OCR
RECOGNISING ACHIEVEMENT

TWENTY FIRST CENTURY SCIENCE SUITE

TEACHERS' HANDBOOK

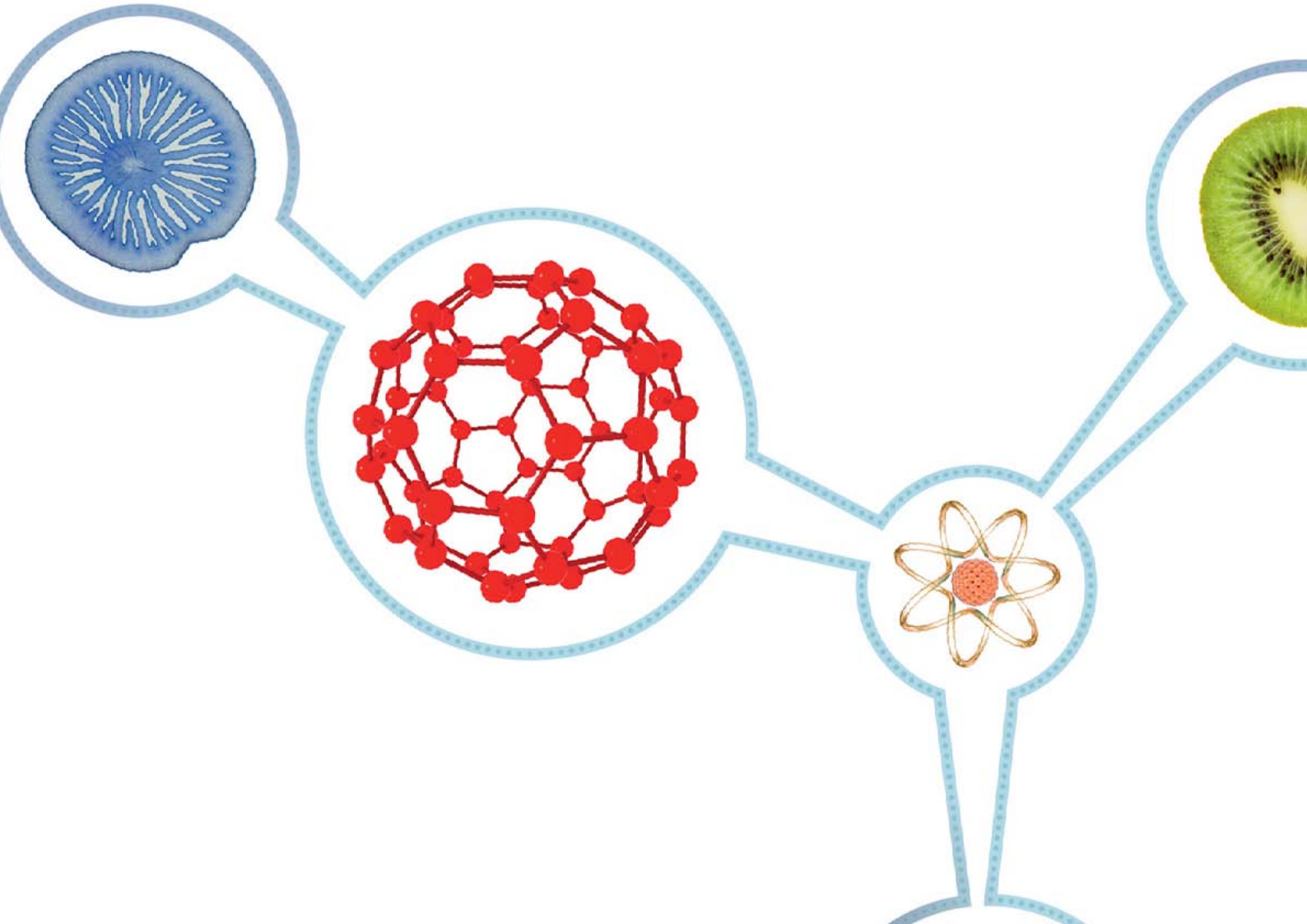
J241 - J245

VERSION 1 AUGUST 2011

www.gcse-science.com

This handbook is designed to accompany the OCR GCSE Twenty First Century Science 2011 specifications for centres teaching the new Twenty First Century Science suite.

We may update this document from time to time, to reflect teachers' needs. Please check our GCSE sciences support website www.gcse-science.com at the start of each academic year to ensure that you are using the latest version.



CONTENTS

THE TWENTY FIRST CENTURY SCIENCE SUITE: REFRESHED FOR 2011

OCR is offering new GCSE science specifications for first teaching in September 2011.

We've taken this opportunity to improve the quality of our GCSEs for teachers and students alike.

We want to make the introduction of these new GCSEs as easy for you to manage as possible.

The main changes are:

- the course content has been brought up-to-date to maintain its relevance to students, with a focus on developing students' personal, learning and thinking skills
- external assessment question papers provide more opportunities for students to demonstrate their skills in extended writing, mathematics and evaluation of evidence
- Controlled Assessment is introduced (to replace coursework).

A MOVE TO LINEAR (100% TERMINAL) ASSESSMENT?

This handbook has been written to accompany the specifications accredited by Ofqual, the examinations regulator, in Spring 2011 for first teaching in September 2011. As such it reflects the fact that the specifications were designed in a unitised format, allowing flexibility for units to be assessed either throughout the course or all together at the end.

At the time of writing (July 2011), Ofqual is consulting on the possible implementation of the proposal by the Rt Hon Michael Gove MP that GCSEs should be assessed in a linear (100% terminal) manner. A selection of Frequently Asked Questions has been provided by Ofqual on their website at the following address:

www.ofqual.gov.uk/help-and-support/94-articles/664-gcse-unitisation-faqs

We will update centres as soon as the Awarding Organisations have received more information from Ofqual. For now, centres should proceed using the unitised specifications and support materials as published.

THE PURPOSE OF THIS HANDBOOK

This handbook accompanies the new OCR GCSE Twenty First Century Science specifications for teaching from September 2011.

It is important to understand that this handbook plays a secondary role to the specifications themselves. The GCSE Twenty First Century Science specifications are the documents upon which assessment is based; they specify the content to be studied and the skills that students need to develop. At all times, therefore, the Teachers' Handbook should be read in conjunction with the specifications.

This Teachers' Handbook aims to:

- summarise what has changed, for the benefit of centres who taught the legacy (2006) Twenty First Century Science specifications
- present an overview of assessment routes and the availability of the assessments
- discuss the format of the external assessment written papers
- highlight useful resources for Twenty First Century Science teachers.

Controlled Assessment is covered in a separate publication, the Guide to Controlled Assessment for GCSE Twenty First Century Science, available to download for free from our specification web pages at www.ocr.org.uk/qualifications/subjects/science/index.html

We may update this handbook from time to time, to reflect teachers' needs. Please check our GCSE sciences support website www.gcse-science.com at the start of each academic year to ensure that you are using the latest version.

OVERVIEW OF CHANGES

The 2011 specifications for the Twenty First Century Science suite are revised and updated versions of the 2006 specifications.

The 2011 specifications have been developed with the principle of minimum change wherever possible. However, where changes have been made this is due to:

- implementation of recommendations of the Ofqual March 2009 report '*The new GCSE science examinations: findings from the monitoring of the new GCSE science specifications 2007 to 2008*'
- the QCDA fundamental review of the GCSE criteria and the bringing of the sciences' criteria into line with other GCSEs
- the issue by QCDA of new subject criteria for GCSE Science, Additional Science, Biology, Chemistry and Physics
- the introduction of the 40% terminal requirement, the new limit to the number of re-sit opportunities, and the new Controlled Assessment regulations
- the need to bring the 2006 specification content up-to-date, in order to maintain its relevance to students in the second decade of the 21st century, and to address issues raised by teachers about particular areas of the specifications and the clarity of the requirements.

Updating the specifications has also provided us with the opportunity to:

- increase the provision of practical opportunities
- ensure continuity from KS3 to KS4, and from KS4 to KS5.

THE NEW GCSE SCIENCES SUBJECT CRITERIA

The new subject criteria for GCSE Science, Additional Science, Biology, Chemistry and Physics were published by QCDA in 2009. They prescribe the content, skills, assessment objectives and assessment weightings for the new science GCSEs to be taught from September 2011.

The subject criteria can be found on the Ofqual website at:

www.ofqual.gov.uk/downloads/category/70-gcse-subject-criteria

The specifications comprise prescribed and additional content as follows:

- For GCSE Science, the content is that of the Programme of Study for KS4, and 100% of the content is prescribed by the subject criteria.
- For GCSE Additional Science, the amount of content prescribed by the subject criteria is approximately 75%. The remaining 25% of content has been developed by OCR in conjunction with teachers and the University of York Science Education Group to complement and expand upon the prescribed material, and to provide engaging topics for students wishing to progress to further studies in science.
- The content of the separate sciences comprises the material from modules 1-6 of GCSE Science and GCSE Additional Science, with additional material included in module 7. For example, GCSE Physics comprises all the physics content of Science and Additional Science (modules P1-P6), with additional material in P7.

WHAT HAS STAYED THE SAME?

Existing teachers of Twenty First Century Science will find that the new specifications are very similar to the 2006 specifications they replace.

- The five specifications within the suite continue to be formed from 21 modules, comprising seven in biology, seven in chemistry and seven in physics. While some topics have been moved between modules to satisfy the new GCSE sciences subject criteria, most of the content within the 21 modules will be very familiar to teachers of the 2006 specifications – the content has been updated rather than re-written.
- The 'Ideas about Science' remain a fundamental part of the Twenty First Century Science content, and while they have been updated to clarify the wording, the concepts match those introduced in the 2006 specifications.
- External assessment question papers are still offered in Foundation and Higher tiers, and retain a mixture of objective and free-response questions.
- GCSE Science A retains the case study and data analysis internal assessments, while GCSE Additional Science A and the separate sciences retain the practical investigation.
- There remain two assessment routes to GCSE Science A, and two assessment routes to GCSE Additional Science A; students can sit either mixed-science papers or separate-science papers.

And fundamentally, the ethos of the Twenty First Century Science suite and its modern and relevant approach to science teaching and learning remain unchanged.

THE TWENTY FIRST CENTURY SCIENCE APPROACH

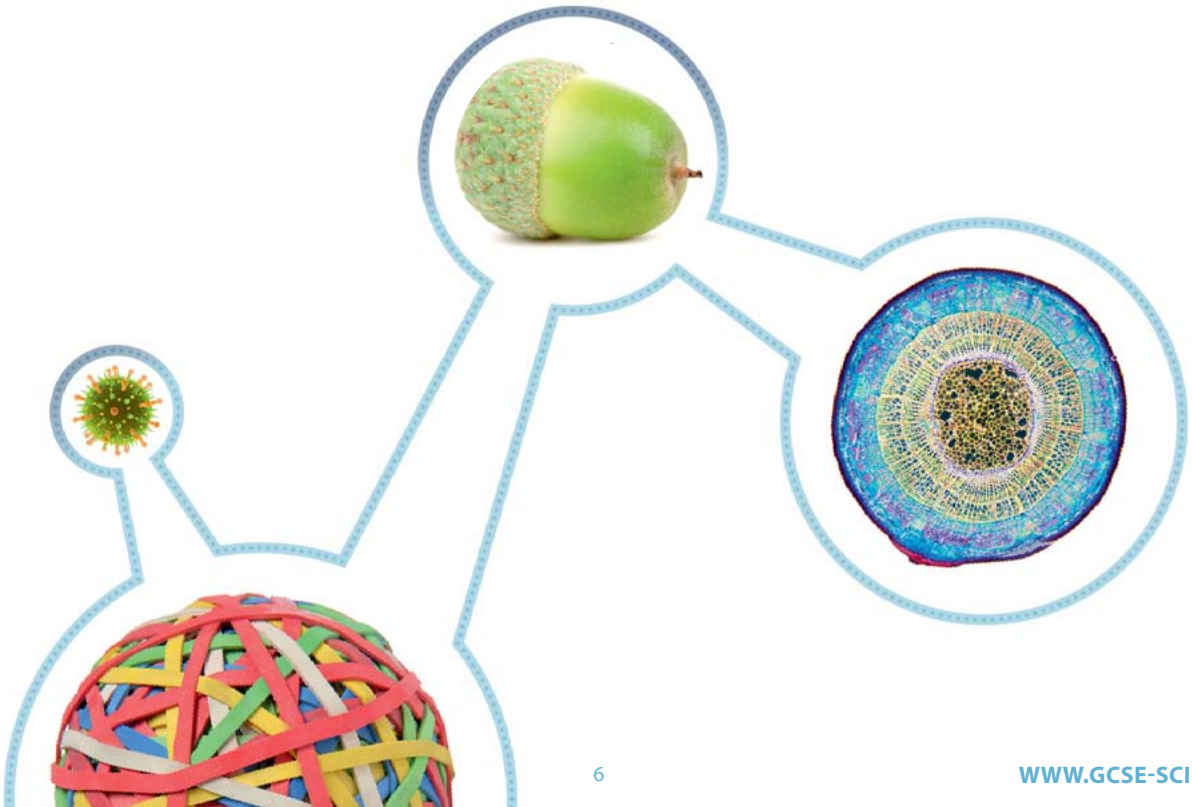
Twenty First Century Science grew out of the recommendations of the *Beyond 2000* report. The report argued that the compulsory science curriculum should develop the scientific literacy of citizens, and that from the age of 14 a separate, parallel course should prepare those planning to continue into more advanced studies in science. Twenty First Century Science adopted these recommendations in full, building them into the development of GCSE Science A and GCSE Additional Science A.

In addition, the Twenty First Century Science suite is unique in having interpreted and extrapolated the principles of 'How Science Works' into a series of 'Ideas about Science'. These ensure students understand how scientific knowledge is obtained, how it is reported in the world outside the classroom, and the impacts of scientific knowledge on society.

The modules in GCSE Science A (B1-B3, C1-C3 and P1-P3), together with the 'Ideas about Science', offer students the chance to develop the scientific literacy needed by active and informed citizens in a modern democratic society where science and technology play key roles in shaping our lives. The course content and the development and assessment of skills have a clear focus on scientific literacy. Students will come to appreciate what science has to say about people, the environment and the Universe.

The modules in GCSE Additional Science A (B4-B6, C4-C6 and P4-P6) accompany GCSE Science A and are aimed at students planning to continue into further studies in science. As such, the course provides progression routes to Level 3 courses in the sciences, and gives emphasis and space to fundamental ideas in the sciences. This ensures that appropriate skills are developed in preparation for further study and provides a stimulating bridge to advanced level studies in science. The emphasis of the course is on 'science for the scientist' and the 'Ideas about Science' that relate to the process of science.

The 'separate sciences' of GCSE Biology A, GCSE Chemistry A and GCSE Physics A comprise all of the content of GCSE Science A and GCSE Additional Science A, with additional development of concepts, 'Ideas about Science' and some new material in Modules B7, C7 and P7. The courses offer students clear progression routes to further study in the sciences post-16.



WHAT HAS CHANGED?

Terminal and re-sit rules

All new GCSEs, including those in the Twenty First Century Science suite, are now subject to the 40% terminal rule and the re-sit rule. These are discussed in the chapter 'Teaching and assessment' later in this handbook.

Assessment units and weightings

All GCSEs in the Twenty First Century Science suite now consist of four units, comprising three external assessment (written paper) units and one internal assessment (Controlled Assessment) unit.

All units are equally weighted at 25% each.

Internal assessment is now worth 25% of each GCSE – down from 33% in the 2006 specifications.

External assessment – increased challenge

All question papers in the Twenty First Century Science suite are now:

- worth 25% of the GCSE
- marked out of a total of 60 marks
- 1 hour in duration.

Ofqual has instructed all assessment organisations to increase the challenge of external assessment papers in the GCSE sciences. But this does not mean simply increasing the difficulty of the questions in the new specification papers; rather, the balance of different question types within the papers has been changed, and candidates will be provided with greater opportunity to demonstrate what they know and can do.

Question papers for the 2011 specifications in the Twenty First Century Science suite will:

- include fewer objective questions
- include fewer 1-mark questions
- include more continuous writing questions (worth 2-5 marks each)
- include more extended writing questions (worth 6 marks each)
- include more assessment of mathematics skills, and ensure that mathematical work is developed towards a scientific end point
- provide a greater variety of question types
- provide less 'scaffolding', particularly in Higher Tier papers
- include more assessment of Assessment Objectives 2 and 3 (AO2 and AO3)
- assess plenty of Higher Tier material in the Higher Tier papers
- include 'stretch and challenge' in the Foundation Tier papers, by assessing material at the C-grade level that is not found on the Higher Tier paper (does not overlap).

In addition, 'Ideas about Science' and Quality of Written Communication (QWC) will now be assessed in **all** question papers within the Twenty First Century Science suite.

Longer papers, more marks, more extended writing, more maths, and marks for QWC in every paper.

'IDEAS IN CONTEXT' PAPERS AND PRE-RELEASE MATERIAL

The 2006 specifications included 'Ideas in Context' papers, in which synoptic content from the specification was assessed based upon pre-release articles.

Due to new limits on the weightings and maximum number of assessment units, the 2011 specifications do not contain an 'Ideas in Context' paper. None of the external assessment units have a pre-release element.

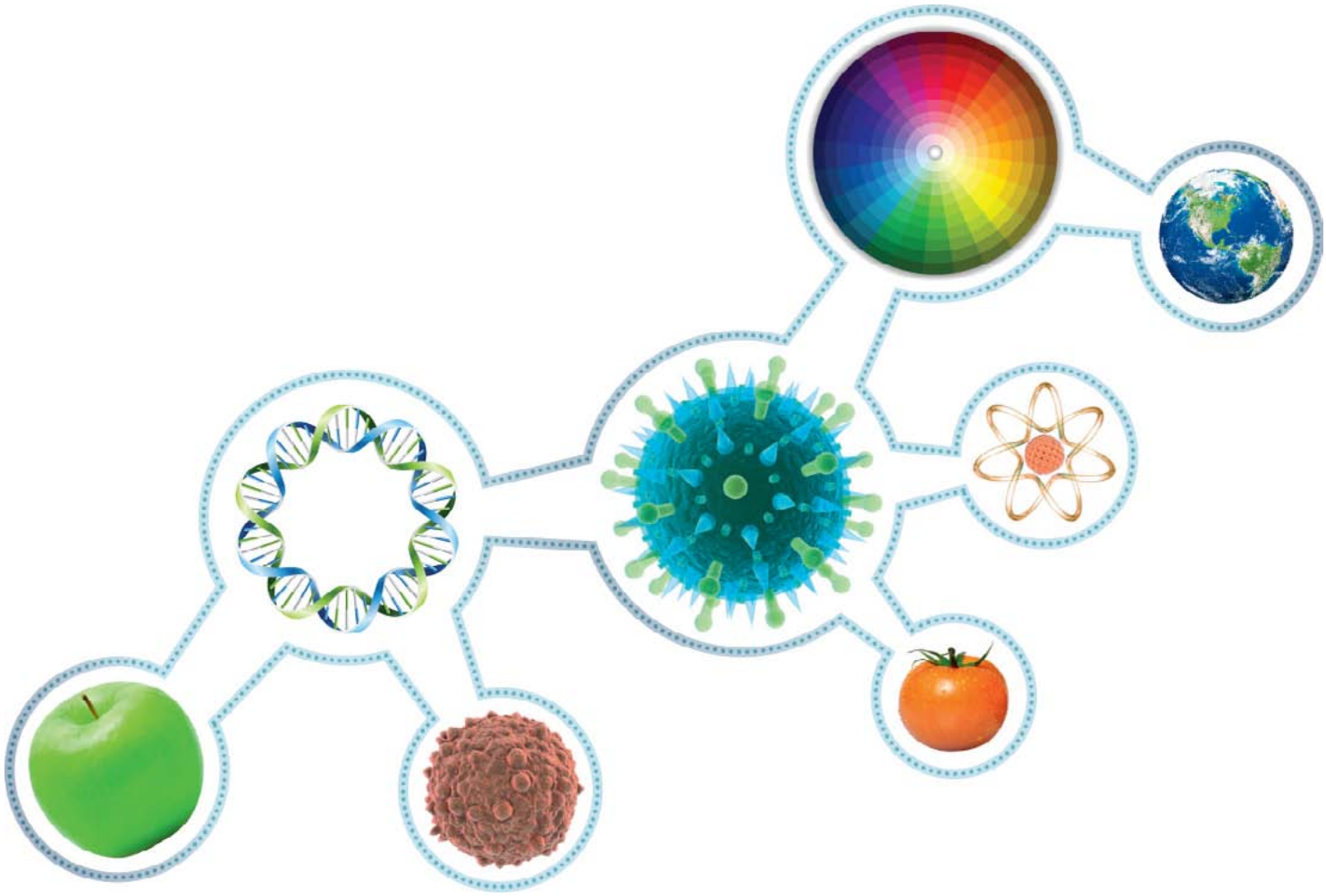
These skills will continue to be assessed, however. All question papers for the new specifications will have an increased emphasis on AO2 (which requires students to apply their knowledge and understanding in unfamiliar contexts), and AO3 (which requires candidates to analyse evidence and draw conclusions).

CONTROLLED ASSESSMENT

Coursework has been replaced by Controlled Assessment, a form of internal assessment that adheres to the new Controlled Assessment regulations.

However, we have retained the familiar feel of Twenty First Century Science internal assessment tasks; the Case Study, Practical Data Analysis and Practical Investigation have been adapted to fit the Controlled Assessment regulations, will be based upon tasks issued annually by OCR, and will be simpler to administer and mark.

For full details, see chapter 5 of each specification in the suite and also the *Guide to Controlled Assessment for GCSE Twenty First Century Science* available to download for free from our specification web pages at www.ocr.org.uk/qualifications/subjects/science/index.html.



SUMMARY OF SPECIFICATION CONTENT CHANGES

Presented here is an overview of the changes in content and emphasis within each module. Note, however, that prior to teaching it is essential that you work through the specifications closely to check the fine detail of the changes.

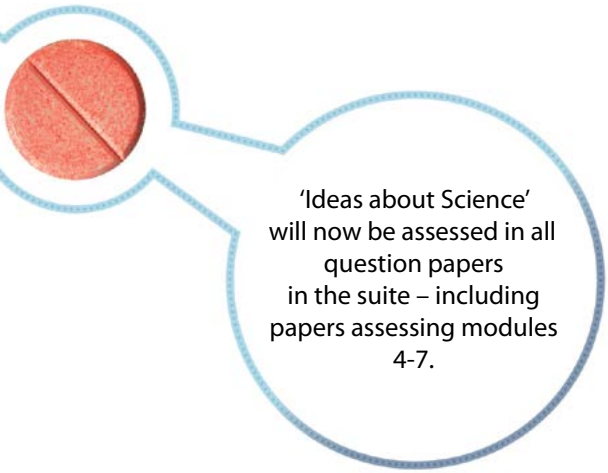
BIOLOGY MODULES	
B1: You and your genes	This module still provides an ideal opportunity to address ethical ideas in science, and focuses on IaS 6 (Making decisions about science and technology). Section B1.3 is about using genetic information, and identifies some key aspects of this module which have ethical considerations. Higher Tier students are required to know and be able to use some technical words: e.g. genotype, phenotype, homozygous, heterozygous, and pre-implantation genetic diagnosis.
B2: Keeping healthy	This module continues to include ideas about infection, vaccines and antibiotics, but does not include the problems with vaccination against influenza and HIV (in the legacy specification B2.2.7–8). New to this module is B2.4 (How do our bodies keep a healthy water balance?). This section covers some of the ideas about homeostasis from the legacy specification B4.4, but does not require detailed knowledge of the structure of the kidney.
B3: Life on Earth	There is a change in emphasis in this module, with more about the interdependence of species (B3.1) and biodiversity (B3.3). Whilst ideas about evolution and natural selection are still included (B3.2), section B3.3 in the legacy specification, about human evolution and the nervous system, has been removed.
B4: The processes of life	This new module focuses on the role of enzymes in cell activity, photosynthesis and processes in plant cells, and respiration in living cells. This module draws on some material from the legacy B7.
B5: Growth and development	This module has the same content as the legacy specification B5. There are some changes in the statements to clarify the detail that is required.
B6: Brain and mind	This module has the same content as the legacy specification B6. There are some changes in the statements to clarify the detail that is required.
B7: Further Biology	This module includes some material from the legacy B7 (the skeletal system and circulation), together with some new topics – energy balance, ecosystems and new technologies.

CHEMISTRY MODULES	
C1: Air quality	This module still considers ideas about conservation of particles in the context of air pollution. There are two new ideas in the module: the early evolution of the atmosphere in C1.1, and identifying the process of combustion as an oxidation reaction in C1.2.
C2: Material choices	This module again provides an opportunity to develop investigative skills and consider the quality of data. C2.1, C2.2 and C2.3 are very similar to the legacy specification. There is a new statement (C2.2.11) which links forces between molecules in crude oil to the energy needed to form a gas. C2.4 on life cycle assessment has been replaced with a section on nanotechnology.
C3: Chemicals in our lives - risks and benefits	This module replaces the legacy module C3 Food matters. C3.1 picks up on ideas about Earth Science from P1.2 and links it to minerals used in the chemical industry. C3.2 focuses on sodium chloride and draws on ideas about salt in our diet from the legacy C3. C3.3 focuses on the importance of alkalis and chlorine. C3.4 considers issues about safety and sustainability in the chemicals industry.
C4: Chemical patterns	This module has the same content as the legacy specification C4. There are some changes in the statements to clarify the detail that is required.
C5: Chemicals of the natural environment	This module has content very similar to the legacy C5 but there is some new material: see C5.1.2 and C5.2.9-16, and C5.3, where the properties of diamond and graphite are considered as well as silicon dioxide.
C6: Chemical synthesis	This is very similar to the legacy C6, with a few additional points: there are new statements about energy in reactions (C6.1.23–25), a change to statement C6.2.21 about collision theory (C6.2.19 in the legacy specification), and some additional compounds are named in C6.3.
C7: Further Chemistry	This module has similar content to the legacy C7, but care should be taken to cross-check the specifications when planning teaching.

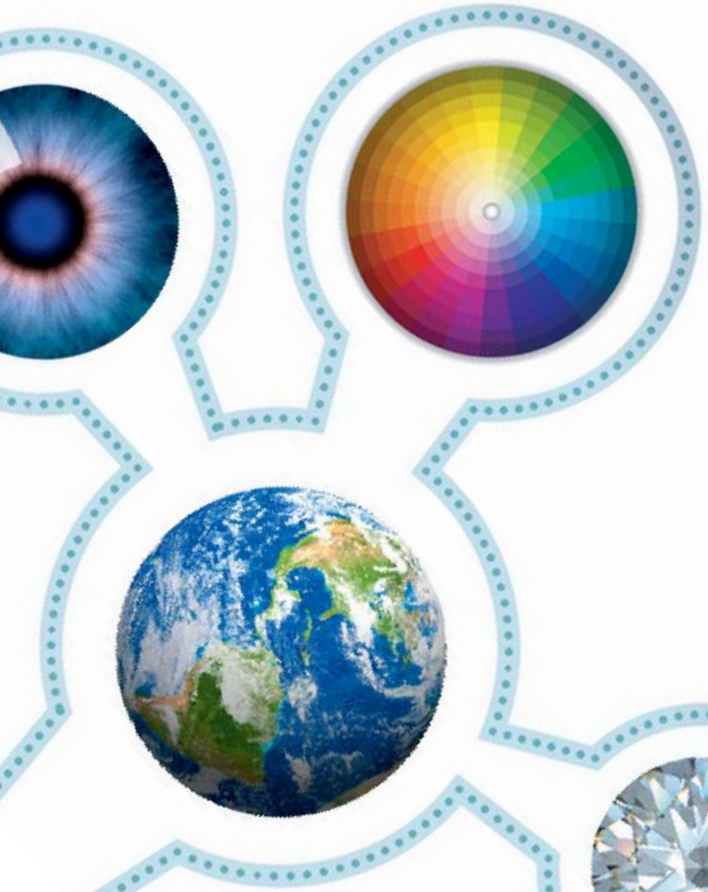
PHYSICS MODULES	
P1: The Earth in the Universe	This module continues to use ideas about cosmology and geophysics to consider how scientists use evidence to develop new ideas. Ideas about asteroid impact and the extinction of the dinosaurs, and SETI have been removed. P1.2 includes new material which introduces ideas about waves in the context of earthquakes.
P2: Radiation and life	This module still considers the uses and risks of electromagnetic radiation and considers the role of infrared radiation in climate change. P2.4 is a new section which introduces ideas about digital communication.
P3: Sustainable energy	This module has changed significantly; it now focuses on energy use, why we need to think carefully about power generation for the future, and what the choices are. It includes calculations using: energy = power x time and power = voltage x current Although nuclear power is considered as one of the options, most of the teaching about radioactivity is now in P6.
P4: Explaining motion	This module is very similar to the legacy module P4, however it now includes calculations of acceleration (P4.1.12–13) and explicit mention of the forces on an object moving vertically.
P5: Electric circuits	This module covers material previously in P5 but there is less about domestic electricity. The module now includes the electric motor (P5.5).
P6: Radioactive materials	This module about radioactivity replaces the legacy P6. Much of the material was previously covered in legacy P3, but this module includes more about nuclear fission and fusion and also Rutherford's alpha particle scattering experiment.
P7: Further Physics – Studying the Universe	This module has similar content to the legacy P7, but some content has moved: Rutherford's experiment is now in P6 but some wave behaviour – diffraction and refraction – are now included here from the legacy P6. There are changes to the specification to clarify the level of detail required throughout this module.

IDEAS ABOUT SCIENCE

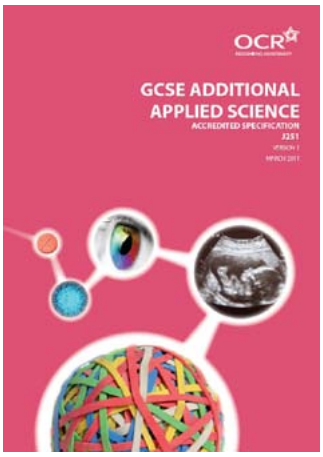
The 'Ideas about Science' remain an integral part of the content of the specifications in the Twenty First Century Science suite. However, they have been updated to clarify the wording in most cases, and subsets of the 'Ideas about Science' will be assessed in **all** question papers within the suite.

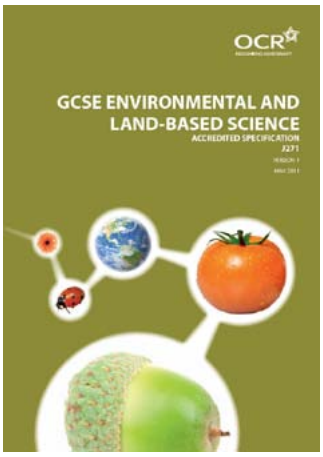


'Ideas about Science' will now be assessed in all question papers in the suite – including papers assessing modules 4-7.



APPLIED ALTERNATIVES TO GCSE ADDITIONAL SCIENCE A





OCR offers two applied science GCSEs, which can be taught with GCSE Science A as an alternative to (or in addition to) GCSE Additional Science A.

These are:

- *GCSE Additional Applied Science*
  For more information, go to:
  www.ocr.org.uk/qualifications/type/gcse_2011/science/add_app/index.html

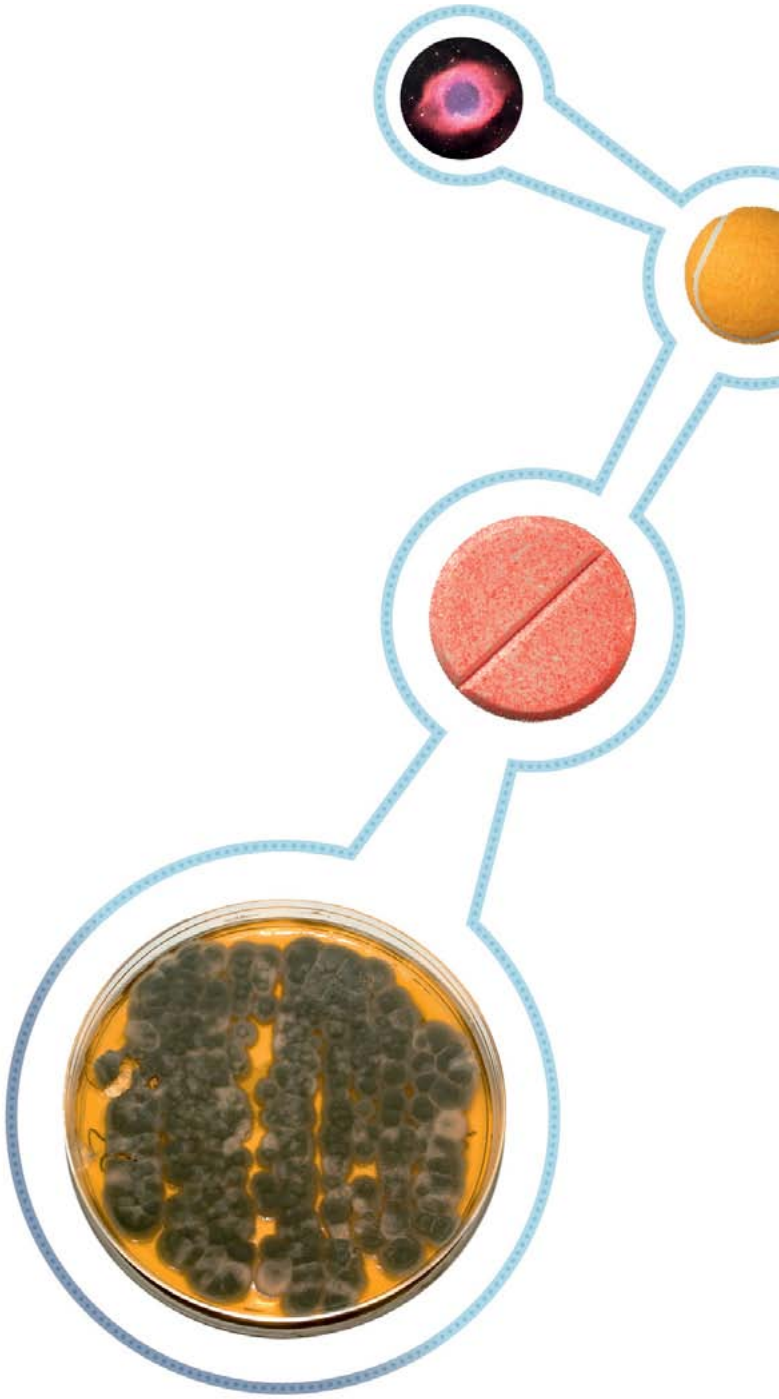
- *GCSE Environmental and Land-Based Science (ELBS)*
  For more information go to:
  www.ocr.org.uk/qualifications/type/gcse_2011/science/elbs/index.html

GCSE Additional Applied Science is no longer considered to be part of the Twenty First Century Science suite. This change reflects the fact that it can be taught equally well alongside either Twenty First Century Science GCSE Science A or Gateway Science GCSE Science B.

GCSE Additional Applied Science will continue to be supported by the University of York Science Education Group and Oxford University Press.

TRANSITION

Information in this chapter is correct at the time of writing (July 2011), but dates may be subject to change. Check www.gcse-science.com for the latest announcements.



FINAL ASSESSMENT AND CERTIFICATION FOR THE 2006 SPECIFICATIONS

The final assessment opportunity will be **June 2012** for the 2006 specifications in:

- GCSE Science A
- GCSE Additional Science A
- GCSE Biology A
- GCSE Chemistry A
- GCSE Physics A.

A re-sit opportunity of examination papers only (not coursework) will be provided in 2013. It has not yet been determined whether the 2013 re-sit session will be offered in January or June – this decision will be made by the Joint Council for Qualifications (www.jcq.org.uk) in due course.

The final opportunity to certificate for any of the 2006 specifications will follow the re-sit session in 2013.

TEACHING TRANSITION STRATEGY

In **September 2011**:

- Students commencing a one-year programme in GCSE Science A should follow the 2011 specification to complete their assessment in June 2012.
- Students who have completed the 2006 specification for GCSE Science A and are commencing a **one-year** programme in GCSE Additional Science A or the separate sciences are advised to follow the 2006 specifications to complete their assessment in June 2012.
- Students commencing a **two-year or three-year** programme must follow the 2011 specifications.

In **September 2012**:

- All students must follow the 2011 specifications.

FIRST ASSESSMENT AND CERTIFICATION FOR THE 2011 SPECIFICATIONS

First assessment and certification dates for the Twenty First Century Science 2011 specifications are as follows:

Specification name	Unit	First assessment*	First certification
GCSE Science A (J241)	Unit A141 (Modules B1, C1, P1)	January 2012	June 2012
	Unit A142 (Modules B2, C2, P2)	January 2012	
	Unit A143 (Modules B3, C3, P3)	June 2012	
	Unit A144 (Controlled Assessment)	June 2012	
GCSE Additional Science A (J242)	Unit A151 (Modules B4, C4, P4)	June 2012	June 2013
	Unit A152 (Modules B5, C5, P5)	June 2012	
	Unit A153 (Modules B6, C6, P6)	June 2013	
	Unit A154 (Controlled Assessment)	June 2013	
GCSE Biology A (J243)	Unit A161 (Modules B1, B2, B3)	January 2012	June 2013
	Unit A162 (Modules B4, B5, B6)	June 2012	
	Unit A163 (Module B7)	June 2013	
	Unit A164 (Controlled Assessment)	June 2013	
GCSE Chemistry A (J244)	Unit A171 (Modules C1, C2, C3)	January 2012	June 2013
	Unit A172 (Modules C4, C5, C6)	June 2012	
	Unit A173 (Module C7)	June 2013	
	Unit A174 (Controlled Assessment)	June 2013	
GCSE Physics A (J245)	Unit A181 (Modules P1, P2, P3)	January 2012	June 2013
	Unit A182 (Modules P4, P5, P6)	June 2012	
	Unit A183 (Modules P7)	June 2013	
	Unit A184 (Controlled Assessment)	June 2013	

** The external assessment (question paper) units of each specification will be assessed in each January and June series starting from the series given in the 'First assessment' column of the table. Controlled Assessment units can be submitted in each June series starting from the series given in the table.*

TEACHING AND ASSESSMENT

A consistent approach is maintained across the Twenty First Century Science suite of GCSEs.

USING THE SPECIFICATIONS

In each specification within the suite, chapter 3 sets out the content that will be assessed, including science explanations and 'Ideas about Science'.

Statements in **bold** in the specifications will only be assessed in **Higher Tier** papers.

Chapter 3 in each specification is divided into three units, each unit corresponding to one of the three question papers that will be used for external assessment of the content in the specification.

Each unit is divided into one or more modules, comprising content focussed on a particular theme or area of science.

It is important to understand the difference between a unit and a module. The first **unit** of GCSE Biology A, Unit A161, contains three **modules**: B1, B2 and B3. The unit is unique, but the modules also appear elsewhere (for example, module B1 appears in Unit A161 of Biology A and in Unit A141 of GCSE Science A).

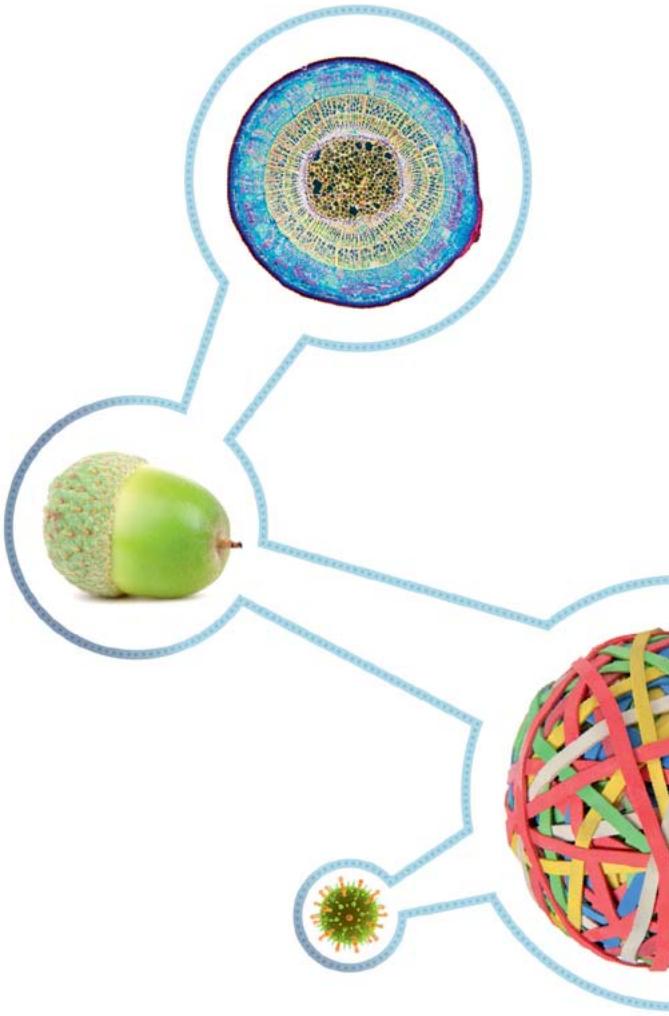
Each module 7 contains **three times as much** material as any module 1-6, so be sure to allocate sufficient teaching time!

HELP WITH SCHEMES OF WORK AND LESSON PLANS

Each module has been designed to tell a logical story, and thus provides an outline scheme of work that can be used to develop lesson plans. However, it is not essential to teach the modules in ascending numerical order; with some care, you can change the order to suit your centre's scheme of work and teaching arrangements.

Sample schemes of work and lesson plans are available to download for free from our specification web pages at www.ocr.org.uk/qualifications/subjects/science/index.html.

The University of York Science Education Group, the Nuffield Foundation and Oxford University Press also offer support in this area – see the 'Additional resources' chapter of this handbook for details.



FLEXIBLE ASSESSMENT ROUTES

Twenty First Century Science retains its flexibility in the assessment model for GCSE Science A and GCSE Additional Science A. In each of these it is possible to enter candidates for units containing mixed modules from the three sciences, or alternatively, single-subject units from the separate sciences.

There are two alternative routes to certification of GCSE Science A (J241).

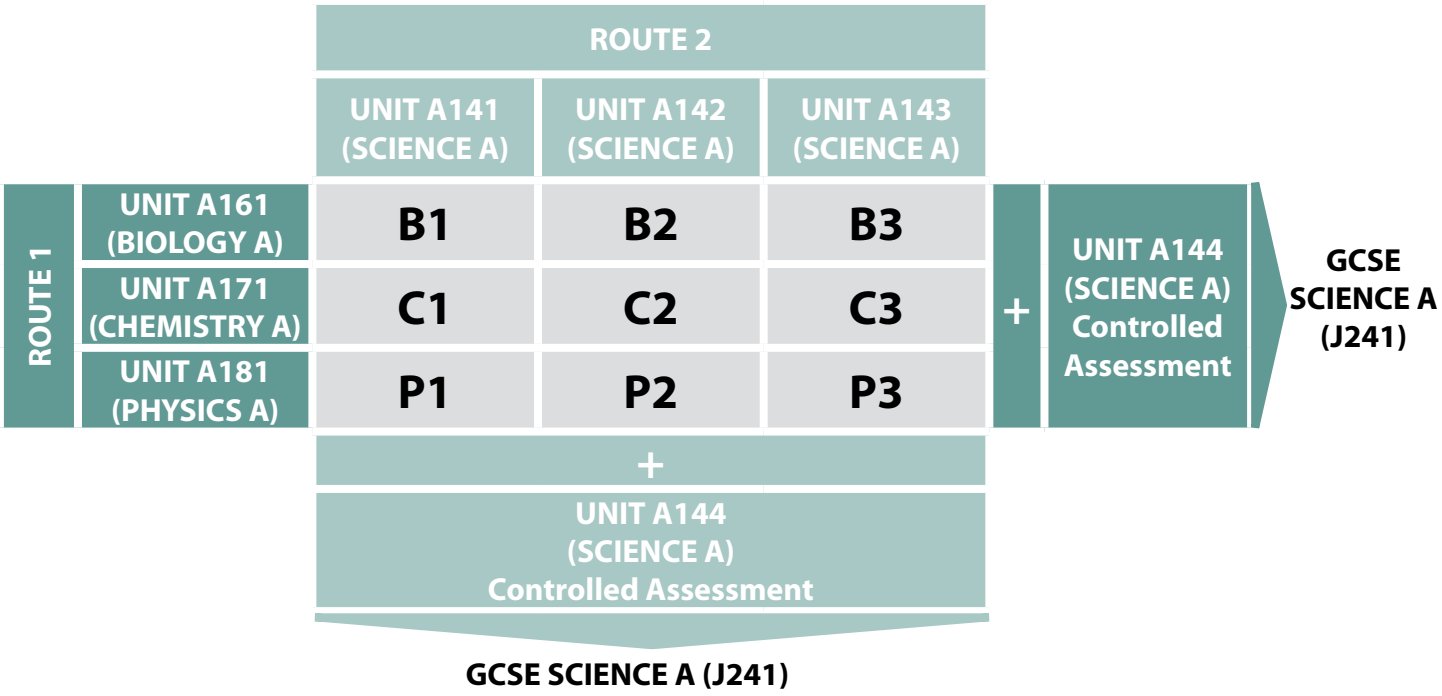
Candidates can certificate for GCSE Science A using either:

Route 1 – using Unit A161 from Biology A, Unit A171 from Chemistry A and Unit A181 from Physics A (separate science papers), plus Unit A144 (Science A Controlled Assessment)

or

Route 2 – using Units A141, A142 and A143 from Science A (mixed science papers), plus Unit A144 (Science A Controlled Assessment).

These two alternative routes can be summarised as follows:



Route 1 enables candidates who have sat assessments for the separate sciences (GCSE Biology A, Chemistry A and Physics A) to certificate instead for GCSE Science A.

Similarly, there are two alternative routes to certification of GCSE Additional Science A (J242).

Candidates can certificate for GCSE Additional Science A using either:

Route 1 – using Unit A162 from Biology A, Unit A172 from Chemistry A and Unit A182 from Physics A (separate science papers), plus Unit A154 (Additional Science A Controlled Assessment).

or

Route 2 – using Units A151, A152 and A153 from Science A (mixed science papers), plus Unit A154 (Additional Science A Controlled Assessment).

These two alternative routes can be summarised as follows:

		ROUTE 2					
		UNIT A151 (ADDITIONAL SCIENCE A)	UNIT A152 (ADDITIONAL SCIENCE A)	UNIT A153 (ADDITIONAL SCIENCE A)			
ROUTE 1	UNIT A162 (BIOLOGY A)	B4	B5	B6	+	UNIT A154 (ADDITIONAL SCIENCE A) Controlled Assessment	GCSE ADDITIONAL SCIENCE A (J242)
	UNIT A172 (CHEMISTRY A)	C4	C5	C6			
	UNIT A182 (PHYSICS A)	P4	P5	P6			
		+					
		UNIT A154 (ADDITIONAL SCIENCE A) Controlled Assessment					

GCSE ADDITIONAL SCIENCE A (J242)

Again, route 1 enables candidates who have sat assessments for the separate sciences (GCSE Biology A, Chemistry A and Physics A) to certificate instead for GCSE Additional Science A.

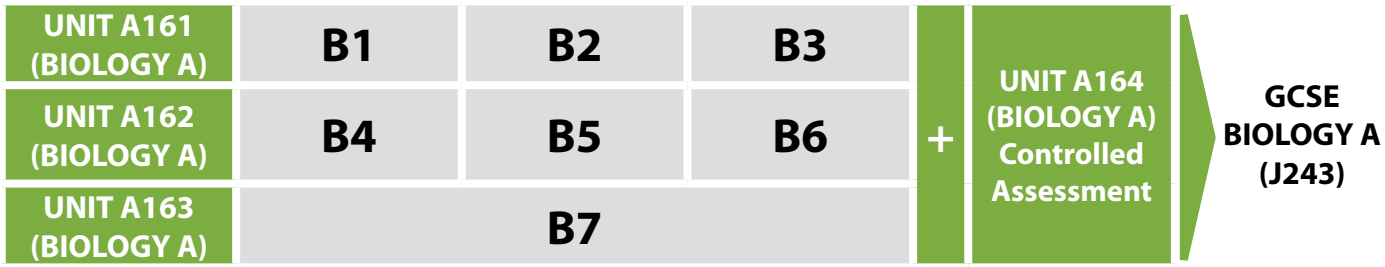
Note that in the case of GCSE Additional Science A, a Controlled Assessment from one of the separate sciences (i.e. Unit A164 from Biology A, or Unit A174 from Chemistry A, or Unit A184 from Physics A) may be used in place of Unit A154.

Unit results from the separate sciences can be used to certificate for GCSE Science A and GCSE Additional Science A. However, the reverse is not possible – unit results from Science and Additional Science **cannot** be used to certificate for any of the separate sciences.

While there is a choice of routes to GCSE Science A and GCSE Additional Science A, there is only one route to each of the separate sciences.

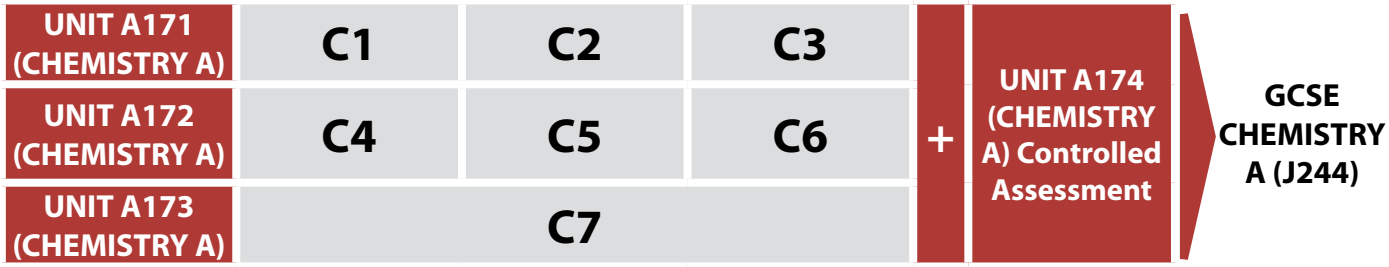
Candidates can only certificate for GCSE Biology A using Units A161, A162 and A163 from Biology A (separate science papers), plus Unit A164 (Biology A Controlled Assessment).

This can be summarised as follows:



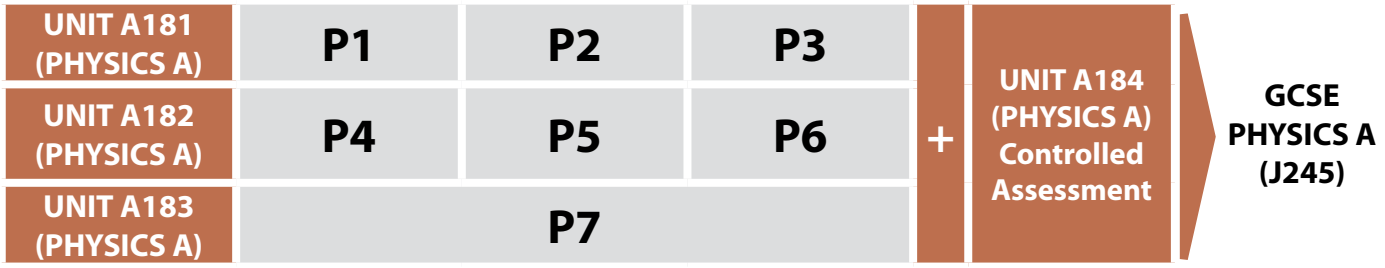
Candidates can only certificate for GCSE Chemistry A using Units A171, A172 and A173 from Chemistry A (separate science papers), plus Unit A174 (Chemistry A Controlled Assessment).

This can be summarised as follows:



Candidates can only certificate for GCSE Physics A using Units A181, A182 and A183 from Physics A (separate science papers), plus Unit A184 (Physics A Controlled Assessment).

This can be summarised as follows:



TERMINAL AND RE-SIT RULES

The 40% terminal rule

For each GCSE, at least **40%** of the assessment must be taken in the examination series in which the qualification is **certificated**.

Note:

- The 40% can comprise any combination of assessment units, including written papers and Controlled Assessment.
- As each assessment unit in Twenty First Century Science is weighted at 25%, candidates will always have to take at least two units in the series in which they plan to certificate, in order to satisfy the 40% terminal rule.
- The final grade will include the unit results which satisfy this terminal requirement. This means that the results for the units used to satisfy the 40% terminal requirement will count (i.e. they will be used to calculate the grade), even if there is a better score for an earlier attempt at one or more of these units.
- If there is more than one way of satisfying the 40% terminal requirement, we will select units in a way that generates the best grade for the candidate.

The re-sit rule

Candidates may re-sit each unit only **once** before certification.

Note:

- The better result counts towards the final grade; however, if a re-sit result forms part of the 40% terminal requirement then this result will be used in the final certification even if it is a lower mark than the original attempt.
- A tiered unit may be re-sat only once, though the re-sit may be at either tier (it does not have to be the same tier as the original attempt).

Re-taking a qualification

A qualification may be taken more than once – either by re-sitting all the units, or by re-sitting some units and reusing previous results for others, subject to the terminal requirement being satisfied.
When a qualification is re-taken (i.e. after first certification), a candidate may have up to two further attempts at each unit. However, only the better of the last two results will count towards the final grade, or the last if it is used to satisfy the terminal requirement.

Use our interactive Assessment Planner to help you ensure your students will meet the 40% terminal and re-sit rules.

www.scienceplanner.ocr.org.uk

A guide to using the planner is available at www.ocr.org.uk/download/sm/ocr_59341_sm_gcse_as-sess_planner.pdf

FREQUENTLY ASKED QUESTIONS

When are candidates eligible for a qualification?
Candidates become eligible to certificate for a qualification in the session in which they:
- have been entered for a valid combination of units, and
- have been entered for certification, and
- have satisfied the 40% terminal rule.

What happens if a certification entry is not made in the final series?
Certification entries must be made. Without a certification entry, the candidate will not receive their subject award. However, you have until the post-results series deadline to make a late certification entry.

What if a candidate is absent?
It is the result of, not the entry for, an assessment unit that counts when considering the re-sit rule. A candidate who enters for a unit but is absent from the examination has not used up one of his/her two possible attempts. However, for award purposes, absence from an assessment unit will be treated as a result of zero marks for that unit.

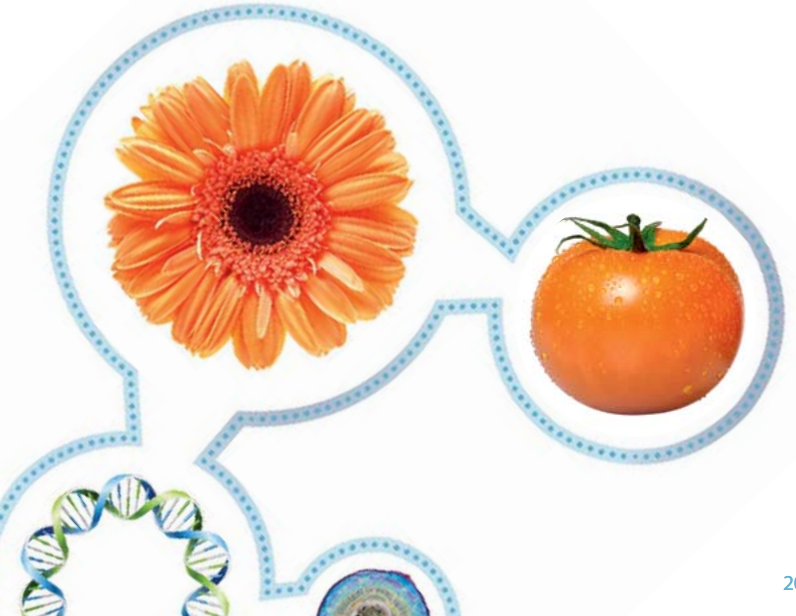
Will my candidates get the best results?
Yes. We will generate the best possible grade for each candidate from their available results, including where, for example:
- they have taken more units than they need to
- there is more than one valid combination of results
- there are results from different tiers.

Of course, the terminal requirement and the re-sit rule must apply and there must also be a certification entry in the final series.

How long will the individual unit results be valid?
Unit results remain valid for the life of the specification.

Can candidates wait and certificate when they have their best results?
Yes, it is possible to make late certification entries (until the post-results service deadline); however, a candidate must have met the terminal requirement in that examination series.

Can a GCSE grade be declined?
No. It is not possible to decline certification of GCSE awards after the results are published. However, certification does not 'use up' unit results; a candidate can re-use results in a later certification (provided that the terminal requirement is met).



THE EXTERNAL ASSESSMENT QUESTION PAPERS

Anatomy of a question paper

Each question paper for each specification in the Twenty First Century Science suite is marked out of a total of 60 marks.

There are no optional questions; **all** questions on each paper must be attempted.

The marks in each paper will be allocated approximately as follows:

Assessment Objective	Proportion of each paper
AO1	approx. 40%
AO2	approx. 45%
AO3	approx. 15%

Type of question	Proportion of each paper
objective-style questions	approx. 40%
1-mark questions	
continuous writing questions (2-5 marks each)	approx. 30%
extended writing questions (6 marks each)	3 x 6-mark questions (30%)

Skill being assessed	Proportion of each paper
mathematics skills	15-30%
quality of written communication	5%
'Ideas about Science'	12-25%

Assessment Objectives (AOs)

Three Assessment Objectives (AOs), defined by the examinations regulators, require students to be able to demonstrate their abilities as follows:

AO1	Recall, select and communicate knowledge and understanding of science.
AO2	Apply skills, knowledge and understanding of science in practical and other contexts.
AO3	Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence.

AO1 requires direct **recall** and communication of knowledge gained by studying the specification.

AO2 requires the **application** of skills learnt from the specification to an **unfamiliar** context. The need for an unfamiliar context in which students can apply their skills and knowledge means that the question may appear, at first glance, to be off-specification. However, the question stem will furnish the student with all the additional information they need to be able to answer the question when they apply what they have learnt to the situation described in the question.

To answer certain questions, students will need to **apply** what they have learnt to an **unfamiliar** situation.

If a student thinks the context described in a question looks unfamiliar, they should:

- think about how it is **similar** to something they have learnt
- look for clues in the question that suggest how they can **relate** the situation to what they know
- and, most of all, **don't panic!**

Note that the command word "describe" does not necessarily mean that an AO1 answer is required, and the command word "explain" does not necessarily require an AO2 answer. For example, if a specification statement requires students to explain something, then any 'explain' question on this learning objective will require an AO1-style (recall) answer.

AO3 requires the student to:

- look at evidence or data
- do more than simply describe evidence
- do more than simply process data
- synthesise their own judgement or conclusion.

An AO3 question will go beyond just "processing for processing's sake", and will require the student to work to an end point that relates to the scientific context given in the question via some sort of conclusion or judgement.

Some questions will ask the student to explain whether they agree or disagree with a statement or conclusion.

No marks will be given for saying "yes/no" or "agree/disagree"; rather, the marks will be awarded for **explaining** or **justifying** this judgement.

Objective-style questions

Objective-style questions are those that require candidates to choose from a selection of possible answers.

Styles of objective question used in Twenty First Century Science question papers include:

- ticking items in a list to identify correct answers, or to distinguish true from false answers
- drawing a ring around correct answers
- selecting a word or phrase to complete a sentence
- ordering statements into the correct sequence
- selecting correct statements from a selection of 'talking heads' speech bubbles
- joining items by drawings lines from one list to another.

Tick-box questions will **not** always indicate how many ticks are required.

Students should **not** assume that the number of marks available indicates the number of ticks required.

Students must evaluate each of the possible answers on its own merit, and then tick each one they think is correct.

Continuous writing questions

Questions worth 2-5 marks in which students must synthesise their own answer (rather than choose from a selection of possible answers) are classed as 'continuous writing' questions.

- The *breadth* of answer required (i.e. how much of the topic to cover in the answer) will be indicated by the question stem, particularly by the command word used and the amount of information given in the stem.
- The *depth* of answer required (i.e. the amount of detail needed) can be judged from the number of answer lines provided and the number of marks allocated to the question.

Guidance on command words is given at the end of this section.

The information given in the question stem will help students to decide how much of the topic they need to cover in their answer, but the examiner will have been careful not to provide too much 'scaffolding'.

For example, consider the following construction:

(b) Explain why the reaction will not work when starch solution is used instead of hydrogen peroxide solution.

In your answer you should write about

- the shape of the substrate
- the shape of the enzyme
- the active site.

.....

.....

.....

[3]

This construction gives the student a lot of guidance about what to include in their answer, and will not be used in questions targeted at grade D or above. It may be seen very occasionally on questions targeted at grades G, F or E.

However, now consider the following construction:

(c) Here are some things Gertrude could do when she repeats her experiment

- repeat the reaction five times at each concentration
- measure the temperature to three decimal places
- add dilute acid to the reaction mixture.

Explain which of these would increase the confidence in her conclusion.

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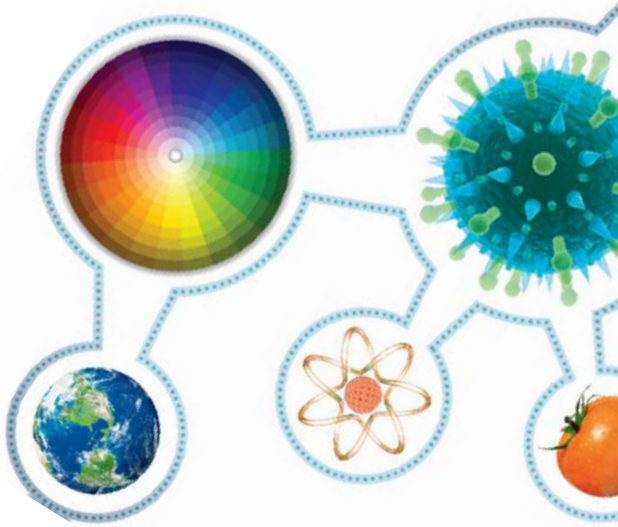
[3]

This construction may be used in any question, because the bullet points present information to be analysed; the student must select what information to include in their answer.

Bullets used in this way increase accessibility of the question when there is a lot of information for the student to read, which may be the case in questions assessing AO2 and AO3 skills.

In continuous writing questions, the examiner will be looking to see that the student has presented a **cohesive argument** in their answer, rather than simply writing several unlinked points.

Students should use conjunctive words and phrases such as "because", "so that" and "however" to link related statements in their answer in a logical way.



Extended writing questions and quality of written communication

Each question paper in Twenty First Century Science will contain **three** extended writing questions.

Each of these questions will:

- be worth 6 marks
- assess the student's Quality of Written Communication (QWC)
- be marked using a 'levels of response' mark scheme.

A pencil icon and a rubric will inform students that their quality of written communication will be assessed in their answer to this type of question.

For example, the following question has been reproduced from the accredited Specimen Assessment Material for GCSE Biology A Unit A162 (Higher Tier):

3 Alex is investigating the activity of an enzyme called salivary amylase. The enzyme breaks down starch into glucose, and is present in saliva in the human mouth.

(a) Alex has read that the digestion of some foods begins in the mouth.

Alex has chicken and chips for lunch. She wonders which parts of her lunch will start to be digested by salivary amylase in her mouth. She knows that chicken meat is made of protein.

Explain why salivary amylase will start digesting the chips in her mouth but will not start digesting the chicken.

The quality of written communication will be assessed in your answer.

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[6]

QWC skills that may be assessed in extended writing questions include:

- spelling, punctuation and grammar
- appropriate use of correct scientific terms
- developing a structured, persuasive argument
- selecting and using evidence to support an argument
- considering different sides of a debate in a balanced way
- logical sequencing.

All six-mark extended writing questions will be marked using a 'levels of response' mark scheme. The assessment of QWC is embedded into the levels described in the mark scheme – it is not a standalone mark, hence the total number of marks available for the question is expressed as **[6],** rather than as **[5+1]**.

The levels of response mark scheme for a six-mark extended writing question will always be divided into columns.

The column entitled "Guidance" gives a list of relevant points that a student might be expected to make if they are performing at the top level. The "relevant points" are not to be taken as marking points, but as a summary of points that will allow examiners to judge how well the candidate has grasped the relevant science and skills of the topic area.

For the example question given on the previous page, the "Guidance" column contains the following list of relevant points:

- chips/potatoes/plants contain starch (as an energy store)
- salivary amylase has an active site
- the shape of the active site complements the shape of a starch molecule
- only a starch molecule will fit into the enzyme's active site and form an enzyme-substrate complex
- this is the 'lock and key' model
- chicken meat is made of protein, not starch
- protein will not fit into the enzyme's active site
- and will not form an enzyme-substrate complex
- so will not be digested

The column entitled "Answer" contains descriptors for four levels, numbered from Level 3 down to Level 0.

For the example question given on the previous page, the "Expected answers" column contains the following level descriptors:

[Level 3]
Answer correctly and clearly describes the lock and key model, notes that chips/potatoes contain starch and explains that substrate specificity is why digestion of starch molecules in the chips by salivary amylase will start in the mouth but digestion of protein molecules in the chicken will not. All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling.

(5 – 6 marks)

[Level 2]
Answer correctly describes some aspects of the lock and key model but may not use the appropriate terminology and may not make clear the importance of the specificity of the active site on the salivary amylase molecule for the shape of the starch molecule. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling.

(3 – 4 marks)

[Level 1]
Answer demonstrates understanding that salivary amylase will start to digest starch in the chips but will not digest protein in the chicken, but does not clearly attribute this to the specificity of the enzyme's active site for the shape of the starch molecule. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science.

(1 – 2 marks)

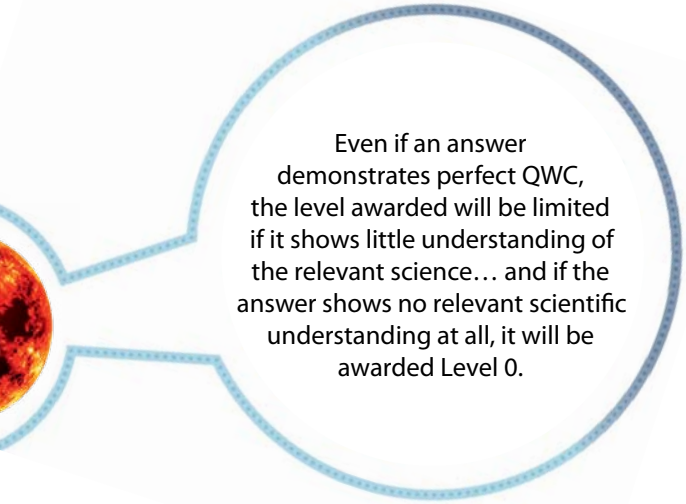
[Level 0]
Insufficient or irrelevant science. Answer not worthy of credit.

(0 marks)

The first sentence or two of each level descriptor describes the indicative scientific content of answers in this level; the following sentences describe the indicative quality of written communication.

The expected quality of written communication is different in the three levels, and it will always be considered at the same time as looking at the scientific information in the answer.

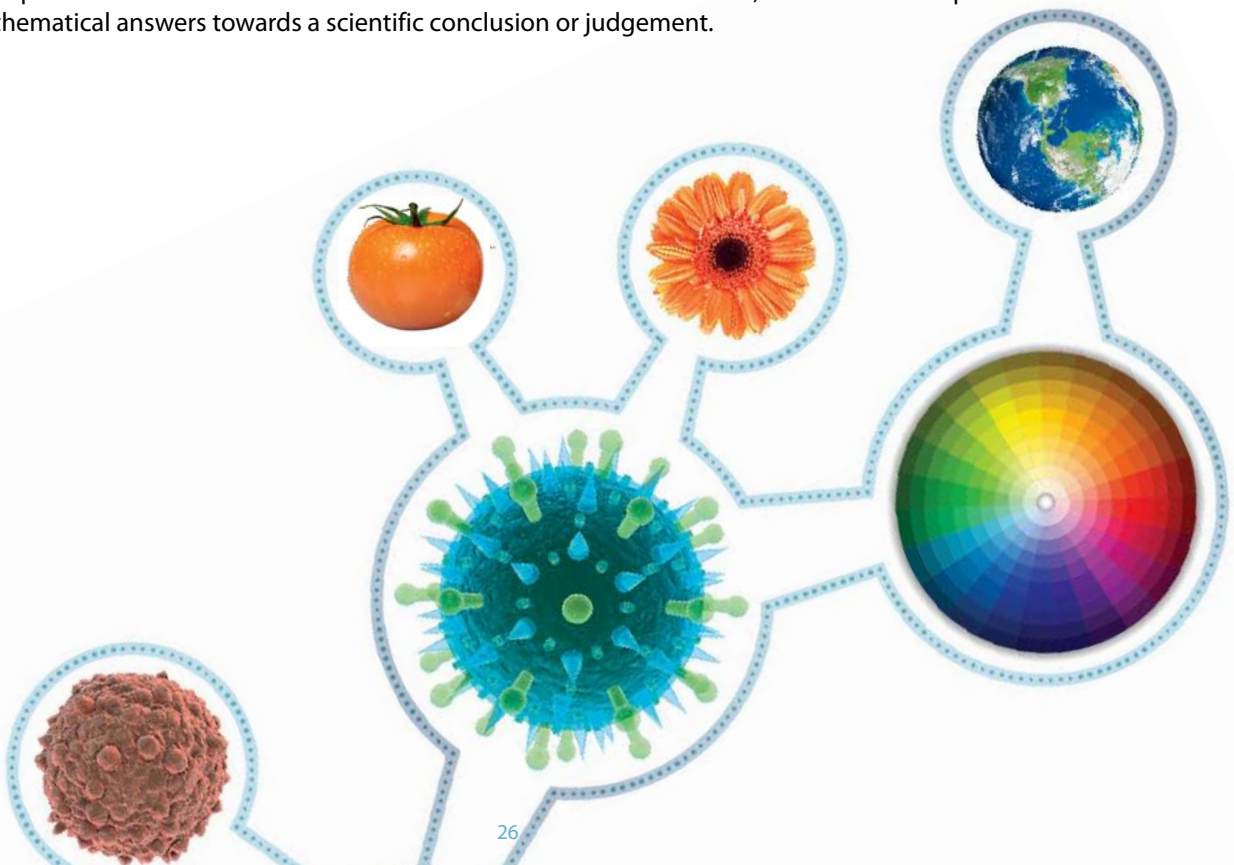
When marking, the examiner will first decide which of these levels best describes a student's answer. The student will then be awarded the higher or lower mark within the level depending on the quality of the science and the quality of the written communication in their answer.



Mathematics skills

"Mathematics skills" does not just mean doing calculations – it includes all of the quantitative, processing, graphical and interrogative skills listed as mathematical skills in the subject criteria for the GCSE sciences. These mathematics skills are reproduced in Appendix C in each specification in the Twenty First Century Science suite.

Within question papers, candidates will need to be able to demonstrate competence in all of the mathematical skills listed in Appendix C of the specification. These skills will be assessed within a scientific context, and will often require candidates to develop their mathematical answers towards a scientific conclusion or judgement.



It may be helpful to understand how certain mathematics skills can be classified as AO1, AO2 or AO3-type skills. The following may be used as a guide:

AO1 – Recall, select and communicate knowledge and understanding

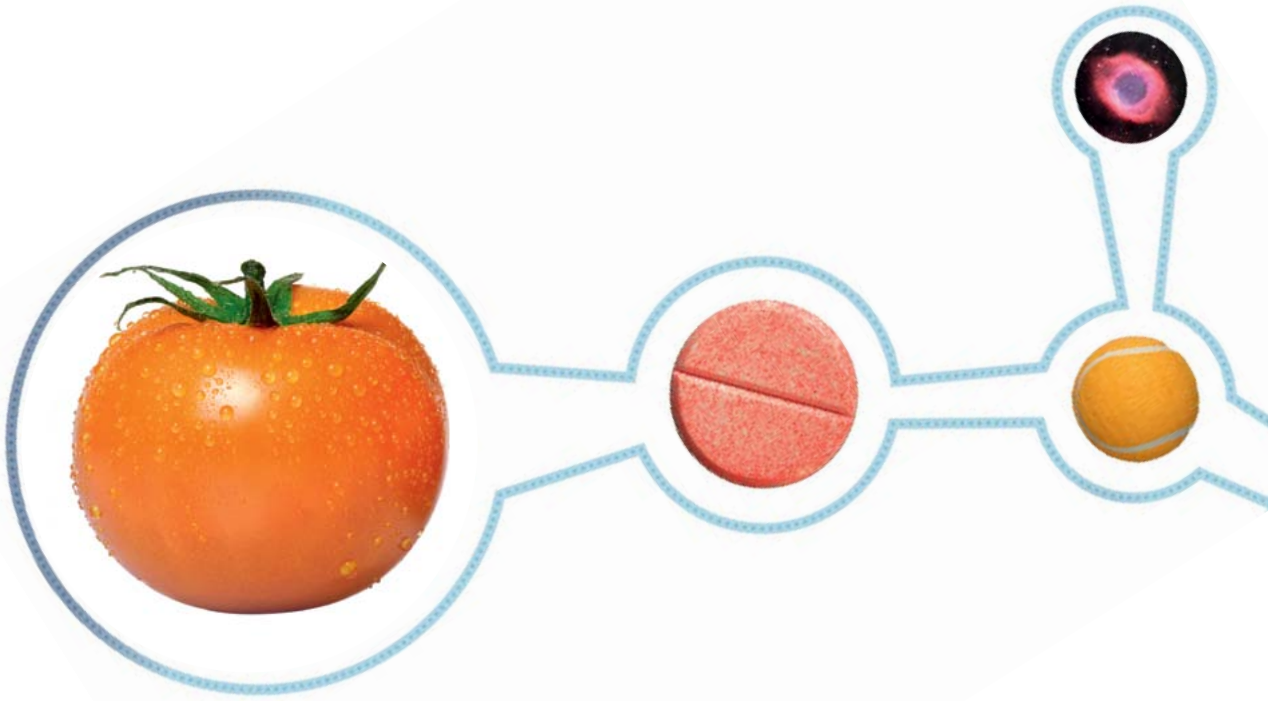
- recall of a unit
- selection of an appropriate formula

AO2 – Apply skills, knowledge and understanding in practical and other contexts

- calculating a value from data
- substitution of numbers into a formula and calculating the answer
- reading or calculating a number from a graph
- description of trends in data or the shape of a graph (i.e. *what* is happening and *when?*)
- explanation of trends in data or the shape of a graph (i.e. *why* is it happening?)
- comparing the data to other data sets
- commenting on how repeatable or reproducible the data are

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

- analysing data or a graph and making a judgement or giving a conclusion, based upon evidence in the data or graph *(Note: reaching a conclusion involves more than just picking out numbers – there should be synthesis of an idea that is based upon the data but is not simply picked out from them)*
- commenting on the implication(s) of the data or experiment (including how it could be useful)
- evaluation – e.g. critique of the method used, commenting on how much confidence can be placed in the conclusion, etc.



Command words

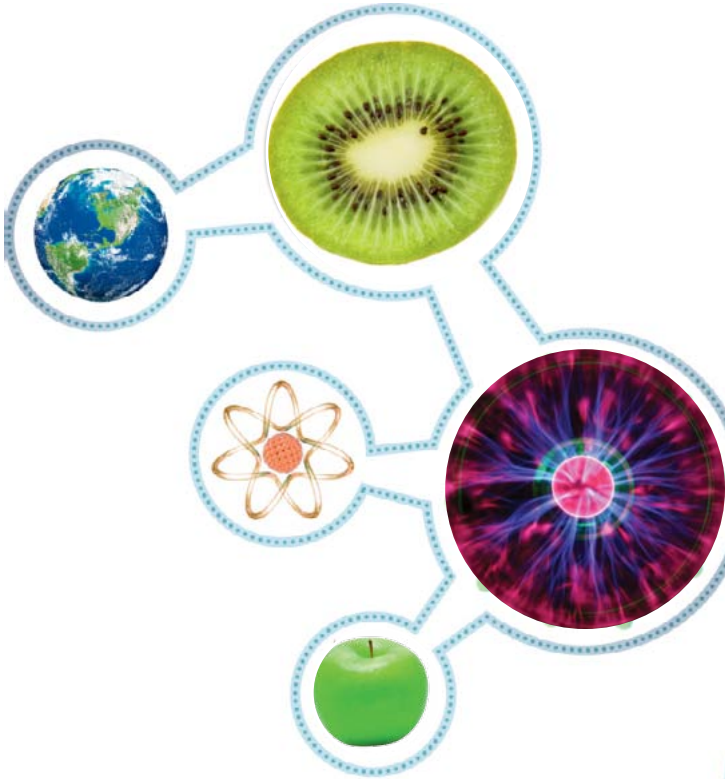
It is important that candidates are able to recognise the command words used in questions in external assessment papers, and understand what kind of response is required by each command word.

This list sets out some of the commonly used command words and provides guidance on the meanings of these words. The list is not intended to be exhaustive or exclusive, but is intended as a guide to the most commonly used command words.

The exact requirements of a command word must always be interpreted within the context of the question in which it appears.

Calculate	Work out a numerical answer. The question will indicate whether or not working must be shown. Appropriate units may be given on the answer line, but if the units are not given they should be included in the answer. *Compare with* ***Estimate*** *and* ***Predict***.
Compare	Identify similarities and differences.
Complete	Add words, numbers, labels or plots to complete a sentence, table, diagram or graph.
Describe	Set out the facts or characteristics. The answer should address *what* happens, and *when* and/or *where* it happens. *Compare with* ***Explain***.
Discuss	Give a detailed account that addresses a range of ideas and arguments. It may be necessary to consider opposing sides of a debate, and/or to include ideas, opinions and facts.
Draw	Produce a diagram with sufficient detail and labels to illustrate the answer. *Compare with* ***Sketch***.
Estimate	Suggest an approximate value, without necessarily performing an accurate calculation or measurement. Appropriate units may be given on the answer line, but if the units are not given they should be included in the answer. *Compare with* ***Calculate*** *and* ***Predict***.
Explain	Set out reasons and/or mechanisms to address *why* and/or *how* something happens. *Compare with* ***Describe.***
Evaluate	Comment on given facts, data or information, and give a judgement, conclusion or opinion if appropriate.
Justify	Provide evidence or explanation that supports an answer, to explain why the answer was given.
Label	Add names or other identifying words to a diagram (using a straight line from the word to the appropriate feature on the diagram).
Measure	Determine a numeric value (a quantity for a variable) using a suitable measuring instrument.
Name	Provide appropriate word(s) or term(s).
Outline	Set out only the key or essential facts, steps or characteristics.
Plot	Translate data into a suitable graph or chart, with labelled axes.
Predict	Write down a possible outcome or value, based on given or calculated information or data. *Compare with* ***Calculate*** *and* ***Estimate***.
Show	Write down details, steps or calculations to prove a fact or answer.
Sketch	Produce a simple, freehand drawing to illustrate the general point being conveyed. Detail is not required. In the context of a graph, the general shape of the curve would be sufficient without plotting precise points. *Compare with* **Draw.**
Suggest	Apply scientific knowledge and understanding from the specification to a novel situation or context.
Write down	Provide a concise answer with no supporting argument.

"Student speak" definitions of common command words have been provided in Appendix B of this handbook, which can be used as a classroom handout.



IDEAS ABOUT SCIENCE

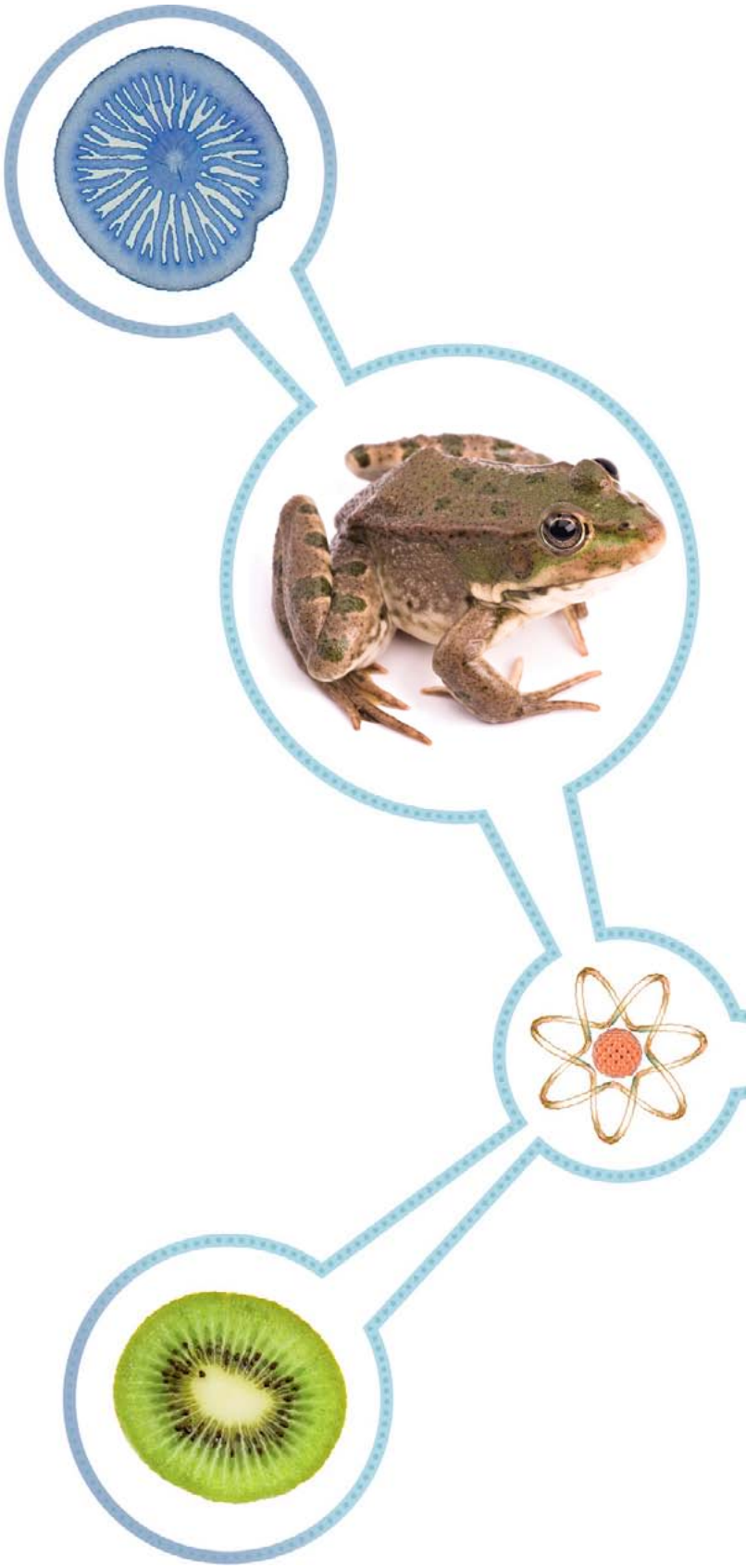
The 'Ideas about Science' (IaS) are a fundamental part of the content of the Twenty First Century Science specifications. They do not sit apart from the course content, but are an integral part of it.

The concepts covered by the IaS should be introduced and developed with students using examples from the modular content of each course, and subsets of the IaS will be assessed in each external assessment question paper.

The IaS are presented in each Twenty First Century Science specification as follows:

- In **Appendix B** of the specification, all of the IaS are written out in full, in an order that shows clearly how the ideas relate to one another and build up the understanding of science that students require.
- At the start of each **module** in the specification (e.g. Module B1), a list is given to identify which of the IaS can be introduced or developed during teaching of the module.
- At the start of each **unit** in the specification (e.g. Unit A161), a list identifies which of the IaS can be assessed in question papers for the unit. These IaS can be assessed within **any** context from the modules within the unit; for example, within Unit A161 an IaS that was taught in the context of B3 could be assessed in a context from B1, B2 or B3.

Check the introduction to each unit in the specification for a list of which IaS can be assessed in question papers for that unit.



ADDITIONAL RESOURCES

Page iii of each specification gives details of support materials, training and services provided by OCR to support you in teaching the Twenty First Century Science 2011 specifications.

This chapter highlights some of these, and also lists other resources you may find useful.

UYSEG, THE NUFFIELD FOUNDATION AND OUP

Twenty First Century Science was developed by the University of York Science Education Group (UYSEG), the Nuffield Foundation, Oxford University Press and OCR.

Extensive support for Twenty First Century Science teachers is offered by the Nuffield Foundation and UYSEG at:

www.nuffieldfoundation.org/twenty-first-century-science

and by Oxford University Press at:

www.twentyfirstcenturyscience.org

OUR PUBLISHER PARTNER AND OTHER ENDORSED RESOURCES

Our official publisher partner is Oxford University Press, and they have been working with the OCR science team, the Nuffield Foundation and the UYSEG Project Team to publish new editions of their Twenty First Century Science resources.

Further details are available on the Oxford University Press website at:

www.oxfordsecondary.co.uk/twentyfirstcenturyscience

In addition, we are also endorsing the updated Twenty First Century Science publications from Collins. Details of these Approved Publications are available at:

www.collinsnewgcsescience.co.uk

THE CLUSTER SUPPORT NETWORK

Teachers of Twenty First Century Science support one another through a network of cluster groups: local clusters of four to eight schools offering mutual support. OCR and the UYSEG Project Team are helping schools to run this network. Cluster groups are organised according to geographical areas and all centres are eligible to join. Each cluster appoints their own coordinator who organises meetings at times to suit the member centres.

OCR supports clusters by providing:

- free training for the coordinator twice a year
- resources to disseminate to the cluster members
- regular updates to the coordinator for dissemination
- a route for clarification of points raised by member centres
- a National Coordinator who maintains regular contact with the coordinators.

For information on joining a Twenty First Century Science cluster group in your area, email the University of York Science Education Group at uyseg-c21@york.ac.uk.

ESSENTIAL BOOKMARKS

- www.gcse-science.com – for the latest updates and free downloads of specifications and support materials
- www.scienceplanner.ocr.org.uk – our free interactive Assessment Planner to help you plan valid assessment routes
- www.nuffieldfoundation.org/twenty-first-century-science – support for Twenty First Century Science from the Nuffield Foundation and University of York Science Education Group (UYSEG), our development partners
- www.twentyfirstcenturyscience.org – support for Twenty First Century Science from Oxford University Press, our publisher partner
- www.ocr.org.uk/training – for information and to book a place on our free INSET courses and new online training events
- www.ocr.org.uk/campaigns/science/world_of_science – our popular 'World of Science' interactive game, supporting the 2011 science specifications
- www.social.ocr.org.uk – join our new science social community for teachers, where you can participate in discussions, ask questions, and upload & download teacher-made resources
- answers.ocr.org.uk – our new question & answer service, available for free 24 hours a day, where you can browse hot topics, FAQs and email us with specific questions
- www.ocr.org.uk/interchange/active_results – our free results analysis service, which allows you to review the performance of individual students or your whole school on a unit or question-by-question basis and compare against national averages

USEFUL WEB RESOURCES

The following list of websites has been compiled from suggestions by teachers, and may be useful in teaching of Twenty First Century Science.

While these websites may be useful, OCR does not contribute to or regulate them in any way, and is not responsible for any of their content or the ways in which they are used. The list is not intended to be exclusive or comprehensive, and inclusion in the list does not constitute endorsement by OCR. Website addresses are correct at the time of printing.

General

- www.delicious.com/MrsWh – a regularly updated list of links to interesting web pages and videos, tagged with the relevant Twenty First Century Science module and IaS number
- www.nhs.uk/News/Pages/NewsIndex.aspx – NHS 'Behind the Headlines', an analysis of the real science behind the science stories that hit the news (a useful training resource for 'Ideas about Science' and the Case Study Controlled Assessment tasks)
- www.nationalstemcentre.org.uk/elibrary - The National STEM centre eLibrary enables you to search thousands of teaching resources for science, technology, engineering and mathematics
- www.collinsnewgcsescience.co.uk/badscience – web resources and lesson plans based on the 'Bad Science' book and newspaper column by Ben Goldacre, unpicking scientific claims, reports and news stories
- www.tes.co.uk/secondary-teaching-resources – TES list of resources for secondary teaching, including lesson plans, worksheets, activities, revision, teaching ideas and classroom resources
- www.abpischools.org.uk/page/resource/age/subject.cfm?age=Age%20Range%2014%2D16 – information and interactive activities on a range of topics relevant to GCSE science
- www.explainthatstuff.com – a large collection of articles, providing easy introductions to science concepts and technology
- www.creative-science.org.uk – ideas and resources to help students create experiments for themselves, from the Creative Science Centre at the University of Sussex
- www.bbc.co.uk/schools/gcsebitesize/science – BBC Bitesize revision for GCSE sciences
- www.s-cool.co.uk/gcse – a colourful revision site

Biology

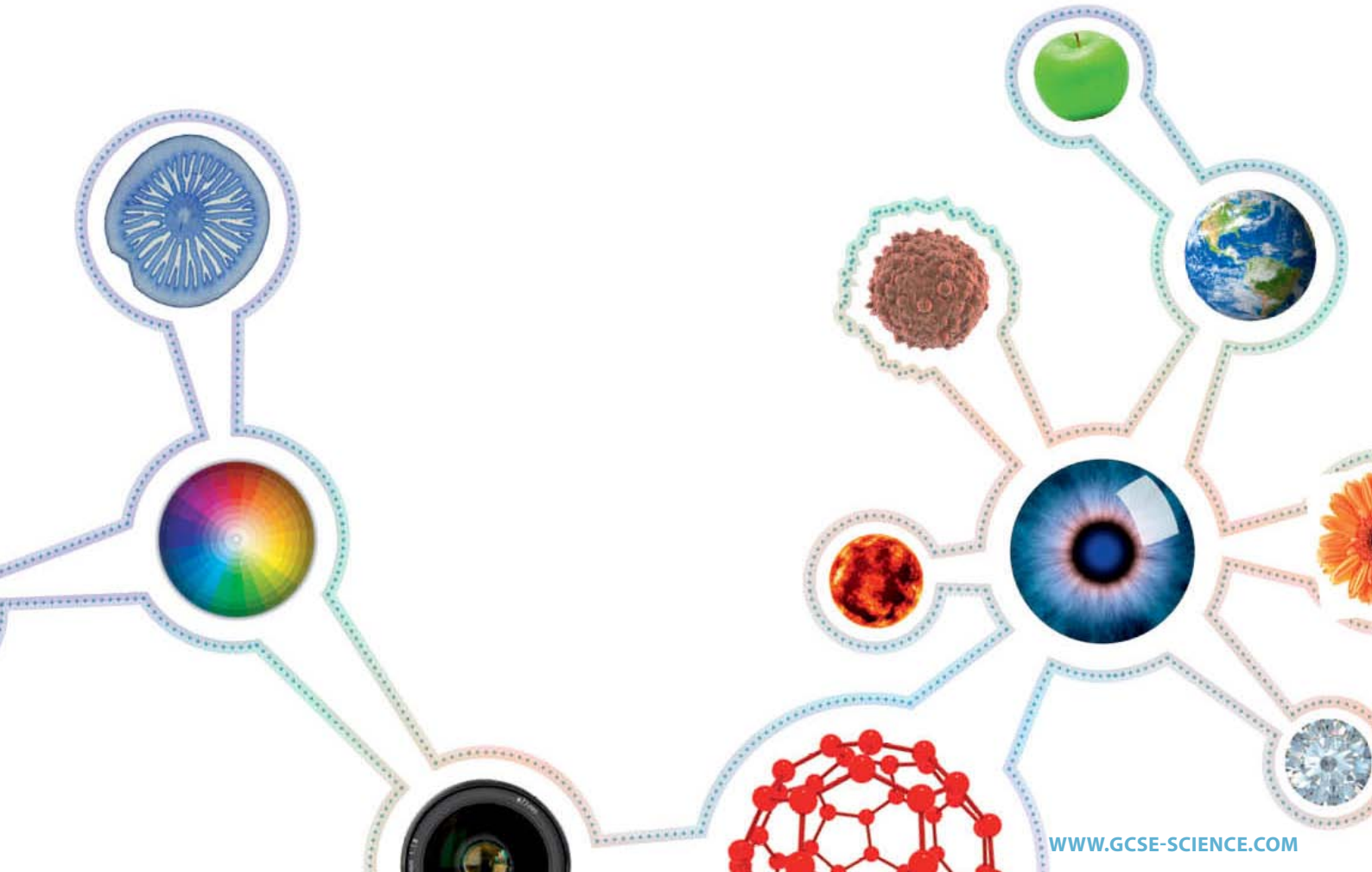
- www.practicalbiology.org – the Society of Biology guide to tried and tested biology experiments for use in schools
- www.saps.org.uk – resources and experiments aimed at stimulating plant science in schools
- www.biology-resources.com – educational materials, presentations and experiments
- nobelprize.org/educational – interactive educational games explaining blood types, Pavlov's dogs, DNA and other topics
- www.drjastrow.de – microscopy images of the human body
- multimedia.mcb.harvard.edu/media.html – 'BioVisions' animations and videos, including 'The Inner Life of the Cell'
- www.bionetonline.org/English/default.htm – accessible debates on issues such as stem cells and genetic engineering, including scientific, ethical and legal aspects
- www.beep.ac.uk – the BioEthics Education Project, supporting the teaching of ethics in biology

Chemistry

- www.rsc.org/Education/Teachers/Resources/OnlineResourcesHome.asp – the Royal Society of Chemistry's list of online resources for chemistry
- www.practicalchemistry.org – a wide range of chemistry experiments for use in schools
- www.periodicvideos.com – videos showcasing every element in the Periodic Table
- www.syngenta.com/country/uk/en/learning-zone/periodictable/Pages/periodictable.aspx – an interactive Periodic Table to help students learn about the elements, groups and compounds, and watch their reactions in a virtual 'reaction zone'
- www.understandingnano.com – an accessible source of information on nanotechnology
- Useful resources for C3:
  - www.bbc.co.uk/programmes/b00n8t48
  - www.geologyrocks.co.uk/tutorials/history_of_uk_part_one
  - www.infobritain.co.uk/Geological_History_UK.htm
  - www.naturalengland.org.uk/ourwork/conservation/geodiversity/englands/counties/area_ID5.aspx
  - www.bgs.ac.uk/discoveringGeology/climateChange/climateThroughTime.html
  - www.winsfordrocksaltmine.co.uk/geology
  - www.timesonline.co.uk/tol/news/environment/article5562015.ece
  - www3.halton.gov.uk/environmentandplanning/pollution/153271
  - www.chlorinetree.org
  - www.hc-sc.gc.ca/hl-vs/iyh-vsv/environ/chlor-eng.php
  - www.valleywater.org/Services/Trihalomethanes.aspx

Physics

- www.physics.org – the Institute of Physics guide to physics resources on the web
- www.practicalphysics.org – a wide range of physics experiments for use in schools
- www.energyquest.ca.gov/projects – practical activities related to energy
- www.technologystudent.com/elec1/elecex.htm – information on electrical components
- www.kpsec.freeuk.com – an online electronics club, with lots of information about circuits and components
- www.youtube.com/watch?gl=GB&v=bjOGNVH3D4Y – 'The Electromagnetic Spectrum Song'
- www.schoolsobservatory.org.uk/teach - the National Schools' Observatory, including activities to run in the classroom and free use of a robotic telescope for UK schools

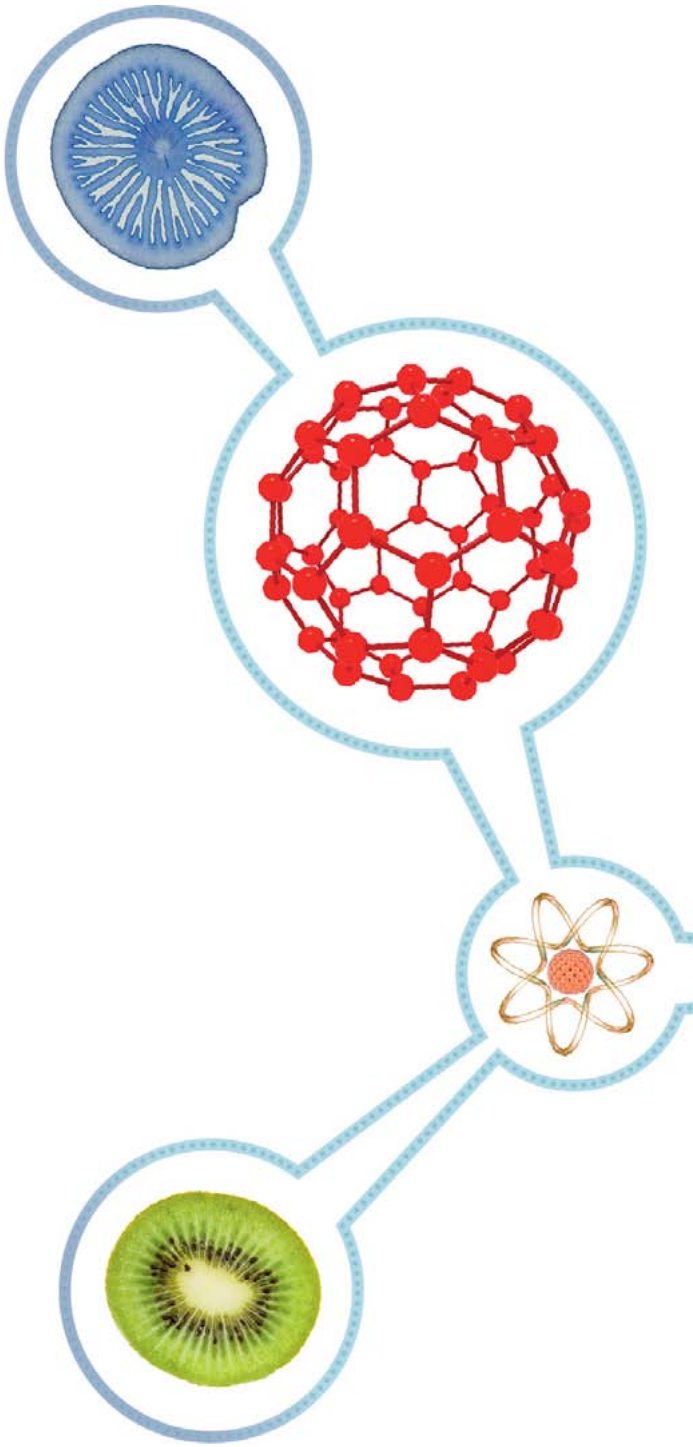


APPENDIX A: HAZARD SYMBOLS

Specification statements C4.1.18 and C6.1.6 require students to recall the chemical hazard symbols for explosive, harmful, toxic, corrosive, oxidizing and highly flammable.

Teachers and technicians will be familiar with the square symbols with orange backgrounds, as defined in EEC Directive 67/548/EEC. However, this Directive will be repealed on 1 June 2015 and the symbols will no longer be used after that date.

A new set of diamond-shaped hazard symbols with white backgrounds is being introduced in Europe, in accordance with the *United Nations Globally Harmonized System of Classification and Labelling of Chemicals* (the "GHS"). The GHS has been adopted in Europe under the *Regulation on the Classification, Labelling and Packaging of Substances and Mixtures* (the "CLP").



How does this affect teaching and assessment?

Guidance for teachers and technicians about using chemicals in school has been issued by CLEAPSS in the leaflet '*An introduction to GHS / CLP chemical hazard labelling*', available to download for free from:

www.cleapss.org.uk/attachments/article/0/GL%20101%20GHS%20CLP%20labelling.pdf?Secondary/Science/Guidance%20Leaflets

Note that under the new GHS/CLP system, the familiar 'X' symbol for 'harmful' will no longer be used. Hazards previously classified as harmful will be covered by the other symbols in the new system, according to the nature of the hazard.

The period up to 1 June 2015 is considered to be a transitional period in which both sets of symbols will be in use. Hence, students are likely to see both sets of symbols on chemical bottles and chemical safety data sheets during the lifetime of the 2011 specifications.

Students should be familiar with both sets of symbols, and should be able to recall both sets during assessment.

The following page shows both sets of symbols (limited to those required by specification statements C4.1.18 and C6.1.6), and can be used as a classroom handout.

HAZARD SYMBOLS

Many chemicals you use in school and at home will be labelled with hazard symbols. For your exams, you need to be able to recall the symbols for explosive, toxic, corrosive, oxidizing, highly flammable and harmful.

The symbols used in Europe are changing, and between 2010 and 2015 two sets of symbols will be in use.

The 'old' symbols are square and have an orange background.

Explosive

Toxic

Corrosive

Oxidizing

Highly flammable

Harmful

The 'new' symbols are diamond-shaped and have a white background.

Explosive

Toxic

Corrosive

Oxidizing

Highly flammable

There is not a symbol for 'harmful' in the new system.

APPENDIX B: COMMAND WORDS

This page explains some of the command words you will see used in exam questions.

Remember that you may see other commands words used in questions, and the exact way you answer a question will always depend on the information given in the question itself.

Calculate
Work out a number. You can use your calculator to help you. You may need to use an equation. The question will say if your working must be shown. (Hint: don't confuse with 'Estimate' or 'Predict')

Compare
Write about the similarities and differences between two things.

Describe
Write a detailed answer that covers *what* happens, *when* it happens and *where* it happens. Talk about facts and characteristics. (Hint: don't confuse with 'Explain')

Discuss
Write about the issues related to a topic. You may need to talk about the opposing sides of a debate, and you may need to show the difference between ideas, opinions, and facts.

Estimate
Suggest an approximate (rough) value, without performing a full calculation or an accurate measurement. Don't just guess – use your knowledge of science to suggest a realistic value. (Hint: don't confuse with 'Calculate' and 'Predict')

Explain
Write a detailed answer that covers *how* and *why* a thing happens. Talk about mechanisms and reasons. (Hint: don't confuse with 'Describe')

Evaluate
You will be given some facts, data or other kind of information. Write about the data or facts and provide your own conclusion or opinion on them.

Justify
Give some evidence or write down an explanation to tell the examiner why you gave an answer.

Outline
Give only the key facts of the topic. You may need to set out the steps of a procedure or process – make sure you write down the steps in the correct order.

Predict
Look at some data and suggest a realistic value or outcome. You may use a calculation to help. Don't guess – look at trends in the data and use your knowledge of science. (Hint: don't confuse with 'Calculate' or 'Estimate')

Show
Write down the details, steps or calculations needed to prove an answer that you have given.

Suggest
Think about what you've learnt and apply it to a new situation or context. Use what you have learnt to suggest sensible answers to the question.

Write down
Give a short answer, without a supporting argument.

APPENDIX C: DEVELOPING STUDENTS' SKILLS

The following chart has been provided to give guidance on the skills which students will develop during courses leading to GCSE qualifications in the sciences.

It is based on Assessing pupils' progress (APP) at Key Stage 3, produced by The National Strategies and the Qualifications and Curriculum Development Agency (QCDA). In Key Stage 3, APP is a structured approach designed to strengthen classroom assessment, resulting in a clear profile of pupils' achievements across a whole subject.

For teachers that value this approach at Key Stage 3, this chart provides a means of continuing to monitor students' learning in science through Key Stage 4. The five columns in the grid correspond with, and provide continuity from, the Assessment Focuses AF1-5 of APP, but the rows have been referenced to GCSE Low, Standard and High Demand, rather than to National Curriculum Levels.

OCR's intention in producing this chart is to support teachers in gathering formative information on students' skill development, to facilitate curriculum planning and personalised learning.

The assessment of these skills in GCSE qualifications varies according to the specification, and teachers are advised to consult the specifications they have chosen to use for further details.

For further details on the use of APP in Key Stage 3, teachers are advised to consult the following references.
Assessing Pupils' Progress in secondary science at key stage 3: Teachers' handbook (DCSF, 2009a).
Assessing Pupils' Progress in secondary science at key stage 3: Standards files (DCSF, 2009b).
Assessing Pupils' Progress in secondary science at key stage 3:Assessment guidelines (DCSF, 2009c).
Assessing Pupils' Progress (APP) guidance for senior leaders (DCSF, 2009d).
Assessing Pupils' Progress (APP) in Key Stage 3 Science. Rowe, N (NFER 2010).

Developing students' skills to support learning in GCSE sciences

	1 Thinking scientifically	2 Understanding the applications and implications of science	3 Communicating and collaborating in science	4 Using investigative approaches	5 Working critically with evidence
High Demand (Grades A*-B)	**Across a range of contexts and in practical work, students:** • Explain a complex scientific process, using abstract ideas or models • Identify the stages in the development of a scientific theory in terms of the way the evidence base has developed over time alongside the development of new ways of interpreting this evidence • Recognise that confidence increases in provisional scientific explanations if observations match predictions but this does not prove the explanation is correct • Evaluate and critically compare different explanations of scientific evidence, justifying why one scientific explanation is preferred to another • Explain how unexpected observations or results can lead to new developments in the understanding of science	**Across a range of contexts and in practical work, students:** • Explain how the values of society have influenced the development of science and technology • Evaluate the application of science and technology, recognising the need to consider o what society considers right or wrong, and o the ideal that the best decision will have the best outcome for the majority of the people involved • Describe the science skills and knowledge required in jobs or roles which involve undertaking original investigations or research • Analyse personal and social choices related to scientific or technological issues, in terms of a balance of risk and benefit	**Across a range of contexts and in practical work, students:** • Communicate abstract ideas clearly and effectively using explanations, arguments, diagrams, graphs, flow charts, pictures and tables • Collate relevant information/data from an appropriate range of sources to present a structured and coherent analysis • Use specialist terms appropriately and spelling punctuation and grammar correctly to communicate scientific understanding • Evaluate critically the quality of scientific information or a range of views, from different sources, in terms of shortcomings in the explanations, misrepresentation or lack of balance • Explain the value of using teams of scientists to investigate scientific problems	**Across a range of contexts and in practical work, students:** • Suggest a reasoned hypothesis, capable of investigation, which provides a provisional scientific explanation of observed data • Justify the choice of equipment and techniques to collect high quality, valid data • Explain how the investigative approach took account of the variables which could not be readily controlled • Explain how a complex investigation has been planned to minimise error and produce high quality, valid data • Prepare a detailed risk assessment to control risks in a complex, unfamiliar practical task	**Across a range of contexts and in practical work, students:** • Justify improvements to apparatus or techniques, or alternative ways to collect data, and explain the advantages of taking an investigation further • Consider critically the quality and validity of the evidence, identifying anomalies and suggesting scientific explanations for unexpected observations or measurements • Identify complex relationships between variables, including inverse relationships, using several mathematical steps • Use ideas of correlation and cause when analysing data and identify what further work would be needed to establish a causal link • Identify and critically analyse conflicting evidence, or weaknesses in the data, which lead to different interpretations, and explain what further data would help to make the conclusion more secure
Standard Demand (Grades C-D)	**Across a range of contexts and in practical work, students:** • Explain a scientific process, using ideas or models • Explain how a scientific idea has changed as new evidence has been found • Recognise that science explanations are provisional because they only explain the current evidence and that some evidence/observations cannot yet be explained • Describe how scientific evidence supports or refutes different scientific explanations • Describe examples of how scientists plan a series of investigations / make a series of observations in order to develop new scientific explanations	**Across a range of contexts and in practical work, students:** • Explain how the application of science and technology depends on economic, social and cultural factors • Identify some arguments for and against a scientific or technological development, in terms of its impact on different groups of people or the environment • Describe the science used in jobs or roles which involve following complex, standard procedures • Recognise that scientific or technological developments may have benefits and risks, and suggest ways of limiting risks from developments	**Across a range of contexts and in practical work, students:** • Communicate qualitative or quantitative information/data, using a clear structure and appropriate visual material • Combine information/data from a limited range of sources to present a clear analysis • Use specialist terms and clear language to communicate scientific understanding • Explain how claims/opinions are based on scientific evidence • Explain how publishing results through scientific conferences and publications enables results to be replicated and further evidence to be collected	**Across a range of contexts and in practical work, students:** • Suggest a hypothesis which provides a limited provisional scientific explanation of observed data • Select techniques and equipment which are appropriate for the ranges of variables, numbers of replicates and values, for the measurements and observations to be taken • Use an investigative approach based on an understanding of the experimental independent and dependent variables • Explain how a straightforward investigation has been planned to minimise error and produce good quality data • Consult appropriate resources to control risks in unfamiliar practical tasks	**Across a range of contexts and in practical work, students:** • Evaluate methodology or apparatus used and suggest improvements • Use the general pattern of results or degree of scatter between repeats to assess the quality of the evidence and decide the extent to which a conclusion can be supported • Select the most appropriate format for presenting data and process data using mathematical techniques, such as statistical methods or calculating the gradients of graphs, to identify trends or patterns • Explain why an observed correlation between a factor and an outcome does not necessarily mean that the factor causes the outcome • Determine the level of confidence in a conclusion based on the identification of a qualitative relationship between variables and describe how further predictions can lead to more evidence being obtained
Low Demand (Grades E-G)	**Across a range of contexts and in practical work, students:** • Describe a simple scientific idea using a simple model • Recognise that scientific explanations are o used to explain observations o tested by collecting data/evidence • Recognise that science explanations are provisional but more convincing if there is more evidence to support them • Identify two different scientific views or explanations of scientific data • Describe examples of how scientists use a scientific idea to explain experimental observations or results	**Across a range of contexts and in practical work, students:** • Identify different views that might be held regarding a scientific or technological development • Identify how a scientific or technological development could affect different groups of people or the environment • Identify the science used in jobs or roles which involve following simple, standard procedures • Describe risks from scientific or technological developments	**Across a range of contexts and in practical work, students:** • Present scientific data in an appropriate format • Combine and present information/data from two different sources • Make limited use of specialist terms to communicate scientific ideas • Distinguish between claims/opinions and scientific evidence in sources • Recognise the importance of the peer review process in which scientists check each other's work	**Across a range of contexts and in practical work, students:** • Suggest a hypothesis or prediction which is relevant to observed data • Select and use equipment to collect a limited amount of data to investigate a specific question or idea • Explain how variables have been controlled to produce a "fair test" • Describe how a routine task has been carried out in terms of repeating observations/ measurements and the ranges/intervals chosen • Control risks in familiar practical tasks	**Across a range of contexts and in practical work, students:** • Suggest and explain how working methods could be improved • Link simply the quality of measurements/ observations with the limitations of the experimental method • Present data as tables, pie charts or line graphs, identify trends in the data, and process data using simple statistical methods, such as calculating a mean • Identify the correlation between a factor and an outcome • Explain how a conclusion is based on the scientific evidence which has been collected

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