Pearson BTEC

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Pearson BTEC
Level 3 National Extended Certificate in

Applied Science (AAQ)

Specification

First teaching from September 2025
First certification from 2027

Pre-publication draft
Qualification Number: XXX/XXXX/X

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Draft

This draft qualification has not yet been accredited by Ofqual. It is published to enable teachers to have early sight of our proposed approach to the Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ). Further changes may be required and no assurance can be given at this time that the proposed qualification will be made available in its current form, or that it will be accredited in time for first teaching in September 2025 and first award in 2027.

About Pearson

We are the world's leading learning company operating in countries all around the world. We provide content, assessment and digital services to students, educational institutions, employers, governments and other partners globally. We are committed to helping equip students with the skills they need to enhance their employability prospects and to succeed in the changing world of work. We believe that wherever learning flourishes so do people.

References to third party materials made in this specification are made in good faith. Pearson does not endorse, approve or accept responsibility for the content of materials, which may be subject to change, or any opinions expressed therein. (Materials may include textbooks, journals, magazines and other publications and websites.)

All information in this specification is correct at time of publication.

VQ000339

Welcome

BTEC Nationals are widely recognised by higher education and industry as the vocational qualification of choice at Level 3. They provide students with meaningful and practical learning experiences across a range of career sectors to prepare them to progress to higher education as a route to graduate-level employment.

Recent data has shown that one in five adults of working age in the UK has a BTEC qualification. What's more, well over 90,000 BTEC students apply to UK universities every year and their BTEC Nationals are accepted by over 150 UK universities and other higher education institutions for relevant degree programmes either on their own or in combination with A Levels.

Why are BTECs so successful?

BTECs embody a fundamentally student-centred approach to the curriculum, with a flexible, unit-based structure and knowledge applied through a balanced combination of assignments and examinations. They enable the holistic development of the practical, interpersonal and thinking skills required to succeed in higher education and employment.

When creating these BTEC Nationals we focused on the skills and personal attributes needed to navigate the future, and have worked with many higher education providers, professional bodies, colleges and schools to ensure that their needs are met. Employers are looking for future employees with a thorough grounding in the latest industry requirements and work-ready skills such as critical thinking and problem solving. Higher education needs students who have experience of research, extended writing and meeting deadlines.

We have addressed these requirements by:

- Facilitating and guiding the development of transferable skills through the design and delivery of the qualifications, using a holistic and practical framework which is based on recent research into the most critical skills needed to navigate the future. This Transferable Skills framework has been used to embed transferable skills in the qualifications where they naturally occur and also to signpost opportunities for delivery and development as a part of the wider BTEC learning experience. See page 6 for further information.
- Supporting the delivery of Sustainability Education and Digital Skills development naturally through the content design of the qualifications. Mapping is provided for each qualification to identify where the opportunities for teaching and learning exist.
- Updating sector-specific content to ensure it is relevant and future-facing.
- Implementing a consistent approach to assessment with a balanced combination of internal and external assessments to better engage students, make the qualifications more accessible for them and more manageable for centres to deliver.

We are providing a wealth of support, both resources and people, to ensure that students and their teachers have the best possible experience during their course. See Section 5 for details of the support we offer.

This specification document should be used in conjunction *with Pearson BTEC Level 3 National Administrative Support Guide* which is available on our website.

A word to students

Today's BTEC Nationals will require commitment and hard work, as you would expect of the most respected applied learning qualification in the UK. You will have to complete a range of units, be organised, take some assessments that we will set and mark and undertake practical tasks and assignments. But you can feel proud to achieve a BTEC because, whatever your plans in life – whether you decide to study further, go on to work or an apprenticeship – your BTEC National will be your passport to success in the next stage of your life.

Good luck, and we hope you enjoy your course.

Contents

1 Introduction

Why choose Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ)?

We've listened to feedback from all parts of the Applied Science subject community, including higher education. We've used this opportunity of curriculum change to redesign qualifications so that they reflect the demands of a truly modern and evolving applied science environment – qualifications that enable your students to apply themselves and give them the skills to succeed in their chosen pathway.

The Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ) enables students to study the principles and applications of biology, chemistry and physics, as well as practical scientific procedures and techniques. Students will also have the opportunity to develop their investigation skills or explore contemporary issues in science.

There are three examined units and two internally assessed units where students will engage in practical tasks to develop their scientific skills and knowledge.

The qualification is designed to be taken alongside A levels as part of a study programme. It can link to learning in a range of A level subjects such as A level Psychology and A level Sociology. The Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ) is intended for students that wish to progress into higher education as a pathway to employment.

Total Qualification Time

For all regulated qualifications, Pearson specifies a total number of hours that it is estimated students will require to complete and show achievement for the qualification: this is the Total Qualification Time (TQT). Within TQT, Pearson identifies the number of Guided Learning Hours (GLH) that we estimate a centre delivering the qualification might provide. Guided learning means activities, such as lessons, tutorials, online instruction, supervised study and giving feedback on performance, that directly involve teachers and assessors in teaching, supervising and invigilating students. Guided learning includes the time required for students to complete external assessment under examination or supervised conditions.

In addition to guided learning, other required learning directed by teachers or assessors will include private study, preparation for assessment and undertaking assessment when not under supervision, such as preparatory reading, revision and independent research.

BTEC Nationals have been designed around the number of hours of guided learning expected. Each unit in the qualification has a GLH value of 60 or 90. There is then a total GLH value for the qualification.

Each qualification has a TQT value. This may vary within sectors and across the suite depending on the nature of the units in each qualification and the expected time for other required learning.

The following table shows the qualifications in this sector and their GLH and TQT values.

Qualification title	Size and structure	Summary purpose
Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ)	360 GLH (500 TQT) Equivalent in size to one A Level. 4 units mandatory units, of which 3 are externally assessed. 2 optional units, of which one must be selected. Mandatory content (75%). External assessment (50%).	The Extended Certificate is for students who are interested in learning about the Applied Science sector alongside other fields of study, with a view to progressing to a wide range of higher education courses, not necessarily in Applied Science - related subjects. It is designed to be taken as part of a programme of study that includes A Levels.

Qualification and unit content

Pearson has developed the content of the new BTEC Nationals in collaboration with representatives from higher education and relevant professional bodies. In this way, we have ensured that content is up to date and that it includes the knowledge, understanding, skills and attributes required in the sector.

Centres should ensure that delivery of content is kept up to date. Some of the units within the specification may contain references to legislation, policies, regulations and organisations, which may not be applicable in the country you deliver this qualification in (if teaching outside of England), or which may have gone out-of-date during the lifespan of the specification. In these instances, it is possible to substitute such references with ones that are current and applicable in the country you deliver subject to confirmation by your Standards Verifier.

Assessment

Assessment is specifically designed to fit the purpose and objective of the qualification. It includes a range of assessment types and styles suited to vocational qualifications in the sector. There are three main forms of assessment that you need to be aware of: external, internal and synoptic.

Externally-assessed units

Each external assessment for a BTEC National is linked to a specific unit. All of the units developed for external assessment are of 60, 90 or 120 GLH to allow students to demonstrate breadth and depth of achievement. Each assessment is taken under specified conditions, then marked by Pearson and a grade awarded. Students are permitted to resit the examination twice. This equates to three attempts in total: one inclusive of registration, the remaining two attempts as resits. If students resit an examined unit, the best grade achieved will count towards their overall qualification grade, not necessarily the most recent sitting. External assessments are available twice a year. For detailed information on the external assessments, please see the table in *Section 3.* For further information on preparing for external assessment, see *Pearson BTEC Level 3 National Administrative Support Guide*, which is available on our website.

Internally-assessed units

Internally-assessed units are assessed by a Pearson Set Assignment Brief (PSAB), which is set by Pearson, marked by you and subject to external standards verification. Before you assess you will need to become an approved centre, if you are not one already. You will need to prepare to assess using the guidance in *Pearson BTEC Level 3 National Administrative Support Guide*, which is available on our website. You will make grading decisions based on the requirements and supporting guidance given in the units. Where a student has not achieved their expected level of performance for an assignment, they may be eligible for one resubmission of improved evidence for each assignment

submitted if authorised by the Lead Internal Verifier. To ensure any resubmissions are fairly and consistently implemented for all students, the Lead Internal Verifier can only authorise a resubmission if certain conditions are met. If the Lead Internal Verifier does authorise a resubmission, it must be completed within 15 working days of the student receiving the results of the assessment.

Feedback to students can only be given to clarify areas where they have not achieved expected levels of performance. Students cannot receive any specific guidance or instruction about how to improve work to meet assessment criteria or be given solutions to questions or problems in the tasks.

If a student has still not achieved the targeted pass criteria following the resubmission of improved evidence for an assignment, the Lead Internal Verifier may authorise, under exceptional circumstances, one retake opportunity to meet the required pass criteria. The retake assignment must be based on a different content theme, sector challenge/issue or context brief as relevant to the PSAB for that subject. The deadline for submission of the retake must fall within the same academic year.

Synoptic assessment

Synoptic assessment requires students to demonstrate that they can identify and use effectively, in an integrated way, an appropriate selection of skills, techniques, concepts, theories and knowledge from across the whole sector as relevant to a key task. Synoptic links between units are flagged within the unit content. Please refer to Unit 4: Practical Scientific Procedures and Techniques for further details.

Language of assessment

Assessment of the internal and external units for these qualifications will be available in English. All student work must be in English. A student taking the qualifications may be assessed in British or Irish Sign Language where it is permitted for the purpose of reasonable adjustment.

For information on reasonable adjustments see *Pearson BTEC Level 3 National Administrative Support Guide*, which is available on our website.

Grading for units and qualifications

Achievement in the qualification requires a demonstration of depth of study in each unit, assured acquisition of a range of practical skills required for progression to higher education, and successful development of transferable skills. Students achieving a qualification will have completed all units.

Units are assessed using a grading scale of Distinction (D), Merit (M), Pass (P), Near Pass (N) and Unclassified (U). The grade of Near Pass is used for externally-assessed units only. All mandatory and optional units contribute proportionately to the overall qualification grade, for example a unit of 120 GLH will contribute double that of a 60 GLH unit.

BTEC National qualifications are graded using a scale of P to D*, **or** PP to D*D*, **or** PPP to D*D*D* depending on the size of the qualification. Please see *Section 6* for more details. The relationship between qualification grading scales and unit grades will be subject to regular review as part of Pearson's standards monitoring processes on the basis of student performance and in consultation with key users of the qualification.

UCAS tariff points

The BTEC Nationals attract UCAS points. Please go to the UCAS website for full details of the points allocated.

Preparing students for the future

Transferable skills

Recent future skills reports have highlighted the growing importance of transferable skills for students to succeed in their careers and lives in this fast-changing world.

Following research and consultation with FE educators and higher education institutions, Pearson has developed a Transferable Skills Framework to facilitate and guide the development of transferable skills through this qualification. The Framework has four broad skill areas, each with a cluster of transferable skills as shown below:

1. Managing Yourself: (1) Taking Personal Responsibility; (2) Personal Strengths & Resilience; (3) Career Orientation Planning; (4) Personal Goal Setting
2. Effective Learning: (1) Managing Own Learning; (2) Continuous Learning; (3) Secondary Research Skills (4) Primary Research Skills
3. Inter-personal Skills: (1) Written Communications; (2) Verbal and Non-verbal Communications; (3) Teamwork; (4) Cultural and Social Intelligence
4. Solving Problems:(1) Critical Thinking (2) Problem Solving; (3) Creativity and Innovation

Each transferable skill has a set of descriptors that outline what achievement of the skill looks like in practice. Each unit in the qualification will show whether a transferable skill has been:

1. fully embedded through the design of the teaching and learning content and assessment of the unit. Skills that are embedded are 'naturally occurring' in that they are inherent to the unit content and doesn't require extension activities to deliver.
2. signposted as an opportunity for delivery and development and would require extension activities to deliver.

Units will show a summary of the transferable skills that have been embedded or signposted and Appendix 2 shows the descriptors for each skill across all the skill clusters.

More information on the framework, its design and relevance for learner progression is available in the *BTEC Transferable Skills Guide for Teachers*. Resources and guidance to support teachers in the delivery and development of these skills will be available in the Delivery Guide for this qualification and through our training offer.

Digital Skills

Digital skills are required in every industry as well as in everyday life and with the acceleration of automation and AI in industry it is critical for students to understand how digital technologies are relevant and applied in the context of the sector they are studying.

With this in mind, we have used the Digital Skills Framework published by IFATE as a frame of reference to identify opportunities for the delivery and development of digital skills in this qualification.

This Digital Skills framework has five categories with specific digital characteristics that apply in varying extent across sectors:

- Problem Solving – The use of digital tools to analyse and solve problems
- Digital Collaboration and Communication – Using digital tools to communicate and share information with stakeholders
- Transacting Digitally – Using digital tools to set up accounts and pay for goods/services
- Digital Security – Identify threats and keep digital tools safe
- Handling Data Safely and Securely – Follow correct procedures when handling personal and organisational data

Opportunities to develop these digital skills are identified where they are relevant and appropriate to a sector, meaning that:

- Where they naturally occur
- Where they add no assessment burden
- Where they will enhance a student's skills and knowledge in the sector.

Appendix 3 shows a mapping of the teaching and learning content to the five categories of the framework to show where opportunities to develop these digital skills exists in this qualification.

Sustainability Education

To help learners develop sustainability skills, practices and mindset, we have designed content in this qualification, aligned to the UNESCO Sustainable Development Goals (17 SDGs), that are relevant and appropriate to the sector. The SDGs are the most common point of reference for content that addresses sustainability education and provides a useful and pragmatic way of presenting this content.

Sustainability knowledge and understanding may be included in the teaching and learning content but not directly assessed. Alternatively, it could be assessed – the approach chosen for each unit is based on the relevance of knowledge and understanding to the purpose and scope of the unit.

Appendix 4 shows a mapping of the teaching and learning content to the relevant SDGs to show where sustainability concepts have been included in this qualification.

2 Qualification purpose

Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ)

In this section you will find information on the purpose of this qualification and how its design meets that purpose through the qualification objective and structure. We publish a full 'Statement of Purpose' for each qualification on our website. These statements are designed to guide you and potential students to make the most appropriate choice of qualification at recruitment.

Who is this qualification for?

The Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ) is an Alternative Academic Qualification (AAQ) designed for post -16 students with an interest in science and aiming to progress to higher education as a route to graduate level employment.

Equivalent to one A Level in size, it is suitable for students looking to develop their applied knowledge and skills in science alongside two A levels.

What will the student study as part of this qualification?

The qualification has been developed in consultation with higher education representatives and sector experts from associated professional bodies to ensure students have the knowledge, understanding and skills they need to progress to, and thrive, in higher education.

The qualification has four mandatory units covering the following topics:

- **Principles and Applications of Biology -** Structure and function of cells and tissues, biological molecules, enzymes and their role in organisms
- **Principles and Applications of Chemistry** - Structure of the Periodic Table and its implications on physical and chemical properties of substances, through analysis of different bonding methods
- **Principles and Applications of Physics -** Waves and their applications; force principles and their application in transportation and construction of electrical circuits
- **Practical Scientific Procedures and Techniques -** Practical applications across the sciences, including chromatography, colorimetry and electrical circuits.

Students have a choice from two optional units covering the following topics:

- **Scientific Investigation Skills -** Investigative research, including planning, data collection, analysis and evaluation.
- **Contemporary Issues in Science –** Contemporary scientific issues including the reliability of sources of scientific information and their associated validity.

What knowledge and skills will the student develop as part of this qualification and how might these be of use and value in further studies?

Students will develop the following knowledge and skills from the mandatory units:

- Fundamental scientific principles and applied knowledge relating to biology, chemistry and physics
- Laboratory techniques, including health and safety assessment, and associated professional practice
- Problem solving.

Students will develop the following knowledge and skills from the optional units:

- Scientific Research skills including researching and planning methodologies, primary data collection and analysis, drawing justified conclusions.
- Secondary research skills including collecting information from a range of sources, its evaluation and interpretation, and its use to draw reasoned conclusions.
- Transferable skills such as critical thinking, taking personal responsibility and written communications.

Students develop the ability to practically apply scientific concepts, which is beneficial to the analytical approach of related degrees. Critical thinking and independent learning help students to be better prepared for the self-directed learning approach used in higher education and become more open-minded to learning. Research and extended writing skills with the other skills, creates a good foundation for academic success.

Which subjects will complement this qualification?

The following subjects would be suitable to combine with this qualification:

- Psychology
- Sociology
- Geography

What further learning will this qualification lead to?

This qualification can lead to progression to the following degrees:

- BSc (Hons) Applied Sport and Exercise Sciences
- BSc (Hons) Nursing
- BSc (Hons) Secondary Science Education

3 Structure

Qualification structure

Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ)

Students must complete four mandatory units and one optional unit.

See *Section 6* for rules on qualification awarding.

Mandatory units – students complete and achieve all units.

Unit number	Unit title	GLH	Type	How assessed
1	Principles and Applications of Biology	**60**	**Mandatory**	External
2	Principles and Applications of Chemistry	**60**	**Mandatory**	External
3	Principles and Applications of Physics	**60**	**Mandatory**	External
4	Practical Scientific Procedures and Techniques	**90**	**Mandatory**	Internal

Optional units – students complete and achieve one unit.

Unit number	Unit title	GLH	Type	How assessed
5	Science Investigation Skills	**90**	**Optional**	Internal
6	Contemporary issues in Science	**90**	**Optional**	Internal

External assessment

60% of the total qualification GLH is made up of external assessment. A summary is given below. See the unit content and sample assessment materials for more information.

Unit	Type	Availability
Unit 1: Principles and Applications of Biology	• An external examination set and marked by Pearson. • 50 marks.	**January and June** **First assessment June 2026**
Unit 2: Principles and Applications of Chemistry	• An external examination set and marked by Pearson. • 50 marks.	**January and June** **First assessment June 2026**
Unit 3: Principles and Applications of Physics	• An external examination set and marked by Pearson. • 50 marks.	**January and June** **First assessment June 2026**

Synoptic assessment

The assessment of synoptic knowledge requires students to apply learning from one unit to the assessment in another unit. Within the assessment for *Unit 4:* Practical *Scientific Procedures and Techniques*, students will be assessed on underpinning knowledge, ideas and concepts from Unit 1: Principles and Applications of Biology; Unit 2: Principles and Applications of Chemistry; and Unit 3: Principles and Applications of Physics.
There might be some further naturally occurring synoptic opportunities across the qualification where students can synthesise their learning. These will be outlined in the Delivery Guide to help with planning for your teaching.

4 Units

Understanding your units

The units in this specification set out our expectations of assessment in a way that helps you to prepare your students for assessment. The units help you to undertake assessment and quality assurance effectively.

Each unit in the specification is set out in a similar way. There are two types of unit format:

- Internally assessed units
- Externally assessed units.

This section explains how the units work. It is important that all teachers, assessors, internal verifiers and other staff responsible for the programme review this section.

Internally assessed units

Section	Explanation
Unit number	The number is in a sequence in the sector. Numbers may not be sequential for an individual qualification.
Unit title	This is the formal title that we always use and it appears on certificates.
Unit level	All units are Level 3 on the national framework.
Unit type	This confirms that the unit is internally assessed. See structure information in *Section 3* for full details.
GLH	Units have Guided Learning Hours (GLH) value of 90. This indicates the number of hours of teaching, directed activity and assessment expected. It also shows the weighting of the unit in the final qualification grade.
Unit in brief	A brief formal statement on the content of the unit that is helpful in understanding its role in the qualification. You can use this in summary documents, brochures etc.
Unit introduction	This is designed with students in mind. It indicates why the unit is important, how learning is structured and how learning might be applied when progressing to employment or higher education.
Learning aims	These help to define the scope, style and depth of learning of the unit. You can see where students should be learning standard requirements ('understand') or where they should be actively researching ('investigate'). You can find out more about the verbs we use in learning aims in *Appendix 1*.

Section	Explanation
Summary of unit	This helps teachers to see the main content areas against the learning aims and the structure of the assessment at a glance.
Content	This sets out the required teaching content of the unit. Content is compulsory except where shown as 'e.g.'. Students should be asked to complete summative assessment only after the teaching content for the unit or learning aim(s) has been covered.
Assessment criteria	Each learning aim has Pass and Merit criteria. Each assignment has at least one Distinction criterion. A full glossary of terms used is given in *Appendix 1*. Distinction criteria represent outstanding performance in the unit. Some criteria require students to draw together learning from across the learning aims.
Transferable skills	This summarises the transferable skills present within this unit. The key helps to identify whether they are signposted but require additional assessment, embedded and achieved on completion or not present in this unit.
Essential information for Pearson Set Assignment Brief (PSAB)	This shows a brief summary of the activities required for the mandatory Pearson Set Assignment Brief. Centres must download and use the mandatory PSAB without alteration or contextualisation.
Further information for teachers and assessors	This gives you information to support the implementation of assessment. It is important that this is used carefully alongside the assessment criteria and PSAB.
Resource requirements	Any specific resource requirements that you need to be able to teach and assess are listed in this section. For more information on support resources, see the *Pearson BTEC Level 3 National Administrative Guide.*
Essential information for assessment decisions	This information gives guidance for each learning aim or assignment of the expectations for Pass, Merit and Distinction standard. This section contains examples and essential clarification.
Links to other units	This shows you the main relationship between units. This can help you to structure your programme and make best use of materials and resources.

Externally assessed units

Section	Explanation
Unit number	The number is in a sequence in the sector. Numbers may not be sequential for an individual qualification.
Unit title	This is the formal title that we always use and it appears on certificates.
Unit level	All units are Level 3 on the national framework.
Unit type	This confirms that the unit is externally assessed. See structure information in *Section 3* for full details.
GLH	Units have a Guided Learning Hours (GLH) value of 90. This indicates the number of hours of teaching, directed activity and assessment expected. It also shows the weighting of the unit in the final qualification grade.
Unit in brief	A brief formal statement on the content of the unit that is helpful in understanding its role in the qualification. You can use this in summary documents, brochures etc.
Unit introduction	This is designed with students in mind. It indicates why the unit is important, how learning is structured and how learning might be applied when progressing to employment or higher education.
Summary of assessment	This sets out the type of external assessment used and the way in which it is used to assess achievement.
Assessment outcomes	These show the hierarchy of knowledge, understanding, skills and behaviours that are assessed. Includes information on how this hierarchy relates to command terms in sample assessment materials (SAMs).
Content	For external units all content is obligatory. The depth of content is indicated in the assessment outcomes and sample assessment materials (SAMs). The content will be sampled through the external assessment over time, using the variety of questions shown.
Transferable skills	This summarises the transferable skills present within this unit. The key helps to identify whether they are signposted but require additional assessment, embedded and achieved on completion or not present in this unit.
Key terms typically used in assessment	These definitions will help you analyse requirements and prepare students for assessment.
Resources	Any specific resource requirements that you need to be able to teach and assess are listed in this section. For more information on

Section	Explanation
	support resources, see the *Pearson BTEC Level 3 National Administrative Guide.*
Links to other units	This shows you the main relationship between units. This can help you to structure your programme and make best use of materials and resources.

Index of units

Unit 1: Principles and Applications of Biology

Level: 3

Unit type: External

Guided learning hours: 60

Unit in brief

This unit explores the key components of biological science. It will examine cells and tissues, their varied structures and functions and the biological components that interact with their existence.

Unit introduction

Scientists and technicians working in science and science-related organisations must have a good understanding of core science concepts. A strong grasp of these concepts will enable you to use and apply this knowledge and understanding in vocational contexts when studying other units within this specification.

The topic areas covered in this unit include:

- animal and plant cells and tissues, including specialised cells
- biological molecules, including water, carbohydrates, proteins and nucleic acid
- cell transport
- enzymes activity

Science professionals need to understand the structure and workings of cells. They build on this knowledge to understand how the body stays healthy as well as the symptoms and causes of some diseases. This allows them to diagnose and treat illnesses. The study of bacterial prokaryotic cells gives an understanding of how some other diseases are caused and can be treated. Scientists and technicians in the food industry also need to understand the structure and function of plant cells to enable them to develop food crops that produce greater yields.

The knowledge and understanding you will learn in this unit will provide a strong basis for you to progress in the science sector and to a variety of science related programmes such as higher nationals and degrees.

Summary of assessment

The unit will be assessed through one examination of 50 marks lasting 1 hour.

The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented.

The assessment availability is twice a year in January and May/June. The first assessment availability is May/ June 2026.

Sample assessment materials will be available to help centres prepare learners for assessment.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of scientific concepts and theories, terminology, definitions and scientific formulae used in Biology.

AO2 Apply knowledge and understanding of scientific concepts and theories, procedures, processes and techniques in Biology.

AO3 Analyse and interpret scientific information in Biology.

[SP-CT]

Content

The essential content is set out under content areas. Learners must cover all specified content before the assessment. All topics require learners to apply knowledge, analyse and evaluate.

A: Structure and function of cells and tissues

A1 Structure and function of cells and tissues

The essential content topics require learners to apply knowledge and understanding to given contexts:

A1.1 Ultrastructure and function of organelles in the following cells:

A1.1.1 prokaryotic cells (bacterial cell), to include:

- nucleoid
- plasmids
- 70S ribosomes
- capsule
- cell wall
- cytoplasm
- plasma membrane
- mesosomes
- flagellae
- pili

A1.1.2 eukaryotic cells, to include:

- plasma membrane
- cytoplasm
- nucleus
- nucleolus
- endoplasmic reticulum (smooth and rough)
- Golgi apparatus
- vesicles
- lysosomes
- 80S ribosomes
- mitochondria
- centrioles
- cilia

- Plant cell specific organelles, to include:
  - cell wall
  - chloroplasts
  - vacuole
  - tonoplast
  - amyloplasts
  - plasmodesmata
  - pits.

A1.2 Recognising organelles from electron micrographs and photomicrographs.

A1.3 Similarities and differences between the structure and function of plant cells and animal cells.

A1.4 Responses of Gram-positive and Gram-negative bacteria when exposed to antibiotics.

A1.5 Calculate magnification and size of cells and organelles from images.

A2 Structure and function of specialised cells in multicellular organisms

A2.1 The structure and function of specialised eukaryotic cells, to include:

- palisade mesophyll cells
- root hair cells
- xylem cells
- phloem cells
- sperm and egg cells in reproduction
- erythrocytes
- leucocytes
- thrombocytes
- neurones.

A3 Structure and function of biological tissues

A3.1 The structure and function of epithelial tissue, to include:

A3.1.1 squamous as illustrated by the role of alveolar epithelium in gas exchange

A3.1.2 columnar as illustrated by goblet cells and ciliated cells in the lungs to include their role in protecting lungs from pathogens.

A3.1.3 the effect of chronic obstructive pulmonary disease (COPD)

A3.2 The structure and function of endothelial tissue, as illustrated by blood vessels in the cardiovascular system, to include:

A3.2.1 risk factors that damage endothelial cells and lead to the development of atherosclerosis.

A3.3 The structure and function of muscular tissue, to include:

A3.3.1 microscopic structure of a skeletal muscle fibre

A3.3.2 structural and physiological differences between fast- and slow-twitch muscle fibres and their relevance to short term and endurance-based activities

A3.4 The structure and function of nervous tissue, to include:

A3.4.1 non-myelinated and myelinated neurones

A3.4.2 the conduction of a nerve impulse along an axon, to include changes in membrane permeability to sodium and potassium ions and the role of the myelination in saltatory conduction

A3.4.3 interpretation of graphical displays of a nerve impulse

A3.4.4 synaptic structure and the role of neurotransmitters

A3.4.5 imbalances of brain chemicals that can contribute to ill health, including dopamine in Parkinson's disease

A3.4.6 effects of drug interaction on synaptic transmission, to include agonists, antagonists and precursors

B: Structure and function of biological molecules

B1 Structure and function of water

B1.1 Structure, to include:

- contains hydrogen (H) and oxygen (O) atoms
- structural and chemical formulae
- within water molecule (covalent bonding)
- polarity
- hydrogen bonds between water molecules

B1.2 Function, to include:

- as a solvent
- medium for chemical reactions and transport
- pH regulation
- electrolyte balance
- temperature regulator
- cohesion-tension in mass flow.

B2 Structure and function of carbohydrates

B2.1 Structure, to include:

- contain carbon (C), hydrogen and oxygen atoms
- monosaccharides, to include:
  - α and β glucose,
  - galactose
  - fructose
  - ribose and deoxyribose.
- disaccharides, to include:
  - lactose
  - maltose
  - sucrose.
- polysaccharides
  - Starch (amylose and amylopectin)
  - cellulose
  - glycogen

B2.2 Function, to include:

- release of energy and the production of ATP
- energy storage
- structural

B2.3 Using iodine and Benedict's solution as tests for presence of carbohydrates.

B3 Structure and function of proteins

B3.1 Structure to include:

- primary structure, including peptide links to give polypeptides
- secondary structure, including α-helices and β-pleated sheets
- tertiary structure, to include:
  - ionic interaction
  - hydrogen bonding
  - di-sulfide bridges/bonds
  - van der Waal's forces.
- quaternary structure, including haemoglobin
- classification as globular or fibrous

B3.2 Function to include:

- muscles
- enzymes
- antibodies
- antigens
- carrier proteins
- hormones
- for transport of other components
- body tissue growth and repair
- blood clotting

B3.3 Using Biuret solution as a test for presence of protein

B4 Structure and function of nucleic acids

B4.1 Structure to include

- nucleotide structure (deoxyribose or ribose, phosphate and purine or pyrimidine base)
- polynucleotide structure with bonds made through condensation reactions
- formation of the DNA double helix through complementary base pairing
- formation of RNA nucleotides

B4.2 Function to include

- DNA in genes
- RNA for protein synthesis and controlling gene expression.

B5 Structure and function of lipids

B5.1 Structure, to include

- carbon, hydrogen and oxygen in fats, oils and waxes
- saturated and unsaturated fats, and formation of diglycerides and triglycerides via esterification reactions

B5.2 Function to include

- energy sources and stores
- insulation and organ protection
- phospholipids in membranes
- steroid hormones

B5.3 Use of emulsion tests to identify presence of lipids

C: Cellular transport and enzyme activity

C1 Cell transport mechanisms

C1.1 Structure of the cell surface membrane with reference to the fluid mosaic model.

C1.2 Methods used to transport molecules, to include:

- through cell membranes, to include:
  - passive transport brought about by diffusion
  - facilitated diffusion
  - osmosis
  - active transport
- bulk transport
  - endocytosis
  - exocytosis

C1.3 Significance of surface area to volume ratio in living organisms.

C2 Enzymes as biological catalysts

C2.1 Structure, to include:

- made of proteins
- active site with specific tertiary structure

C2.2 Function to include

- biological catalysts
- collision theory
- lock and key theory
- formation of enzyme-substrate complex
- specificity of enzymes
- importance of measuring initial rates of reaction

C2.3 Factors affecting enzyme activity

- optimum
- denaturing
- temperature
- pH
- substrate and enzyme concentration

C3 Homeostasis

C3.1 The purpose of homeostasis in relation to:

- optimum
- stimulus
- receptors/ sensors
- control centres
- effectors
- feedback.

C3.2 Negative feedback loops effecting the body, to include:

- blood pressure
- body fluids (osmoregulation)
- gas concentration
- blood sugar levels.

C3.3 Positive feedback loops effecting the body, to include:

- blood clotting
- labour contractions.

C3.4 Interrelationship between nervous and endocrine system responses.

C3.4.1 role of the autonomic nervous system, breathing, heartbeat

C3.4.2 role of adrenal glands (fight and flight, heart rate)

C3.4.3 hypothalamus, endocrine and nervous system

C3.4.4 peripheral nervous system, autonomic system, relaying information to the brain.

C3.5 Disturbance of homeostasis

C3.5.1 ageing, weakening of feedback loops, heart failure, diabetes

C3.5.2 influence of lifestyle, to include:

- nutrition
- physical activity
- drug/alcohol abuse

Transferable skills

Managing Yourself	Effective Learning	Interpersonal Skills	Solving Problems
MY – TPR	EL – MOL	IS – WC	SP – CT*
MY – PS&R	EL – CL	IS – V&NC	SP – PS
MY – COP	EL – SRS	IS – T	SP – C&I
MY – PGS	EL – PRS	IS – C&SI	

Table key

*	Signposted to indicate opportunities for development as part of wider teaching and learning.
√	Embedded in teaching, learning and assessment
Blank	TS not embedded or signposted in unit

Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure learners are rewarded for demonstrating the necessary skills.

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only.

Command or term	Definition
Add/label	Students label or add to a stimulus material given in the question, for example labelling a diagram, adding units on a table, adding points or line to a graph.
Assess	Students give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something and come to a conclusion where needed.
Calculate	Students obtain a numerical answer, showing relevant working and appropriate units where required.
Compare	Students look for the similarities **and** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question.
Complete	Students complete a table/ diagram.
Deduce	Students draw/reach conclusion(s) from the information provided.
Describe	Students give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	Students' answers must have an element that is quantitative from the stimulus provided or must show how the answer can be reached quantitatively
Devise	Students plan or invent a procedure from existing principles/ ideas.
Discuss	Consider the different aspects in detail of an issue, situation, problem or argument and how they interrelate. Does not require a conclusion.
Draw	Create a graphical or visual representation of information.

Command or term	Definition
Evaluate	Students review information then bring it together to form a conclusion, drawing on evidence, strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.
Explain	Students identify a point and then give a linked justification/ reasoning of the given point. For a 3-mark question a further linked justification/reasoning is required. For a 4-mark question there could be two separate identification points that would require appropriate expansion, or one identification with three detailed additional points for expansion.
Give/state/name	These generally require recall of one or more pieces of information.
Give a reason	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Predict	Students give an expected result.
Sketch	Students produce a freehand drawing showing a trend line. The axes are labelled but not scaled.
State what is meant by	Provide the accepted definition of a term
Suggest	Propose a likely solution or application.
Which	Select one correct answer from a choice of four options.

Unit 2: Principles and Applications of Chemistry

Level: 3

Unit type: External

Guided learning hours: 60

Unit in brief

Students will explore some of the fundamental concepts which underpin the chemistry and chemical reactions of the world around them.

Unit introduction

Chemistry is not just a subject; it influences many aspects of other sciences. Everything you see, everything you do, everywhere you go, you are surrounded by chemistry and the chemical reactions that are needed for it. Chemistry makes up the world we live in today.

In this unit, you will re-examine basic chemistry (the periodic table, atomic and electronic structure, bonding and structure) with more advanced concepts such as ionisation energy, electronegativity, polarity, molecular shape and intermolecular forces. Periodicity will be explored through the study of Period 3 elements and their compounds, focusing on changes in oxidation number, physical and chemical properties, and making predictions for other elements. You will learn about the main branches of physical chemistry (chemical kinetics, energetics and equilibrium), perform mole calculations, and consider the impact of green chemistry in the chemical industry. You will learn the basics of organic chemistry, naming and drawing formulae, understanding isomerism and other properties, the reactions of different types of organic compound, and the benefits or problems that organic chemistry can provide.

The content covered at the beginning, will provide you with the pre-requisite knowledge to explore the subject further in the latter stages of the unit. The content enables you to build on your understanding as you progress towards your final assessment.

This unit will help you progress to higher education and professional qualifications either in chemistry, or other science-based qualifications. It will also help you to progress to employment in the chemical or scientific industry.

Summary of assessment

The unit will be assessed through one examination of 50 marks lasting 1 hour.

The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented.

The assessment availability is twice a year in January and May/ June. The first assessment availability is May/ June 2026.

Sample assessment materials will be available to help centres prepare students for assessment.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of scientific concepts and theories, terminology, definitions and scientific formulae used in Chemistry.

AO2 Apply knowledge and understanding of scientific concepts and theories, procedures, processes and techniques in Chemistry.

AO3 Analyse and interpret scientific information in Chemistry.

[SP-CT]

Content

The essential content is set out under content areas. Students must cover all specified content before the assessment. All topics require learners to apply knowledge, analyse and evaluate.

A: Atomic and electronic structure

A1.1 Features of the periodic table and their relationship with atomic structure:

A1.1.1 symbols, atomic number, mass number

- use of these concepts to determine numbers of subatomic particles (protons, neutrons and electrons) in atoms, isotopes and ions

A1.1.2 relative atomic mass

- use of relative atomic mass to determine relative abundance of isotopes (and use of relative abundance of isotopes to determine relative atomic mass)
- use of relative atomic mass to determine relative formula masses

A1.1.3 group, period, blocks

- use of these concepts to determine the number and arrangement of electrons in atoms and ions

A1.2 Electronic structure

A1.2.1 energy levels (shells), subshells and electronic orbitals

A1.2.2 rules to determine the electronic structure of atoms

A1.2.3 represent electronic configuration for atoms and ions of elements with atomic numbers 1- 36 in terms of:

- s, p and d notation
- electron-in-boxes diagrams.

A1.3 Ionisation energy

A1.2.1 definition and equations for first and successive ionisation energies

A1.2.2 evidence from successive ionisation energies for the electronic structure of an atom

A1.2.3 factors affecting ionisation energy trends down a group and across a period

- nuclear charge
- number of shells
- shielding
- subshells

B: Bonding and structure

Learners will need to be able to describe and represent different types of bonding and structure listed in **B1.1**, **B1.2** and **B1.3** as dot-and-cross diagrams and/or lattice arrangements for atoms, ions and molecules.

B1.1 Metallic bonding and giant metallic structures

B1.2 Ionic bonding and giant ionic structures

B1.3 Covalent bonding and molecules:

- electrostatic attraction between two nuclei and the shared pair of electrons between them
- single, double, triple and dative covalent (coordinate) bonds
- sigma and pi molecular orbitals
- relationship between bond lengths and bond strength
- simple molecular structures and giant covalent structures

B1.4 Typical physical properties of substances with different types of bonding and structure in **B1.1**, **B1.2** and **B1.3**, to include melting point and electrical conductivity

B1.5 Molecular shape – the use of electron pair repulsion theory to determine shapes of molecules (up to 6 electron pairs around the central atom) to include:

- linear
- non-linear
- trigonal planar
- pyramidal
- tetrahedral
- trigonal bipyramidal
- octahedral and their associated bond angles

B1.6 Electronegativity and polarity

- definition of electronegativity, trends across a period and down a group
- use of electronegativity to determine bond polarity
- use of electronegativity and molecular shape to identify molecules as polar or non-polar

B1.7 Intermolecular forces:

- London dispersion forces / temporary dipole – induced dipole forces
- permanent dipole – permanent dipole forces
- hydrogen bonding (and effects on physical properties)

B1.8 Effect of hydrogen bonding on the properties of water (melting and boiling point, densities of ice and liquid water, surface tension of water)

C: Periodicity

Learners will need to be able to use the principles covered in section A (atomic and electronic structure) and section B (structure and bonding) to describe and explain the properties and reactions covered in this section.

C1.1 Changes in physical properties for the elements across Period 3 (Na to Ar), to include:

- atomic radius and ionic radius (positively and negatively charged ions)
- melting point
- electrical conductivity

C1.2 Oxidation number concept, oxidation and reduction

C1.2.1 determination of the oxidation number of an element in compounds and ions using the oxidation number concept

C1.2.2 application of the oxidation number concept to determine the formula of common oxides, hydroxides/acids and chlorides of Period 3 elements

C1.2.3 oxidation and reduction in terms of loss and gain of electrons

C1.2.4 construct half equations and redox equations

C1.3 Trends and observations for the reactions of the Period 3 elements with

C1.3.1 oxygen (formation of the products Na_2O, MgO, Al_2O_3, P_4O_{10} and SO_2 only)

C1.3.2 water (formation of the products $NaOH$, $Mg(OH)_2$ and $Al(OH)_3$ only)

C1.3.3 chlorine (formation of the products $NaCl$, $MgCl_2$, Al_2Cl_6, $SiCl_4$, and PCl_5 only)

C1.4 Differences in physical properties (melting point and electrical conductivity only) for the Period 3 oxides and chlorides listed in **C1.3**

C1.5 Acid-base behaviour of Period 3 oxides and hydroxides listed in **C1.3.1**, and of the compounds SiO_2, H_3PO_4, H_2SO_4, HCl, $HClO$ and $HClO_4$

C1.6 The action of water with Period 3 chlorides listed in **C1.3.3** and the pH of the solutions produced

C1.7 Write balanced equations for reactions in **C1.3**, **C1.5** and **C1.6**.

C1.8 Predict the physical and chemical properties of elements in other periods based upon knowledge of the Period 3 elements

C1.9 Uses of Period 3 elements and compounds, based upon their physical and chemical properties

D: Physical chemistry

D1.1 Concept of the mole and use in calculations involving:

- mass and molar mass (relative atomic mass or relative formula mass)
- empirical formula and stochiometric ratios in equations
- gas volume and molar volume (24dm3 at room temperature and pressure)
- percentage yield, actual yield and theoretical yield

D1.2 Chemical kinetics

D1.2.1 factors affecting rate of reaction to include concentration, pressure, temperature, surface area and catalysis

D1.2.2 collision theory and activation energy

D1.2.3 interpretation of concentration vs time graphs

D1.2.4 Maxwell-Boltzmann distribution curves – effect of changes in concentration, temperature and catalysis

D1.2.5 determination of rate equations, to include finding orders of reaction and the value of a rate constant (and its units), when given appropriate data

D1.3 Chemical energetics

D1.3.1 enthalpy change – definition, endothermic and exothermic processes

D1.3.2 energy level diagrams and reaction profile diagrams

D1.3.3 standard enthalpy changes –standard conditions and definitions of standard enthalpy change of formation, of combustion and of reaction

D1.3.4 Hess's Law and energy cycles

D1.3.5 calculations involving energy cycles and standard enthalpy changes

D1.4 Chemical equilibrium

D1.4.1 dynamic equilibrium – definition and characteristics

D1.4.2 Le Chatelier's principle and predicting the effect on equilibrium of changes in concentration, pressure and temperature, and the presence of a catalyst

D1.4.3 equilibrium constant expressions (K_c or K_p) and units

D1.4.4 calculations involving equilibrium constants and concentrations or partial pressures

D1.4.5 interpretation of yield vs pressure or temperature graphs

D1.5 Application of chemical kinetics, energetics and equilibrium to the chemical industry

(Learners are not required to have knowledge of specific chemical industries)

D1.6 Application of green chemistry in the chemical industry

- atom economy and uses of waste products
- renewable and recycled resources
- energy efficiency and catalysis
- hazards of reactants and products
- recycling of unused reactants
- end-of-life for products (recycling and degradation).

E: Organic chemistry

E1.1 Knowledge and understanding of key terms used in organic chemistry:

- saturated hydrocarbon and unsaturated hydrocarbon
- straight-chain, branched chain and cyclic organic compounds
- homologous series and functional group
- general formulae for alkanes, alkenes, halogenoalkanes and alcohols

E1.2 Structure representations of organic compounds, using

- full (displayed) structural formula (fully displayed and condensed formulae)
- skeletal formulae
- 3D representations using wedge/dashed line diagrams

E1.3 Naming alkanes, alkenes, halogenoalkanes and alcohols, using International Union of Pure and Applied Chemistry (IUPAC) nomenclature rules (up to 6 carbon atoms)

E1.4 Isomerism – predicting and explanation of occurrence of:

- structural isomerism
- stereoisomerism (E/Z and cis-trans stereoisomers only)

E1.5 Sigma and pi molecular orbitals in alkanes and alkenes

E1.6 Changes in boiling point within due to changes in chain length or branching

E1.7 Types of reactions of organic compounds

E1.7.1 addition reactions of alkenes with H_2, halogens, hydrogen halides and steam

E1.7.2 substitution reactions of alkanes with halogens using UV radiation

E1.7.3 substitution reactions of halogenolkanes with aqueous sodium hydroxide

E1.7.4 substitution reactions of alcohols with PCl_5 and with HBr

E1.7.5 elimination reactions of halogenoalkanes using ethanolic sodium hydroxide

E1.7.6 oxidation of primary alcohols to carboxylic acids using acidified $K_2Cr_2O_7$

E1.7.7 condensation reactions of alcohols with carboxylic acids to form esters *(Learners are required to predict products of the reactions and know reaction conditions. Learners are not required to know reaction mechanisms or practical techniques).*

E1.8 Reactions of commercial importance

E1.8.1 combustion (complete and incomplete) of hydrocarbons and alcohols

E1.8.2 cracking of large chain alkanes (into smaller alkanes and alkenes)

E1.8.3 addition polymerisation

E1.8.4 condensation polymerisation (dicarboxylic acids with diols or diamines) *(Learners are required to write equations and predict products for these reactions)*

E1.9 Benefits and problems arising from combustion, halogenoalkanes (CFCs), polymers (plastics) and alcohol (ethanol)

E1.10 Solutions to environmental problems caused by organic compounds and their usage in **E1.8** and **E1.9**.

Transferable skills

Managing Yourself	Effective Learning	Interpersonal Skills	Solving Problems
MY – TPR	EL – MOL	IS – WC	SP – CT*
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Table key

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√	Embedded in teaching, learning and assessment
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Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure students are rewarded for demonstrating the necessary skills.

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Add/label	Students label or add to a stimulus material given in the question, for example labelling a diagram, adding units on a table, adding points or line to a graph.
Balance	Provide an appropriate number/formula to complete an equation.
Calculate	Students obtain a numerical answer, showing relevant working and appropriate units where required.
Compare	Students look for the similarities **and** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question.
Complete	Students complete a table/diagram.
Deduce	Students draw/reach conclusion(s) from the information provided.
Describe	Students give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	Students' answers must have an element that is quantitative from the stimulus provided or must show how the answer can be reached quantitatively.
Devise	Students plan or invent a procedure from existing principles/ ideas.
Discuss	Consider the different aspects in detail of an issue, situation, problem or argument and how they interrelate. Does not require a conclusion.
Draw	Create a graphical or visual representation of information.
Evaluate	Students review information then bring it together to form a conclusion, drawing on evidence, strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.

Command or term	Definition
Explain	Students identify a point and then give a linked justification/ reasoning of the given point. For a 3-mark question a further linked justification/reasoning is required. For a 4-mark question there could be two separate identification points that would require appropriate expansion, or one identification with three detailed additional points for expansion.
Give/state/name	These generally require recall of one or more pieces of information.
Give a reason	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Plot	Students produce a graph by marking points accurately on a grid from data that is provided and then drawing a suitable line. A suitable scale and appropriately labelled axes must be included if these are not provided in the question.
Predict	Students give an expected result.
Sketch	Students produce a freehand drawing showing a trend line. The axes are labelled but not scaled.
State what is meant by	Provide the accepted definition of a term
Suggest	Propose a likely solution or application.
Which	Select one correct answer from a choice of four options.
Write	Provide the correct equation or formula

Unit 3: Principles and Applications of Physics

Level: 3

Unit type: External

Guided learning hours: 60

Unit in brief

Students will explore the use of practical and mathematical skills in the study of waves, motion and electricity.

Unit introduction

If you've ever considered how the mechanics of a car, your mobile phone or how circuitry work, you shouldn't be surprised that physics plays a huge part in their action. This unit will explore the role physics has on our everyday tasks and activities, communication networks and our work with electrical circuits.

In this unit, you will learn about waves and how electromagnetic waves are the basis for our modern communication systems. Mobile phones, Wii-FI and Bluetooth© will no doubt be concepts you're already familiar with. This unit will enable you to develop an insight into how these systems work and the activities they perform. The study of motion and laws of motion are also important when developing safety products for our everyday lives. Seat belts, air bags and crumple zones are just three innovations that came about through the study of motion. Electricity, electrical circuits and their relationship to energy usage, are also very important as our use of electrical devices continues to rise. By using physics, it is possible to understand how we can create energy alternatives that can help us develop greater more sustainability in our future environment.

Understanding the physical principles, practical investigations and mathematical skills developed in this unit will allow for progression to higher education and professional qualifications such as nursing, health and social care, technicians in medicine, dentistry and laboratory quality control.

Summary of assessment

The unit will be assessed through one examination of 50 marks lasting 1 hour.

The paper will include a range of question types, including multiple choice, calculations, short answer and extended open response. These question types will assess knowledge and understanding of the content in this unit. Students will need to explore and relate to contexts and data presented.

The assessment availability is twice a year in January and May/ June. The first assessment availability is May/ June 2026

Sample assessment materials will be available to help centres prepare students for assessment.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of scientific concepts and theories, terminology, definitions and scientific formulae used in Physics.

AO2 Apply knowledge and understanding of scientific concepts and theories, procedures, processes and techniques in Physics.

AO3 Analyse and interpret scientific information in Physics.

[SP-PS]

Content

The essential content is set out under content areas. Students must cover all specified content before the assessment. All topics require learners to apply knowledge, analyse and evaluate.

A: Understanding waves and optical fibres

A1 Working with waves

A1.1 Features common to waves

A1.1.1 understand terminology, to include:

- periodic time
- wave speed
- wavelength
- frequency
- amplitude
- oscillation

A1.1.2 graphical and diagrammatic representation of wave features.

A1.2 Similarities and differences between transverse and longitudinal waves

A1.3 Concepts of; displacement, coherence, path difference, phase difference and superposition of waves as applied to diffraction gratings.

A1.3.1 emission of different light frequencies due to electron energy level changes within the atom.

A1.3.2 using diffraction gratings to form line emission spectra

A1.3.3 using the lines of emission spectra to identify elements in gases.

A1.4 Using the wave equation: $v = f\lambda$

A1.5 Concepts and applications of stationary waves and resonance in strings and pipes.

A1.5.1 concepts and applications of stationary waves and resonance to musical instruments.

A1.5.2 using the equation: speed of a transverse wave on a string, $v = \sqrt{(T/\mu)}$ where T is the tension in the string and μ is the mass per unit length of the string

A2 Principles of optical fibres

A2.1 Concept of refraction and total internal reflection (TIR)

A2.1.1 use equations for refractive index $n = \frac{C}{V} = \frac{Sin\ i}{Sin\ r}$

A2.1.2 know that total internal reflection only occurs when the angle of incidence in the more optically dense medium is greater than the critical angle

A2.1.3 calculate the critical angle at a glass–air interface given the refractive index of glass using:

$$sin\ c = \frac{l}{n}$$

A2.1.4 know how cladding of optical fibres effects the critical angle in the fibre

A2.2 Applications of optical fibres in engineering, communication, and medicine.

A2.3 Differences between analogue and digital signals

A3 Uses of electromagnetic waves in communication

A3.1 All electromagnetic waves travel at the speed of light in a vacuum.

A3.2 Use the inverse square law in relation to the intensity of a wave: $I = \frac{k}{r^2}$

A3.3 Regions of electromagnetic spectrum overlap and have different frequencies and wavelengths

A3.3.1 using electromagnetic waves and frequencies in communication applications, to include:

- satellite communication and GPS positioning
- mobile phones
- Bluetooth©
- infrared
- Wi-Fi

B: Forces in transportation and Newtons Laws of Motion

B1 Measurement and representation of motion

B1.1 Standard SI units

B1.1.1 standard SI units and symbols for initial velocity (u), final velocity (v), distance and displacement (s), time (t), and acceleration (a).

B1.1.2 units of speed: kilometres per second (kms^{-1}), kilometres per hour (kmh^{-1}).

B1.2 Calculating speed and average speed

B1.2.1 speed = distance ÷ time

B1.2.2 average speed = total distance ÷ total time.

B1.3 Using vector and scalar quantities to describe motion, to include:

B1.3.1 using velocity as a vector quantity that has magnitude and direction

B1.3.2 using distance as a scalar quantity that has magnitude only

B1.3.3 using displacement/time graphs to find velocity

B1.3.4 using velocity time graphs to describe the motion of an object

B1.3.5 using velocity/time graphs to find the distance travelled from the area beneath the graph

B1.3.6 using velocity/time graphs to find acceleration as rate of change of velocity from the gradient of the graph, $a = \frac{(v-u)}{t}$

B1.3.7 find the acceleration of a trolley moving down a gradient

B1.3.8 use equations for the calculation of motion:

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

B1.4 Understand the applications of accelerometers, to include: 'fitbits', mobile phones and blood pressure monitors

B2 Laws of motion

B2.1 Newton's First Law of Motion – the application of a resultant force to make an object move or stop

B2.2 Definitions of inertia, mass and weight.

B2.2.1 inertia as a resistance to change in motion

B2.2.2 gravitational field strength (g) and weight

B2.2.3 calculations for weight, equation $W = mg$

B2.3 Calculation of the coefficient of friction (μ) using the equation: force $F = \mu N$ where N is the normal reaction force, the weight of object on a horizontal surface.

B2.3.1 measuring coefficient of static friction, where *F* is the force applied just as the object is about to move

B2.3.2 measuring coefficient of dynamic (kinetic) friction, where *F* is the force applied to keep the object moving at a constant velocity.

B2.4 Calculating the momentum (p) of objects using the equation $p = mv$

B2.5 Using Newton's Second Law of Motion, force is proportional to rate of change of momentum, to include:

$F = \frac{(mv-mu)}{t}$ and $F = ma$

force is proportional to acceleration for a constant mass

B2.5.1 calculations using Newtons Second Law

B2.5.2 implications for transportation when travelling at high speed with low mass and low speed with high mass

B2.5.3 use of impact force controls, to include:

- air bags
- seat belts
- helmets for motor bike users
- passenger 'cells'
- crumple zones.

B2.6 Newton's third law of motion action and reaction are equal and opposite

B2.7 Know that if *F* is the resultant force on an object, the object accelerates, if the forces are balanced *F* is zero and the object is moving at a constant velocity or stationary

B2.7.1 effect of air resistance, drag and terminal velocity in different applications, to include:

- vehicles on roads
- falling parachutes
- objects falling in liquids

C: Electrical circuits and the transfer of energy

C1 Use of electrical components

C1.1 Identifying circuit symbols

C1.2 Defining terminology - current, potential difference, energy and power

C1.2.1 identifying the electrical units of measurement:

- current in amps (A)
- potential difference in volts (V)
- power in watts (W)
- energy in joules (J)
- resistance in ohms (**Ω**)

C1.3 Connecting circuits with cells, batteries, power supplies, lamps, resistors, variable resistors, switches, ammeters and voltmeters.

C1.3.1 using electrical meters in series and parallel to measure current and potential difference

C1.3.2 using an ohmmeter to measure the resistance of a component

C1.4 Using electrical components in circuits, to include:

- filament lamps
- diodes
- thermistors
- light dependent resistors (LDR)
- photodiodes and light emitting diodes (LED)

C2 Equations

C2.1 Using equations for electrical calculations:

C2.1.1 power = potential difference × current **($P = IV$)**

C2.1.2 voltage = current × resistance **($V = IR$)**

C2.1.3 power = work done/ time **($P = \frac{E}{t}$)**

C2.1.4 energy = potential difference × current × time **($E = VIt$)**

C3 Electrical energy usage

C3.1 Relating to different domestic appliances to calculate energy usage.

C3.2 Relating fuse size to current.

C3.3 Calculating transferred energy using the equation:
Energy transferred = power in kilowatts × time in hours (kWh = kW × h)

C4 Energy transfer

C4.1 Defining units – joules (J), kilojoules (kJ), mega joules (MJ)

C4.2 Converting temperatures between Celsius (°C) and Kelvin (K)

C4.3 The transfer of energy to give a change of temperature and change of state

C4.4 Temperature change

C4.4.1 measuring specific heat capacity of liquids and solids

C4.4.2 using equation:
Thermal energy = mass × specific heat capacity × temperature change
$\Delta Q = m\ c\ \Delta T$

C4.4.3 unit of measurement of specific heat capacity J $kg^{-1}K^{-1}$

C5 Change of state

C5.1 Measuring specific latent heat fusion and vapourisation for a liquid

C5.2 Using the equation:
Thermal energy = mass x specific latent heat. $\Delta Q = m\ L$

Transferable skills

Managing Yourself	Effective Learning	Interpersonal Skills	Solving Problems
MY – TPR	EL – MOL	IS – WC	SP – CT
MY – PS&R	EL – CL	IS – V&NC	SP – PS *
MY – COP	EL – SRS	IS – T	SP – C&I
MY – PGS	EL – PRS	IS – C&SI	

Table key

*	Signposted to indicate opportunities for development as part of wider teaching and learning.
√	Embedded in teaching, learning and assessment
Blank	TS not embedded or signposted in unit

Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure learners are rewarded for demonstrating the necessary skills.

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only.

Command or term	Definition
Add/label	Students label or add to a stimulus material given in the question, for example labelling a diagram, adding units on a table, adding points or line to a graph.
Assess	Students give careful consideration to all the factors or events that apply and identify which are the most important or relevant. Make a judgement on the importance of something and come to a conclusion where needed.
Calculate	Students obtain a numerical answer, showing relevant working and appropriate units where required.
Compare	Students look for the similarities **and** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question.
Complete	Students complete a table/diagram.
Describe	Students give an account of something. Statements in the response need to be developed as they are often linked but do not need to include a justification or reason.
Determine	Students' answers must have an element that is quantitative from the stimulus provided or must show how the answer can be reached quantitatively.
Devise	Students plan or invent a procedure from existing principles/ ideas.
Discuss	Consider the different aspects in detail of an issue, situation, problem or argument and how they interrelate. Does not require a conclusion.
Draw	Create a graphical or visual representation of information.
Evaluate	Students review information then bring it together to form a conclusion, drawing on evidence, strengths, weaknesses, alternative actions, relevant data or information. Come to a supported judgement of a subject's qualities and relation to its context.

Command or term	Definition
Explain	Students identify a point and then give a linked justification/ reasoning of the given point. For a 3-mark question a further linked justification/reasoning is required. For a 4-mark question there could be two separate identification points that would require appropriate expansion, or one identification with three detailed additional points for expansion.
Give/state/name	These generally require recall of one or more pieces of information.
Give a reason	When a statement has been made and the requirement is only to give the reasons why.
Identify	Usually requires some key information to be selected from a given stimulus/resource.
Predict	Students give an expected result.
Show that	Students prove that a numerical figure is given to one more decimal place than stated in the question.
Sketch	Students produce a freehand drawing showing a trend line. The axes are labelled but not scaled.
State what is meant by	Provide the accepted definition of a term
Suggest	Propose a likely solution or application.
Which	Select one correct answer from a choice of four options.

Unit 4: Practical Scientific Procedures and Techniques

Level: 3

Unit type: Internal

Guided learning hours: 90

Unit in brief

Students will be introduced to quantitative laboratory techniques, including chromatography, colorimetry and laboratory safety, which are relevant to the scientific laboratory environments.

Unit introduction

This unit introduces you to standard laboratory equipment and techniques, including titration, colorimetry, chromatography, calibration procedures and laboratory safety. Through the practical tasks in the unit, you will develop proficiency in the quantitative analytical techniques of titration and colorimetry, including learning to calculate the concentration of solutions. You will use measurement of temperature to study cooling curves and be introduced to paper and thin-layer chromatography (TLC). You will also have the opportunity to calibrate equipment and will be encouraged to be aware of the safety aspects of given laboratory procedures and techniques.

While you develop your practical skills, the discussion and analysis of group results will allow you to understand your progress in relation to that of others and also to gain an understanding of the reliability, repeatability and reproducibility of various procedures and techniques. You will have the opportunity to use problem-solving skills when you undertake chromatography work. There is scope throughout the unit to reflect on the skills you have gained and how you may develop further.

The fundamental knowledge, practical skills, transferable skills – for example, organisation, self-assessment and critical thinking, and the ability to interpret data – all developed in this unit will give you confidence when you undertake the more complex practical techniques.

The experience you gain will be invaluable in scientific higher education where there is a requirement for you to follow written scientific procedures and a desire to ensure accuracy by utilising correct technical procedures. Additionally, calibration procedures may be beneficial for allied health profession routes, where pipettes, balances, pH meters and thermometers may be appropriate to use.

Learning aims

In this unit you will:

A Undertake techniques to prepare solutions and determine concentrations and purity.

B Undertake biological procedures to investigate concentration and distribution of biological components.

C Undertake physical procedures to examine energy transfer

D Review personal development of scientific skills for laboratory work.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Undertake techniques to prepare solutions and determine concentrations, and purity.	**A1** Laboratory equipment and its calibration **A2** Preparation and standardisation of solutions using titration **A3** Determination of purity of organic compounds **A4** Evaluating accuracy and reliability using critical thinking	Students to carry out practical procedures in Chemistry and report the outcomes.
B Undertake biological procedures to investigate concentration and distribution of biological components	**B1** Colorimetry **B2** Plant growth	Students to carry out practical procedures in Biology and report the outcomes.
C Undertake physical procedures to examine energy transfer	**C1** Transfer of thermal energy **C2** Transfer of energy through electrical circuits **C3** Transfer of energy using a renewable source	Students to carry out practical procedures in Physics and report the outcomes.
D Review personal development of scientific skills for laboratory work	**D1** Personal responsibility **D2** Interpersonal skills **D3** Professional practice	A presentation or report that focuses on the evaluation of students' performance and skill development across all scientific procedures and techniques carried out in learning aims A, B and C.

Content

The essential content is set out under content areas. Students must cover all specified content before the assessment. All topics require students to apply knowledge, analyse and evaluate.

Learning aim A: Undertake techniques to determine chemical concentration and composition of substances.

A1 Laboratory equipment and its calibration

- Equipment and glassware used in titration, the importance and processes involved in calibration of measuring equipment.
- Use of balances for weighing and associated techniques:
  - electronic weighing balances – rough balances (two decimal places), analytical balances (four decimal places)
  - checking calibration with certified weights
  - measurement of mass using balances of different accuracy
  - suitable containers for weighing liquids and solids
  - determining the exact mass transferred from the mass of the container before and after the transfer of its contents.
- Use of volumetric glassware and associated techniques:
  - measuring cylinders and limitations
  - pipettes - bulb, graduated, automated and teat
  - burettes – design and purpose
  - conical flasks
  - volumetric flasks
  - accurate and serial dilution
  - use of water as a standard for calibrating volumetric glassware
  - cleaning and rinsing of different glassware in preparation for use
  - taking measurements and readings from different volumetric glassware
  - uncertainty of the equipment and percentage error of the measurements.

A2 Preparation and standardisation of solutions using titration

- Processes involved in the preparation and standardisation of solutions using titration.
- Use of primary and secondary titrimetric standards
- Preparation of a primary standard solution using a volumetric flask
- Calculation of molar concentration from mass, molar mass and volume
- Practical titration techniques – addition and mixing of solutions
- Determination of titration end-point from the colour change of a suitable indicator
- Rough and accurate titres

- Concordant and mean titres
- Calculation of concentrations from moles and volume.
- Use of stoichiometric ratios from chemical equations
- Systematic and random errors.

A3 Determination of purity of organic compounds

Techniques to determine purity:

- Chromatography:
  - types – thin layer chromatography (TLC), paper chromatography, ion exchange, gas chromatography (GC), high performance liquid chromatography (HPLC)
  - stationary phase and mobile phase
  - equipment - application of sample, suitable vessel, method of component location (uv light, locating reagents such as iodine and ninhydrin)
  - determination of Rf values from chromatograms
  - identification of component – comparison with pure substance and with literature
  - degree of separation of components as a percentage difference
  - factors affecting degree of separation – sample loading, humidity, temperature, nature of solvent, substrate and product molecule (polarity), contamination
- Melting point determination:
  - equipment – capillary tube, thermometer, melting point apparatus or Thiele tube
  - indication of melting - sintering / contraction of solid prior to melting
  - indication of impurity – melting over a temperature range, lower melting point
  - mixed melting point determination with pure compound
  - comparison with actual melting point as a percentage difference

A4 Evaluating accuracy and reliability using critical thinking skills

- questioning relevance of data and challenging own biases.
- breaking information/data into parts and identifying trends and patterns.
- identifying strengths and/or weaknesses and significance of information/data.
- drawing conclusions supported by structured reasoning and evidence.

Learning aim B: Undertake biological procedures to investigate concentration and distribution of biological components

B1 Colorimetry

Understanding and practical application of colorimetry techniques.

- Selection and use of a colorimeter or visible spectrometer – selection of filter (colorimeter) or fixed wavelength (spectrometer).
- Measurement and use of absorbance readings.

- Diluting stock solutions to prepare a range of calibration standards with absorbance in the range 0 to 1.
- Use of blank solutions.
- Using calibration curves
- Determination of unknown solution concentration from reading from graph (graph paper) or from the equation of a linear trend line through the origin (Microsoft Excel).

B2 Plant growth

Understanding plant growth and distribution.

- Investigate biodiversity using ecological sampling in fieldwork, including quadrats
- Investigate factors which affect plant growth, to include:
  - light intensity,
  - nutrient availability,
  - interspecific competition
  - intraspecific competition
- Safely use instruments for dissection of a plant organ.
- Use a light microscope at high power and low power, to include:
  - use of a graticule.
- Produce annotated images of plant tissues.

Learning aim C: Undertake physical procedures to examine energy transfer

C1 Transfer of thermal energy

Construction and interpretation of cooling curves:

- Understand the methods of thermal energy transfer, conduction, convection and radiation.
- Temperature as a function of time.
- Cooling curve for water in a beaker
- Rate of cooling from the gradient of the tangent to the cooling curve at five points.
- Factors which affect rate of cooling
- Determination of relationship between rate of cooling and difference in temperature between water and surroundings (excess temperature)
- Maintaining controls to produce a second cooling curve for a different liquid.
- Compare the rates of cooling at the same temperature for each liquid
- Knowing the specific heat capacity of water, determine the specific heat capacity for the second liquid.

C2 Transfer of energy through electrical circuits

- Use of circuit diagrams to set up series and parallel circuits to include; voltmeter, ammeter, lamp, variable resistor, thermistor, switch, cells, power supply, light emitting diodes
- Calibration and use of ammeters, voltmeters and/or ohmmeters
- Use of circuits to determine variation of resistance of a wire with length
- Measure the diameters of five wires of the same material but different cross-sectional area
- Determine the of the resistivity of the material used for the wires
- Discuss the factors which affect the resistance of other electrical components such as thermistors, light emitting diodes and filament lamps.

C3 Transfer of energy from a renewable resource]

- Applications of energy from renewable resources
- Investigating solar cell construction
- Using circuits to determine the voltage output of a solar panel under different conditions.
- Produce quantitative data to find relationships between voltage output and distance from source, angle of solar panel. light intensity and light colour,
- Investigating optimum conditions needed to achieve the maximum voltage reading and relate this to power generation

Learning aim D: Review personal development of scientific skills for laboratory work [MY-PGS]

D1 Personal responsibility

Understanding of the personal responsibilities that must be accepted for successful work in science.

- Clarity on own roles and responsibilities
- Work to appropriate standards and protocols.
- Application of safe working practices.
- Accept responsibility for the quality of own work.
- Take responsibility for completing tasks and procedures as well as using judgements within defined parameters; demonstrate accountability for actions.

D2 Interpersonal skills

Understanding and development of skills for effective and efficient working with others:

- communication and co-operation in the scientific working environment
- time management and effective use of resources including strategies and planning
- give and receive constructive feedback; respond positively to feedback
- behaviour for safe and efficient working in science.

D3 Professional practice

Understanding and personal development of standard practices applicable to working as a professional scientist:

- recognise problems and apply appropriate scientific methods to identify causes and achieve solutions
- identify, organise and use resources effectively to complete tasks maintain and enhance competence.
- action planning for future progression, including setting SMART goals, identifying resources, activities, success criteria and milestones. Seeking feedback and monitoring progress

Assessment criteria

Learning aim A: Undertake techniques to prepare solutions and organic compounds and determine concentrations, yield and purity

Pass	Merit	Distinction
A.P1 Demonstrate accurate procedures to prepare, dilute and calculate correctly the concentration of a standard solution. [EL-PRS]	**A.M1** Demonstrate procedures and volumetric techniques in titration to determine accurately the concentration of solutions used.	**A.D1** Evaluate the procedures and volumetric techniques used in titration, in relation to their accuracy and reliability for measurement and concentrations. [SP-CT]
A.P2 Use practical techniques to estimate the purity of an organic solid. [EL-PRS]	**A.M2** Explain the scientific principles underpinning the techniques used to estimate purity of a solid organic compound.	**A.D2** Evaluate the accuracy of the estimates of the purity of a solid organic compound. [SP-CT]

Learning aim B: Undertake biological procedures to investigate concentration and distribution of biological components

Pass	Merit	Distinction
B.P3 Carry out procedures to calibrate equipment used for colorimetry. [EL-PRS]	**B.M3** Accurately use colorimetry to determine the concentration of a solution.	**B.D3** Evaluate the results from a practical colorimetry technique. [SP-CT]
B.P4 Carry out an investigation into the factors which affect the distribution and growth of plants. [EL-PRS]	**B.M4** Analyse plant characteristics using microscopy.	**B.D4** Evaluate the practical techniques used, suggesting developments and improvements to the methods. [SP-CT]

Learning aim C: Undertake physical procedures to examine energy transfer

Pass	Merit	Distinction
C.P5 Correctly obtain data to construct cooling curves. [EL-PRS]	**C.M5** Use cooling curves to determine correctly the specific heat capacity of liquids.	**C.D5** Correctly justify the choice of a liquid for given applications.
C.P6 Create a circuit using a circuit diagram that can be used to take readings of current and voltage, to find the resistance of a carbon resistor. [EL-PRS]	**C.M6** Use a circuit to measure the variation of resistance with length and cross-sectional area of a wire.	**C.D6** Evaluate the accuracy of the circuit techniques used and suggest improvements. [SP-CT]
C.P7 Demonstrate how voltage is produced by a solar panel. [EL-PRS]	**C.M7** Explain two factors that affect the voltage produced by a solar panel	**C.D7** Discuss how the output of solar panels used in commercial or domestic applications could be improved.

Learning aim D: Review personal development of scientific skills for laboratory work

Pass	Merit	Distinction
D.P8 Describe the practical skills and personal competencies that you have used in this unit. [MY-TPR]	**D.M8** Assess what practical skills and personal competencies that have developed and suggest improvements in each area.	**D.D6** Evaluate the practical skills and personal competencies that have been developed and propose an action plan for future progression.

Transferable skills

Managing Yourself	Effective Learning	Interpersonal Skills	Solving Problems
MY – TPR √	EL – MOL	IS – WC	SP – CT √
MY – PS&R	EL – CL	IS – V&NC	SP – PS
MY – COP	EL – SRS	IS – T	SP – C&I
MY – PGS *	EL – PRS √	IS – C&SI	

Table key

*	Signposted to indicate opportunities for development as part of wider teaching and learning.
√	Embedded in teaching, learning and assessment
Blank	TS not embedded or signposted in unit

Essential information for Pearson Set Assignment Brief (PSAB)

Pearson sets the assignment for the assessment of this unit.

The PSAB will take 75 hours to complete.

The PSAB will be marked by centres and verified by Pearson.

The PSAB will be valid for the lifetime of this qualification.

Assessing the PSAB

You will make assessment decisions for the PSAB using the assessment criteria provided.

Section 1 gives information on PSABs and there is further information on our website.

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- a well-equipped laboratory with a fume cupboard
- accurate weighing balances
- a range of volumetric glassware (pipettes, burettes, volumetric flasks, conical flasks)
- thermometers and temperature probes (access to data-logging software is useful but not essential)
- melting point apparatus or Thiele tubes
- colorimeter or visible spectrometer
- chromatography paper, TLC plates
- a range of suitable chemicals, in line with the practical activities identified.

Essential information for assessment decisions

Learning aim A

For distinction standard, students will evaluate the outcomes of their quantitative analytical procedures and techniques to make sound judgements on the accuracy and reliability of them. They will assess the accuracy of their results in the context of the solution concentrations and their own calculated concentrations. They will also determine the percentage uncertainty in the measurements from the weighing scales, the volumetric flask, the pipette and the burette, and comment upon the relative accuracy of the equipment used. Students will also coherently discuss in qualitative terms the strengths and weaknesses in the procedures and techniques used that may include mixing of solutions, observation of colour change and uncertainty in measurements. Students will provide suggestions to improve accuracy, precision and reliability, giving a strong rationale (or for justifying the appropriate steps already taken should no problems be identified). Students will provide sound discussion of inherent hazards and risks associated with the volumetric techniques and procedures, for example justifying why certain aspects are carried out in a particular way on safety grounds.

Students will be able to evaluate how successfully they have carried out the purification of their organic compound, based upon their tests for purity. Students should be critical in their evaluation of the quality of their chromatograms, comparing at least one of their own against that of another learner, technician or tutor. They should discuss how the quality and separation of their best chromatogram could be improved further with reference to changes that could be made such as solvent, substrate, loading and other factors.

Students must discuss the differences (if any) in the melting points of the product. They will need to compare their melting point, the Rf value of their product, against a value obtained by a student or tutor, and against a cited reference value for the compound. Calculation of percentage differences between values will be expected as part of the student's comparison. They will evaluate any procedures and techniques used in their practical work that would account for a lower (or higher) quality of purity. They will comment on the reliability of the techniques used as effective ways to assess whether the solid is pure. They will consider the suitability of other types of chromatography that could have been used (such as GC or HPLC) and any other tests or procedures that could be used to check the purity.

For merit standard, students will undertake titrations and other volumetric techniques with minimal supervision. Before starting work, students will produce a risk assessment of all chemical and techniques to be used in their practical work. Students must calibrate pipettes and burettes before commencing titration work, documenting the outcomes of this. They will use their standard solution to standardise an acid or alkali of approximate concentration by titration using an appropriate indicator. They will then use the standardised acid or alkali to find the unknown concentration of an alkali or acid.
It is expected that students will be assessed using a pipette, using the burette, and demonstrating best practice in addition and mixing of solutions, as well as taking readings accurately. Volumetric techniques will be performed to a high degree of accuracy, precision and reliability in order to achieve concordant titres, with all readings and titres tabulated clearly. In determining the average titre, students will be expected to identify anomalies and give the reason for their exclusion. The concentration of both the standardised solution and the alkali/acid solution for which it is used with must be calculated, showing full working and appropriate presentation of the value in terms of significant figures and units.
Students will independently carry out chromatography and melting point techniques to determine the purity of a solid organic compound. They will carry out procedures safely, proficiently and with minimal supervision. They will produce chromatograms using paper or thin-layer chromatography (TLC) for an organic product , in comparison with samples from a range of sources as a means of identification and indication of purity. In order to demonstrate the best quality separation, students will need to repeat the experiment at least once to show that they have improved the separation and quality of their chromatograms. Photographs or drawings of the chromatograms and calculated Rf values for component spots must form part of their evidence. Students will also accurately calculate and tabulate Rf values for the components that are present in the chromatograms. Students will measure the melting point of an organic solid and compare this against a supplied pure sample or cited values.

For pass standard, students will follow instructions to safely prepare a standard solution for titration. In order to produce the standard solution of the specified concentration, students will need to calculate the mass of the solid that they will need to weigh, and which will need to be checked by the Assessor before use in practical work. Students will need to calibrate the weighing balance and the volumetric flask that they will be using before use and document the outcomes of this. It is expected that students will be assessed making a solution by accurately weighing, transferring and dissolving the solid, and making the solution up to an accurate volume. Weighing's will be tabulated clearly, showing masses before and after transfer of the solid, so that the exact mass transferred can be determined. Students will recalculate the concentration of the standard solution on the basis of the exact mass used.

Students will correctly and competently follow given procedures and techniques to estimate the purity of a solid organic compound. Before starting work, students will produce a risk assessment of all chemicals and techniques to be used in their practical work. It is expected that at pass standard, students will be given support to assemble the equipment associated with these techniques safely, whereas merit and distinction students will be able to work independently.

Learning aim B

For distinction standard, students will interpret outcomes of their colorimetry and ecological fieldwork procedures and techniques to make sound judgements on the accuracy of them. They will place the accuracy of their results in the context of those obtained by other students in a meaningful and quantitative way. Students will be able to coherently discuss problems/ issues with the quantitative procedures and techniques used and develop a strong rationale for suggestions made to improve accuracy and precision in order to obtain reliable and valid outcomes (or for justifying the appropriate steps already taken should no problems be identified).

Students will provide sound discussion of inherent hazards and risks associated with the analytical techniques and procedures, for example justifying why certain aspects are carried out in a particular way on safety grounds.

For merit standard, students will undertake quantitative analytical procedures and techniques with minimal supervision using appropriate software and/or tools to process data, carry out research and report findings.

Students will perform to a high degree of accuracy and precision in order to obtain reliable and valid outcomes, with consideration for health and safety. Students will demonstrate skill and fluency in a number of areas, such as: measuring volumes, mixing solutions, making the dilutions for colorimetry standards, use of fieldwork techniques, use of a light microscope and production of microscope slides. They will be fully prepared in terms of equipment, reference material and consumables before attempting each step.

For pass standard, students will follow instructions to safely and correctly use appropriate apparatus and materials (including ICT) to carry out investigative activities and experimental techniques in order to ensure suitably accurate results can be obtained. Students will identify and control significant quantitative variables where applicable and will plan approaches to take account of variables that cannot readily be controlled. Students will obtain accurate, precise and sufficient data for experimental and investigative procedures, records their observations and results.

Learning aim C

For distinction standard, students will articulate strong links between outcomes and techniques used in order to give a rationale for specific improvements that could be made to the measuring techniques and the maintenance of controls. Students will interpret outcomes of their quantitative procedures and make sound judgements on the accuracy of measurements by considering the uncertainties in their results. They will correctly choose a liquid for a given application in heating or cooling and justify their choice by referring to specific heat capacity and other properties of the liquid. They will compare their results for resistivity with the standard published values. They will comment on the precision of their techniques and articulate what would happen if a particular change were to be made to a control. They will demonstrate awareness of the need to calibrate thermometers, keep good electrical contacts in circuits and the inherent hazards and risks associated with using hot liquids and resistance wires.

For merit standard, students will demonstrate safe working practices and a high level of proficiency when carrying out cooling curves and setting up circuits with minimal supervision. They will produce graphs which show correct quantitative relationships and be able to process data obtained from drawing tangents to graphs. Students will demonstrate that they can use a micrometer and calculate cross sectional areas. They will determine the specific heat capacity of three liquids. Students will also work safely to minimise any risks from the spillage of hot liquids or over heating wires.

For pass standard, students will follow instructions, demonstrating good working practices and a good level of ability when taking measurements for cooling curves and will produce results to safely plot a cooling curve. Students will demonstrate safe working practices in setting up circuits to show from measurements that the resistance of a wire changes with length and the thickness of a wire. Students will investigate factors affecting the voltage produced by a solar panel, comment on the suitability of the techniques used and be able to record results in the form of a graph showing the relationship between a factor affecting the voltage and the voltage output produced.

Learning aim D

For distinction standard, students will draw upon all tasks that they have carried out to evaluate the strengths and weaknesses of their own practical performance and personal competencies developed over the tasks. In order to access this level, students will need independent and documented feedback that they can critically reflect upon. This can be from peers within the group, teachers, technicians and other staff with experience of practical science working or personal development. They should use this feedback and their own self-assessment to make a judgement on how competent they actually now are to perform similar tasks in the future. At this grade, self-evaluation must be based upon the feedback of others as well as own self-reflection, in order to develop balanced progression goals. Students must also propose a personal action plan for future progression. This will have an overall goal such as their next stage of study on the course, progression on to a higher level qualification or a future career. The personal action plan will have SMART goals and activities, with rationales, realistic targets, resources and milestones for completion.

For merit standard, students will need to assess the practical and personal skills that they have developed over the course of the tasks. They will do this by comparing what they able to do prior to the tasks and what they are now able to do and could use a self-assessment survey to support this. Students will also make judgements upon their skill development and competence in relation to other students in the group, that they have either observed or have worked with, and also an experienced member of staff (such as a technician or teacher). At this grade, self-assessment based upon the student's own reflections, notes and thoughts is sufficient. Students will recognise where they have a shortfall in their skills or that the skills need to be practiced from each task and will suggest ways these can be improved or maintained. They will also discuss how the skills that they have used and intend to develop further will be important or transferable in their intended further study or career options.

For pass standard, students must describe areas of experimental work undertaken in relation to the learning aims of this unit where their practical scientific skills have been developed. They should describe their previous experience and knowledge of the practical techniques and equipment, and what they have learnt or are now able to do from the tasks set. They will also describe the personal skills and competencies that they have developed during the practical work, which will include areas such as communication, co-operation with others, organisation including use of resources, working safely and responsibly in line with protocols, time management, and dealing with issues. Students will describe how the skills that they have developed are relevant and transferable for any further study or career (either scientific or non-scientific) that they intend to do next.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

Unit 1: Principles and Applications of Biology

Unit 2: Principles and Applications of Chemistry

Unit 3: Principles and Applications of Physics

Employer involvement

- Centres may involve employers in the delivery of this unit if there are local opportunities.
- guest speakers from industry representatives
- visits to a local laboratory facilities
- local organisations that provide scientific application.

Unit 5: Science Investigation Skills

Level: 3

Unit type: Internal

Guided learning hours: 90

Unit in brief

This unit enables learners to gain an understanding and the skills required to undertake an investigative project.

Unit introduction

In this unit, you will carry out an individual investigative project that you have chosen in collaboration with your teacher. You will carry out a scientific literature search and review, considering the project's aims and objectives and formulating a suitable hypothesis that you can test by using practical work. You will then produce a realistic plan and submit it to your tutor for the first assessment and feedback. Once you have approval to continue, over the course of several weeks you will carry out the project safely using your scientific investigation skills, project management skills and what you have learnt from the other units. Finally, you will prepare an evaluative report that will consider the project outcomes and suggest amendments that may have improved those outcomes.

Completing an investigative project is an excellent way for you to develop independent learning skills, primary and secondary research skills, along with communication and critical thinking skills to facilitate an understanding of the science-related workplace. of considerable benefit for progression to higher education in a variety of science and science-related courses and to employment in the science or applied science sector.

Learning aims

In this unit you will:

A Undertake a literature search and review to produce an investigative project proposal

B Produce a plan for an investigative project based on a proposal

C Safely undertake the project, collecting, analysing and presenting the results

D Present the conclusions from the project using correct scientific principles.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Undertake a literature search and review to produce an investigative project proposal	**A1** Literature review **A2** Investigative project proposal **A3** Methods of data collection and analysis	Present a literature review and project proposal
B Produce a plan for an investigative project based on a proposal	**B1** Project scheduling **B2** Project planning **B3** Health and safety and ethical considerations	
C Safely undertake the project, collecting, analysing and presenting the results	**C1** Experimental procedures and techniques **C2** Collect, collate and analyse data **C3** Data presentation	Carry out suitable experimental procedures and techniques, collecting data for analysis.
D Present the conclusions from the project using correct scientific principles	**D1** Scientific report for the investigative project **D2** Scientific evaluation of findings **D3** Skill development within project work	Evaluate the outcomes of the investigative experiment.

Content

The essential content is set out under content areas. Students must cover all specified content before the assessment. All topics require learners to apply knowledge, analysis and evaluation.

Learning aim A: Undertake a literature search and review to produce an investigative project proposal [EL-SRS]

Students must select a relevant area of study linked to chemistry, physics or biology, or a combination of different fields.

A1 Literature review

- Criteria for the review, to include:
  - how many sources
  - dates of resources
  - academic level of resources.
- Nature of practical study, to include:
  - field work
  - laboratory-based work
  - sports facility
  - workshop.
- Sources of information:
  - identification and location of relevant and reliable sources of information, to include:
    - journal articles
    - textbooks
    - reliable websites.
  - obtains information from different sources, to include:
    - libraries
    - resource centres
    - organisations
    - government organisations
    - charities.
  - protocols for referencing information sources, to include:
    - Harvard and Vancouver referencing systems.

A2 Investigative project proposal

- Developing a project proposal:
  - area of study – suitable for interest and based on literature review
  - background
  - hypothesis
  - suitable aims and objectives.

- Potential limitations of the project, to include:
  - availability of resources
  - participant availability
  - time constraints.

Learning aim B: Produce a plan for an investigative project based on a proposal [MY-TPR]

B1 Project scheduling

Timeline for the project, to include:

- Start date
- Completion date
- Scheduling.

B2 Project planning

- Relevant methods for processes/procedures.
- Use of resources, participants, equipment and instrumentation, materials.
- Contingency planning and remedial actions (resources, revision of plan).
- Control groups, representative and random sampling.
- Realistic and viable, will test the hypothesis.

B3 Health and safety and ethical considerations

- Identification of hazards, to include:
  - personal protective equipment (PPE)
  - controlling of substances hazardous to health (COSHH) regulations
  - health and safety legislation
  - environmental protection.
- Risk assessments, to include:
  - type of hazard
  - level of risk
  - prevention and minimising of hazards.
- Ethical considerations, to include:
  - project method
  - informed consent
  - maintaining confidentiality

Learning aim C: Safely undertake the project, collecting, analysing and presenting the results [MY-TPR]

C1 Experimental procedures and techniques

- Assembly of relevant equipment and materials.
- Adhering to risk analysis, relevant legislation and local rules during practical investigation.
- Skills of transferring, handling and using equipment and materials.
- Use of equipment, instruments, sensors and techniques for taking measurements; calibration, repeating readings and measurements.
- Observation and measurement skills.

C2 Collect, collate and analyse data

- Capturing and recording results with, accuracy, integrity, precision.
- Maintenance of laboratory logbook and record keeping.
- Organisation of data in class intervals, tallying.
- Methods and uses of data processing and analysis, mean, mode, median, standard deviation, standard error, significance tests (t-test, chi-square test, confidence levels of 95% and 99%).
- Inclusion and use of correct units for quantities.
- Use of correct number of decimal places and significant figures.
- Assessment of experimental accuracy, reliability and precision.

C3 Data presentation

- Appropriate methods used for data presentation.
- Choice of data presentation explained; representation of variability of data.

Learning aim D: Present the conclusions from the project using correct scientific principles [MY-TPR]

D1 Scientific report for the investigative project

- Correct scientific principles:
  - structure and format
  - use of correct scientific terminology, past tense, passive voice and in third person
  - correct and consistent use of the Harvard or Vancouver referencing system.

D2 Scientific evaluation of findings

- Validation of method and results:
  - fitness for purpose of methods used
  - repeatability
  - sources and magnitudes of errors in readings taken

- Evaluation of statistical results.
- Reasoned conclusions drawn from primary and secondary data using scientific principles; use of critical thinking skills.
- Limitations of investigative project and areas for improvement.
- Assessment of information sources used and relevance to investigation experimental and literature investigations.
- Evaluation of proof, or otherwise, of hypothesis.
- Recommendations for further research.

D3 Skill development within project work

- Time management and organisation.
- Adhering to and following appropriate standards and protocols.
- Taking responsibility for completing tasks/procedures.
- Making judgements within defined parameters.
- Application of safe and legal working practice.
- Give and receive constructive feedback.
- Identify, organise and use resources effectively to complete tasks.
- Utilising channels of communication.
- Resourceful and using initiative.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Undertake a literature search and review to produce an investigative project proposal		**AB.D1** Evaluate different approaches available for the investigative project, leading to a justification of the hypothesis and proposal, including proposed data presentation and analysis techniques. [SP-CT]
A.P1 Carry out a literature search and review of a chosen scientific area. [EL-PRS]	**A.M1** Analyse the literature search and discuss its relevance to inform the investigative project proposal.	
A.P2 Produce an adequate proposal for an investigative project that includes a research hypothesis. [EL-PRS]	**A.M2** Produce a detailed proposal for a scientific investigation, to include a testable hypothesis and potential limitations.	
Learning aim B: Produce a plan for an investigative project based on a proposal		
B.P3 Produce an appropriate proposal for a project, including health and safety resources required. [EL-PRS]	**B.M3** Produce a realistic proposal for a project, including risk assessments and contingency planning.	

Learning aim C: Safely undertake the project, collecting, analysing and presenting the results

Pass	Merit	Distinction
C.P4 Assemble relevant apparatus/equipment and materials, and carry out the project using safe working practices. [EL-PRS]	**C.M4** Use practical procedures and techniques skilfully to produce accurate and reliable results which enable the hypothesis to be tested.	**C.D2** Analyse the effectiveness of their practical procedures and techniques, justifying any changes they made. [SP-CT]
C.P5 Present the results obtained using appropriate descriptive statistics**.** [EL-PRS]	**C.M5** Test the significance of results by using appropriate statistical analysis	

Learning aim D: Present the conclusions from the project using correct scientific principles

Pass	Merit	Distinction
D.P6 Produce a report of the findings, using scientific terminology and protocol and drawing conclusions. [EL-PRS]	**D.M6** Produce a scientific report of the findings, correctly using scientific terminology, protocol and formatting and drawing valid conclusions.	**D.D3** Evaluate the conclusions of the investigative project and its practical aspects, discussing limitations, making and justifying suggestions for improvements and for extending the study. [SP-CT]
D.P7 Summarise skills developed in the investigative project undertaken.	**D.M7** Discuss the importance of skills developed during the project to the achievement of the project's objectives.	**D.D4** Evaluate the skills used during the project and suggest improvements. [SP-CT]

Transferable skills

Managing Yourself	Effective Learning	Interpersonal Skills	Solving Problems
MY – TPR *	EL – MOL	IS – WC	SP – CT √
MY – PS&R	EL – CL	IS – V&NC	SP – PS
MY – COP	EL – SRS *	IS – T	SP – C&I
MY – PGS	EL – PRS √	IS – C&SI	

Table key

*	Signposted to indicate opportunities for development as part of wider teaching and learning.
√	Embedded in teaching, learning and assessment
Blank	TS not embedded or signposted in unit

Essential information for Pearson Set Assignment Brief (PSAB)

Pearson sets the assignment for the assessment of this unit.

The PSAB will take 65 hours to complete.

The PSAB will be marked by centres and verified by Pearson.

The PSAB will be valid for the lifetime of this qualification.

Assessing the PSAB

You will make assessment decisions for the PSAB using the assessment criteria provided.

Section 1 gives information on PSABs and there is further information on our website.

Further information for teachers and assessors

Resource requirements

For this unit, students must have access to:

- a well-equipped laboratory (and maybe a fume cupboard or access to suitable environments to carry out field work)
- materials/equipment and/or laboratory instruments/sensors that will enable them to carry out practical work
- appropriate science and maths software packages to help them present and analyse their data in the most appropriate way.

Essential information for assessment decisions

Learning aims A and B

For distinction standard, students must justify their project proposal in terms of the choice of investigation, the hypothesis they are going to test and how they are going to test it. This will be evidenced by students identifying information that they have used and have not used from their literature search, and why. They will justify their hypothesis by explaining how it is valid and measurable and how the investigation will build upon the information from the literature search rather than simply replicating it.

The students must also justify their plan and the methods that they will use, including how they will present their results and test their significance. Where they have made their own choices of methods, resources or other variables, they will give their own reasons for this, which will be coherent and logical. Students will show that they have considered more than one appropriate investigative approach to tackling the hypothesis and explain why they have settled upon their chosen approach.

For merit standard, students must analyse the information from their literature search and use this to identify the topic for their project. They must produce a hypothesis that they can test by means of practical work using the available facilities. They must show that they understand the potential limitations to their proposed investigation, such as the accuracy of graduated apparatus or limitations of instruments and sensors.

The plan produced by the student must be realistic and must enable the hypothesis to be tested correctly. It will include contingency planning (for example if a sensor/instrument stopped working or if a test or experiment yielded unexpected or inaccurate results).

The proposal, hypothesis and plan will require only minimal intervention by the tutor.

For pass standard, students must carry out a search of reliable sources of information about the scientific area for their project. They are expected to give a comprehensive bibliography and list of references using a standard protocol, such as the Harvard system. Students should review the information they have gathered, using the information from different sources. This information will be used to form the basis of their project proposal. Students will produce an adequate research project proposal and hypothesis for an investigation.

Students will produce a plan for their investigation. This must have a set schedule (with dates) for each stage of the project, and it must identify the equipment, consumables and other resources needed. The plan must include relevant safety resources.

The tutor may need to intervene to ensure that the proposal, hypothesis or plan are appropriate (i.e. achievable, safe, ethical).

Learning aim C

For distinction standard, students must assess the effectiveness of their project plan. The student will show how they reflected upon the feedback received from their Assessor about their proposed plan and how they modified it or left it unchanged, explaining their decisions. They will carry out a trial run and consider whether the method worked as expected or needed modifying, again using examples to explain their decision. It is probable that internal or external factors will mean that changes will be necessary during the investigation itself, such as to their timeline or the equipment or methods used. In all instances, students must justify the changes, explaining how the change was expected to improve the outcomes of the project.

For merit standard, students will carry out their practical work safely and with minimal supervision. They will perform to a high degree of accuracy and precision to obtain reliable and valid results. They will demonstrate skill and fluency in several areas appropriate to the techniques that they use. This is likely to include including choosing and calibrating equipment correctly, measuring quantities accurately, minimising losses and keeping to schedules. They will record data to an appropriate number of decimal places and be able to justify why this is required. They will repeat tests and measurements to ensure reliability and they will identify incorrect measurements and respond appropriately. They will revise their practical approach and plan when this will improve the outcomes of their project and they will justify these changes.

The student will use the results of an appropriate statistical test to judge correctly whether or not their results are significant. They can use given worksheets, apps or spreadsheets for the statistical tests, but they do need to be able to explain what the test means and what is the degree of confidence in the result.

For pass standard, students will each assemble the apparatus/equipment for their project and select the correct materials before carrying out all procedures safely. There will be robust evidence for each learner to show that they have done this. This could take the form of annotated images of the learner doing this; a reflective account of what they have done (for example in their laboratory log or note book; video of them working with explanatory commentary; detailed Observation Records or Witness Statements which are specific to the learner). Any combination of these methods could be used, and alternative methods would be acceptable, as long as they are specific to the student and provide clear evidence of how the learner carried out the practical work. For a student working at no higher than Pass level, the tutor may need to intervene to ensure that the procedure is safe and likely to yield acceptable results. Students must keep a laboratory notebook and the tutor should regularly check that this is up to date and correct and sign and date the section seen.

Students will collect the results of their investigation and calculate appropriate descriptive statistics correctly (e.g. mean, standard error). They can use given apps, programmes or spreadsheets for this. They will present the results appropriately and correctly (e.g. in tables and graphs), using the descriptive statistics.

Learning aim D

For distinction standard, students will review the information they have obtained from their practical work, and decide on its validity, reliability and accuracy, and whether their hypothesis has been correctly tested. They will discuss the implications of their findings, drawing on their earlier review of the literature.

Their results will be compared with published information (where possible) and the limitations of their project will be discussed. They will provide and justify suggestions for improving and extending their study including an evaluation of alternative experimental approaches.

Students will draw on all areas of their project work to reflect critically on the strengths and weaknesses of their own performance and skill development, drawing on feedback from other people. Students will demonstrate how self-reflection and feedback (which could be through collaborative working) has aided their project work, and also suggest areas for improvement and the steps necessary to achieve them.

For merit standard, within their report, students will interpret correctly their results and statistical analysis. Unreliable results, and the causes of the unreliability, will be identified. The student will explain whether or not their findings support their hypothesis.

The project report will be well-written in the required format. The findings from the project will be correctly interpreted leading to valid conclusions.

Students will review the skills that they have developed in the course of their project, discussing how their skills improved and how this contributed to the achievement of the project's objectives.

For pass standard, students will interpret the results of their investigation, stating whether or not their original objective has been met and hypothesis proven and drawing appropriate conclusions. They will produce a written report in the standard scientific format and in a formal manner, using the information and data they have collected throughout the project. The report will be written using accepted scientific terminology and protocols, passive voice and past tense. It will be conventionally formatted, including having title, abstract, introduction, materials and methods, results, discussion and conclusions, bibliography. Students will correctly describe the skills that they have developed during their project.

Links to other units

This unit requires the learners to complete a substantial, individual practical investigation. This assessment for this unit should draw on knowledge, understanding and skills developed from:

Unit 1: Principles and Applications of Biology

Unit 2: Principles and Applications of Chemistry

Unit 3: Principles and Applications of Physics

Unit 4: Practical Scientific Procedures and Techniques

Unit 6: Contemporary Issues in Science

Level: 3

Unit type: Internal

Guided learning hours: 90

Unit in brief

This unit will explore contemporary science issues and their impact on the world we live in. It will develop the students' skills of analysis and interpretation across a broad range of scientific issues while exploring how they are reported in the media and in publications.

Unit introduction

Scientific issues are all around us and impact on the day to day lives of everyone. Some of the problems facing humans and the planet have been the result of some scientific and technological advances, but science is also key to finding solutions.

These issues affect us in various ways, for good or harm, and in various dimensions. They may have social, economic, political, ethical and environmental implications and you will explore these in this unit. You will develop skills of analysing information and research to find out how various organisations exert effects on the issues. You will need to draw on your learning from across the Applied Science qualification.

You will develop critical thinking skills and be able to analyse various articles that convey scientific information and be able to evaluate the effects of misinformation and disinformation spread via social media. You will understand the importance of validity and reliability when reporting scientific information and how it can influence the accuracy of information that's needed in contemporary science. You will also write articles on scientific issues that are suitable for a general audience and for a professional audience.

Learning aims

In this unit you will:

A Investigate contemporary scientific issues that impact the global population and environment.

B Examine the effect different organisations have on contemporary science.

C Understand how to evaluate and report scientific information.

Summary of unit

Learning aim	Key content areas	Assessment approach
A Investigate contemporary scientific issues that impact the global population and environment.	**A1** Scientific issues **A2** Implications of scientific issues	Pearson-set Assignment Brief Learners will investigate scientific projects over the last 30 years. They will describe how they have been implemented, the effects they have had on people and the environment, including whether they have raised any ethical issues.
B Examine the effect different organisations have on contemporary science.	**B1** Government and global organisations **B2** Non-governmental organisations (NGOs) **B3** Businesses including multinationals	Pearson-set Assignment Brief Learners will identify different organisations and the influence they have had on contemporary issues in science. Learners will examine the methods used by organisations and the effectiveness they have.
C Understand how to evaluate and report scientific information.	**C1** Reporting of scientific information **C2** Scientific information **C3** Presenting scientific information	Pearson-set Assignment Brief Leaners will understand different types of scientific reporting and the recipient they're targeted at and level of understanding. Learners will examine the reliability of information and disinformation along with source reporting and referencing. Learners will also write articles on scientific issues that are suitable for a general and professional audience.

Content

The essential content is set out under content areas. Learners must cover all specified content before the assessment.

Learning aim A: Investigate contemporary scientific issues that impact the global population and environment.

A1 Scientific issues

- Climate change, to include:
  - anthropogenic causes and effects
  - measures to mitigate change
  - measures to reach carbon neutral: non-carbon energy sources, renewables, biofuels, carbon capture
- Food security, to include:
  - modern farming methods
  - genetic modification
  - animal welfare
  - land use and conservation
- Clean energy, to include:
  - lithium batteries in electric cars
  - wind power
  - solar power
  - nuclear power
  - nuclear fusion
  - hydroelectric power.
- Health for all, to include:
  - inequalities
  - regenerative medicine, stem cell therapy, genetic modification
  - health promotion, vaccination, healthy and harmful behaviours
  - preparing for pandemics
- Medical treatments, to include:
  - Proton beam therapy
  - Stem cell therapy
  - Genetic engineering
  - Prosthetics

A2 Implications of scientific issues

- Social – types of interaction between individuals and collectives of people; improvements and deterioration in social factors caused by a scientific issue (e.g. health, employment, education, travel, communication)
- Economic – production, distribution and trade of goods, services or resources; supply and demand of goods, services or resources; impact on a macro and microeconomic scale; income, expenditure or investment in a scientific issue.
- Ethical – values held by individuals; rights and wrongs of a scientific issue; areas of conflict with other influences over a scientific issue (e.g. political, medical, legal, religious, social, economic).
- Environmental – surroundings or conditions; biotic (living) and abiotic (non-living) elements of the environment; local and global environments; natural and developed environments; changes to the environment caused by a scientific issue

Learning aim B: Examine the effect different organisations have on contemporary science.

B1 Governmental and global organisations

- United Nations (UN)
- World Health Organization (WHO)
- International Group of 7 (G7)
- UK Government
- Department of Health and Social care (DHSC),
- National Health Service;
    - Department for Environment
    - Food and Rural Affairs (DEFRA)
    - Centre for Environment Fisheries and Aquaculture Science (CEFAS)
    - Forestry Commission
    - UK Research and Innovation (UKRI).
- Regulators:
    - Environment Agency
    - Food Standards Agency
    - Medicines and Healthcare Regulatory Agency (MHRA)
    - Human Fertilisation and Embryology Authority.

B2 Non-governmental organisations (NGOs)

- Professional organisations and Learned Societies:
  - Scientific societies: Royal Society of Biology (RSB), Royal Society of Chemistry (RSC), Institute of Physics (IOP)
  - The Royal Society
  - Medical Royal Colleges
  - Universities and publicly-funded research organisations
- Pressure Groups, Trusts and Charities
  - Environment and conservation: Greenpeace, Friends of the Earth, National Parks, National Trust, National Farmers' Union (NFU)
  - Health: The King's Fund, Action on Smoking and Health (ASH), British Heart Foundation (BHF), Cancer Research Campaign, Terrence Higgins Trust, Family Planning Association
  - Think tanks: Institute of Economic Affairs (IEA), Chatham House, Institute for Public Policy Research (IPPR)

B3 Businesses including multinationals

- Utilities: Energy companies, water companies
- Pharmaceutical companies
- Health food companies
- Tobacco companies
- Food producers, agriculture, fisheries

Learning aim C: Understand how to evaluate and report scientific information. [EL-SRS]

C1 Reporting of scientific information

- Reporting medium:
  - Specialist or peer-reviewed journals
  - Science magazine
  - Newspaper articles, local, national and international
  - TV news, documentaries, film and television series
  - Internet
    - impact of social media on national and global reporting of science, to include current social media trends.
- The target audience:
  - general public
  - social groups, including different age/generations, social activities and pastimes
  - scientific community
  - pressure groups/lobbyists
  - political representatives

C2 Scientific information

- Different types of scientific information.
  - Qualitative – referenced to established sources of information
  - Quantitative – data driven, calculations, numerical graphs, charts, tables and statistics.
- Validity and reliability of source information:
  - sample size
  - selection bias
  - references and authenticity/ peer review
  - use and misuse of data
  - misinformation and disinformation
  - digital security

C3 Presenting scientific information

- Level of scientific detail:
  - use of correct scientific terminology
  - language
  - accuracy
- Style of writing and reporting: past tense, passive voice and in third person.
- Importance of independent or biased information
- Differentiating between quantity and quality of scientific information
- Use of visual and graphics for interpretation
- Level of referencing, and sources of information
- Correct and consistent use of the Harvard or Vancouver referencing system
- Evidence to support conclusions/claims made
- Critically valuating evidence to support or refute the conclusions presented in the scientific information.
- Considering why it is important for the public to understand science

Assessment criteria

Learning aim A: Investigate contemporary scientific issues that impact the global population and environment

Pass	Merit	Distinction
A.P1 Carry out a literature search on chosen scientific developments and summarise research	**A.M1** Explain the effects of two scientific developments on society and the environment.	**A.D1** Evaluate the effects of two scientific developments on society and the environment. [SP-CT]
A.P2 Describe the effects of scientific developments on society.		
A.P3 Describe the effects of scientific developments on the environment.		

Learning aim B: Examine the effect different organisations have on contemporary science.

Pass	Merit	Distinction
B.P4 Describe the role of governmental and global organisations in connection with contemporary scientific issues.	**B.M2** Explain the impact that different organisations have on contemporary scientific issues.	**B.D2** Evaluate the impact that different organisations have on contemporary scientific issues. [SP-CT]
B.P5 Describe the role that non-governmental organisations have on contemporary scientific issues.		
B.P6 Describe the role of business organisations in connection with contemporary scientific issues.		

Learning aim C: Understand how to evaluate and report scientific information

Pass	Merit	Distinction
C.P7 Explain how a scientific issue is reported and presented for different audiences.	**C.M3** Produce an article which discusses a scientific issue for a general audience, using information from selected sources. [IS-WC]	**C.D3** Produce an article which evaluates a scientific issue for a professional audience, using selected sources and further research. [SP-CT]
C.P8 Explain how the reporting of contemporary science issues could be interpreted as valid and reliable.		

Transferable skills

Managing Yourself	Effective Learning	Interpersonal Skills	Solving Problems
MY – TPR	EL – MOL	IS – WC √	SP – CT √
MY – PS&R	EL – CL	IS – V&NC	SP – PS
MY – COP	EL – SRS *	IS – T	SP – C&I
MY – PGS	EL – PRS	IS – C&SI	

Table key

*	Signposted to indicate opportunities for development as part of wider teaching and learning.
√	Embedded in teaching, learning and assessment
Blank	TS not embedded or signposted in unit

Essential information for Pearson Set Assignment Brief (PSAB)

Pearson sets the assignment for the assessment of this unit.

The PSAB will take 60 hours to complete.

The PSAB will be marked by centres and verified by Pearson.

The PSAB will be valid for the lifetime of this qualification.

Assessing the PSAB

You will make assessment decisions for the PSAB using the assessment criteria provided.

Section 1 gives information on PSABs and there is further information on our website.

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- a well-equipped resource facility, including access to diverse range of relevant scientific research literature.

Essential information for assessment decisions

Learning aim A

For distinction standard, students must evaluate how at least two specific scientific developments have led to impacts on society (social, economic and ethical effects) and the environment. Giving specific examples, they must consider how each of the scientific developments has brought benefits and drawbacks in terms of their impacts on affected groups of people and (where relevant) ecosystems. For each development their evaluation must arrive at a judgement about whether or not the development is beneficial to people and/or the environment. This judgement must be supported by reliable evidence although the students should also explain why some groups of people might arrive at a different judgement. The students must use (and cite by a conventional method, such as Harvard or Vancouver) reliable sources of information when identifying and describing the effects.

For merit standard, the students must explain how at least two specific scientific developments have impacted on society and the environment. They must provide details about the effects, including what or who is affected, and they must make clear how each of the scientific developments resulted in or contributed to the effects.

For pass standard, students must carry out a search of reliable sources of information about the scientific contemporary issues. Students should summarise the information they have gathered, using the information from different sources. This information will be used to form the basis of their assignment. Students will describe how specific recent scientific developments have led to the impacts to society (social, economic and ethical effects) and the environment. They must consider at least two scientific developments and a range of effects for society and the environment. The students should recognise that there may be different effects on different groups of people or different environments and that effects can be beneficial, harmful or both.

Learning aim B

For distinction standard, students must evaluate the impact that different organisations have on at least two contemporary scientific issues. They must assess the different viewpoints and vested interests of the organisations (governmental, non-governmental and business), comparing and contrasting their objectives, roles and activities. The effectiveness of the organisations in terms of influencing the development of the scientific issue must be evaluated, using specific examples. The evaluation must lead to judgements about which organisation has been most influential in each scientific issue, using examples to justify why. The students must use (and cite by a conventional method, such as Harvard or Vancouver) reliable sources of information when evaluating the influence and role of each organisation.

For merit standard, students must explain how the activities of different organisations influence scientific developments. This must include explanations of specific activities by each of the organisations (governmental, non-governmental and business) chosen at Pass and the effects these activities have on at least two contemporary scientific issues. The examples and information used must be derived from reliable sources which are cited by a conventional method.

For pass standard, students will need to describe at least two different organisations from each category (governmental, non-governmental and business) that have (or seek to have) influence on at least two scientific issues. They must clearly name the organisation and its relevance to each scientific issue. They must describe the roles and objectives of each organisation and explain why these mean it seeks to influence scientific issues. Each organisation may fall into more than one category so must be categorised (e.g. governmental and funded-research groups, pressure groups that are global organisations, businesses that are multi-national etc.).

Learning aim C

For distinction standard, students will produce an article which evaluates information and evidence for a scientific issue for their target audience of professionals. The article will follow the learner's plan for structure, content, detail, style and tone, but will also need to be clear, coherent, consistent and logical in its reporting. The article will use the learner's own further research integrated with the selected sources of information, to give a synthesised report. Students will evaluate supporting and conflicting evidence and will put forward a reasoned conclusion or recommendation on the scientific issue.

For merit standard, students will produce an article which discusses a scientific issue for a general audience. The article will follow the learner's plan for structure, content, detail, style and tone, but will also need to be clear and coherent. The article will select and summarise the main points and evidence from the selected sources, including any supporting and conflicting statements.

For pass standard, students will examine a minimum of three different articles on the same scientific issue to explain how it is reported and presented for its target audience. The articles selected must come from very different publications or media. They must identify the types of information (e.g. qualitative, quantitative) presented. Students will identify the intended audience for the article and will explain how the structure and content of the article is suited to them. Students must explain what is meant by valid and reliable scientific information and how this can be recognised. They will explain what can cause scientific information not to be reliable (including bias, poor techniques and inadequate sampling) and how some sources of information (e.g. scientific journals and fact-checking sites) try to overcome these problems.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

Unit 1: Principles and Applications of Biology

Unit 2: Principles and Applications of Chemistry

Unit 3: Principles and Applications of Physics

Unit 4: Practical Scientific Procedures and Techniques

5 Planning your programme

Supporting you in planning and implementing your programme

There will be lots of free teaching and learning support to help you deliver the new qualifications, including:

- Our Delivery Guide will help you to plan how to deliver the content and assessments that make up the Pearson BTEC Level 3 National Certificate in Applied Science (AAQ) qualification. It also highlights opportunities to develop the transferable skills identified within the units in this specification.
- Sample Assessment materials are available for each external unit to help you to plan and prepare for assessments.
- Our mapping document highlights key differences between the new qualification and the Pearson BTEC Level 3 National in Applied Science (601/7436/5), which this qualification replaces.

Is there a student entry requirement?

As a centre it is your responsibility to ensure that students who are recruited have a reasonable expectation of success on the programme. There are no formal entry requirements but we expect students to have qualifications at or equivalent to Level 2.

Students are most likely to succeed if they have:

- five GCSEs at good grades, and/or
- BTEC qualification(s) at Level 2
- achievement in English and mathematics through GCSE or Functional Skills.

Students may demonstrate ability to succeed in various ways. For example, students may have relevant work experience or specific aptitude shown through diagnostic tests or non-educational experience.

6 Understanding the qualification grade

Awarding and reporting for the qualification

This section explains the rules that we apply in awarding a qualification and in providing an overall qualification grade for each student. It shows how all the qualifications in this sector are graded.

The awarding and certification of these qualifications will comply with regulatory requirements.

Eligibility for an award

In order to be awarded a qualification, a student must:

- achieve Near Pass (N) or above in all external units
- complete and **have an outcome** (D, M, P, N or U) for all units within a valid combination
- achieve the **minimum number of points** at a grade threshold.

Students who do not achieve the required minimum grade (N) for the external assessments will not achieve a qualification.

Award of the qualification grade

The final grade awarded for a qualification represents an aggregation of a student's performance across the qualification. As the qualification grade is an aggregate of the total performance, there is some element of compensation in that a higher performance in some units may be balanced by a lower outcome in others.

BTEC Nationals are Level 3 qualifications and are awarded at the grade ranges shown in the table below.

Qualification	Available grade range
Extended Certificate	P to D*

The *Award of qualification grade* table, shown further on in this section, shows the minimum thresholds for calculating these grades. The table will be kept under review over the lifetime of the qualification. The most up-to-date table will be issued on our website.

Pearson will monitor the qualification standard and reserves the right to make appropriate adjustments.

Students who do not meet the minimum requirements for a qualification grade to be awarded will be recorded as Unclassified (U) and will not be certificated. They may receive a Notification of Performance for individual units. The *Information Manual* gives full information.

Points available for internal units

The table below shows the number of **points** available for internal units. For each internal unit, points are allocated depending on the grade awarded.

Grade	Unit size (90 GLH)
U	0
Pass	9
Merit	15
Distinction	24

Points available for external units

Raw marks from the external units will be awarded **points** based on performance in the assessment. The table below shows the **minimum number of points** available for each grade in the external units.

Grade	Unit size (60 GLH)
U	0
Near Pass	4
Pass	6
Merit	10
Distinction	16

Pearson will automatically calculate the points for each external unit once the external assessment has been marked and grade boundaries have been set. For more details about how we set grade boundaries in the external assessment please go to our website.

Claiming the qualification grade

Subject to eligibility, Pearson will automatically calculate the qualification grade for your students when the internal unit grades are submitted and the qualification claim is made. Students will be awarded qualification grades for achieving the sufficient number of points (with valid combinations) within the ranges shown in the relevant *Award of qualification grade* table for the cohort.

Award of qualification grade

Applicable for registration from 1 September 2025.

Extended Certificate (360 GLH)

Grade	Points threshold
U	0
Pass	36
Merit	52
Distinction	74
Distinction *	90

The table is subject to review over the lifetime of the qualification. The most up-to-date version will be issued on our website.

Grading table for Pearson BTEC Level 3 National Extended Certificate in Applied Science (AAQ)

Example of a grading table and how a qualification grade is awarded.

Unit number	GLH	Type (Int/Ext)	Grade	Unit points
1	60	Ext	Merit	10
2	60	Ext	Near Pass	4
3	60	Ext	Distinction	16
4	90	Int	Distinction	24
5	90	Int	Merit	15
TOTAL	**360**		**Merit**	**69**

Appendix 1 Glossary of terms used for internally-assessed units

Term	Definition
Adequate	Student work is satisfactory or acceptable in quality and quantity.
Analyse	Students break the issue/situation down into the key elements and show their understanding of the issues/situation applied to the scenario/context. Responses would be significantly beyond generic.
Apply/use/employ	Students implement a method, technique, process or approach in an activity.
Assess	Students give careful consideration to all the factors or events that apply, identify which are the most important or relevant and make a judgement on the importance of the factors.
Carry out	Students demonstrate skills through practical activities, in line with certain requirements.
Clearly	The qualities required are well demonstrated, unambiguous and beyond a basic level.
Coherent	Student intentions are clear, logically structured and can be interpreted by others.
Compare	Students show knowledge and understanding by identifying the main factors relating to two or more items/situations or aspects of a subject that is extended with the required explanations, e.g, similarities /differences, advantages/disadvantages, impacts.
Comprehensive	Used to describe either scope or depth, e.g. • Student work is well developed and thorough covering all aspects/information in terms of both depth and breadth Or: • Students demonstrate in-depth and accurate understanding of the aspects being assessed.
Confident	Student work demonstrates well-developed and secure application of skills or processes that are significantly beyond a basic level.
Consistent	Students demonstrate reliable and constant practice that maintains a set standard.
Create/produce	Students generate an idea/outcome to specific criteria.
Effective	Students demonstrate skills or provide outcomes that are well developed with a range of proficient qualities and that achieves objectives
Describe	Students provide an account of something, or highlight a number of key features of a given topic or process that shows a level of understanding.
Detailed	Students cover most if not all of the expected requirements and demonstrate a high level of understanding.

Term	Definition
Demonstrate	Students carry out and apply knowledge, understanding and/or skills in a practical situation.
Develop	Students apply a process of improving/progressing skills, concepts or work in order to produce outcomes.
Discuss	An issue, situation, process will be presented and the student will need to break the issue/situation/process down into the key elements, show their understanding of the issues/situation/process applied to the scenario/context (so generic answers are not acceptable), and show interrelationship in their answers.
Evaluate	Students consider various aspects of a subject's qualities in relation to its context such as: strengths or weaknesses, advantages or disadvantages, pros or cons. They will come to a judgement supported by evidence which will often be in the form of a conclusion.
Examine	Students demonstrate an ability to thoroughly inspect something in order to determine its qualities beyond a basic exploration.
Explain	Students can give an insight into the topic showing some level of understanding by providing reasons or examples.
Explore	Students undertake practical research or investigation to develop their skills or understanding of the topic/activity.
Implement	Students take actions or measures to put something into effect.
Investigate	Students perform a systematic inquiry into a topic using research skills, usually to demonstrate their understanding of a topic.
Justify	Students give relevant and logical reasons or evidence to support their actions or opinions.
Partial/some	To an extent, but not completely. Students do not include all of the requirements.
Perform	Students demonstrate a range of skills required to complete a given activity.
Prepare	Students organise a task/equipment/individuals/activities in advance of carrying it out.
Refine/optimise	Students make considered improvements to outcomes.
Review	Students consider evidence in order to make judgements about the qualities.
Realistic/feasible	Students demonstrate insight into the logistics and manageability of proposals/plans/objectives/ideas and show consideration of the potential to achieve the outcomes.
Understand	Students demonstrate insight or ability to interpret a subject.
Undertake	Students demonstrate skills through practical activities, often referring to given processes or techniques.

***** These verbs are normally qualified by definitions of the qualities required through the evidence.

Appendix 2 Transferable Skills framework

Code = transferable skill initials-skill cluster initials

Managing yourself

Code	Skill cluster	Performance Descriptor
MY-TPR	Taking personal responsibility	• Demonstrates understanding of their role and responsibilities and the expected standards of behaviour. • Demonstrates compliance with codes of conduct and ways of working. • Makes use of available resources to complete tasks. • Manages their time to meet deadlines and the required standards. • Demonstrates accountability for their decisions or actions.
MY-PS&R	Personal strengths and resilience	• Identifies own personal strengths and demonstrates the ability to utilise/ these in relevant areas. • Demonstrates the ability to adapt own mindset and actions to changing situations or factors. • Uses challenges as learning opportunities.

Code	Skill cluster	Performance Descriptor
MY-COP	Career orientation planning	• Undertakes research to understand the types of roles in the sector in which they could work. • Reviews own career plans against personal strengths and identifies areas for development to support progression into selected careers. • Takes part in sector-related experiences to support career planning.
MY-PGS	Personal goal setting	• Sets SMART goals using relevant evidence and information. • Reviews progress against goals and identifies realistic areas for improvement. • Seeks feedback from others to improve own performance.

Effective learning

Code	Skill cluster	Performance Descriptor
EL-MOL	Managing own learning	• Maintains a focus on own learning objectives when completing a task. • Demonstrates the ability to work independently to complete tasks. • Reviews and applies learning from successful and unsuccessful outcomes to be effective in subsequent tasks.

Code	Skill cluster	Performance Descriptor
EL-CL	Continuous learning	• Engages with others to obtain feedback about own learning progress. • Responds positively to feedback on learning progress from others. • Monitors own learning and performance over the short and medium term.
EL-SRS	Secondary research skills	• Define the research topic or question • Uses valid and reliable sources to collate secondary data. • Interprets secondary data and draws valid conclusions. • Produces a reference list and cites sources appropriately.
EL-PRS	Primary research skills	• Define the research topic or question • Carries out primary data collection using appropriate and ethical research methodology. • Interprets primary data to draw valid conclusions

Interpersonal skills

Code	Skill cluster	Performance Descriptor
IS-WC	Written communication	• Produces clear formal written communication using appropriate language and tone to suit purpose. • .
IS-V&NC	Verbal and non-verbal communications	• Uses verbal communication skills effectively to suit audience and purpose. • Uses body language and non-verbal cues effectively • Uses active listening skills and checks understanding when interacting with others.
IS-T	Teamwork	• Engages positively with team members to understand shared goals and own roles and responsibilities. • Respectfully consider the views of team members and consistently shows courtesy and fairness. • Completes activities in line with agreed role and responsibilities. • Provide support to team members to achieve shared goals.
IS-C&SI	Cultural and social intelligence	• Demonstrates awareness of own cultural and social biases • Demonstrates diversity, tolerance and inclusivity values in their approach to working with others.

Solving problems

Code	Skill cluster	Performance Descriptor
SP-CT	Critical thinking	• Demonstrates understanding of the problem or issue to be addressed • Makes use of relevant information to build ideas and arguments • Assesses the importance, relevance and/or credibility of information or ideas • Analyses, interprets and evaluates information to present reasoned conclusions
SP-PS	Problem solving	• Presents a clear definition of the problem • Gathers relevant information to formulate proposed solutions • Selects relevant and significant information to formulate proposed solutions. • Identifies negative and positive implications of proposed solutions. • Presents and justifies selected solutions to problems.
SP-C&I	Creativity and innovation	• Identifies new and relevant ideas to help solve a problem. • Refines ideas into workable solutions based on test results and/or feedback.

Appendix 3 Digital Skills framework

Problem solving

Using digital tools to analyse and solve problems:

Performance descriptor	Unit mapping
Use digital tools and techniques for research, collaboration and resolution of problems.	Unit 3, A3 Uses of electromagnetic waves in communication Unit 3, B1 Measurement and representation of motion Unit 3, C1 Use of electrical components Unit 4, C3 Transfer of energy from a renewable resource Unit 5, C1 Experimental procedures and techniques
Have up-to-date knowledge of ways that technology is used within a sector.	Unit 4, C3 Transfer of energy using a renewable source Unit 4, D1 Personal responsibility
Present ideas and finding using digital tools.	Unit 5, C3 Data presentation Unit 5, D1 Scientific report for the investigative project Unit 6, C3 Presenting scientific information
Use digital tools to manipulate data.	Unit 5, C2 Collect, collate and analyse data

Digital collaboration and communication

Using digital tools to communicate and share information with stakeholders:

Performance descriptor	Unit mapping
Understand and use digital collaboration and communication platforms.	Unit 6, C1 Reporting of scientific information
Use collaboration tools to meet with, share and collaborate with customers and colleagues.	Unit 6, C1 Reporting of scientific information

Transacting digitally

Using digital tools to set up accounts and pay for goods/services:

Performance descriptor	Unit mapping
Use online systems to access and update digital records.	Unit 5, C3 Data presentation Unit 6, C1 Reporting of scientific information
Set-up accounts to complete transactions.	

Digital security

Identify threats and keep digital tools safe:

Performance descriptor	Unit mapping
Understand the types of malware.	
Understand the threats involved in carrying out online activities.	Unit 6 C1 Reporting of scientific information Unit 6, C2 Scientific information
Protect personal and organisation information and data.	Unit 6, C2 Scientific information
Keeping systems secure.	Unit 6, C2 Scientific information

Handling data safely and securely

Follow correct procedures when handling personal and organisational data:

Performance descriptor	Unit mapping
Manage passwords and keep them secure.	
Identify website and services that are secure and insecure.	Unit 6, C2 Scientific information
Understand the digital policy for a sector.	Unit 4, D1 Personal responsibility
Understand the impact of online data.	Unit 6, C1 Reporting of scientific information
Understand copyright and intellectual property.	Unit 6, C2 Scientific information

Appendix 4 Sustainability framework

Sustainable development goal	Unit mapping
SDG 1: No poverty	
SDG 2: Zero hunger	
SDG 3: Good health and wellbeing	
SDG 4: Quality education	
SDG 5: Gender equality	
SDG 6: Clean water and sanitation	
SDG 7: Affordable and clean energy	Unit 2, D1 Green chemistry Unit 2 E1 Reactions of commercial importance Unit 2 E1 Solutions to environmental problems caused by organic compounds. Unit 4 C3 Transfers of energy using a renewable source Unit 6, A1 Scientific issues clean energy
SDG 8: Decent work and economic growth	
SDG 9: Industry, innovation and infrastructure	
SDG 10: Reduced inequalities	
SDG 11: Sustainable cities and communities	
SDG 12: Responsible consumption and production	Unit 2 D1 Yield and Equilibrium Unit 2 D1 Green Chemistry Unit 2 E1 Reactions of commercial importance Unit 3 C3 Electrical energy usage

Sustainable development goal	Unit mapping
	Unit 4 C3 Transfers of energy using a renewable source Unit 6A1 Food security Unit 6 A1 Clean energy
SDG 13: Climate action	Unit 6, A1 Climate change
SDG 14: Life below water	
SDG15: Life on land	Unit 4 B2 Plant growth Unit 6, A1 Food security
SDG 16: Peace, justice and strong institutions	
SDG 17: Partnerships for the goals	

Appendix 5 Formulae Sheet

Summary formulae sheet for Unit 3 Principles and Applications of Physics:

Wave speed	$v = f\lambda$
Speed of a transverse wave on a spring	$v = \sqrt{\frac{T}{\mu}}$
Refractive index	$n = \frac{c}{v} = \frac{\sin i}{\sin r}$
Critical angle	$\sin C = \frac{1}{n}$
Inverse square law in relation to the intensity of the wave	$I = \frac{k}{r^2}$
Distance travelled = average speed x time	
Acceleration = change in speed ÷ time	$a = \frac{(v - u)}{t}$
Force = mass x acceleration	$F = m \times a$
Weight = mass x gravitational field strength	$W = m \times g$ $g = 9.81\ N/m^2$
Momentum = mass x velocity	$p = m \times v$
Force as rate of change of momentum	$F = \frac{(mv - mu)}{t}$
Force due to friction	$F = \mu N$

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Power = work done ÷ time taken

Power = energy transferred ÷ time taken

$$P = \frac{E}{t}$$

Potential difference = current x resistance

$$V = I \times R$$

Electrical power = current x potential difference

$$P = I \times V$$

Energy

$$E = V \times I \times t$$

Specific heat capacity

$$Q = mc\Delta T$$

Specific latent heat

$$Q = mL$$

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