which when taken in conjunction with 3 modules from GCSE Science and GCSE Additional Science gives the full GCSE in each strand.

- Physics A Unit 4 is practical data analysis and case study
- Physics A Unit 5 is practical investigation

Content

Modules from the GCSE science qualification are used to emphasise scientific literacy and provide learners with the knowledge and understanding needed to engage in science-based issues.

The additional science modules are concept led and give more emphasis and space for developing fundamental ideas, with the further science module enabling the exploration of new concepts and the ability to draw together the ideas previously developed.

The further science module has been developed to link into the previous six modules so it can be taught throughout the year rather than in a block at the end. Care has also been taken to ensure it is not ‘more of the same.’

It aims to extend the coverage of key physics themes, explore selected ideas about science in physics contexts and illustrate modern applications of physics. In this sense it incorporates aspects of the suite’s GCSE science, additional science and additional applied science courses.¹¹

How science works is also central to the content with ‘Science Explanations’ providing a broad understanding of scientific ideas and ‘Ideas about Science’ reflecting on the knowledge, how it was produced, the reasoning used and the issues arising when it is put to practical use.¹²

The further science module topics are;

- How do astronomers observe the sky?
- How does a telescope work?
- What are the objects we see in the night sky and how far away are they?
- What are stars?
- How do astronomers work together?

Assessment

The assessment objectives and their weighting are;

- 30.0% knowledge and understanding
- 40.6% application of skills knowledge and understanding, analysis and evaluation
- 29.3% enquiry

Units 1 and 2 are both worth 16.7% of the GCSE, assessed through a forty minute written paper in each. The papers assess knowledge and understanding of the content and its application.

Unit 3 is worth 33.3% of the total GCSE, assessed through a sixty minute written paper. The paper assesses learners on pre-release material from one or two of the P1 to P6 modules, with the remainder focussing

¹¹ OCR GCSE Physics A Further Science Module Map, <http://www.21stcenturyscience.org/data/files/mp7-10166.pdf>

¹² OCR 21st Century Science Physics Specification, http://www.ocr.org.uk/Data/publications/key_documents/GCSE_TFC_Physics_A_Specification.pdf

on the P7 further science content.

Through these units 66.7% of the GCSE is externally assessed.

Unit 4 is an internal skills assessment worth 33.3% of the GCSE. This is based on a critical analysis of primary data and a case study of a topical scientific issue.

Unit 5 is also an internal skills assessment worth 33.3% of the GCSE. This comprises five strands which together form a complete investigative task.

The grading scale used is A*, A, B, C, D, E, F, and G.

Chemistry

GCSE Science (Edexcel)

Content	<p>Edexcel's GCSE Science qualification is a single GCSE covering the KS4 programme of study.</p> <p>The chemistry content of the qualification is considered below.</p> <p>Content allows teachers to make links to work-related learning and uses how science works to help learners see science in their everyday lives.</p> <p>Chemistry is delivered in two units with two topics in each.</p> <ul style="list-style-type: none">• C1 a looks at properties and chemical reactions• C1 b looks at the earth, its resources and consumption and the production of products with specific properties and their uses <p>'Have you ever wondered' questions are used to guide learners on the content and raise enthusiasm in each topic. For example '<i>can chemists turn cheap metal into gold</i>'¹³</p>
Assessment	<p>The assessment objectives and their weighting are;</p> <ul style="list-style-type: none">• 20-40% knowledge and understanding of science and how science works• 30-55% application of skills knowledge and understanding• 20-40% practical, enquiry and data handling skills <p>40% of the course is internally assessed. 10% covers practical skills throughout the course with 10% gained from an assessment activity based on how science works in the context of the unit. Each activity is forty-five minutes long with the remaining 20% made up of activities in physics and biology.</p> <p>The 60% external assessment is made up of six twenty minute multiple choice tiered tests, with two in each strand. Chemistry tests are based on the chemistry content.</p> <p>The grading scale used is A*, A, B, C, D, E, F, and G.</p>

¹³ Edexcel 360 Science GCSE Science specification, September 2007, http://360science.edexcel.org.uk/VirtualContent/95173/UG018535_Science_2101new.pdf

GCSE Additional Science (WJEC)

GCSE Additional Science is part of WJEC's suite of science qualifications.

Taken with WJEC's GCSE Science gives two GCSE grades. Additional science emphasises the explaining, theorising and modelling aspects of science from the GCSE science course.

Content

Development of scientific ideas, how science works and practical and ICT skills are all developed in the course.

Chemistry content is delivered in one unit made up of a variety of topics;

- Atomic structure
- Chemical bonding and calculations
- Production of metals
- Materials
- Water

Assessment

The assessment objectives and their weighting are;

- 32-37% Knowledge and understanding of science and how science works
- 30-36% Application of skills, knowledge and understanding
- 31-37% Practical, enquiry and data-handling skills

75% of the course is externally assessed through forty-five minute written papers in each strand. These are worth 25% each.

25% of the course is internally assessed, through practical tasks in each strand which are set out by WJEC. These must be completed in each subject in two hours, or alternatively, learners can submit an extended report on relevant subject content from the units in one strand. The report can be in the form of power point or a range of posters.¹⁴

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE in Applied Science (Double Award) (AQA)

This GCSE qualification is worth two GCSE grades and is part of AQA's GCSE Science suite.

The course aims to enthuse young people into learning about science, in terms of how science works and its importance for society whilst providing the skills and knowledge needed to continue science study post 16 or begin science related employment.¹⁵

¹⁴ WJEC Additional Science GCSE specification 2007/08, <http://www.wjec.co.uk/uploads/publications/3430.pdf>

¹⁵ AQA GCSE in Applied Science (Double Award) specification 2010, <http://www.aqa.org.uk/qual/pdf/AQA-4861-W-SP-10.PDF>

Content

The course is split into four interdisciplinary units;

- *Science in the workplace* deals with general issues of working in safely with science
- *Science for the needs of society*, in terms of chemistry includes topics on countryside and environmental management and the home environment
- *Developing scientific skills* looks at how analytical chemists find out about substances
- *Using scientific skills for the benefit of society* deals with making a useful product.

Each unit is designed to develop learners' practical, communication, presentation and ICT skills.

Assessment

The assessment objectives and their weighting are;

- 30% Knowledge and understanding of science and how science works
- 30% Application of skills, knowledge and understanding
- 40% Practical, enquiry and data-handling skills

65% of the course is internally assessed with 35% externally assessed.

Units 1, 3 and 4 are assessed through a portfolio of evidence throughout the course. Unit 1 is worth 10% of the GCSE including two reports on science in the workplace. Unit 3 is worth 27.5% of the GCSE and includes records of three practical exercises covering three areas with Unit 4 also worth 27.5% of the GCSE comprising records of four activities.

Unit 2 is worth 35% of the GCSE and is assessed through an external one hour fifteen minute written paper based on all three strands.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE Additional Applied Science (AQA)

Additional applied science is an alternative to additional science, and can be taken with GCSE science (A or B) to give two full GCSE's.

The course builds on the work in GCSE science using vocational relevance and contexts focussed on the skills and knowledge used by scientists in the workplace.

Currently, additional applied science is only available in the AQA and OCR science suites.

Content

The course consists of three units;

- Unit 1 Science in the workplace
- Unit 2 Science at work

- Unit 3 Using scientific skills

Unit 1 is interdisciplinary and based on how science is used at work and how to use science safely.

Units 2 and 3 are interdisciplinary and split into three main areas of food science, sports science and forensic science.

Chemistry content is mainly based on the food science aspects in each unit, including work on food additives, organic farming, food production, vitamins and food testing.

However there are aspects of chemistry in the forensic and sports science areas including analysing crime scene substances using chemical formulae and sports nutrition.

Assessment

The assessment objectives and their weighting are;

- 35% knowledge and understanding of science and how science works
- 30% application of skills knowledge and understanding
- 35% practical, enquiry and data handling skills

Units 1 and 3 are both internally assessed, with Unit 2 externally assessed through a one hour written paper worth 40% of the GCSE, based on scientists work in food science, sports science and forensic science.

Unit 1 is assessed through a portfolio including two reports, one each on workplaces that use scientific skills and carrying out scientific work safely. This incorporates all three science strands and is worth 20% of the GCSE.

Unit 3 is a portfolio worth 40% of the GCSE, based on a report on one practical investigation set in a vocational context of food science, sports science or forensic science.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE in Chemistry (Edexcel)

This is Edexcel's standard GCSE in chemistry which can be taken with GCSE science to provide two GCSE's or with biology and physics as part of the triple science programme.

Content

The content is based on 3 units, with units 1 and 2 taken from the GCSE science and additional science GCSE's respectively.

Unit 3 is a further unit developed specifically for the subject. This builds on the content from Unit 1 and 2 to help students develop their questioning, analytical and evaluative skills alongside core practical skills.¹⁶

Unit 1 and 2 include content on properties, earth, products, synthesis, elements and chemical structures.

¹⁶ Edexcel GCSE Chemistry homepage, <http://360science.edexcel.org.uk/home/what-is-360science/gcse-bio-che-phy/>

Assessment	<p>The specialist chemistry unit is based on chemical detection and chemicals working for us.</p> <p>The assessment objectives and their weighting are;</p> <ul style="list-style-type: none">• 20-40% knowledge and understanding of science and how science works• 30-55% application of skills knowledge and understanding• 20-40% practical, enquiry and data handling skills <p>Edexcel's 360 Science suite incorporates a flexible approach to internal and external assessment.</p> <p>50% of assessment comprises compulsory routes. 30% internal assessment is based on two activities on Unit 1 and 2 worth 10% each, with a remaining 10% on a practical skills assessment.</p> <p>20% external assessment is based on two multiple choice tiered tests on Unit 1.</p> <p>The second 50% of the GCSE is flexible. 20% is a choice of two assessments based on unit 2, either a multiple choice test, structured examination paper or centre devised internal assessment. The remaining 30% is made up of a structured examination or centre devised internal assessment on the specialist extension unit.</p> <p>The grading scale used is A*, A, B, C, D, E, F, and G.</p>
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21st Century Science Chemistry A (OCR)

Overall Structure	<p>Chemistry A is the chemistry strand of OCR's 21st Century Science suite of GCSE qualifications.</p> <p>It is available as a single GCSE alongside GCSE science or as part of the triple science programme as one of three separate GCSE's.</p> <p>The qualification is made up of seven modules numbered C1 to C7, assessed through four units. Students must take Units 1, 2 and 3 and either 4 or 5.</p> <ul style="list-style-type: none">• Unit 1 comprises modules C1 to C3 from the 21st Century Science GCSE qualification• Unit 2 comprises modules C4 to C6, the chemistry modules from the 21st Century Science GCSE Additional Science qualification• Unit 3 is module C7, a Further Science module taken in conjunction with the above to complete the full GCSE grade• Physics A Unit 4 is practical data analysis and case study• Physics A Unit 5 is practical investigation
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Content	<p>The Further Science module enables the exploration of new concepts and the ability to draw together the ideas previously developed in units</p>
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C1 to C6.

It is designed to link into the previous 6 modules so it can be taught throughout the year rather than in a block at the end. Care has also been taken to ensure it is not ‘more of the same.’

It aims to extend the coverage of key chemistry themes, explore selected ideas about science in chemistry contexts and illustrate modern applications of chemistry.

By doing so it incorporates aspects of the suite’s GCSE science, additional science and additional applied science courses.¹⁷

The content in the further chemistry module is;¹⁸

- Alcohols, carboxylic acids and esters
- Energy changes in chemistry
- Reversible reactions and equilibria
- Analysis
- Green chemistry

How science works is central to the content with ‘Science Explanations’ providing a broad understanding of scientific ideas and ‘Ideas about Science’ reflecting on the knowledge, how it was produced, the reasoning used and the issues arising when it is put to practical use.

The specification includes *Issues for citizens* and *Questions that science may help to answer* to illustrate to learners how the content can be applied to their everyday lives.

Assessment

The assessment objectives and their weighting are;

- 30.0% knowledge and understanding
- 40.6% application of skills knowledge and understanding, analysis and evaluation
- 29.3% enquiry

66.7% of the course is externally assessed with 33.3% internally assessed.

Units 1 and 2 are both worth 16.7% of the GCSE, assessed through forty minute written papers assessing knowledge and understanding of the content and its application.

Unit 3 is a sixty minute written paper worth 33.3% of the total GCSE, assessing learners on pre-release material from one or two of the C1 to C6 modules, with the remainder focussing on the C7 content.

Unit 4 is a skills assessment worth 33.3% of the GCSE. This is based on a critical analysis of primary data and a case study of a topical scientific issue.

Unit 5 is also a skills assessment worth 33.3% of the GCSE. This comprises five strands which together form a complete investigative task.

¹⁷ OCR GCSE Physics A Further Science Module Map, <http://www.21stcenturyscience.org/data/files/mp7-10166.pdf>

¹⁸ OCR 21st Century Science Chemistry A GCSE specification 2007/08, http://www.ocr.org.uk/Data/publications/key_documents/GCSE_TFC_Chemistry_A_Specification.pdf

The grading scale used is A*, A, B, C, D, E, F, and G.

Biology

GCSE Science (WJEC)

Content	<p>The GCSE Science is WJEC’s single science GCSE qualification covering the KS4 programme of study.</p> <p>The content of the GCSE is based on scientific evidence in terms of collecting, analysing and using it and how science works. It also aims to develop ICT and practical skills.</p> <p>Biology content is made up of eight topics based on <i>genes and variety</i> and <i>body maintenance and protection</i>.¹⁹</p> <p>How science works is developed through data, evidence, theories and explanations, practical, enquiry and communication skills and applications and implications of science.</p>
Assessment	<p>The assessment objectives and their weighting are:</p> <ul style="list-style-type: none">• 32-37% Knowledge and understanding of science and how science works• 30-36% Application of skills, knowledge and understanding• 31-37% Practical, enquiry and data-handling skills <p>75% of the course is externally assessed with 25% internally assessed.</p> <p>Internal assessment is based on assessed practicals to be completed in two hours in biology, chemistry and physics. As an alternative learners can submit an extended report on relevant subject content in one strand, but must complete at least two practical activities in total.</p> <p>External assessment is based on a forty-five minute written paper in each strand worth 25% of the GCSE.</p> <p>The grading scale used is A*, A, B, C, D, E, F, and G.</p>

GCSE Additional Science (AQA)

Content	<p>Additional science builds on the content from GCSE science and ensures a good progression route into further education science courses.</p> <p>Where AQA’s GCSE Science emphasises evaluating evidence and the implications of science for society, additional science has greater emphasis on explaining, theorising and modelling in science.²⁰</p> <p>8 topics make up the biology unit of additional science, broadly based on;</p>
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¹⁹ WJEC GCSE Science specification 2007/08, <http://www.wjec.co.uk/uploads/publications/3430.pdf>

²⁰ AQA Additional Science GCSE specification 2010, <http://www.aqa.org.uk/qual/pdf/AQA-4463-W-SP-10.PDF>

- Assessment
- Animals and plants
 - The food chain
 - Cells
 - The human body
- The assessment objectives and their weighting are:
- 36% Knowledge and understanding of science and how science works
 - 44% Application of skills, knowledge and understanding
 - 20% Practical, enquiry and data-handling skills
- 75% of the course is externally assessed through forty-five minute written papers worth 25% in each of the three strands.
- The remaining 25% is a centre assessed unit based on an investigative skills assignment on normal practical work followed by a forty-five minute externally set, internally assessed written paper and a holistic practical skills assessment.
- The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE Applied Science (Double Award) (WJEC)

- The double award in applied science is an alternative way to achieve two full GCSE science grades.
- The course is based on the science used in everyday life and a variety of jobs, aimed at introducing learners to the science sector and preparing them for further study on a vocational course in science or employment in a science related industry.
- The course is interdisciplinary in nature dealing with aspects of working with science safely, practical tasks and using science.
- Specific biology content is considered below.
- Content
- The course is split into 3 units;
- Unit 1 Developing scientific skills
 - Unit 2 Science in society
 - Unit 3 Science at work
- Unit 1 deals with working safely in science and carrying out practical tasks. In biology this covers '*investigating living organisms*'²¹ which looks at microscopy and micro-organisms in applied contexts.
- Unit 2 looks at the living organisms that scientists work with, covering the human body and the environment.
- Unit 3 asks how science can be used to the benefit of industry and society. Biology content looks at monitoring living organisms.

²¹ WJEC GCSE in Applied Science (Double Award) specification 2009, <http://www.wjec.co.uk/uploads/publications/2700.pdf>

Assessment

The assessment objectives and their weighting are;

- 33.3% knowledge and understanding of science and how science works
- 33.3% application of skills knowledge and understanding
- 33.3% practical, enquiry and data handling skills

Each unit is worth 33% with Units 1 and 3 internally assessed and Unit 2 externally assessed.

Unit 1 is based on a portfolio including a report of an investigation carried out into working safely in science and evidence of practical activities in areas of relevant subject content, in biology in microscopy and micro-organisms.

Unit 2 is a 1 hour 15 minute test based on the content of the unit as a whole.

Unit 3 is also based on a portfolio indicating how science is used for the benefit of society. This includes an assignment on science in the workplace and two reports into the growth and/or response of living organisms under controlled conditions, showing appropriate care and consideration investigating them.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE Additional Applied Science (AQA)

Additional applied science is an alternative to additional science, and can be taken with GCSE science (A or B) to give two full GCSE's.

The course builds on the work in GCSE science using vocational relevance and contexts focussed on the skills and knowledge used by scientists in the workplace.

Content

The course is split into three units;

- Unit 1 Science in the workplace
- Unit 2 Science at work
- Unit 3 Using scientific skills

Unit 1 is interdisciplinary and based on how science is used at work and how to use science safely.

Units 2 and 3 are interdisciplinary and split into three main areas of food science, sports science and forensic science.

Biology content is mainly found in the sports and food science aspects of each unit, including micro-organisms and the production and safety of food and exercise and the human body.

Assessment

The assessment objectives and their weighting are;

- 35% knowledge and understanding of science and how science

works

- 30% application of skills knowledge and understanding
- 35% practical, enquiry and data handling skills

Units 1 and 3 are both internally assessed, with Unit 2 externally assessed through a one hour written paper worth 40% of the GCSE, based on scientists work in food science, sports science and forensic science.

Unit 1 is assessed through a portfolio including two reports, one each on workplaces that use scientific skills and carrying out scientific work safely. This incorporates all three science strands and is worth 20% of the GCSE.

Unit 3 is a portfolio worth 40% of the GCSE, based on a report on one practical investigation set in a vocational context of food, sports or forensic science.

The grading scale used is A*, A, B, C, D, E, F, and G.

GCSE in Biology (Edexcel)

Content

This is Edexcel's standard GCSE in biology worth one GCSE, which can be taken with GCSE science to provide two GCSE's or with biology and physics as part of the triple science programme.

The content is based on 3 units, with units 1 and 2 taken from the GCSE science and additional science GCSE's respectively. Unit 3 is a specialist unit developed for those specialising in the subject.

Units 1 and 2 consist of four topics with unit 3 consisting of two.

Unit 1 and 2 include content on environment, genes, electrical and chemical signals, use, misuse and abuse, cells and interdependence.

Unit 3 builds on the content from Unit 1 and 2 to help students develop their questioning, analytical and evaluative skills alongside core practical skills.²²

Assessment

Specific content is based on biotechnology and behaviour in humans and other animals.

Edexcel's 360 Science suite incorporates a flexible approach to internal and external assessment.

50% of assessment comprises compulsory routes. 30% internal assessment is based on two activities on Unit 1 and 2 worth 10% each, with a remaining 10% on a practical skills assessment.

20% external assessment is based on two multiple choice tiered tests on Unit 1.

The second 50% of the GCSE is flexible. 20% is a choice of two assessments based on unit 2, either a multiple choice test, structured examination paper or centre devised internal assessment.

The remaining 30% is made up of a structured examination or centre

²² Edexcel GCSE Biology homepage, <http://360science.edexcel.org.uk/home/what-is-360science/gcse-bio-che-phy/>

devised internal assessment on the specialist extension unit (Unit 3).

21st Century Science Biology A (OCR)

Biology A is the chemistry strand of OCR's 21st Century Science suite of GCSE qualifications.

It is available as a single GCSE alongside GCSE science or as part of the triple science programme as one of three separate GCSE's.

Overall Structure

The qualification is made up of seven modules numbered B1 to B7 and assessed through four units. Students must take Units 1, 2 and 3 and either 4 or 5.

- Unit 1 comprises modules B1 to B3 from the 21st Century Science GCSE qualification
- Unit 2 comprises modules B4 to B6 from the 21st Century Science GCSE Additional Science qualification
- Unit 3 is module B7, a Further Science module taken in conjunction with the above to complete the full GCSE grade
- Physics A Unit 4 is practical data analysis and case study
- Physics A Unit 5 is practical investigation

Content

Modules B1 to B3 from the GCSE Science qualification are used to emphasise scientific literacy and provide learners with the knowledge and understanding needed to engage in science-based issues.

They cover genes, keeping healthy and life on earth.

The Additional Science modules are concept led and give more emphasis and space for developing the fundamental ideas, covering homeostasis, growth and development and the brain and mind.

The Further Science module enables the exploration of new concepts whilst drawing together the ideas previously developed in units B1 to B6.

It links into the previous six modules so it can be taught throughout the year rather than in a block at the end and care has been taken to ensure it is not 'more of the same' and therefore disinteresting for learners.

The module draws together the key ideas from units B1 to B6 to highlight how biology is at the forefront of science and consider how it is applied by those working in improving people's health and fitness.

The content in the Further Biology module is;²³

²³ OCR 21st Century Science Biology A GCSE specification 2007/08,
http://www.ocr.org.uk/Data/publications/key_documents/GCSE_TFC_Biology_A_Specification.pdf

- Living organisms are interdependent
- Photosynthesis
- Heterotrophic nutrition
- New technologies
- Respiration
- Circulation
- Skeletal systems

How science works is also central to the content.

The specification includes *Issues for citizens* and *Questions that science may help to answer* to illustrate to learners how the content can be applied to their everyday lives.

Assessment

The assessment objectives and their weighting are;

- 30.0% knowledge and understanding
- 40.6% application of skills knowledge and understanding, analysis and evaluation
- 29.3% enquiry

66.7% of the course is externally assessed with 33.3% internally assessed.

Units 1 and 2 are both worth 16.7% of the GCSE, assessed through a forty minute written paper in each assessing knowledge and understanding of the content and its application.

Unit 3 is worth 33.3% of the total GCSE, assessed through a sixty minute written paper.

This paper assesses learners on pre-release material from one or two of the C1 to C6 modules, with the remainder focussing on the C7 content assessing knowledge and understanding and communication skills.

Unit 4 is a skills assessment worth 33.3% of the GCSE. This is based on a critical analysis of primary data and a case study of a topical scientific issue.

Unit 5 is also a skills assessment worth 33.3% of the GCSE. This comprises five strands which together form a complete investigative task.

The grading scale used is A*, A, B, C, D, E, F, and G.

Level 3 Qualifications

Overview of Level 3 Qualifications

The dominant qualifications at Level 3 are A and AS level qualifications, awarded in the individual science subjects of physics, chemistry and biology. These are modular qualifications in which the AS level is taught and examined first; learners wishing to achieve an A-level in the same subject must then supplement the AS level with a further A2 course. Success in both elements results in the award of a single A-level.

Added to this are the Advanced Extension Awards in science, the further level 3 awards aimed at the top 10% in subjects nationally and those performing above the A grade at A Level, and the International Baccalaureate, the international qualification offered in many UK schools which is highly valued by universities and learners alike. AEs are included in this paper for comparison purposes but the qualifications are due to be removed in 2009 with a possible final opportunity for re-sit examinations in 2010,

In addition, the Salters Institute suite of AS/A Level qualifications offer an alternative style of teaching and learning to other A-level courses.

The current Salters AS/A Levels were launched in 2003 and successfully revised in 2006, and incorporate contemporary scientific issues and practical applications, with extensive use of ICT and support materials.

The Salters qualifications have been notably successful and enjoyed consistent growth. Recently, they have seen over 4000 students join each year, and this is paralleled by translation and adaptation of the courses for use abroad in Germany, Spain, Sweden and Russia.

Finally, the International Baccalaureate (IB) is a composite qualification like the Diploma which allows for practical and alternative forms of learning and achievement. Subject teaching retains a strong theoretical and academic focus, and qualification enjoys considerable prestige as basis for progression to tertiary level study. As a result of a specific government initiative, the IB is now widely available in the UK.

This section considers these qualifications in detail, and will give a good understanding of the range of qualifications available at Level 3, the science content they cover, and the different approaches to assessment and grading they employ.

Physics

GCE AS/A Level Physics A (AQA)

Content

The AQA Physics AS/A Level course provides transition from previous studies at Level 1 and 2 with choices of topics at AS so teachers can begin with a new or familiar topic.

The specification provides a wide range of opportunities to develop *How Science Works* by linking the general criteria on the nature of science to specific topics throughout the specification.²⁴

There are six units in the course, three each at AS and A Level. All six must be completed for the full A level grade.

AS units are;

- Unit 1 Particles, quantum phenomena and electricity,
- Unit 2 Mechanics, materials and waves
- Unit 3 Investigative and practical skills in AS Physics

²⁴ AQA GCE AS/A Level Physics A specification 2010, <http://www.aqa.org.uk/qual/gce/pdf/AQA-2450-W-SP-10.PDF>

A2 units are;

- Unit 4 Fields and further mechanics
- Unit 5 One of Astrophysics, Medical Physics, Applied Physics or Turning Points in Physics

Unit 6 Investigative and practical skills in A2 Physics

Assessment

The assessment objectives and weightings are;

- 40% Knowledge and understanding of science and of How Science Works
- 40% Application of knowledge and understanding of science and of How Science Works
- 20% How Science Works

Units 1 and 2 are externally assessed one hour fifteen minute written examinations, each worth 20% of the A Level and consisting of six or seven structured questions.

Unit 3 is flexible with either a centre assessed route or external assessment. Learners can choose a practical skills assignment and investigative skills assignment or externally assessed practical skills verification by a teacher and an externally marked practical assignment. This is worth 10% of the A level.

Unit 4 is an externally verified written examination lasting one hour forty-five minutes, split into twenty five multiple choice questions and four or five structured questions worth 20% of the A Level.

Unit 5 is also an externally verified written examination, one hour forty-five minutes long, split into four or five structured questions on Nuclear and Thermal physics and four or five structured questions on one of the four options, worth 20% of the A level.

Unit 6 is also flexible and assessed in the same way as unit 3 and worth 10% of the A level.

The AS qualification is graded on a five-point grade scale of A, B, C, D and E. The full A Level qualification is graded on a six-point scale of A*, A, B, C, D and E.

Advanced Extension Award Physics (CEA)

The AEA is aimed at the top 10% performers in physics nationally and should be offered to those performing significantly above A grade at A Level.

It helps students demonstrate and develop a deeper understanding of physics than that required at AS/A Level.

Content

It will help preparation for degree level study of the subject, enable learners to gain more UCAS points and help universities differentiate between the most able students.

AEA content is taken from AS/A Level Physics but differs as it demands a deeper understanding of the skills and knowledge previously set out.

The content is broadly based on knowledge and understanding, analysing and evaluating evidence and further mathematical techniques.

Topics include;

- mechanics
- momentum and energy
- electricity
- atomic and nuclear physics
- quantum physics
- waves
- fields
- magnetic effects

Assessment

The assessment objective will assess candidates abilities to apply and to communicate effectively their understanding of the fundamental principles and concepts of physics, using and applying the skills of critical analysis, evaluation, and synthesis, and applying mathematical techniques to physical contexts.²⁵

The AEA is externally assessed through a three hour written examination worth 100%.

Grading is based on a two point scale of merit and distinction.

International Baccalaureate (IB)

The IB is an international qualification offered by 2,075 schools in 125 countries, including more than 100 UK schools.

There are three programmes of study of which the diploma programme for 16-19 year olds is most comparable with GCE AS/A Levels.

Learners choose six subjects from six subject groups. Experimental sciences includes chemistry, biology and physics.

Normally, three of the six subjects are studied at higher level (courses representing 240 teaching hours) with the remaining three subjects studied at standard level (courses representing 150 teaching hours).²⁶

Over 2 years students complete an extended essay, follow a theory of knowledge course (TOK) (to learn *how* you are able to know something) and participate in creativity, action, service (CAS) (150 hours on activities that develop learners creatively, physically and socially).

²⁵ CEA Physics AEA specification, http://www.rewardinglearning.org.uk/common/includes/microsite_doc_link.aspx?docid=1259-1

²⁶ International Baccalaureate homepage, <http://www.ibo.org/diploma/curriculum/>

Content

Physics content is split into eight core topics studied by all, six additional higher level topics studied by higher level learners and a choice of two topics from seven options at standard level (15 hours each) and two from six at higher level (22 hours each).

Core topics include;²⁷

- Physics and physical measurement
- Mechanics
- Thermal physics
- Oscillations and waves
- Electric currents
- Fields and forces
- Atomic and nuclear physics
- Energy, power and climate change

Assessment

IB assessment objectives are to;

- Demonstrate an understanding of scientific facts and concepts, methods and techniques, terminology and methods of presenting scientific information
- Apply and use scientific facts and concepts, methods and techniques, terminology and methods to present scientific information
- Construct, analyse and evaluate hypothesis, research questions and predictions, scientific methods and techniques and scientific explanations²⁸

Assessment is 76% external and 24% internal.

External assessment is in the form of three papers. Paper 1 worth 20% of the IB is multiple choice testing the core for those at standard level and the core and additional higher learning for those at higher.

Paper 2 is split into two sections worth 32% at standard level and 36% at higher; data is analysed by learners followed by short answer and one extended question from a choice of three for standard level learners and two from a choice of four for higher.

Paper 3 is worth 24% at standard level and 20% at higher. It tests knowledge of the options taken, with standard level required to answer several short questions in both options taken and higher learners required to answer several short questions and an extended question in the options taken.

The 24% internal assessment consists of an interdisciplinary project where learners from all science subjects investigate a common topic and other short and long term class investigations.

IB subjects are graded 1-7 with 7 meaning excellent and 1 very poor. The TOK course and extended essay are graded from A meaning

²⁷ International Baccalaureate Physics specification, http://ibchem.com/root_pdf/IBPhysics2009.pdf

²⁸ *ibid.*

excellent to N meaning no grade.

GCE Physics B (Advancing Physics) (Salters) (OCR)

Advancing physics is part of the Salters suite of qualifications developed in partnership by the Salters Institute and the Horners Company and produced by the Science Education Group at the University of York.

Content

Similarly to other Salters AS/A Level courses, Advancing Physics is a context led course placing students in the environments in which physics operates.

The contexts used are varied and aim to enthuse learners into the subject. For example in physics bungee jumping is used to explain forces by creating a model bungee jump.

There are 6 units in total, all of which must be completed to achieve the full A Level grade.

They are;²⁹

- Unit 1 Physics in action
- Unit 2 Understanding processes and experimentation and data handling
- Unit 3 Physics in practice
- Unit 4 Rise and fall of the clockwork universe
- Unit 5 Field and particle pictures
- Unit 6 Researching physics

The course also includes a visit to a science workplace to study physics at work.

Assessment

Assessment objectives and weighting are;

- 30% knowledge and understanding
- 50% application of knowledge and understanding
- 20% how science works

Unit 1 is assessed externally in a one hour written paper of short and structured questions worth 30% of the AS Level and 15% of the A Level.

Unit 2 is a one hour forty-five minute written paper with the same structure but also questions on an advance notice issued to centres in the weeks before the examination. This is externally assessed and worth 50% of the AS level and 25% of the A level.

Unit 3 is worth 20% of the AS level and 10% of the A level and is internally assessed on coursework, including a measurement task and a

²⁹ OCR GCE Physics B (Advancing Physics) (Salters) specification,
http://www.ocr.org.uk/Data/publications/key_documents/cquartetOCRTempFileuzyy4kbLM6.pdf

presentation on a researched topic chosen by the candidate.

Unit 4 is a one hour fifteen minute written paper consisting of structured and short questions worth 15% of the A level grade. This and Unit 5 are both synoptic papers.

Unit 5 is assessed in the same way as unit 2, with unit 6 worth 10% of the A Level based on coursework on a practical investigation and research briefing chosen by the learner.

AS and A level are graded on an A-E scale and Unclassified.

Chemistry

Advanced Subsidiary GCE in Chemistry (Edexcel)

Content

The Edexcel GCE in Chemistry aims to include motivating contemporary chemistry contexts to encourage students to study the subject and teachers to update the content they deliver.³⁰

The content covers a range of topics that learners will come into contact with in their everyday lives such as climate change.

The structure is made up of six units, three at AS level and three at A level, of which all six must be completed for the full A level grade.

The units are;

AS

- Unit 1 The Core Principles of Chemistry
- Unit 2 Application of Core Principles of Chemistry
- Unit 3 Chemistry Laboratory Skills I

A2

- Unit 4 General Principles of Chemistry I - Rates, Equilibria and Further Organic Chemistry
- Unit 5 General Principles of Chemistry II - Transition Metals and Organic Nitrogen Chemistry
- Unit 6 Chemistry Laboratory Skills II

Assessment

Assessment objectives and weighting are;

- 31.7% Knowledge and understanding of how science works
- 40.7% Application of knowledge and understanding of how science works
- 27.6% How science works

Unit one is externally assessed through a one hour fifteen minute paper split into two sections comprising an objective test section and a mixture of short answer and extended answer questions worth 20% of the A level.

Unit two is also worth 20% of the A level and assessed in the same way as unit 1, but uses questions on contemporary contexts rather than

³⁰ Edexcel Advanced Subsidiary GCE in Chemistry specification,
<http://www.edexcel.com/migrationdocuments/GCE%20New%20GCE/spec-gce-chemistry.pdf>

extended answer questions.

Unit three is internally assessed in four areas, general practical competence, qualitative observation, quantitative measurement and preparation and worth 10% of the A level.

The A level units are assessed in a similar way with unit four externally assessed through a one hour forty-five minute paper based on an objective test section, a mixture of short and extended answer questions and data questions on a data booklet learners are provided with for the examination. This is worth 20% of the A level.

Unit 5 is also worth 20% of the A level and is assessed in the same way as unit 4 but uses questions on the analysis and evaluation of practical work rather than the data booklet.

Finally unit 6 is internally assessed in four different ways like unit three above, however there is flexibility in the routes available. All learners are assessed on general practical competence and qualitative observation but can then either complete a quantitative measurement and a preparation task or a multi stage experiment consisting of a quantitative measurement and preparation. This is worth 10% of the A level.

The AS qualification is graded on a five-point grade scale of A, B, C, D and E. The full A Level qualification is graded on a six-point scale of A*, A, B, C, D and E.

AEA Chemistry (AQA)

The AQA AEA Chemistry is one of four AEA's offered by AQA, alongside biology as the only two science options.

Aimed at the top 10% of students nationally in the subject, the AEA is for those performing significantly above A grade at A level.

The aim is to demonstrate depth of knowledge and understanding of the material within the Advanced GCE through applying chemical concepts in context, critically analysing chemical information, proposing solutions to chemical problems and evaluating information and evidence about how chemistry is used and applied in society.³¹

Content

Content is based on the content of the AS/A Level specification but with a deeper understanding of the knowledge and skills required.

It is split into three main areas;

Knowledge, understanding and skills including formulae, atomic structure, bonding, energetics, kinetics, redox, inorganic and organic chemistry, periodic table and modern analytical techniques.

Experiment and investigation deals with analysing evidence and drawing conclusions and evaluating evidence and procedures.

Mathematical requirements look at applying the required formulae to

³¹ AQA AEA Chemistry specification http://www.qca.org.uk/libraryAssets/media/3580_aea_test_spec_chem.pdf

Assessment	<p>develop a deeper understanding of the subject.</p> <p>The AEA in chemistry will assess candidates' abilities to apply and communicate effectively their understanding of chemistry, using the skills of critical analysis, evaluation, synthesis and by applying mathematical techniques to chemical contexts.³²</p> <p>The assessment is an externally marked, three hour written paper worth 100% of the AEA.</p> <p>Grading is based on a two point scale of merit and distinction.</p>
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International Baccalaureate (IB)

Content	<p>The IB diploma programme for 16-19 year olds is comparable with GCE AS/A Levels.</p> <p>Chemistry content is split into eleven core topics studied by all, nine additional higher level topics studied by higher level students giving greater breadth to the core topics and a choice of two topics from seven options at standard level (15 hours each) and higher level (22 hours each).</p> <p>Core topics include;</p> <ul style="list-style-type: none">• Quantitative chemistry• Atomic structure• Periodicity• Bonding• Energetics• Kinetics• Equilibrium• Acids and bases• Oxidation and reduction• Organic chemistry• Measurement and data processing
Assessment	<p>IB assessment objectives are;</p> <ul style="list-style-type: none">• Demonstrate an understanding of scientific facts and concepts, methods and techniques, terminology and methods of presenting scientific information• Apply and use scientific facts and concepts, methods and techniques, terminology and methods to present scientific information• Construct, analyse and evaluate hypothesis, research questions and predictions, scientific methods and techniques and scientific explanations³³ <p>Assessment is 76% external and 24% internal.</p>

³² Ibid.

³³ International Baccalaureate Chemistry specification, 2009, <http://www.scribd.com/doc/3195959/IB-Chemistry-Syllabus>

External assessment is in the form of three papers. Paper 1 worth 20% of the IB is multiple choice testing the core for those at standard level and the core and additional higher learning for those at higher level.

Paper 2 is split into two sections worth 32% at standard level and 36% at higher; a data based question on data that has to be analysed by the learners and the remainder short answer questions and one extended question from a choice of three for standard level learners and two from a choice of four for those at higher level.

Paper 3 is worth 24% at standard level and 20% at higher. It tests knowledge of the options taken, with standard level required to answer several short questions in both options taken and higher level learners required to answer several short questions and an extended question in the options taken.

The 24% internal assessment consists of an interdisciplinary project where learners from all science subjects investigate a common topic and other short and long term class investigations.

IB subjects are graded 1-7 with 7 meaning excellent and 1 very poor. The TOK course and extended essay are graded from A meaning excellent to N meaning no grade.

GCE Chemistry B (Salters) (OCR)

GCE Chemistry B is the Salters Chemistry AS/A Level qualification providing a context led approach to teaching and learning.

Content

The course is written as a series of modules based on contemporary issues in chemistry, allowing learners to learn in a spiral way where chemical ideas are introduced early in a topic and reinforced later.³⁴

The course is made up of six units in total, three at AS and three at A level, of which all six must be completed for the full grade.

Units are;

- Unit 1 Chemistry for life
- Unit 2 Chemistry of natural resources
- Unit 3 Chemistry in practice
- Unit 4 Chemistry of materials
- Unit 5 Chemistry by design
- Unit 6 Chemistry individual investigation

Assessment

Applications of the content include examining how octane in petrol causes knocking and creating medicines by modifying the structure of existing medicines.

Assessment objectives and weighting are;

- 31% knowledge and understanding

³⁴ OCR GCE Chemistry B (Salters) specification 2008, http://www.ocr.org.uk/Data/publications/key_documents/AS_ALevel_GCE_Chemistry_B_Salters_Specification.pdf

- 39% application of knowledge and understanding
- 30% how science works

Unit 1 is assessed externally in a one hour twenty-five minute written paper based on the unit content and set in context. This is worth 30% of the AS Level and 15% of the A Level.

Unit 2 is a one hour forty-five minute written paper with the same structure but also questions on an advance notice issued to centres in the weeks before the examination. This is externally assessed and worth 50% of the AS level and 25% of the A level.

Unit 3 is worth 20% of the AS level and 10% of the A level and is internally assessed on coursework, based on five skills including ability to work over a range of practical activities and activities set by OCR, completed under controlled conditions and marked by teachers.

Unit 4 is a one hour thirty minutes written paper consisting of synoptic questions worth 15% of the A level grade. Unit 5 is a two hour written, synoptic paper worth 20% of the A level.

Unit 6 is internally assessed coursework worth 15% of the A Level based on a chemical investigation of the candidate's choice.

AS and A level are graded on an A-E scale and Unclassified.

Biology

AS/A Level GCE in Biology (WJEC)

Content

WJEC's AS/A Level biology qualification has been revised for first teaching in 2009/10.

Like the majority of AS/A Levels the course is made up of six units, three at each level with all six required for the full A Level qualification;

AS

- Unit 1 Basic bio-chemistry and cell structure
- Unit 2 Bio-diversity and physiology of body systems
- Unit 3 Practical work

A2

- Unit 4 Metabolism, microbiology and homeostasis
- Unit 5 Environment, genetics and evolution
- Unit 6 Practical work

The specification also sets out the various ways of incorporating how science works into the teaching and learning.

Assessment

Assessment objectives and weighting are;

- 35% Knowledge and understanding of science and of how science works
- 45% Application of knowledge and understanding of science and of how science works
- 20% How science works

Units one and two are externally assessed through one hour thirty minute papers comprising short answer and extended answer questions and a choice of essay. Both are worth 20% of the A level grade.

Unit three is an internal practical assessment worth 10% of the A Level grade based on experimental work set in the centre over a three month period. This must include a low power plan microscope drawing.

The A level units are assessed in a similar way with unit four externally assessed through a one hour forty-five minute paper with marks also gained for synoptic understanding. Unit 5 is also assessed in this way and both are worth 20% of the A level.

Unit 6 is assessed in the same way as the AS practical skills and is also worth 10% of the qualification. However this must include one microscope drawing and calibration.³⁵

The AS qualification is graded on a five-point grade scale of A, B, C, D and E. The full A Level qualification is graded on a six-point scale of A*, A, B, C, D and E.

AEA Biology (AQA)

The AQA AEA Chemistry is one of four AEA's offered by AQA.

The aim is to demonstrate depth of knowledge and understanding of the material within the Advanced GCE by thinking critically about the role of biology in society, applying biological concepts and proposing biological solutions, bringing together the different aspects of biology that are related and communicating this effectively to others.³⁶

Content

Content is based on the content of the AS/A Level specification but with a deeper understanding of the knowledge and skills required.

It is split into three main areas;

Knowledge, understanding and skills including organisms, molecules, enzymes, substances, adaptation, genes, cell cycles, selection and evolution, energy flows, ecosystems and the environment.

Experiment and investigation deals with planning, analysing evidence and drawing conclusions and evaluating evidence and procedures.

Mathematical requirements look at applying the required formulae to develop a deeper understanding of the subject, mainly algebra, graphs, arithmetic and computation and handling data.

³⁵ WJEC AS/A Level GCE in Biology specification, 2009/10, <http://www.wjec.co.uk/uploads/publications/6257.pdf>

³⁶ AQA AEA Biology specification, http://www.qca.org.uk/libraryAssets/media/3578_aea_test_spec_hubi.pdf

Assessment

The AEA in biology will assess candidates' abilities to apply, and to communicate effectively, their knowledge and understanding of biology by using the skills of comprehension, critical analysis, evaluation, and synthesis and by applying quantitative techniques.³⁷

The assessment is an externally marked, three hour written paper worth 100% of the AEA.

Grading is based on a two point scale of merit and distinction.

International Baccalaureate (IB)

Content

The main areas covered by the core units are listed below;

- Biochemistry
- Genetics
- Ecology
- Human physiology

Assessment

IB assessment objectives are;

- Demonstrate an understanding of scientific facts and concepts, methods and techniques, terminology and methods of presenting scientific information
- Apply and use scientific facts and concepts, methods and techniques, terminology and methods to present scientific information
- Construct, analyse and evaluate hypothesis, research questions and predictions, scientific methods and techniques and scientific explanations

Assessment is 76% external and 24% internal.

External assessment is in the form of three papers. Paper 1 worth 20% of the IB is multiple choice testing the core for those at standard level and the core and additional higher learning for those at higher level.

Paper 2 is split into two sections worth 32% at standard level and 36% at higher; a data based question on data that has to be analysed by the learners and the remainder short answer questions and one extended question from a choice of three for standard level learners and two from a choice of four for those at higher level.

Paper 3 is worth 24% at standard level and 20% at higher. It tests knowledge of the options taken, with standard level required to answer several short questions and higher required to answer several short

³⁷ *ibid.*

questions and an extended question.

The 24% internal assessment consists of an interdisciplinary project where learners from all science subjects investigate a common topic and other short and long term class investigations.

IB subjects are graded 1-7 with 7 meaning excellent and 1 very poor.

The TOK course and extended essay are graded from A meaning excellent to N meaning no grade.

Advanced Subsidiary GCE in Biology (Salters-Nuffield) (Edexcel)

Salters-Nuffield Advanced Biology is a two year course produced by the partnership between the Salters Institute and the Nuffield Foundation.

It introduces key ideas in advanced biology using story-style contexts to link topics to real life. The idea is to teach young people biological skills and knowledge in the context of the way they are used by a professional biologist.

Content

The course is made up of six units, three at AS and three at A level. All six must be completed for the full grade.

Units include;

- Unit 1 Lifestyle, transport genes and health
- Unit 2 Development, plants and the environment
- Unit 3 Report and practical review
- Unit 4 Environment and survival
- Unit 5 Energy, exercise and co-ordination (coursework)
- Unit 6 Synoptic paper

The content includes extensive use of ICT including online learning online activities, and a dedicated website for support, all of which have been popular with learners. Unit 3 also includes a visit to a site of biological interest or a report of non-practical research into a biological topic.

Assessment

Assessment objectives and weighting are;

- 35.5% knowledge with understanding
- 29.5% application of knowledge and understanding, analysis, synthesis and evaluation
- 15% experiment and investigation
- 20% synthesis of knowledge, understanding and skills

Unit 1 is assessed externally in a one hour fifteen minute written paper of seven structured questions worth 15% of the A Level grade. Unit 2 is an externally assessed, one hour thirty minute written paper with the same structure worth 20%, but also requires at least one question in continuous prose.

Unit 3 is worth 15% of the A level in two 7.5% papers. These focus on the

visit or research into a biological topic. The first is a 2000 word report into the report or issue, with the second a written paper and practical work review of two practicals. Both aspects are internally assessed.

Unit 4 is another externally assessed one hour fifteen minute written paper consisting of seven structured questions worth 15% of the A level grade.

Unit 5 is a coursework investigation worth 20%, 10% for a written paper and 10% for a 3000 word report on an experimental investigation designed and carried out by the student.

Unit 6 is a two hour synoptic paper consisting of two compulsory questions and one essay question worth 15% of the A Level.³⁸

AS and A level are graded on an A-E scale and Unclassified.

Summary

Level 1 and 2 Qualifications

Content

Structure

Following the Key Stage 4 reforms discussed in the introduction to this Appendix, the main awarding bodies have revised their level one and two specifications to meet the new criteria.

As a result, the structure of awarding body qualifications at these levels are very similar in order to meet the pathways leading to learner entitlements of a double award (equivalent) science course or the new triple science programme.

All awarding bodies utilise three units in each strand for core science, three in additional science (which gives the second GCSE of the double award equivalency), and an extension unit for those taking triple science.

Although the 21st Century Science suite in particular promotes the triple science extension unit as a new unit and not 'more of the same,' the majority of the course in each strand is made up of modules from the core science and additional science specifications.

These specifications have been revised to incorporate how science works and the KS4 programme of study.

Taking into account the 21st Century Science suite which was the first of

³⁸ Edexcel Advanced Subsidiary GCE in Biology specification 2007, http://www.edexcel.com/migrationdocuments/GCE%20Curriculum%202000/321146_Biology_Salters_Nuffield_8048_9048_spec.pdf

the new GCSE sciences piloted (and successfully so), the revisions made by other awarding bodies have ensured the options available across them, in terms of structure, are effectively the same.

21st Century Science

Where the 21st Century Suite and, to a lesser extent, Edexcel's 360 science suite, stand out from other awarding body qualifications is the approach taken to inform and guide learners on the content.

Both these suites use context led approaches characterised by guidance questions aimed to inspire and enthuse learners.

'Questions science may be able to answer' in the 21st Century suite help learners relate each topic to everyday life in exciting contexts.

For example, the Further Physics module making up the triple science qualification is based on context specific questions such as, *'How do astronomers observe the sky?'*³⁹

In contrast AQA and WJEC specifications list topics in order of how they are learnt, advising of the various contexts topics can be learnt in but not offering the same learner-centred approach as seen above. As a result it may be more difficult to link the content of these awarding body qualifications to everyday life.

Subject content

Across all the featured qualifications, "how science works" and key aspects of the programme of study at KS4 are included.

In each strand this covers;

- Physics - electricity, radiation, energy, the solar system
- Chemistry - chemical reactions and structures, elements, products
- Biology - living organisms, human body, animals and plants

In the interdisciplinary non-applied courses such as science, additional science and triple science, the three strands are rigidly listed with clear distinctions between each.

In contrast the interdisciplinary applied science and additional applied science courses link the three science strands together within set topics.

For example, AQA's additional applied science course considers food science, sports science and forensic science as the three main contexts in each unit, with biology and chemistry in particular featuring prominently across all three.

This approach is not replicated in the non-applied GCSE's which tend to keep the three science strands separate.

Learning in context

³⁹ OCR 21st Century Science Physics Specification,
http://www.ocr.org.uk/Data/publications/key_documents/GCSE_TFC_Physics_A_Specification.pdf

Context-led learning is visible in each of the qualifications featured as a result of the how science works aspect of the KS4 reforms.

There are currently no visits to a science workplace included in these courses, although content does relate to such activities.

Assessment

Assessment Objectives

The assessment objectives set out by the different awarding bodies are very similar and only differ in terms of their weighting values and wording in the case of the 21st Century Science suite.

The three assessment objectives used by AQA, Edexcel and WJEC are;

- Knowledge and understanding of science and how science works
- Application of skills knowledge and understanding
- Practical, enquiry and data handling skills

In contrast the OCR 21st Century Suite does not explicitly recognise how science works in their assessment objectives;

- Knowledge and understanding
- Application of skills knowledge and understanding, analysis and evaluation
- Enquiry

The type of qualification studied determines the weightings of the assessment objectives.

In the non-applied science GCSE's, application of skills and knowledge and understanding is given the largest weighting, with knowledge and understanding and practical, enquiry and data handling skills given similar sizes.

However, in the applied and additional applied science GCSE's the assessment objectives are weighted differently, with the practical, enquiry and data handling skills in some instances given highest weight, but in the majority of cases all three are given equal sizes.

Further to this, Edexcel incorporates a flexible system which allows objectives to be weighted according to the assessment methods chosen. This is a product of Edexcel's flexible assessment methods system which is discussed in more detail below.

Internal and External Assessment

The proportions of internal and external assessment also vary between qualifications and awarding bodies.

Generally, non-applied subjects are mainly externally assessed with the opposite true for the applied sciences.

For example, both AQA and WJEC's core science courses use 75% external and 25% internal assessment, with Edexcel's version 60% external and 40% internal.

By contrast AQA and WJEC's applied science courses are 65% and 66% internally assessed respectively.

Edexcel are the only awarding body offering a flexible approach to learning based on the routes taken by the individual. For example their additional science course is 40% compulsory internal assessment with the remaining 60% available through internal, centre devised assessments or externally assessed multiple choice tests.

Assessment Methods

The assessment methods used by awarding bodies generally assess practical skills internally and knowledge and understanding externally through written papers.

The internal assessment aspects of the non-applied science courses from AQA and Edexcel focus on practical skills in terms of a Practical Skills Assessment compiled by the teacher, based on the use of practical skills throughout the course.

These bodies also incorporate activities set on the unit content on which learners are internally assessed.

In contrast ,OCR and WJEC utilise a wider range of approaches in their non-applied courses including, in WJEC's case, a range of two hour practicals in each science strand with the option of writing an extended report on relevant subject content as an alternative in one strand.

If taken, learners can produce their report as a series of posters or a PowerPoint presentation.

OCR also offer a broad range of internal assessment opportunities in the 21st Century Science suite, including the critical analysis of primary data, a case study of a topical scientific issue and an investigative task assessed by the teacher.

The greater degree of options is designed to meet learner needs.

The internal assessment of the applied science subjects is similar across the awarding bodies as the content of these qualifications is often the same.

WJEC and AQA both offer applied and additional applied science which look at science in the workplace, using science safely and set contexts for each of the three main strands. As a result the internal assessment, which consists of a portfolio, includes reports into science in the workplace and working safely in science and the plan and delivery of an investigation based on the set contexts.

In terms of external assessment written papers are the most commonly used method with AQA, Edexcel, OCR and WJEC all incorporating short and long answer question papers ranging from forty minutes to one hour forty-five minutes in length.

21st Century Science GCSE's offer learners tests based on pre-release

material and the opportunity to undertake a case study based on a topical scientific issue, both aspects that are not found in the other qualifications.

Grading across the GCSE qualifications is common, using an eight point scale from A* to G and also including U for unclassified results.

Level 3 Qualifications

Structure

Unlike the GCSE's at level one and two, the level three qualifications are varied in terms of structure.

The majority of standard GCE AS/A Levels and all those featured in this paper consist of a total of six units, three at AS level and three at A2, with each set of three worth 50% of the final A Level grade.

In comparison, the AEA's are characterised by broad topics rather than specific units, with content taken from the AS/A level courses but demanding a deeper understanding and application of the skills and knowledge required.

The Salters qualifications also consist of six units but these are more context-led in nature and, for example, in biology include a visit to a site of biological interest, and in physics a visit to a workplace to see physics at work.

Science in the IB is available at standard or higher level, unlike the qualifications above which are delivered at a single level with grading differentiating between ability.

It incorporates a Theory of Knowledge element which is best compared to how science works, and a *Creativity, Action, Service* agenda which, if completed within science, would not compare to any aspect of the above qualifications.

The structure of the IB also makes it impossible to study physics, biology and chemistry at the same time.

Subject content

Despite the different structures of the qualifications there are similarities in the content covered.

For example, the AQA Physics A Level, CEA AEA Physics, Salters Physics and the IB all cover forces.

The same applies to properties in chemistry and the human body in biology. In this sense the courses all cover the main aspects of the programme of study for AS/A Level courses.

Differences lie in subject content when considering the amount of topics.

The AQA physics AS/A Level consists of six units, compared to eight broad areas in the CEA AEA and six context led areas in the Salters physics course.

However, higher level learners taking physics in the IB will complete 16 shorter length topics.

The same applies to chemistry where Edexcel and Salters six units compare to ten broad AEA areas and twenty two topics in the IB course.⁴⁰

IB subject content is delivered in much smaller units throughout the course, ensuring a greater range of topics are covered rather than examining larger areas in detail.

The IB also includes a project in which students from all three strands work together on a common topic.

Assessment

Assessment objectives

The assessment objectives at level 3 are more varied than those at levels one and two, reflecting the varied nature of the qualifications.

The standard AS/A Level assessment objectives from AQA, Edexcel and WJEC across the three strands focus on how science works in terms of knowledge and understanding and effective application of it.

Salter's also takes a similar approach to physics and chemistry but in biology incorporates experiment and investigation and synthesis of knowledge, understanding and skills.

In the AEA the single objective is more focussed on the application of fundamental principles and critical analysis and evaluation of data. The AEA also indicates the importance of mathematics content more than the other qualifications.

IB assessment objectives focus on how science works and its application too but also look at constructing, analysing and evaluating hypothesis, research questions and predictions, scientific methods and techniques and scientific explanations.

Weighting in the IB is flexible depending on individual choices, whereas the single objective in the AEA is worth 100%.

In the three strands of standard AS/A Levels and Salters physics and chemistry, application of the understanding of science and how science works averages the highest weighting of assessment.

Internal and External Assessment

The internal and external assessment weightings of the level three qualifications are more rigid than those at levels one and two.

In both the IB and the AEA's the weightings are set with no flexibility. The IB consists of 76% external and 24% internal assessment whereas the AEA consists of 100% external assessment.

⁴⁰ Biology comparison not made as 2009 specification was not available

The standard AS/A Levels featured from AQA, Edexcel and WJEC in physics, chemistry and biology respectively all include 80% external and 20% internal assessment, however the 20% internal assessment in AQA physics can be assessed externally as an alternative.

Assessment Methods

The assessment methods used vary by awarding body, type of qualification and science strand in question.

In terms of the AEA's the assessment scheme for physics, chemistry and biology all incorporate a three hour written examination based on the subject content worth 100% of the grade.

The IB also has structured assessment methods across the three science strands, with the 76% external assessment made up of multiple choice questions on the core topics worth 20%, analysis of data and subsequent short and longer questions worth 36% at higher and 32% at standard level and short and extended questions on the options taken worth 20% at higher and 24% at standard level.

The 24% internal assessment is based on an interdisciplinary project and a mixture of short and long term investigations.

In contrast the assessment methods used in standard AS/A Level science qualifications differ by awarding body.

AQA physics uses multiple choice and short and structured question papers to assess 80% of the course externally and practical skills verification by a teacher and a skills assignment in class to make up the 20% internal assessment.

Edexcel's chemistry AS/A Level has the same internal and external weightings but incorporates objective, context led questions in the written papers and laboratory and practical skills assessments in the internal aspects.

WJEC's biology AS/A Level differs again, with short and extended question papers making up the 80% external assessment and 20% internal assessment based on experimental work and microscopic drawing tasks.

Using the example of microscopic drawings, the assessment methods for the course have been structured around the content of the course and the skills necessary to progress.

Grading

Grading of the level three qualifications is also different to that seen at levels one and two.

The standard and Salters AS/A Levels are graded on a scale from A to E at AS Level and A* to E at A Level.

However, the AEA's are graded on a two point scale of Merit and Distinction, with one argument finding them a waste of school resources, considering a distinction is worth only 40 UCAS points compared to an A Level A grade's 120 and a reported 50.4% of pupils who failed to get any mark (below merit) in 2004.⁴¹

⁴¹ Education Guardian, AEA 2004, <http://www.guardian.co.uk/education/2004/aug/19/alevels2004.alevels2>

The IB is also graded differently to the above qualifications, with a score from 1 meaning very poor to 7 meaning excellent for each subject. Three additional points are also available for the theory of knowledge and extended essay aspects with a total of forty-five points available.

On a UCAS tariff scale, forty-five points is the equivalent of six A grade A Levels with thirty points equivalent to three A grades.