Understanding Science Assessment in England

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Session overview

- Secondary assessment in England: who does what and when?
- Structure of science assessments at GCSE and A-level
- Assessment of practical skills
- Resources available

Secondary assessment in England

Secondary assessment in England

How is the Secondary Educational system structured in England?

When and what are the assessments in the English educational system?

What is the role of the DfE?

Who is Ofqual, and how is their role different from the DfE's?

What are the three main awarding bodies in England?

Educational system in England

	Year / Class	Key Stage	Age
Secondary School	Years 7-9	Key Stage 3	11-14
	Years 10-11	Key Stage 4	14-16
6th Form	Years 12-13	Key Stage 5	16-18

Typically 8-11 GCSE subjects

Typically 3 A Level subjects

Science subject reforms in England

2011 - Introduction of the English Baccalaureate (EBacc): The EBacc became a performance measure for schools, encouraging students to take a core set of academic subjects at GCSE level, including sciences. This led to an increase in the number of students studying science subjects at GCSE.

2014 - Introduction of the New National Curriculum: The National Curriculum for science was revised, with a focus on developing a deeper understanding of scientific concepts and principles. The curriculum emphasised scientific knowledge, practical skills, and the application of science in real-world contexts.

2015 - A level reforms: Significant reforms were made to Science qualifications, including changes to content, assessment structure, and grading criteria for science subjects including the introduction of the Science Practical Endorsement. This aimed to ensure that students develop essential practical skills during their science studies.

2016 – GCSE reforms: Significant reforms were made to Science qualifications, including changes to content, assessment structure, and grading criteria for science subjects.

The role of the DfE

The Department for Education (DfE)

'… is responsible for children's services and education, including higher and further education policy, apprenticeships and wider skills in England.'

Has overall responsibility for setting national policy with regard to education:

- National Curriculum (Key Stages 1–4)
- Types of qualifications (GCSEs, A-levels, Technical Awards etc) including subjects
- Subject content

The DfE subject content

- **The DfE specify the minimum content that must be in a subject specification (the subject content).**
- **For GCSE science the subject content:**
    - overlaps with the Science Programme of Study (KS1-4)
    - provides continuity and progression to AS/A-level
- **The GCSE and A-level sciences subject content was produced in consultation with Ofqual, all four awarding organisations and key stakeholders (ASE, RSB, RSC, IOP)**
- **Any organisation wishing to produce a GCSE or A-level science qualification which is recognised for performance table points:**
    - must use the DfE subject content and
    - must have the qualification accredited by Ofqual.

Regulation: the role of Ofqual

Sets the assessment criteria for qualifications (eg the types and duration of assessment – exam papers, NEA, etc)

Regulates the day-to-day activity of the awarding bodies:

- Awarding and standards
- Malpractice
- Ensures that what we are telling centres is fair and equitable
- Conflicts of interest (eg examiners who write textbooks / teachers who write assessments)

GCSE and A-level awarding bodies in England

AQA

Pearson | Edexcel

OCR
Oxford Cambridge and RSA

Role of the awarding bodies

- Produce the specifications for each qualification using the DfE subject content.
- Provide summative assessment for the specifications.
- Write the assessments to the criteria set by Ofqual (eg types, levels of demand, minimum length of assessment).
- Provide valid and reliable assessments that can differentiate students within a cohort, while maintaining standards from one year to the next.
- Award grades that maintain standards year on year.
- Issue certificates.
- Deal with special considerations.

Structure of science assessments at GCSE and A-level

AQA - Science for all: 16 specifications

Entry Level Certificate	GCSE	AS level	A-level	Level 3 Applied General Science
Single award 5961	Biology 8461	Biology 7401	Biology 7402	Certificate 1776
Double award 5962	Chemistry 8462	Chemistry 7404	Chemistry 7405	Extended Certificate 1777
	Physics 8463	Physics 7407	Physics 7408	
	Combined Science: Synergy 8465		Environmental Science 7447	
	Combined Science: Trilogy 8464			

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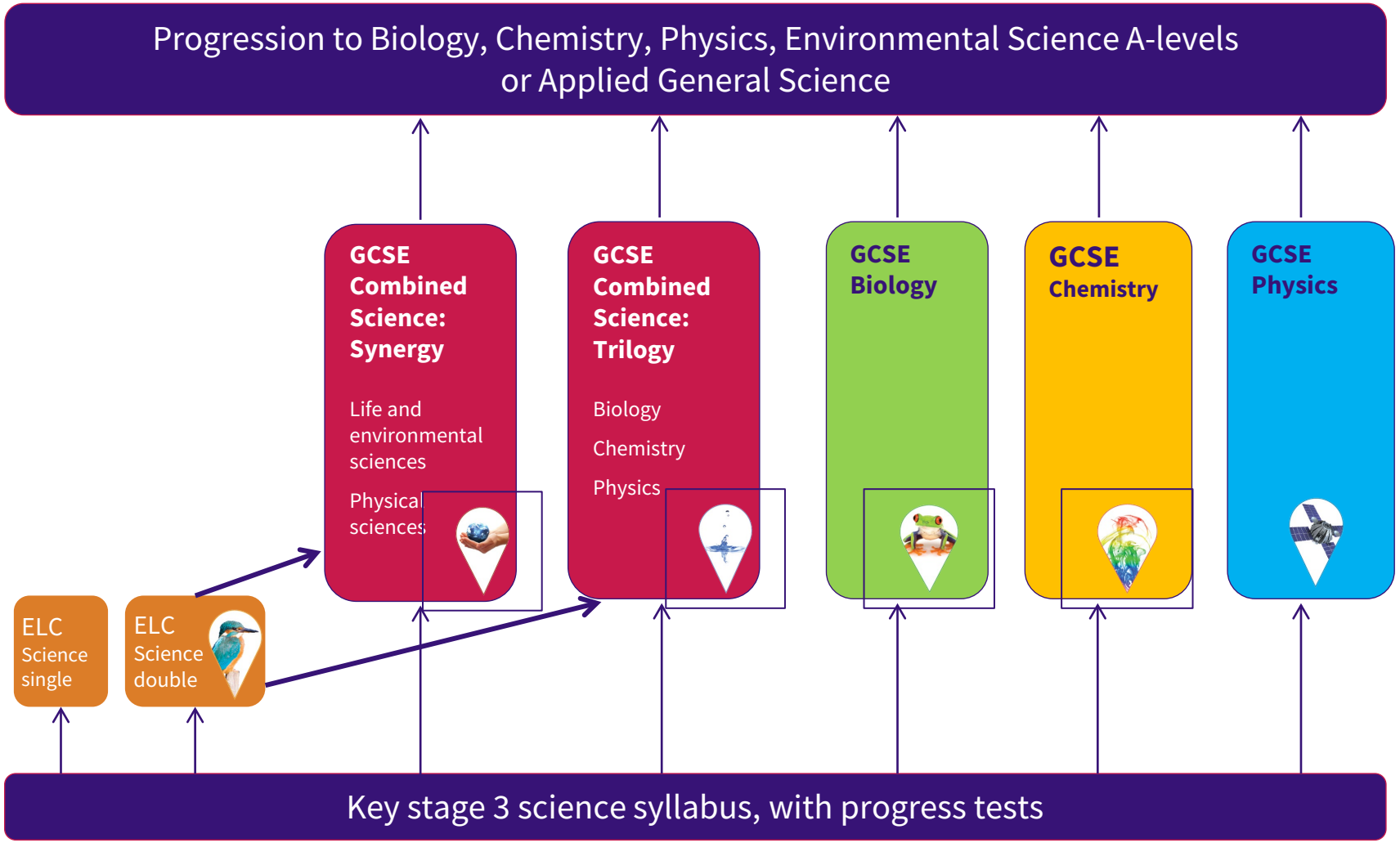
Transition from KS3, choice at KS4, and progression



Grading systems in England

Old grades	New grades
A*	9
	8
A	7
B	6
	5 Strong Pass
C	4 Standard Pass
D	3
E	2
F	1
G	
U	U

New GCSE grading system first used in 2017

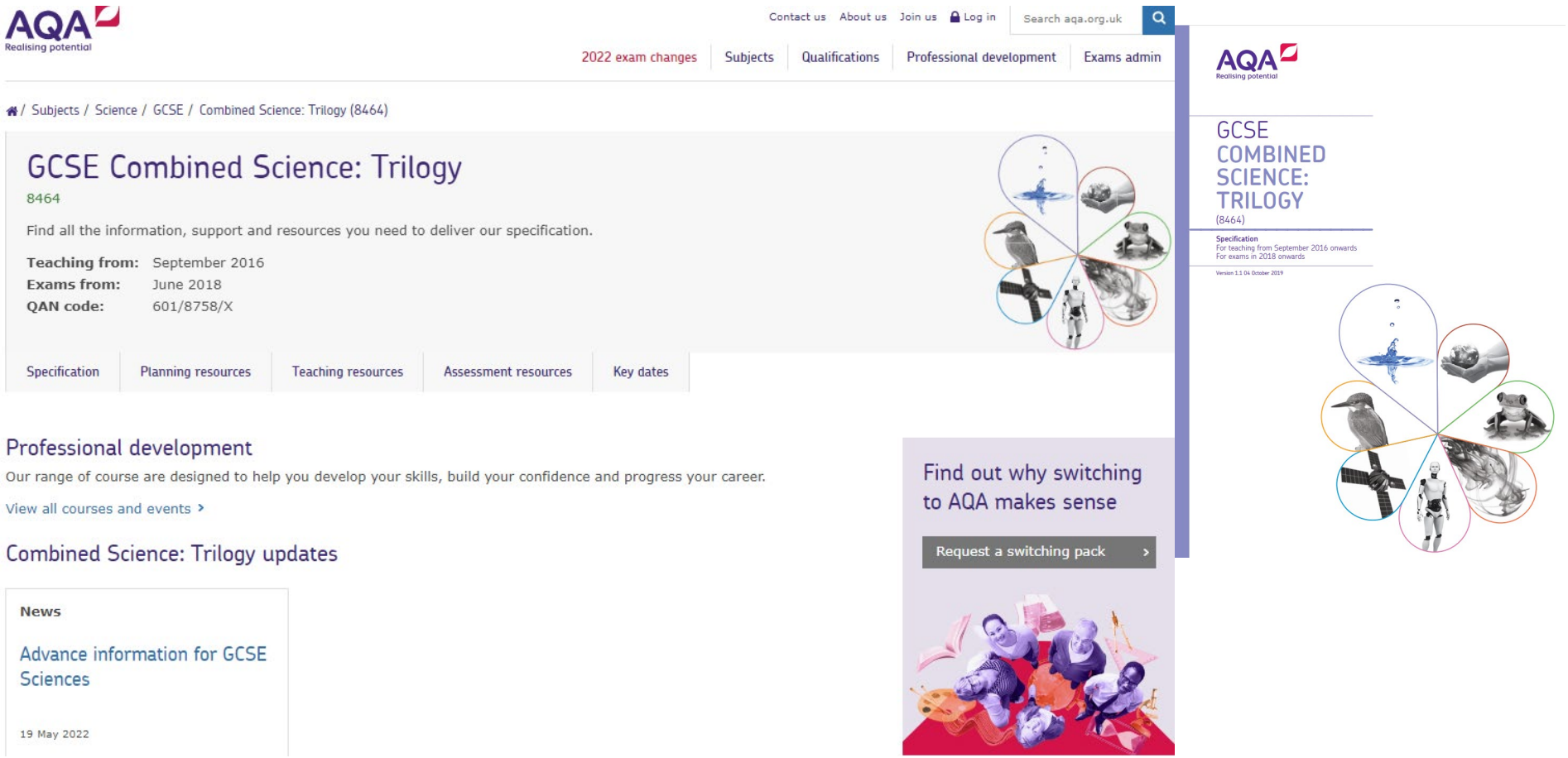
AS Level	A Level	UCAS Points
–	A*	56
–	A	48
–	B	40
–	C	32
–	D	24
A	–	20
B	E	16
C	–	12
D	–	10
E	–	6

GCSE sciences: summary

- **Five specifications – Biology, Chemistry, Physics, Combined Science: Trilogy, Combined Science: Synergy**
- **All courses are linear.**
- **Combined Science: Trilogy and Combined Science: Synergy both cover the DfE subject criteria but are set out and assessed differently.**
- **All specifications available at Foundation or Higher Tier.**
- **All assessment by external exam.**
- **Required practicals for each specification.**
- **Assessments available in May / June only.**
- **Biology, Chemistry Physics graded 9 to 1.**
- **Combined Science is a Double award graded 9-9 to 1-1.**

Trilogy (8464) Specification / Syllabus

https://filestore.aqa.org.uk/resources/science/specifications/AQA-8464-SP-2016.PDF



Contents

Are you using the latest version of this specification?

- You will always find the most up-to-date version of this specification on our website at aqa.org.uk/8464
- We will write to you if there are significant changes to the specification.

AOs, Maths, ATs and working scientifically

Regardless of the GCSE specification:

- 40% of marks assess AO1 (recall of knowledge and understanding)
- 40% assess AO2 (application of knowledge and understanding)
- 20% assess AO3 (analysis and evaluation).

Maths skills to be assessed in science (10% of marks in Biology, 20% in Chemistry, 30% in Physics, 20% in Combined Science) are listed in the back of each specification.

- Foundation tier: maths demand no lower than KS3
- Higher tier: maths demand no lower than Foundation tier GCSE maths.

At least 15% of marks assess the practical skills criteria (the ATs) listed in the back of the specification.

Working scientifically skills are listed at the front of each specification. Most questions will assess one or more aspects of WS.

Working scientifically

1 Development of scientific thinking

Students should be able to:	Examples of what students could be asked to do in an exam
WS 1.1 Understand how scientific methods and theories develop over time.	Give examples to show how scientific methods and theories have changed over time.

2 Experimental skills and strategies

Students should be able to:	Examples of what students could be asked to do in an exam
WS 2.1 Use scientific theories and explanations to develop hypotheses.	Suggest a hypothesis to explain given observations or data.

3 Analysis and evaluation

WS 3.6 Presenting reasoned explanations including relating data to hypotheses.	Comment on the extent to which data is consistent with a given hypothesis. Identify which of two or more hypotheses provides a better explanation of data in a given context.

4 Scientific vocabulary, quantities, units, symbols and nomenclature

Students should be able to:	Examples of what students could be asked to do in an exam
WS 4.1 Use scientific vocabulary, terminology and definitions. WS 4.2 Recognise the importance of scientific quantities and understand how they are determined.	The knowledge and skills in this section apply across the specification, including the required practicals.

Practical assessment

10 Practical assessment

Practical work is at the heart of science, so we have placed it at the heart of this specification.

There are three interconnected, but separate reasons for doing practical work in schools. They are:

1. To support and consolidate scientific concepts (knowledge and understanding).

   This is done by applying and developing what is known and understood of abstract ideas and models. Through practical work we are able to make sense of new information and observations, and provide insights into the development of scientific thinking.
2. To develop investigative skills. These transferable skills include:
   - devising and investigating testable questions
   - identifying and controlling variables
   - analysing, interpreting and evaluating data.
3. To build and master practical skills such as:
   - using specialist equipment to take measurements
   - handling and manipulating equipment with confidence and fluency
   - recognising hazards and planning how to minimise risk.

By focusing on the reasons for carrying out a particular practical, teachers will help their students understand the subject better, to develop the skills of a scientist and to master the manipulative skills required for further study or jobs in STEM subjects.

Questions in the written exams will draw on the knowledge and understanding students have gained by carrying out the practical activities listed below. These questions will count for at least 15% of the overall marks for the qualification. Many of our questions will also focus on investigative skills and how well students can apply what they know to practical situations often in novel contexts.

The practical handbook will help teachers plan purposeful practical work that develops both practical and investigative skills and encourages the thinking behind the doing so that they can reach their potential.

Teachers are encouraged to further develop students' abilities by providing other opportunities for practical work throughout the course. Opportunities are signposted in the right-hand column of the content section of this specification for further skills development.

Our Combined Science: Trilogy scheme of work will provide ideas and suggestions for good practical activities that are manageable with large classes.

10.1 Use of apparatus and techniques

All students are expected to have carried out the required practical activities in Required practical activities (page 175). The following list includes opportunities for choice and use of appropriate laboratory apparatus for a variety of experimental problem-solving and/or enquiry-based activities.

Safety is an overriding requirement for all practical work. Schools and colleges are responsible for ensuring that appropriate safety procedures are followed whenever their students undertake practical work, and should undertake full risk assessments.

Use and production of appropriate scientific diagrams to set up and record apparatus and procedures used in practical work is common to all science subjects and should be included wherever appropriate.

10.1.1 Biology

	Apparatus and techniques
AT 1	Use of appropriate apparatus to make and record a range of measurements accurately, including length, area, mass, time, temperature, volume of liquids and gases, and pH (links to A-level AT a).
AT 2	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater (links to A-level AT a).
AT 3	Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes.
AT 4	Safe and ethical use of living organisms (plants or animals) to measure physiological functions and responses to the environment (links to A-level AT h).
AT 5	Measurement of rates of reaction by a variety of methods including production of gas, uptake of water and colour change of indicator.
AT 6	Application of appropriate sampling techniques to investigate the distribution and abundance of organisms in an ecosystem via direct use in the field (links to A-level AT k).
AT 7	Use of appropriate apparatus, techniques and magnification, including microscopes, to make observations of biological specimens and produce labelled scientific drawings (links to A-level AT d and e).

10.1.2 Chemistry

	Apparatus and techniques
AT 1	Use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature, and volume of liquids and gases (links to A-level AT a).
AT 2	Safe use of appropriate heating devices and techniques including use of a Bunsen burner and a water bath or electric heater (links to A-level AT b).
AT 3	Use of appropriate apparatus and techniques for conducting and monitoring chemical reactions, including appropriate reagents and/or techniques for the measurement of pH in different situations (links to A-level AT a and d).
AT 4	Safe use of a range of equipment to purify and/or separate chemical mixtures including evaporation, filtration, crystallisation, chromatography and distillation (links to A-level AT d and g).
AT 5	Making and recording of appropriate observations during chemical reactions including changes in temperature and the measurement of rates of reaction by a variety of methods such as production of gas and colour change (links to A-level AT a and l).
AT 6	Safe use and careful handling of gases, liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes and/or products (links to A-level AT a and k).

Maths

9 Mathematical requirements

Students will be required to demonstrate the following mathematics skills in GCSE Combined Science assessments.

Questions will target maths skills at a level of demand appropriate to each subject. In Foundation Tier papers questions assessing maths requirements will not be lower than that expected at Key Stage 3 (as outlined in *Mathematics programmes of study: Key Stage 3* by the DfE, document reference DFE-00179-2013). In Higher Tier papers questions assessing maths requirements will not be lower than that of questions and tasks in assessments for the Foundation Tier in a GCSE Qualification in Mathematics.

1	Arithmetic and numerical computation
a	Recognise and use expressions in decimal form
b	Recognise and use expressions in standard form
c	Use ratios, fractions and percentages
d	Make estimates of the results of simple calculations

2	Handling data
a	Use an appropriate number of significant figures
b	Find arithmetic means
c	Construct and interpret frequency tables and diagrams, bar charts and histograms
d	Understand the principles of sampling as applied to scientific data (biology questions only)
e	Understand simple probability (biology questions only)
f	Understand the terms mean, mode and median
g	Use a scatter diagram to identify a correlation between two variables (biology and physics questions only)
h	Make order of magnitude calculations

3	Algebra
a	Understand and use the symbols: =, <, <<, >>, >, ∝ , ~
b	Change the subject of an equation
c	Substitute numerical values into algebraic equations using appropriate units for physical quantities (chemistry and physics questions only)
d	Solve simple algebraic equations (biology and physics questions only)

4	Graphs
a	Translate information between graphical and numeric form
b	Understand that $y = mx + c$ represents a linear relationship

4	Graphs
c	Plot two variables from experimental or other data
d	Determine the slope and intercept of a linear graph
e	Draw and use the slope of a tangent to a curve as a measure of rate of change (chemistry and physics questions only)
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate (physics questions only)

5	Geometry and trigonometry
a	Use angular measures in degrees (physics questions only)
b	Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects (chemistry and physics questions only)
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes

Mathematical skills references are taken from the DfE subject criteria.

Layout of specifications: A-levels and most GCSEs

3.4.1.5 Newton's laws of motion

Content	Opportunities for skills development
Knowledge and application of the three laws of motion in appropriate situations. $F = ma$ for situations where the mass is constant.	**PS 4.1 / MS 0.5, 3.2 / AT a, b, d** Students can verify Newton's second law of motion. **MS 4.1, 4.2** Students can use free-body diagrams.

Left-hand side: Content.
Everything on this side can be assessed in question papers.

Required practicals are here also.

Right-hand side: Opportunities for skills development.

Shows where teachers could introduce:
AT – apparatus and techniques
MS – mathematical skills
PS – practical skills (A-levels)
WS – working scientifically (GCSEs).

The numbers reference specific skills in these separate sections of the specification.

Specification: at a glance

Content	Key opportunities for skills development
The resistance of a thermistor decreases as the temperature increases. The applications of thermistors in circuits eg a thermostat is required. The resistance of an LDR decreases as light intensity increases.	
The application of LDRs in circuits eg switching lights on when it gets dark is required. Students should be able to:	WS 1.2, 1.4
• explain the design and use of a circuit to measure the resistance of a component by measuring the current through, and potential difference across, the component • draw an appropriate circuit diagram using correct circuit symbols.	AT 6 Investigate the relationship between the resistance of a thermistor and temperature. Investigate the relationship between the resistance of an LDR and light intensity.
Students should be able to use graphs to explore whether circuit elements are linear or non-linear and relate the curves produced to their function and properties.	WS 1.2, 1.4 MS 4c, 4d, 4e

Required practical activity 16: use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements, including a filament lamp, a diode and a resistor at constant temperature.

AT skills covered by this practical activity: physics AT 6 and 7.

This practical activity also provides opportunities to develop WS and MS. Details of all skills are given in Key opportunities for skills development (page 186).

6.2.2 Series and parallel circuits

Content	Key opportunities for skills development
There are two ways of joining electrical components, in series and in parallel. Some circuits include both series and parallel parts. For components connected in series: • there is the same current through each component • the total potential difference of the power supply is shared between the components • the total resistance of two components is the sum of the resistance of each component.	

Content	Key opportunities for skills development
$R_{Total} = R_1 + R_2$ resistance, R, in ohms, Ω For components connected in parallel: • the potential difference across each component is the same • the total current through the whole circuit is the sum of the currents through the separate components • the total resistance of two resistors is less than the resistance of the smallest individual resistor. Students should be able to:	MS 1c, 3b, 3c, 3d
• use circuit diagrams to construct and check series and parallel circuits that include a variety of common circuit components • describe the difference between series and parallel circuits • explain qualitatively why adding resistors in series increases the total resistance whilst adding resistors in parallel decreases the total resistance	AT 7
• explain the design and use of dc series circuits for measurement and testing purposes	WS 1.4
• calculate the currents, potential differences and resistances in dc series circuits • solve problems for circuits which include resistors in series using the concept of equivalent resistance. Students are **not** required to calculate the total resistance of two resistors joined in parallel.	MS 1c, 3b, c, d

6.2.3 Domestic uses and safety

6.2.3.1 Direct and alternating potential difference

Content	Key opportunities for skills development
Mains electricity is an ac supply. In the United Kingdom the domestic electricity supply has a frequency of 50 Hz and is about 230 V. Students should be able to explain the difference between direct and alternating potential difference.	

GCSE assessments: timing and marks

Specification	Total assessment time (hours)	Number and length of papers	Marks for practical	Marks for maths
Biology	3½ each	2 × 1¾ hours, each 100 marks equal weighting	15%	10%
Chemistry				20%
Physics				30%
Combined Science: Trilogy	7½	6 × 1¼ hours 2 biology 2 chemistry 2 physics each 70 marks equal weighting	15%	20% in the ratio 1:2:3 biology: chemistry: physics
Combined Science: Synergy	7	4 × 1¾ hours each 100 marks equal weighting	15%	20% in the ratio 1:2:3 biology: chemistry: physics

Exam papers: GCSE Trilogy (Double award)

Biology Paper 1		
What's assessed Biology topics 1–4: Cell Biology; Organisation; Infection and response; and Bioenergetics.	Atomic structure and the periodic table; Bonding, structure, and the antitative chemistry; Chemical changes; and Energy changes.	lectricity; Particle model of matter; and Atomic structure.
How it's assessed • Written exam: 1 hour 15 minutes • Foundation and Higher Tier • 70 marks • 16.7% of GCSE	ur 15 minutes gher Tier	inutes er
Questions Multiple choice, structured, closed short answer, and open response.	ed, closed short answer, and open response.	ed short answer, and open response.

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Biology Paper 2		
What's assessed Biology topics 5–7: Homeostasis and response; Inheritance, variation and evolution; and Ecology.	The rate and extent of chemical change; Organic chemistry; Chemical e atmosphere; and Using resources. ay draw on fundamental concepts and principles from Sections 5.1 to 5.3.	Waves; and Magnetism and electromagnetism
How it's assessed • Written exam: 1 hour 15 minutes • Foundation and Higher Tier • 70 marks • 16.7% of GCSE	ur 15 minutes gher Tier	inutes er
Questions Multiple choice, structured, closed short answer, and open response.	ed, closed short answer, and open response.	ed short answer, and open response.

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GCSE assessments: content covered

Specification	Content covered in each paper	Extra information
Biology	Paper 1 Topics 1–4 Paper 2 Topics 5–7	Understanding of some fundamental principles may be assessed in either paper
Chemistry	Paper 1 Topics 1–5 Paper 2 Topics 6–10	Some content in Topics 1–3 also assessed in Paper 2
Physics	Paper 1 Topics 1–4 Paper 2 Topics 5–8	Questions in Paper 2 may draw on understanding from Topics 1 and 2
Combined Science: Trilogy	Papers 1 and 2 Biology Papers 3 and 4 Chemistry Papers 5 and 6 Physics	Content split in the same way as separates
Combined Science: Synergy	Papers 1 and 2 Life and environmental sciences Papers 3 and 4 Physical sciences	Papers split by skill: Papers 1 and 3 more AO1 and AO2 Papers 2 and 4 more AO3 and practical skills

Structure of the GCSE assessments

Questions are made up of several ‘items’

Each question covers an area of science. The stem introduces it.

Papers are ramped and tiered

Common questions make up 30% of marks

Demand	Target grades	% marks	Tier
Low	1 - 3	60%	Foundation
Standard	4 - 5	40%	Foundation
Standard	4 - 5	40%	Higher
High	6 - 9	60%	Higher

Types of questions

Different question types

- **Multiple choice, link boxes: 1 or 2 marks**
- **Short answer: 1–3 marks**
- **Calculations: 1–4 marks (compensatory marks)**
- **Extended response:**
  - 4–6 marks (levels of response mark scheme)
- **Multistep calculation: 4–6 marks**
- **Graphs: generally 3 marks (plots, axis, scale, line of best fit)**
- **Diagrams**

Questions cover several AOs

Tiering and grading

All GCSE sciences available at Foundation and Higher tier.

Can sit different qualifications at different tiers, but must sit the same tier for all papers within a qualification.

Separate sciences graded on 9-point scale (9 to 1).

Combined science graded on a 17-point scale:

- either two numbers the same (9-9, 8-8, 7-7, 6-6, 5-5, 4-4, 3-3, 2-2, 1-1)
- or one number different (9-8, 8-7, 7-6, 6-5, 5-4, 4-3, 3-2, 2-1).

Foundation tier grades 5 to 1 (Combined science 5-5 to 1-1).

Higher tier grades 9 to 4 (Combined science 9-9 to 4-4).

Higher tier 'Safety net' Grade 3 (Combined science Grade 4-3).

Overlap at grades 4 and 5: common questions.

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Required practical activities (RPAs)

RPAs are embedded in the specification content and listed separately in the back of the specification, along with the Apparatus and Techniques (AT) criteria.

All schools have to do the RPAs to ensure that all students cover the AT criteria laid down by Ofqual for each subject.

There are 21 RPAs for Combined Science. They are the same for both Synergy and Trilogy.

The RPAs for the separate sciences are the same as for the Combined ones, plus some extras:

- GCSE Biology, 3 extras are biology only (10 in total)
- GCSE Chemistry 2 extras are chemistry only (8 in total)
- GCSE Physics 2 extras are physics only (10 in total)

Suggested methods are given in the practical handbooks – but teachers should choose a method that is appropriate to their circumstances.

Subject	Number of RPAs
Combined Science	7+6+8 =21
Biology	7+3=10
Chemistry	6+2=8
Physics	8+2=10

A-level sciences: summary

- Both (AS and A-level) courses are linear
- AS and A-level content overlap for co-teaching
- Graded A* to E
- All assessment by external exam
- Assessments available in June only
- Biology, Chemistry and Physics have practical endorsement (a grade on certificate)
- Assessment model different for all three sciences
- Environmental Science has requirement for 4 days fieldwork

A-levels: assessments

	AS	A-level
Total assessment time (hours)	3	6
Number of papers (B, C, P)	2 (2 × 1½ h)	3 (3 × 2 h)
Number of papers (Environmental Science)		2 × 3 h
Practical endorsement (B, C, P only, not Environmental Science)	No	Yes
Marks for practical	15% of total	15% of total
Marks for maths	Biology 10%, Chemistry 20%, Physics 40%, Environmental Science 10%	

There is no AS qualification for Environmental Science

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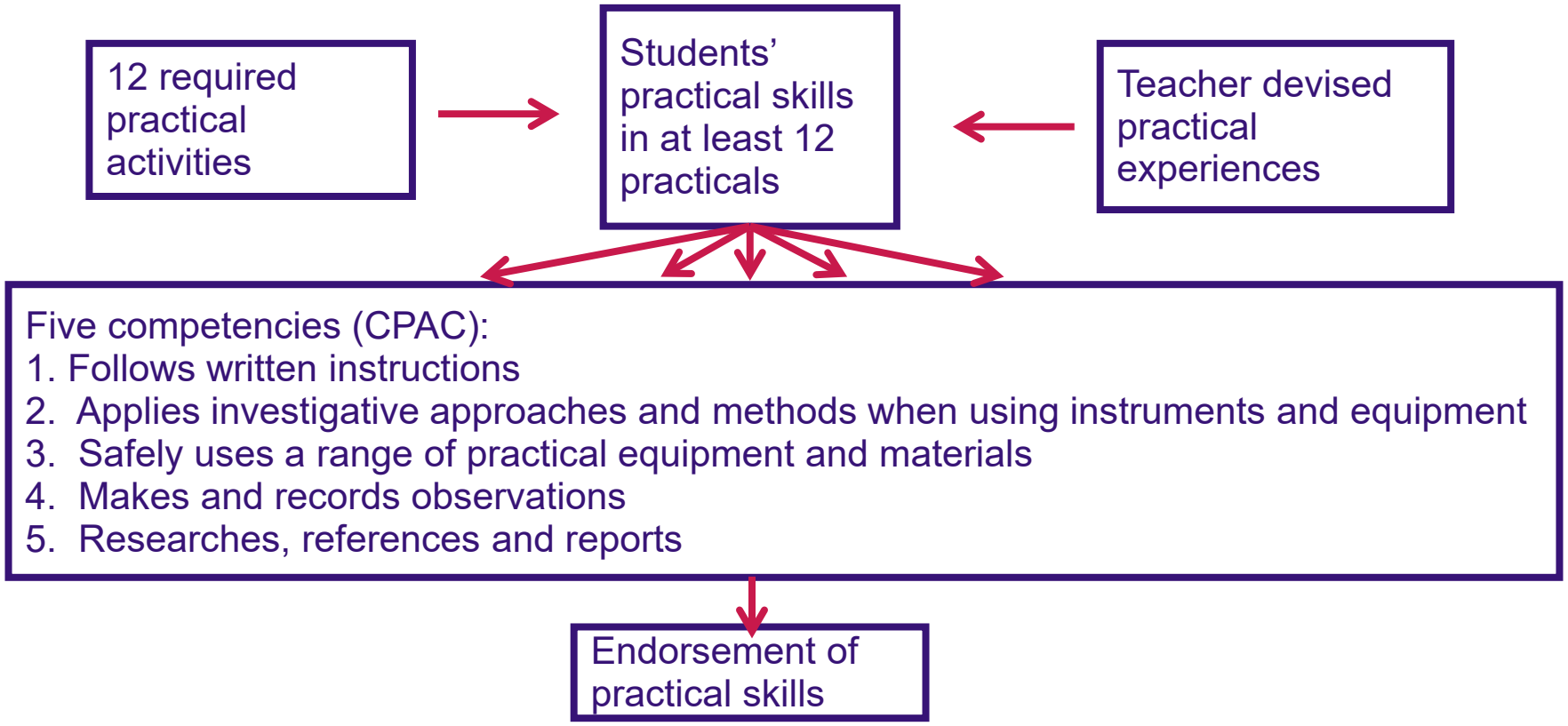
A-level practical work: Biology / Chemistry / Physics summary

- 12 Required Practicals for each subject: 6 AS and 6 A-level.
- Practicals written to ensure the Apparatus and Techniques (AT) criteria are covered.
- AT criteria listed at the back of the specification.
- Practical knowledge and understanding is assessed on the exam papers.
- At least 15% of marks for the qualification based on practical work.
- Students' practical abilities assessed by teachers through five competencies (CPAC), leading to endorsement (A-level only, not AS).
- Guidance for teachers on website (eg Biology: AQA | AS and A-level | Biology | Teaching resources).

Assessment for endorsement (A-level only)

Teacher assesses students' abilities in practical work through a set of competencies (CPAC). Holistic judgement throughout the 2-year course. A pass will be recorded on the student's certificate.



Evidence required for endorsement

- **Lead teachers must complete online practical endorsement training and cascade information to team. The certificate as proof of training is required.**
- **Documented plans to carry out sufficient practicals.**
- **A record of each practical activity and the date it was completed.**
- **A record of the criteria being assessed in that practical activity.**
- **A record of student attendance.**
- **A record of which students met the criteria and which did not.**
- **Student work showing evidence required for the particular task, with date.**
- **Any associated material provided for the practical activity, eg written instructions.**
- **https://www.aqa.org.uk/resources/science/as-and-a-level/teach/practicals**

Assessment of practical skills

Practical assessment: GCSE

GCSE Science prior to 2016 revisions

Students sat examination papers which accounted, in total, for 75 per cent of their marks for the GCSE qualification.

The remaining 25 per cent of the marks were determined by their performance in controlled assessment. This was made up of a report or evaluation of data from a practical activity set by the exam board and carried out under controlled conditions. At a minimum, a student would need to complete only one such activity to achieve a GCSE science qualification.

AQA **Controlled Assessment Method sheet**

Science A - BU1.2 Energy from Food

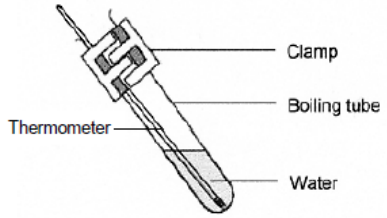
This method could be used to investigate the following hypothesis;

'The energy content of food depends upon the proportion of fat in the food.'

You will need to prepare a table for the results.

Equipment:

Several types of 'crisp' and/or cracker (e.g. corn, rice and potato based)
Information about the fat content of the foods used, from the packet
Metal tongs
Bunsen burner
Boiling tube
Measuring cylinder (to measure 20cm^3)
Clamp stand
Thermometer
Balance
Water
Heat resistant mat



Method:

1. Measure 20cm^3 of cold water into a boiling tube.
2. Clamp the tube carefully, at an angle (see diagram), about 30cm above the bench surface.
3. Measure and record the initial temperature of the water.
4. Weigh a piece of one of the foods.
5. Grip the food with the tongs and hold it in a hot Bunsen burner flame until it ignites.
6. Hold the burning food about 2cm underneath the tube of water.
   If the flame goes out, try to reignite the food in the Bunsen burner flame.
7. When the food has finished burning, measure and record the final temperature of the water.
8. Repeat with other foods, using cold water each time.
9. Record the fat content of the foods you used, from the information provided.

Practical assessment: GCSE

Problems with GCSE science assessment prior to 2016 revisions

Scientists agree that practical work is central to good school science and that science GCSEs should require it. The problem is how to make sure students get sufficient and stimulating experience of it, and then how best to assess it when so much rides on results, for students and for schools.

It has long been recognised that assessment drives teaching and learning, but assessment has led to a narrowing of the curriculum. It is important to have reliable assessment in a high-stakes environment. We do not have the evidence that practical science work can be assessed reliably enough by marked non-exam assessment, particularly if marks for direct assessment of practical skills are included in grades, given other pressures on schools.[1]

Consultation on the Assessment of Practical Work in GCSE Science (2014): Ofqual

Practical assessment: GCSE

Outcome of consultation

Responses from across the respondent groups were against the idea that teachers directly assess science practicals (67 per cent) due to this being unmanageable for qualifications of this type. Respondents stated that direct assessment is impractical and that the time it takes to adequately assess makes it impossible for a qualification the size of a GCSE and given the student numbers involved. In addition, a number of responses stated that if teachers directly assessed the practicals there is potential for the pressures of the accountability system to place them in an unmanageable position (where they are acting as the assessor and being judged themselves through the outcomes of the assessments they make), as found currently in controlled assessments.

There was strong agreement with the proposal to assess practical work via questions in the exam; 80 per cent of the standard-format responses approved of the proposal. Most of the comments from respondents stated that the proposal will ensure teachers provide a range of opportunities to conduct practical work and will raise students' motivation and interest in science. Overall, teachers were supportive, reiterating that these proposals would reduce the pressures they faced with controlled assessment, giving them independence to teach and offer a range of practicals.[2]

Assessment of Practical Work in GCSE Science: Analysis of Consultation Responses (2015) Ofqual /15/5624

Practical assessment: GCSE

Practical work is at the heart of science. There are three interconnected, but separate reasons for doing practical work in schools. They are:

1. **To support and consolidate scientific concepts (knowledge and understanding).**

- This is done by applying and developing what is known and understood of abstract ideas and models. Through practical work we are able to make sense of new information and observations and provide insights into the development of scientific thinking.

2. **To develop investigative skills. These transferable skills include:**

- devising and investigating testable questions
- identifying and controlling variables
- analysing, interpreting and evaluating data.

3. **To build and master practical skills such as:**

- using specialist equipment to take measurements
- handling and manipulating equipment with confidence and fluency
- recognising hazards and planning how to minimise risk.

Practical assessment: GCSE

Revision for 2016

Questions in the written exams will draw on the knowledge and understanding students have gained by carrying out the practical activities listed below.

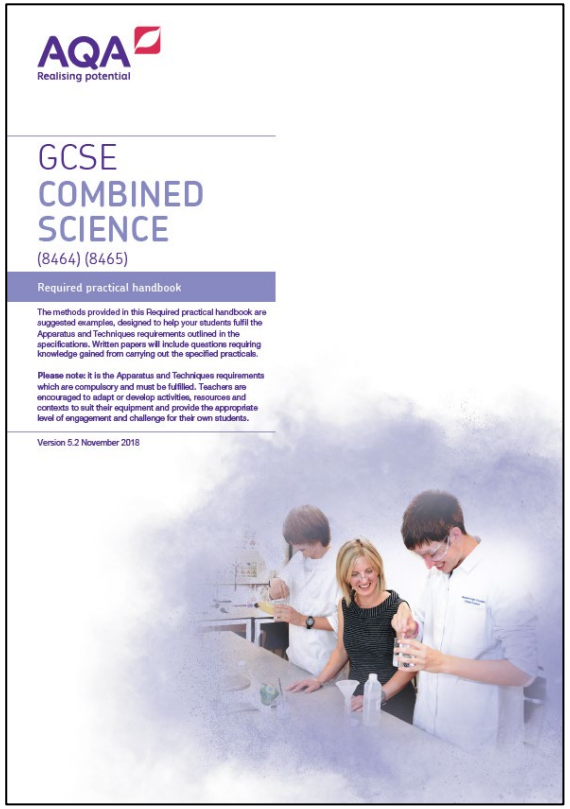
These questions will count for at least **15%** of the overall marks for the qualification.

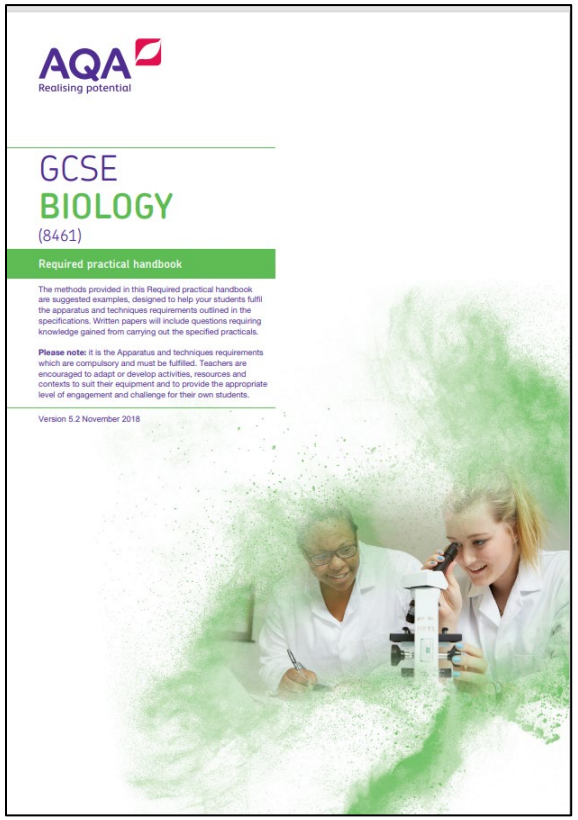
Many of our questions will also focus on investigative skills and how well students can apply what they know to practical situations often in novel contexts.

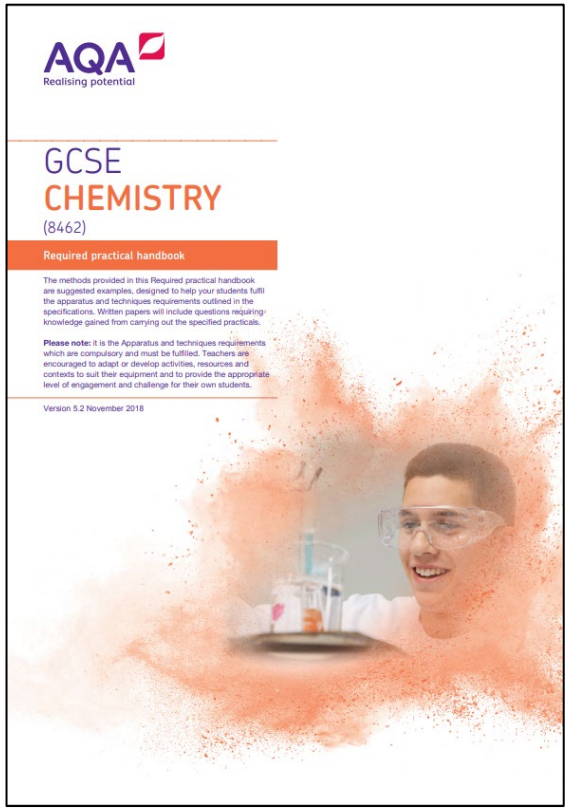
Practical assessment: GCSE required practicals

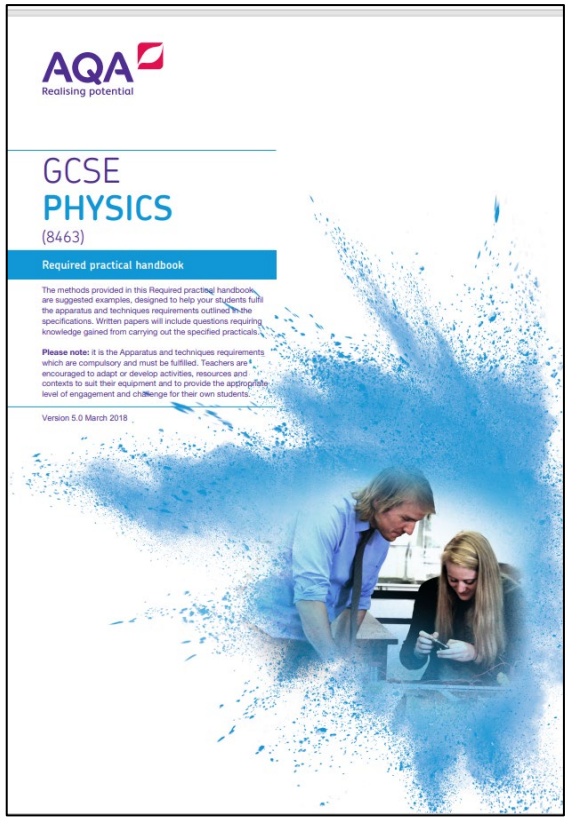
Biology	Chemistry	Physics
Microscopy - Use a light microscope to observe, draw and label biological specimens.	**Water purification** - Analysis and purification of water samples from different sources. To include pH measurement, removal of dissolved solids and distillation.	**Specific heat capacity** – An investigation to determine the specific heat capacity of one or more materials.
Osmosis - Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.	**Temperature changes** - Investigate the variables that affect temperature change in chemical reactions eg acid plus alkali.	**Resistance** - Use circuit diagrams to set up and check appropriate circuits to investigate the factors that affect the resistance of an electrical circuit.
Enzymes - Investigate the effect of pH on the rate of reaction of amylase enzyme.	**Rates of reaction** - Investigate how changes in concentration affect the rates of reactions by both measuring the volume of a gas produced and monitoring a change in colour or turbidity.	**I-V characteristics** - Use circuit diagrams to construct appropriate circuits to investigate the I–V characteristics of a variety of circuit elements including a filament lamp, a resistor and a diode at constant temperature.
Food tests - Use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars, iodine test for starch and Biuret reagent for protein	**Chromatography** - Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.	**Density** - Use appropriate apparatus to make and record the measurements needed to determine the densities of regular and irregular solid objects and liquids.
Photosynthesis - Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.	**Electrolysis** - Investigate what happens when aqueous solutions are electrolysed using inert electrodes.	**Force and extension** - Investigate the relationship between force and extension of a spring.
Reaction time - Plan and carry out an investigation into the effect of a factor on human reaction time.	**Making salts** - Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution.	**Acceleration** – Investigate the effect of varying the force on the acceleration of an object of constant mass and the effect of varying the mass of an object on the acceleration produced by a constant force.
Field investigations - Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.		**Waves** - Make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and in a solid.
		Radiation and Absorption - Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.

Practical assessment: GCSE practical handbooks









Practical assessment: GCSE Biology

0 3 Amylase is an enzyme that digests starch.

0 3 . 1 Which organs in the human digestive system produce amylase?

[1 mark]

Tick (✓) **one** box.

- Liver, small intestine and large intestine ☐
- Salivary glands, stomach and liver ☐
- Salivary glands, pancreas and small intestine ☐
- Stomach, pancreas and large intestine ☐

A student investigated the effect of pH on the activity of amylase.

This is the method used.

1. Prepare amylase solution at pH 5
2. Mix the amylase solution with starch in a boiling tube.
3. Remove a drop of the amylase-starch mixture every 30 seconds and test it for the presence of starch.
4. Record the time when all the starch has been digested.
5. Repeat steps 1 to 4 using amylase solution prepared at pH 6, then at pH 7 and then at pH 8

0 3 . 2 What was the independent variable in this investigation?

[1 mark]

_____

_____

0 3 . 3 Describe how the student would know when all the starch had been digested.

[1 mark]

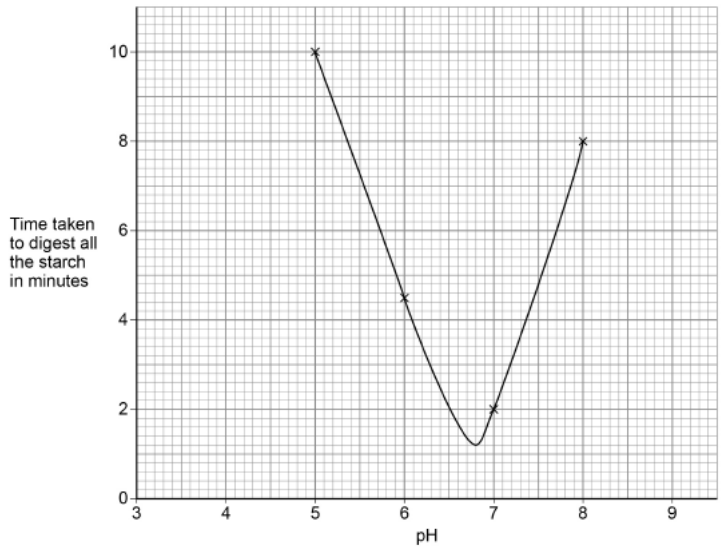
_____

_____

_____

0 3 . 4 **Figure 6** shows the student's results.

Figure 6



What was the optimum pH for the amylase?

Use **Figure 6**.

[1 mark]

Optimum pH = _____

0 3 . 6 Determine the rate of sugar production per minute at 40 seconds.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

Rate = _____ arbitrary units per minute

0 3 . 7 Explain how the structure of enzyme molecules is related to the effect of pH on the activity of amylase.

[6 marks]

_____

_____

_____

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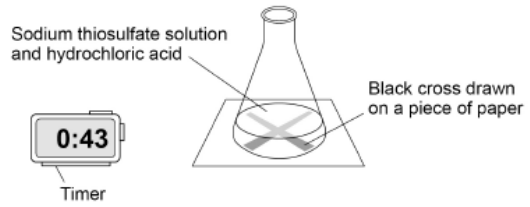
Practical assessment: GCSE Chemistry

0 4 A student investigates the effect of concentration on the rate of the reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 6 shows the experiment.

The experiment was done in a fume cupboard.

Figure 6



This is the method used.

1. Pour 50 cm^3 of sodium thiosulfate solution into a conical flask.
2. Put the conical flask on a black cross drawn on a piece of paper.
3. Pour 10 cm^3 of hydrochloric acid into the conical flask and start a timer.
4. Stop the timer when the cross can no longer be seen.
5. Repeat the experiment with different concentrations of sodium thiosulfate solution.

0 4 . 1 Draw **one** line from each type of variable to the correct example of the variable in this investigation.

[2 marks]

Type of variable	Example of variable
	Concentration of sodium thiosulfate solution
Dependent	
	Temperature of reaction mixture
	Time taken for the cross to no longer be seen
Independent	
	Volume of acid
	Volume of the flask

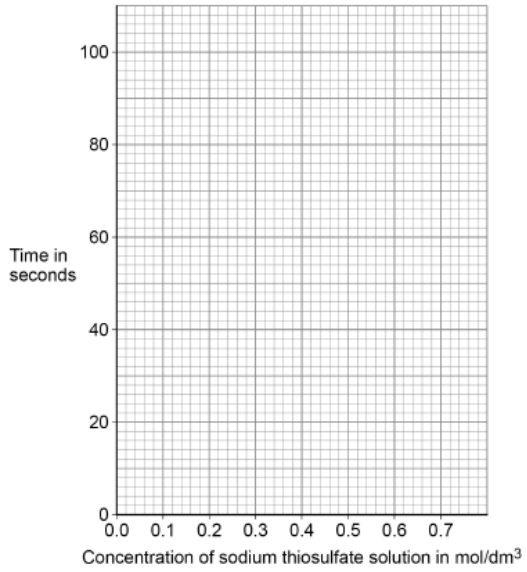
Question 4 continues on the next page

0 4 . 3 Plot the data from **Table 1** on **Figure 8**.

Draw a line of best fit.

[3 marks]

Figure 8



0 4 . 4 Predict the time taken for the cross to no longer be seen at a concentration of 0.7 mol/dm^3

Use your graph in **Figure 8**.

[1 mark]

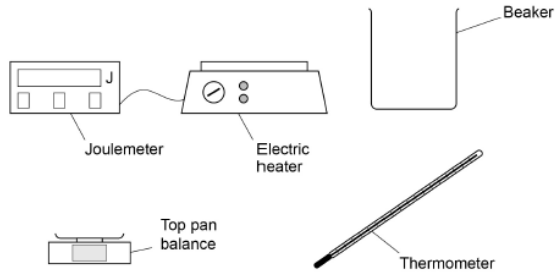
Time = _____ s

Practical assessment: GCSE Physics

0 2 A student made measurements to determine the specific heat capacity of vegetable oil.

Figure 2 shows the equipment used.

Figure 2



0 2 . 1 Describe how the student could use the equipment shown in **Figure 2** to determine the specific heat capacity of vegetable oil.

[6 marks]

0 2 . 2 Give **one** risk when using the equipment in **Figure 2**.

[1 mark]

A different student did not have a joulemeter and calculated the energy transferred by the electric heater.

Use the Physics Equations Sheet to answer questions **02.3** and **02.4**.

0 2 . 3 Write down the equation linking energy transferred (E), power (P) and time (t).

[1 mark]

0 2 . 4 The electric heater had a power output of 50 watts.

Calculate the time taken for the electric element to transfer 4750 joules of energy to the vegetable oil.

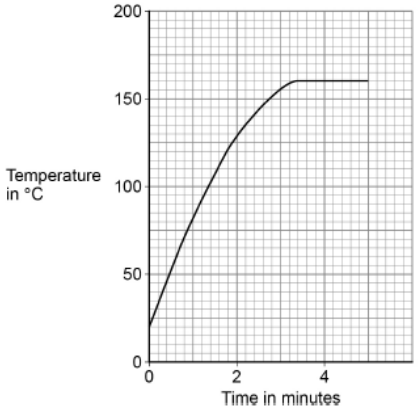
[3 marks]

Time taken = _____ s

0 2 . 6 The electric heating element in the deep fryer automatically switches off when the vegetable oil reaches a certain temperature.

Figure 4 shows how the temperature of the vegetable oil changed after the deep fryer was switched on.

Figure 4



Determine the resistance of the electrical component when the electric heating element automatically switched off.

Use **Figure 3** and **Figure 4**.

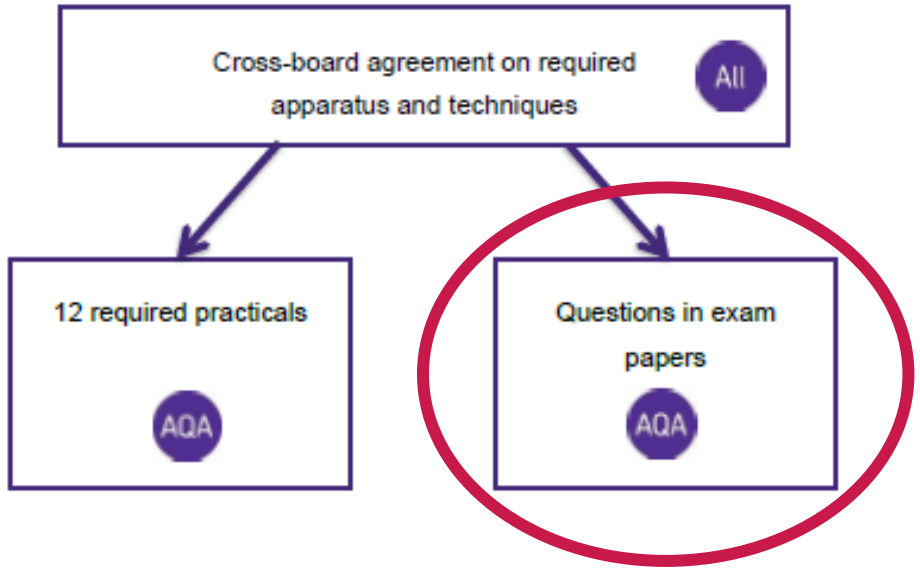
[2 marks]

Resistance = _____ Ω

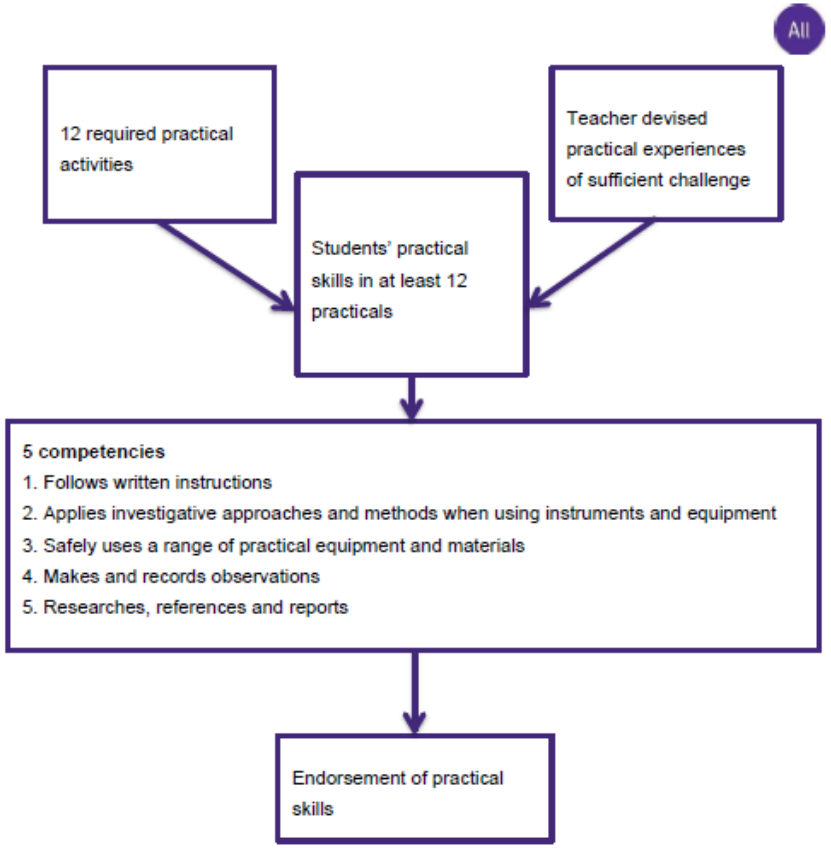
Practical assessment: A-level

Assessed in two ways:

1. **Questions in the written papers, assessed by AQA (AS and A-level)**
2. **The practical endorsement, directly assessed by teachers (A-level only)**



Practical endorsement



Practical assessment: A-level required practicals

Biology required activities (1-6 AS), (1-12 A-level)

Required activity
1. Investigation into the effect of a named variable on the r enzyme-controlled reaction
2. Preparation of stained squashes of cells from plant root up and use of an optical microscope to identify the stag mitosis in these stained squashes and calculation of a n index
3. Production of a dilution series of a solute to produce a c curve with which to identify the water potential of plant t
4. Investigation into the effect of a named variable on the permeability of cell-surface membranes
5. Dissection of animal or plant gas exchange or mass trar system or of organ within such a system
6. Use of aseptic techniques to investigate the effect of an substances on microbial growth
7. Use of chromatography to investigate the pigments isol leaves of different plants, eg leaves from shade-tolerant shade-intolerant plants or leaves of different colours
8. Investigation into the effect of a named factor on the rat dehydrogenase activity in extracts of chloroplasts
9. Investigation into the effect of a named variable on the r respiration of cultures of single-celled organisms
10. Investigation into the effect of an environmental variable movement of an animal using either a choice chamber c
11. Production of a dilution series of a glucose solution and colorimetric techniques to produce a calibration curve w to identify the concentration of glucose in an unknown ' sample
12. Investigation into the effect of a named environmental fa the distribution of a given species

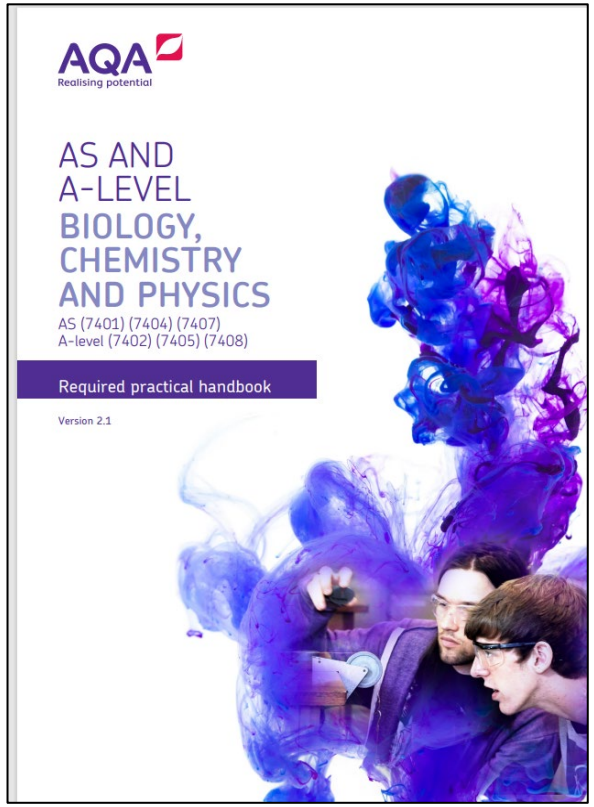
Chemistry required activities (1-6 AS), (1-12 A-

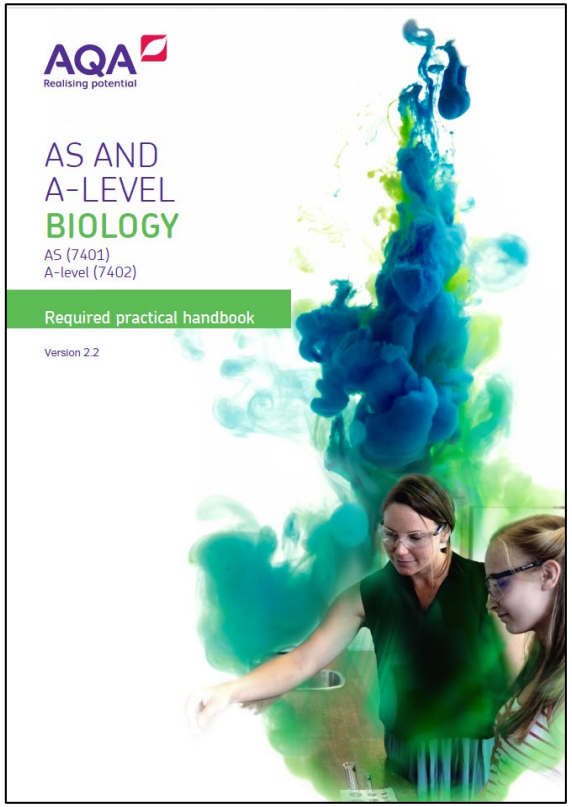
Required activity
1. Make up a volumetric solution and carry out a simple titration
2. Measurement of an enthalpy change
3. Investigation of how the rate of a reaction changes wi temperature
4. Carry out simple test-tube reactions to identify: • cations – Group 2, NH_4^+ • anions – Group 7 (halide ions), OH^-, CO_3^{2-}, SO_4^{2-}
5. Distillation of a product from a reaction
6. Tests for alcohol, aldehyde, alkene and carboxylic ac
7. Measuring the rate of reaction: • by an initial rate method • by a continuous monitoring method
8. Measuring the EMF of an electrochemical cell
9. Investigate how pH changes when a weak acid react strong base and when a strong acid reacts with a wea
10. Preparation of: • a pure organic solid and test of its purity • a pure organic liquid
11. Carry out simple test-tube reactions to identify transiti in aqueous solution
12. Separation of species by thin-layer chromatography

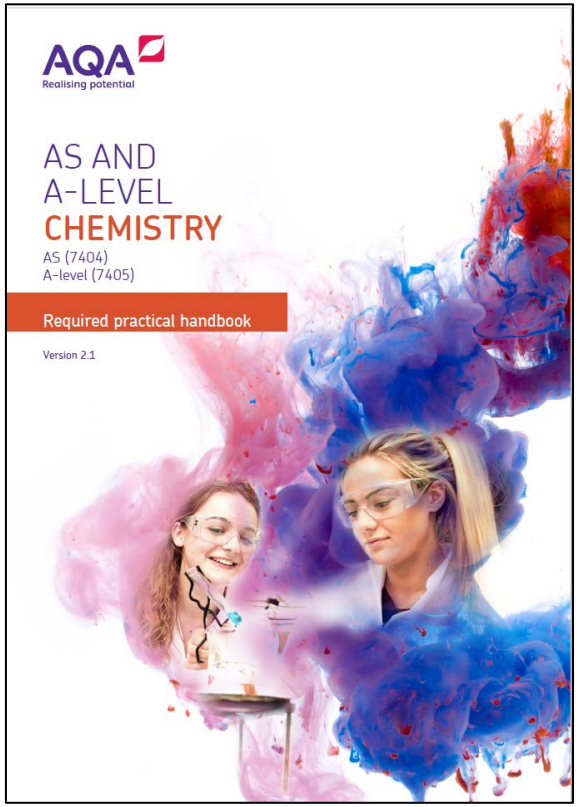
Physics required activities (1-6 AS), (1-12 A-level)

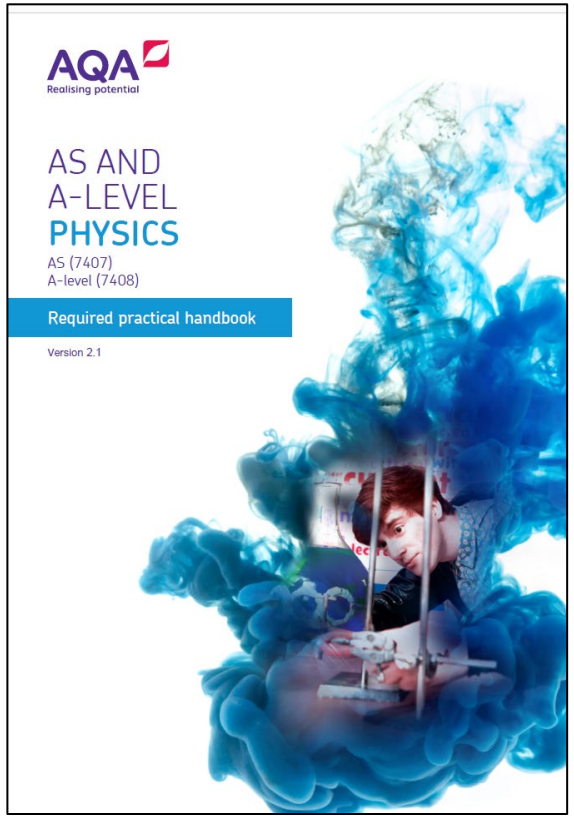
Required activity	Apparatus and technique reference
1. Investigation into the variation of the frequency of stationary waves on a string with length, tension and mass per unit length of the string	a, b, c, i
2. Investigation of interference effects to include the Young's slit experiment and interference by a diffraction grating	a, j
3. Determination of g by a free-fall method	a, c, d, k
4. Determination of the Young modulus by a simple method	a, c, e
5. Determination of resistivity of a wire using a micrometer, ammeter and voltmeter	a, b, e, f
6. Investigation of the emf and internal resistance of electric cells and batteries by measuring the variation of the terminal pd of the cell with current in it	b, f, g
7. Investigation into simple harmonic motion using a mass-spring system and a simple pendulum	a, b, c, h, i
8. Investigation of Boyle's (constant temperature) law and Charles' (constant pressure) law for a gas	a
9. Investigation of the charge and discharge of capacitors. Analysis techniques should include log-linear plotting leading to a determination of the time constant RC	b, f, g, h, k
10. Investigate how the force on a wire varies with flux density, current and length of wire using a top pan balance	a, b, f
11. Investigate, using a search coil and oscilloscope, the effect on magnetic flux linkage of varying the angle between a search coil and magnetic field direction	a, b, f, h
12. Investigation of the inverse-square law for gamma radiation	a, b, k, l

Practical assessment: A-level practical handbooks









Practical assessment: A-level

Exam papers

The AS and A-level papers contain the following types of questions which relate to practical work:

1. Questions set in a practical context, where the question centres on the science, not the practical work.
2. Questions that require specific aspects of a practical procedure to be understood in order to answer a question about the underlying science.
3. Questions directly on the required practical procedures.
4. Questions applying the skills from the required practical procedures and the apparatus and techniques list.

Practical assessment: Exam papers

Example (A-level Physics Specimen Paper 3)

0 2 . 6 The experiment is performed with a capacitor of nominal value 680 μF and a manufacturing tolerance of ± 5 %. In this experiment the charging current is maintained at 65 μA. The data from the experiment produces a straight-line graph for the variation of pd with time. This shows that the pd across the capacitor increases at a rate of 98 $\mathrm{mV\ s^{-1}}$.

Calculate the capacitance of the capacitor.

[2 marks]

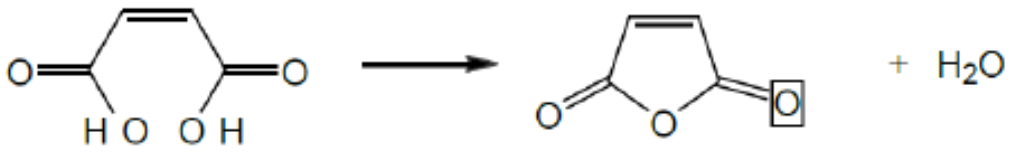
capacitance = _____ μF

This question is set in a practical context, and particular readings need to be used to calculate the answer, but the specific practical set-up is not important.

Practical assessment: Exam papers

Example (AS Chemistry Specimen Paper 2)

0 1 . 4 The effect of gentle heat on maleic acid is shown below.



A student predicted that the yield of this reaction would be greater than 80%.

In an experiment, 10.0 g of maleic acid were heated and 6.53 g of organic product were obtained.

Is the student correct? Justify your answer with a calculation using these data.

[2 marks]

To answer this question, the student must understand the process of yield calculation (which will have been gained through practical work), but again the details of the practical procedure are unimportant.

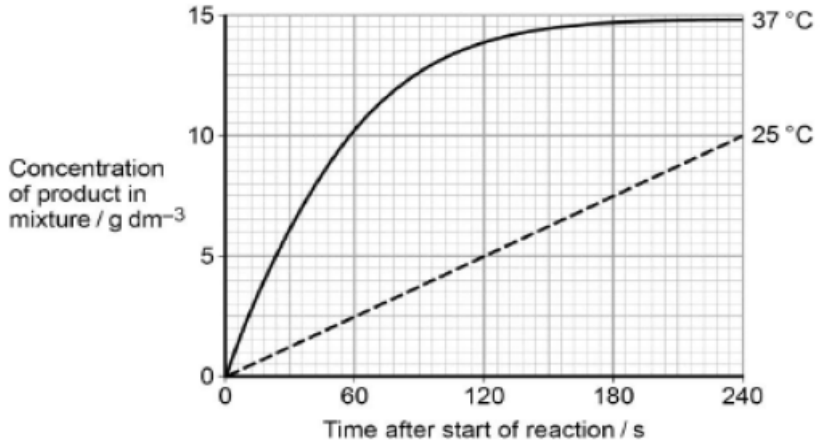
Practical assessment: Exam papers

Example (AS Biology Specimen Paper 1)

2 A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same volume of substrate solution and the same volume of enzyme solution.

Figure 2 shows his results.

Figure 2



0 2 . 1 Give one other factor the technician would have controlled.

[1 mark]

0 2 . 2 Calculate the rate of reaction at 25 °C.

[2 marks]

Similarly, in this example, the students should have done a very similar experiment.

The first question is simple recall of the factors involved in the rate of enzyme controlled reactions.

The second requires the calculation of a gradient, which is a skill students will have learned through their practical and other work.

Preparation for curriculum changes

Future Curriculum development

Process for qualification renewal:

1) DfE produces new subject criteria
2) Exam boards produce draft specifications (syllabus) with sample assessment materials for approval
3) DfE approves specifications
4) Exam boards publish specifications
5) First teaching (usually to begin next academic year) with first assessment 2 years later

Resources available for teachers

Support meetings: online, on-demand

GCSE Getting started courses: Online e-learning – introduction to the GCSE specifications and assessments. Great for new teachers or teachers new to AQA.

Mark scheme guidance: Applying mark schemes – talk through by senior examiner, GCSE and A-level (Biology, Chemistry, Physics).

Feedback on the exams: All specifications and all levels (Biology, Chemistry, Physics, Trilogy, Synergy, Environmental Science, Applied General and Entry Level Certificate), recorded sessions discussing key aspects of the 2023 exams and insight into possible future strategies.

Support meetings: online, free live sessions

GCSE Science Curriculum Connect: March 2024 – focus on levels of demand mark schemes and extended response questions.

Supporting Student Exam Prep: March 2024 – all levels, all subjects (GCSE and A-level). Focus on key areas of assessment to improve student confidence. Refresh of previous session, so some content will be repeated.

A-level practical endorsement: e-learning for the A-level practical science endorsement.

Resources: main website and secure website

Marking guidance: Standardising marking of mocks - 2023 GCSE Paper 1 and 2; AS Biology, Chemistry, Physics paper 1 and 2; Environmental Science A-level Paper 1 and 2. All available on Centre Services.

GCSE Focus on Success packs: Disciplinary language; Extended response; Practical work; Maths in science, AO2, AO3.

Teaching guides: Exploring common misunderstandings in GCSE Science; maths skills presentations.

Virtual Communities meetings: materials from these meetings can be used to aid teacher and student understanding. Topics include extended prose questions, progression in practical skills, understanding key command words, assessing maths skills at different levels of demand.

Website: resources

/ Subjects / Science / GCSE / Combined Science: Trilogy (8464)

GCSE Combined Science: Trilogy

8464

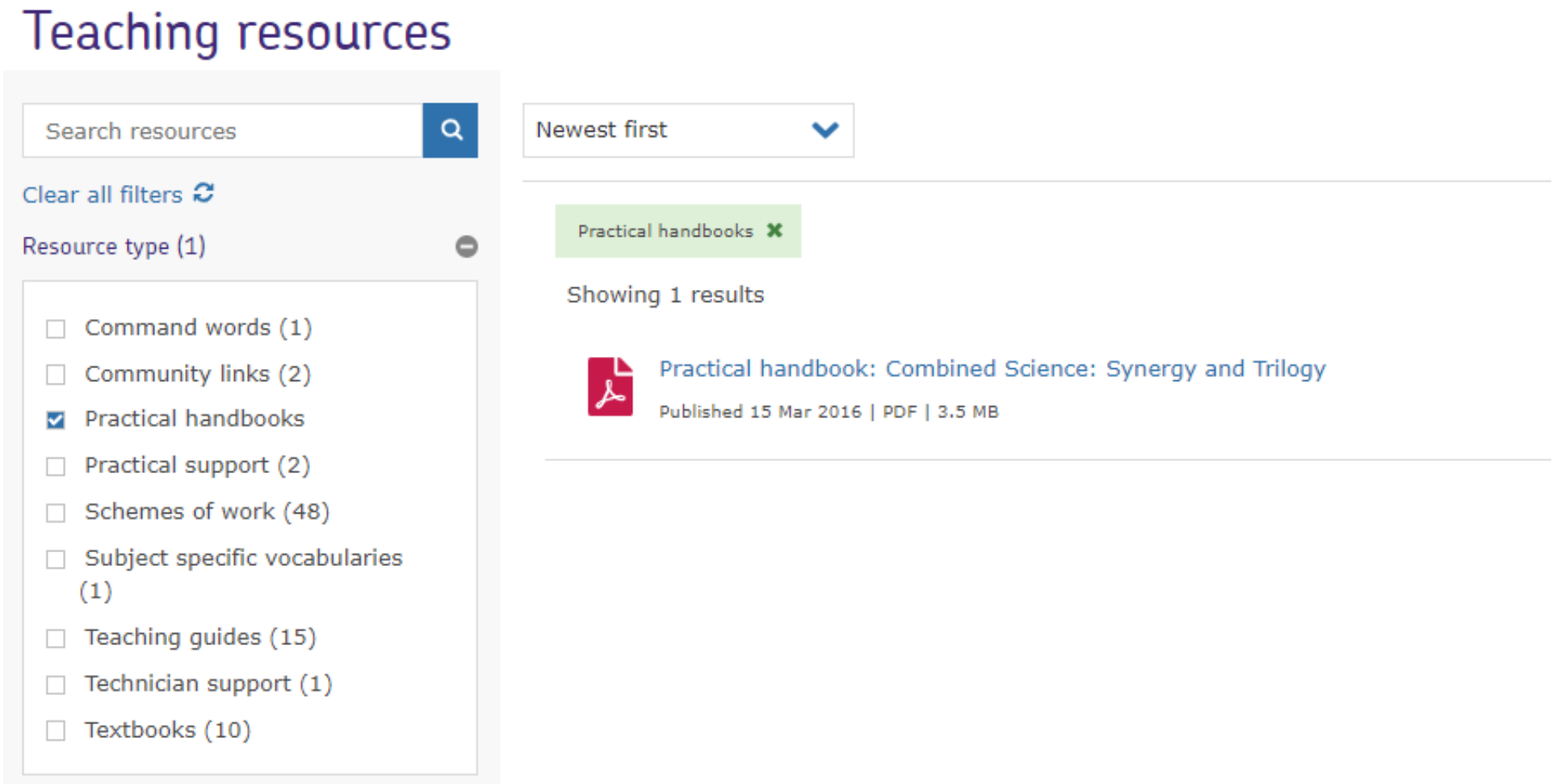
Because of the impact of Coronavirus (COVID-19) there are some changes to how GCSE Combined Science: Trilogy will be assessed in 2022. Find out more.

Find all the information, support and resources you need to deliver our specification.

Teaching from: September 2016
Exams from: June 2018
QAN code: 601/8758/X

Specification | Planning resources | Teaching resources | Assessment resources | Key dates

Website: resources



Practical handbook

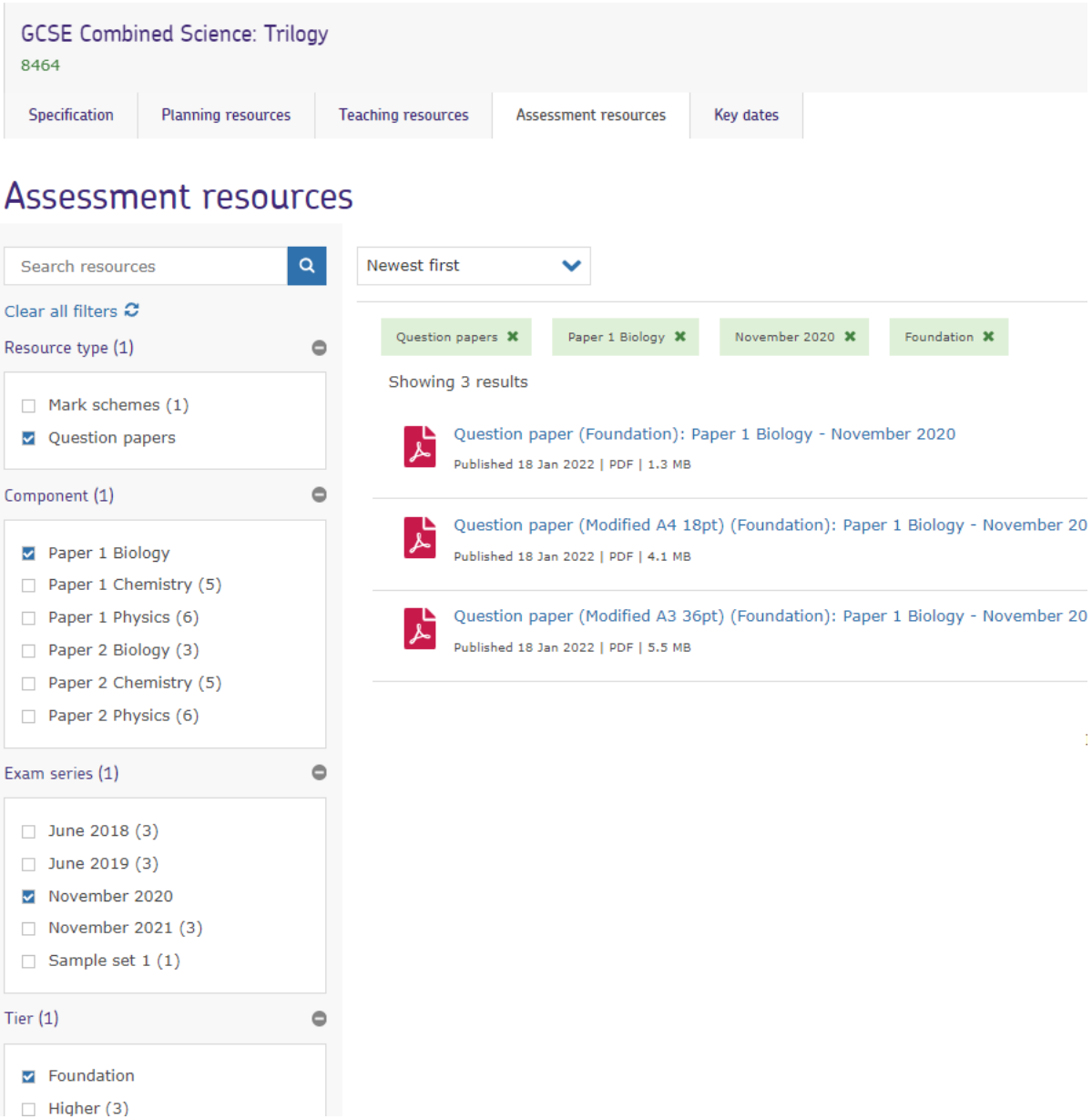
Rates of reaction

Investigate how changes in concentration affect the rates of reactions by both measuring the volume of a gas produced and monitoring a change in colour or turbidity.

	Trilogy	Synergy	Chemistry
RPA	11	19	5
Specification reference	5.6.1.2	4.7.4.3	4.6.1.2

By using this method your students will have the opportunity to develop the following aspects of the chemistry AT skills	
AT1	use of appropriate apparatus to make and record a range of measurements accurately, including mass, time, temperature and volumes of liquids and gases
AT 3	use of appropriate apparatus and techniques for conducting and monitoring chemical reactions
AT 5	making and recording appropriate observations during chemical reactions including the measurement of rates of reaction by a variety of methods such as production of gas and colour change
AT 6	safe and careful handling of liquids and solids, including careful mixing of reagents under controlled conditions, using appropriate apparatus to explore chemical changes

Website: resources



GCSE science resources

- Six self-guided modular training packs
- AQA | GCSE | Combined Science: Trilogy | Planning resources

- Helping teachers to better understand the assessment requirements

- Each pack includes notes, ideas for group discussion, an activities booklet and handouts. They cover:
  - **Practical questions**
  - Disciplinary language
  - Extended response questions
  - AO2
  - AO3
  - Maths in Science

Resources in development

GCSE Sustainability and Climate Change: new resource developed with the RMetS to support teaching the sustainability and climate change elements of AQA GCSE sciences.

A-level Focus on Success: Biology, Chemistry, Physics, Environmental Science – focusing on key areas of teaching relevant to each specification (eg Biology supporting learning of skills needed to tackle the essay, Chemistry supporting understanding of organic mechanisms).

A-level Biology and A-level Environmental Science essay guidance: Everything a teacher needs to understand how we mark these 25-mark synoptic questions and support students to write better essays. Using detailed guidance and clearly annotated examples.

A-level Getting Started: Online, on-demand e-learning – introduction to each A-level specification and its assessments. Great for teachers new to A-level or to AQA.

Get in touch

Tel: 01483 477 756

Email: gcsescience@aqa.org.uk

alevelscience@aqa.org.uk

X: @Science_AQA

aqa.org.uk

Evaluation

Scan the QR code and complete the questions

Supporting ITT - Understanding GCSE Science Assessment 2023/4

https://forms.office.com/e/J0UJySymiE

Thank you