CAMBRIDGE
ADVANCED
NATIONALS

OCR
Oxford Cambridge and RSA

Specification

DRAFT

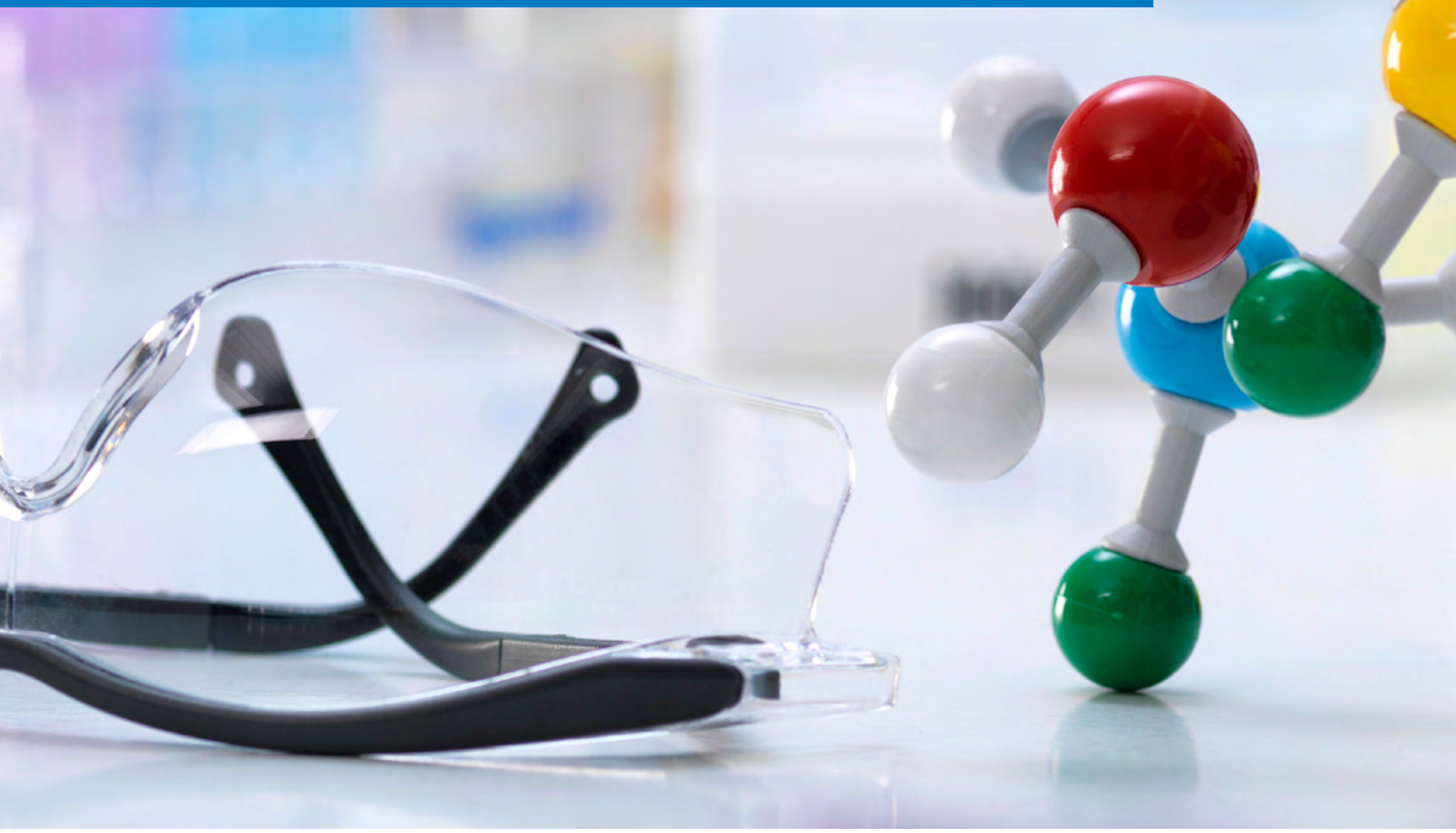
LEVEL 3 CAMBRIDGE ADVANCED NATIONAL (AAQ) IN

APPLIED SCIENCE

Certificate H051

Extended Certificate H151

For first teaching in 2025



Version 1.0 (September 2023)

ocr.org.uk/cambridge-advanced-nationals

Tell us what you think

Your feedback plays an important role in how we develop, market, support and resource qualifications now and into the future. Here at OCR, we want teachers and students to enjoy and get the best out of our qualifications and resources, but to do that we need honest opinions to tell us whether we're on the right track or not. That's where you come in.

You can email your thoughts to **ProductDevelopment@OCR.org.uk** or visit the **OCR feedback page** to learn more about how you can help us improve our qualifications.

Designed and tested with teachers and students

Helping young people develop an ethical view of the world

Equality, diversity, inclusion and belonging (EDIB) are part of everything we do

Are you using the latest version of this specification?

The latest version of our specifications will always be on **our website** and may differ from printed versions. We will inform centres about changes to specifications.

Disclaimer

Specifications are updated over time. Whilst every effort is made to check all documents, there may be contradictions between published resources and the specification, therefore, please use the information on the latest specification at all times. Where changes are made to specifications these will be indicated within the document, there will be a new version number indicated, and a summary of the changes. If you do notice a discrepancy between the specification and a resource please contact us at: resources.feedback@ocr.org.uk

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1 Why choose OCR?

Choose OCR and you've got the reassurance that you're working with one of the UK's leading exam boards. We've developed our specifications in consultation with teachers, employers, subject experts and higher education institutions (HEIs) to give students a qualification that's relevant to them and meets their needs.

We're part of Cambridge University Press & Assessment. We help millions of people worldwide unlock their potential. Our qualifications, assessments, academic publications and original research spread knowledge, spark curiosity and aid understanding around the world.

We work with a range of education providers in both the public and private sectors. These include schools, colleges, HEIs and other workplaces. Over 13,000 centres choose our A Levels, GCSEs and vocational qualifications including Cambridge Nationals and legacy Cambridge Technicals.

1.1 Our specifications

We provide specifications that help you bring the subject to life and inspire your students to achieve more.

We've created teacher-friendly specifications based on extensive research and engagement with the teaching community. Our specifications are designed to be straightforward to deliver and accessible for students. The design allows you to tailor the delivery of the course to suit your needs.

1.2 Our support

We provide a range of support services to help you at every stage, from preparation to delivery:

- A wide range of high-quality creative resources including resources created by leading organisations in the industry.
- Textbooks and teaching and learning resources from leading publishers. The Cambridge Advanced Nationals (AAQs) page on our website has more information about all the published support for the qualifications that we have endorsed.
- Professional development for teachers to meet a range of needs. To join our training (either face-to-face or online) or to search for training materials, go to the **Professional Development page** on our website.
- **Active Results** which is our free results analysis service. It helps you review the performance of individual students or whole groups.
- **ExamBuilder** which is our free question-building platform. It helps you to build your own tests using past OCR exam questions.
- OCR Subject Advisors, who give information and support to centres. They can help with specification and non examined assessment (NEA) advice, updates on resources developments and a range of training opportunities. They use networks to work with subject communities and share ideas and expertise to support teachers.

1.2.1 More help and support

Whether you are new to OCR or already teaching with us, you can find useful information, help and support on our **website**. Or get in touch:

support@ocr.org.uk

@ocrexams

01223 553998

1.3 Aims and learning outcomes

Our Cambridge Advanced Nationals (AAQs) in Applied Science will encourage students to:

- develop key knowledge, understanding and skills, relevant to the subject
- think creatively, innovatively, analytically, logically and critically
- develop valuable communication skills that are important in all aspects of further study and life
- develop transferable learning and skills, such as evaluation, planning, presentation and research skills, that are important for progression to HE and can be applied to real-life contexts and work situations
- develop independence and confidence in applying the knowledge and skills that are vital for progression to HE and relevant to the sciences sector and more widely.

1.4 What are the key features of this specification?

The key features of OCR's Cambridge Advanced Nationals (AAQs) in Applied Science for you and your students are:

- a simple and intuitive assessment model, that has:
  - externally assessed units, which focus on subject knowledge and understanding
  - applied and practical non examined assessment units (NEA)
  - optional NEA units to provide flexibility
- a specification developed with teachers specifically for teachers. The specification lays out the subject content, assessment criteria, teacher guidance and delivery requirements clearly
- a flexible support package made based on teachers' needs. The support package will help teachers to easily understand the qualification and how it is assessed
- a team of OCR Subject Advisors who directly support teachers
- a specification designed to:
  - complement A Levels in a Post-16 curriculum
  - develop wider transferable skills, knowledge and understanding desired by HEIs. More detail about the transferable skills these qualifications may develop is in **Section 5.3**.

All Cambridge Advanced Nationals (AAQs) qualifications offered by OCR are regulated by Ofqual, the Regulator for qualifications offered in England.

The qualification numbers for OCR's Cambridge Advanced Nationals (AAQs) in Applied Science are:

- Certificate: QN TBC
- Extended Certificate: TBC

2 Qualification overview

2.1 OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) at a glance

Qualification number	TBC
First entry date	01 September 2025
Guided learning hours (GLH)	180
Total qualification time (TQT)	220
OCR entry code	H051
Approved age range	16-18, 18+, 19+
Offered in	England only
Performance table information	This qualification is designed to meet the Department for Education's requirements for qualifications in the Alternative Academic Qualifications category of the 16-19 performance tables.
Eligibility for funding	This qualification meets funding approval criteria.
UCAS Points	This qualification is recognised in the UCAS tariff tables. You'll find more information on the **UCAS website**.
This qualification is suitable for students who:	• are age 16-19 and on a full-time study programme • want to develop applied knowledge and skills in applied science • want to progress onto other related study, such as higher education courses, for example: Biological Science degree, Allied Health and Nursing degree, Life Sciences degree and Forensic Science degree.
Entry requirements	We recommend that students have achieved a science qualification at Level 2, for example: • a GCSE in Biology or Chemistry at grade 4 or above or a GCSE in Combined Science at grade 4-4 or above • a Level 2 vocational qualification such as OCR Level 2 Cambridge Technical in Science We also recommend that: • students have grade 4/grade C or above in Maths and English GCSE • you carry out an initial assessment to make sure students can reach the required standards of the qualification
Qualification requirements	Students must complete two units: • one externally assessed unit • one NEA unit

Assessment method/model	Unit F180 is assessed by an exam and marked by us. You will assess the NEA unit and we will moderate it. The NEA assignments will be valid for 2 years. The dates for which they are live will be shown on the front cover. You must make sure you use a live assignment for students' assessments and submit in the period in which assignments are live.
Exam series each year	• January • June
Exam resits	Students can resit the examined unit twice before they complete the qualification.
NEA submission	There are two windows each year to submit NEA outcomes and request a moderation visit by an OCR Assessor. You must make unit entries for students before you can submit outcomes to request a visit. All dates are on our administration pages.
Resubmission of students' NEA work	If students have not performed at their best in the NEA assignments they can improve their work and submit it to you again for assessment. They must have your agreement and you must be sure it is in the student's best interests. We use the term 'resubmission' when referring to student work that has previously been submitted to OCR for moderation. Following OCR moderation, a student can attempt to improve their work for you to assess and provide the final mark to us. There is one resubmission opportunity per NEA assignment. All work submitted (or resubmitted) must be based on the assignment that is live for assessment. For information about feedback see **Section 6**. The final piece of work must be completed solely by the student and teachers must not detail specifically what amendments should be made.
Grading	Information about unit and qualification grading is in **Section 5.**

2.2 OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) at a glance

Qualification number	TBC
First entry date	01 September 2025
Guided learning hours (GLH)	360
Total qualification time (TQT)	440
OCR entry code	H151
Approved age range	16-18, 18+, 19+
Offered in	England only
Performance table information	This qualification is designed to meet the Department for Education's requirements for qualifications in the Alternative Academic Qualifications category of the 16-19 performance tables.
Eligibility for funding	This qualification meets funding approval criteria.
UCAS Points	This qualification is recognised in the UCAS tariff tables. You'll find more information on the **UCAS website**.
This qualification is suitable for students who:	• are age 16-19 and on a full-time study programme • want to develop applied knowledge and skills in applied science • want to progress onto other related study, such as higher education courses, for example: Biological Science degree, Allied Health and Nursing degree, Life Sciences degree and Forensic Science degree
Entry requirements	We recommend that students have achieved a science qualification at Level 2, for example: • a GCSE in Biology or Chemistry at grade 4 or above or a GCSE in Combined Science at grade 4-4 or above • a Level 2 vocational qualification such as OCR Level 2 Cambridge Technical in Science We also recommend that: • students have grade 4/grade C or above in Maths and English GCSE • you carry out an initial assessment to make sure students can reach the required standards of the qualification
Qualification requirements	Students must complete five units: • two externally assessed units • three NEA units
Assessment method/model	Units F180 and F181 are assessed by an exam and marked by us.

	You will assess the NEA units and we will moderate them. The NEA assignments will be valid for 2 years. The dates for which they are live will be shown on the front cover. You must make sure you use a live assignment for students' assessments and submit in the period in which assignments are live.
Exam series each year	• January • June
Exam resits	Students can resit each examined unit twice before they complete the qualification.
NEA Submission	There are two windows each year to submit NEA outcomes and request a moderation visit by an OCR Assessor. You must make unit entries for students before you can submit outcomes to request a visit. All dates are on our administration pages.
Resubmission of students' NEA work	If students have not performed at their best in the NEA assignments they can improve their work and submit it to you again for assessment. They must have your agreement and you must be sure it is in the student's best interests. We use the term 'resubmission' when referring to student work that has previously been submitted to OCR for moderation. Following OCR moderation, a student can attempt to improve their work for you to assess and provide the final mark to us. There is one resubmission opportunity per NEA assignment. All work submitted (or resubmitted) must be based on the assignment that is live for assessment. For information about feedback see **Section 6**. The final piece of work must be completed solely by the student and teachers must not detail specifically what amendments should be made.
Grading	Information about unit and qualification grading is in **Section 5.**

2.3 Qualification structure

Key to units for these qualifications:

M = Mandatory	Students must complete these units.
O = Optional	Students must complete some of these units.
E = External assessment	We set and mark the exams.
N = NEA	We set the assignment. You assess the assignment and we moderate it.

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate)

For this qualification, students must complete two units:

- One mandatory externally assessed unit
- One mandatory NEA unit

Unit no	Unit title	Unit ref no (URN)	Guided learning hours (GLH)	How is it assessed?	Mandatory or optional
F180	Fundamentals of science	TBC	90	E	M
F182	Investigating science	TBC	90	N	M

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate)

For this qualification, students must complete five units:

- Two mandatory externally assessed units
- one mandatory NEA unit
- two optional NEA units

Unit no	Unit title	Unit ref no (URN)	Guided learning hours (GLH)	How is it assessed?	Mandatory or optional
F180	Fundamentals of science	TBC	90	E	M
F181	Science in society	TBC	60	E	M
F182	Investigating science	TBC	90	N	M
F183	Analytical techniques in chemistry	TBC	60	N	O
F184	Environmental studies	TBC	60	N	O
F185	Forensic biology	TBC	60	N	O
F186	Medical physics	TBC	60	N	O

2.4 Purpose statement – Certificate

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate)

Qualification number: TBC

Overview

Who this qualification is for

The OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) is for students aged 16-19 years old. It will develop knowledge, understanding and skills that will help you to progress to university and are relevant to the Applied Science sector.

When taken in addition to A Levels, OCR's Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) qualification aims to prepare you for undergraduate study in a wide range of science related courses by developing and assessing specific skills and foundational knowledge not covered in A Levels. This qualification provides you with an understanding of applied science practical techniques and applications. Through a combination of theoretical study and hands on experience, you will develop the necessary knowledge and skills that can support progression to higher education study.

You might be interested in this qualification if you want to develop key theoretical knowledge and understanding of the subject, but also apply what you learn to different situations and contexts and practical tasks, such as:

- Researching the fundamentals of science
- Planning and performing laboratory investigations

The qualification will also help you develop independence and confidence in using skills that are relevant to the sector and that prepare you for progressing to university courses where independent study skills are needed. You will develop the following transferable skills that can be used in both higher education and other life and work situations:

- Communicating effectively with individuals or groups.
- Researching topic areas and recording research sources, then using them to interpret findings and present evidence.
- Problem solving when matching and analysing data.

This qualification will complement other learning that you're completing at Key Stage 5. If you are a full-time student, it will be part of your studies along with your A Levels.

What you will study when you take this qualification

The qualification is made up of 50% examined content and 50% non examined assessment (NEA) content. This approach supports you to develop both theoretical knowledge and understanding **and** the skills needed to apply it in different contexts, helping you to develop a broad and relevant set of skills and experiences.

In the examined unit, you will study key knowledge and understanding relevant to Applied Science. In the non examined assessment (NEA) unit, you will demonstrate knowledge and skills you learn by completing a practical assignment. More information about the knowledge and skills you will develop is below.

The qualification has 2 mandatory units.

These are the mandatory units – you must take **both** of these units:

- Unit F180: Fundamentals of science

  This unit is assessed by an exam.

  In this unit you will learn about the key topics that are important in biology, chemistry and physics. You will study two key practicals for each of those components to be assessed as part of section D of the exam. Topics include:

  Section A (Biology)

  - Topic Area 1 Cell structure and microscopy
  - Topic Area 2 Bioenergetics
  - Topic Area 3 Structure and function of biological molecules
  - Topic Area 4 Biodiversity and ecosystems

  Section B (Chemistry)

  - Topic Area 1 Atomic structure and the Periodic Table
  - Topic Area 2 Quantitative chemistry
  - Topic Area 3 Structure and bonding
  - Topic Area 4 Rates of reactions and enthalpy changes

  Section C (Physics)

  - Topic Area 1 Electricity
  - Topic Area 2 Motion
  - Topic Area 3 Medical physics

  Section D

  - Practicals

- Unit F182: Investigating Science

  This unit is assessed by an assignment.

  In this unit you will learn about the role of a research scientist in industry by learning how to conduct your own scientific investigation. You will develop the skills to research, plan and risk assess your investigation before safely undertaking the practical tasks. Topics include:

  - Topic Area 1 Planning a scientific investigation
  - Topic Area 2 Performing a scientific investigation
  - Topic Area 3 Analysing and communicating results
  - Topic Area 4 Evaluating a scientific investigation

The subjects that complement this course

This qualification is designed to be taken alongside A Levels to enhance learning and support a balanced, engaging, broad and relevant programme of study.

These A Level subjects might complement this qualification:

- A Level Biology
- A Level Chemistry
- A Level Geography
- A Level Environmental Science
- A Level Physical Education

The types of courses you may progress to

Both the subject-specific knowledge, understanding and skills, and broader transferable skills developed through this qualification, will help you progress to further study in related areas such as:

- Biomedical Science degree
- Allied Health and Nursing degree
- Life Sciences degree
- Forensic Science degree

Why you should take the OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate)

There are two qualifications available in Applied Science. These are:

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) – this is 180 GLH in size

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) – this is 360 GLH in size

You should take this Certificate qualification if you want a Level 3 qualification that builds applied knowledge and skills in Applied Science. This qualification is an Alternative Academic Qualification (AAQ) that is the same size as an AS Level. When it is taken alongside A Levels it will complement them, helping you to build broader knowledge and skills that are valued in undergraduate study, and relevant for progression to higher education. You would take this qualification alongside A Levels as part of your programme of study at Key Stage 5.

More information

More information about the OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) is in these documents:

- Specification: <<insert link>>
- Sample Assessment Material (SAM) Question Paper:
    - F180: <<insert link>>
- Guides to our SAM Question Paper:
    - F180: <<insert link>>
- SAM Set assignment(s):
    - F182: <<insert link>>
- Student Guide to NEA Assignments: <<insert link>>

2.5 Purpose statement – Extended Certificate

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate)

Qualification number: TBC

Overview

Who this qualification is for

The OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) is for students aged 16-19 years old. It will develop knowledge, understanding and skills that will help you to progress to university and are relevant to the Applied Sciences sector.

When taken in addition to A Levels, OCR's Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) qualification aims to prepare you for undergraduate study in a wide range of science related courses by developing and assessing specific skills and foundational knowledge not covered in A Levels. This qualification provides you with an understanding of applied science practical techniques and applications. Through a combination of theoretical study and hands on experience, you will develop the necessary knowledge and skills that can support progression to higher education study.

You might be interested in this qualification if you want to develop key theoretical knowledge and understanding of the subject, but also apply what you learn to different situations, contexts and practical tasks, such as:

- Researching the fundamentals of science
- Planning and performing laboratory investigations
- Researching and undertaking an ecological survey report
- Conducting a forensic crime scene investigation and evidence analysis
- Testing unknown organic and inorganic compounds

The qualification will also help you develop independence and confidence in using skills that are relevant to the sector and that prepare you for progressing to university courses where independent study skills are needed. You will develop the following transferable skills that can be used in both higher education and other life and work situations:

- Communicating effectively with individuals or groups.
- Researching topic areas and recording research sources, then using them to interpret findings and present evidence.
- Presenting information, this will involve managing time and identifying aims, purpose, resources, methods.
- Problem solving when matching and analysing data.

This qualification will complement other learning that you're completing at Key Stage 5. If you are a full-time student, it will be part of your studies along with your A Levels.

What you will study when you take this qualification

The qualification is made up of 40% examined content and 60% non examined assessment (NEA) content. This approach supports you to develop both theoretical knowledge and understanding **and** the skills needed to apply it in a range of contexts, helping you to develop a broad and relevant set of skills and experiences.

In the examined units, you will study key knowledge and understanding relevant to Applied Science. In the non examined assessment (NEA) units, you will demonstrate knowledge and skills you learn by completing applied and practical assignments. More information about the knowledge and skills you will develop is below.

The qualification has three mandatory units and four optional units.

These are the **mandatory** units – you must take **all** these units:

- F180: Fundamentals of science

  This unit is assessed by an exam.

  In this unit you will learn about the key topics that are important in biology, chemistry and physics and you will study two key practicals for each of those components to be assessed as part of section D of the exam. Topics include:

  Section A (Biology)

  - Topic Area 1 Cell structure and microscopy
  - Topic Area 2 Bioenergetics
  - Topic Area 3 Structure and function of biological molecules
  - Topic Area 4 Biodiversity and ecosystems

  Section B (Chemistry)

  - Topic Area 1 Atomic Structure and the Periodic Table
  - Topic Area 2 Quantitative Chemistry
  - Topic Area 3 Structure and Bonding
  - Topic Area 4 Rates of reactions and enthalpy changes

  Section C (Physics)

  - Topic Area 1 Electricity
  - Topic Area 2 Motion
  - Topic Area 3 Medical physics

  Section D

  - Practicals

- F181: Science in society

  This unit is assessed by an exam.

  In this unit you will learn about the skills scientists use and the roles they perform in an international scientific community. You will examine different types of scientific data and learn how scientists use them to draw conclusions that can contribute to scientific advancement.

  Topics include:

  - Topic Area 1 What scientists do
  - Topic Area 2 Handling scientific data
  - Topic Area 3 Scientific developments
  - Topic Area 4 Communicating science

- F182: Investigating science

  This unit is assessed by an assignment.

  In this unit you will learn about the role of a research scientist in industry by learning how to conduct your own scientific investigation. You will develop the skills to research, plan and risk assess your investigation before safely undertaking the practical tasks. Topics include:

  - Topic Area 1 Planning a scientific investigation
  - Topic Area 2 Performing a scientific investigation
  - Topic Area 3 Analysing and communicating results
  - Topic Area 4 Evaluating a scientific investigation

These are **optional** units – you must take **two** of these units:

- F183: Analytical techniques in chemistry

  This unit is assessed by an assignment.

  In this unit you will learn how to plan and perform practical investigations to separate substances and purify them. Topics include:

  - Topic Area 1: Techniques to categorise and separate chemical substances
  - Topic Area 2: Quantitative and qualitative analytical techniques to quantify and identify substances
  - Topic Area 3: The principles of spectroscopic techniques and interpreting spectra for chemical substances

- F184: Environmental studies

  This unit is assessed by an assignment.

  In this unit, you will learn to use primary and secondary data to study ecosystems. You will develop the skills to carry out *in situ* fieldwork investigations to survey an area using different sampling techniques. Topics include:

  - Topic Area 1: Ecosystems and biodiversity
  - Topic Area 2: Impact of human activity and natural events
  - Topic Area 3: Waste management
  - Topic Area 4: Environmental management and conservation
  - Topic Area 5: Fieldwork

- F185: Forensic biology

  This unit is assessed by an assignment.

  In this unit you will learn how to perform investigations of the macro- and ultrastructure of cells and tissues from fresh and prepared material, using optical microscope techniques and electron micrographs. Topics include:

  - Topic Area 1: Forensic biology disciplines and evidence
  - Topic Area 2: Cells, Tissues and Organs in Forensic Biology
  - Topic Area 3: Investigation and Evidence Collection
  - Topic Area 4: Analytical Techniques and Evidence Interpretation

- F186: Medical physics

  This unit is assessed by an assignment.

  In this unit you will learn about the different diagnosis techniques and therapies used in medicine. Topics include:

  - Topic Area 1: Application of non-ionising diagnosis techniques
  - Topic Area 2: Application of ionising diagnosis techniques
  - Topic Area 3: Application of ionising therapy techniques
  - Topic Area 4: Application of non-ionising therapy techniques
  - Topic Area 5: Planning for diagnosis and therapy

The subjects that complement this course

This qualification is designed to be taken alongside A Levels to enhance learning and support a balanced, engaging, broad and relevant programme of study.

These A Level subjects might complement this qualification:

- A Level Biology
- A Level Chemistry
- A Level Geography
- A Level Environmental Science
- A Level Physical Education

The types of courses you may progress to

Both the subject-specific knowledge, understanding and skills, and broader transferable skills developed through this qualification, will help you progress to further study in related areas such as:

- Biomedical Science degree
- Allied Health and Nursing degree
- Life Sciences degree
- Forensic Science degree

Why you should take the OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate)

There are 2 qualifications available in Applied Science. These are:

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) – this is 180 GLH in size

OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) – this is 360 GLH in size

You should take this Extended Certificate qualification if you want a Level 3 qualification that builds applied knowledge and skills in applied science. This qualification is an Alternative Academic Qualification (AAQ) that is the same size as an A Level. When it is taken alongside A Levels it will complement them, helping you to build broader knowledge and skills that are valued in undergraduate study, and relevant for progression to higher education. You would take this qualification alongside A Levels as part of your programme of study at Key Stage 5.

More information

More information about the OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) is in these documents:

- Specification: <<insert link>>
- Sample Assessment Material (SAM) Question Papers:
  - F180: <<insert link>>
  - F181: <<insert link>>
- Guides to our SAM Question Papers:
  - F180: <<insert link>>
  - F181: <<insert link>>
- SAM Set assignment(s):
  - F182: <<insert link>>
  - F183: <<insert link>>
  - F184: <<insert link>>
  - F185: <<insert link>>
  - F186: <<insert link>>
- Student Guide to NEA Assignments: <<insert link>>

3 About these qualifications

3.1 Qualification size

The size of each qualification is described in terms of Guided Learning Hours (GLH) and Total Qualification Time (TQT).

GLH indicates the approximate time (in hours) you will spend supervising or directing study and assessment activities. We have worked with people who are experienced in delivering related qualifications to determine the content that needs to be taught and how long it will take to deliver.

TQT includes two parts:

- GLH
- an estimate of the number of hours a student will spend on unsupervised learning or assessment activities (including homework) to successfully complete their qualification.

The OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) is 180 GLH and 220 TQT.

The OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) is 360 GLH and 440 TQT.

3.2 Availability and language

The Level 3 Cambridge Advanced Nationals (AAQs) are available in England only. They are **not** available in Wales or Northern Ireland.

The qualifications and their assessment materials are available in English only. We will only assess answers written in English.

3.3 Prior knowledge and experience

Recognition of prior learning (RPL) is the process for recognising learning that never received formal recognition through a qualification or certification. It includes knowledge and skills gained in school, college or outside of formal learning situations. These may include:

- domestic/family life
- education
- training
- work activities
- voluntary activities.

In most cases RPL will not be appropriate for directly evidencing the requirements of the NEA assignments for the Cambridge Advanced Nationals (AAQs) qualifications. However, if you feel that your student could use RPL to support their evidence, you must follow the guidance provided in our **RPL Policy**.

4 Units

4.1 Guidance on unit content

This section describes what must be taught so that students can access all available marks and meet assessment criteria.

4.1.1 Externally assessed units (F180 and F181)

The externally assessed units contain a number of topic areas.

For each topic area, we list the **teaching content** that must be taught and give information on the **breadth and depth** of teaching needed.

Teaching content

A direct question can be asked about any content in the teaching content column.

Breadth and depth

The breadth and depth column:

- clarifies the breadth and depth of teaching needed
- indicates the range of knowledge and understanding that can be assessed in the exam
- confirms any aspects that you do not need to teach as 'does not include' statements.

Teaching must cover **both** the **teaching content** and **breadth and depth** columns.

Knowledge and understanding

This is what we mean by knowledge and understanding:

Knowledge	• Be able to identify or recognise an item, for example on a diagram. • Use direct recall to answer a question, for example the definition of a term.
Understanding	• To assess and evidence the perceived meaning of something in greater depth than straight identification or recall. • Understanding will be expressed and presented using terms such as: how; why; when; reasons for; advantages and disadvantages of; benefits and limitations of; purpose of; suitability of; recommendations for improvement; appropriateness of something to/in different contexts.

Students will need to **understand** the content, unless the breadth and depth column identifies it as knowledge only.

Any item(s) that should be taught as **knowledge** only will start with the word 'know' in the breadth and depth column.

All other content must be taught as understanding.

4.1.2 NEA units (F182-F186)

The NEA units contain a number of topic areas.

For each topic area, we list **teaching content** that must be taught and give **exemplification**. The exemplification shows the teaching expected to equip students to successfully complete their assignments.

4.1.3 Command words

Appendix B gives information about the command words that will be used in the external assessments and the NEA assessment criteria.

4.1.4 Performance Objectives (POs):

Each Cambridge Advanced National (AAQ) qualification has four Performance Objectives.

PO1	Show knowledge and understanding
PO2	Apply knowledge and understanding
PO3	Analyse and evaluate knowledge, understanding and performance
PO4	Demonstrate and apply skills and processes relevant to the subject

PO1 is assessed in the externally assessed unit only.

PO4 is assessed in the NEA units only.

The weightings of the Performance Objectives across the units in the **Certificate** qualification are:

Performance Objective	Externally Assessed unit (range)	NEA unit	Overall weighting
PO1	21.4 – 28.6%	n/a	21.4 – 28.6%
PO2	21.4 – 28.6%	12.5%	33.9 – 41.1%
PO3	0.0	12.5%	12.5%
PO4	n/a	25.0%	25.0%
Overall weighting of assessments	50.0%	50.0%	100.0%

The weightings of the Performance Objectives across the units in the **Extended Certificate** qualification are:

Performance Objective	Externally Assessed unit (range)	NEA units	Overall weighting
PO1	13.3 – 20.0%	n/a	13.3 – 20.0%
PO2	15.0 – 21.7%	15.0 – 17.5%	30 – 39.2%
PO3	5.00%	15.8 – 19.2%	20.8 – 24.2%
PO4	n/a	25.0 – 27.5%	25.0 – 27.5%
Overall weighting of assessments	40.0%	60.0%	100%

4.2 Externally assessed units

4.2.1 Unit F180: Fundamentals of science

Unit aim

An understanding of Applied Science is exciting and challenging and essential to appreciate how the world works. Chemicals are in the food we eat, the medicines we take, the clothes we wear and the fuels we use. In addition, a greater insight into biological processes from individual cells to organisms, metabolic reactions and the way we interact with other living things is fascinating. We are also dependent on the physical forces around us and on the energy we harvest and use, whilst seeking to understand more about the world around us.

In this unit you will learn about the structure and composition of substances and how they can combine to form new useful substances. Exploring living systems is equally rewarding, enabling you to find out more about yourself and how you are placed in your environment. You will also explore electrical circuits which will support understanding of applications of Physics, the fundamental theory which supports medical physics, and how we can interpret data about the physical world.

Unit F180: Fundamentals of science	
BIOLOGY	
Topic Area B1: Cell structure and microscopy	
Teaching content	**Breadth and Depth**
1.1 Cell structure and function	
1.1.1 Ultrastructure and function of cells and their components □ Features common to all cells	To include: □ Why it is essential for living cells to have a cell surface membrane, cytoplasm and nucleic acid □ The 'cell theory' □ Viruses are not living cells
□ Eukaryotic cells • Cell surface membrane • Cytoplasm • Nucleus and nucleolus • Mitochondrion • Centriole • Smooth endoplasmic reticulum (SER) • Rough endoplasmic reticulum (RER) • 70s and 80s ribosomes • Golgi apparatus/body • Vesicles and lysosomes • Flagellum and cilium • Chloroplast • Cell wall	□ How to use the features of a photomicrograph to draw and label a low-power plan of a eukaryotic cell □ Features of the cell surface membrane as shown by the fluid mosaic model, including relevance in osmosis, simple and facilitated diffusion and active transport □ The functional link between the Golgi apparatus, and vesicles/lysosomes
□ Plant and animal cells	□ The key differences between plant and animal cells □ Why a fungal cell could be identified as both a plant cell and an animal cell
□ Prokaryotic cells	□ How prokaryotic cells differ from eukaryotic cells

	□ The difference between gram-positive and gram-negative bacteria □ How the differential response to antibiotics can be used to identify bacteria Does not include: □ Details of cell autolysis or apoptosis
1.1.2 Cell specialisation □ Significance of cell specialisation in living organisms □ Structure and function of specialised animal cells: • Erythrocytes • Leukocytes • Epithelial cells • Sperm and egg cells • Muscle cells □ Importance of retaining undifferentiated stem cells within the adult animal or plant □ Structure and function of specialised cells found in a plant leaf: • Epithelial cells and cuticle • Mesophyll cells • Guard cells • Xylem and phloem	To include: □ Why cells have different functions in a multi-cellular organism □ How to interpret photomicrographs to identify the cells found in blood □ Differences between the appearance, dimensions and function of the 5 types of leukocytes □ The key features of squamous, ciliated and columnar epithelial cells □ Why sperm and egg cells are so specialised □ The key features of sperm cell and egg cell structures that allow them to carry out their role □ Differences between cardiac, smooth and skeletal muscle cells □ How animal stem cells can differentiate into a wide range of specialised cells □ How to identify the key cells found in a leaf TS □ Opening and closure of stomata and the significance of chloroplasts in the guard cells □ Why water flows along the transpiration stream in a plant leaf □ Why nutrients flow along phloem sieve elements in a plant leaf Does not include: □ Details of other specialised animal/plant cells
1.1.3 Tissue structure and function □ Definition of a tissue in animals and plants □ Tissues found in animals • Epithelial • Blood • Lung • Gastrointestinal • Endocrine	To include: □ A tissue is a collection of identical or similar cells sharing a common function □ How to extrapolate the function of a tissue, based on its structural features shown in a diagram and photomicrograph □ Comparison of lung and gastrointestinal epithelial tissues in the context of molecular movement across a membrane

□ Tissues found in plants: • Epidermis • Parenchyma • Xylem • Phloem	□ Why root tissues are usually non-photosynthetic □ What is the function of root hairs □ Why the retention of roots is essential for successful transplantation □ Differences between the transport of substances in xylem and phloem Does not include: □ Details of hormonal activity □ Biochemical details of photosynthesis □ Other plant and animal tissues
1.2 Microscopy	
1.2.1 Light and electron microscopy □ Key features of light/optical microscopes (LM) and electron microscopes (EM) □ Temporary microscope slides □ Resolving power and magnification □ Estimating the number of cells in a sample	To include: □ The stages in producing a temporary, stained mount of an LM specimen □ Advantages and disadvantages of LM and EM □ Differences between transmission electron microscopes (TEM) and scanning electron microscopes (SEM) □ Advantages and disadvantages of the TEM and SEM □ How to draw a low-power plan of an EM image □ Advantages and disadvantages of using a haemocytometer vs a Coulter counter Does not include: □ Freeze-etching technique for EM □ Details of staining of permanent slides □ The physics of LM and EM techniques
1.2.2 Practical 1: Light microscopy	To include: □ How to prepare and examine microscope slides for use in light microscopy, including the use of an eyepiece graticule and stage micrometer □ How to use and interpret the most commonly used stains, including iodine, safranin, methylene blue and Leishman stain □ How to draw a low-power plan of an LM image □ How to use a haemocytometer and a Coulter counter to count cells in a sample □ Appropriateness of using the units of mm, μm and nm in microscopy □ Use of the equation: total magnification = magnification of objective lens × magnification of eyepiece lens □ Use of the equation: $\text{magnification} = \frac{\text{observed size}}{\text{actual size}}$

	Questions relating to this teaching content will be included in Section D: Practicals in the exam
Topic Area B2: Bioenergetics	
Teaching content	**Breadth and Depth**
2.1 Photosynthesis	
2.1.1 Site of photosynthesis □ Structure and function of chloroplast components • Outer membrane • Stroma • Granal and intergranal thylakoids □ Location of chloroplasts • Distribution within individual plant cells • Concentration across a plant leaf	To include: □ How to interpret biological drawings and photomicrographs of chloroplasts □ How the outer membrane of the chloroplast provides an enclosed site for different stages of photosynthesis, including the impact on enzyme / substrate collision □ Benefit of the large surface area:volume (SA : Vol) ratio provided by the stacked thylakoids bathed in watery stroma Does not include: □ Details of proton pumps located on thylakoids
2.1.2 Biochemistry of photosynthesis □ Balanced chemical and word equations of photosynthesis □ Photosynthetic pigments involved in photosynthesis □ Importance of CO_2 absorption on climate change	To include: □ Why water is not combined with carbon dioxide to form glucose □ How light absorption is affected by the type of photosynthetic pigment found and the concentration of chloroplasts □ How to interpret the light absorption spectrum for different photosynthetic pigments □ How to interpret graphs showing the impact of light intensity on the rate of photosynthesis in pondweed □ Why CO_2 absorption can reduce the predicted increase of greenhouse gas levels in the context of climate change Does not include: □ Details of the biochemical reactions within cyclic and non-cyclic photophosphorylation and the Calvin cycle
2.2 Cellular respiration	
2.2.1 Site of cellular respiration □ Structure of mitochondria • Smooth outer membrane • Matrix • Cristae • 70S ribosomes □ Location of mitochondria • Distribution within plant and animal cells • Concentration differences in relation to plant and animal cell specialisation and function	To include: □ How to interpret biological drawings and photomicrographs of mitochondria □ How the mitochondrion provides an enclosed site for different stages of cellular respiration, a large SA: Vol ratio for reactions, including the impact on enzyme- substrate collision □ Benefits of the folded cristae and watery matrix to the aerobic phase of cellular respiration

	□ Why active animal cells have an abundance of mitochondria, including: • Sperm cell • Muscle cell / fibre • Renal tubule cell • Synaptic knob of neuron □ Why active plant cells have an abundance of mitochondria, including: • Root hair cell • Phloem companion cell □ Why water-logged soils can reduce the active uptake of mineral ions Does not include: □ Details of proton pumps located on cristae
2.2.2 Biochemistry of cellular respiration □ Balanced chemical and word equations of aerobic and anaerobic respiration □ Net production of ATP	To include: □ Similarities and differences between aerobic and anaerobic respiration □ Why ATP synthesis is not 100% efficient □ When anaerobic respiration can be applied to industrial and agricultural processes Does not include: □ Details of the biochemical reactions along the phases of glycolysis, link reaction, Krebs cycle and electron transfer chains
Topic Area B3: Structure and function of biological molecules	
Teaching content	**Breadth and Depth**
3.1 Biological molecules	
3.1.1 Structure and function of carbohydrates □ Monomers / monosaccharides • Alpha (α) and beta (β) glucose • Fructose • Galactose □ Disaccharides • Maltose • Sucrose • Lactose □ Polysaccharides • Starch • Glycogen • Cellulose □ Condensation and hydrolysis reactions	To include: □ How to interpret molecular diagrams of monosaccharides, disaccharides and polysaccharides □ Comparison of C1-4 and C1-6 glycosidic bonds □ Advantages and disadvantages of starch and glycogen as carbohydrate stores □ The key features of the iodine test, reducing sugar test and non-reducing sugar test Does not include: □ Details of monosaccharide isomers
3.1.2 Structure and function of lipids □ Saturated and unsaturated fatty acids □ Mono-, di- and triglycerides □ Phospholipids □ Condensation and hydrolysis reactions	To include: □ How to interpret molecular diagrams of mono-, di- and triglycerides □ The key features of ester bond formation between glycerol and fatty acids □ Relevance of phospholipids within the cell surface membrane, including the effect of saturated and unsaturated fatty acids on membrane thickness and fluidity

	◻ Why triglycerides are an effective energy source in plants (including seeds) and animals (within adipose tissue) ◻ How lipids in the myelin sheath provide insulation of the neuron axon ◻ The key features of the emulsion and Sudan IV tests Does not include: ◻ Recognition of fatty acids beyond their saturated or unsaturated properties
3.1.3 Structure and function of proteins ◻ Amino acid structure ◻ Characteristic features of dipeptides and polysaccharides ◻ Condensation and hydrolysis reactions ◻ Levels of protein organisation ◻ Enzyme structure and function • Lock and key and induced fit hypotheses • Factors affecting the rate of enzyme-catalysed reactions	To include: ◻ How to interpret molecular diagrams of amino acids ◻ How to carry out thin layer chromatography (TLC) ◻ How to interpret chromatograms to identify amino acids ◻ The key features of the biuret test ◻ How carboxylic and amino groups form the peptide bond between adjacent amino acids ◻ The differences between primary, secondary, tertiary and quaternary levels of organisation ◻ Why there is such a diverse range of proteins, including structural and functional types ◻ Key features of the enzyme as a protein ◻ Functions of lipases, proteases and carbohydrases ◻ How to explain the lock and key and induced fit hypotheses ◻ The effect of enzyme concentration, substrate concentration, temperature, pressure and pH on reaction rate Does not include: ◻ Inorganic catalysts, cofactors and coenzymes
3.1.4 Structure and function of nucleic acids ◻ Key features of a nucleotide ◻ ATP and ADP as mononucleotides ◻ DNA and RNA as polynucleotides ◻ Condensation and hydrolysis reactions ◻ Significance of base pairing	To include: ◻ How to interpret molecular diagrams of mono- and polynucleotides, including both DNA and RNA ◻ Function of nuclease enzymes ◻ Relevance of the mononucleotide structure of ATP and ADP ◻ Purpose and function of DNA and RNA in inheritance and protein synthesis

	□ Similarities and differences between DNA and RNA, including mtDNA, rRNA, mRNA and tRNA □ How base pairing is fundamental to the integrity of DNA and the formation of RNA □ Know why alterations in the sequence of bases can lead to mutations Does not include: □ Details of protein synthesis at the ribosome □ Detailed steps of the PCR protocol
Topic Area B4: Biodiversity and ecosystems	
Teaching content	**Breadth and Depth**
4.1 The distribution of organisms	
4.1.1 Distribution of organisms □ The location and interaction of organisms in the living world • Ecosystem • Community • Population • Habitat □ Factors affecting the distribution of organisms in an ecosystem • Abiotic (climatic and edaphic) factors • Biotic factors • Human influences	To include: □ The relationship between ecosystem, community, population, habitat and niche □ How organisms participate in food chains and food webs, including brown food chains □ How the percentage efficiency of energy transfer limits the number of trophic levels □ Use of the equation: Percentage efficiency = $100 \times \frac{\text{useful energy transferred}}{\text{total energy transferred)}}$ □ The impact of abiotic and biotic factors on the distribution and survival of organisms within an ecosystem □ Why climate change has such a profound influence on the distribution and survival of organisms Does not include: □ Details of energy transfer estimates across an ecosystem □ Political issues related to climate change
4.2 Sampling	
4.2.1 Sampling techniques □ Influences on the choice of sampling technique • Type of organisms • Density of populations • Environmental characteristics	To include: □ Why different sampling techniques are needed for different types of organisms, including: • Plants • Sedentary or mobile animals • Algae and seaweed □ Characteristic features of pitfall traps, sweep nets, quadrats and pooters
□ Features of random sampling	□ Benefits and limitations of random sampling, including bias
□ Measurement of abiotic factors	□ Abiotic factors including light intensity, air, water, substrate or soil, temperature and pH □ How to determine soil features of water, humus, and particulate mass

	□ Importance of sampling techniques in agriculture Does not include: □ Analysis of kite diagrams □ Calculation of standard error
4.2.2 Practical 2: Sampling □ Use of simple and grid quadrats □ Line and belt transects	To include: □ How to decide the appropriate type of sampling technique for collecting random and non-random samples in the field □ How to use a quadrat for sampling in an area and along a transect □ How to estimate % plant cover within a quadrat □ How to measure abiotic factors under field conditions Does not include: □ Point quadrats *Questions relating to this teaching content will be included in Section D: Practicals in the exam*
CHEMISTRY	
Topic Area C1: Atomic structure and the Periodic Table	
Teaching content	**Breadth and Depth**
1.1 Atomic structure	
1.1.1 Atomic structure □ The structure of atoms in terms of protons, neutrons and electrons □ The existence of isotopes □ Relative atomic mass □ Mass spectra of elements □ Electron configuration of atoms in terms of main shells and sub-shells	To include: □ Know definitions of atomic number (Z) and mass number (A) □ How to represent an atom's structure using the Bohr model of the atom up to Z = 20 □ The relative charges and relative masses of protons, neutrons and electrons □ The existence of isotopes □ Use of the equation: relative atomic mass = $\frac{\sum(\text{isotope mass} \times \text{isotope abundance})}{100}$ □ How to interpret simple mass spectra of elements (limited to ions with single charges) □ How to work out the electron configuration of atoms in terms of main shells and sub-shells (s,p and d) up to Z = 36 Does not include: □ Electron spin □ Orbitals and their shapes □ Knowledge of the main principles of the mass spectrometer

1.2 The Periodic Table	
Arrangement of elements in the Periodic Table □ Periods □ Groups □ Blocks	To include: □ The order of the elements in the Periodic Table in terms of increasing atomic (proton) number □ The arrangement of elements in periods showing repeating trends in physical and chemical properties (periodicity) □ Arrangement of elements in groups having similar chemical properties □ The periodic trend in electron configurations of periods 2 and 3 □ How to classify elements into s-, p- and d-block elements □ The relationship between electron configuration and the position of the element in the Periodic Table Does not include: □ f block □ The development of the Periodic Law or modern Periodic tables
Topic Area C2: Quantitative chemistry	
Teaching content	**Breadth and Depth**
2.1 Amount of substance	
2.1.1 The mole and molar mass □ The mole □ Molar mass □ Calculation of the number of moles from the mass in g and the molar mass □ Empirical formula □ Molecular formula □ Formula unit	To include: □ The terms: • Amount of substance • The mole (symbol 'mol'), as the unit for amount of substance • The Avogadro constant, N_A, as the number of particles in one mole (6.02×10^{23} mol^{-1}) • Molar mass as the mass of one mole (units $g\,mol^{-1}$) □ What is meant by empirical formula, molecular formula for covalent molecules, and formula unit for ionic compounds □ How to calculate the empirical formula of a compound from the % by mass of its elements □ Use of the equation: $\text{number of moles (mol)} = \frac{\text{mass of substance (g)}}{\text{relative formula mass (mol}\,g^{-1})}$ Does not include: □ Definitions of the mole □ Relative formula mass in terms of Carbon-12

2.1.2 Balancing equations and reacting masses □ Classification of typical types of reaction □ Calculations involving reacting masses	To include: □ How to classify types of reaction to include acid-base, acid-carbonate, acid-metal, thermal decomposition, redox and precipitation □ How to write balanced chemical equations for the types of reactions listed above, including state symbols □ How to calculate reacting masses and masses of products based on balanced chemical equations
2.1.3 Number of moles in aqueous solutions and preparation of a standard solution □ Calculations involving volume and concentration of solutions □ Standard solution	To include: □ Use of the equation: $\text{Concentration } (\text{g dm}^{-3}) = \frac{\text{mass of solute (g)}}{\text{volume (dm}^3\text{)}}$ □ Use of the equation: $\text{concentration } (\text{mol dm}^{-3}) = \frac{\text{number of moles of solute(mol)}}{\text{volume (dm}^3\text{)}}$ □ How to convert between g dm^{-3} and mol dm^{-3}
2.1.4 Neutralisation	To include: □ Neutralisation as the reaction between acids and bases, including alkalis and carbonates, to form salts □ Formulae of the common acids (HCl, H_2SO_4, HNO_3 and CH_3COOH) and alkalis ($NaOH$, KOH and NH_3) □ How to determine the formulae and names of salts produced by acids
2.1.5 Practical 3: volumetric analysis	To include: □ The use of acid-base titration to determine concentration □ The use of appropriate indicators to determine the end point of an acid-base titration, including the colour changes expected □ The use of apparatus, techniques and procedures to carry out acid-base titrations □ The use of titration curves for acid-base titrations □ Structured titration calculations based on experimental results of familiar and non-familiar acids and bases Does not include: □ How and why indicators change colour *Questions relating to this teaching content will be included in Section D: Practicals in the exam*

2.1.6 Moles and volumes of gases	To include: □ Molar gas volume as the volume occupied by one mole of any gas (24 dm^3 at RTP) □ How to calculate reacting masses and volume of gases from balanced equations, using the concept of amount of substance □ Use of the equation: number of moles of gas (mol) = $\frac{\text{volume of gas in sample (dm}^3\text{)}}{24\,(\text{dm}^3)}$ Does not include: □ The Ideal Gas Equation, PV=nRT
Topic Area C3: Structure and bonding	
Teaching content	**Breadth and Depth**
3.1 Bonding	
3.1.1 Bonding □ Ionic Bonding • Formation of ionic compounds • Formation of giant ionic lattices □ Covalent Bonding • Formation of covalent substances (simple molecular and giant covalent) • Electronegativity and bond polarity • Intermolecular forces	To include: □ Ionic bonding as electrostatic attraction between positive and negative ions □ The solid structures of giant ionic lattices, resulting from oppositely charged ions strongly attracted in all directions, for example, $NaCl$ □ The effects that ionic radius and ionic charge have on the strength of ionic bonding □ Covalent bond as the strong electrostatic attraction between a shared pair of electrons and the nuclei of the bonded atoms □ How to construct 'dot-and-cross' diagrams of molecules and ions to represent single covalent and multiple covalent bonding □ Electronegativity as the ability of an atom to attract the bonding electrons in a covalent bond □ How to interpret Pauling electronegativity values □ Why some bonds are polar □ Intermolecular forces based on permanent dipole–dipole interactions and induced dipole–dipole (London) interactions □ Hydrogen bonding as intermolecular bonding between molecules containing N, O or F and the H atom of –NH, –OH or HF □ The solid structures of simple molecular lattices, as covalently bonded molecules attracted by intermolecular forces □ The solid giant covalent lattices of carbon (diamond, graphite and graphene) and silicon as networks of atoms bonded by strong covalent bonds

□ Metallic Bonding	□ Metallic bonding as strong electrostatic attraction between cations (positive ions) and delocalised electrons, creating a giant metallic lattice structure Does not include: □ Shapes of molecules □ No details of cubic or hexagonal packing required
3.1.2 Formulae of ions and compounds □ Cations and anions □ Formulae of ionic compounds and covalent substances	To include: □ How to write formulae of ionic compounds from ionic charges □ How to predict ionic charge from the position of an element in the Periodic Table □ Know the names and formulae of the following ions: NO_3^-, CO_3^{2-}, SO_4^{2-}, OH^-, NH_4^+, Zn^{2+} and Ag^+ □ How to use chemical symbols to write the formulae of elements and covalent and ionic compounds
3.2 Structures and properties	
3.2.1 Physical properties of metals, ionic compounds and covalent substances	To include: □ Physical properties of metals, ionic compounds and covalent substances (both simple molecular and giant covalent) to include melting point and electrical conductivity □ How to explain the properties in terms of the type of bonding, the particles present and the forces between particles
3.3 Organic chemistry	
3.3.1 Core concepts of organic chemistry □ Nomenclature □ Structure of common organic compounds □ Structural isomerism □ Combustion equations of alkanes and alcohols	To include: □ How to use IUPAC rules of nomenclature for systematically naming organic compounds, limited to: alkanes; alkenes; alcohols; aldehydes; ketones; carboxylic acids; haloalkanes □ Know the definition of structural isomers □ How to draw the structural and displayed formulae of the first six members of the alkane series and their corresponding alkyl groups and write their chemical formulas □ Classification of alcohols into primary, secondary and tertiary alcohols □ How to write balanced equations for the complete combustion of alkanes and alcohols □ Advantages and disadvantages of using alkanes and alcohols as fuels Does not include: □ Use of the general formula of a homologous series to predict the formula of any member of the series

	□ Qualitative tests for different functional groups □ Definitions of displayed formula and skeletal formula □ Details of reactivity of each homologous series
Topic Area C4: Rates of reaction and enthalpy changes	
Teaching content	**Breadth and Depth**
4.1 Rates of reaction	
4.1.1 Factors which affect reaction rate □ Collision theory □ Boltzmann distribution of molecular energies □ Activation energy	To include: □ Know rate of reaction as the change in mass or volume of a reactant or product per unit time □ Activation energy as the minimum amount of energy required for a reaction to occur □ The effect of concentration of solutions, surface area of solids, pressure of gases, temperature and catalyst on reaction rate □ The role of a catalyst • in increasing reaction rate without being used up by the overall reaction • in allowing a reaction to proceed via a different route with lower activation energy □ The effect of concentration, surface area and pressure on reaction rate in terms of simple collision theory □ The Boltzmann distribution and its relationship with activation energy □ The qualitative effect of temperature changes and catalysts on the proportion of molecules exceeding the activation energy using Boltzmann distributions Does not include: □ Homogeneous and heterogeneous catalysts □ Detailed knowledge of how catalysts work
4.1.2 Practical 4: Investigating reaction rates □ Experimental techniques for measuring rate □ Analysis of results	To include: □ The use of continuous monitoring methods to measure changes in mass or gas volume □ The use of apparatus, techniques and procedures to investigate reaction rates □ Reaction rate from the gradient of a graph or experimental data *Questions relating to this teaching content will be included in Section D: Practicals in the exam*

4.2 Enthalpy Changes	
4.2.1 Exothermic and endothermic reactions □ Energy profiles □ Examples of exothermic and endothermic reactions □ Energy profile diagrams	To include: □ Energy profiles for exothermic and endothermic reactions □ Combustion and respiration as examples of exothermic reactions □ Thermal decomposition and cracking as examples of endothermic reactions □ The signs and units of ΔH for exothermic and endothermic reactions
4.2.2 Enthalpy change of combustion of alcohols	To include: □ The enthalpy change of combustion $\Delta_c H$, as the enthalpy change when 1 mol of a substance undergoes complete combustion □ How to determine the enthalpy change of combustion of fuels directly □ Assumptions and limitations of experimentally determined enthalpies □ How to use $q = mc\Delta T$ to calculate $\Delta_c H$ of fuels (in $kJ\,mol^{-1}$) from experimental results Does not include: □ Any other enthalpy terms
PHYSICS	
Topic Area P1: Electricity	
Teaching content	**Breadth and Depth**
1.1 Circuits	
1.1.1. Charge and current	To include: □ The definition of electric current in metals and electrolytes □ The unit of current □ Conventional current and electron flow □ Direct current □ The unit of charge □ Elementary charge, e, including charge of an electron and proton □ Use of the equation, $Q = It$ Does not include: □ Mean drift velocity □ Alternating current
1.1.2. Potential difference, and resistance □ I-V characteristics	To include: □ The definition of potential difference □ The unit of potential difference □ How resistance is defined by $R = V / I$ □ The unit of resistance □ I-V characteristics of resistor, light-dependent resistor, filament lamp, thermistor, diode, and light-emitting diode (LED) □ Use of the equation, $V = IR$ □ Ohm's law

	□ Resistance of NTC thermistors with temperature, and resistance of LDRs with light intensity Does not include: □ Superconductivity □ Semiconductors □ Conductance and conductivity □ E.M.F. and internal resistance
1.1.3 Power and energy in circuits	To include: □ The definition of power □ The unit of power □ Use of the equations, $P = IV$, $P = I^2R$ and $P = V^2/R$ □ The definition of an electronvolt □ Use of the equation, $W = VIt$ □ Use of the equation, $W = VQ$
1.1.4 Series and parallel circuits □ Circuits □ Conservation of charge and energy □ Kirchoff's Laws □ Solving circuit problems	To include: □ Know the circuit symbols as set out in ASE publication Signs, Symbols and Systematics (The ASE Companion to 16–19 Science) □ The relationships between currents, voltages and resistances in series and parallel, including how potential difference varies for cells in series and cells in parallel □ Conservation of charge and Kirchoff's first law □ Conservation of energy and Kirchoff's second law □ Use of the equation $R_T = R_1 + R_2$… for two or more resistors in series □ Use of the equation $1/R_T = 1/R_1 + 1/R_2$… for two or more resistors in parallel □ How to solve problems for series and parallel circuits Does not include: □ Derivation of equations for calculating total resistances in series and parallel
1.1.5 Potential dividers	To include: □ The principles of a potential divider circuit □ The use of a potentiometer as a potential divider □ The use of potential divider circuits with LDRs and thermistors □ How to solve problems for potential divider circuits with potentiometers, LDRs and thermistors
1.1.6 Practical 5: Potential divider circuits	To include: □ Use of apparatus, techniques and procedures to investigate potential divider circuits which may include a sensor such as a thermistor or an LDR

	□ How to identify and fix faults in potential divider circuits
Topic Area P2: Motion	
Teaching content	**Breadth and Depth**
2.1 Energy	
2.1.1 Energy stores and energy transfers □ Energy stores and energy transfers □ Conservation of energy □ Sankey diagrams	To include: □ How energy is stored □ How energy is transferred via energy carriers or pathways □ How diagrams can be used to represent energy transfers
2.1.2 Work and energy	To include: □ The definition of work done by a force □ The unit of work done □ Use of the equations, $W = Fs\cos\theta$ and $W = Fs$ □ Law of conservation of energy □ The relationship between work done and energy transferred Does not include: □ Radians
2.1.3 Kinetic and potential energy	To include: □ Use of the equation, $E = 1/2mv^2$ □ Use of the equation, $E = mg\Delta h$ □ Use of the equations, $E = 1/2Fx = 1/2kx^2$ □ How to apply conservation of energy to examples involving gravitational potential energy, elastic potential energy, and kinetic energy Does not include: □ Gravitational potential energy between two point masses
2.1.4 Power and Efficiency	To include: □ Use of the equation, $P = W/t$ □ Use of the equation: $\text{efficiency} = \dfrac{\text{useful output energy}}{\text{total input energy}}$
2.1.5 Force □ Newton's first and third laws of motion □ Newton's second law of motion for constant mass □ Scalar and vector quantities □ SUVAT	To include: □ Use of the equation, $F = ma$ □ Use of Newton's three laws of motion including how to use free-body force diagrams to solve problems □ The terms tension, normal contact force, weight and friction □ The vector–scalar distinction as it applies to displacement and distance, velocity and speed □ Use of average velocity equation, $v = s / t$ □ Use of constant acceleration equation, $a = (v – u) / t$

	◻ Use of SUVAT equations to solve constant acceleration problems ◻ Use of velocity–time and displacement–time graphs to solve problems Does not include: ◻ Resolving forces using vector triangles ◻ Terminal velocity
2.1.6 Practical 6: Investigating motion	To include: ◻ Use of apparatus, techniques and procedures to accurately determine the acceleration of free fall using trapdoor and electromagnet arrangement, and light gates and timer
Topic Area P3: Medical physics	
Teaching content	**Breadth and Depth**
3.1 X-rays and ultrasound	
3.1.1 The atom ◻ The Rutherford–Bohr model ◻ Energy levels in atoms	To include: ◻ Electron transitions ◻ Ground state, excited state, and ionised state Does not include: ◻ Alpha particle scattering ◻ Electric force and strong nuclear force ◻ Electron stationary waves in atoms ◻ Nuclear radius – Radius of nuclei $R = r_o A^{1/3}$
3.1.2 Electromagnetic radiation ◻ Types of electromagnetic radiation ◻ Quantum energy ◻ Photoelectric effect	To include: ◻ The similarities and differences between the types of electromagnetic (EM) radiation, including in terms of production, penetration, uses, frequency and wavelength ◻ The definition of a quantum and a photon ◻ Use of the equation, $E = hf = hc/\lambda$ Does not include: ◻ Investigating the photoelectric effect experimentally ◻ Stopping potential difference ◻ Spectral lines ◻ Wave-particle duality
3.1.3 X-rays ◻ X-ray tube ◻ Beam intensity ◻ Attenuation	To include: ◻ Basic structure of an X-ray tube including: heater (cathode), anode, target metal and high voltage supply ◻ How X-rays are produced in an X-ray tube, including thermionic emission and energy transfers ◻ How tube current and voltage affects the X-ray beam ◻ Attenuation of X-rays by absorption and scattering

	□ Use of the attenuation of X-rays equation to calculate intensity, $I = I_0e^{-\mu x}$ with e = 2.718 □ Mass attenuation coefficient □ Use of the equation, $\mu_m = \mu/\rho$ □ Use of the equation, $\rho = m/V$ Does not include: □ Logarithms □ Calculus □ X-ray attenuation mechanisms □ Types of X-ray, e.g. Bremsstrahlung □ Formation of an X-ray image □ Photographic film □ Charge-coupled device □ X-ray spectra graphs
3.1.4 Wave motion □ Progressive Waves □ Longitudinal and transverse waves □ Wave motion in terms of displacement, amplitude, wavelength, time period, frequency and wave speed □ Graphical representations of longitudinal and transverse waves □ Intensity of a progressive wave	To include: □ Examples of longitudinal and transverse waves including sound waves and electromagnetic waves □ Use of the equation, $f = 1/T$ □ Use of the equation for wave speed, $v = f\lambda$ □ Use of the equation for intensity, $I = P/A$ □ The relationship between intensity and amplitude Does not include: □ Phase difference
3.1.5 Ultrasound □ Transducer □ Acoustic impedance □ Intensity reflection coefficient □ Attenuation □ A-scans and B-scans	To include: □ Definition of ultrasound, including in medical contexts □ Reflection, and transmission of ultrasound □ Know that a transducer can both transmit pulses and receive reflected pulses □ Use of the acoustic impedance equation, $Z = \rho c$ □ Use of the intensity reflection coefficient equation, $\alpha = I_R/I_0 = (Z_2 - Z_1/Z_2 + Z_1)^2$ □ Attenuation of ultrasound by absorption and scattering □ Impedance matching and coupling mediums □ How to interpret and use A-scans to solve problems Does not include: □ Know the details of the piezoelectric effect □ Advantages and disadvantages of A scans and B scans □ How to produce clear images using ultrasound □ Advantages and disadvantages of ultrasound imaging □ Destructive ultrasound □ Doppler effect in ultrasound □ Determining the speed of blood

3.2 Radioactivity	
3.2.1 Fundamentals of radioactivity □ Radioactive decay □ Properties of nuclear radiation (alpha, beta and gamma)	To include: □ The spontaneous and random nature of nuclear radioactive decay □ Types of decay □ Nuclear decay equations Does not include: □ Electron capture and transmutation □ How to use a G-M tube to measure half-life □ Detecting alpha, beta and gamma emissions □ Beta plus decay □ Graph of N against Z for stable nuclei □ Effect of magnetic field on alpha, beta and gamma □ Big Bang Theory and Cosmic Microwave Background Radiation
3.2.2 Mathematical analysis of radioactivity □ Activity of a source □ Decay Law □ Half-life	To include: □ Use of the activity equation: $A = \lambda N$ □ Use of the equations to determine $N/N_0/A/A_0$: $N = N_0 e^{-\lambda t}$ and $A = A_0 e^{-\lambda t}$ with e = 2.718 □ Biological, physical and effective half-lives □ Use of the effective half-life equation, $1/t_E = 1/t_{1/2} + 1/t_B$ □ How to graphically determine the physical half-life of an isotope □ Use of the equation $t_{1/2} = 0.693/\lambda$ Does not include: □ Logarithms □ Differential rate of decay equation, $-dN/dt = \lambda N$ □ Calculus □ Use of the equation: N = mass of radioactive sample × Avogadro constant / relative atomic mass
3.2.3 Radiation hazards □ Effects of radiation □ Ionisation □ Absorbed and effective dose	To include: □ Irradiation and contamination □ Physiological effects of radiation □ Mechanism of direct and indirect ionisation of biological molecules Does not include: □ Measuring radiation exposure
3.2.4 Using radionuclides □ Radiopharmaceuticals □ Radionuclides	To include: □ The definition of radiopharmaceuticals □ Use of radionuclides in sterilisation, cancer treatments and medical tracers □ How to select a radionuclide for an appropriate use

	Does not include: □ Uses of radioactive nuclides in testing for cracks, carbon dating, dating rocks, smoke detectors □ Know the use and function of gamma cameras □ Know the components of a gamma camera □ Know the use and function of PET scans □ Know the components of a PET scanner □ Artificial radioactive nuclides □ Manufacture of radionuclides

Assessment guidance

This unit is assessed by an exam. The exam is 1 hour and 30 minutes and has **70** marks in total. All questions in the exam should be answered.

- The exam has four Sections: Section A has 20 marks.
- Section B has 20 marks.
- Section C has 20 marks.
- Section D has 10 marks.
-

Content in Section A will be sampled from topic areas B1-B4, with at least one question or part question relating to each topic area.

Content in Section B will be sampled from topic areas C1-C4, with at least one question or part question relating to each topic area.

Content in Section C will be sampled from topic areas P1-P3, with at least one question or part question relating to each topic area.

Content in Section D will be sampled from Practicals 1-6.

Content in this exam will have links to the 'How Science Works Concepts and Skills' and 'Mathematical skills for Applied Science'.

Sections A-C **do not** explicitly assess knowledge of practicals 1-6. However, knowledge of the practicals may help to answer the questions in these sections.

Section D **does** explicitly assess knowledge of practicals 1-6. Knowledge from B1-B4, C1-C4, and P1-P3 will help to answer the questions in Section D.

This will be conducted under examination conditions. For more details refer to the **Administration area.**

A range of question types will be used in the exam including:

- Forced choice/controlled response questions – including MCQ
- Short answer, closed response questions (with or without diagrams)
- Short answer with calculation/working
- Extended constructed response with points-based mark scheme

The Applied Science **Guide to our Sample Assessment Material** gives more information about the layout and expectations of the exam.

The exam for this unit assesses the following Performance Objectives:

- PO1 – Show knowledge and understanding
- PO2 – Apply knowledge and understanding

Synoptic assessment

This unit allows students to gain underpinning knowledge and understanding relevant to the qualification and sector. The NEA units draw on and strengthen this learning with students applying their learning in an applied or practical way.

The following NEA units have synoptic links with this unit. The synoptic grids at the end of these NEA units show these synoptic links.

- Unit F182: Investigating science
- Unit F183: Analytical techniques in chemistry
- Unit F184: Environmental studies
- Unit F185: Forensic biology
- Unit F186: Medical physics

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic Assessment.**

4.2.2 Unit F181: Science in society

Unit aim

Science has transformed the world we live in and brought about many benefits to society, raising living standards and improving peoples' health and life expectancy. Scientific knowledge enables new technologies to be developed, practical problems to be solved and informed decisions to be made. The challenges facing modern society, such as the emergence of new diseases, climate change and sustainability of natural resources, are being addressed by scientists across the world. This unit explores the work of scientists to collect, analyse and present data, using a process called the Scientific Method, to increase knowledge and address these challenges. Communication in science helps inform, educate, and raise awareness of science-related topics within society, inspiring future scientists like you so that scientific technologies continue to progress.

In this unit you will learn about the skills scientists use and the roles they perform in an international scientific community. You will examine different types of scientific data and learn how scientists use them to draw conclusions that can contribute to scientific advancement. You will investigate what makes a scientific theory different to a scientific law by reviewing past scientific discoveries. You will explore current scientific developments and future challenges facing society that science will need to solve. You will consider ways that science is communicated in the scientific and wider communities, the implications of miscommunication and the importance of communication in driving future scientific advances.

Unit F181: Science in society	
Topic Area 1: What scientists do	
Teaching content	**Breadth and Depth**
1.1 The skills of scientists	
1.1.1 The skills scientists use to carry out research into the natural world and developing new technologies: □ Analysis □ Communication □ Problem-solving □ Creativity □ Open-mindedness □ Scepticism □ Logic □ Observation □ Objectivity □ Pragmatism □ Curiosity	To include: □ What each skill involves □ How these skills are used by scientists □ Reasons why these skills are important in science □ How to recognise when scientists are employing these skills in their work
1.2 The Scientific Method	
1.2.1 Steps in the Scientific Method: □ Defining the problem □ Research □ Formulating a hypothesis and making predictions □ Undertaking experiments □ Analysing the data □ Drawing conclusions □ Communicating results to others	To include: □ Key features of each step □ The importance of each step □ The reasons for the order of the steps □ The role of inductive and deductive reasoning in the scientific method □ How the approach to the scientific method varies in different disciplines of science
1.2.2 The scientific method is a non-linear process: □ Iterative and cyclical nature of science research	To include: □ How scientific inquiry can be cyclical and continuous □ The importance of flexibility and adaptability in scientific research

◻ The role of serendipity and intuition in discovery ◻ Cross-disciplinary approaches ◻ Inductive reasoning that leads to hypotheses	◻ Accidental scientific discoveries occur occasionally in comparison to planned research ◻ Scientific research often involves colleagues from multiple disciplines ◻ Observations and patterns can lead to theories that explain them and conclusions that are likely
1.3 The Scientific Community	
1.3.1 Scientists can work: ◻ Alone ◻ In a team ◻ Collaboratively in an international community	To include: ◻ Advantages and disadvantages of each type of working ◻ Reasons why collaboration is important in scientific research ◻ Ways that scientists collaborate ◻ The importance of diversity and inclusivity in a team
1.3.2 Successful collaborations in science	To include: ◻ What was accomplished and how ◻ The necessity for collaboration in these successes ◻ Why it is important to have scientists from different disciplines working together Examples of **successful collaborations in science** may include: ◻ Human Genome Project ◻ ATLAS Project ◻ International Space Station ◻ Global Climate Observing System ◻ Collaborative Partnership on Sustainable Wildlife Management
1.3.3 International Scientific Organisations	To include: ◻ Role of international organisations in developments in science ◻ Why it is an advantage to have these organisations Examples of **international scientific organisations** may include: ◻ WHO ◻ UNESCO ◻ IUCN ◻ WWF ◻ CERN ◻ IPCC
1.4 The role of scientists	
◻ Scientists have many varied roles across different disciplines of natural sciences ◻ Applied science uses scientific knowledge to achieve practical goals • Solve real-world problems • Develop useful technologies	To include: ◻ How to recognise the different disciplines of science and the roles of scientists in them ◻ Why it is useful to think of science as different disciplines

	◻ Why it is important to consider the interconnectivity and overlap between the disciplines ◻ The role of 'pure' and applied science and their dependence on each other
Topic Area 2: Handling scientific data	
Teaching content	**Breadth and Depth**
2.1 Types of scientific data	
◻ Qualitative and quantitative data ◻ Continuous and discrete data ◻ Data from observations and measurements ◻ Primary and secondary data	To include: ◻ Know what each type of data looks like ◻ How to classify data into these types ◻ How to represent these different types of data appropriately
2.2 Collecting scientific data	
Scientific data can be collected using: ◻ Observation and measurement from experiments ◻ Surveys ◻ Sampling • Random • Systematic ◻ Estimation ◻ Cohort studies ◻ Meta-studies ◻ Computer modelling	To include: ◻ Key concepts and uses of each collection method ◻ The types of scientific disciplines that use these methods ◻ Advantages and disadvantages of each collection method ◻ The impact of bias in data collection methods ◻ The importance of diversity and inclusivity, where appropriate
2.3 Storage and presentation of scientific data	
2.3.1 Scientific data can be stored on a: ◻ Personal database ◻ National database ◻ International database	To include: ◻ Key features and uses of each type of database ◻ When it is appropriate to use one database type rather than another ◻ Examples of the type of data stored in each way and why ◻ Advantages and disadvantages of each type of database
2.3.2 Scientific data can be represented in different graphical forms: ◻ Scatter and line graph ◻ Bar chart ◻ Histogram ◻ Pie chart ◻ Kite diagram ◻ Cumulative graph ◻ Box and whisker plots	To include: ◻ Key features and uses of each ◻ Why different graphs may be used to communicate to different audiences or for different purposes ◻ How to represent data in these graphical forms with accuracy
2.4 Interpreting data	
2.4.1 Identifying patterns and relationships to: ◻ Draw conclusions ◻ Accept or reject a hypothesis ◻ Inform further scientific investigation	To include: ◻ Patterns from data and graphs ◻ Use of mathematical skills when determining patterns from data and graphs ◻ Conclusions from data or graphs ◻ Decisions about further investigation

Topic Area 3: Scientific developments	
Teaching content	**Breadth and Depth**
3.1 Hypothesis, theory, and law	
3.1.1 Scientific use of terms: □ Hypothesis □ Prediction □ Theory □ Law	To include: □ Definitions of the terms □ How to write a hypothesis and predictions □ How a hypothesis may become a theory □ How the term theory is used in science and in everyday language □ The role of assumptions, estimations and approximations in science
3.1.2 Scientific theory vs scientific law	To include: □ How a law is different from a theory □ Both theories and laws require evidence and can be open to change and revision Examples of **scientific theories** may include: □ Theory of evolution □ Theory of relativity □ Atomic theory Examples of **scientific laws** may include: □ Newton's Laws of motion □ Periodic Law □ Laws of thermodynamics Does not include: □ Detailed information on each law or theory
3.2 Using new technologies in science	
3.2.1 New technologies play an important part in continuing scientific development: □ Robotics and automation □ Computer aided design (CAD) □ Artificial intelligence and machine learning □ Quantum computing □ Big data analytics □ Smart technologies □ Advanced imaging technologies □ Augmented and virtual reality	To include: □ Key concepts of each type of new technology □ Advantages of the new technologies to further scientific development □ How scientific disciplines might be supported by these technologies Does not include: □ Detailed descriptions of how each technology works
3.2.2 Limitations and risks of new technologies in society	To include: □ Impacts on people, money, security and the environment □ How to identify the limitations and risks □ How judgements are made about the use of these new technologies
3.3 Implications and limitations of scientific developments	
3.3.1 Considerations for scientific developments: □ Monetary costs and funding □ Social, ethical, and moral issues □ Environmental issues □ Benefits and limitations to society	To include: □ Importance of funding in science □ The role of private companies, charitable foundations or governments in scientific research

	□ Factors that affect research that is carried out □ How scientists receive funding for research □ What issues might arise and how they are classified as social, ethical or moral issues Examples of **scientific developments** may include: □ Stem cell therapies □ Proton beam therapy □ Electric vehicles □ GM crops Does not include: □ Detailed understanding of research grant applications □ Detailed information on examples of scientific developments
3.3.2 Contemporary issues that science will need to solve in the future: □ Climate change □ Sustainability of natural resources □ Conservation □ Public health □ Energy sources □ Transport □ Manufactured products	To include: □ Key concepts of these main issues □ What scientific disciplines will be necessary to solve these issues □ Social, ethical, and moral issues arising □ Economical and environmental considerations Examples of **contemporary issues** may include: □ Antibiotic resistance □ Self-driving electric vehicles □ Use of palm oil □ Nanotechnology
Topic Area 4: Communicating science	
Teaching content	**Breadth and Depth**
4.1 Methods of communication	
4.1.1 Communicating science to the public using the media: □ Popular science books □ TV documentaries □ Blogs and vlogs □ Podcasts □ Social media □ Websites □ National newspapers □ Science magazines	To include: □ Key features of each media □ Advantages and disadvantages of communicating using each media □ Target audiences of each media □ Language, structure, and images used for engagement of target audience □ How to assess the effectiveness of a source of information in providing accurate information and being engaging □ How to assess the validity of a source of information
4.1.2 Communicating science between experts: □ Journals □ Meetings and seminars □ Conferences and symposia □ Online platforms and forums	To include: □ Why it is important for experts within scientific disciplines to engage with each other □ Why it is important for experts across scientific disciplines to engage with each other

	□ Key features of each type of communication
□ The process of peer review	□ Steps in the process of peer review □ Why peer review is important □ How the process of peer review increases reliability and validity of published information
4.2 Plagiarism	
□ Complete □ Direct □ Self □ Source-based □ Accidental	To include: □ Definition of each type of plagiarism □ When each type of plagiarism could occur □ Why people plagiarise and why it matters □ How to avoid plagiarism □ Potential consequences of plagiarism
4.3 Using science to inform decision making	
Different organisations that use science to inform their decision making: □ Government organisations □ Non-governmental organisations □ Private and commercial organisations □ Pressure, voluntary and charitable groups	To include: □ How organisations use scientific information and data □ Aims and objectives of these types of organisations □ The importance of these organisations in influencing public opinion □ The importance of these organisations in future scientific advancement Examples of different organisations may include: □ Environment Agency (EA) □ Health and Safety Executive (HSE) □ European Union (EU) □ United Nations (UN) □ Worldwide Fund for Nature (WWF) □ Greenpeace
4.4 Problems with communicating science	
4.4.1 Public trust in the scientific community and developments □ Misinformation in science □ Misinformation vs disinformation □ Ways of improving public trust in the scientific community and developments	To include: □ How to differentiate between misinformation and disinformation □ How to identify potential misinformation and disinformation in science □ Why science might be misrepresented □ Different ways science can be misrepresented □ Possible causes of misinformation □ Sources of misinformation □ Definition of scientific literacy □ Why it is important for all citizens in society to be scientifically literate □ How scientists can improve communication with citizens about developments and research
4.4.2 Bias in science communication □ Confirmation bias □ Publication bias □ Reporting bias	To include: □ Contrast in how the term bias is used in science and in everyday language

□ Biased language □ Conclusions influenced by other factors	□ Key ideas about each type of bias in science communication □ Possible consequences of bias in science communication □ How to avoid bias in science communication

Assessment guidance

This unit is assessed by an exam which contains pre-release material. The exam is 1 hours and 15 minutes and has 50 marks in total. All questions in the exam should be answered.

The exam has two sections:

- Section A has a range of 23-27 marks. Questions in Section A are specifically based on the pre-release material and can come from anywhere in the unit content.
- Section B has a range of 23-27 marks. Questions in Section B are not based on the pre-release material, and can come from anywhere in the unit content

The combined total of Section A and Section B will be 50 marks.

Content will be sampled from all topic areas of F181: Science in Society, with at least one question or part question relating to each topic area.

Content in this exam will have links to the 'How Science Works Concepts and Skills' and 'Mathematical skills for Applied Science'.

The pre-release material will be used to introduce novel contexts. This will provide opportunities for students to develop the skills of scientific literacy, research and scientific enquiry, and to engage more in self-directed learning.

The pre-release material will be issued electronically via OCR's secure website six weeks prior to the examination date. A clean hard copy of the pre-release material will be provided with the question paper in the examination.

This will be conducted under examination conditions. For more details refer to the **Administration area.**

A range of question types will be used in the exam including:

- Forced choice/controlled response questions – including MCQs
- Short answer, closed response questions (with or without diagrams)
- Short answer with calculation/working
- Extended constructed response with points-based mark scheme
- Extended constructed response with levels of response mark scheme

The Applied Science **Guide to our Sample Assessment Material** gives more information about the layout and expectations of the exam.

The exam for this unit assesses the following Performance Objectives:

- PO1 – Show knowledge and understanding
- PO2 – Apply knowledge and understanding
- PO3 – Analyse and evaluate knowledge, understanding and performance.

Synoptic assessment

This unit allows students to gain underpinning knowledge and understanding relevant to the qualification and sector. The NEA units draw on and strengthen this learning as students will apply their learning to practical or applied tasks.

The following NEA units have synoptic links with this unit. The synoptic grids at the end of these NEA units show these synoptic links.

- Unit F182: Investigating science
- Unit F184: Environmental studies
- Unit F185: Forensic biology
- Unit F186: Medical physics

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic Assessment.**

4.3 NEA Units

4.3.1 Unit F182: Investigating science

Unit Aim

Scientific research and investigation happen continuously. Scientific investigation is a series of steps of research that scientists take to solve problems by asking questions and testing possible answers. Research scientists conduct scientific investigations to test out new ideas, find explanations, build knowledge, and develop new technologies.

In this unit you will learn about the role of a research scientist in industry by learning how to conduct your own scientific investigation. You will develop the skills to research, plan and risk assess your investigation before safely undertaking the practical tasks. You will learn how to collect and analyse data and communicate your findings in a scientific report and a presentation. Finally, you will develop the skills to evaluate your investigation, including assessing the effectiveness of the methods used and suggesting improvements that could be made. You will be able to assess the relevance of your investigation to environmental, commercial and industrial processes.

F182: Investigating science	
Topic Area 1: Planning a scientific investigation	
Teaching content	**Exemplification**
1.1 Researching the topic	
1.1.1 □ How to undertake research: • Selecting appropriate sources of primary and secondary information • Selecting methodologies to answer a question • Providing background information for putting an investigation in context • Risks and hazards associated with materials and methods • Limitations and sources of error	To include: □ How to identify relevant sources for an investigation □ How to evaluate sources of information using the Currency, Relevance, Authority, Accuracy and Purpose (CRAAP) test □ The importance of exploring multiple sources □ How to use research to relate an investigation to an environmental, commercial or industrial process □ Why there are limits to the amount and type of research that are achievable
□ Developing a research question for an investigation	□ How to create an appropriate research question from a set title □ What makes a good research question, for example, that is SMART □ Understand the constraints of carrying out an investigation in schools
□ Creating a hypothesis and prediction	□ The difference between a research question, hypothesis and prediction □ How to construct a hypothesis and prediction from a research question □ The importance of explaining the scientific principles behind an investigation □ How to explain the scientific principles that support a hypothesis and prediction □ Why a null hypothesis may also be useful and when they are appropriate □ How to accept or reject a hypothesis

◻ Identifying relevant variables for an investigation	◻ The difference between independent, dependent and control variables ◻ How to identify all relevant variables that might affect the outcome of an investigation ◻ How to decide if a variable is qualitative or quantitative ◻ How to evaluate significant variables to control in an investigation
1.1.2 ◻ Referencing using standard methods: • In-text citation • End-text citation • Creating a bibliography	To include: ◻ How to reference citations in-text and end-text ◻ Why referencing is important ◻ The existence of different referencing systems ◻ The importance of consistency and clarity in referencing Does not include: ◻ Specific details of any one referencing system
1.2 Designing a scientific investigation	
1.2.1 ◻ A plan should include decisions about: • Variables • Method • Equipment • Measurements • Preliminary testing	To include: ◻ How to select an investigation method that will answer the research question ◻ Making modifications to methods to answer a research question ◻ How to decide what values to select for the relevant variables in the investigation ◻ How to ensure a method is valid ◻ How to decide what preliminary tests are necessary for the success of the investigation ◻ How to modify a method to reduce errors ◻ What is meant by data of sufficient quality ◻ How to select equipment that produces data of sufficient quality ◻ The use of online databases, simulations and models as alternatives to practical investigations ◻ Why there are limitations for the types of investigations that can be carried out in schools
1.2.2 ◻ Risk assessment: • Identifying hazardous equipment, chemicals, biological hazards and procedures • Risks • Control measures • Emergency measures	To include: ◻ How to complete a risk assessment ◻ How to differentiate between a hazard and risk ◻ How to identify appropriate risks and hazards for an investigation ◻ Hazard symbols and what they represent ◻ How to select and interpret relevant information from chemical safety data sheets ◻ How to explain control measures using scientific principles

	□ Why it is important to be aware of emergency measures before carrying out an investigation
1.3 Conducting preliminary experiments	
1.3.1 □ Conducting preliminary experiments for making decisions about: • Techniques • Equipment □ Modifying a plan in response to preliminary testing	To include: □ Why preliminary experiments are important □ What information can be gained by conducting preliminary experiments □ How to record and present outcomes of preliminary testing □ How to evaluate the data from preliminary testing to decide if modifications are necessary □ How to justify a plan using the data from the preliminary testing Examples of **conducting preliminary experiments for making decisions** may include: □ Techniques – length of time required, repeats required, values for variables □ Equipment – sizes of equipment, quantities, concentrations of chemicals
Topic Area 2: Performing a scientific investigation	
Teaching content	**Exemplification**
2.1 Practical skills and apparatus	
2.1.1 □ Practical techniques • Common practical methods available in schools ○ Types of variable that can be altered and measured ○ Risks and hazards • Equipment ○ Common equipment available in schools ○ Calibration ○ Data collection of sufficient quality ○ Uncertainties ○ Common errors • Databases and simulations	To include: □ How the practical techniques in Unit F180: Fundamentals of science can be modified for use in an investigation □ Why it is important to develop competency in practical techniques and how this can be achieved □ How to access and use databases and simulations to produce data □ Why it is important to work safely and with due care and attention in a scientific practical investigation □ How to demonstrate skilful use of practical apparatus □ How to identify and mitigate sources of error □ How data of sufficient quality can be collected □ How to determine the uncertainty associated with different measuring equipment and reduce uncertainty □ How to calibrate equipment to reduce errors □ How to assess the cleanliness and proper function of equipment

2.2 Recording data from experiments	
2.2.1 □ Types of data available in practical investigations: • Qualitative and quantitative data • Continuous and discrete data • Data from observations and measurements (including repeats) □ Recording data in: • Diagrams, images, and video • Results tables • Spreadsheets • Dataloggers	To include: □ Key features of each type of data □ Advantages of each type of data in practical investigations □ Appropriate units and conventions for each type of data □ The importance of recording all relevant forms of data □ Advantages and disadvantages of different ways of recording data □ How to select a format for recording data that suits the data being collected □ Use of appropriate column headings and units □ Use of appropriate levels of precision
Topic Area 3: Analysing and communicating results	
Teaching content	**Exemplification**
3.1 Analysing data	
3.1.1 □ Using mathematical skills from Mathematical Skills for Applied Science (Appendix D) to analyse data in investigations • Processing data • Using graphical techniques to analyse data	To include: □ How to select which mathematical skills are appropriate □ The value of processing raw data for analysis □ How to use appropriate mathematical skills □ How to propagate uncertainties to determine total uncertainty □ How to determine when and which statistical analysis is appropriate □ How to use spreadsheets to process data □ How to draw each type of graph, including error bars and lines and curves of best fit □ How to select appropriate graph(s) to suit the data recorded □ How to use spreadsheets to draw graphs, error bars, and lines and curves of best fit
3.1.2 □ Types of errors • Random • Systematic □ Outliers and anomalous data	To include: □ Definitions of random and systematic error □ How to identify each type of error in an investigation □ How to explain reasons for errors □ The difference between an outlier and an anomalous result □ How to identify outliers and anomalous data in tables and graphs □ Causes and effects of outliers and anomalous data □ How to account for outliers and anomalous data

3.2 Writing conclusions	
3.2.1 □ Using mathematical skills from Mathematical Skills for Applied Science (Appendix D) to interpret data from graphs: □ Using patterns and relationships from graphs to make conclusions.	To include: □ How to mathematically interpret data from graphs and when it is necessary □ How to find values by interpolation and extrapolation □ How to interpret patterns of data from different types of graphs □ How to describe relationships shown by patterns in graphs □ The difference between a correlation and causation □ Examples of patterns and relationships from graphs to include: • Overlapping error bars between plotted points • Slope of lines of best fit • Inflexion points
3.2.2 □ Conclusions from data • Comparing results to secondary data • Confidence in conclusions • Relating the investigation and data to environmental, commercial and industrial processes • Answering the research question	To include: □ How to write a concise conclusion(s) from primary and secondary data □ How to select appropriate data from secondary sources to compare results to □ How to make valid comparisons between primary and secondary data □ What is meant by confidence in conclusions for an investigation □ How to explain the impact of limitations on a conclusion □ How the conclusion(s) is/are relevant to environmental, commercial and industrial processes □ How to address the extent to which the research question was answered
3.3 Communicating results	
3.3.1 □ Writing a scientific report of the investigation	To include: □ What should be included in a scientific report □ The importance of each section of the report □ Use of appropriate scientific terminology and the level of detail required in scientific reports Does not include: □ Writing abstracts
3.3.2 □ Defending conclusions	To include: □ What is meant by a defence of conclusions □ How scientists defend their research to peers □ How to present a brief summary of the investigation □ How to communicate clearly

	□ How to prepare for challenges to the conclusions of an investigation □ How to form relevant questions to challenge the investigation of peers
Topic Area 4: Evaluating a scientific investigation	
Teaching content	**Exemplification**
4.1 Evaluating the investigation	
4.1.1 □ Evaluating the investigation • Equipment • Methods • Outcomes • Sources of information and secondary data	To include: □ Why it is important to evaluate an investigation □ How to assess the effectiveness of the equipment and methods used □ How to assess the methods used to process and display the data □ How to explain the limitations and sources of error in collected data □ How to decide the reliability of sources of information and secondary data used in the investigation □ How to suggest improvements for an investigation, limited to those available in schools □ How to decide if the improvements are appropriate and what impact they will have

Assessment criteria

Section 6.4 provides full information on how to assess the NEA units and apply the assessment criteria.

These are the assessment criteria for the tasks for this unit. The assessment criteria indicate what is required in each task. Students' work must show that all aspects of a criterion have been met in sufficient detail for it to be **successfully achieved** (see **Section 6.4.1**). If a student's work does not fully meet a criterion, you must not award that criterion.

The command words used in the assessment criteria are defined in **Appendix B**.

Pass	Merit	Distinction
P1: Use research to **create** an appropriate research question from **one** of the given investigation titles.	**M1: Explain** the scientific principles behind the investigation.	**D1:** Use research to **explain** how the scientific principles behind the investigation relate to environmental, commercial, and industrial processes.
P2: Construct a hypothesis, and a prediction.		
P3: Produce a plan for the full investigation which includes a method for the preliminary testing.	**M2: Explain** the choice of equipment and variables for the full investigation.	**D2: Justify** the plan using the data from the preliminary testing.
	M3: Explain the choices for the preliminary testing aspect of your method.	
P4: Use research to **complete** a risk assessment for your investigation.		

Pass	Merit	Distinction
P5: Present the outcomes of your preliminary testing.		
P6: Complete the investigation by following your plan safely.	**M4: Collect** data of sufficient quality to help answer the research question.	
P7: Collect valid data following your plan.		
P8: Record the data obtained in appropriate ways using correct conventions and units.		
P9: Use standard mathematical skills to process data.	**M5: Use** spreadsheets to appropriately process the data.	**D3: Justify** the methods used to process and display data.
P10: Use appropriate graphical representation(s) to display data.		
	M6: Calculate percentage uncertainties for the investigation.	**D4: Explain** the sources of error.
P11: Write appropriate conclusions from the data obtained.	**M7: Make** valid qualitative comparisons between primary and secondary data.	
P12: Explain the limitations of the data collected, including the method used to collect the data.	**M8: Evaluate** the sources of information and secondary data.	**D5: Justify** suggestions for any improvements that could be made.
		D6: Assess the relevance of your investigation and data to environmental, commercial and industrial processes.
P13: Present your conclusions.		
P14: Defend your conclusions.		

Assessment guidance

This assessment guidance gives you information relating to the assessment criteria. There might not be additional assessment guidance for each assessment criterion. It is included only where it is needed.

Assessment Criteria	Assessment guidance
P1	• The research question must include one independent and one dependent variable, and an indication of how investigation will be performed (e.g. via titration, using gas syringe, colorimetry). • The data collected for both variables will need to be quantitative. • The research should include data that the student can use to help them create their research question, and to allow them to then make a comparison later on between this data and their collected data in **M7**. • The research element of this criterion does not need to be completed under supervised conditions.
M1	• Students must apply knowledge and understanding from Unit F180 to explain the scientific principles behind the investigation.
D1	• Students must explain how the scientific principles in **M1** and their research question in **P1** can relate to real world understanding or applications. Students must explain how the scientific principles behind the investigation relate to environmental, commercial, and industrial processes. • If any of environmental, commercial and/or industrial processes are not appropriate, students must explain why. • The research element of this criterion does not need to be completed under supervised conditions.
P3	• Students must provide a step-by-step method that includes all of the equipment they wish to use, including sizes and quantities, personal protective equipment (PPE) as appropriate, and includes the number of repeats they will do. • There must be a separate section describing how the preliminary tests will be carried out. • They must state the control variables and account for how they will be controlled throughout the investigation. This could be in the form of a table.
P4	• The research element of this criterion does not need to be completed under supervised conditions.
P5	• A results table may be appropriate for most investigations, but qualitative descriptions are also suitable. • The teacher observation record form should comment on the independent collection of data from preliminary testing.
M2	• Students must consider how the equipment chosen will help with the collection of valid and high-quality data. • Students must explain why each variable (independent, dependent and control) was chosen for this investigation, and explain the range of value(s) they have decided to test.
M3	• Students must give reasons for the method and range of variables to be tested in the preliminary testing, and what information they expect to be useful for carrying out the full investigation.
D2	• Students must explain any decisions made about modifications to the original plan in relation to the preliminary testing. They must also account for any absence of modifications.

P6	• Students must follow their plan safely, including consideration of the control measures outlined in their risk assessment. • The teacher observation record form should comment on the safe carrying out of the procedures.
P7	• Students must collect data about all of the variables discussed in the plan, i.e. also the control variables.
M4	• The teacher observation record form should comment on the skilful use of apparatus and the accuracy and precision of data collected.
P9	• Students must use mathematical skills identified in the specification to process their data appropriately. • They must show at least one example of their full working out in the written evidence.
P10	• Appropriate trendlines and error bars should be included.
P11	• An analysis of the data is required to write appropriate conclusions. • A limited scientific explanation is required.
M5	• Students must use spreadsheet packages (e.g. Microsoft Excel) to calculate, for example, standard deviation. • Students can also use spreadsheets to help them process and represent data in **P9** and **P10**.
M6	• Students must calculate the percentage uncertainty on each piece of equipment used and the combined uncertainty for each repeat. • They must show their full working out in the written evidence.
M7	• Students must make a qualitative comparison between their collected data and one source of appropriate secondary data. • The secondary data should come from the research completed in **P1**.
D3	• Students must justify their methods for processing and displaying the data in their report. E.g. the type of graph used, any data they had identified as anomalous, positioning of lines of best fit, etc.
D4	• Students must account for any anomalous results or patterns in the data that do not appear to fit the hypothesis. • If there are no anomalous results, students must explain how they arrived at this decision. • This should be done qualitatively only.
P12	• Students should also explain how well they were able to collect good quality data with the techniques and equipment chosen. • This should be supported by evidence collected during the investigation.
P13	• The research question should be presented, a brief explanation of the methods followed, and the data summarised. The extent to which the research question was answered should be justified. • This can be delivered to the assessor and/or peers.

P14	• The assessor should ask appropriate questions to enable the student to defend their investigation adequately. For example:
	  o Were there any limitations that prevented the research question being answered in full?
	  o Are you confident errors had little impact on your results?
	  o Are your conclusions justified sufficiently by the data you collected?
	• The teacher observation record form should include the questions posed and comment on how well they were answered following the student's presentation in **P13**.

M8	• Students should include judgements on their confidence in the sources used throughout the investigation, e.g. those used to design the method, create the risk assessment, and the secondary data, with reference to reliability and validity.
D5	• Students should give valid reasons for improvements to the investigation that would improve the conclusion(s) or help answer the research question. • Processed data should be used to support any recommendations. • If no improvements can be recommended then this needs to be explained using evidence from the investigation.
D6	• Students should provide reasons, based on the evidence collected during the investigation, about the relevance of conclusions made to environmental, commercial and industrial processes. • If any of environmental, commercial and/or industrial processes are not relevant, students must explain why.

Synoptic assessment

Some of the knowledge, understanding and skills needed to complete this unit will draw on the learning in Units F180 and F181.

This table details these synoptic links.

Unit F182: Investigating science		Unit F180: Fundamentals of science	
Topic Area		Topic Area	
2	Performing a scientific investigation	B1	Cell structure and microscopy
		B4	Biodiversity and ecosystems
		C2	Quantitative chemistry
		C4	Rates of reaction and enthalpy changes
		P1	Electricity
		P2	Motion

Unit F182: Investigating science		Unit F181: Science in society	
Topic Area		Topic Area	
1	Planning a scientific investigation	4	Communicating science
3	Analysing and communicating results	1	What scientists do

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic assessment.**

4.3.2 Unit F183: Analytical techniques in chemistry

Unit Aim

Science is ever evolving. Improving our understanding of substances and how they are composed and interact is key to driving innovation in areas such as chemical sciences, forensic science, biochemical science and environmental science. This unit explores how to identify chemical substances and determine quantities present by using a wide range of techniques to separate and analyse the composition. The knowledge and skills developed will give you a solid basis for further progression in a range of scientific fields.

In this unit you will learn how to plan and perform practical investigations to separate substances and purify them. You will also learn how to categorise different types of substance according to their physical properties and determine amounts present in a substance or solution. You will develop the skills to use chemical tests to identify the presence of specific ions and molecules and interpret spectra to provide information about the structure of molecules. Studying this unit will help you develop analytical skills, make logical deductions and conclusions from observations and interpret results and data. You will gain planning and problem-solving skills by selecting and applying techniques as well as understanding the principles behind the tests and equipment used.

Unit F183: Analytical techniques in chemistry	
Topic Area 1: Techniques to categorise and separate chemical substances	
Teaching content	**Exemplification**
1.1 Chemical substances and their properties	
1.1.1 Distinguishing between different types of chemical substance □ Elements • Metal • Metalloid • Non-metal □ Mixtures □ Compounds □ Structure types • Lattices • Giant • Simple □ Physical properties of substances • Electrical and thermal conductivity • Melting and boiling point • Density • Malleability • Ductility • Brittleness • Hardness • Solubility	To include: □ The difference between a pure substance and a mixture □ Methods to determine the physical properties of a substance to support identification □ How to compare physical properties of materials with data books/tables to support identification □ The limitations of data from books and tables □ How to distinguish between a pure substance and a mixture via physical properties and other observations □ The limitations of using physical properties to predict the identity of a material □ How physical properties of mixtures can be altered, for example, melting point □ Determining and comparing the cooling curves of pure and impure compounds □ The use of IT to create cooling curves Does not include: □ Atomic structure, isotopes, periodicity, reactivity
1.2 Separating chemical substances	
1.2.1 Techniques to separate substances □ Filtration • Gravity • Reduced pressure □ Centrifugation □ Solvent extraction	To include: □ Why all substances can be considered to be mixtures □ The principles of each separation technique and their use

□ Recrystallisation □ Drying □ Sublimation □ Distillation • Simple • Steam • Reduced pressure □ Fractional distillation □ Chromatography • Paper • Thin Layer Chromatography (TLC) • Column • Ion-exchange • Gel-permeation • Gas-Liquid Chromatography (GLC) • High Performance Liquid Chromatography (HPLC)	□ The appropriateness of each separation technique for different types of mixtures □ How to carry out those separation techniques available to schools □ The risks and hazards associated with the techniques that can be performed in schools □ The advantages and disadvantages of each separation technique • Examples to include decomposition, flammability and reactivity □ Why some techniques are combined or repeated to increase the purity of a substance Does not include: □ Synthesis of compounds
1.2.2 Testing the purity of a substance □ Chromatogram analysis • Number and amount of components • Determining R_f from chromatograms □ Boiling point determination and techniques □ Melting point determination and techniques □ Instrumental analysis	To include: □ The principles and use of techniques to determine purity of a substance, including the instrumental techniques mentioned within this unit □ How to choose appropriate tests for purity □ The advantages and disadvantages of each test □ How to perform tests for purity available to schools □ The risks and hazards associated with the tests that can be performed in schools □ Suitability of different types of equipment for each test to produce accurate results, and their uncertainties □ Analysing chromatograms to determine percentage purity and identities of components □ Calculating Rf values and using these to identify a substance □ Use the equation: $Rf = \frac{\text{distance of component from base line}}{\text{distance of solvent front from base line}}$ □ Using data books or tables to identify substances by their Rf values □ The limitations of data from books and tables □ Analysing cooling curves to determine melting or boiling points and purity of substances

Topic Area 2: Quantitative and qualitative analytical techniques to quantify and identify substances	
Teaching content	**Exemplification**
2.1 Quantitative analysis	
2.1.1 Quantitative analysis of solids □ Reacting masses □ Changes in mass □ Precipitation gravimetric analysis □ Thermal gravimetric analysis □ Changes in gas volume □ Gas collection and measurement methods □ Instrumental analysis	To include: □ How amount, mass and volume of substances produced in reactions can be used to determine the identity of a substance □ How to select the appropriate quantitative analysis technique, including the instrumental techniques mentioned within this unit □ The advantages and disadvantages of each method of quantitative analysis □ How to carry out the analysis techniques available to schools □ The risks and hazards associated with the techniques that can be performed in schools □ Suitability of different types of equipment for each technique to produce accurate results, and their uncertainties □ Examples: • Determine chemical formulae of metal oxides • Determine stoichiometric equation and chemical formulae of products of thermal decomposition • Identify unknown metals / metal carbonates from their reaction with an acid • Identify ions using precipitation reaction
2.1.2 Quantitative analysis of solutions □ Volumetric analysis □ Indicator selection □ Serial dilutions □ Alternative instrumentation for titration • Thermometer • pH meter • Autotitrators □ Analysis by colorimetry □ Instrumental analysis	To include: □ How to select the appropriate quantitative analysis technique, including the instrumental techniques mentioned within this unit □ How to identify the appropriate standard solution to use in a titration □ How to select the correct indicator for a titration □ Preparation of and importance of serial dilutions □ How to carry out different types of titration to determine concentration, including acid-base, redox, complexometric and back titrations □ Suitability of different types of equipment in a titration to produce accurate results, and their uncertainties □ Common errors, risks and hazards associated with techniques available in schools

	□ How to use a colorimeter, produce calibration curves and use IT in colorimetry □ How to use instrumentation in titration: • Thermometer for thermometric titration • pH meter for monitoring pH change • Autotitrators □ The advantages and disadvantages of each method of quantitative analysis
2.2 Qualitative analysis	
2.2.1 Identification of inorganic substances □ Chemical tests for gases • Hydrogen • Oxygen • Carbon dioxide • Chlorine • Hydrogen halides • Ammonia □ Chemical tests for cations • Li^+ • Na^+ • K^+ • Mg^{2+} • Ca^{2+} • Ba^{2+} • Al^{3+} • Fe^{2+} • Fe^{3+} • Cu^{2+} • H^+ • NH_4^+ □ Chemical tests for anions • Hydroxide (OH^-) • Carbonate (CO_3^{2-}) • Sulfate (SO_4^{2-}) • Chloride (Cl^-) • Bromide (Br^-) • Iodide (I^-) □ Combined chemical tests to identify inorganic compounds □ Alternative techniques using instrumentation • Atomic emission spectroscopy (AES) • Colorimetry	To include: □ How to perform qualitative analysis for the presence (and absence) of the listed anions, cations and gases to determine the identity of an inorganic substance □ How to use these tests to confirm purity of a substance □ Common errors, risks and hazards associated with tests available in schools □ How to select the appropriate qualitative analysis technique, including the instrumental techniques □ The principles of each instrumental technique and their use to identify ions and gases □ The advantages and disadvantages of each method of qualitative analysis
2.2.2 Identification of organic compounds □ Chemical tests for functional groups of organic compounds • Alkenes • Alcohols • Halogenoalkanes • Carbonyl compounds • Carboxylic acids	To include: □ How to perform chemical tests to identify the functional group of these organic compounds □ How to use these tests to confirm purity of a substance □ Common errors, risks and hazards associated with tests available in schools

□ Alternative techniques using instrumentation • Infrared spectroscopy • UV-visible spectroscopy • Fluorescence spectroscopy • Colorimetry	□ How to select the appropriate qualitative analysis technique, including the instrumental techniques □ The principles of each instrumental technique and their use to confirm the organic compounds □ The advantages and disadvantages of each method of qualitative analysis
Topic Area 3: The principles of spectroscopic techniques and interpreting spectra for chemical substances	
3.1 Spectroscopic techniques	
3.1.1 Mass spectrometry □ Principles □ Spectrum interpretation □ Relative Atomic Mass (RAM) and Relative Formula Mass (RFM) determination □ Molecular ion □ Fragmentation patterns	To include: □ An introduction to the principles of mass spectrometry and its applications □ Interpreting mass spectra to determine the RFM of molecules, limited to those encountered in this specification. □ How to interpret fragmentation patterns to deduce structural features for molecules □ How to use mass spectrometry in conjunction with percentage mass data, qualitative tests and chromatography (GC-MS) Does not include □ Ions with charges greater than 1 □ Detailed features of mass spectroscopy and the equipment involved
3.1.2 Infrared spectroscopy □ Principles □ Spectrum interpretation □ Use of data reference table of covalent bonds	To include: □ An introduction to the principles of infrared spectroscopy and its applications □ How to interpret infrared spectrums to determine the types of covalent bonds and functional groups present in molecules, limited to those given in this specification □ How to determine the purity or concentration of compounds □ How to use infrared spectrometry in conjunction with percentage mass data, qualitative tests and mass spectrometry to identify an unknown organic compound
3.1.3 Carbon-13 Nuclear magnetic resonance (^{13}C-NMR) spectroscopy □ Principles □ Spectrum interpretation using data reference table of chemical shifts	To include: □ An introduction to the principles of NMR spectroscopy and its applications □ How to interpret ^{13}C-NMR spectrums to determine the structure of molecules, limited to those given in this specification □ How to use NMR spectrometry in conjunction with percentage mass data, qualitative tests, mass spectrometry and infrared spectrometry to confirm the identity of an organic compound

	Does not include: □ Details about the use of TMS or magnetic fields □ Detailed knowledge about magnetic nuclear spin

Assessment criteria

Section 6.4 provides full information on how to assess the NEA units and apply the assessment criteria.

These are the assessment criteria for the tasks for this unit. The assessment criteria indicate what is required in each task. Students' work must show that all aspects of a criterion have been met in sufficient detail for it to be **successfully achieved** (see **Section 6.4.1**). If a student's work does not fully meet a criterion, you must not award that criterion.

The command words used in the assessment criteria are defined in **Appendix B**.

Pass	**Merit**	**Distinction**
P1: Identify appropriate tests and techniques to investigate the unknown compounds in a logically sequenced order.		
P2: Identify appropriate equipment, reagents and quantities to investigate the unknown compounds.		
P3: Use research to **complete** a risk assessment for your investigation.		
P4: Perform separating techniques identified in the plan for the unknown organic compound safely and skilfully.	**M1: Use** appropriate techniques to confirm the purity of the isolated compound.	**D1: Justify** the identity of the organic compound.
P5: Perform qualitative tests identified in the plan to determine the functional group of the organic compound safely.	**M2: Interpret** spectra to confirm the identity of the organic compound.	
P6: Perform appropriate separating techniques for the unknown inorganic compound.	**M3: Use** appropriate techniques to confirm the purity of the isolated compound.	**D2: Evaluate** the accuracy of the percentage purity of the inorganic compound.
P7: Perform qualitative tests identified in the plan to confirm the identity of the inorganic compound.	**M4: Explain** the identity of the inorganic compound.	
P8: Use research to **identify** appropriate techniques and reagent(s) to determine concentration.		
P9: Prepare appropriate standard solution(s).		

Pass	Merit	Distinction
P10: Use appropriate technique(s) to determine reacting volumes safely and skilfully.	**M5: Calculate** the concentration of the solution and the combined uncertainty in this result.	**D3: Evaluate** concentration of the solution in comparison with the actual concentration that is suggested in the scenario.
P11: Explain other tests or techniques that could be used to help confirm the identity of the compounds and the concentration of the solution.	**M6: Assess** the quality of the data collected.	**D4**: **Evaluate** the tests and techniques used to confirm the identity and concentrations of the compounds.
		D5: Justify suggestions for improvements that could be made.

Assessment guidance

This assessment guidance gives you information relating to the assessment criteria. There might not be additional assessment guidance for each assessment criterion. It is included only where it is needed.

Assessment Criteria	Assessment guidance
P1	• **P1** does not require research from students, it should be from taught Unit F183 knowledge. • **P1** should not be a standalone list, it should form part of a written, logically sequenced plan for the investigation.
P2	• The size, quantity and type of equipment (e.g. size and type of pipettes/beakers etc.) will need to be specified by the student to achieve **P2**. • **P2** should not be a standalone list, it should form part of the written, logically sequenced plan for the investigation.
P3	• Students will need to complete some basic research to help them identify the risks associated with the reagents and techniques chosen. • References should be included at the end of the risk assessment template. • The research element of this criterion does not need to be completed under supervised conditions.
P4	• Students should use annotated photographic evidence to help them describe qualitative observations. • The teacher observation record form should comment on the safe carrying out of the separating techniques and the skilful use of apparatus by the student to collect data of sufficient quality.
P5	• Students should use annotated photographic evidence to help them describe qualitative observations. • The teacher observation record form should comment on the safe carrying out of the qualitative tests by the student.

M2	• Students should match the evidence collected from **P4**, **P5** and **M1** to the spectroscopic data provided, to identify the type of organic compound. • Students should then use calculations to confirm the identity of the organic compound. • The name of the organic compound should be provided using IUPAC nomenclature, as well as the displayed or structural formula of the organic compound.
D1	• Students should explain how they matched the evidence from **P4**, **P5** and **M1** to the spectroscopic data. Students should also explain why they rejected the other spectroscopic data. • Annotations to the spectroscopic data should be made to help students form their explanation.
P6	• Students should use annotated photographic evidence to help them describe qualitative observations.
P7	• Students should use annotated photographic evidence to help them describe qualitative observations.
M4	• Students should explain how they collated evidence from **P6**, **P7** and **M3** to identify the ions in the inorganic compound. Students should explain why they rejected the presence of other ions in the inorganic compound. • The name of the inorganic compound should be provided using IUPAC nomenclature, as well as the chemical formula.
D2	• Students should use appropriate techniques (including gravimetric analysis) to calculate the percentage purity of the inorganic compound. • Students should then consider how accurate this value is considering the techniques used in **P6** and **M3**.
P8	• Research is required to select appropriate reagents to determine the concentration of the unknown inorganic compound. • The research element of this criterion does not need to be completed under supervised conditions.
P9	• The teacher observation record form should comment on the skilful preparation of standard solutions.
P10	• Students should use annotated photographic evidence to help them indicate that they have collected data of sufficient quality. • The teacher observation record form should comment on the safe carrying out of the quantitative tests by the student.
M5	• Students should process raw data appropriately and indicate their decisions in their written evidence. All working out should be included in the written evidence, with appropriate units.
P11	• Students should not be restricted to the tests or techniques available in their school.
M6	• Students should use their understanding of quality data to offer a reasoned judgment of the data collected. • Students should consider the purity of the final compounds they isolated, potential losses during separation techniques, and any other errors that may have been introduced during the investigation. • They should not attribute errors in the data to the materials provided by the centre or that provided in the scenario.
D4	• Students should consider the strengths and limitations of the apparatus, tests, and techniques that were used. • Combined uncertainty calculated in M5 should form part of this judgment.

D5	• Students should consider all techniques explored in Unit F183 when making their decisions about improvements. • The justification should be restricted to the tests or techniques available in their school.

Synoptic assessment

Some of the knowledge, understanding and skills needed to complete this unit will draw on the learning in Unit F180.

This table details these synoptic links.

Unit F183: Analytical techniques in chemistry		Unit F180: Fundamentals of science	
Topic Area		Topic Area	
1	Techniques to categorise and separate chemical substances	C3	Structure and bonding
2	Quantitative and qualitative analytical techniques to quantify and identify substances	C2	Quantitative chemistry
3	The principles of spectroscopic techniques and interpreting spectra for chemical substances	C1	Atomic structure and the Periodic Table

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic assessment.**

4.3.3 Unit F184: Environmental studies

Unit Aim

Human activity has significant impact on the environment and the species living within it. This unit explores ecosystems and biodiversity, how ecosystems are managed and the conservation strategies used in their management. The unit also considers the strategies for managing domestic and industrial waste.

In this unit you will learn to use primary and secondary data to study ecosystems. You will develop the skills to carry out *in situ* fieldwork investigations to survey an area using different sampling techniques. You will learn about the different surveys available for studying the environment and how *in situ* and *ex situ* conservation strategies are used to protect species and their environments. You will also learn how to use online information to learn about biodiversity and compare different ecosystems. Finally, you will be able to research some of the strategies used to monitor and treat waste products in places such as landfill sites and water courses.

Unit F184: Environmental studies	
Topic Area 1: Ecosystems and biodiversity	
Teaching content	**Exemplification**
1.1 Ecosystems	
1.1.1 What an ecosystem is □ Abiotic factors □ Biotic factors	To include: □ Ecosystems range in size and are dynamic □ Organisms engage in complex interactions with their environment □ The composition of an ecosystem is affected by abiotic factors and biotic factors □ The role of interdependence in an ecosystem
1.1.2 Types of ecosystem □ Terrestrial ecosystems □ Aquatic ecosystems	To include: □ Different terrestrial ecosystems □ Different aquatic ecosystems □ Abiotic and biotic factors common to these ecosystems □ How adaptations of different species enable them to live and survive in different ecosystems Examples of **ecosystems** may include: □ Pond, tree, local park, local woodland, school playing field
1.2 Biodiversity	
1.2.1 Levels of biodiversity □ Species diversity □ Ecosystem diversity □ Genetic biodiversity	To include: □ Species diversity as a measure of species richness and species evenness □ Ecosystem diversity as a measure of the range of ecosystems in a specific area □ Genetic diversity as the biological variation within a species □ The interactions and influences of each level on the others Does not include: □ Calculations of genetic diversity

1.3 Importance of conserving ecosystems and maintaining biodiversity	
1.3.1 Importance of ecosystems □ Ecological reasons □ Life support functions □ Ecosystem-support functions □ Endemic species □ Economic reasons □ Aesthetic reasons	To include: □ Provision of specific habitats and niches for different species □ Why ecosystem conservation is particularly important to endemic species □ How sustainable habitat management can secure future supplies of natural resources, such as wood and food □ The role of biomimetics in design and manufacture
1.3.2 Importance of maintaining biodiversity □ Importance of ecosystems with high biodiversity (species-rich areas) □ Keystone species □ Foundation species	To include: □ Why healthy, biodiverse ecosystems are important □ The use of wildlife and plant life as pest control or sources of new medicines □ The role of genetic diversity as a source for improving agricultural crops □ How to identify keystone and foundation species Examples may include: □ Improve air and water quality □ Prevent soil erosion □ Seed dispersal and pollination □ Recycle nutrients □ Provide food and raw materials
1.4 Understanding case studies	
1.4.1 Case studies as a unique source of information	□ The advantages of a case study over other forms of scientific research in informing developments □ How to select appropriate case studies to support research and decision making □ How to evaluate the relevance, limitations, and methodologies used by a case study about an ecosystem or development
Topic Area 2: Impact of human activity and natural events	
Teaching content	**Exemplification**
2.1 Impact of human activities	
2.1.1 Change of land use □ Farming practices □ Industrial practices □ Housing and commercial □ Recreation and tourism	To include: □ How the need for more food and more housing due to increasing human population leads to change of land use □ How change of land use has impacts on biodiversity and the environment Examples of **impacts of human activities** may include: □ Use of large agricultural machinery results in need for bigger fields so removal of hedgerows as natural boundaries

	□ Removal of grasslands and deforestation for building industrial units and housing developments □ Changing natural lakes into parcourse fishing lake
2.1.2 Species exploitation and eradication □ For resources □ For sport	To include: □ Historical, cultural and economical reasons for direct and deliberate destruction of populations of animal and plant life Examples of **species exploitation for resources** may include: □ Food, fashion, furniture and traditional medicines
2.1.3 Introduction of alien species □ Invasive species □ Impact of pets □ Trade in exotic species □ Impact of farm animals	To include: □ The difference between native and invasive species □ How invasive species are introduced into the environment and how they impact native species □ Why the introduction of domestic pets impacts biodiversity, including food webs and predator-prey relationships □ How trade in exotic species causes imbalance in the food webs and reduces biodiversity □ How intensive farming impacts the environment
2.1.4 Pollution □ Air pollution □ Water pollution □ Soil pollution □ Noise pollution	To include: □ Origins and effects of different types of pollution on ecosystems and biodiversity □ Wider impacts on society □ The difference between point source and non-point source pollution □ General ways to mitigate pollution and the reasons why pollution continues Examples of origins of **pollution** may include: □ Transport □ Mining □ Energy generation □ Manufacture of goods
2.2 Impact of natural events	
2.2.1 Disease □ Genetic disease □ Infectious disease	To include: • How disease affects population numbers and ecosystems • Why species with small gene pools or small populations are more at risk
2.2.2 Earth events □ Effects of natural disasters and events	To include: □ How natural disasters affect biodiversity and the environment Examples of **earth events** may include: □ Earthquakes

	◻ Wildfires ◻ Flooding ◻ Drought ◻ Volcanic activity
Topic Area 3: Waste management	
Teaching content	**Exemplification**
3.1 Dealing with domestic waste	
3.1.1 Processing domestic waste in the UK ◻ Landfill	To include: ◻ Different types of solid domestic waste and how it is collected and distributed ◻ What happens to waste in landfill sites including: • Different routes for different types of waste • Possible environmental damage • Monitoring waste gases produced
◻ Recycling	◻ What happens to items recycled by households including: • Methods for sorting different recyclable materials • Routes taken by different materials • How new products are made
◻ Exporting waste	◻ What happens to exported waste including: • Waste shipped to other countries in containers ◻ Advantages and disadvantages of different methods of dealing with domestic waste
3.1.2 Processing sewage ◻ Sewage treatment plants ◻ Septic tanks	To include: ◻ What happens to domestic wastewater once it leaves homes and businesses ◻ What happens to wastewater from treatment plants ◻ What happens to waste water from septic tanks Examples of **processing sewage** may include: ◻ How solid waste can be made into biofuels ◻ Impact of large environmental footprints
3.2 Dealing with industrial waste	
3.2.1 Waste from industry ◻ Categories of industrial waste ◻ Strategies used for dealing with industrial waste	To include: ◻ How different types of industrial waste need specific disposal to prevent environmental damage and impact on biodiversity ◻ Advantages and disadvantages of: • reduce, reuse, recycle strategy • financial incentives

Topic Area 4: Environmental management and conservation	
Teaching content	**Exemplification**
4.1 Environmental surveying	
4.1.1 Types of environmental survey □ Ecological surveys □ Water quality surveys □ Noise surveys □ Dust in air surveys □ Temperature surveys □ Carbon dioxide surveys □ Peat core surveys	To include: □ Why environmental surveys are needed □ The importance of ecological monitoring in conservation planning □ How different types of surveys can be carried out □ Which survey to use depending on nature of development and location in the country □ Which methods are used for obtaining qualitative and quantitative data □ Data analysis and calculations, including to show correlation such as Spearman's rank correlation coefficient Examples of **ecological surveys** may include: □ Bog restoration surveys to determine the success of habitat management measures. □ Tree planting success for the establishment of new areas of woodland.
4.2 Environmental management	
4.2.1 Environmental management methods □ Manage resources □ Manage waste and pollution □ Develop sustainably □ Preserve and improve biodiversity □ Maintain and develop ecosystems	To include: □ Role of education and social responsibility in protecting the environment □ Role of laws and legislation in protecting the environment □ Role of governments in managing environments □ Role of businesses in managing environments
4.2.2 Role of governments in managing environments □ Setting environmental policy, legislation and regulations □ Raising public awareness □ Establishing agencies, authorities, policies and legislation designed to protect and manage the environment □ Providing funding for environmental protection	To include: □ How environmental regulations are enforced □ How public awareness is raised, including through the use of education □ How agencies, authorities, policies and legislation can be used to ensure human needs are met sustainably Examples of **agencies and authorities** with responsibility in creating policies and enforcing them may include: □ Office for Environmental Protection (OEP) □ The Environment Agency □ Local Planning Authority □ Environmental Investigation Agency Examples of **policies and legislation** may include: □ The Town and Country Planning (Environmental Impact Assessment) Regulations 2017

	□ The wildlife and countryside act (1981) □ The Environment Act 2021 Does not include: □ Specific details of the work of international agencies
4.2.3 Role of businesses in managing environments □ Environmental management systems (EMSs) □ Environmental impact assessments (EIAs)	To include: □ How to create EMSs and EIAs □ Who is required to have EMSs and EIAs □ The role of case studies and stakeholders in writing EIAs □ Why EMSs and EIAs are important to managing an environment and protecting an ecosystem □ Advantages to organisations and business in creating, implementing and monitoring EMSs and EIAs □ Impacts on businesses from failing to comply with legislations and industry standards to protect the environment □ The importance of sustainability and sustainable development
4.2.4 Barriers to effective environmental management □ Issues that can prevent effective management of an environment	To include: □ Barriers that impact the rate of habitat and biodiversity loss □ Why different barriers for managing an environment exist and how these barriers prevent effective management of that environment or ecosystem □ How to identify these barriers from a case study or other information □ Ways in which these barriers may be addressed in the sustainable management of an environment Examples of **barriers** may include: □ Religious or cultural □ Education □ Economical
4.3 Conservation strategies	
4.3.1 *in situ* conservation □ Methods to conserve species *in situ*	To include: □ How to select appropriate *in situ* conservation methods □ Advantages and disadvantages of *in situ* conservation methods Examples **of *in situ* conservation** may include: □ Marine conservation zones and wildlife reserves

4.3.2 *ex situ* conservation □ Methods to conserve species ex *situ*	To include: □ How to select appropriate *ex situ* conservation methods □ Advantages and disadvantages of *ex situ* conservation methods Examples of ***ex situ* conservation methods** may include: □ Seed banks, botanic gardens and zoos
Topic Area 5: Fieldwork	
Teaching content	**Exemplification**
5.1 Location analysis	
5.1.1 Location Analysis □ Physical characteristics □ Human uses □ Important environmental features □ History of location □ Biodiversity □ Use of maps □ Use of databases	To include: □ How to use maps and databases to find information about a potential location of fieldwork □ How to find out about monthly and yearly weather patterns for a potential location □ How to decide if the data is reliable and relevant Examples of **physical characteristics** may include: □ Climate, soil type, roads and rivers Examples of **human uses** may include: □ Current and planned, agriculture and industry Examples of **important environmental features** may include: □ Protected areas and rare species Examples of **history of location** may include: □ Past land uses and environmental accidents Examples of **biodiversity** sources may include: □ Office for National Statistics □ National Biodiversity Network □ Local wildlife trusts □ Local biodiversity action plans
5.2 Suitability of the environment	
Measuring abiotic factors □ Light intensity □ Temperature □ Wind velocity □ Humidity □ Water analysis □ Soil analysis	To include: □ Techniques and apparatus to collect data *in situ* and samples for testing in a laboratory □ When to use each technique and the information it will provide about an ecosystem □ How each technique is performed to collect data of sufficient quality and have minimal impact on the local environment

	◻ The limitations of techniques that can be performed in schools compared with those that are performed professionally
5.3 Sampling techniques	
5.3.1 Population sampling ◻ Representative sampling • Random sampling • Stratified sampling • Systematic sampling ◻ Species lists ◻ Abundant Common Frequent Occasional Rare (ACFOR) scale ◻ Dominant Abundant Frequent Occasional Rare (DAFOR) scale ◻ Sample timing, size and number ◻ Species identification	To include: ◻ The importance of representative sampling ◻ How to choose appropriate sampling techniques to gather data of sufficient quality for an EIA ◻ How to avoid bias in sampling ◻ The importance of standardisation of techniques and clear descriptions of methodologies ◻ How to design experiments that collect statistically significant data relevant to an EIA ◻ Strengths and weaknesses of each sampling technique ◻ The role of species lists and the ACFOR and DAFOR scales in collecting appropriate data ◻ The importance of when sampling should be carried, and how much to sample, to get representative data ◻ The role of a running mean to assess representation ◻ Using field guides, online databases and apps to identify species
5.3.2 Vegetation sampling ◻ Use of quadrats ◻ Transects ◻ Qualitative sampling ◻ Tree height ◻ Satellite and drone imagery	To include: ◻ Techniques available to schools and conservationists for sampling vegetation ◻ How to carry out different types of transects ◻ How to select quadrat size and type ◻ Use of density/coverage vs frequency ◻ How to measure tree height using a clinometer ◻ Advantages and disadvantages of each technique
5.3.3 Sampling mobile organisms ◻ Freshwater invertebrates ◻ Soil invertebrates ◻ Invertebrates on trees and bushes ◻ Signs of presence ◻ Direct counts ◻ Mark, release and recapture ◻ Telemetry ◻ Satellite and drone imagery ◻ Genetic sampling ◻ Camera trapping and acoustic monitoring	To include: ◻ The importance of sampling mobile organisms and consistency in techniques used ◻ Techniques available to schools and wildlife conservationists for sampling mobile organisms ◻ How to select the appropriate techniques to gather data for an EIA ◻ Assumptions made while sampling mobile organisms ◻ Advantages and disadvantages of each technique

5.4 Risk assessment	
□ Identifying hazardous equipment, chemicals and locations □ Risks involved □ Control measures required □ Emergency measures considered	To include: □ Importance of a risk assessment when carrying out fieldwork □ Use of a well-designed risk assessment template □ Differentiation between hazard and risk □ Appreciation of hazard symbols and their meanings □ How to select and interpret relevant information about hazardous chemicals □ Appreciation of external factors that need to be considered, such as the public, traffic, location choice □ How to explain control measures using scientific principles
5.5 Data processing and analysis	
□ Averages and ranges □ Percentage frequency □ Local frequency □ Percentage abundance □ Calculating tree height □ Species richness □ Species evenness □ Simpson's index of diversity □ Chi-squared test □ Spearman's rank correlation coefficient	To include: □ How to carry out the calculations □ How to decide the appropriate calculations and statistical analysis to use □ How to design the fieldwork to ensure data of sufficient quality for statistical analysis is collected □ How to interpret the results □ The strengths and weakness of each statistical test

Assessment criteria

Section 6.4 provides full information on how to assess the NEA units and apply the assessment criteria.

These are the assessment criteria for the tasks for this unit. The assessment criteria indicate what is required in each task. Students' work must show that all aspects of a criterion have been met in sufficient detail for it to be **successfully achieved** (see **Section 6.4.1**). If a student's work does not fully meet a criterion, you must not award that criterion.

The command words used in the assessment criteria are defined in **Appendix B**.

Pass	Merit	Distinction
P1: Use research to help **summarise** information from the chosen case study.	**M1: Discuss** the sustainability of the environmental management and conservation methods used.	
P2: Describe how surveys were used to inform the environmental management and conservation methods used.		
P3: Use research to **describe** the characteristics of the environment and the ecosystem of the chosen area.		

Pass	Merit	Distinction
P4: Create a plan to carry out appropriate surveys.	**M2: Explain** how the methodology of your surveys will enable data of sufficient quality to be gathered.	**D1: Discuss** how the proposed surveys are appropriate to inform planning and environmental management.
		D2: Evaluate the usefulness of the case study to inform your planning.
P5: Complete a risk assessment for your surveys.		
P6: Use your planned surveys to **collect** sufficient raw data.		
P7: Present your raw data in appropriate ways.	**M3:** Use appropriate calculations to **process** your raw data.	**D3: Analyse** the raw and processed data collected from your surveys.
P8: Write appropriate conclusions from the data obtained.	**M4:** Use research to **identify** appropriate methods for conserving and managing the chosen area.	**D4: Justify** suggested methods for conserving and managing the area in a sustainable way.
P9: Describe how the development could affect the chosen area.		
P10: Summarise the strengths and weaknesses of your plan.	**M5: Suggest** appropriate improvements to your plan.	**D5: Justify** improvements that could increase your confidence in your report.
P11: Assess the quality of the data collected.	**M6: Suggest** how to improve the quality of the data collected.	

Assessment guidance

This assessment guidance gives you information relating to the assessment criteria. There might not be additional assessment guidance for each assessment criterion. It is included only where it is needed.

Assessment Criteria	Assessment guidance
P1	• Students should research the case study selected to help them interpret the information. Students may use an alternative case study from that in the scenario but should ensure that it is easily accessible and referenced. • Students should summarise relevant information about how the impact of human activity has affected the ecosystem in the chosen case study, and methods of environmental management and conservation used. • The research element of this criterion does not need to be completed under supervised conditions.

P3	• Students should research the area chosen for the development. • Students must do a location analysis to be able to describe the characteristics of the area chosen for their development. • They must provide information on both **abiotic** and **biotic** factors of the ecosystem in the chosen area. • The research element of this criterion does not need to be completed under supervised conditions.
P4	• Students must create a plan for at least **two** appropriate surveys which they will carry out in the chosen area. • Within their plan, students must include details of methodology and appropriate equipment required.
P5	• Students must consider the environmental impact of the fieldwork as part of the risk assessment, including how any damage can be minimised.
D1	• Students must discuss the appropriateness of the survey(s) planned in **P4** and how results from these survey(s) will help to inform planning for the development in the chosen area.
D2	• Students should make a reasoned qualitative judgment about the usefulness of the case study to their plan.
P6	• Students should collect photographic evidence while performing the surveys they have planned. This should be annotated to describe to the assessor what the photographs are showing. • The teacher observation record form should be used to detail students following their plan safely, according to their risk assessment.
P7	• The teacher observation record form should also confirm that students collected all of the data recorded.
M3	• Students must show their detailed working of the calculations used to process the data.
D3	• Students must analyse their data quantitatively and qualitatively. • Students should comment on the characteristics of the data.
P8	• Students should use their analysis of the data from **D3** to help them make reasoned conclusions about the chosen area.
P9	• Students must write about the potential impact of the development on the chosen area, using conclusions from **P8** where appropriate.
M4	• The appropriateness of the methods must be linked to **P9**.
P10	• If changes were made to the original plans created in Task 2, these should be reflected upon when summarising the strengths and weaknesses of the methodology.
M6	• Improvements to the data collected should be linked to the assessment of the quality of the data collected in **P11**.
D5	• This should focus on improvements that would increase your confidence in your report to the organisation.

Synoptic assessment

Some of the knowledge, understanding and skills needed to complete this unit will draw on the learning in Units F180 and F181.

This table details these synoptic links.

Unit F184: Environmental studies		Unit F180: Fundamentals of science	
Topic Area		Topic Area	
5	Fieldwork	4	Biodiversity and ecosystems
1	Ecosystems and biodiversity		

Unit F184: Environmental studies		Unit F181: Science in society	
Topic Area		Topic Area	
5	Fieldwork	2	Handling scientific data
2	Impact of human activity and natural events	3	Scientific developments

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic assessment.**

4.3.4 Unit F185: Forensic biology

Unit Aim

Forensic biology skills may be used in a number of situations, whether in the field collecting evidence or analysing such evidence in the laboratory. Forensic biologists are employed by government agencies as well as in the private sector. This unit explores how forensic biologists collect and analyse biological evidence that is relevant to a legal investigation in order to match evidence from a crime scene to individuals or organisations. Such investigations include robberies, environmental contamination and wildlife crime. This unit explores the disciplines of forensic biology and associated evidence: the types of cells, tissues and body fluids that may be collected, how the investigation involves biological evidence collection and analysis, and how it is recorded and reported.

In this unit you will learn how to perform investigations of the macro- and ultrastructure of cells and tissues from fresh and prepared material, using optical microscope techniques and electron micrographs. You will develop the skills to complete the safe culturing of bacteria and to perform practical investigations to collect, log and analyse biological evidence using standard procedures. You will learn how to carry out risk assessments, following current guidance, before completing any practical work. You will develop confidence in using laboratory equipment and microscopes.

Unit F185: Forensic biology	
Topic Area 1: Forensic biology disciplines and evidence	
Teaching content	**Exemplification**
1.1 The nature and origins of forensic science	
1.1.1 Features of forensic science and forensic biology □ Forensic science is the application of science to criminal and civil laws □ The importance of Locard's *exchange principle* to modern forensic science □ Forensic biology is confined to biological evidence	To include: □ The difference between criminal and civil law □ The principle that every contact leaves a trace □ The differences between forensic biology and forensic science Does not include: □ Historical backgrounds of forensic science
1.2 Forensic biology disciplines	
1.2.1 Disciplines associated with forensic biology □ Serology □ Pathology □ Anthropology □ Odontology □ Botany □ Microbiology □ Ornithology □ Entomology	To include: □ The area of study involved in each discipline □ How each discipline could be used as a tool that supports an investigation □ The type of evidence each discipline can contribute to an investigation Does not include: □ Forensic chemistry or toxicology
1.3 Types of evidence in forensic biology	
1.3.1 Evidence available from crime scenes and individuals, relevant to forensic biology □ Biological evidence □ Physical evidence □ Trace evidence	To include: □ The relative importance of each type of evidence in securing particular convictions □ How each type of evidence may be used for generic (class evidence) or unique identification (individual evidence) purposes □ The role evidence plays in supporting time of death in an investigation

	□ How blood patterns can be used to indicate how blood was shed □ The limitations of techniques available in schools for a full forensic analysis of evidence Examples of each **type of evidence** may include: □ **Biological**: hair, tissues, microorganisms in soil □ **Physical**: fingerprints, footprints □ **Trace**: fibres, hair, soil
Topic Area 2: Cells, tissues and organs in forensic biology	
Teaching content	**Exemplification**
2.1 Microscopy in forensic biology	
2.1.1 Key features of microscopy □ Light microscopes (LM) □ Stereo microscopes □ Electron microscopes (EM)	To include: □ How to select the appropriate type of microscopy to use for different forensic evidence □ Limitations of each type of microscopy to observe forensic evidence
2.1.2 Use of light microscopes (LM) and stereomicroscopes to observe forensic evidence	To include: □ How to measure evidence using an eyepiece graticule in eyepiece units (EPUs) and calibrating the units into μm using a stage micrometer □ How to provide actual sizes of forensic evidence observed
2.1.3 Preparing forensic evidence for microscopy	To include: □ The difference between wet and dry mounts of specimens and when to use them □ How to produce a temporary, stained mount of an LM specimen, for example, for cheek cells □ How to produce a temporary, dry mount of a LM specimen, for example, for pollen □ Staining and lifting techniques for tissues, for example, skin and hair
2.2 Observing biological evidence	
2.2.1 Cellular evidence in Forensic Biology □ Prokaryotes • Bacteria □ Eukaryotes • Yeasts • Unicellular algae • Pollen • Fungal Spores • Cheek cells • Skin cells • Blood cells **2.2.2 Tissue evidence in Forensic Biology** □ Hair	To include: □ Cell and tissue structure as observed and measured from: • Temporary slides • Microscope drawings/photographs • Electron micrographs • Generalised diagrams/photographs □ The type of information that cell, tissue, and organ evidence can reveal as forensic proof □ How to record quantitative and qualitative information about biological evidence □ The limitations from observing this evidence alone when trying to match to an individual

□ Skin □ Blood □ Bodily fluids **2.2.3 Organ evidence in Forensic Biology** □ Teeth □ Bone □ Leaves □ Seeds □ Fruits □ Flowers □ Roots	
2.3 Microbiology in Forensic Science	
2.3.1 Contributions of microbiology to forensics □ Bioterrorism □ Cause of death □ Time of death □ Place of death □ Outbreaks of foodborne disease □ Biosecurity □ Identification of individuals	To include: □ How microorganisms isolated, identified and genetically sequenced from microbiomes may contribute to forensic investigations
2.3.2 Culturing microorganisms effectively and safely □ Preparation of work area □ Aseptic technique □ Preparation of sterile agar plates and nutrient media □ Preparation of sterilized equipment □ Disposal	To include: □ The importance of aseptic technique in culturing microorganisms and for forensic proof □ Use of alcohol and other sterilisation procedures □ Consideration of airflow around workspace □ Use of PPE and biosafety cabinets □ How to safely culture microorganisms: • Implications of temperature • Contamination and sealing Petri dishes • Incubation time • Importance of keeping Petri dishes closed after incubation □ Sterilisation, disinfection and safe disposal after exposure Does not include: □ Preparation of specialised growth media □ Culturing viruses or parasites
2.3.3 The culture of microorganisms by the inoculation of agar plates □ Streak plates □ Lawn plates □ Pour plates	To include: □ The culture of bacteria and fungi obtained from non-pathogenic, approved sources □ How to culture bacteria and fungi using the three inoculation techniques, where appropriate □ How to culture microorganisms found at a crime scene □ The advantages and disadvantages of culturing microorganisms in forensic proof

2.3.4 The identification of bacteria and fungi through: □ Appropriate staining □ Microscopy □ Colony morphology □ Selective and differential media □ Serology □ DNA analysis	To include: □ How to identify colony types and match to reference samples □ How to carry out testing for gram-negative and gram-positive bacteria □ The role of different types of growth media in the culturing and identification of microorganisms □ How to compare bacterial and fungal cultures from the scene with those provided from individuals □ The advantages and disadvantages of each technique for forensic proof □ The limitations of techniques available in schools to safely identify microorganisms Does not include: □ Detailed knowledge of how to carry out DNA analysis
Topic Area 3: Investigation and evidence collection	
Teaching content	**Exemplification**
3.1 Scene investigation and preservation of site	
3.1.1 Restriction of the scene and access to the scene □ Police tape □ Scenes of Crime Officers (SOCO) □ Forensic tents / work areas □ Cordon log	To include: □ The purpose of crime scene preservation and initial documentation □ How to carry out appropriate scene preservation in schools
3.1.2 Recording and documenting the scene □ Crime scene notes and visual evidence □ Search patterns • Quadrant • Lane • Grid • Spiral • Wheel □ Documenting trace materials • Scene of crime documentation • Crime scene notes • Sketches and photographs • Video • Evidence labels	To include: □ The importance of recording detailed observations at the crime scene □ How to select suitable search patterns □ How to document trace materials from a crime scene □ How to record and document crime scenes and evidence appropriately
3.2 Collection of evidence	
3.2.1 Hazards associated with forensic work □ At the crime scene □ In the laboratory	To include: □ How unfamiliar environments may pose physical, chemical and biological risk □ Biological hazards associated with the collection and analysis of the biological evidence

	□ The need for suitable personal protective equipment (PPE) and other appropriate control measures to reduce risk □ How to complete a risk assessment for a crime scene investigation and laboratory analysis of samples
3.2.2 Collection of evidence □ Evidence recognition □ Recovery of trace materials • Swabbing • Forceps • Taping • Shaking, brushing and vacuuming • Marks and impressions • Print lifting	To include: □ How to identify probative evidence at the crime scene □ How to recover trace evidence in the correct order to prevent damage and loss of evidence □ How to recover trace materials appropriately □ The importance of correct methods for individual recovery methods to avoid cross-contamination □ The usefulness of the method of recovery for each sample of biological evidence □ The use of the double swab technique for recovering DNA evidence
3.2.3 Storing evidence □ Packaging and labelling □ Storage and transport of a variety of forensic evidence □ Chain of evidence	To include: □ How packaging, labelling and storage are selected for the recovered materials by forensic biologists □ How to ensure effective preservation and storage of evidence to prevent contamination and degradation □ The importance of storage and preservation for recovered trace materials □ The stages in the chain of evidence and how they preserve the integrity of the evidence □ How to package, label and store evidence in schools and the differences from techniques available to forensic biologists
Topic Area 4: Analytical techniques and evidence interpretation	
Teaching content	**Exemplification**
4.1 Observational analytical techniques	
4.1.1 Types of observational evidence □ Bodily fluids □ Fingerprints	To include: □ The components of bodily fluids and their role in matching to individuals □ How forensic biologists make use of bodily fluids to support an investigation Examples of **bodily fluids** may include: □ Blood □ Saliva □ Urine □ Fingerprint patterns, ridge characteristics and ridge counting

□ Footprints □ Other forms of print	□ The types of information available from finger, foot and shoe prints and how to use them for identification □ How lip and ear prints, among others, can also be used to confirm identity
□ Hair identification	□ The types of information that can be observed by comparing trace and hair samples □ How human and animal hair differ
□ Bone, teeth and skeletal anatomy	□ The types of evidence bones and skeletons can reveal □ The advantages and disadvantages of using teeth to identify individuals
□ Plant material	□ Combining evidence collected from different plant regions, including roots, stems, leaves, flowers and seeds
□ Fingernail clippings and scrapings □ Skin	□ Using microscopy to detect the presence of cells and tissues in recovered evidence
□ Insects • Flies (Diptera) • Beetles (Coleoptera)	□ Ways insect identification and life cycle can be used to estimate the post-mortem interval
□ Fibres	□ Fibres as important sources of forensic evidence □ Limitations of observational evidence techniques and when each technique is appropriate to use
4.1.2 Analysing observational evidence □ Microscopy □ Observing □ Measuring □ Drawing □ Photography □ Electron micrographs □ DNA identification □ X-rays □ CT scans □ Presumptive tests • Luminol • Leucomalachite green (LMG) □ Blood groups and Rhesus system □ Blood splatter identification	To include: □ The difference between DNA sequencing and profiling □ Principles and application of restriction enzyme analysis □ Principles and application of gel electrophoresis □ Why polymerase chain reaction (PCR) is important to DNA profiling material □ The value of presumptive tests in identification of blood □ The limitations of blood group analysis alone for identification □ How blood patterns can provide indications about how blood was shed □ When the use of X-rays and CT scans is appropriate and their value for forensic biology □ How to perform observational analysis safely and skilfully

	Does not include: □ Presumptive tests other than those used for blood
4.2 Microbiological analytical techniques	
4.2.1 □ Microbes (bacteria, fungi, algae and diatoms) and viruses	To include □ Using microscopy to detect the presence of microbes in recovered evidence □ The role of microbiological evidence in forensic biology and identification □ The importance of diatoms in forensic investigations □ The limitations of techniques available in schools □ How to perform microbiological analysis safely and skilfully
□ Culturing microbiological evidence samples on agar plates for identification	□ How to analyse colony morphology using: • Size • Shape • Colour • Surface appearance □ The limitations of using agar plates in schools and the impact of following safety protocols for microbial identification Does not include: □ Haemolysis
4.3 Reviewing evidence	
4.3.1 Interpreting results of analyses □ Conclusions from observations of circumstances of the crime scene □ Justification for conclusions □ Unbiased expert opinion □ Quality of data collected from the analytical techniques	To include: □ The limitations of individual pieces of evidence □ Ways that evidence can be tampered with or destroyed deliberately □ How to evaluate how effective the chain of evidence has been throughout the investigation □ How well the preservation methods prevented contamination and/or destruction of the evidence from the point of recovery □ The existence of false positives and negatives in forensic tests □ How the identification of individuals from false positive evidence can be avoided □ How to assess the quality of the data collected in terms of accuracy, validity, and precision
4.3.2 Communicating results of analysis □ Role of forensic biologist in crime scene investigations	To include: □ How a forensic biologist communicates the results of the analyses and for whom □ How a forensic biologist makes judgments □ What a forensic biologist does not make judgments on

Assessment criteria

Section 6.4 provides full information on how to assess the NEA units and apply the assessment criteria.

These are the assessment criteria for the tasks for this unit. The assessment criteria indicate what is required in each task. Students' work must show that all aspects of a criterion have been met in sufficient detail for it to be **successfully achieved** (see **Section 6.4.1**). If a student's work does not fully meet a criterion, you must not award that criterion.

The command words used in the assessment criteria are defined in **Appendix B**.

Pass	Merit	Distinction
P1: Explain which potential forensic biology disciplines could aid the investigation.		
P2: Create a plan to preserve the crime scene and collect the evidence.	**M1: Explain** the choice of preservation and collection methods.	
P3: Create a plan to analyse the evidence from the scenario.	**M2: Explain** the choice of analytical techniques.	
P4: Complete a risk assessment for the crime scene investigation and evidence analysis.		
P5: Preserve the crime scene.	**M3: Explain** the suitability of the preservation, and collection methods performed.	
P6: Use appropriate techniques to **collect** evidence from the crime scene.		
P7: Select appropriate techniques for the evidence.	**M4: Explain** how the integrity of the evidence is maintained.	**D1: Justify** the choice of techniques for the evidence.
P8: Perform observational analysis safely and skilfully.		**D2: Evaluate** the effectiveness of the risk assessment.
P9: Perform microbiological analysis safely and skilfully.		
P10: Record results of the analysis in suitable formats.		
P11: Assess which individual(s) most closely matches each piece of evidence from the crime scene.	**M5: Discuss** the validity and the limitations of the analytical techniques conducted.	**D3: Assess** the relative importance of the results from the analytical techniques to the investigation.
	M6: Suggest appropriate improvements to the investigation.	**D4: Discuss** the effectiveness of the collection of evidence.
		D5: Justify improvements to increase confidence in the conclusions.

Assessment guidance

This assessment guidance gives you information relating to the assessment criteria. There might not be additional assessment guidance for each assessment criterion. It is included only where it is needed.

Assessment Criteria	Assessment guidance
P1	• Students must recognise the potential evidence likely to be obtained from the crime scene, and the evidence collected from the individuals, identify the forensic biology disciplines required for the investigation, and then explain how each of the disciplines could aid the investigation.
P2	• Students must show how they intend to preserve the crime scene through site restriction, notes and visual evidence and a suitable search pattern. • Students must show how they will collect the evidence from the crime scene through the recovery of trace materials, together with the ways the evidence is packaged, labelled, stored, and transported.
P3	• The evidence from the scenario is the evidence collected by the police from the individuals in the scenario.
M1	• The focus of the explanation should only be on why the particular preservation and collection methods chosen **are** appropriate based on the initial photographic or video evidence provided by the centre.
M2	• The focus of the explanation should only be on why the particular analytical methods chosen **are** appropriate based on the initial photographic or video evidence provided by the centre.
P5	• Students should follow their plan created in **P2** to preserve the crime scene. • Students should also record and document the crime scene to provide evidence of the preservation, including the location and condition of the biological evidence.
P6	• Students should follow their plan created in P2 to collect evidence from the crime scene. • The teacher observation record should indicate how safely students preserved and collected evidence from the crime scene. • The appropriate techniques include recovering, recording, packaging, labelling, and storing evidence from the crime scene.
M3	• This is an extension of **P5**. • Students must explain how suitable their methods of crime scene preservation and evidence collection were from their plan in **P2** in achieving minimal contamination and disturbance of all the physical evidence. • Students must also include any adaptations that were required to their plan to preserve the crime scene and collect the evidence.
P7	• Students must select appropriate observational and microbiological analytical techniques for the evidence obtained from the crime scene and for the evidence collected from the individuals.
P8	• The teacher observation record form should comment on the safe and skilful use of observational analytical techniques performed by the student.
P9	• The teacher observation record form should comment on the safe and skilful use of microbiological analytical techniques performed by the student.

P10	• Formats could include tables and written descriptions with annotated sketches and photographs.
M4	• Students must explain how the integrity of the evidence is maintained through the chain of evidence.
D1	• This is an extension of **P7**. • Students should use their understanding of the unit content to provide valid scientific reasoning for the choice of tests. Additional research is not required.
D2	• Students must evaluate the effectiveness of the risk assessment in terms of how well the risk assessment protected them from physical, biological and chemical hazards.
M5	• Consideration should be given to the likelihood of false positives, the size and condition of each piece of evidence, the quality of preservation and storage methods prior to testing, and equipment used.
M6	• They should reflect on their approaches to **Tasks 2** and **3** and consider the way contamination risks could be reduced, chain of evidence correctly maintained, and analysis of evidence improved.
D3	• This is an extension of **P11.** • Consideration should be given to the type of evidence: generic (class evidence) or unique (individual evidence) and the relative importance of each type of evidence.
D4	• Following the student's analysis from Task 3, students should make a reasoned judgment about: ○ the effectiveness of the recovery of trace materials ○ the effectiveness of the preservation and storage of evidence to prevent contamination and degradation.
D5	• Students should consider which suggestions in **M6** would improve confidence in the conclusions made in **P11.**

Synoptic assessment

Some of the knowledge, understanding and skills needed to complete this unit will draw on the learning in Units F180 and F181.

This table details these synoptic links.

Unit F185: Forensic biology		Unit F180: Fundamentals of science	
Topic Area		Topic Area	
2	Cells, tissues and organs in forensic biology	B1	Cell structure and microscopy

Unit F185: Forensic biology		Unit F181: Science in society	
Topic Area		Topic Area	
4	Analytical techniques and evidence interpretation	4	Communicating science
		2	Handling scientific data

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic assessment.**

4.3.5 Unit F186: Medical physics

Unit Aim

This unit explores different imaging techniques used for medical diagnosis and different therapies used for medical treatment.

In this unit you will learn about the different diagnosis techniques and therapies that are used in medicine. You will apply what you learn about each technique to some specific scenarios, making decisions about the most appropriate imaging technique and types of therapies that can be used. You will suggest how the imaging and therapy techniques will need to be performed and the impact they will have on patients and professionals.

Unit F186: Medical physics	
Topic Area 1: Application of non-ionising diagnosis techniques	
Teaching content	**Exemplification**
1.1 Magnetic Resonance Imaging (MRI)	
□ Basic structure of machine □ Resonance (qualitative only) □ Relaxation time (qualitative only) □ Safety considerations □ Professionals involved	To include: □ How an MRI scanner uses a magnetic field and radio waves to stimulate hydrogen atoms □ How altering the radio frequency can distinguish between different types of tissues □ Why MRI is a safe technique for visualising the entire body □ Advantages and disadvantages of MRI, including the quality of the image, cost and availability □ Risks to patients and staff, including noise, use of sedatives and contrast agents □ Who manages the MRI machine and who produces and interprets MRIs Does not include: □ Detailed understanding of nuclear precession, spin or Larmor frequency □ Calculations relating to relaxation or precession □ T1/T2 relaxation time
1.2 Diagnostic ultrasound	
□ Anatomical ultrasound □ Doppler ultrasound □ Types of transducer □ Image quality □ Role of ultrasound gel □ Interpreting scan data and images □ Safety considerations □ Professionals involved	To include: □ The role of the transducer and boundaries between tissues in generating an image □ How to decide which type of transducer to use □ The relationships between frequency, gain, wavelength, penetration and resolution in producing clear images using ultrasound □ The difference between anatomical and doppler □ Ultrasound and its use □ How to select the most appropriate ultrasound gel □ Why ultrasounds are safe to use

	□ Advantages and disadvantages of ultrasound as an imaging technique, including the quality of the image, cost and availability □ Who manages the ultrasound machine and who produces and interprets ultrasounds Does not include: □ Theoretical understanding of doppler effect □ Other forms of functional ultrasound □ Determining the speed of blood
1.3 Endoscopy	
□ Basic structure and function □ Types of endoscopy □ How to prepare for endoscopy □ Safety considerations □ Professionals involved	To include: □ Modern endoscopes, including the use of non-coherent fibres and capsule endoscopy □ How to decide which type of endoscopy to use □ Advantages and disadvantages of endoscopy as an imaging technique, including the quality of the image, cost and availability □ Risks to the patient undergoing endoscopy □ Who performs endoscopies and interprets the images Does not include: □ Total internal reflection and critical angle
1.4 Electrocardiogram (ECG)	
□ Basic structure of the heart • Sino-atrial node • Atrioventricular node □ Interpreting ECGs □ Safety considerations □ Professionals involved	To include: □ How the structures of the heart coordinate to a create a heartbeat □ Common issues with the heart detected by an ECG □ Position of electrodes, their role in measuring potential difference (p.d.) and the difference between positive and negative deflections □ How to identify P waves, QRS waves, and heart rate □ How to interpret simple ECGs, to include irregular heart rhythms, and evidence of heart attack □ Advantages and disadvantages of ECG as a diagnostic technique □ How ECGs can be used to improve CT scans □ Risks to the patient undergoing an ECG Does not include: □ ST segments □ T wave

Topic Area 2: Application of ionising diagnosis techniques	
Teaching content	**Exemplification**
2.1 X-ray imaging	
2.1.1 Plain X-ray image □ X-ray tube structure □ Production of X-rays □ X-ray attenuation □ Effective radiation dose □ Safety considerations □ Professionals involved	To include: □ Optimizing settings of the X-ray tube voltage (kVp), current (mA) and exposure time (s) for image quality and safety for different types of patients □ Common uses of X-ray imaging □ The use of image contrast enhancement in X-ray imaging □ How to position patients to optimise images and reduce artifacts □ Use of collimators and filters to improve image quality □ The effective radiation dose from different types of X-ray scan □ Advantages and disadvantages of X-ray as an imaging technique □ Safety procedures to protect patients and staff from ionising radiation □ Who manages the equipment, conducts the procedure and interprets the images Does not include: □ Types of X-ray (e.g. Bremsstrahlung) □ Formation of an X-ray image □ X-ray attenuation mechanisms □ X-ray spectra graphs □ Photographic film □ Charge-coupled device □ Measuring radiation exposure
2.1.2 Computerised tomography (CT) scans and contrast media □ Basic structure and function of a CT machine □ Radiopaque media • Barium swallow • Angiogram □ Safety considerations □ Effective radiation dose □ Professionals involved	To include: □ How a CT scan is used to image the body □ Advantages and disadvantages of CT imaging, including the quality of image, cost and availability □ Why some patients may have both an MRI and a CT scan □ Use of a contrast medium to form an image including examples such as barium meal □ Risks associated with some contrast media □ The effective radiation dose from CT scans □ How specific health problems are diagnosed using these methods □ Safety procedures to protect patient and staff from ionising radiation □ Who manages the equipment, conducts the procedure and interprets the images Does not include: □ Detailed structure of CT scanning machine □ Different types of CT scan

2.2 Radionuclides	
2.2.1 Radiopharmaceuticals □ Use of gamma camera □ Function of a tracer □ Radiation dose □ Half-life and effective half-life □ Types of radiation □ Radiation properties □ Health and safety □ Professionals involved	To include: □ Basic structure of the gamma camera □ Function of radiopharmaceuticals in the body as a tracer □ Comparison of dose level from different types, considering half-life and radiation type □ How to select the type of tracer to use based on delivery method, age and health of the patient, lifestyle of the patient and its elimination from the body □ Safety procedures to protect patient and staff from ionising radiation □ Health and safety legislation linked to use of radioactive materials, including ARSAC □ Who prescribes and administers the radiopharmaceutical, and monitors the patient □ Advantages and disadvantages of radiopharmaceuticals for diagnosis, including the quality of image, cost and availability Does not include: □ Manufacture of radiopharmaceuticals
2.2.2 Positron emission tomography (PET) □ Use of Gamma camera □ Radiolabelled glucose □ Gamma radiation detection □ Combining with CT scan □ Locating a tumour □ Health and safety	To include: □ Basic principles of a PET scan □ How PET is able to visualise the body, including the role of fluorodeoxyglucose (FDG) □ Why PET scans are used □ Advantages and disadvantages of this imaging technique, including the quality of image, cost and availability □ Why combining this with a CT scan is necessary to accurately locate a tumour □ Safety procedures to protect patient and staff from ionising radiation □ Who administers the FDG, and who performs the PET scan
Topic Area 3: Application of ionising therapy techniques	
Teaching content	**Exemplification**
3.1 Treatment with external source	
□ Radiotherapy using X-rays □ Radiotherapy using gamma □ UV skin treatment □ Proton beam □ Safety considerations □ Professionals involved	To include: □ Penetration of each type through the body □ Relative energy delivered to cells from each type □ Accuracy of each type in treating damaged cells/tissues and risks associated □ Conditions for which different types of external source are required and contraindications

	□ Advantages and disadvantages of these imaging techniques, cost and availability □ Safety procedures to protect patient and staff from ionising radiation □ Who manages the equipment and conducts the procedure
3.2 Treatment with internal source	
□ Radionuclide therapy □ Brachytherapy □ Safety considerations □ Professionals involved	To include: □ Types of radionuclide sources used for different treatments □ The use of internal source therapy instead of external source in some situations □ Conditions for which different types of internal source are required and contraindications □ How to select the type of therapy, considering the dose required, retention in the body, excretion, health of the patient, delivery method and risk to bystanders □ Advantages and disadvantages of these imaging techniques, cost and availability □ Safety procedures to protect patient and staff from ionising radiation □ Who prescribes and administers the radiotherapy, and monitors the patient
Topic Area 4: Application of non-ionising therapy techniques	
Teaching content	**Exemplification**
4.1 Lasers	
□ Basic principles □ Low-level laser therapy (LLLT) □ Laser cutting/burning □ Light frequency and wavelength □ Safety considerations	To include: □ Properties of laser light that make it suitable for therapies □ How different frequencies are used to cut, burn or repair different types of tissue selectively □ Conditions or treatments for which lasers are beneficial and contraindications □ Risks and benefits associated with each technique □ Beam power required for different procedures □ Why lasers are not ionising, even at high power, in terms of photon energy □ Advantages and disadvantages of lasers for therapy including cost and availability □ Who manages the equipment and conducts the procedure Does not include: □ Types of stimulated emission □ Semiconductor lasers □ Population inversion □ Pumping □ Structure of lasers

4.2 Photodynamic therapy (PDT)	
□ Basic principles □ Use of laser □ Cancer treatment □ Safety considerations	To include: □ How PDT is performed and the role of phototoxicity □ Conditions for which PDT is effective □ Advantages and disadvantages of PDT over ionising therapies □ Risks and benefits associated with PDT □ Possible side effects of PDT and comparison to ionising therapies □ Who manages the equipment and conducts the procedure
4.3 Artificial cardiac devices	
□ Pacemaker structure □ Pacemaker function □ Pacemaker purpose □ ICD structure □ ICD function □ ICD purpose □ Safety considerations	To include: □ Conditions for which artificial cardiac devices are appropriate and contraindications □ How pacemaker and ICD can affect heart rhythm □ Comparison of pacemaker and ICD □ Advantages and disadvantages of each device for treating different conditions □ Risks and benefits associated with artificial cardiac devices □ Who manages the equipment and conducts the procedure Does not include: □ Understanding of battery technology □ How they are fitted □ How pacemakers are charged
4.4 Ultrasound therapies	
□ Basic principles □ Tissue Repair □ High intensity focused ultrasound (HIFU) □ Low intensity pulsed ultrasound (LIPUS) □ Shock wave lithotripsy (SWL) □ Hyperthermia □ Safety considerations	To include: □ Differences in procedure, technique and equipment compared with imaging □ Conditions for which each ultrasound therapy is effective and contraindications □ Required dose protocols for treating different types of condition □ Risks and benefits of using different ultrasound therapies □ Advantages and disadvantages of each technique for treating different conditions □ Who manages the equipment and conducts the procedure

Topic Area 5: Planning for diagnosis and therapy	
Teaching content	**Exemplification**
5.1 Diagnosis plan	
□ Producing a diagnosis plan □ Risk assessment □ Communicating a diagnosis plan □ Information and advice given to patients □ Healthcare professionals involved □ Healthcare professional roles	To include: □ How to write a logical diagnosis plan □ How to assess the quality of a diagnosis plan □ How to create a risk assessment that is linked to a diagnosis plan □ How to create a presentation of the diagnosis plan that is appropriate for healthcare professionals and other appropriate audiences □ How to communicate an appropriate diagnosis plan to healthcare professionals and other appropriate audiences □ Why it is important to consider the needs of the patient, costs, and availability of equipment and techniques □ The possible social, emotional, and mental health effects to the patient before, during, and after the diagnosis plan □ How to obtain appropriate feedback on a diagnosis plan and then summarise the feedback □ How to prepare for questions that may be asked by healthcare professionals and other audiences
5.2 Therapy Plan	
□ Producing a therapy plan □ Risk assessment □ Communicating a therapy plan □ Information and advice given to patients □ Healthcare professionals involved □ Healthcare professional roles	To include: □ How to write a logical therapy plan □ How to assess the quality of a therapy plan □ How to create a risk assessment that is linked to a therapy plan □ How to create a presentation of the therapy plan that is appropriate for patients and other appropriate audiences □ How to communicate an appropriate therapy plan to patients and other appropriate audiences □ Why it is important to consider the needs of the patient, costs, and availability of equipment and techniques □ The possible social, emotional, and mental health effects to the patient before, during, and after the therapy plan □ How to obtain appropriate feedback on a therapy plan and then summarise the feedback □ How to prepare for questions that may be asked by healthcare professionals and other audiences

Assessment criteria

Section 6.4 provides full information on how to assess the NEA units and apply the assessment criteria.

These are the assessment criteria for the tasks for this unit. The assessment criteria indicate what is required in each task. Students' work must show that all aspects of a criterion have been met in sufficient detail for it to be **successfully achieved** (see **Section 6.4.1**). If a student's work does not fully meet a criterion, you must not award that criterion.

The command words used in the assessment criteria are defined in **Appendix B**.

Pass	Merit	Distinction
P1: Summarise the ionising diagnosis technique(s) that are suitable for the diagnosis scenario.	**M1: Explain** why other diagnosis techniques are not suitable.	**D1: Analyse** the advantages and disadvantages of your diagnosis plan.
P2: Summarise the non-ionising diagnosis technique(s) that are suitable for the diagnosis scenario.		
P3: Create a logical diagnosis plan for the patient in the diagnosis scenario, taking into account their needs.	**M2:** Use research to **justify** the diagnosis plan for the patient in the therapy scenario.	
P4: Create a risk assessment linked to the diagnosis plan.		
P5: Summarise the ionising therapy technique(s) that are suitable for the therapy scenario.	**M3: Explain** why other therapy techniques are not suitable.	**D2: Analyse** the advantages and disadvantages of your therapy plan.
P6: Summarise the non-ionising therapy technique(s) that are suitable for the therapy scenario.		
P7: Create a logical therapy plan for the patient in the therapy scenario, taking into account their needs.	**M4:** Use research to **justify** the therapy plan for the patient in the therapy scenario.	
P8: Create a risk assessment linked to the therapy plan.		
P9: Create an appropriate presentation for the chosen scenario.	**M5: Deliver** a presentation tailored to the intended audience, including information beyond what is included in the presentation document.	**D3: Justify** the design and content of the presentation.
P10: Suggest adaptations to the presentation for healthcare professionals or the patient.		
P11: Summarise the feedback received for your chosen plan.	**M6: Assess** the strengths and weaknesses of your chosen plan.	**D4: Justify** potential improvements to the plan.

Pass	Merit	Distinction
		D5: Evaluate the presentation to better meet the needs of the target audience.

Assessment guidance

This assessment guidance gives you information relating to the assessment criteria. There might not be additional assessment guidance for each assessment criterion. It is included only where it is needed.

Assessment Criteria	Assessment guidance
P1	• Students only need to include the important and relevant facts about the suitability of each technique, limited to those explored in Unit F186.
P2	• Students only need to include the important and relevant facts about the suitability of each technique, limited to those explored in Unit F186.
P3	• The plan should be presented in an appropriate format.
P4	• The risk assessment should contain risks to the patient and other individuals. • The risk assessment only requires qualitative detail.
M1	• The explanations should include scientific reasoning.
M2	• This is an extension of the diagnosis plan created in **P3**. • Students should use research to give valid reasons for how the diagnostic techniques should be carried out. • The justification should include how the patient's needs were accounted for. • The research element of this criterion does not need to be completed under supervised conditions.
D1	• The focus of this analysis should be on the specific needs of the patient in the diagnosis scenario. • Reasoned comments on the viability of the diagnosis plan should be provided.
P5	• Students only need to include the important and relevant facts about the suitability of each technique, limited to those explored in Unit F186.
P6	• Students only need to include the important and relevant facts about the suitability of each technique, limited to those explored in Unit F186.
P7	• The plan should be presented in an appropriate format.
P8	• The risk assessment should contain risks to the patient and other individuals. • The risk assessment only requires qualitative detail.
M3	• The explanations should be brief and include scientific reasoning.
M4	• This is an extension of the therapy plan created in **P7**. • Students should use research to give valid reasons for how the therapy techniques should be carried out. • The justification should include how the patient's needs were accounted for. • The research element of this criterion does not need to be completed under supervised conditions.

D2	• The focus of this analysis should be on the specific needs of the patient in the therapy scenario. • Reasoned comments on the viability of the therapy plan should be provided.
P9	• The presentation should be in the format they feel is most appropriate, which could include a leaflet, a PowerPoint presentation, a flow diagram, etc. • There must be sufficient detail in the presentation to demonstrate the key components of their chosen plan.
P10	• If students have chosen to present the diagnosis plan, they should suggest adaptations to the presentation for the patient. • If students have chosen to present the therapy plan, they should suggest adaptations to the presentation for healthcare professionals.
M5	• Students must deliver their presentation to the class and/or teacher, but it must be delivered as though they were conveying the information to the audience selected. • The presentation delivered must go beyond what the students have prepared. • The teacher observation record form should comment on students' ability to deliver information that is beyond the presentation content e.g. students could respond appropriately to questions from the audience.
D3	• Students should give valid reasons for the design and content of the presentation. • Students should also give valid reasons for information that is not explicitly provided in the presentation that created. • The scientific understanding of the techniques should inform the justification.
P11	• Students should be selective when summarising the feedback received. • The feedback on the student's plan can be provided by the teacher and/or other students. Feedback on the student's plan can include feedback on the presentation itself.
M6	• This is an extension of **P11**.
D4	• Students should give valid reasons for their suggested improvements. • Students should consider any limitations of the information provided in the scenario. • The scientific understanding of the techniques should inform the justification.

Synoptic assessment

Some of the knowledge, understanding and skills needed to complete this unit will draw on the learning in Units F180 and F181.

This table details these synoptic links.

Unit F186: Medical physics		Unit F180: Fundamentals of science	
Topic Area		Topic Area	
1	Application of non-ionising diagnosis techniques	P3	Medical physics
2	Application of ionising diagnosis techniques	P3	Medical physics

Unit F186: Medical physics		Unit F181: Science in society	
Topic Area		Topic Area	
5	Planning for diagnosis and therapy	4	Communicating science
		1	What scientists do

More information about synoptic assessment in these qualifications can be found in **Section 5.2 Synoptic assessment.**

5 Assessment and grading

5.1 Overview of the assessment

Entry code	H051
Qualification title	OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate)
GLH	180*
Reference	TBC
Total Units	Has two units: • Two mandatory units: F180, F182

Entry code	H151
Qualification title	OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate)
GLH	360*
Reference	TBC
Total Units	Has five units: • Three mandatory units F180, F181, F182 • Two optional units from: F183, F184, F185, F186.

*the GLH includes assessment time for each unit

Unit F180: Fundamentals of science
90 GLH 1 hour 30 minute written exam 70 marks (70 UMS) OCR-set and marked A scientific calculator and a ruler are required in this exam The exam has four sections: • Section A – 20 marks which assess content from B1-B4 in F180 • Section B – 20 marks which assess content from C1-C4 in F180 • Section C – 20 marks which assess content from P1-P3 in F180 • Section D – 10 marks which assess content from Practicals 1-6.

Sections A-C do **not** explicitly assess knowledge of practicals 1-6. However, knowledge of the practicals may help to answer the questions in these sections.

Section D explicitly assesses knowledge of practicals 1-6. Knowledge from B1-B4, C1-C4, and P1-P3 will help to answer the questions in Section D.

A range of item types will be used in this assessment including:

- Forced choice/controlled response questions - typically 1 mark but a maximum of four marks for a single MCQ.
- Short answer, closed response questions (with or without diagrams) – typically 1 to 4 marks.
- Short answer with calculation/working – typically 1 to 4 marks.
- Extended constructed response with points-based mark scheme – 1 mark per factor or feature to a stated maximum, typically 1 to 4 marks.
-

Unit F181: Science in society

60 GLH

1 hour 15 minute written exam

50 marks (50 UMS)

OCR-set and marked

A scientific calculator and a ruler are required in this exam.

The exam has two sections:

- Section A (pre-release based) has a range of 23-27 marks. Questions in Section A are specifically based on the pre-release material and can come from anywhere in the unit content of F181.
- Section B (**not** pre-release based) has a range of 23-27 marks. Questions in Section B are not based on the pre-release material and can come from anywhere in the unit content of F181.

The combined total of Section A and Section B will be 50 marks.

A range of question types will be used in this assessment including:

- Forced choice/controlled response questions - typically 1 mark but a maximum of four marks for a single MCQ.
- Short answer, closed response questions (with or without diagrams) – typically 1 to 4 marks.
- Short answer with calculation/working – typically 1 to 4 marks.
- Extended constructed response with points-based mark scheme – typically 1 to 4 marks, 1 mark per factor or feature to a stated maximum.
- Extended constructed response with levels of response mark scheme – one 6 mark question and one 9 mark question.

Unit F182: Investigating science
90 GLH OCR-set assignment Centre-assessed and OCR-moderated This set assignment has 5 practical tasks. It should take 20-25 GLH to complete.

Unit F183: Analytical techniques in chemistry
60 GLH OCR-set assignment Centre-assessed and OCR-moderated This set assignment has 5 practical tasks. It should take 18-23 GLH to complete.

Unit F184: Environmental studies
60 GLH OCR-set assignment Centre-assessed and OCR-moderated This set assignment has 5 practical tasks. It should take 18-23 GLH to complete

Unit F185: Forensic biology
60 GLH OCR-set assignment Centre-assessed and OCR-moderated This set assignment has 4 practical tasks. It should take 18-23 GLH to complete.

Unit F186: Medical physics
60 GLH OCR-set assignment Centre-assessed and OCR-moderated This set assignment has 4 practical tasks. It should take 15-20 GLH to complete.

OCR-set assignments for NEA units are on our secure website, **Teach Cambridge**.

5.2 Synoptic assessment

Synoptic assessment is a built-in feature of these qualifications. It means that students need to use an appropriate selection of their knowledge, understanding and skills developed across each qualification in an integrated way and apply them to a key task or tasks.

This helps students to build a holistic understanding of the subject and the connections between different elements of learning, so they can go on to apply what they learn from these qualifications to new and different situations and contexts.

The externally assessed units allow students to gain underpinning knowledge and understanding relevant to Applied Science. The NEA units draw on and strengthen this learning by assessing it in an applied and practical way.

It is important to be aware of the synoptic links between the units so that teaching, learning and assessment can be planned accordingly. Then students can apply their learning in ways which show they are able to make connections across the qualification. **Section 4.3** shows the synoptic links for each unit.

5.3 Transferable skills

These qualifications give students the opportunity to gain broad, transferable skills and experiences that they can apply in future study, employment and life.

Higher Education Institutions (HEIs) have told us that developing some of these skills helps students to transition into higher education.

These skills include:

- Communication
- Creativity
- Critical thinking
- Independent learning
- Presentation skills
- Problem solving
- Project and team-based working
- Referencing
- Reflection
- Research skills
- Self-directed study
- Time management
- Writing for different purposes

5.4 Grading and awarding grades

Externally assessed units

We mark all the externally assessed units.

Each external assessment is marked according to a mark scheme, and the mark achieved will determine the unit grade awarded (Pass, Merit or Distinction). We determine grade boundaries for each of the external assessments in each assessment series.

If a student doesn't achieve the mark required for a Pass grade, we issue an unclassified result for that unit. The marks achieved in the external assessment will contribute towards the student's overall qualification grade, even if a Pass is not achieved in the unit assessment.

NEA units

NEA units are assessed by the teacher and externally moderated by us.

Each unit has specified Pass, Merit and Distinction assessment criteria. The assessment criteria for each unit are provided with the unit content in **Section 4.3** of this specification. Teachers must judge whether students have met the criteria or not.

A unit grade can be awarded at Pass, Merit or Distinction. The number of assessment criteria needed to achieve each grade has been built into each assignment. These are referred to as design thresholds. The table below shows the design thresholds for each grade outcome for the NEA assessments in these qualifications. This table shows the number of criteria needed to achieve a Pass, Merit or Distinction for the NEA units in these qualifications. The unit grade awarded is based on the **total** number of achieved criteria for the unit. The total number of achieved criteria for each unit can come from achievement of any of the criteria (Pass, Merit or Distinction). This is **not** a 'hurdles-based' approach, so students do **not** have to achieve **all** criteria for a specific grade to achieve that grade (e.g. all Pass criteria to achieve a Pass).

To make sure we can keep outcomes fair and comparable over time, we will review the performance of the qualifications through their lifetime. The review process might lead to changes in these design thresholds if any unexpected outcomes or significant changes are identified.

Unit size (GLH)	**60**	**90**
Total number of criteria	22	28
Number of pass criteria	11	14
Number of merit criteria	6	8
Number of distinction criteria	5	6
Total number of criteria needed for a unit pass	9	12
Total number of criteria needed for a unit merit	13	17
Total number of criteria needed for a unit distinction	18	23

If a student doesn't achieve enough criteria to achieve a unit Pass, we will issue an unclassified result for that unit. The number of criteria achieved will be converted into a mark on the Uniform Mark Scale (UMS) and will contribute towards the student's overall qualification grade, even if a Pass is not achieved in the unit assessment. More information about this is in Section below (**Calculating the qualification grades**).

Qualifications

The overall qualification grades are:

- Distinction* (D*)
- Distinction (D)
- Merit (M)
- Pass (P)
- Unclassified (U)

Calculating the qualification grades

When we work out students' overall grades, we need to be able to compare performance on the same unit in different assessments over time and between different units. We use a Uniform Mark Scale (UMS) to do this.

A student's uniform mark for each externally assessed unit is calculated from the student's raw mark on that unit. A student's uniform mark for each NEA unit is calculated from the number of criteria the student achieves for that unit. The raw mark or number of criteria achieved are converted to the equivalent mark on the uniform mark scale. Marks between grade boundaries are converted on a pro rata basis.

When unit results are issued, the student's unit grade and uniform mark are given. The uniform mark is shown out of the maximum uniform mark for the unit (for example, 48/60).

The student's uniform marks for each unit will be aggregated to give a total uniform mark for the qualification. The student's overall grade will be determined by the total uniform mark.

The tables below show:

- the maximum raw marks or number of criteria, and uniform marks for each unit in the qualifications
- the uniform mark boundaries for each of the assessments in each qualification
- the minimum total mark for each overall grade in the qualifications.

Certificate Qualification:

Unit	Maximum raw mark/number of criteria	Maximum uniform mark (UMS)	Distinction* (UMS)	Distinction (UMS)	Merit (UMS)	Pass (UMS)
F180	70	70		56	42	28
F182	28	70		56	42	28
Qualification Totals	98	140	135	112	84	56

Extended Certificate Qualification:

Unit	Maximum raw mark/number of criteria	Maximum uniform mark (UMS)	Distinction* (UMS)	Distinction (UMS)	Merit (UMS)	Pass (UMS)
F180	70	70		56	42	28
F181	50	50		40	30	20
F182	28	70		56	42	28
F183	22	55		44	33	22
F184	22	55		44	33	22
F185	22	55		44	33	22
F186	22	55		44	33	22
Qualification Totals	192	300	270	240	180	120

You can find a marks calculator on the qualification page of the OCR website to help you convert raw marks/number of achieved criteria into uniform marks.

5.5 Performance descriptors

Performance descriptors indicate likely levels of attainment by representative students performing at the Pass, Merit and Distinction grade boundaries at Level 3.

The descriptors must be interpreted in relation to the content in the units and the qualification as a whole. They are not designed to define that content. The grade achieved will depend on how far the student has met the assessment criteria overall. Shortcomings in some parts of the assessment might be balanced by better performance in others.

Level 3 Pass

At Pass, students show adequate knowledge and understanding of the basic elements of much of the content being assessed. They can develop and apply their knowledge and understanding to some basic and familiar contexts, situations and problems.

Responses to higher order tasks involving detailed discussion, evaluation and analysis are often limited.

Many of the most fundamental skills and processes relevant to the subject are executed effectively but lack refinement, producing functional outcomes. Demonstration and application of more advanced skills and processes might be attempted but not always executed successfully.

Level 3 Merit

At Merit, students show good knowledge and understanding of many elements of the content being assessed. They can sometimes develop and apply their understanding to different contexts, situations and problems, including some which are more complex or less familiar.

Responses to higher order tasks involving detailed discussion, evaluation and analysis are likely to be mixed, with some good examples at times and others which are less accomplished.

Skills and processes relevant to the subject, including more advanced ones, are developed in terms of range and quality. They generally lead to outcomes which are of good quality, as well as being functional.

Level 3 Distinction

At Distinction, students show thorough knowledge and understanding of most elements of the content being assessed. They can consistently develop and apply their understanding to different contexts, situations and problems, including those which are more complex or less familiar.

Responses to higher order tasks involving detailed discussion, evaluation and analysis are successful in most cases.

Most skills and processes relevant to the subject, including more advanced ones, are well developed and consistently executed, leading to high quality outcomes.

6 Non examined assessment (NEA) units

This section gives guidance on completing the NEA units. In the NEA units, students build a portfolio of evidence to meet the assessment criteria for the unit.

Assessment for these qualifications **must** adhere to JCQ's **Instructions for Conducting Coursework**. Do **not** use JCQ's Instructions for Conducting Non-examination Assessments – these are only relevant to GCE and GCSE specifications.

The NEA units are centre-assessed and externally moderated by us.

You **must** read and understand all the rules and guidance in this section **before** your students start the set assignments.

If you have any questions, please contact us for help and support.

6.1 Preparing for NEA unit delivery and assessment

6.1.1 Centre and teacher/assessor responsibilities

We assume the teacher is the assessor for the NEA units.

Before you apply to us for approval to offer these qualifications you must be confident your centre can fulfil all the responsibilities described below. Once you're approved, you can offer any of our general qualifications, Cambridge Nationals or Cambridge Advanced Nationals (AAQs) **without** having to seek approval for individual qualifications.

Here's a summary of the responsibilities that your centre and teachers must be able to fulfil. It is the responsibility of the head of centre[1] to make sure our requirements are met. The head of centre must ensure that:

- there are enough trained or qualified people to teach and assess the expected number of students you have in your cohorts.
- teaching staff have the relevant level of subject knowledge and skills to deliver and assess these qualifications.
- teaching staff will fully cover the knowledge, understanding and skills requirements in teaching and learning activities.
- allowed combinations of units are considered at the start of the course to be confident that all students can access a valid route through the qualifications.
- all necessary resources are available for teaching staff and students during teaching and assessment activities. This gives students every opportunity to meet the requirements of the qualification and reach the highest grade possible.
- there is a system of internal standardisation in place so that all assessment decisions for centre-assessed assignments are consistent, fair, valid and reliable (see **Section 6.4.3**).
- there is enough time for effective teaching and learning, assessment and internal standardisation.
- processes are in place to make sure that students' work is individual and confirmed as authentic (see **Section 6.2.1**).

[1] This is the most senior officer in the organisation, directly responsible for the delivery of OCR qualifications, For example, the headteacher or principal of a school/college. The head of centre accepts full responsibility for the correct administration and conduct of OCR exams.

- OCR-set assignments are used for students' summative assessments.
- OCR-set assignments are **not** used for practice. Sample assessment material for each of the NEA units is available on the OCR website. This sample assessment material can be used for practice purposes.
- students understand what they need to do to achieve the criteria.
- students understand what it means when we say work must be authentic and individual and they (and you) follow our requirements to make sure their work is their own.
- students know they must not reference another individual's personal details in any evidence produced for summative assessment, in accordance with the Data Protection Act 2018 and the UK General Data Protection Regulations (UK GDPR). It is the student's responsibility to make sure evidence that includes another individual's personal details is anonymised.
- outcomes submitted to us are correct and are accurately recorded.
- assessment of set assignments adheres to the JCQ **Instructions for Conducting Coursework** and JCQ **AI Use in Assessments: Protecting the Integrity of Qualifications**.
- a declaration is made at the point you're submitting any work to us for assessment that confirms:
    - all assessment is conducted according to the specified regulations identified in the **Administration** area of our website,
    - students' work is authentic.
    - marks have been transcribed accurately.
- centre records and students' work are kept according to these requirements:
    - students' work **must** be kept until **after** the unit has been awarded and any review of results or appeals processed. We cannot consider any review if the work has not been kept.
    - internal standardisation and assessment records must be kept securely for a minimum of three years after the date we've issued a certificate for a qualification.
- all cases of suspected malpractice involving teachers or students are reported (see **Section 6.3.1**).

6.2 Requirements and guidance for delivering and marking the OCR-set assignments

The assignments are:

- set by us.
- taken under supervised conditions (unless we specify otherwise in the assessment guidance)
- assessed by the teacher.
- moderated by us.

You can find the set assignments on our secure website, **Teach Cambridge**.

The set assignments give an approximate time that it will take to complete all the tasks. These timings are for guidance only, but should be used by you, the teacher, to give students an indication of how long to spend on each task. You can decide how the time should be allocated between each task or part task. Students can complete the tasks and produce the evidence across several sessions. Student evidence must be securely stored between supervised sessions.

We will publish a new set assignment each year and they will be live for 2 years(s). Each new set assignment will be released on 1 June. You must check our secure website, **Teach Cambridge**, and use a set assignment that is live for assessment. The live assessment dates will be shown on the front cover. Students are allowed one resubmission of work based on the same live assignment.

You must have made unit entries before submitting NEA work for moderation.

Appendix A of this specification gives guidance for creating electronic evidence for the NEA units. Read Appendix A in conjunction with the unit content and assessment criteria grids to help you plan the delivery of each unit.

The rest of this section is about how to manage the delivery and marking of the set assignments so that assessment is valid and reliable. Please note that failing to meet these requirements might be considered as malpractice.

Here is a summary of what you need to do.

You **must**:

- have covered the knowledge, understanding and skills with your students and be sure they are ready for assessment **before** you start the summative assessment.
- use an OCR-set assignment for summative assessment of the students.
- give students the **Student Guide** before they start the assessment.
- familiarise yourself with the assessment guidance relating to the tasks. The assessment guidance for each unit is in **Section 4** after the assessment criteria grids and with the student tasks in the assignments.
- make sure students are clear about the tasks they must complete and the assessment criteria they are attempting to meet.
- give students a reasonable amount of time to complete the assignments and be fair and consistent to all students. The estimated time we think each assignment should take is stated in the OCR-set assignments. In that time students can work on the tasks under the specified conditions until the date that you collect the work for centre assessment.
- tell the students the resources they can use in the assignment before they start the assessment tasks.
- only give students OCR-provided templates. If they choose to use a different template from a book, a website or course notes (for example, to create a plan) they **must** make sure the source is referenced.
- monitor students' progress to make sure work is capable of being assessed against the assessment criteria, on track for being completed in good time and is the student's own work:
    - NEA work must be completed in the centre under teacher supervision in normal curriculum time:
        - work must be completed with enough supervision to make sure that it can be authenticated as the student's own work. You must be familiar with the requirements of the JCQ document **AI Use in Assessments: Protecting the Integrity of Qualifications** before assessment starts.

- there may be exceptions to the requirement for supervised conditions if there is work to complete to support the assignment tasks (e.g. research). The assignment and assessment guidance will specify if there are exceptions.

  Where students are allowed to complete work outside of supervised conditions (e.g. research that may be allowed between supervised sessions) you must make sure that they only bring notes relating to the work they are allowed to complete unsupervised into the supervised sessions (e.g. notes relating to the research they have done). They must not use unsupervised time as an opportunity to:

  - Create drafts of work for their tasks.
  - Gather information to use in other aspects of their tasks.

- if you provide any material to prepare students for the set assignment, you must adhere to the rules on using referencing and on acceptable levels of guidance to students. This is in section **6.2.3 and 6.3**.

- students must produce their work independently (see sections **6.2.1 and 6.3**).

- you must make sure students know to keep their work and passwords secure. They must not share them with other students.

- complete the **Teacher Observation Record** that is with the assignments for tasks that state it is needed. You **must** follow the guidance given when completing it.

- use the assessment criteria to assess students' work.

- before submitting a final outcome to us, you can allow students to repeat any part of the assignment and rework their original evidence. But any feedback you give to students on the original (assessed) evidence, must:

  - only be generic.
  - be recorded.
  - be available to the OCR assessor.

(See **Section 6.3** on **Feedback** and **Section 6.4.4** on **resubmitting work**).

You **must not**:

- change any part of the OCR-set assignments (scenarios or tasks).

- accept multiple resubmissions of work where small changes have been made in response to feedback.

- allow teachers or students to add, amend or remove any work **after** students have submitted work for moderation. This will constitute malpractice.

- give detailed advice and suggestions to individuals or the whole class on how work may be improved to meet the assessment criteria.

- allow students access to their assignment work between teacher supervised sessions. (There may be exceptions where students are allowed to complete work independently (e.g. research). Any exceptions will be stated in the assignments.)

- practice the live OCR-set assignment tasks with the students.

6.2.1 Ways to authenticate work

You must use enough supervision and complete enough checks to be confident that the work you mark is the student's own and was produced independently.

Where possible, you should discuss work in progress with students. This will make sure that work is being completed in a planned and timely way and will give you opportunities to check the authenticity of the work.

You **must**:

- have read and understood the JCQ document **AI Use in Assessments: Protecting the Integrity of Qualifications**.
- make sure students and other teachers understand what constitutes plagiarism.
- not accept plagiarised work as evidence.
- use supervision and questioning as appropriate to confirm authenticity.
- make sure students and teachers fill in declaration statements.

6.2.2 Group work

Group work is not allowed for the NEA assignments in these qualifications.

Where this is allowed, you must make sure that each student generates their own individual evidence to show they've met the assessment criteria.

When working in a group, all students in the group must have a responsibility and/or a role that gives them the opportunity to generate individual evidence for assessment. For example, if the unit requires students to plan the organisation of an activity this could be managed in a group discussion. The group discusses ideas for the activity, organisational requirements, roles and responsibilities to complete the activity, etc. All students must show that they've demonstrated the skill of planning so all members of the group must take part in the discussion. If three members of the group contributed to the discussion and one member took notes but did not contribute to the discussion, their note taking would not be considered a contribution towards planning.

6.2.3 Plagiarism

Students must use their own words when they produce final written pieces of work to show they have genuinely applied their knowledge and understanding. When students use their own words, ideas and opinions, it reduces the possibility of their work being identified as plagiarised. Plagiarism is:

- the submission of someone else's work as your own
- failure to acknowledge a source correctly, including any use of Artificial Intelligence (AI).

You might find the following JCQ documents helpful:

- **Plagiarism in Assessments**
- **AI Use in Assessments: Protecting the Integrity of Qualifications**

Due to increasing advancements in AI technology, we strongly recommend that you are familiar with the likely outputs from AI tools. This could include using AI tools to produce responses to some of the assignment tasks, so that you can identify typical formats and wording that these may produce. This may help you identify any cases of potential plagiarism from students using AI tools to generate written responses.

Plagiarism makes up a large percentage of cases of suspected malpractice reported to us by our assessors. You must **not** accept plagiarised work as evidence.

Plagiarism often happens innocently when students do not know that they must reference or acknowledge their sources or aren't sure how to do this. It's important to make sure your students understand:

- the meaning of plagiarism and what penalties may be applied.
- that they can refer to research, quotations or evidence produced by somebody else, but they must list and reference their sources and clearly mark quotations.
- quoting someone else's work, even when it's properly sourced and referenced, doesn't evidence understanding. The student must 'do' something with that information to show they understand it. For example, if a student has to analyse data from an experiment, quoting data doesn't show that they understand what it means. The student must interpret the data and, by relating it to their assignment, say what they think it means. The work must clearly show how the student is using the material they have referenced to inform their thoughts, ideas or conclusions.

We have **The OCR Guide to Referencing** on our website. We have also produced a **poster** about referencing and plagiarism which may be useful to share with your students.

Teach your students how to reference and explain why it's important to do it. At Key Stage 5 they must:

- use quote marks to show the beginning and end of the copied work.
- list the html address for website text and the date they downloaded information from the website.
- for other publications, list:
    - the name of the author.
    - the name of the resource/book/printed article.
    - the year in which it was published.
    - the page number.

Teach your students to:

- always reference material copied from the internet or other sources. This also applies to infographics (graphical information providing data or knowledge).
- always identify information they have copied from teaching handouts and presentations for the unit, using quote marks and stating the text is from class handouts.

Identifying copied/plagiarised work

Inconsistencies throughout a student's work are often indicators of plagiarism. For example:

- different tones of voice, sentence structure and formality across pieces of work.
- use of American expressions, spellings and contexts (such as American laws and guidelines).
- dated expressions and references to past events as being current.
- sections of text in a document where the font or format is inconsistent with other sections.

What to do if you think a student has plagiarised

If you identify plagiarised work during assessment or internal standardisation, you must:

- consider the plagiarism when judging the number of assessment criteria achieved.
    - if the work is part of the moderation sample, it must be included with the other work provided to the OCR assessor. You must add a note on the Unit Recording Sheet to state that there is plagiarism in the work and the number of criteria achieved has been adjusted accordingly.
- report the student(s) for plagiarism in line with the JCQ document **Suspected Malpractice Policies and Procedures**
    - fill in the **JCQ form M1**.

In line with JCQ's policies and procedures on suspected malpractice, the penalties applied for plagiarism will usually result in the work not being allowed or the mark being significantly reduced.

6.3 Feedback

Feedback to students on work in progress towards summative assessment

You can discuss work in progress towards summative assessment with students to make sure it's being done in a planned and timely way. It also provides an opportunity to check the authenticity of the work. You must intervene if there's a health and safety risk (and reflect this in your assessment if the student's ability to operate safely and independently if that is part of the criteria).

Generic guidance to the whole class is also allowed. This could include reminding students to check they have provided evidence to cover all key aspects of the task. Individual students can be prompted to double check for gaps in evidence providing that specific gaps are not pointed out to them.

You can give general feedback and support if one or more students are struggling to get started on an aspect of the assignment or following a break between sessions working on the assignment. For example, if a student is seeking more guidance that suggests they are not able to apply knowledge, skills and understanding to complete their evidence, you can remind them that they had a lesson which covered the topic. The student would then need to review their own notes to find this information and apply it as needed.

Feedback must not provide specific advice and guidance that would be construed as coaching. This would compromise the student's ability to independently perform the task(s) they are doing and constitutes malpractice. Our assessors use a number of measures to assure themselves the work is the student's own.

Once work has been assessed, you must give feedback to students on the work they submitted for assessment.

Feedback **must**:

- be supportive, encouraging and positive.
- tell the student what has been noticed, not what the teacher thinks (for example, if you have observed the student completing a task, you can describe what happened, what was produced and what was demonstrated).

Feedback **can**:

- identify what task and part of the task could be improved, but not say how to improve it. You could show the student work from a **different** unit that demonstrates higher achievement, but you must not detail to the student how they could achieve that in their work. If you are using another student's work from a different unit as an example, you must anonymise this work and make sure that the potential to plagiarise from this work is minimised. You could remind students that they had a lesson on a specific topic and that they could review their notes, but you must not tell them how they could apply the teaching to improve their work.

- comment on what has been achieved, for example 'the evidence meets the P2 and M2 criteria'.
- identify that the student hasn't met a command word or assessment criteria requirement. For example, 'This is a description, not an evaluation'.
- use text from the specification, assignment or assessment criteria in general guidance to clarify what is needed in the work. For example, 'You demonstrated that you safely preserved and collected evidence from the crime scene'.

Feedback **must not**:

- point out specific gaps. For example, you must not prompt the student to include specific detail in their work, such as 'You should be using a bar chart rather than a line graph for this type of data'
- be so detailed that it leads students to the answer. For example, you must not give:
  - model answers.
  - step-by-step guidance on what to do to complete or improve work.
  - headings or templates that include examples which give all or part of what students have to write about or produce.
- talk the student through how to achieve or complete the task.
- give detail on where to find information/evidence.

In other words, feedback must help the student to take the initiative in making changes. It must not direct or tell the student what to do to complete or improve their work in a way that means they do not need to think how to apply their learning. Students need to recall or apply their learning. You must not do the work for them.

Neither you nor the student can add, amend or remove any work after the final mark has been submitted for moderation.

Please see additional guidance for students who wish to resubmit their work following OCR moderation in **Section 6.4.4**.

What over-direction might look like

When we see anything that suggests the teacher has led students to the answer, we become concerned because it suggests students have not worked independently to produce their assignment work. The following are examples of what might indicate over-direction by the teacher:

- prompts that instruct students to include specific detail in their work, such as, 'You need to include the aims of the activity. Who is it aimed at? What is the purpose of the activity? How will it benefit the specific group/individual?
- headings or templates that include examples which give all or part of what students have to write about or produce, such as sources of support.

OCR Assessors will report suspected malpractice when they cannot see differences in content between students' work in the sample they are moderating. An exception is when students have only used and referenced technical facts and definitions. If the OCR assessor is in any doubt, they will report suspected malpractice. The decision to investigate or not is made by us, not the assessor.

6.3.1 Reporting suspected malpractice

It is the responsibility of the head of centre to report all cases of suspected malpractice involving teachers or students.

A JCQ Report of Suspected Malpractice form (JCQ/M1 for student suspected malpractice or JCQ/M2 for staff suspected malpractice) is available to download from the **JCQ website**. The form must be completed as soon as possible and emailed to us at **malpractice@ocr.org.uk**.

When we ask centres to gather evidence to assist in any malpractice investigation, heads of centres must act promptly and report the outcomes to us.

The JCQ document **Suspected Malpractice Policies and Procedures** has more information about reporting and investigating suspected malpractice, and the possible sanctions and penalties which could be imposed. You can also find out more on our **website.**

6.3.2 Student and centre declarations

Both students and teachers must declare that the work is the student's own:

- **each student** must sign a declaration before submitting their work to their teacher. A **candidate authentication statement** can be used and is available to download from our **website**. You must keep these statements in the centre until all enquiries about results, malpractice and appeal issues have been resolved. You **must** record a mark of zero if a student cannot confirm the authenticity of their work.
- **teachers** must declare the work submitted for centre assessment is the students' own work by completing a **centre authentication form (CCS160)** for each unit. You must keep centre authentication forms in the centre until all post-results issues have been resolved.

6.3.3 Generating evidence

The set assignments will tell the students what they need to do to meet the assessment criteria for the NEA units. It is your responsibility to make sure that the methods of generating evidence for the assignments are:

- valid
- safe and manageable
- suitable to the needs of the student.

Valid

The evidence presented must be valid. For example, it would not be appropriate to present an organisation's equal opportunities policy as evidence towards a student's understanding of how the equal opportunities policy operates in an organisation. It would be more appropriate for the student to incorporate the policy in a report describing the different approaches to equal opportunities.

Safe and manageable

You must make sure that methods of generating evidence are safe and manageable and do not put unnecessary demands on the student.

Suitable to the needs of the student

We are committed to ensuring that achievement of these qualifications is free from unnecessary barriers.

You must follow this commitment through when modifying tasks (where this is allowed) and/or considering assessment and evidence generation. If you are modifying tasks and are not sure what is acceptable, **contact us**.

Observation and questioning

The primary evidence for assessment is the work submitted by the student, however the following assessment methods might be suitable for teachers/assessors to use for some aspects of these qualifications, where identified:

- **observation** of a student doing something
- **questioning** of the student or witness.

Observation

The teacher/assessor and student should plan observations together, but it is the teacher's/assessor's responsibility to record the observation properly (for example observing a student undertaking a practical task). More information is in the Teacher Observation Records section.

Questioning

Questioning the student is normally an ongoing part of the formative assessment process and may, in some circumstances, provide evidence to support achievement of the criteria.

Questioning is often used to:

- test a student's understanding of work which has been completed outside of the classroom
- check if a student understands the work they have completed
- collect information on the type and purpose of the processes a student has gone through.

If questioning is used as evidence towards achievement of specific topic areas, it is important that teachers/assessors record enough information about what they asked and how the student replied, to allow the assessment decision to be moderated.

6.3.4 Teacher Observation Records (TOR)

You **must** complete the Teacher Observation Record form in the OCR-set assignment for:

Unit F182 Investigating Science (Tasks 2, 3, and 5, Topic Areas 1, 2, 3, and 4) for each student as evidence of the independent collection of data from preliminary testing, the safe carrying out of the procedures for the full investigation, the skilful use of apparatus to collect accurate and precise data, and how well students answered questions following the presentation of their conclusions.

Unit F183 Analytical Techniques in Chemistry (Tasks 2 and 4, Topic Areas 1, 2, and 3) for each student as evidence of the safe carrying out of the separating techniques and the skilful use of apparatus to collect data of sufficient quality, the safe carrying out of the qualitative tests, the skilful preparation of standard solutions, and the safe carrying out of the quantitative tests.

Unit F184 Environmental Studies (Task 3, Topic Area 5) for each student as evidence of the safe carrying out of the student's plan according to their risk assessment, and students independently collecting all of the data recorded.

Unit F185 Forensic Biology (Tasks 2 and 3, Topic Areas 2, 3, and 4) for each student as evidence of how safely students preserved and collected evidence from the crime scene, the safe and skilful use of observational analytical techniques, and the safe and skilful use of microbiological analytical techniques.

Unit F186 Medical Physics (Task 3, Topic Areas 1, 2, 3, 4, and 5) for each student as evidence of student's ability to deliver information that is beyond the presentation content. Teacher observation **cannot** be used as evidence of achievement for a whole unit. Most evidence **must** be produced directly by the student. Teacher observation **must only** be used where specified as an evidence requirement.

Teacher Observation Records must be suitably detailed for each student, to help assessors to determine if the assessment criteria have been met. You must follow the guidance provided in the 'guidance notes' section of the form so that the evidence captured and submitted is appropriate. Both you and the student must sign and date the form to show that you both agree its contents.

Where the guidance has not been followed, the reliability of the form as evidence may be called into question. If doubt about the validity of the Teacher Observation Record form exists, it cannot be used as assessment evidence and marks based on it cannot be awarded. OCR assessors will be instructed to adjust centre marks accordingly.

6.3.5 Presentation of the final piece of work

Students must submit their evidence in the format specified in the tasks where specific formats are given. Written work can be word processed or hand-written and tables and graphs (if relevant) can be produced using appropriate ICT.

Any sourced material must be suitably acknowledged. Quotations must be clearly marked and a reference provided.

A completed Unit Recording Sheet (URS) must be attached to work submitted for moderation.

The URS can be downloaded from the qualification webpage. Centres **must** show on the URS where specific evidence can be found. The URS tells you how to do this.

Work submitted digitally for moderation should be on electronic media (for example, on our portal, CD or USB Drive). Work **must** be in a suitable file format and structure. **Appendix A** gives more guidance about submitting work in digital format.

6.4 Assessing NEA units

All NEA units are assessed by teachers and externally moderated by OCR assessors. Assessment of the set assignments must adhere to JCQ's **Instructions for Conducting Coursework**.

The centre is responsible for appointing someone to act as the internal assessor. This would usually be the teacher who has delivered the programme but could be another person from the centre. The assessment criteria must be used to assess the student's work. These specify the levels of skills, knowledge and understanding that the student needs to demonstrate.

6.4.1 Applying the assessment criteria

When students have completed the assignment, they must submit their work to you to be assessed.

You must assess the tasks using the assessment criteria and any additional assessment guidance provided. Each criterion states what the student needs to do to achieve that criterion (e.g. Produce a plan for the full investigation which includes a method for the preliminary testing). The command word and assessment guidance provide additional detail about breadth and depth where it is needed.

You must judge whether each assessment criterion has been **successfully achieved** based on the evidence that a student has produced. For the criterion to be achieved, the evidence must show that all aspects have been met in sufficient detail.

When making a judgement about whether a criterion has been **successfully achieved**, you must consider:

- the requirements of the NEA task
- the criterion wording, including the command word used and its definition
- any assessment guidance for the criterion
- the unit content that is being assessed.

You must annotate the work to show where evidence meets each criterion (see **Section 6.4.2**). You can then award the criterion on the Unit Recording Sheet (URS). Assessment should be positive, rewarding achievement rather than penalising failure or omissions.

The number of criteria needed for each unit grade (Pass, Merit or Distinction) is provided in **Section 5**.

You must complete a Unit Recording Sheet (URS) for each unit a student completes. On the URS you must identify:

- whether the student has met each criterion or not (by adding a tick (✓) or X in the column titled **Assessment criteria achieved**)
  - you should also indicate where the evidence can be found if a '✓' is identified.
  - a X indicates that there is insufficient evidence to fully meet the criterion or it was not attempted.
- the total number of criteria achieved by the student for the unit.

You must be convinced, from the evidence presented, that students have worked independently to the required standard.

Your centre must internally standardise the assessment decisions for the cohort **before** you give feedback to students (see **Section 6.4.3**). When you are confident the internal assessment and standardisation process is complete, you can submit work for moderation at the relevant time. You **must not** add, amend or remove any work after it has been submitted to us for final moderation.

6.4.2 Annotating students' work

Each piece of NEA work must show how you are satisfied the assessment criteria have been met.

Comments on students' work and the Unit Recording Sheet (URS) provide a means of communication between teachers during internal standardisation, and with the OCR assessor if the work is part of the moderation sample.

6.4.3 Internal standardisation

It is important that all teachers are assessing work to common standards. For each unit, centres must make sure that internal standardisation of outcomes across teachers and teaching groups takes place using an appropriate procedure.

This can be done in a number of ways. In the first year, reference material and OCR training meetings will provide a basis for your centre's own standardisation. In following years, this, and/or your own centre's archive material, can be used. We advise you to hold preliminary meetings of staff involved to compare standards through cross-marking a small sample of work. After you have completed most of the assessment, a further meeting at which work is exchanged and discussed will help you make final adjustments.

If you are the only teacher in your centre assessing these qualifications, we still advise you to make sure your assessment decisions are internally standardised by someone else in your centre. Ideally this person will have experience of these types of qualifications, for example someone who:

- is delivering a similar qualification in another subject.
- has relevant subject knowledge.

You must keep evidence of internal standardisation in the centre for the OCR assessor to see.

We have a **guide** to how internal standardisation can be approached on our website.

6.4.4 Resubmitting work to OCR to improve the grade

As described in **Section 6.2**, before submitting a final outcome to us, you can allow students to repeat any element of the assignment and rework their original evidence. We refer to this as a 'resubmission'. This is to allow the student to reflect on feedback, which must be recorded, and improve their work. It is **not** an iterative process where they make small modifications through ongoing feedback to eventually achieve the desired grade.

6.4.5 Submitting outcomes

When you have assessed the work and it has been internally standardised, outcomes can be submitted to us. For the purpose of submission, outcomes will be considered as 'marks'. You will submit the total number of criteria achieved for units as marks. You can find the key dates and timetables on our **website**.

There should be clear evidence that work has been attempted and some work produced. If a student does not submit any work for an NEA unit, the student should be identified as being absent from that unit.

If a student completes any work at all for an NEA unit, you must assess the work using the assessment criteria and award the appropriate number of criteria. This might be zero.

6.5 Moderating NEA units

The purpose of external moderation is to make sure that the standard of assessment is the same for all centres and that internal standardisation has taken place.

The administration pages of our **website** give full details about how to submit work for moderation.

This includes the deadline dates for entries and submission of marks. For moderation to happen, you must submit your marks by the deadline.

6.5.1 Sample requests

Once you have submitted your marks, we will tell you which work will be sampled as part of the moderation process. Samples will include work from across the range of students' attainment. Copies of students' work must be kept until after their qualifications have been awarded and any review of results or appeals processed.

Centres will receive the final outcomes of moderation when the provisional results are issued. Results reports will be available for you to access. More information about the reports that are available is on our website.

We need sample work to help us monitor standards. We might ask some centres to release work for this purpose. We will let you know as early as possible if we need this from you. We always appreciate your co-operation.

7 Administration

This section gives an overview of the processes involved in administering these qualifications. Some of the processes require you to submit something to OCR by a specific deadline. More information about the processes and deadlines involved at each stage is on our **administration pages**.

7.1 Assessment availability

There are two assessment opportunities available each year for the externally assessed units: one in January and one in June. Students can be entered for different units in different assessment series.

All students must take the exams at a set time on the same day in a series.

Qualification certification is available each January and June.

NEA assignments can be taken by students at any time during the live period shown on the front cover.

There are two windows each year to submit NEA outcomes. Submission of student outcomes will initiate the moderation visit by the OCR Assessor.

You must make unit entries for students before you can submit outcomes to request a visit. All dates relating to NEA moderation are on our administration pages.

Qualification certification is available at each results release date.

7.2 Equality Act information relating to Cambridge Advanced Nationals (AAQs)

The Cambridge Advanced Nationals (AAQs) require assessment of a broad range of skills and, as such, prepare students for further study and higher-level courses.

The Cambridge Advanced Nationals (AAQs) qualifications have been reviewed to check if any of the competences required present a potential barrier to disabled students. If this was the case, the situation was reviewed again to make sure that such competences were included only where essential to the subject.

7.3 Accessibility

There can be adjustments to standard assessment arrangements based on the individual needs of students. It is important that you identify as early as possible if students have disabilities or particular difficulties that will put them at a disadvantage in the assessment situation and that you choose a qualification or adjustment that allows them to demonstrate attainment.

If a student requires access arrangements that need approval from us, you must use **Access arrangements (online)** to gain approval. You must select the appropriate qualification type(s) when you apply. Approval for GCSE or GCE applications alone does not extend to other qualification types. You can select more than one qualification type when you make an application. For guidance or support please contact the **OCR Special Requirements Team**.

The responsibility for providing adjustments to assessment is shared between your centre and us. Please read the JCQ document **Access Arrangements and Reasonable Adjustments**.

If you have students who need a post-exam adjustment to reflect temporary illness, indisposition or injury when they took the assessment, please read the JCQ document **A guide to the special consideration process.**

If you think any aspect of these qualifications unfairly restricts access and progression, please email **Support@ocr.org.uk** or call our Customer Support Centre on **01223 553998**.

The following access arrangements are allowed for this specification:

Access arrangement	**Type of assessment**
Reader/Computer reader	All assessments
Scribes/Speech recognition technology	All assessments
Practical assistants	All assessments
Word processors	All assessments
Communication professional	All assessments
Language modifier	All assessments
Modified question paper	Timetabled exams
Extra time	All assessments with time limits

7.4 Requirements for making an entry

We provide information on key dates, timetables and how to submit marks on our **website**.

Your centre must be registered with us to make entries. We recommend that you apply to become a registered centre with us well in advance of making your first entries. Details on how to register with us are on our **website**.

It is essential that unit entry codes are stated in all correspondence with us.

7.4.1 Making estimated unit entries

Estimated entries are not needed for Cambridge Advanced Nationals (AAQs) qualifications.

7.4.2 Making final unit entries

When you make an entry, you must state the unit entry codes and the component codes. Students submitting work must be entered for the appropriate unit entry code from the table below.

The short title for these Cambridge Advanced Nationals (AAQs) is CAMTECH. This is the title that will be displayed on our secure website, **Interchange**, and some of our administrative documents.

You do **not** need to register your students first. **Individual unit entries should be made for each series in which you intend to submit or resubmit an NEA unit or sit an externally assessed examination**.

Make a certification entry using the overall qualification code (see **Section 7.5**) in the final series only.

Unit entry code	**Component code**	**Assessment method**	**Unit titles**
F180	01	Written paper	Fundamentals of science
F181	01	Written paper	Science in society
F182A	01	Visiting	Investigating science
F182B	02	Remote	Investigating science
F183A	01	Visiting	Analytical techniques in chemistry
F183B	02	Remote	Analytical techniques in chemistry
F184A	01	Visiting	Environmental studies
F184B	02	Remote	Environmental studies
F185A	01	Visiting	Forensic biology
F185B	02	Remote	Forensic biology

F186A	01	Visiting	Medical physics
F186B	02	Remote	Medical physics

7.5 Certification rules

You must enter students for qualification certification separately from unit assessment(s). If a certification entry is **not** made, no overall grade can be awarded. These are the qualifications that students should be entered for:

- OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Certificate) - certification code H051.
- OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science (Extended Certificate) - certification code H151.

7.6 Unit and qualification resits

Students can resit each unit and the best result will be used to calculate the certification result.

Resit opportunities must be fair to all students and **not** give some students an unfair advantage over other students. For example, the student must not have direct guidance and support from the teacher in producing further evidence for NEA units. When resitting an NEA unit, students must submit new, amended or enhanced work, as detailed in the JCQ **Instructions for Conducting Coursework**.

When you arrange resit opportunities, you must make sure that you do not adversely affect other assessments being taken.

Arranging a resit opportunity is at the centre's discretion. Summative assessment series must not be used as a diagnostic tool and resits should only be planned if the student has taken full advantage of the first assessment opportunity and any formative assessment process.

7.7 Post-results services

A number of post-results services are available:

- Reviews of results - if you think there might be something wrong with a student's results, you may submit a review of marking or moderation.
- Missing and incomplete results - if an individual subject result for a student is missing, or the student has been omitted entirely from the results supplied you should use this service.
- Access to scripts - you can ask for access to marked scripts.
- Late certification - following the release of unit results, if you have not previously made a certification entry, you can make a late request, which is known as a **late certification**. This is a free service.

Please refer to the JCQ **Post-Results Services booklet** and the **OCR Administration page** for more guidance about action on the release of results.

For NEA units the enquiries on results process cannot be carried out for one individual student; the outcome of a review of moderation must apply to a centre's entire cohort.

Appendix A: Guidance for the production of electronic evidence

Structure for evidence

The NEA units in these qualifications are units F182-F186. For each student, all the tasks together will form a portfolio of evidence, stored electronically. Evidence for each unit must be stored separately.

An NEA portfolio is a collection of folders and files containing the student's evidence. Folders should be organised in a structured way so that the evidence can be accessed easily by a teacher or OCR assessor. This structure is commonly known as a folder tree. It would be helpful if the location of particular evidence is made clear by naming each file and folder appropriately and by use of an index called 'Home Page'.

There should be a top-level folder detailing the student's centre number, OCR candidate number, surname and forename, together with the unit code (F182–F186), so that the portfolio is clearly identified as the work of one student.

Each student's portfolio should be stored in a secure area on the centre's network. Before submitting the portfolio to OCR, the centre should add a folder to the folder tree containing the internal assessment and summary forms.

Data formats for evidence

It is necessary to save students' work using an appropriate file format to minimise software and hardware capability issues.

Students must use formats appropriate:

- to their evidence
- for viewing for assessment and moderation.

Formats must be open file formats or proprietary formats for which a downloadable reader or player is available. If a downloadable reader or player is not, the file format is **not** acceptable.

Evidence submitted is likely to be in the form of word-processed documents, presentation documents, digital photos and digital video.

All files submitted electronically must be in the formats listed on the following page. Where new formats become available that might be acceptable, we will give more guidance. It is the centre's responsibility to make sure that the electronic portfolios submitted for moderation are accessible to the OCR assessor and fully represent the evidence available for each student.

Standard file formats acceptable as evidence for the Cambridge Advanced Nationals (AAQs) are listed here.

File type	File format	Max file size*
Audio	.3g2 .3ga .aac .aiff .amr .m4a .m4b .m4p .mp3 .wav	25GB
Compression	.zip .zipx .rar .tar .tar .gz .tgz .7z .zipx .zz	25GB
Data	.xls .xlsx .mdb .accdb .xlsb	25GB
Document	.odt .pdf .rtf .txt .doc .docx .dotx .	25GB
Image	.jpg .png .jpeg .tif .jfif .gif .psd .dox .pcx .bmp .wmf	15MB
Presentation	.ppt .pptx .pdf .gslides .pptm .odp .ink .potx .pub	25GB
Video	.3g2 .3gp .avi .flv .m4v .mkv .mov .mp4 .mp4v .wmp .wmv	25GB
Web	.wlmp .mts .mov-1 .mp4-1 .xspf .mod .mpg	25GB

If you are using **.pages** as a file type, please convert this to a .pdf prior to submission.

*max file size is only applicable if using our Submit for Assessment service.

Submit for Assessment is our secure web-based submission service. You can access Submit for Assessment on any laptop or desktop computer running Windows or macOS and a compatible browser. It supports the upload of files in the formats listed in the table above as long as they do not exceed the maximum file size. Other file formats and folder structures can be uploaded within a compressed file format.

When you view some types of files in our Submit for Assessment service, they will be streamed in your browser. It would help your OCR assessor or examiner if you could upload files in the format shown in the table below:

File type	File format	Chrome	Firefox
Audio	.mp3	Yes	Yes
Audio	.m4a	Yes	Yes
Audio	.aac	No	Yes
Document	.txt	Yes	Yes
Image	.png	Yes	Yes
Image	.jpg	Yes	Yes
Image	.jpeg	Yes	Yes
Image	.gif	Yes	Yes
Presentation	.pdf	Yes	Yes
Video	.mp4	Yes	Yes
Video	.mov	No	Yes
Video	.3gp	Yes	No
Video	.m4v	Yes	Yes
Web	.html	Yes	Yes
Web	.htm	Yes	Yes

Appendix B: Command Words

External assessment

The table below shows the command words that will be used in exam questions. This shows what we mean by the command word and how students should approach the question and understand its demand. Remember that the rest of the wording in the question is also important.

Command Word	Meaning
Analyse	• Separate or break down information into parts and identify their characteristics or elements • Explain the different elements of a topic or argument and make reasoned comments • Explain the impacts of actions using a logical chain of reasoning
Annotate	• Add information, for example, to a table, diagram or graph
Calculate	• Work out the numerical value. Show your working unless otherwise stated
Choose	• Select an answer from options given
Compare	• Give an account of the similarities and differences between two or more items or situations
Complete	• Add information, for example, to a table, diagram or graph to finish it
Describe	• Give an account that includes the relevant characteristics, qualities or events
Discuss (how/whether/etc)	• Present, analyse and evaluate relevant points (for example, for/against an argument) to make a reasoned judgement
Draw	• Produce a picture or diagram
Explain	• Give reasons for and/or causes of something • Make something clear by describing and/or giving information
Give examples	• Give relevant examples in the context of the question
Identify	• Name or provide factors or features from stimulus
Label	• Add information, for example, to a table, diagram or graph until it is final
Outline	• Give a short account or summary
State	• Give factors or features • Give short, factual answers

Non examined assessment (NEA)

The table shows the command words that will be used in the NEA assignments and/or assessment criteria.

Command Word	Meaning
Adapt	• Change to make suitable for a new use or purpose
Analyse	• Separate or break down information into parts and identify their characteristics or elements • Explain the different elements of a topic or argument and make reasoned comments • Explain the impacts of actions using a logical chain of reasoning
Assess	• Offer a reasoned judgement of the standard or quality of situations or skills. The reasoned judgement is informed by relevant facts
Calculate	• Work out the numerical value. Show your working unless otherwise stated
Classify	• Arrange in categories according to shared qualities or characteristics
Compare	• Give an account of the similarities and differences between two or more items, situations or actions
Conclude	• Judge or decide something
Describe	• Give an account that includes the relevant characteristics, qualities or events
Discuss (how/whether/etc)	• Present, analyse and evaluate relevant points (for example, for/against an argument) to make a reasoned judgement
Evaluate	• Make a reasoned qualitative judgement considering different factors and using available knowledge/experience
Examine	• To look at, inspect, or scrutinise carefully, or in detail
Explain	• Give reasons for and/or causes of something • Make something clear by describing and/or giving information
Interpret	• Translate information into recognisable form • Convey one's understanding to others, e.g. in a performance
Investigate	• Inquire into (a situation or problem)
Justify	• Give valid reasons for offering an opinion or reaching a conclusion
Research	• Do detailed study in order to discover (new) information or reach a (new) understanding
Summarise	• Express the most important facts or ideas about something in a short and clear form

We might also use other command words but these will be:

- commonly used words whose meaning will be made clear from the context in which they are used (e.g. create, improve, plan)
- subject specific words drawn from the unit content.

Appendix C: How Science Works Concepts and Skills

In order to be able to develop their skills, knowledge and understanding in OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science, students need to have acquired competence in the 'how science works' concepts and skills listed in the table of coverage.

The concepts and skills set out in this section are intended to develop learners as critical and creative thinkers, and to enable learners to solve problems in a variety of contexts. The concepts and skills are set out as references and associated statements.

All how science works' references will be assessed within the lifetime of the specification across the examined assessment units as appropriate. Students will also be required to apply their knowledge and understanding of the 'how science works concepts and skills' across the NEA units as appropriate.

Terms associated with measurement and data analysis are used in accordance with their definitions in the Association of Science Education publication *The Language of Measurement (2010).*

How Science Works Reference	**How Science Works Statement**	**To include understanding of:**
HSW1	Use theories, models, and ideas to develop scientific explanations	• Peer review • Use of a variety of models (representational, spatial, descriptive, computational, and mathematical) to solve problems • Hypotheses and predictions
HSW2	Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and ideas	• Use of online and offline research skills • Correctly citing sources of information • How to present reasoned explanations, including relating data to hypotheses
HSW3	Use appropriate methodology, including information and communication technology (ICT) to answer scientific questions and solve scientific problems	• Experimental design, including to solve problems in a practical context • Control variables, dependent variables, and independent variables • Appropriateness of an experimental method to meet expected outcomes • Importance of scientific quantities and how they are determined • How to determine an appropriate sample size and/or range of values to be measured
HSW4	Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts	• How to use the apparatus, techniques and procedures correctly, skilfully and safely • Apply investigative approaches and methods to practical work
HSW5	Use data to provide evidence, and recognise correlations and causal relationships	• Appropriate units for measurements (this already exists as part of Maths skills) • How to present observations and data in an appropriate format • How to process data using appropriate prefixes (e.g. tera, giga, mega, kilo, centi, milli,

How Science Works Reference	How Science Works Statement	To include understanding of:
		micro and nano) and powers of ten for orders of magnitude • How to distinguish between a correlation and a cause-effect link • How to translate data from one form to another • How to identify the presence/absence of a mechanism as reasonable grounds for accepting/rejecting a claim that a factor is a cause of an outcome
HSW6	How to evaluate methodology, evidence and data, and resolve conflicting evidence	• How to interpret and make judgments and draw conclusions from qualitative and quantitative experimental results (including observations and graphs) • Anomalies and outliers in experimental measurements • How to use appropriate maths skills for analysis of quantitative data • Limitations in experimental procedures • Precision, accuracy, repeatability, reproducibility, and validity of measurements and data, including margins of error, percentage errors and uncertainties in apparatus • How to refine experimental design by suggestion of improvements to the apparatus, procedures, and techniques • Confidence in a prediction or hypothesis
HSW7	How scientific knowledge and understanding develops over time	• How theories have developed over time and been modified when new evidence has become available • Problems that science cannot currently answer
HSW8	How to communicate information and ideas in appropriate ways using appropriate scientific terminology	• Use of diagrammatical, graphical, numerical and symbolic forms in communication • Paper based and electronic forms of presentation • Accurate representation and labelling of objects observed
HSW9	Consider applications and implications of science and evaluate their associated benefits and risks	• Examples of technological applications of science that have made significant positive differences to people's lives • Risks that have arisen from new scientific or technological advances • Perceived and calculated risk in relation to data and consequences
HSW10	Consider impact of science and technology on humans, other organisms, and the environment	• Reasons why different decisions on the same issue might be appropriate in view of differences in personal, social, economic or environmental context, and be able to make decisions based on the evaluation of evidence and arguments

How Science Works Reference	How Science Works Statement	To include understanding of:
HSW11	How to evaluate the role of the scientific community in validating new knowledge and ensuring integrity	• Reasons why scientists should communicate their work to a range of audiences
HSW12	How to evaluate the ways in which society uses science to inform decision making	• How to distinguish between questions that could be answered using a scientific approach, from those that could not

Appendix D: Mathematical skills for Applied Science

In order to be able to develop their skills, knowledge and understanding in OCR Level 3 Cambridge Advanced National (AAQ) in Applied Science, students need to have acquired competence in the mathematical skills listed in the table of coverage.

All mathematical references will be assessed within the lifetime of the specification across the examined assessment units as appropriate. Students will also be required to apply their knowledge and understanding of the 'mathematical skills' across the NEA units as appropriate.

A minimum of 25% of the marks available in the exams for the externally-assessed units will be for the assessment of mathematical skills. These skills will be applied in the context of the relevant science.

A minimum of 10% of the criteria in any combination of the NEA assignments will be for the explicit assessment of mathematical skills.

Mathematical skill to be assessed		Exemplification of the mathematical skill in context
M0 – Arithmetic and numerical computation		
M0.1	Recognise and make use of appropriate units in calculations	e.g. converting mm^3 to cm^3 or cm^3 to dm^3 as part of volumetric calculations.
M0.2	Recognise and use expressions in decimal, ordinary and standard form	e.g. carrying out calculations using numbers expressed in standard form such as speed of light in a vacuum.
M0.3	Use ratios, fractions and percentages	e.g. calculating surface area to volume ratio
M0.4	Estimate results	e.g. estimating effect of changing experimental parameters on measurable values
M0.5	Use calculators to find and use power functions	e.g. solving for number of undecayed nuclei in $N = N_0e^{-lt}$
M0.6	Use calculators to find cos x when x is expressed in degrees	e.g. calculating the work done when the direction of the force is not in the same direction as the displacement
M1 – Handling data		
M1.1	Use an appropriate number of significant figures	e.g. reporting calculations to an appropriate number of significant figures given raw data quoted to varying numbers of significant figures
M1.2	Understand the terms mean, median and mode	e.g. calculating or comparing the mean, median and mode of a set of data such as height/mass of a group of organisms
M1.3	Understand simple probability	e.g. understanding probability in context of radioactive decay
M1.4	Make order of magnitude calculations	e.g. making order of magnitude calculations in relation to magnification
M1.5	Uncertainties in measurements and use of simple techniques to determine uncertainty when data are combined by addition, subtraction, multiplication, division and raising to powers	e.g. determining uncertainty when two burette readings are used to calculate a titre value / calculate percentage error where there are uncertainties in measurement
M1.6	Frequency tables and diagrams, bar charts, line graphs, scatter plots, pie charts, and histograms	e.g. plotting a range of data in an appropriate format, e.g. data relating to cars
M1.7	Understand the principles of sampling as applied to scientific data, including representative sampling	e.g. how to ensure sampling is representative in a population
M1.8	Understand measures of dispersion, including standard deviation and range	e.g. understanding why standard deviation might be a more useful measure of dispersion for a given set of data, such as where there is an outlying result
M2 - Algebra		

M2.1	Understand and use the symbols: =, <, >, ≤, ≥, <<, >>, ∝, ≠, ±, ≈, D	e.g. recognising the significance of the symbols in the expression F ∝ Dp/ Dt
M2.2	Change the subject of an equation, including non-linear equations	e.g. carrying out structured and unstructured mole calculations
M2.3	Substitute numerical values into algebraic equations using appropriate units for physical quantities	e.g. carrying out enthalpy change calculations
M2.4	Solve algebraic equations, including quadratic equations	e.g. solving equations for constant acceleration such as v = u + at
M3 - Graphs		
M3.1	Translate information between graphical, numerical, and algebraic forms	e.g. interpreting and analysing spectra
M3.2	How to plot two variables from experimental or other data	e.g. plotting graphs of current against potential difference
M3.3	Understand that y = mx + c represents a linear relationship	e.g. rearranging and comparing v = u + at with y = mx + c for velocity-time graphs in constant acceleration problems
M3.4	The slope and intercept of a linear graph	e.g. reading off and interpreting the initial velocity in a velocity-time graph
M3.5	Rate of change from a graph showing a linear relationship	e.g. calculating acceleration from a linear velocity-time graph
M3.6	The slope of a tangent to a curve as a measure of rate of change	e.g. calculating the rate of a reaction from the gradient of a gas volume-time graph
M3.7	Instantaneous rate of change and average rate of change	e.g. understanding that the gradient of the tangent of a displacement-time graph gives the velocity at a point in time, which is a different measure to the average velocity
M3.8	Understand the possible physical significance of the area between a curve or line and the x-axis and be able to calculate it or estimate it by graphical methods as appropriate	e.g. recognising that the area under a force-extension graph is equivalent to the energy stored
M3.9	Sketch relationships for graphs	e.g. sketching the relationship between resistance and temperature for a thermistor
M4 – Geometry and trigonometry		
M4.1	Use angles in regular 2D and 3D structures	e.g. measuring angles in force diagrams to solve problems for work done
M4.2	Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects	e.g. drawing different forms of isomers
M4.3	Areas of triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders, and spheres	e.g. calculating the surface area or volume of a cell

The questions and tasks across all units that are used to target mathematical skills will be at a level of demand that is appropriate to Level 3 Cambridge Advanced National (AAQ) in Applied Science. The questions that assess mathematical skills will not be of a lower demand than that of questions and tasks in the assessment for the Higher Tier in a GCSE qualification in Mathematics.

The list of examples provided in the table is not exhaustive and is not limited to Level 2 examples. These skills could be developed in other areas of the specification content from those indicated.

Students will not be expected to memorise mathematical formulas. Any mathematical formulas will be provided in the examination paper on a separate data sheet. Students will not be expected to memorise the content of the Periodic Table.

Mathematical skills should be taught using both theoretical and practical contexts.

Units in Applied Science

It is expected that learners will show and be able to apply understanding of the physical quantities and corresponding units, and SI base units and derived units listed below, and be able to use them in qualitative work and calculations.

Physical quantity	Common symbol(s) (use of these symbols is optional)	SI base unit	Unit abbreviation
length	h – height (e.g. height raised above ground level to calculate gravitational potential energy) l – length (e.g. of a wire) s – displacement (e.g. displacement of a force along its direction of action) x – extension (e.g. of a spring) or distance travelled (e.g. for attenuation of x-rays through a medium) λ (lambda) = wavelength	metre	m
mass	m	kilogram	kg
time	t t_E (effective half life) $t_{1/2}$ (physical half life) t_B (biological half life)	second	s
temperature	T – for Kelvin temperature $\Delta\theta$ (theta) – for change in Kelvin temperature	kelvin	K
current	I	ampere	A
amount of a substance	n	mole	mol

The following table includes SI derived or SI accepted units for quantities which will be commonly used across the qualification:

Physical quantity	Common symbol(s) (use of these symbols is optional)	SI derived / accepted unit	Unit abbreviation
area	A	squared metre	m^2
acceleration	a	metre per squared second	ms^{-2}
acoustic impedance	Z	kilogram per squared metre per second	$kgm^{-2}s^{-1}$
activity	A	Becquerel (one decay per second); per second	Bq; s^{-1}
concentration	c	mole per decimetre cubed; gram per decimetre cubed	mol dm^{-3}; g dm^{-3}
density	r (rho)	kilogram per cubic metre	kg m^{-3}

energy	E - energy W – work done q – (thermal) energy	joule	J
enthalpy change of combustion	$\Delta_c H$	kilojoules per mole	kJ mol^{-1}
electric charge	Q	coulomb	C
electric potential difference	V	volt	V
electric resistance	R	Ohm	Ω
force	F	newton	N
frequency	f	hertz	Hz
gravitational field strength	g	newton per kilogram	Nkg^{-1}
intensity	I	Power per unit cross-sectional area	Wm^{-2}
linear attenuation coefficient	μ	per centimetre; per metre	cm^{-1}; m^{-1}
mass attenuation coefficient	μ_m	squared metre per kilogram; squared centimetre per kilogram	m^2kg^{-1} cm^2g^{-1}
power	P	watt	W
pressure	p	Pascal; Nm^{-2}	Pa
radioactive decay constant	λ	per second	s^{-1}
specific heat capacity	c	Joule per kilogram per degree Celsius ; Joule per kilogram per degree Kelvin	J kg^{-1} $^oc^{-1}$; J kg^{-1} K^{-1}
spring constant	k	newton per metre	Nm^{-1}
temperature	θ (theta) – for Celsius temperature Δθ (theta) – for change in Celsius temperature	degree Celsius	°C
time period	T	second	s
velocity	v – final velocity u – initial velocity	metre per second	ms^{-1}
volume	V	cubic metre; litre; cubic decimetre	m^3; l; dm^3

Appendix E: Data, Formulae and Relationships Booklet

OCR Level 3 Cambridge Advanced National (AAQ) in Human Biology (Certificate)

OCR Level 3 Cambridge Advanced National (AAQ) in Human Biology (Extended Certificate)

Data, Formulae and Relationships Booklet

The Periodic Table of the Elements

Key
atomic number
Symbol
name
relative atomic mass

(1)	(2)											(3)	(4)	(5)	(6)	(7)	(0)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1 **H** hydrogen 1.0																	2 **He** helium 4.0
3 **Li** lithium 6.9	4 **Be** beryllium 9.0											5 **B** boron 10.8	6 **C** carbon 12.0	7 **N** nitrogen 14.0	8 **O** oxygen 16.0	9 **F** fluorine 19.0	10 **Ne** neon 20.2
11 **Na** sodium 23.0	12 **Mg** magnesium 24.3											13 **Al** aluminium 27.0	14 **Si** silicon 28.1	15 **P** phosphorus 31.0	16 **S** sulfur 32.1	17 **Cl** chlorine 35.5	18 **Ar** argon 39.9
19 **K** potassium 39.1	20 **Ca** calcium 40.1	21 **Sc** scandium 45.0	22 **Ti** titanium 47.9	23 **V** vanadium 50.9	24 **Cr** chromium 52.0	25 **Mn** manganese 54.9	26 **Fe** iron 55.8	27 **Co** cobalt 58.9	28 **Ni** nickel 58.7	29 **Cu** copper 63.5	30 **Zn** zinc 65.4	31 **Ga** gallium 69.7	32 **Ge** germanium 72.6	33 **As** arsenic 74.9	34 **Se** selenium 79.0	35 **Br** bromine 79.9	36 **Kr** krypton 83.8
37 **Rb** rubidium 85.5	38 **Sr** strontium 87.6	39 **Y** yttrium 88.9	40 **Zr** zirconium 91.2	41 **Nb** niobium 92.9	42 **Mo** molybdenum 95.9	43 **Tc** technetium	44 **Ru** ruthenium 101.1	45 **Rh** rhodium 102.9	46 **Pd** palladium 106.4	47 **Ag** silver 107.9	48 **Cd** cadmium 112.4	49 **In** indium 114.8	50 **Sn** tin 118.7	51 **Sb** antimony 121.8	52 **Te** tellurium 127.6	53 **I** iodine 126.9	54 **Xe** xenon 131.3
55 **Cs** caesium 132.9	56 **Ba** barium 137.3	57–71 lanthanoids	72 **Hf** hafnium 178.5	73 **Ta** tantalum 180.9	74 **W** tungsten 183.8	75 **Re** rhenium 186.2	76 **Os** osmium 190.2	77 **Ir** iridium 192.2	78 **Pt** platinum 195.1	79 **Au** gold 197.0	80 **Hg** mercury 200.6	81 **Tl** thallium 204.4	82 **Pb** lead 207.2	83 **Bi** bismuth 209.0	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89–103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium		114 **Fl** flerovium		116 **Lv** livermorium		

57 **La** lanthanum 138.9	58 **Ce** cerium 140.1	59 **Pr** praseodymium 140.9	60 **Nd** neodymium 144.2	61 **Pm** promethium 144.9	62 **Sm** samarium 150.4	63 **Eu** europium 152.0	64 **Gd** gadolinium 157.2	65 **Tb** terbium 158.9	66 **Dy** dysprosium 162.5	67 **Ho** holmium 164.9	68 **Er** erbium 167.3	69 **Tm** thulium 168.9	70 **Yb** ytterbium 173.0	71 **Lu** lutetium 175.0
89 **Ac** actinium	90 **Th** thorium 232.0	91 **Pa** protactinium	92 **U** uranium 238.1	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

General information

Physical constant	Symbol	Value and units
Acceleration of free fall	g	$9.81 ms^{-2}$
Avogadro constant	N_A	$6.02 \times 10^{23} mol^{-1}$
Elementary charge	e	1.60×10^{-19} C
Electron rest mass	m_e	9.11×10^{-31} kg
Neutron rest mass	m_n	1.675×10^{-27} kg
Planck constant	h	6.63×10^{-34} Js
Proton rest mass	m_p	1.673×10^{-27} kg
Speed of light in a vacuum	c	$3.00 \times 10^{8} ms^{-1}$
Molar gas volume (at room temperature and pressure, RTP)	V_m	$24.0 dm^3 mol^{-1}$
Euler's number	e	2.718

Conversion factors: 1 eV = 1.60×10^{-19} J

Mathematical Equations

Circumference of circle = $2\pi r$

Area of circle = πr^2

Curved surface area of cylinder = $2\pi rh$

Surface area of sphere = $4\pi r^2$

Area of trapezium = $\frac{1}{2}(a+b)h$

Volume of cylinder = $\pi r^2 h$

Volume of sphere = $4/3\pi r^3$

Formulae and relationships for Unit F180

B1 Cell structure and microscopy	
Total magnification = magnification of objective lens x magnification of eyepiece lens	$M_T = M_O \times M_E$
Magnification = $\frac{\text{observed size}}{\text{actual size}}$	

B4 Biodiversity and ecosystems	
Percentage efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}} \times 100\%$	

C1 Atomic Structure and the Periodic Table	
Relative atomic mass = $\frac{\sum (\text{isotope mass} \times \text{isotope abundance})}{100}$	

C2 Amount of substance	
Number of moles = $\frac{\text{mass of substance}}{\text{relative formula mass}}$	$n = m / M_r$
Concentration = $\frac{\text{number of moles of solute}}{\text{volume}}$	$c = n / V$
Concentration = $\frac{\text{mass of solute}}{\text{volume}}$	$c = m / V$
Number of moles of gas = volume of gas in sample x 24	n = V x 24

C4 Rates of Reaction and Enthalpy Changes	
Thermal energy = mass x specific heat capacity x change in temperature	$q = mc\Delta T$

P1 Electricity	
Charge = current x time	Q = It
Potential difference = current x resistance	V = IR
Power = current x potential difference	P = IV
Power = $(\text{current})^2$ x resistance	$P = I^2R$
Power = $\frac{(\text{potential difference})^2}{\text{resistance}}$	$P = \frac{V^2}{R}$
Work done = potential difference x current x time	W = VIt
Work done = potential difference x charge	W = VQ
Total resistance in series = resistance of resistor 1 + resistance of resistor 2 + …	$R_T = R_1 + R_2 + \ldots$
Total resistance in parallel = $\frac{1}{\text{Resistance of resistor 1}} + \frac{1}{\text{Resistance of resistor 2}}$	$1/R_T = 1/R_1 + 1/R_2 + \ldots$

P2 Forces & Motion	
Work done = force x distance moved in the direction of the force	W = Fs
Work done = force x distance moved in the direction of the force x $\cos\theta$	$W = Fs\cos\theta$

Kinetic energy = ½ x mass x $(velocity)^2$	$E = 1/2mv^2$
Gravitational potential energy = mass x acceleration of free fall x height	$E = mg\Delta h$
Elastic potential energy = ½ x force x extension = ½ x spring constant x $(extension)^2$	$E = 1/2Fx = 1/2kx^2$
Power = $\frac{\text{work done}}{\text{time}}$	P = W/t
Efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$	
Net force = mass x acceleration	F = ma
Average velocity = $\frac{\text{displacement}}{\text{time taken}}$	$v = \frac{s}{t}$
Acceleration = $\frac{\text{final velocity – initial velocity}}{\text{time taken}}$	$a = \frac{v - u}{t}$
Final velocity = initial velocity + (acceleration x time taken)	v = u + at
Displacement = ½ (initial velocity + final velocity) x time taken	s = ½(u+v)t
Displacement = (initial velocity x time taken) + (1/2 x acceleration x time taken^2)	$s = ut + 1/2at^2$
$\text{Final velocity}^2 = \text{initial velocity}^2$ + 2 x acceleration x displacement	$v^2 = u^2 + 2as$

P3.1 Medical Physics	
Energy of a photon = Planck constant x frequency	E = hf
Energy of a photon = $\frac{\text{Planck constant x speed of light in a vacuum}}{\text{wavelength}}$	$E = hc/\lambda$
Intensity of emergent beam = intensity of incident beam x Euler's number$^{-1 \text{ x linear attenuation coefficient x distance travelled through the medium}}$	$I = I_0e^{-\mu x}$
Mass attenuation coefficient = $\frac{\text{linear attenuation coefficient}}{\text{density of medium}}$	$\mu_m = \mu/\rho$
density = $\frac{\text{mass}}{\text{volume}}$	$\rho = m/V$
Frequency = $\frac{1}{\text{time period}}$	f = 1/T
Wave speed = frequency x wavelength	$v = f\lambda$
Intensity = $\frac{\text{Power}}{\text{Area}}$	I = P/A

Acoustic impedance = density of medium x speed of sound in the medium	$Z = \rho c$
Intensity reflection coefficient = Intensity of reflected wave / Intensity of incident wave = (acoustic impedance of second medium – acoustic impedance of initial medium / acoustic impedance of second medium + acoustic impedance of initial medium)^2	$\alpha = I_r/I_o = (Z_2 - Z_1/Z_2 + Z_1)^2$

P3.2 Radioactivity	
Physical half-life = $\dfrac{0.693}{\text{radioactive decay constant}}$	$t_{1/2} = 0.693/\lambda$
1/effective half-life = 1/physical half-life + 1/biological half-life	$1/t_E = 1/t_{1/2} + 1/t_B$
Activity = radioactive decay constant x number of undecayed nuclei	$A = \lambda N$
Number of undecayed nuclei = initial number of undecayed nuclei x Euler's number$^{-1 \text{ x radioactive decay constant x time}}$	$N = N_0 e^{-\lambda t}$
Activity = initial activity x Euler's number$^{-1 \text{ x radioactive decay constant x time}}$	$A = A_0 e^{-\lambda t}$


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